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Eel and Elver Management Fund Plan

A Report to the Joint Standing Committee on Marine Resources

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Executive Summary

The Commissioner of the Department of Marine Resources (DMR) is required to present a plan to the Joint Standing Committee on Marine Resources for expenditures from the dedicated Eel and Elver Management Fund by May 1 of each year for the next fiscal year, beginning in calendar year 1997. In order to develop the plan, the Department of Marine Resources formed a 12-member Eel and Elver Management Fund Committee in 1996, representing elver, yellow eel, and silver eel fisheries; hydro-electric interests; law enforcement; academia; and resource managers from DMR and the Department of Inland Fisheries and Wildlife (DIFW). The Committee met three times between 1996 and 1997 to identify and prioritize research, monitoring and enforcement needs.

This document summarizes the research, management and enforcement undertaken on eels and elvers in 2001, lists proposed work for 2002, and presents a plan for expenditures from the fund for fiscal year 2003. The proposed expenditures will fund research, monitoring, and enforcement needs that were identified by the Committee or that are required by the Atlantic States Marine Fisheries Commission.

The laws and regulations governing the elver fishery did not change in 2001, except the lottery for elver licenses was open to the general public. The fishery began to decline in 1999 when the market for elvers collapsed, and this trend continued in 2001. Only 459 licenses were sold in 2001, 206 fewer than the number sold the previous year. Harvesters paid gear fees for 521 fyke nets and 251 dip nets. As in the previous two years, few of the licensed elver fyke nets were set during 2001, because of low prices paid by dealers. To date, dealers reporting purchasing 3131 pounds of elvers in 2001.

The DMR initiated a young-of-year glass eel recruitment study that is required by the Atlantic States Marine Fisheries Commission. Approximately 52, 640 glass eels and 1,429 small pigmented eels used elver passages to enter West Harbor Pond (Boothbay Harbor) between May 2 and June 14. The timing of the migration was unrelated to six measured environmental variables. As the season progressed eel pigmentation increased, but neither length nor weight varied consistently.

Upstream passage was monitored at two sites and the location for passage was investigated at an additional five sites in the Kennebec River watershed. Approximately 224,373 eels were passed at Ft. Halifax and 231,859 at Benton Falls on the Sebasticook River. Locations for passages were identified at the remaining five sites, although two sites need to be revisited in 2002.

A telemetry study of the behavior of downstream migrating silver eels at dams was conducted for the second year at the Benton Falls and Ft. Halifax projects. Of the 5 eels fitted with radio tags and released above Benton Falls, three did not pass, and two passed through the turbine and apparently were killed.

In 2002, DMR personnel will continue to 1) obtain harvest, effort, and location data for all eel fisheries, 2) assess young-of-year recruitment survey, 3) install and monitor upstream passages and obtain recruitment data, 4) study downstream passage measures, 5) and comment on hydropower relicensings.

Eel and Elver Management Fund Committee

The Department of Marine Resources formed the Eel and Elver Management Fund Committee in 1996 to develop a multi-year plan for expenditures from the fund. The 12 members of the committee (Table 1) represent elver, yellow eel, and silver eel fisheries, hydroelectric interests, law enforcement, academia, and resource managers from DMR and DIFW. The Committee met three times between 1996 and 1997, and developed a comprehensive list of 25 research, monitoring, and enforcement needs. Many of the reseach projects have been completed (see brief descriptions below), and have been removed from the list. Table 2 contains the list of ongoing and uninitiated research and monitoring projects and enforcement needs. Since 1998, the members of the Committee have met annually to review activities from the previous fiscal year and to consider those proposed for current fiscal year.

Beginning in 1996, the Department of Marine Resources contracted with the University of Maine to conduct seven research projects. These were designed to 1) characterize the population structure of eels (size, sex ratio, age, growth) in four rivers varying in fishing pressure for elvers, 2) model the impact of dams on reproductive potential, 3) determine the trophic role of eels in freshwater, 4) estimate the efficiency of the weir fishery, 5) determine the age and growth of elvers in estuaries, 6) estimate the impact of the inland pot fishery for yellow eels, and 7) determine the growth rates and movements of eels in inland waters. Final reports and have completed for all but the last project, which is expected to be completed by the end of 2002. The results of several projects have been published in peer reviewed journals.

The Department of Marine Resources completed a study of the efficiency of the elver fishery, and is engaged in several long term-monitoring projects (glass eel recruitment, elver recruitment, upstream and downstream passage design and efficiency). In addition, the US Fish and Wildlife Service Gulf of Maine Project has completed GIS data layers of Maine waters utilized by several species of migratory fishes.

DMR research, monitoring, and enforcement activity in 2001

Elver fishery

The laws and regulations governing the elver fishery did not change in 2001. The fishery currently is controlled by legislation, passed in 1999, which instituted a limited entry system for the elver fishery, reduced the amount of gear a harvester could use, and decreased the length of the season. Participation in the fishery was limited to 827 people, initially those who held elver licenses and gear tags in each of the three years of 1996, 1997, and 1998. The amount of gear allowed per individual in 1999 was equal to the average amount of gear used by that individual in 1996, 1997, and 1998 with a maximum of two units. The elver fishing season was reduced approximately three weeks from 3/15-6/15 to 3/22-5/31. Additional legislation was passed in 2000 that authorized the Commissioner of DMR to establish a lottery system under which a person who did not hold an elver license in the previous year could become eligible to obtain a license, with the stipulation that the total number of elver licenses issued not exceed 827, and that a person obtaining a license through the lottery is restricted to a single piece of gear. In 2000, only people with a two-year history in the elver fishery were eligible to participate in the lottery, but thereafter anyone not holding an elver license in the previous year is eligible to participate.

The fishery began to decline in 1999 when the market for elvers collapsed (elvers primarily were shipped to Asia for aquaculture in ponds), and this trend continued in 2001. Fewer licenses have been sold each year since 1999 (Table 3; Table 4), and the greatest decrease occurred in 2001. Only 459 licenses were sold, 206 fewer than in 2000. Harvesters paid gear fees for 521 fyke nets and 251 dip nets. As in the previous two years, few of the licensed elver fyke nets were set, because of low prices paid by dealers. To date, elver dealers reported purchasing 3131 pounds of elvers at an average price of $30.00/pound. These were primarily caputred by fyke net. Current licensing information indicates that the fishery may be stabilizing. A total of 442 licenses were sold in 2002 (Table 3). This number includes 46 people who entered the lottery for 361 available licenses.

Young-of-year recruitment study

Introduction

The current status of the American eel stock is poorly understood because of limited and non-uniform information on abundance and age across the range of this species. The glass eel life stage provides a unique opportunity to assess the annual recruitment of each year's cohort, because glass eels result from the previous year's spawning activity, and are all the same age. In order to assess the annual variation in recruitment of American eel, the Atlantic States Marine Fisheries Commission's (ASMFC) *Interstate Fishery Management Plan for American Eel* requires that each member state conduct an annual survey of young-of-year (YOY) abundance.

Methods

The study was conducted at the outlet of West Harbor Pond, Boothbay Harbor (Fig. 1), because previous research on elvers had been conducted by DMR at this site. Fresh water from Knickerbocker Lakes and West Harbor Pond flows through a culvert under Route 27 directly into high salinity coastal water. A concrete dam at the end of the culvert prevents salt water from entering the pond except during spring flood tides greater than 11 ft. The mean tidal range at this site is 8.8 ft, and mean spring tidal range is 10.1 ft. Approximately 10 years ago, DMR installed a steeppass fishway at the dam, which was designed to pass adult alewives. However, when tidal height exceeds 11 ft, flow in the fishway reverses, and eels near the fishway entrance are carried "downstream" by the current into West Harbor Pond.

Three elver passages were installed at the concrete dam. Passage 1 was oriented parallel to the dam and passages 2 and 3 were perpendicular to the dam. Passage 1 was 12 ft long and 1 ft wide. Passages 2 and 3 were 10 ft long and 1 ft wide. Passage 1 and 2 were covered with Enkamat flatback 7220 and passage 3 with Akwadrain Soil Strip Drain (25 mm thickness). Each passage terminated in a reverse ramp and tube that emptied into an escape-proof collection box. A float switch at the bottom of the passages turned on attraction water, which was provided for 6-7 hours around high tide both day and night. One battery-powered 500-gallon per hour (GPH) pump supplied attraction water for passages 1 and 2, and a second similar pump supplied water for passage 3.

Passages were operational continually for 44 days (6 weeks) from May 2 to June 14. They were tended daily until May 12 when catches began to decline. Thereafter, they were tended every 1-3 days. The eels in each catch box were removed and taken to the DMR laboratory for processing. In the laboratory, the pigmented eels from each passage were counted, and glass eels from each passage were counted and/or weighed. All eels were released into West Harbor Pond approximately 100 ft above the passages to minimize the chance of recapture. Environmental data including air temperature, sea temperature, wind speed, precipitation and tidal heights were obtained from the DMR laboratory. Water temperature in the pond was monitored with an automated datalogger (HOBO).

Results

All three passages combined passed approximately 52,640 glass eels and 1,429 pigmented eels. More glass eels and pigmented eels used passage 2 than passage 1 or passage 3 (Table 5).

Approximately 99% of the glass eels recruited to inland waters in the first 10 days of the study (Fig. 2A). Recruitment of small pigmented eels was slightly more protracted, although a majority (70%) migrated to inland waters in the first 10 days of the study (Fig. 2B). The timing of migration to inland waters of glass eels and small pigmented eels was not highly correlated with any of the measured environmental variables (air temperature, sea surface temperature, pond temperature, tide stage, wind, rain). As the season progressed, pigmentation of individual eels increased on average, but neither total length nor the weight changed in a consistent manner (Table 6).

Discussion

Passages were installed rather late in the season compared to when elver nets had been set for the escapement study in previous years (May 2 versus March 22-24). Early spring rains raised the water level in the pond, resulting in several inches of spill over the dam. The spill delayed installation of the passages for approximately a month.

Elver upstream passage and recruitment monitoring

Introduction

Juvenile eels, known as glass eels or elvers depending on the degree of pigmentation, migrate into Maine's coastal waters in the spring. Some elvers remain in estuarine habitat, but many attempt to migrate to growth habitat in inland waters. Natural and man-made obstacles, such as hydropower dams, may prevent or delay the upstream migration. Two management plans, Maine's *American Eel (Anguilla rostrata) Species Management Plan* and the Atlantic States Marine Fisheries Commission's *American Eel Fisheries Management Plan*, call for 1) maintaining and enhancing eel abundance in all watersheds where they now occur, 2) restoring eels to waters where they had historical presence but may now be absent, and 3) providing adequate upstream passage and escapement into inland waters of elvers and eels. Migration of eels past dams and other obstacles must be improved to accomplish these goals.

During the Federal Energy Regulatory Commission (FERC) licensing process, the owner of a hydropower facility consults with resource agencies to determine appropriate fish passage measures. Once the license is issued, the operating conditions are fixed for the licensing period, typically 30-50 years. Since 1997, DMR has been requesting upstream and downstream passage for eels at appropriate hydropower projects during the licensing process.

The *Lower Kennebec River Comprehensive Hydropower Settlement Accord*, signed prior to the removal of Edwards dam in Augusta, requires that Kennebec Hydro-Developers Group (KHDG) dam owners and DMR undertake a three-year research project to study upstream and downstream passage measures for eels at the seven KHDG facilities. Three of the facilities are located on the Sebasticook River and four on the mainstem Kennebec River (Fig 3). The primary objective of this study was to determine where juvenile eels pass or attempt to pass upstream at each of the hydropower facilities. Secondary objectives were to determine the timing of the upstream migration, the magnitude of the migration, and the size distribution of the migrants.

Methods

In 2001, upstream passages were installed at the Ft. Halifax and Benton Falls projects, and nighttime visual observations were made at the remaining five KHDG projects. At Ft. Halifax, the full-length passage used in 2000 was reinstalled in 2001. At Benton Falls a portable passage initially was installed at the east end of the spillway, but was too small to accommodate the large number of eels attempting to migrate upstream. After several weeks it was replaced with a full-length passage that was cooperatively designed and constructed by Stacy Fitts, operator of the Benton Falls Project, and DMR personnel. The passage consisted of two 66-inch long entrance ramps angled at 47°, a level transition platform, a 36-ft long ramp angled at 39°, and a 12-ft long ramp angled at 4° that emptied into a holding pen. The entrance ramps and platform were constructed of ¼-inch marine plywood, but the rest of the passage was made of 1.5-ft wide aluminum cable tray with plywood screwed to the cross braces. Climbing substrate (Enkamat 7220 flatback) was stapled to the plywood. At each of the remaining five projects, DMR personnel conducted nighttime visual observations on foot or by canoe to determine where eels were passing or attempting to pass upstream (Table 7). The locations of concentrations of eels were noted, an estimate was made of the number of eels, and in most cases a sample was taken for total

length measurements. However, at Hydro-Kennebec a portable passage was used for several hours to obtain a sample of eels.

In general, the passages at Ft. Halifax and Benton Falls were operated five days per week, and were tended at least three days per week. If the number of eels captured at a project was less than 70, all eels were counted and total weight recorded. If catches exceeded 70, all eels were weighed and the number estimated from subsamples. Eels were released above each dam into the headpond after measurements were taken. Water temperature in the Ft. Halifax headpond at a depth of eight feet was recorded every six hours, and other environmental information was recorded when the passages were tended.

Results and Discussion

An estimated 224,373 migrating eels were passed at **Ft. Halifax** in 2001, nearly triple the number passed in 2000 (Table 8). Approximately 90% of the eels moved upstream within a 30-day period (Fig. 4A), similar to the pattern seen in 1999 and 2000. The size range of eels was similar to that of previous years (80-199 cm total length) with a median of 110-114 mm (Fig. 5).

Approximately 231,859 eels were passed at **Benton Falls,** more than six times the number passed in 2000 (Table 8). Approximately 86% of the eels migrated within a 30-day period (Fig. 4B); this percentage probably would have been higher if the full-length passage has been available at the beginning of the season. The size range of eels was similar to previous years (85-270 mm total length), with a median of 110-114 mm (Fig. 6).

The **Burnham** project was visited at night on two occasions. On June 21 approximately 16 eels were observed on the east side of the spillway, but many more were observed on the western side of the spillway, below the two easternmost set of stoplogs (Fig. 7). On July 5, many thousand were observed in this same location. Approximately 306 eels were captured by dipnet, and 60 were measured. Eels ranged from 101-160 mm total length with a median of 125-129 mm (Fig. 8A). DMR recommends installation of an eel passage at this location.

Nighttime observations were made at the **Lockwood** Project on July 26, 2001. Most of the spillway is covered with a mat of wiry live vegetation, and is wet due to varying degrees of flow over or under the flashboards. Near the abandoned fishway, a rocky outcrop with interconnecting pools rises from the main channel to just below the flashboards. A small numbers of eels were observed at various locations on either side of the rocky outcrop (Fig. 9), but none were seen on the east side of the spillway. Eels ranged from 85-232 mm total length with a mode of 115-119 mm (Fig. 8B). Eels are probably able to climb the dam at a number of places, but may be concentrated near the abandoned fishway. Passage for eels is probably not needed at this project, but DMR intends to make additional observations at Lockwood to confirm this initial recommendation.

Two nighttime visits were made to the west side of the spillway at the **Hydro-Kennebec** Project. On July 5, eels were not seen prior to sunset. At 8:45 PM, eels began to move in the shallow water along the shoreline, and 500–1000 were seen climbing the rock ledge along the dam base and moving westward toward the corner (Fig. 10). Eels were observed hiding under rocks at this same location during the day on August 8. No eels were observed attempting to climb the concrete dam at any other point along this side of the dam. On August 13 a portable passage was installed, and attraction water was started during the day on August 14. Approximately 265 eels were caught in 8 hours, but thousands were congregated in the area. Eels ranged from 91-167 mm total length with a median of 125-129 mm (Fig. 8C). DMR recommends installation of an eel passage at this location.

The **Shawmut** Project was visited twice. On July 12, 12-20 eels were observed swimming in the upper pool below the easternmost side of the spillway (Fig. 11). A few eels were observed about three feet up the dam face in the corner, although there was about an inch of spill over the flashboards. No elvers were observed in the lower pools or actively climbing the lower rocks and rivulets or at any other location. On July 26, many eels were seen resting and hiding in a smaller pool below, but adjacent to the large pool where eels were observed on the previous date. No eels were observed in any other pools or were

seen climbing at any other location. Approximately 50 eels dipnetted from the pool ranged from 101-291 mm total length, but most were greater than 170 mm (Fig. 8D). DMR recommends installation of an eel passage at this location.

Nighttime observations were made at the south channel dam of the **Weston** Project on July 18, 2001. No eels were observed in the underpass and culvert system under Dexter Shoe. Although this stream system is dark, has ample water flow, and an abundance of cover, no eels were seen resting, moving or climbing in this complex. Eels were observed actively climbing the southernmost section of the southern channel dam after 6:00 PM, and 10–12 eels were climbing ledge and rock at the base of the southern corner of the dam and the base concrete of the two southernmost gate chambers (Fig. 12). No eels were observed at the bases of the dam gates, on the walls within the gate chambers, or in any of the pools, although turbulent water made it difficult to see into the pools. Six eels collected by dipnet from the rocks ranged from 129-144 mm total length. Only a few eels were seen on the south channel dam during a second visit on August 29, and no eels were seen on the north channel dam, which was inspected from above with lights. DMR recommends installation of an eel passage at the eastern side of the south channel dam.

Downstream passage of silver eels

Introduction

Adult eels, known as silver eels, migrate in late summer and fall from Maine's inland waters to the sea to spawn. Two management plans, Maine's *American Eel (Anguilla rostrata) Species Management Plan* and the Atlantic States Marine Fisheries Commission's *American Eel Fisheries Management Plan*, call for 1) maintaining and enhancing eel abundance in all watersheds where they now occur, 2) restoring eels to waters where they had historical presence but may now be absent, and 3) providing adequate escapement to the ocean of prespawning adult eels. Migration of eels past dams and other obstacles must be improved to accomplish these goals.

During the Federal Energy Regulatory Commission (FERC) licensing process, the owner of a hydropower facility consults with resource agencies to determine appropriate fish passage measures. Once the license is issued, the operating conditions are fixed for the licensing period, typically 30-50 years. Since 1997, DMR has been requesting upstream and downstream passage for eels at appropriate hydropower projects during the licensing process.

The *Lower Kennebec River Comprehensive Hydropower Settlement Accord*, signed prior to the removal of Edwards dam in Augusta, requires that Kennebec Hydro-Developers Group (KHDG) dam owners and DMR undertake a three-year research project to study downstream passage measures for eels at the KHDG facilities, three of which are located on the Sebasticook River and four on the mainstem Kennebec River. The primary objectives of this study were to determine the seasonal and diel timing of the downstream migration of adult eels, the behavior of migrating adult eels at hydropower facilities, and the efficiency of existing downstream passage measures for adult eels.

Methods

The study was conducted from 10/10-12/11 at the Benton Falls Project and the Ft. Halifax Project on the Sebasticook River (Fig. 3). The Benton Falls project is located approximately 5.2 miles above the Ft. Halifax Project, and the latter is located 1400 feet above the confluence of the Sebasticook River and the Kennebec River. Eels used for study were obtained from a commercial eel harvester whose weir is located near the mouth of Twenty-Five Mile Stream, which enters the Sebasticook River approximately 14 miles above the Benton Falls Project.

Radio telemetry equipment was installed and calibrated at the two sites between 8/20 and 10/10. Three automated scanning receivers (Model SRX-400, Lotek Engineering, Newmarket, Ontario, Ca) were deployed at the Benton Falls Project and six (same model, provided by FPLE) were deployed at the Ft.

Halifax Project to record the passage of radio-tagged eels. Two types of antennas (6-element Yagi and "dropper") were used to monitor different areas at each project. Yagi antennas were deployed above the water surface, while dropper antennas (coaxial cable with distal 18" of insulation removed) were inserted inside braided nylon line or 1" plastic pipe and deployed underwater. Each antenna was connected to a scanning receiver unless otherwise stated. In general, antennas were deployed and gain settings were adjusted so antennas would detect signals in a particular area, with little overlap between antennas.

Deployment of antennas at Benton Falls in 2001 was the same as in 2000. One 6-element Yagi was used to monitor the turbine intake area and a second 6-element Yagi was used to monitor the headpond immediately above the spillway and gates; these two antennas were attached via a switcher to a single receiver. A third 6-element Yagi monitored the water immediately below the spillway and gates (spill and main channel). One dropper antenna was deployed in the drop-box of the downstream bypass and another dropper antenna was installed in the draft tube of the smaller turbine. The larger turbine was not operated due to low water, therefore, an antenna was not deployed in the tailrace.

Minor changes were made in the deployment of antennas at Ft. Halifax on the basis of the 2000 results. One 6-element Yagi monitored an area from several hundred yards above the dam to the east side of the powerhouse. A second 6-element Yagi scanned the water immediately above and below the Obermeyer gate. One dropper was placed in each of the two turbine intakes and in each of the two draft tubes.

Only downstream migrating female eels were used in this study because their large size (≥400 mm) makes them particularly susceptible to turbine injury or mortality. Eels to be radio-tagged were removed from the weir and placed individually into a cooler containing a solution of Eugenol for 5-10 minutes to anaesthetize them. A small ventral incision was made approximately 1 ¾ " anterior to the vent and a 16-gauge needle was inserted about ½" posterior to the incision. The radio tag was inserted into the incision and the tag antenna trailed from the body cavity through the small puncture left by the needle. The incision was sutured and treated with betadine. The coded radio tags (Model MCFT-3CM, Lotek Engineering, Newmarket, Ontario, Ca) were 11 mm in diameter, 36 mm long, weighed 5.9 g in air and 2.6 g in water, and had a typical operation life of 100 days. The tags emitted a coded signal every 5 sec at 149.460 MHz.

Five eels were tagged at the weir site (Table 9) between 12:45-3:00 PM on 10/10, transported in aerated water, and released at 4:30 PM upsteam of the Route 139 bridge in Benton. Additional eels were not tagged because the downstream migration of eels on Twenty-Five Mile Stream ended in early October, presumably due to extremely low flows.

Data from the scanning receivers usually were downloaded 2-3 times during the week and notes were made on the operating conditions at each of the two projects. Water temperature was measured and recorded six times a day at a depth of 8 ft in the headpond at the Ft. Halifax Project.

Results

Water flow in the Sebasticook River was low during the study as a result of few rain events through the late summer and fall. Instantaneous streamflow rarely exceeded the mean daily streamflow (based on 68 years of record for USGS gauge 01049000). Because of low flow, neither turbine at Ft. Halifax nor the large turbine at Benton Falls were operated during the study period.

Average daily water temperature in the river at Ft. Halifax ranged from 14.5-3.7 °C during the study period. One rainfall event occurred on 10/15, but did not noticeably increase flow.

Of the five eels released above Benton Falls, three did not pass the project (Table 10). One eel (8) was never detected, one eel (1) was detected a single time in the headpond 7.56 hours after release, and one eel (9) was detected in the headpond 2.9 hours after release and sporadically for the next 67.28 hours. DMR personnel attempted to locate these eels on 10/26 by boat using a datalogger/receiver and directional loop antenna. The area from the safety floats to about one-half mile above the bridge was

searched. One signal was detected in the headpond on the east side of the spillway, but recover was not attempted.

The two remaining eels (7, 10) were detected at the Benton Falls dam 0.59-170.28 hours after being released (Table 10). The time from arrival to passage ranged from 5.53-29.0 hours. Both eels (40%) passed through the small turbine. DMR personnel attempted to recover these eels on five occasions (10/22, 10/26, 10/31, 11/2, and 12/7). An underwater camera revealed a deep hole below the tailrace that contained many portions of eel carcasses in various states of decay. It was apparent these eels had been killed by turbine blades. Although radio signals originated from this hole, the tags could not be recovered.

Migrating eels were more active during darkness in 2001 than in the previous year (Table 11; Fig. 13). No contacts were made between 4 AM and 2 PM. The two eels that passed through the turbines at Benton Falls did so at 6 PM and 10 PM.

Discussion and recommendations

Three of five eels (60%) did not pass Benton Falls, and two (40%) passed through the turbine. We have strong evidence (videotape) that these two eels were killed. As in 2000, passage at Ft. Halifax could not be evaluated because turbines were not running during the study. Based on two years of data, the surface bypass at Benton Falls does not pass eels efficiently. DMR will continue to evaluate downstream passage at KHDG projects, but will work at mainstem projects in 2002.

Elver enforcement

Marine patrol officers in each division worked fewer hours on elver enforcement in 2001 than any previous year, reflecting the low fishing effort during the season (Table 12). Division I officers spent more time on elvers than Division II officers. The number of warnings in Division I and warnings and summonses in Division II were higher in 2001 than in the previous year (Table 13).

Coastal and inland eel fishery

Each year the Department of Marine Resources obtains harvest information from eel fishermen. Beginning in 2001, providing harvest information became mandatory as required by the Atlantic States Marine Fisheries Commission. A total of 36 licenses and permits were issued in 2001 for the coastal eel pot, inland eel pot, and inland weir fisheries (Table 14). Harvesters reported a total catch of 14,482 pounds of eels.

The estimated harvest of eels in Maine, from inland and coastal waters, has varied enormously from a high of 400,130 pounds in 1912 to a low of 8,764 pounds in 1984. The average annual harvest for the period from 1887-1997 is 96,167 pounds. Catches exceeded the long-term average from 1900-1933 and from 1975-1980 (Fig. 14). However, the peak in catch in the late 1970s was not as pronounced nor as long-lived as the peak in early 1900s.

Relicensing of Hydropower Projects

The Department currently is consulting on 20 hydropower projects in Maine that are being relicensed or are conducting fish passage studies. The location and status of these projects is summarized in Table 15.

Table 1. Members of the Eel and Elver Management Fund Committee.

Name / phone number	Affiliation	Address
Patricia Bryant 563-5611 (began attending in 1999)	Elver Association	74 Duck Puddle Road Nobleboro, ME 04555
Randal Bushey 546-2804	Elver fisherman Elver dealer	PO Box 394 Millbridge, ME 04658
Gerald Crommett 732-3504	Silver/yellow eel fisherman Eel dealer	Maine Live Fish, Inc. PO Box 48 Passadumkeag, ME 04475
Scott Hall 827-5364	Hydro-power	PPL Maine, LLC PO Box 276 Milford, ME 04461
Bill Jackson 596-0331	Elver dealer	North Atlantic Products PO Box 146 Rockland, ME 04841
Peter Bourque 287-5261	Resource manager-DIFW	State Street Augusta, ME 04401
Bob Richter 771-3536	Hydro-power	FPL Energy, Inc 100 Middle St. Portland, ME 04101
James McCleave 581-4392	Researcher	School of Marine Sciences 5751 Libby Hall University of Maine Orono, ME 04469
Charles Messer 723-4550	Silver eel fisherman	2 Katahdin Ave. Ext. Millinocket, ME 04462
Lt. Dan Morris 633-9596	Law enforcement-DMR	PO Box 8 West Boothbay Harbor, ME 04575
Tom Squiers 624-6348	Resource manager-DMR	#21 State House Station Augusta, ME 04333
Glenn Steeves 655-3303	Yellow eel fisherman Elver fisherman	109 Valley Rd Raymond, ME 04071
Gail Wippelhauser 624-6349	Resource manager-DMR	#21 State House Station Augusta, ME 04333

Table 2. Status of research, monitoring, and enforcement needs. These were identified by the Eel and Elver Management Fund Committee in 1996-1997. The number preceding each item does not indicate priority.

Research, monitoring, and enforcement needs	**Status**
01 Obtain harvest, effort, fishing location for all eel fisheries	DMR ongoing
02 Conduct annual young-of-year (YOY) survey	DMR ongoing
03 Comment on hydropower licenses to improve eel passage	DMR ongoing
04 Maintain enforcement in elver fishery	DMR ongoing
05 Design and test upstream passage, obtain recruitment data	DMR ongoing
06 Determine downstream mortality/behavior of adult eels at dams	DMR ongoing
07 Determine extent, size, and timing of the fall run of adult eels and environmental correlates of migration	DMR ongoing
08 Work with eel/elver industry to develop legislation/regulations	DMR ongoing
09 Assess bycatch of elver fishery	DMR ongoing
10 Collect information of eel aquaculture	DMR ongoing
11 Determine effect of pollutants on eels (chlorine, PCBs, dioxins etc)	DMR assisting DEP
12 Determine behavior of elvers at dams (time before ascending)	
13 Determine effectiveness of diversion techniques for eels at dams	
14 Determine effect of eel stocking in areas where eels have declined	
15 Determine why are eels scarce/absent from some areas	
16 Determine why some areas have big elver runs but no big eels	

Table 3. Number of licenses by gear type for the elver fishery, 1996-2002. A maximum of 1868 people legally fished for elvers in 1995 (prior to legislation requiring an elver fishing license). Nonresident licenses were not sold after 1999 (9 were sold in 1996, 15 in 1997, 21 in 1998 and 1 in 1999).

	Resident						
License type	1996	1997	1998	1999	2000	2001	2002
1 fyke	34	22	41	33	24	33	51
2 fykes	50	55	61	272	263	175	160
3 fykes	6	6	64				
4 fykes	5	6	8				
5 fykes	37	25	27				
1 fyke + dip	362	202	344	225	204	138	123
2 fykes + dip	318	223	307				
3 fykes + dip	61	40	237				
4 fykes + dip	20	23	51				
5 fykes + dip	198	127	271				
Dip net	1,107	655	882	213	174	113	108
Total	2,198	1,384	2,293	743	665	459	442

Table 4. Harvest and effort for the elver fishery, 1977-2002.

Year	Harvest (pounds)	Number of licenses	Number of fyke nets	Number of dip nets	Total number of nets
2002		442	494	231	725
2001	3131	459	521	251	772
2000	2,625	665	754	378	1,132
1999	3,587	744	804	438	1,242
1998	14,360	2,314	3,806	2,111	5,917
1997	7,360	1,399	1,844	1,283	3,127
1996	10,193	2,207	2,632	2,075	4,707
1995	16,599	$\leq$ 1,868			
1994	7,374				
1978	16,645				
1977	22,000				

Table 5. Summary of glass eels and pigmented eels recruiting to West Harbor Pond in 2001.

Gear	Number glass eels	Number pigmented eels	Total
Passage 1	18,321	388	18,709
Passage 2	34,303	867	35,170
Passage 3	16	174	190
Total	52,640	1,429	54,069

Table 6. Average changes in total length, weight, and pigmentation stage of glass eels, 2001.

Date	Average total length (mm)	Average weight (g)	Average pigment stage
5/14/01	59.45	0.121	
5/18/01	60.18	0.157	2.7
5/21/01	61.20	0.178	4.5
5/23/01	60.07	0.141	4.3
5/29/01	61.17	0.154	4.8
6/1/01	60.30	0.148	4.9
6/4/01	61.07	0.131	4.6
6/8/01	60.37	0.132	5.1
6/11/01	59.94	0.098	5.7
6/14/01	59.79	0.162	5.2

Table 7. Summary of visual observations at five projects. Observations were made at night unless otherwise noted.

Project	Observation 1	Observation 2	Observation 3
Burnham	6/21/01	7/5/01	
Lockwood	7/26/01		
Hydro-Kennebec	7/3/01 day	7/5/01	8/8/01 day
Shawmut	7/12/01	7/26/01	
Weston	7/3/01 day	7/18/01	7/29/01

Table 8. Summary of upstream eel migration at Ft. Halifax and Benton Falls projects, 1999-2001.

	2001		2000		1999	
Project	Operation dates	Number of eels	Operation dates	Number of eels	Operation dates	Number of eels
Ft. Halifax	5/26-8/24	224,373	6/21-7/28; 8/15-8/22	81,628	6/4-9/15	551,262
Benton Falls	6/6-8/24	231,859	6/29-7/28; 8/14-8/24	37,207	6/22-/16	14,335

Table 9. Summary of the tag and release date, size of tagged eels, and release location for the 2001 telemetry field season.

Date tagged and released	Tag number	Eel total length (mm)	Release location
10/10	1	840	Benton Falls headpond, Rt 139 bridge
10/10	7	858	Benton Falls headpond, Rt 139 bridge
10/10	8	939	Benton Falls headpond, Rt 139 bridge
10/10	9	778	Benton Falls headpond, Rt 139 bridge
10/10	10	832	Benton Falls headpond, Rt 139 bridge

Table 10. Time of release, arrival, and passage for radio-tagged silver eels at the Benton Falls Project during the 2001 field season.

	Release		Arrival at dam		Passage at dam		Release to	Arrival to	
Tag	Date	Time	Date	Time	Date	Time	arrival (hr)	passage (hr)	Route
1	10/10	1630	10/11	0003			7.56		didn't pass
7	10/10	1630	10/10	1705	10/11	2205	0.59	29.00	turbine
8	10/10	1630							no contact; didn't pass
9	10/10	1630	10/10	1924			2.90		didn't pass
10	10/10	1630	10/17	1847	10/18	0019	170.28	5.53	turbine

Table 11. Total number of contacts and nighttime contacts made with radio-tagged silver eels at the Benton Falls Project during the 2001 field season. IN = turbine intake; 6 UR = headpond above the gate and spillway; BY = bypass; 6 DR = channel below the gate and spillway; TR = tailrace.

	Number of contacts					Contacts during
Tag	IN	6 UR	BY	6 DR	TR	darkness
1	0	0	0	1	0	100%
7	44	22	1	9	7	99%
8	0	0	0	0	0	
9	12	6	0	0	0	72%
10	1	0	0	3	1	100%

Table 12. Summary of Marine Patrol activities, 1996-2001.

	Division I					Division II				
Category	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001
Eel Enforcement Hours Worked	3134	3516	1533.5	587	258	2354	2748.5	756.5	467	337
Overtime Hours Worked	844	766	336.5	29	1.5	539	540	104	0	0
Summons Issued	113	73	5	2	1	101	131	8	2	5
Verbal and Written Warnings Issued	93	145	23	5	12	95	119	10	5	14
Complaints Addressed	205	248	39	1	9	219	132	4	0	4

Table 13. Summary of elver fishery violations, 1996 –2001.

	Division I									
	Warnings					Summons				
Violation	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001
Closed Season, Harvesting	0	0	0	0	1	0	0	0	1	0
Closed Season, Locating Nets	0	0	0	0	0	0	0	1	0	0
Closed Season, Setting Nets and Traps	0	0	2	3	4	0	0	1	1	0
Closed Season, Nets of Certain Sizes	0	0	0	0	0	0	2	0	0	0
Closed Period, Harvesting	33	18	6	0	0	33	24	1	0	1
Closed Area, Fishing for Elvers	0	11	1	0	0	0	2	0	0	0
Closed Area, 150' of a Fishway	0	6	0	0	0	26	2	0	0	0
Closed Area, Fishing Middle Third	32	70	7	1	1	13	15	0	0	0
Closed Area, Use of Dip Net Inside Fyke Net	2	0	0	0	0	2	4	0	0	0
Closed Area, Alewife Trap	0	0	0	0	0	1	0	0	0	0
Method of Elver Fishing, Limits on Gear	0	21	3	0	5	0	2	0	0	0
Method of Elver Fishing, Fishing from a Boat	0	2	0	0	0	0	0	0	0	0
Method of Elver Fishing, Standing in Water	6	9	0	0	0	12	12	0	0	0
Molesting Lobster Gear	4	1	2	0	1	4	2	0	0	0
Elver Fishing License (Fishing without a License)	7	2	0	1	0	9	3	2	0	0
Elver Tags (Untagged Nets)	8	5	2	0	0	6	4	0	0	0
Theft	0	0	0	0	0	0	1	0	0	0
Miscellaneous	1	0	0	0	0	7	0	0	0	0
Totals	93	145	23	5	12	113	73	5	2	1

	Division II									
	Warnings					Summons				
	1997	1998	1999	2000	2001	1997	1998	1999	2000	2001
Closed Season, Harvesting	0	4	0	4	0	0	4	0	0	0
Closed Season, Locating Nets	0	4	1	0	0	0	1	0	2	0
Closed Season, Setting Nets and Traps	0	0	0	0	0	0	1	1	0	0
Closed Season, Nets of Certain Sizes	0	6	0	0	0	0	11	0	0	0
Closed Period, Harvesting	25	9	1	0	5	16	19	5	0	3
Closed Area, Fishing for Elvers	0	9	2	0	3	0	4	0	0	2
Closed Area, 150' of a Fishway	5	3	0	0	0	7	6	0	0	0
Closed Area, Fishing Middle Third	31	50	3	1	3	23	51	2	0	0
Closed Area, Use of Dip Net Inside Fyke Net	0	0	1	0	0	0	4	0	0	0
Closed Area, Alewife Trap	0	0	0	0	0	0	1	0	0	0
Method of Elver Fishing, Limits on Gear	0	8	0	0	0	0	8	0	0	0
Method of Elver Fishing, Fishing from a Boat	0	1	0	0	0	0	0	0	0	0
Method of Elver Fishing, Standing in Water	10	4	0	0	0	24	10	0	0	0
Molesting Lobster Gear	1	5	0	0	0	3	1	0	0	0
Elver Fishing License (Fishing without a License)	10	0	1	0	1	4	1	0	0	0
Elver Tags (Untagged Nets)	13	16	1	0	2	18	9	0	0	0
Theft	0	0	0	0	0	0	0	0	0	0
Miscellaneous	0	0	0	0	0	6	0	0	0	0
Totals	95	119	10	5	14	101	131	8	2	5

Table 14. Eel pot licenses issued by Department of Maine Resources (DMR) and eel pot and weir permits issued by Department of Inland Fisheries and Wildlife (DIFW).

Year	Number DMR licenses	Number DIFW permits	Total licenses and permits
2001	15	21	36
2000	25	27	52
1999	26	42	68
1998	41	79	120
1997	53	74	127
1996	48	71	119
1995	no data	124	124
1994	55	51	106
1993	39	60	99
1992	33	80	113
1991	32	56	88
1990	29	34	63
1989	19	25	44
1988	17	22	39
1987	14	16	30
1986	12	23	35
1985	28	23	51
1984	30	24	54

Table 15. Status of hydroelectric projects being relicensed in Maine. Dam number refers to relative position in the river (e.g. the dam at Veazie is the first dam on the Penobscot River encountered by a fish migrating from the ocean).

River system	Dam number	Project name	Location	Status
Penobscot	1	Veazie	Veazie	Consulting
	2	Great Works	Old Town	Consulting
	4	Howland	Howland	Consulting
	6	Medway	Medway	New license with eel measures
Kennebec	1	Lockwood	Waterville/Winslow	DMR studies in 2001
	2	Hydro-Kennebec	Hydro-Kennebec	DMR studies in 2001
	3	Shawmut	Fairfield	DMR studies in 2001
	4	Weston		DMR studies in 2001
	5	Abenaki	Madison	Consulting
	6	Anson	Madison	Consulting
Sebasticook	1	Ft Halifax	Winslow	DMR studies in 2001
	2	Benton Falls	Benton	DMR studies in 2001
	3	Burnham	Burnham	DMR studies in 2001
Presumpscot	3	Saccarappa	Westbrook	Consulting
	4	Mallison	Gorham/Windham	Consulting
	5	Little Falls	Gorham/Windham	Consulting
	6	Gambo	Gorham/Windham	Consulting
	7	Dundee	Gorham/Windham	Consulting
	9	Eel Weir	Standish/Windham	Consulting
Salmon Falls	1	South Berwick	South Berwick	Consulting

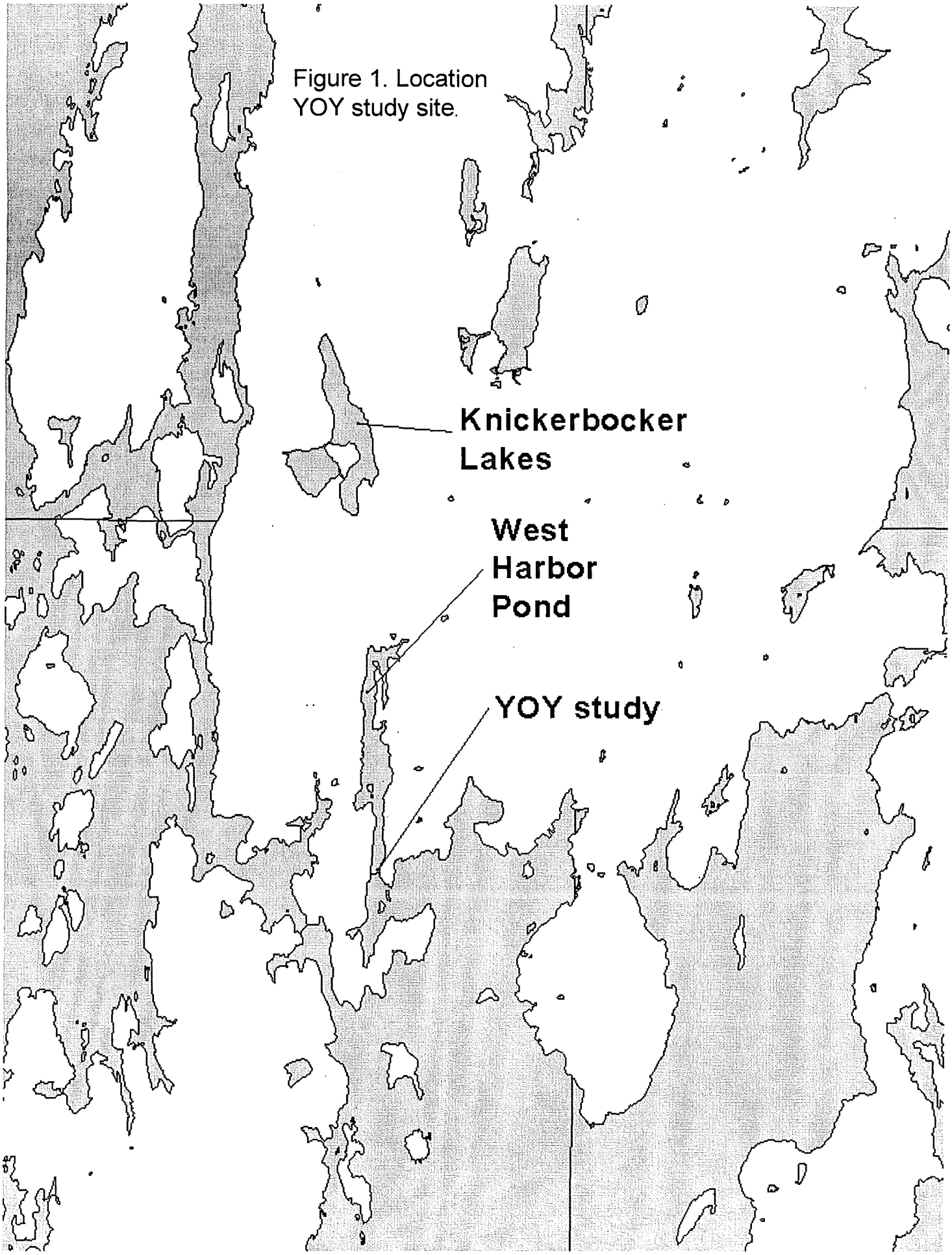
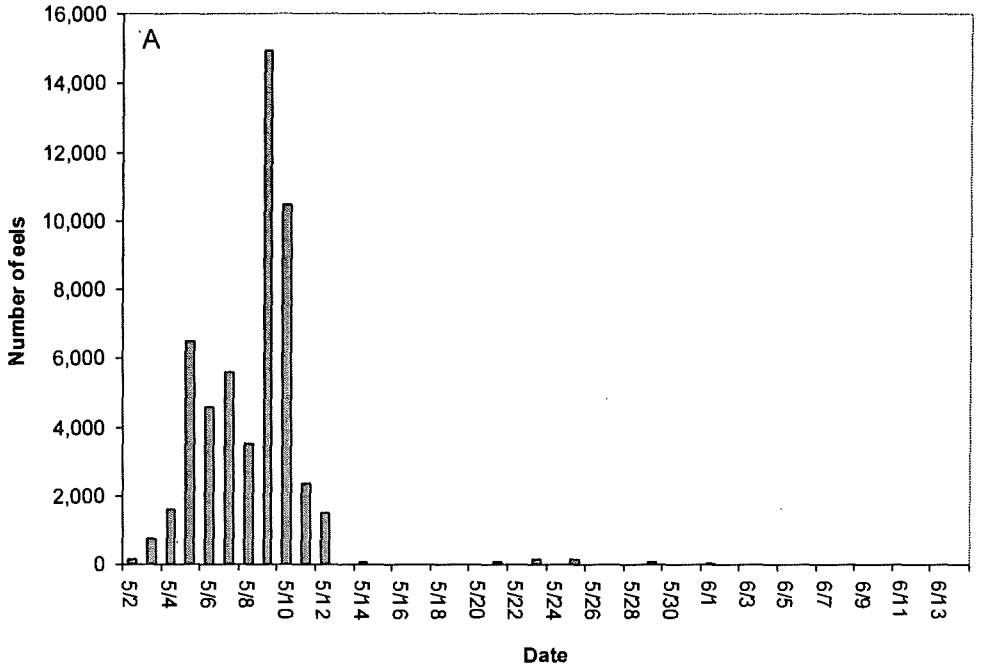


Figure 1. Location
YOY study site.

Figure 2. Daily recruitment of (A) glass eels and (B) pigmented eels at West Harbor Pond.



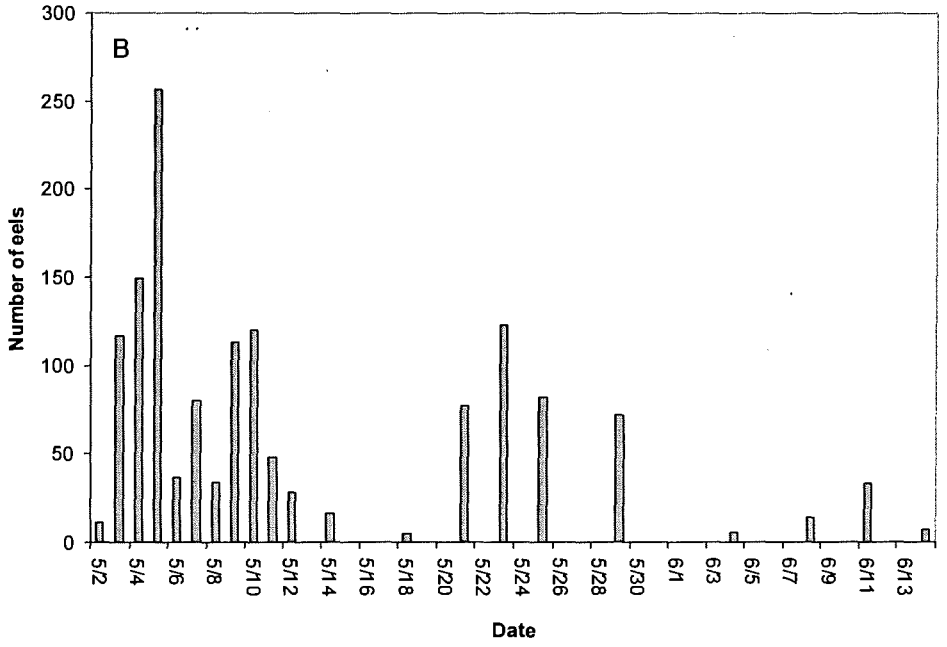


Figure 3. Location of dams on Kennebec River and Sebasticook River.

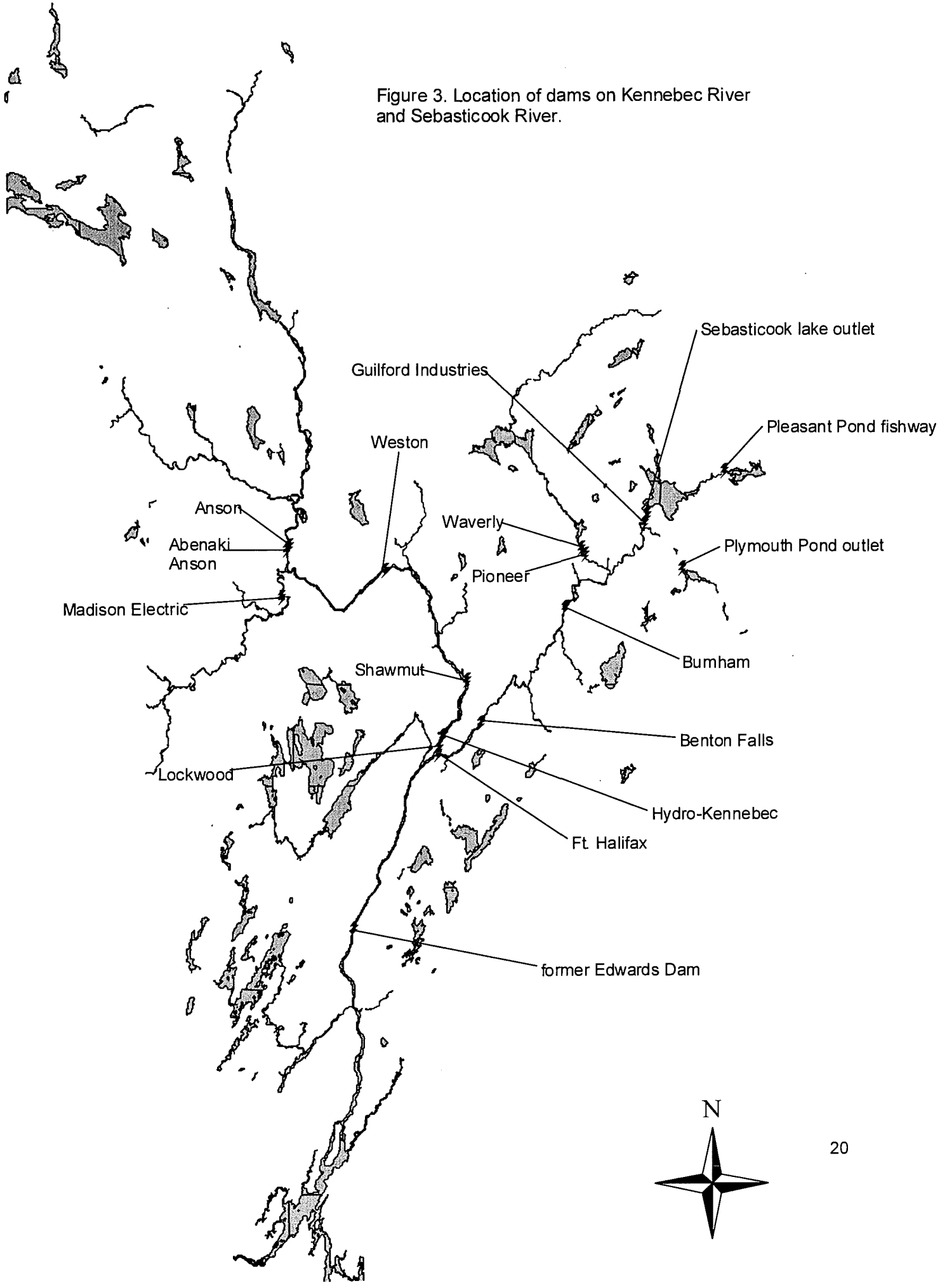
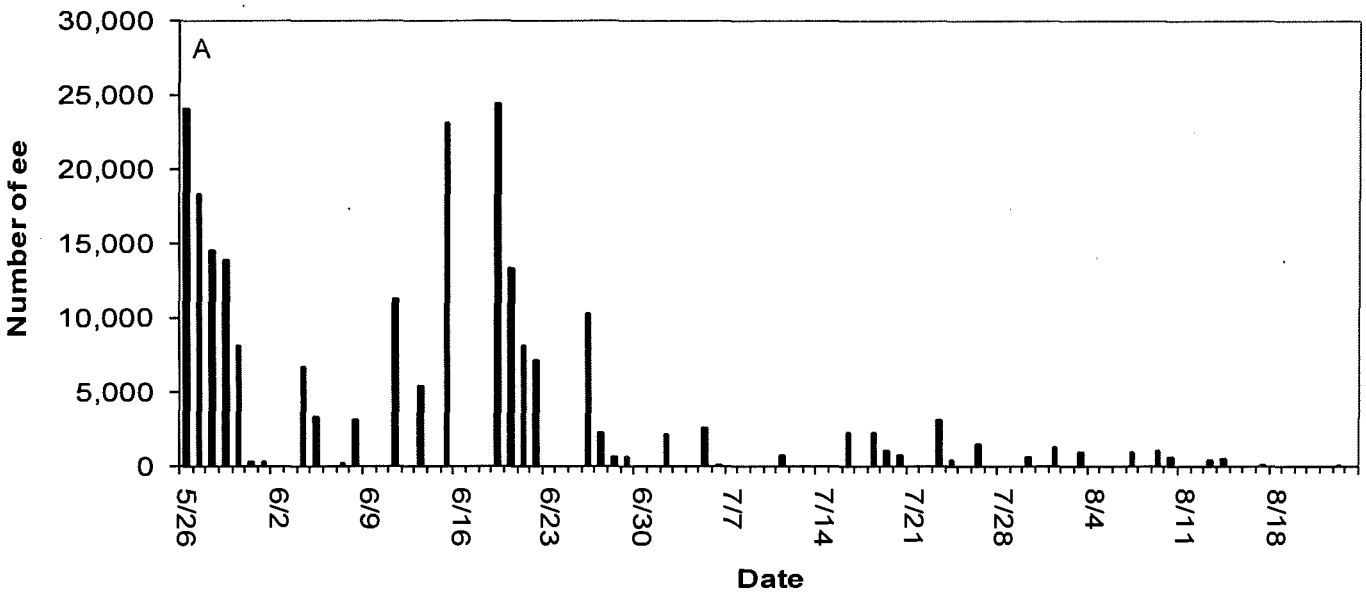


Figure 4. Eel passage at A) Ft. Halifax and B) Benton Falls in 2001.



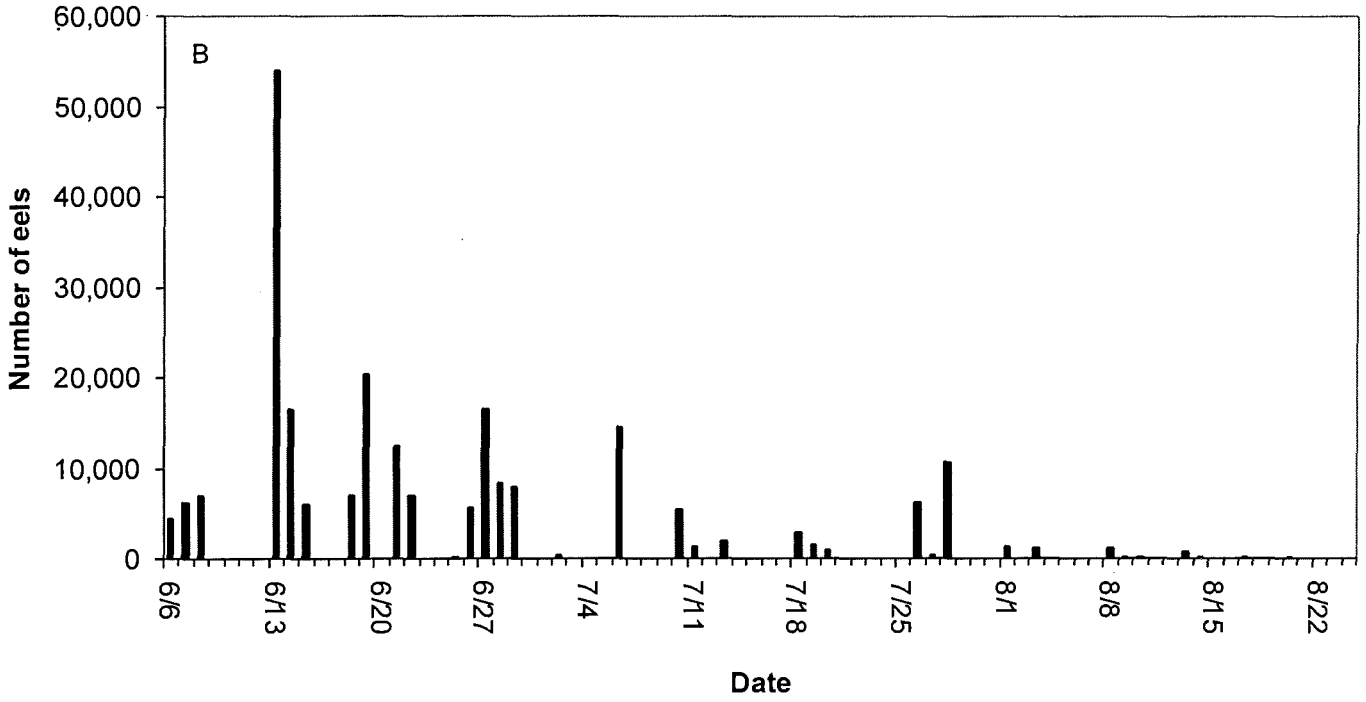
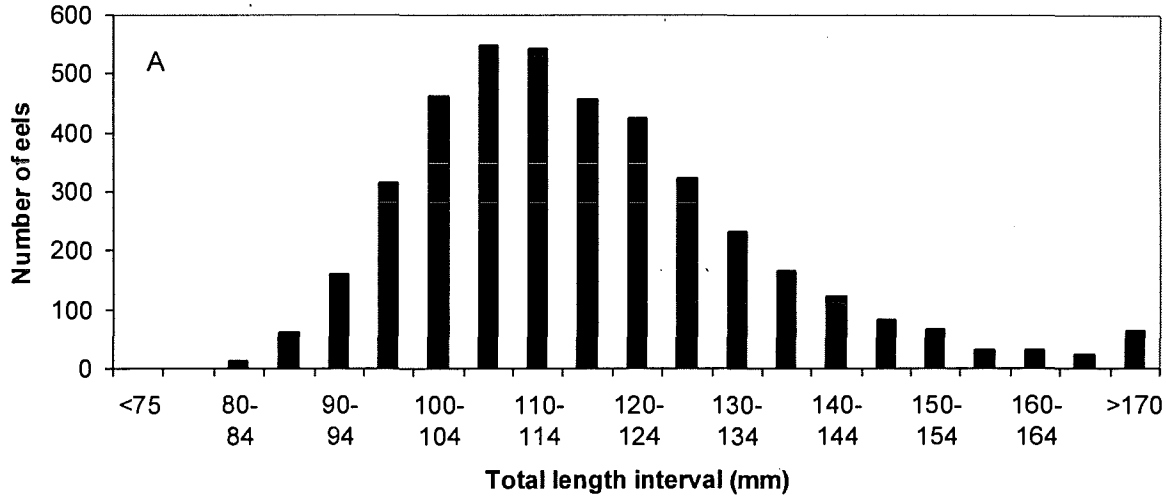
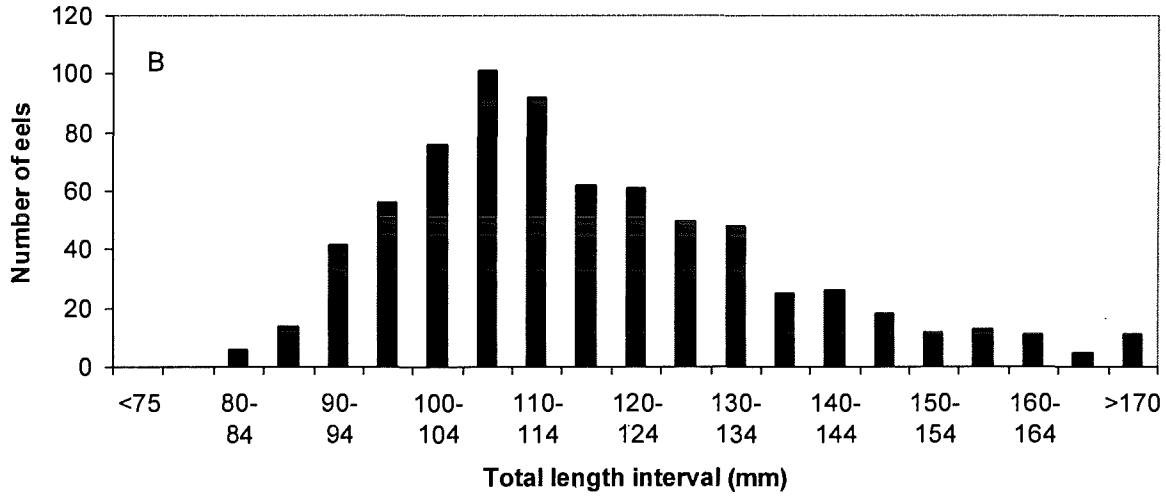


Figure 5. Total length of eels passed at Ft. Halifax in A) 1999, B) 2000, and C) 2001.





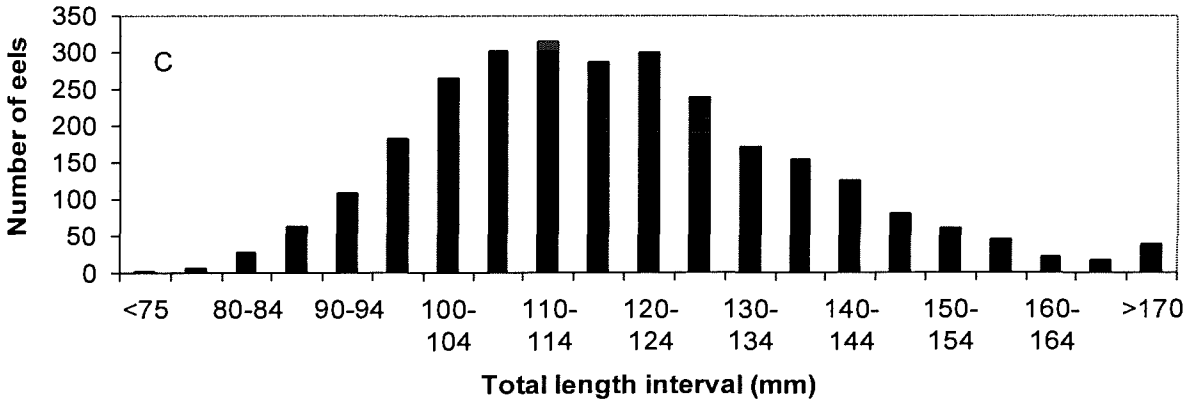
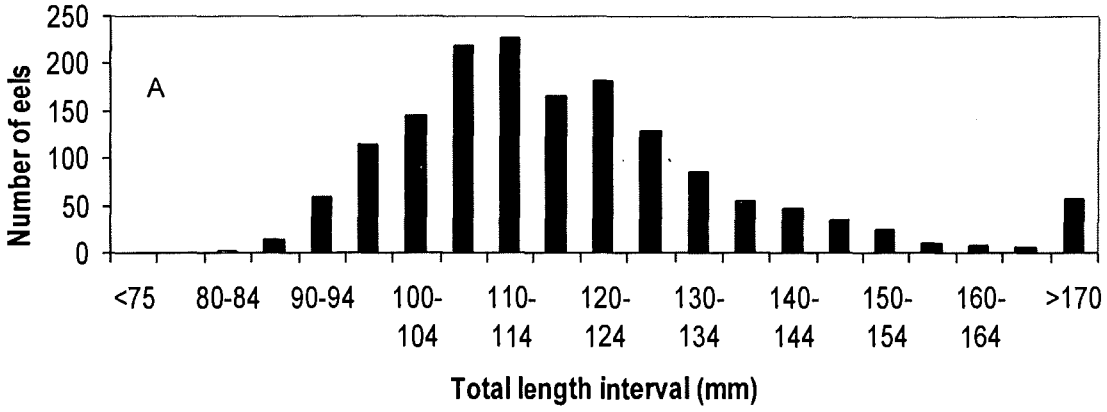
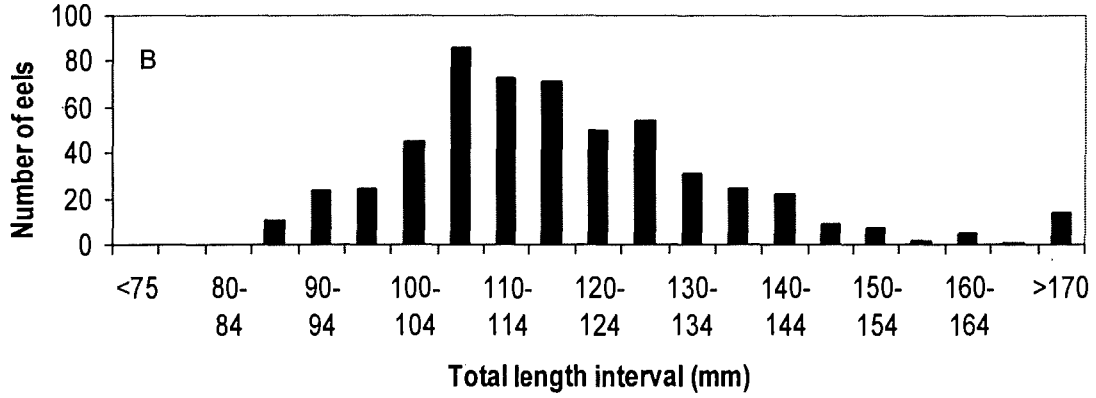


Figure 6. Total length of eels passed at Benton Falls in A) 1999, B) 2000, and C) 2001.





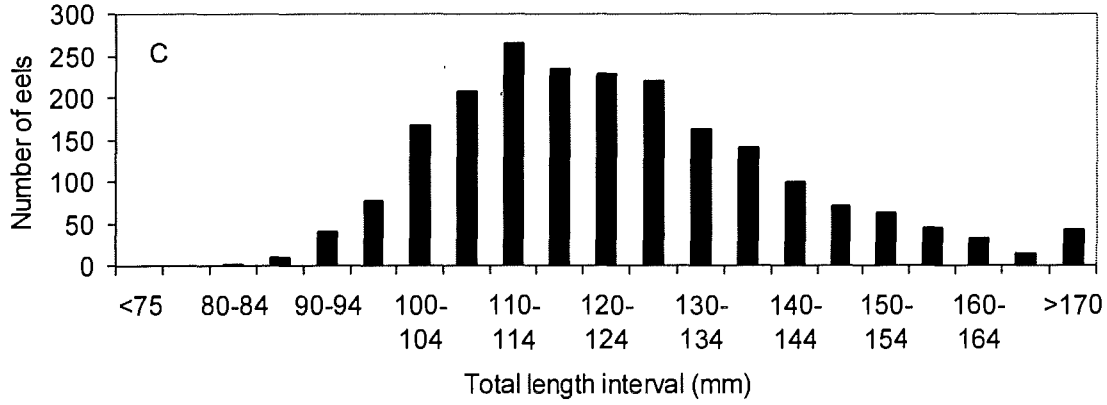


Figure 7. Arrow indicates location of eels attempting to pass at Burnham.

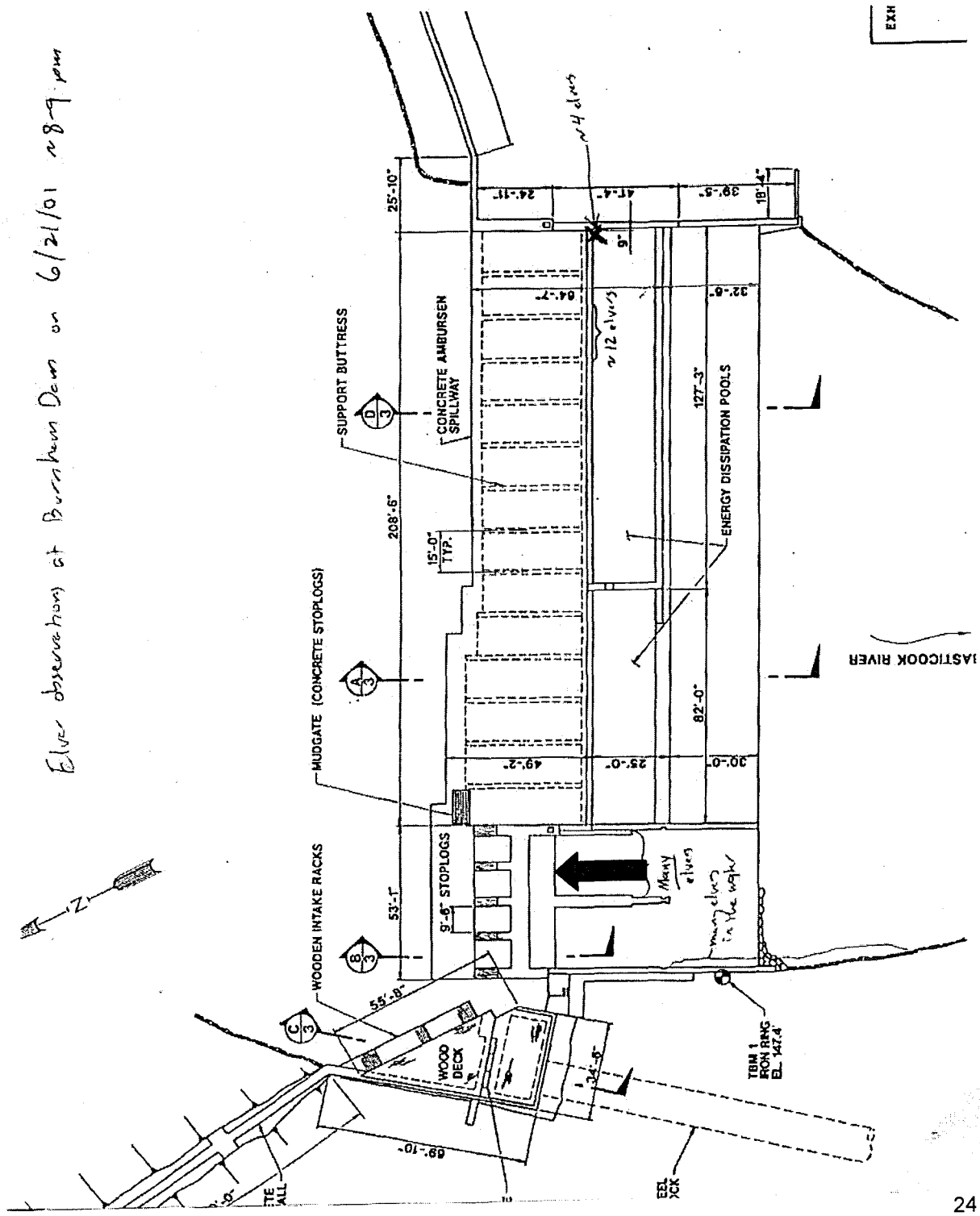


Figure 8. Total lengths of eels collected at A) Burnham, B) Lockwood, C) Hydro-Kennebec, and D) Shawmut.

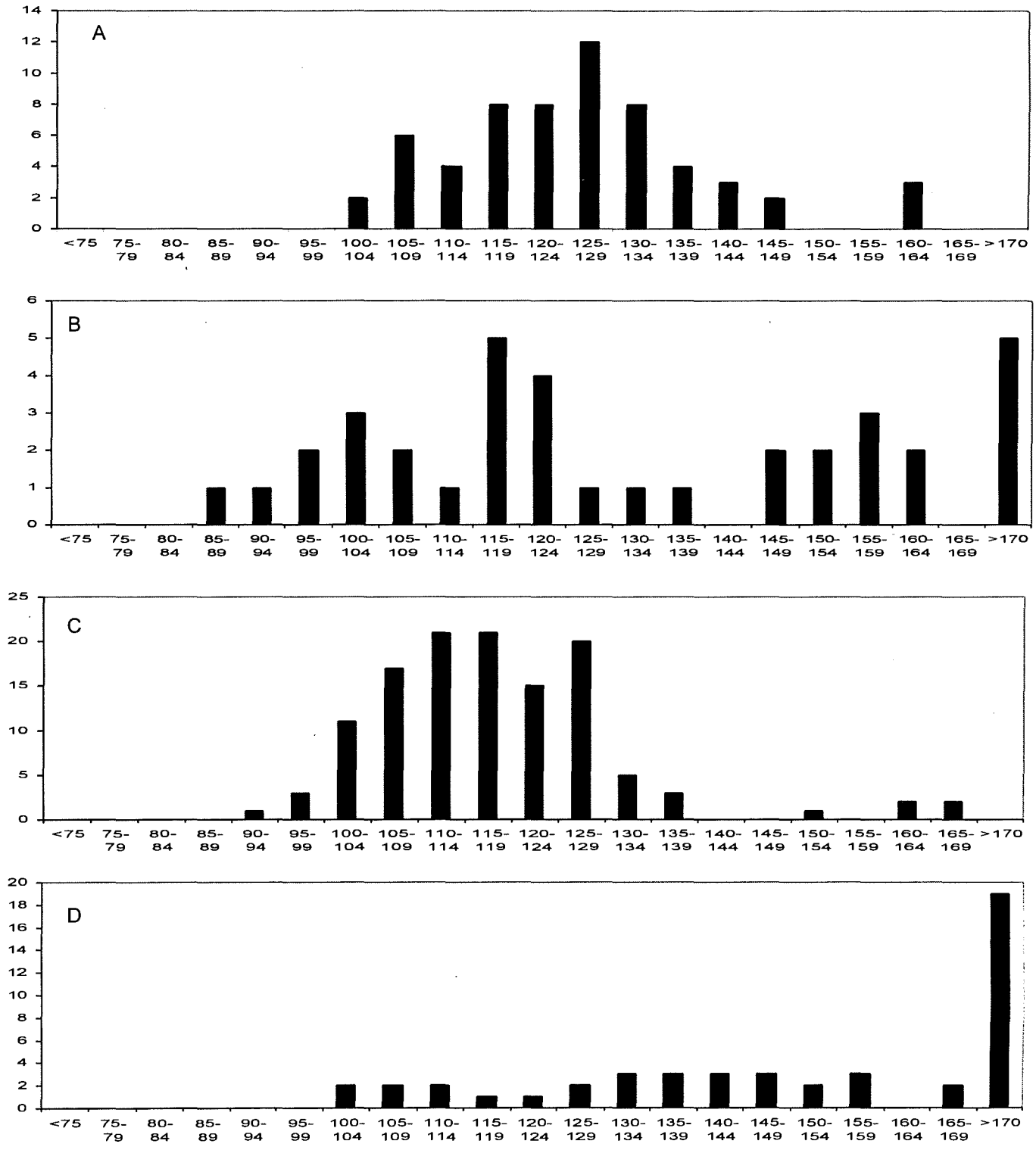


Figure 9. Arrow indicates location of eels attempting to pass at Lockwood.

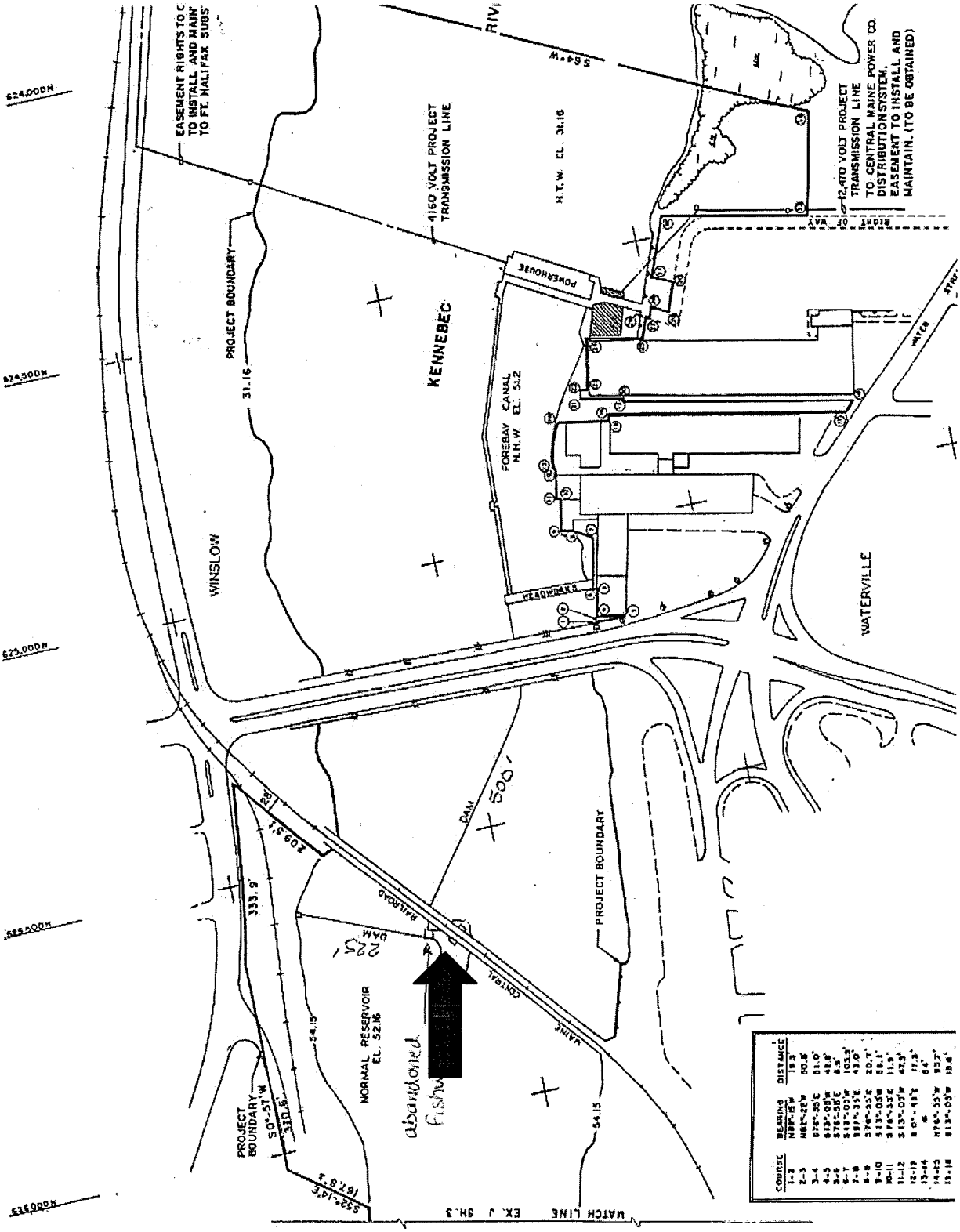


Figure 10. Arrow indicates location of eels attempting to pass at Hydro-Kennebec.

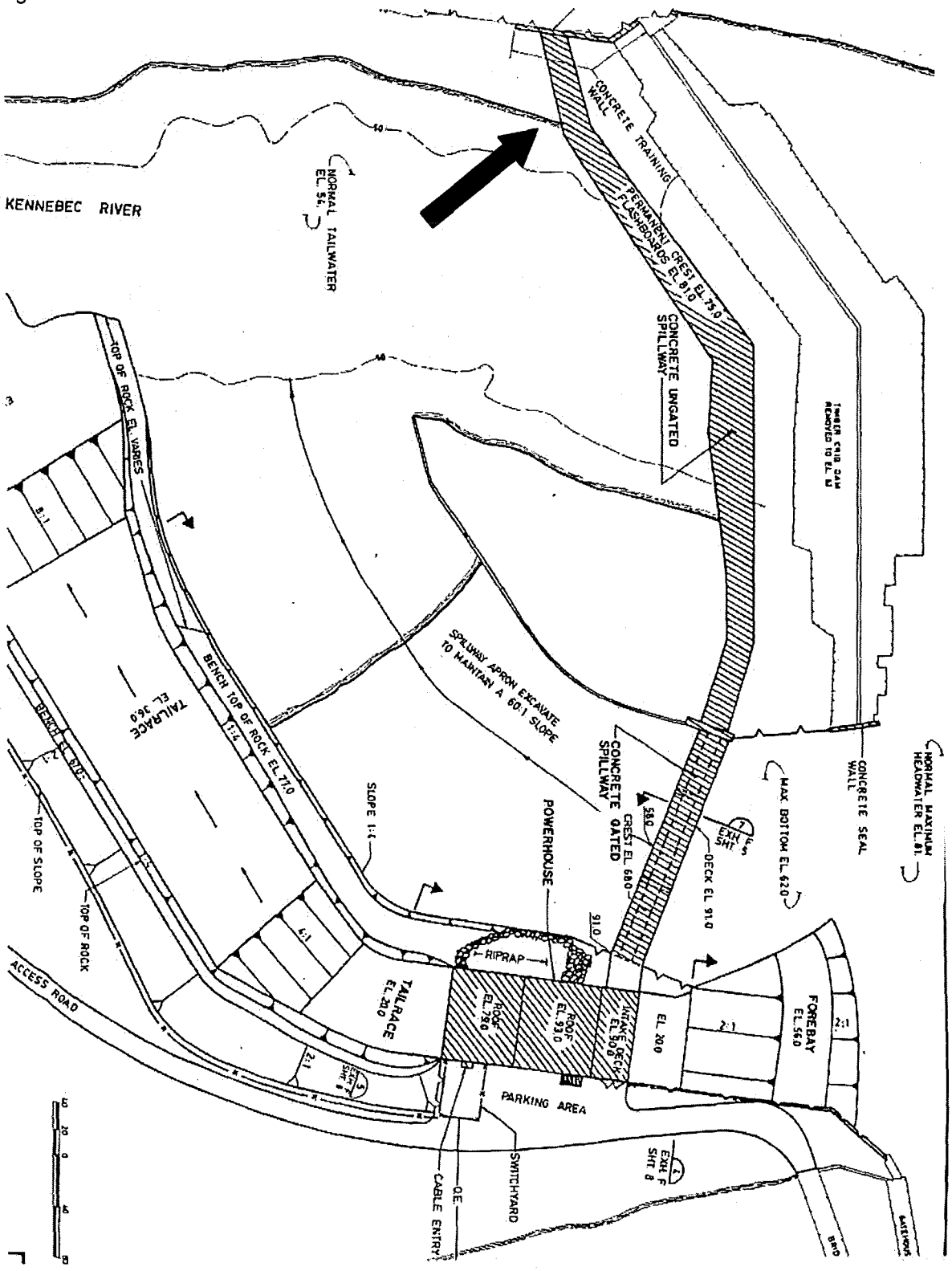


Figure 11. Arrow indicates location of eels attempting to pass at Shawmut.

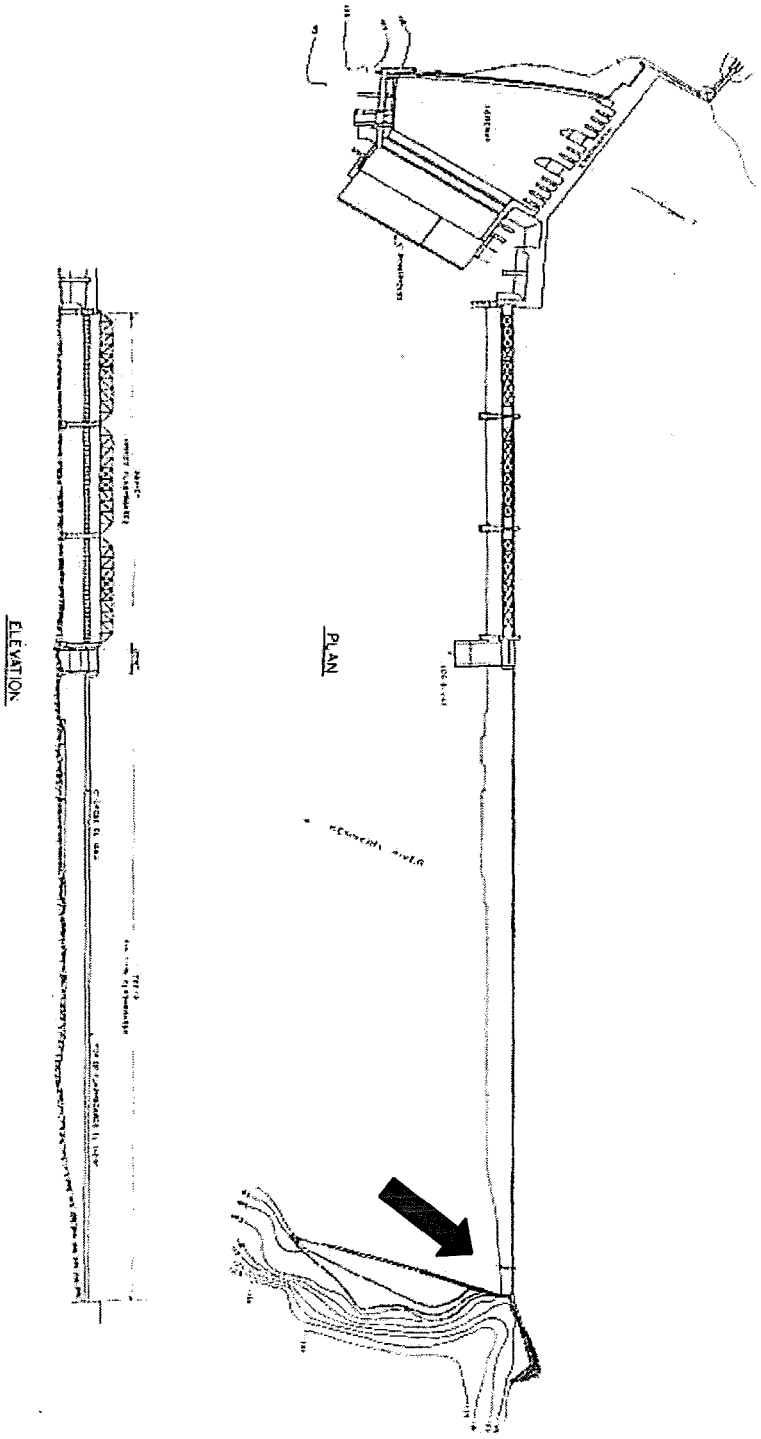


FIGURE 1

Figure 12. Arrow indicates location of eels attempting to pass at Weston.

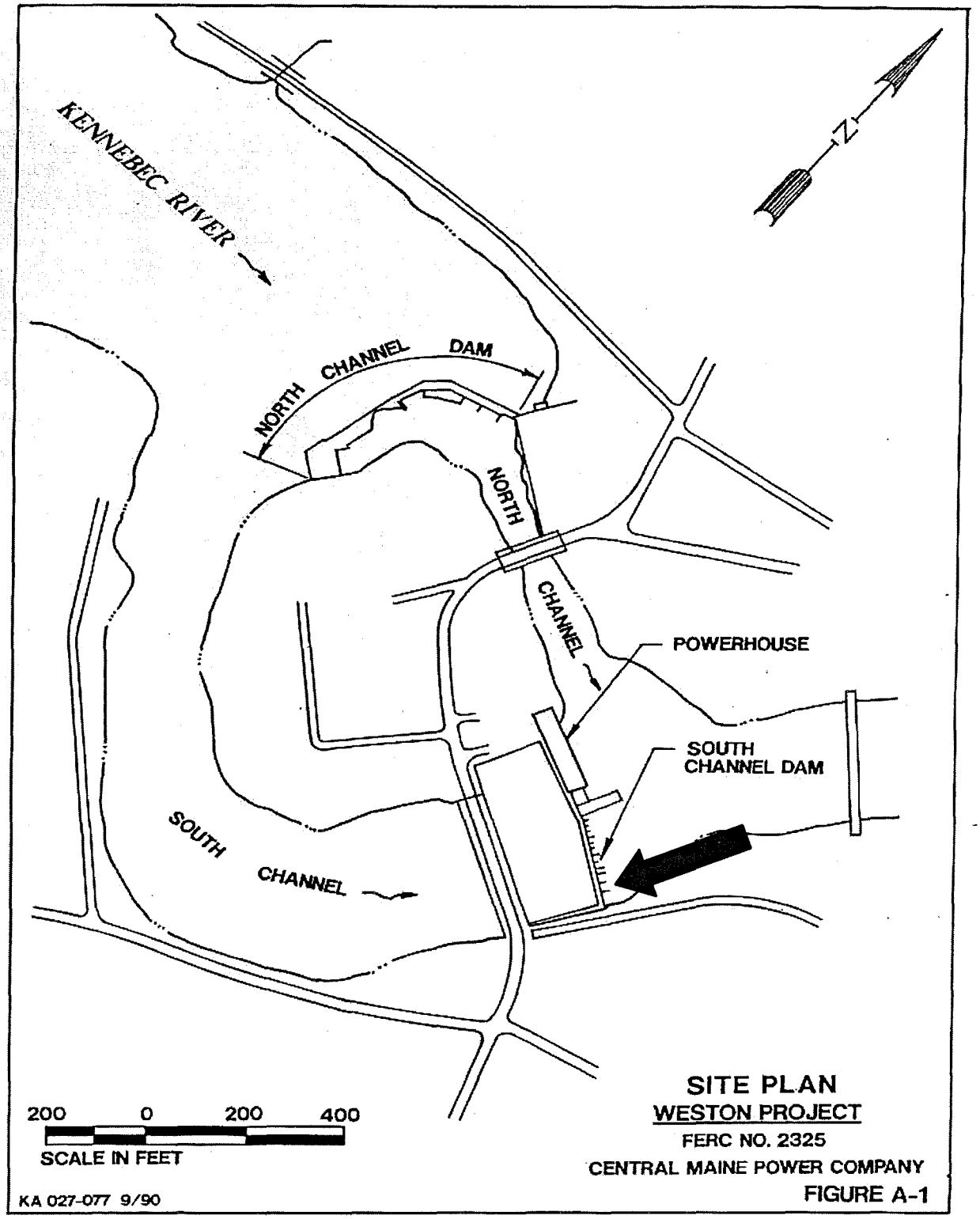


Figure 13. Number of telemetry contacts made by time of day for A) 2001 and B) 2000.

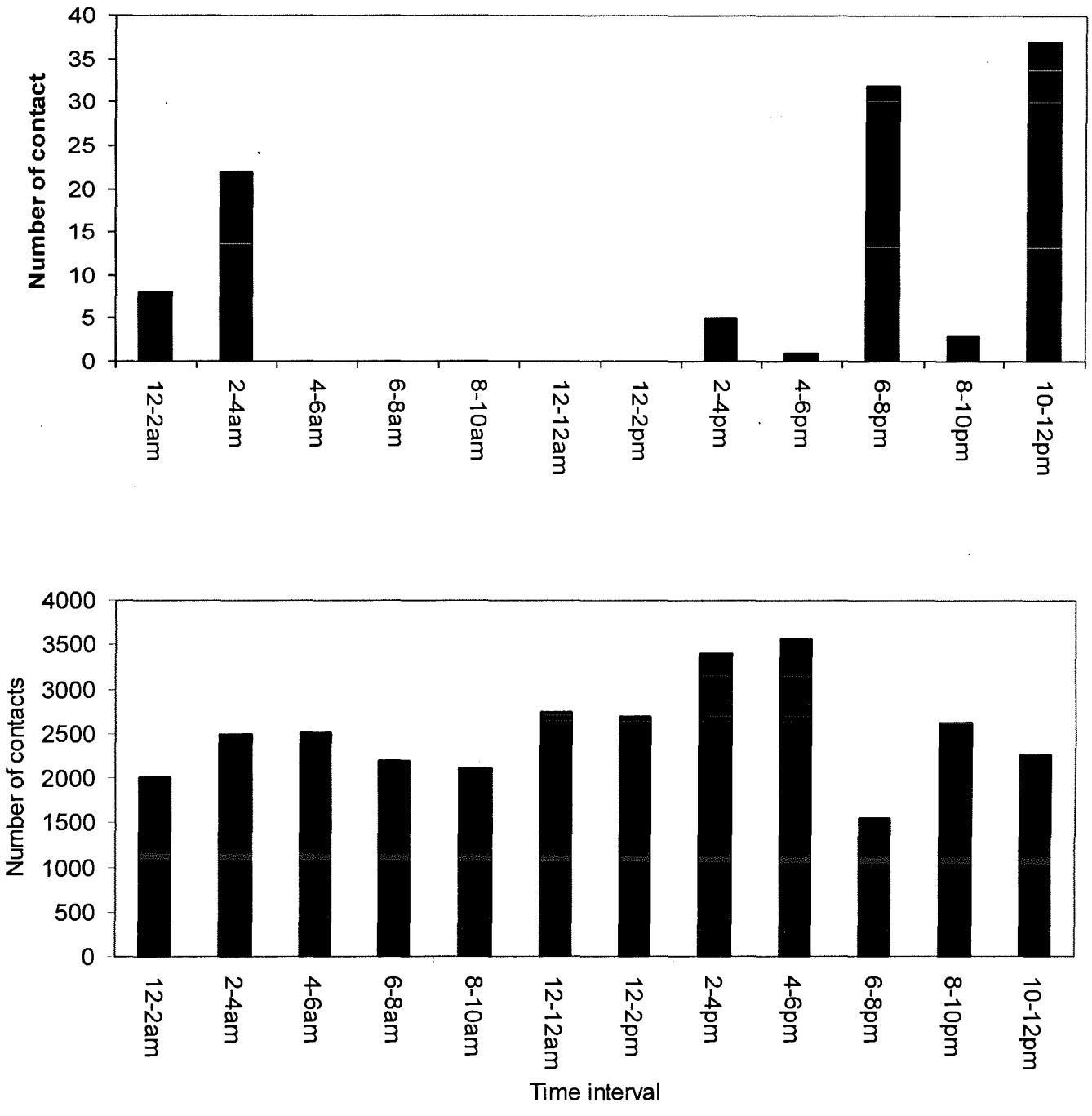


Figure 14. Total Maine landings.