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Eel and Elver Management Fund Plan

A Report to the Joint Standing Committee on Marine Resources

May 2003

Committee members:

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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 2002, and lists proposed work for 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 have not changed since 1999 with the exception of a lottery that allows people to enter the fishery as other leave. The numbers of harvesters and the amount of gear declined from 1999 to 2001, but has been stable since then. The 2002 harvest was 9,653 pounds, and average price was $28.80 per pound. Marine patrol officers spent more time on enforcement in 2002 than in 2001, in part because of the continued influx of new harvesters to the fishery.

DMR completed a second year of the young-of-year glass eel recruitment study that is required by the Atlantic States Marine Fisheries Commission. Approximately 82,860 glass eels and 1,712 small pigmented eels used elver passages to enter West Harbor Pond (Boothbay Harbor) between March 29 and May 30. The timing of the migration was unrelated to six measured environmental variables. As the season progressed, average total length and weight declined slightly, while pigmentation increased.

Upstream passage was monitored at two sites, and nighttime observations were made at five sites in the Kennebec River watershed to verify the probable locations for upstream passage. Approximately 56,292 eels were passed at Ft. Halifax and 22,502 at Benton Falls on the Sebasticook River. Locations for passages were verified at four sites, and additional observations are needed at the Lockwood Project.

A telemetry study of the behavior of downstream migrating silver eels at dams was conducted at the Lockwood project on the mainstem Kennebec River. Of the 5 eels fitted with radio tags and released above the project, two passed through the turbines, one used the bypass, and two passed without being detected.

A total of 23 licenses and permits were issued in 2002 for the coastal eel pot, inland eel pot, and inland weir fisheries. Harvesters reported a total catch of 13,133 pounds of eels.

DMR is consulting on fish passage for diadromous fishes at 19 hydropower projects. This includes providing comments during the relicensing process, and consulting on studies of fish passage efficiency.

In 2003, 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 the relicensing of hydropower projects.

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 research 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 2003. 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.

Elver fishery

The laws and regulations governing the elver fishery did not change in 2002. The fishery 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 by approximately three weeks; elvers can be harvested from 3/22 to 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.

The fishery began to decline in 1999 when the market for elvers collapsed (elvers primarily were shipped to Asia for aquaculture in ponds). The number of licenses and amount of gear declined between 1999 and 2001, but has been relatively stable since 2001 (Table 3). A total of 443 licenses were sold in 2002, and harvesters paid gear fees for 496 fyke nets and 231 dip nets. The catch (9,654 pounds) was higher than in the previous three years (Table 4), but the price has remained low (average $28.82/pound). As in previous years, eels were primarily captured by fyke net.

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). 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 unusually high spring flood tides. The mean tidal range at this site is 8.8 ft, and mean spring tidal range is 10.1 ft. Approximately 11 years ago, DMR installed a steeppass fishway at the dam, which was designed to pass adult alewives. 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.

DMR staff observed in 2001 that many eels congregated at the face of the dam beneath the three elver passages (ramps) that had been installed. We attempted to correct this problem in 2002 by replacing the western ramp with a vertical piece of plywood (21.5-inch long, 12-inch wide, covered with Enkamat flatback 7220 climbing substrate) that extended from a ledge outcrop to the top of the dam, and was attached to seaward face of the dam (Fig. 1). The other two ramps were installed perpendicular to the dam as they had been in 2001. After one week it became clear that glass eels were using the vertical passage, and we replaced the eastern ramp with a vertical piece of Enkamat-covered plywood (60-in long, 12-in wide). The middle ramp, covered with Akwadrain Soil Strip Drain (25 mm thickness) and perpendicular to the dam, was not changed. 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 all passages.

Passages were operational continually for 63 days (8+ weeks) from March 29 to May 30. They were tended every 1-3 days. The eels in each catch box were removed, and taken to the DMR laboratory for processing. Pigmented eels from each passage were counted, and glass eels from each passage were counted, and total number estimated gravimetrically. 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

Approximately 82,860 glass eels and 1,712 pigmented eels used the three passages in 2002. The vertical passages appear to be as efficient as the ramps at passing glass eels and small pigmented eels at this site (Table 5; west and east passage in 2002 vs. 2001).

Approximately 99% of the glass eels recruited to inland waters in the first 30 days of the study (Fig. 2A). Recruitment of small pigmented eels occurred later in the season and was slightly more protracted, although a majority (82%) migrated to inland waters in the first 30 days of the study (Fig. 2B). The timing of migration to inland waters of glass 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, average total length and weight declined slightly, while pigmentation increased (Table 6).

Discussion

Passages were installed earlier in the season in 2002 compared to 2001 (March 29 vs. May 2), because water levels were lower in 2002.

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

DMR staff conducted nighttime visual observations at five sites in 2002 (Table 7). As in previous years, 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. On several occasions eels were videotaped.

Upstream passages, which have been described in previous reports, were installed at the Ft. Halifax and Benton Falls projects. In general, the passages were operated five days per week, and were tended at least twice 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 at Ft. Halifax was obtained from Normandeau Associates. Other environmental information was recorded when the passages were tended.

Results and Discussion

The **Burnham** project was visited at night on July 24, and observations were made from shore using binoculars and a 500,000 candlepower light. As in 2001, eels were observed on the western side of the spillway, below the two easternmost sets of stoplogs.

Observations were made on seven occasions at the **Lockwood** Project (Table 7), and a fyke net was set above the abandoned fishway where eels were observed in 2001. DMR staff determined that there is no single place where eels tend to concentrate because of widespread leakage. Juvenile American eels attempt to scale the dam at numerous locations along the spillway and adjacent canal wall where spray or leakage occurs, and the locations vary daily with changes in river flow and impoundment level. After climbing to the crest of the dam or top of the canal wall, eels are commonly washed downstream when encountering the brunt of leakage flow passing through small holes in the flashboards or small cracks in the concrete. At two locations where eels had been seen climbing, Lockwood personnel cut small grooves into the concrete to reduce leakage flow velocity, but the effectiveness of these modifications are not known. Eels collected by dip net below the dam ranged from 85-210 mm total length. The median size was 115-119 mm (Fig. 4A).

After consulting with DMR, personnel at the **Hydro-Kennebec** Project installed an experimental upstream eel passage, made of flexible exhaust hose with Enkamat lining the invert, on the west side of the spillway. Problems with leakage, attraction water, entrance location, and the climbing substrate were identified and corrected through the summer. Testing of this experimental passage will continue in 2003. Eels collected by dip net below the dam ranged from 91-167 mm total length. The size distribution was bimodal with peaks at 110-119 mm and 125-129 mm (Fig. 4B).

The **Shawmut** Project was visited three times (Table 7). As in 2001, eels were observed swimming in the upper pool below the easternmost side of the spillway. Twelve eels, captured below the dam by dip net, ranged from 246-311 mm total length.

Nighttime observations were made on two dates at the south and north channel dams of the **Weston** Project (Table 7). Eels were observed actively climbing the southernmost section of the southern channel dam, the same area where they were seen in 2001. Eels collected by dip net below the dam ranged from 112-148 mm total length with a median of 125-129 mm (Fig. 4C).

An estimated 56,292 migrating eels were passed at **Ft. Halifax** in 2002, the lowest number ever passed (Table 8). Approximately 96% of the eels moved upstream within a 36-day period (Fig. 5A), similar to the pattern seen in previous years. The size range of eels was similar to that of previous years (78-188 mm total length) with a median of 110-114 mm (Fig. 6A).

An estimated 22,500 eels were passed at **Benton Falls,** the second lowest number passed (Table 8). Approximately 96% of the eels migrated within a 30-day period (Fig. 5B). The size range of eels was similar to previous years (86-236 mm total length), but the median size was greater than in previous years (115-124 mm), and 37% of the eels were greater than 150mm (Fig. 6B).

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 9/30-11/22 at the Lockwood Project, which is located on the Kennebec River approximately 0.5 mile above the confluence of the Sebasticook River and the Kennebec River. Eels used for study were obtained from Carrabasset Stream, located in Clinton approximately 5.75 miles above the Lockwood Project.

Radio telemetry equipment was installed and calibrated at the Lockwood Project from 9/30-10/24. Eight automated scanning receivers (Model SRX-400, Lotek Engineering, Newmarket, Ontario, Ca) were deployed at the site to record the passage of radio-tagged eels. Three types of antennas (4-element Yagi, 6-element Yagi, and "dropper") were used to monitor different areas of the 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, 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. One 4-element Yagi monitored the power canal, one 6-element Yagi was used to monitor the river channel, and a second 6-element Yagi was used to monitor the tailrace. The canal and river channel antennas were attached to a switcher, connected to a single receiver. One dropper antenna was deployed in each of the seven turbine draft tubes (although two were shut down for repair during the entire study period) and in the downstream bypass. In addition to the fixed stations, eels were located by scanning sections of the river on foot or by boat with a radio receiver and hand-held Yagi antenna on eight occasions between 10/25 and 11/15. Data from the scanning receivers was downloaded four times during the study period. Water temperature was measured and recorded six times a day at a depth of 12 ft in the canal at the Lockwood Project.

Eels to be radio-tagged were captured on 10/22 and 10/31 (Table 9) in a fyke net set in Carrabasset Stream. On both dates the captured eels were removed from the net, transported to the Hydro-Kennebec Project that is located approximately 0.5 mile above the Lockwood Project, and held overnight in a net pen prior to being fitted with a transmitter. During the tagging procedure, an individual eel was placed in a cooler containing a solution of Eugenol for 15-20 minutes to anaesthetize it. A small ventral incision

was made approximately 1.75 inch anterior to the vent, and a 16-gauge needle was inserted about 0.5-inch 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.

Four eels were tagged between 12:00-13:30 on 10/24, held overnight in the net pen, and released at noon on 10/25 in the Hydro-Kennebec tailrace. A single eel was tagged between 12:30-14:00 on 11/01, and released the same day at 16:00 in the Hydro-Kennebec tailrace.

Results

Daily mean water flow in the Kennebec River was below the 16-year mean each day of the study. Instantaneous streamflow ranged from 2960-6790 cfs, and average daily water temperature in the canal at Lockwood ranged from 9.3-3.7 °C during the study period.

Eels were detected at the Lockwood Dam from 6.7 to 223.3 hours after being released in the Hydro-Kennebec tailrace (Table 10). Two eels began moving downstream soon after being released. After four hours, eel 12 had moved into the open river, and eel 13 had traveled approximately halfway to Lockwood. The two slowest eels, which arrived at Lockwood 4-9 days after release, remained at the release point for several days. Once in the forebay of the Lockwood Project, eels passed downstream very quickly. The time from arrival to passage ranged from 1-21 minutes.

All five eels released above Lockwood passed the project (Table 10). Two eels (40%) passed through turbines, one eel (20%) used the downstream bypass, and two eels (40%) passed by an unknown route. On the basis of signal strengths obtained from the receivers, the latter two eels either used the bypass or passed through turbine 7.

The eel that used the bypass (12) appeared to continue its downstream migration. One day after passing the project it was located approximately 0.5 mile downstream in Taconic Bay. It was not detected three days later, when the 17-mile stretch from Waterville to Augusta was checked for signals by boat. Eels that passed through the turbines (13, 14) did not continue migrating, and were presumed to be injured or dead. Eel 13 was detected in a pool east of the powerhouse on 10/28, 10/30, and 11/1. A diver attempted to locate it on 11/1 without success. Eel 14 was located once along the west shore of Taconic Bay. The remaining two eels (11, 15), which passed by an unknown route, were located on several dates below the project. Eel 15 was found opposite the Waterville boat launch on 10/30, 10/31, 11/4, and 11/12. Eel 11 was located on 10/30 and 10/31below the Sebasticook River on the east shore.

Migrating eels were active primarily during darkness. Approximately 89% of the contacts were made between 6 PM and 6 AM (Fig. 7), and all eels passed during darkness.

Discussion and recommendations

The study will be continued in 2003.

Elver enforcement

Marine patrol officers in each division worked more hours on elver enforcement in 2002 than in the previous year (Table 11). Division II officers spent slightly more time on elvers than Division I officers. Officers in both divisions addressed more complaints than in the previous two years (Table 11). The number of summons issued in Division I and Division II were higher in 2002 than in the previous year (Table 12). The most common violations were: harvesting during the closed period, harvesting within 150' of a fishway, harvesting in the middle third of the waterway, having an inadequate excluder panel, and using untagged nets.

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 23 licenses and permits were issued in 2002 for the coastal eel pot, inland eel pot, and inland weir fisheries (Table 13). Harvesters reported a total catch of 13,133 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 1887-2002 is 91,775 pounds. Catches exceeded the long-term average from 1900-1933 and from 1975-1980 (Fig. 8). 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 14.

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

Name/phone number	Affiliation	Address
Patricia Bryant 563-5611	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 732-4536	Silver/yellow eel fisherman Eel dealer	82 Pleasant Street PO Box 49 Passadumkeag, ME 04475
Merry Gallagher 941-4381	Resource Manager-DIFW	650 State Street Bangor, ME 04401
Scott Hall 827-5364	Hydro-power	PPL Maine, LLC PO Box 276 Milford, ME 04461
James McCleave 581-4392	Researcher	School of Marine Sciences 5751 Libby Hall University of Maine Orono, ME 04469
Lt. David Mercier 633-9595	Law enforcement-DMR	PO Box 8 West Boothbay Harbor, ME 04575
Bob Richter 771-3536	Hydro-power	FPL Energy, Inc 100 Middle St. Portland, ME 04101
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 resident 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).

License type	1996	1997	1998	1999	2000	2001	2002	2003
1 fyke	34	22	41	33	24	33	51	137
2 fykes	50	55	61	272	263	175	161	135
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	99
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	91
Total	2,198	1,384	2,293	743	665	459	443	462

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
2003		462	506	190	696
2002	9,654	443	496	231	727
2001	3,131	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	< 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 2002.

	2001		2002	
Gear	Number glass eels	Number pigmented eels	Number glass eels	Number pigmented eels
West passage	18,321	388	43,207	91
East passage	34,303	867	38,766	1,483
Middle passage	16	174	886	138
Total	52,640	1,429	82,860	1,712

Table 6. Average total length, weight, and pigmentation stage of glass eels, 2001-2002.

Date	Avg TL (mm)	Avg weight (g)	Avg pigmentation
05/14/01	59.45	0.12	
05/18/01	60.18	0.16	2.67
05/21/01	61.20	0.18	4.53
05/23/01	60.07	0.14	4.29
05/29/01	61.17	0.15	4.75
06/01/01	60.30	0.15	4.91
06/04/01	61.07	0.13	4.56
06/08/01	60.37	0.13	5.11
06/11/01	59.94	0.10	5.67
06/14/01	59.79	0.16	5.15
04/11/02	63.12	0.17	1.23
04/17/02	65.14	0.18	1.57
04/25/02	62.71	0.16	1.93
05/02/02	63.03	0.17	2.69
05/13/02	59.90	0.15	4.50

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

Project	Dates of nighttime observations						
Burnham	7/24						
Lockwood	7/30	8/1	8/7	8/16	8/28	8/29	9/3
Hydro-Kennebec	8/20	9/5					
Shawmut	7/30	8/20	8/28				
Weston	7/24	8/7					

Table 8. Summary of upstream eel migration at Ft. Halifax and Benton Falls projects, 1999-2002.

	Fort Halifax		Benton Falls	
Year	Passage operating	Eel passed	Passage operating	Eels passed
2002	6/10-9/13	56,292	6/18-9/13	22,502
2001	5/26-8/24	224,373	6/6-8/24	231,859
2000	6/21-7/28; 8/15-8/22	81,628	6/29-7/28; 8/14-8/24	37,207
1999	6/4-9/15	551,262	6/22-9/16	14,335

Table 9. Summary of the tag and release date, size of tagged eels, and release location for the 2002 telemetry field season.

Date tagged	Date released	Tag number	Eel total length (mm)	Release location
10/24	10/25	11	614	Hydro-Kennebec tailrace
10/24	10/25	12	588	Hydro-Kennebec tailrace
10/24	10/25	13	552	Hydro-Kennebec tailrace
10/24	10/25	15	558	Hydro-Kennebec tailrace
11/01	11/01	14	644	Hydro-Kennebec tailrace

Table 10. Time of release, arrival, and passage for radio-tagged silver eels at the Lockwood Project during the 2002 field season.

	Release		Arrival at dam		Passage at dam		Release to	Arrival to passage	
Tag	Date	Time	Date	Time	Date	Time	arrival (hr)	(min)	Route
11	10/25	1200	10/30	2:06	10/30	2:07	110.1.	1	unknown
12	10/25	1200	10/27	1:11	10/27	1:14	37.19	3	bypass
13	10/25	1200	10/25	18:43	10/25	18:47	6.70	4	turbine
15	10/25	1200	10/27	4:19	10/27	4:23	40.33	4	unknown
14	11/01	1600	11/10	23:19	11/10	23:30	223.32	21	turbine

Table 11. Summary of Marine Patrol activities, 1996-2002.

	Division I						Division II					
Category	1997	1998	1999	2000	2001	2002	1997	1998	1999	2000	2001	2002
Eel Enforcement Hours Worked	3134	3516	1533.5	587	258	543.5	2354	2748.5	756.5	467	337	561
Overtime Hours Worked	844	766	336.5	29	1.5	1	539	540	104	0	0	42
Summons Issued	113	73	5	2	1	3	101	131	8	2	5	12
Verbal and Written Warnings Issued	93	145	23	5	12	0	95	119	10	5	14	13
Complaints Addressed	205	248	39	1	9	14	219	132	4	0	4	9

Table 12. Summary of elver fishery violations, 1998 –2002.

	Division I									
	Warnings					Summons				
Violation	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
Closed Season, Harvesting	0	0	0	1	0	0	0	1	0	0
Closed Season, Locating Nets	0	0	0	0	0	0	1	0	0	0
Closed Season, Setting Nets and Traps	0	2	3	4	0	0	1	1	0	0
Closed Season, Nets of Certain Sizes	0	0	0	0	0	2	0	0	0	0
Closed Period, Harvesting	18	6	0	0	0	24	1	0	1	1
Closed Area, Fishing for Elvers	11	1	0	0	0	2	0	0	0	0
Closed Area, 150' of a Fishway	6	0	0	0	0	2	0	0	0	1
Closed Area, Fishing Middle Third	70	7	1	1	0	15	0	0	0	0
Closed Area, Use of Dip Net Inside Fyke Net	0	0	0	0	0	4	0	0	0	0
Method of Elver Fishing, Limits on Gear	21	3	0	5	0	2	0	0	0	0
Method of Elver Fishing, Fishing from a Boat	2	0	0	0	0	0	0	0	0	0
Method of Elver Fishing, Standing in Water	9	0	0	0	0	12	0	0	0	0
Method of Elver Fishing, Inadequate Excluder Panel	0	0	0	0	0	0	0	0	0	1
Molesting Elver Gear	1	2	0	1	0	2	0	0	0	0
Elver Fishing License (Fishing without a License)	2	0	1	0	0	3	2	0	0	0
Elver Tags (Untagged Nets)	5	2	0	0	0	4	0	0	0	0
Theft	0	0	0	0	0	1	0	0	0	0
Miscellaneous	0	0	0	0	0	0	0	0	0	0
Totals	145	23	5	12	0	73	5	2	1	3

	Division II									
	Warnings					Summons				
Violation	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
Closed Season, Harvesting	4	0	4	0	0	4	0	0	0	0
Closed Season, Locating Nets	4	1	0	0	0	1	0	2	0	0
Closed Season, Setting Nets and Traps	0	0	0	0	0	1	1	0	0	0
Closed Season, Nets of Certain Sizes	6	0	0	0	0	11	0	0	0	0
Closed Period, Harvesting	9	1	0	5	6	19	5	0	3	4
Closed Area, Fishing for Elvers	9	2	0	3	1	4	0	0	2	0
Closed Area, 150' of a Fishway	3	0	0	0	0	6	0	0	0	1
Closed Area, Fishing Middle Third	50	3	1	3	1	51	2	0	0	3
Closed Area, Use of Dip Net Inside Fyke Net	0	1	0	0	0	4	0	0	0	0
Closed Area, Alewife Trap	0	0	0	0	0	1	0	0	0	0
Method of Elver Fishing, Limits on Gear	8	0	0	0	0	8	0	0	0	0
Method of Elver Fishing, Fishing from a Boat	1	0	0	0	0	0	0	0	0	0
Method of Elver Fishing, Standing in Water	4	0	0	0	0	10	0	0	0	0
Method of Elver Fishing, Inadequate Excluder Panel	0	0	0	0	1	0	0	0	0	1
Molesting Elver Gear	5	0	0	0	4	1	0	0	0	0
Elver Fishing License (Fishing without a License)	0	1	0	1	0	1	0	0	0	0
Elver Tags (Untagged Nets)	16	1	0	2	0	9	0	0	0	3
Totals	119	10	5	14	13	131	8	2	5	12

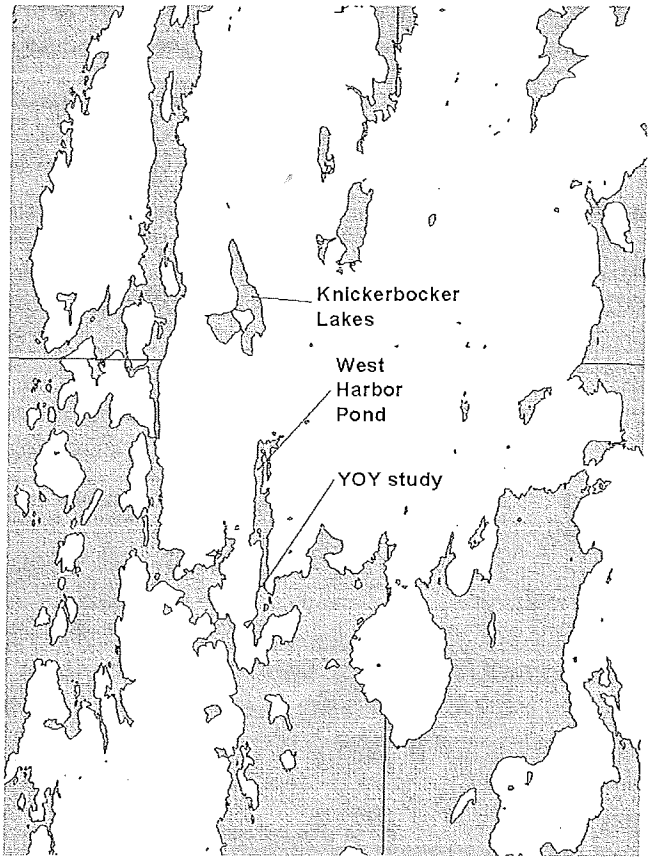
Table 13. Eel pot licenses and permits.

Year	Number DMR pot licenses (tidal water)	Number DIFW pot permits (inland water)
2002	10	13
2001	15	21
2000	25	27
1999	26	42
1998	41	79
1997	53	74
1996	48	71
1995	no data	124
1994	55	51
1993	39	60
1992	33	80
1991	32	56
1990	29	34
1989	19	25
1988	17	22
1987	14	16
1986	12	23
1985	28	23
1984	30	24

Table 14. 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 on studies
	6	Medway	Medway	Consulting on studies
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	Skowhegan	DMR studies in 2001
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	2	Saccarappa	Westbrook	Consulting
	3	Mallison	Gorham/Windham	Consulting
	4	Little Falls	Gorham/Windham	Consulting
	5	Gambo	Gorham/Windham	Consulting
	6	Dundee	Gorham/Windham	Consulting
	8	Eel Weir	Standish/Windham	Consulting
Salmon Falls	1	South Berwick	South Berwick	Consulting on studies
Saco	4	Bar Mills	Hollis/Buxton	Consulting

Figure 1. Location of young-of-year survey, and close-up view of vertical elver passage.



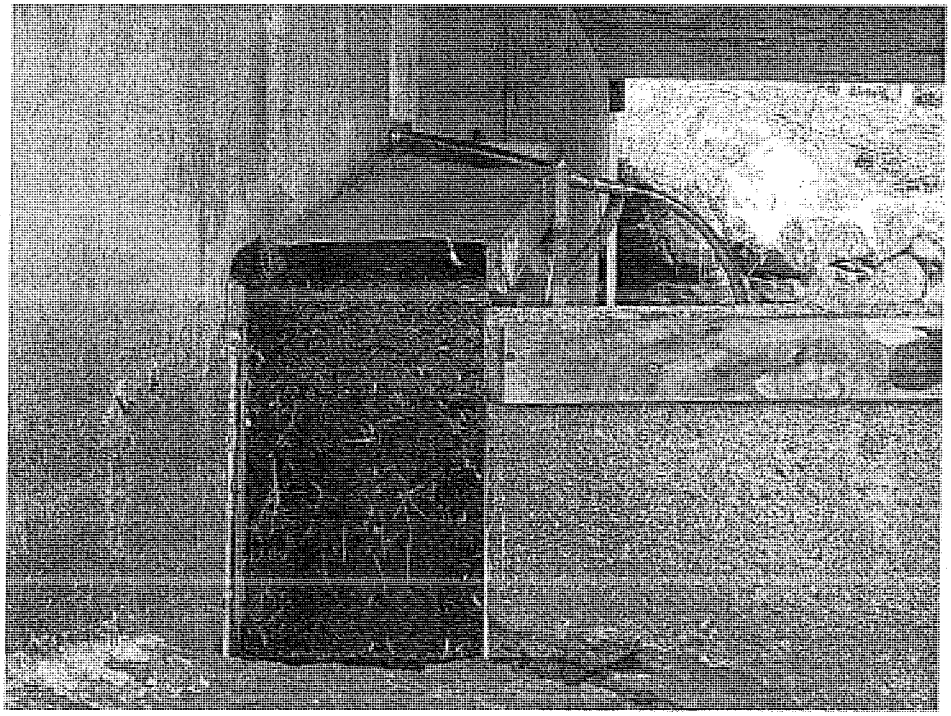
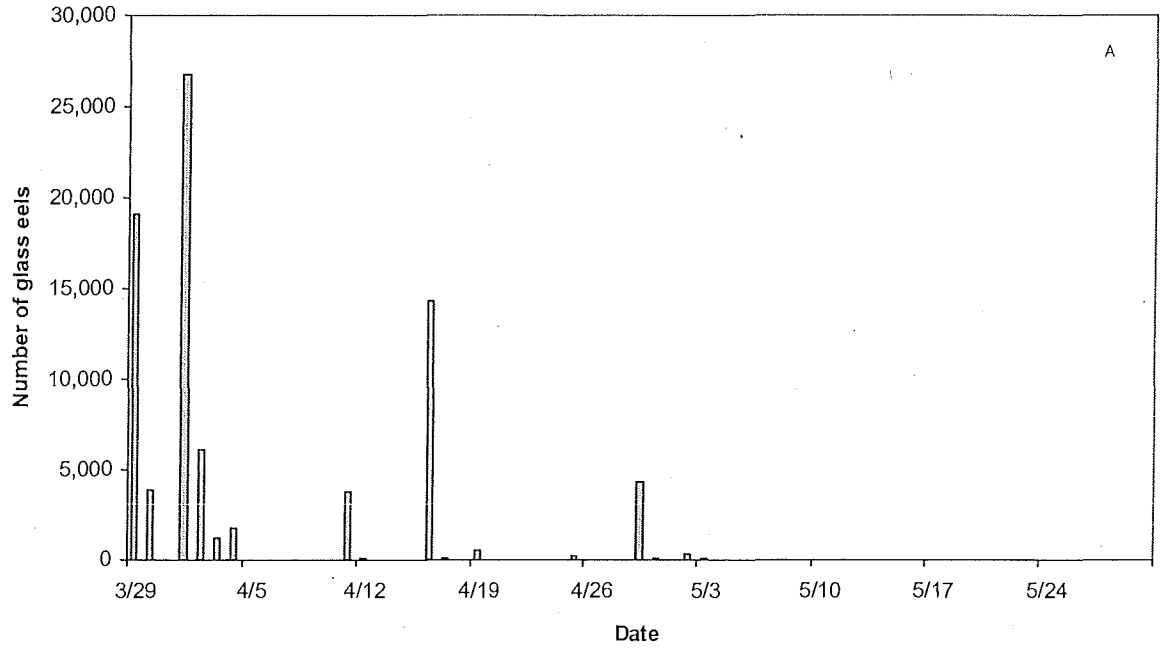


Figure 2. Recruitment of (A) glass eels and (B) pigmented eels into West harbor Pond, 2002.



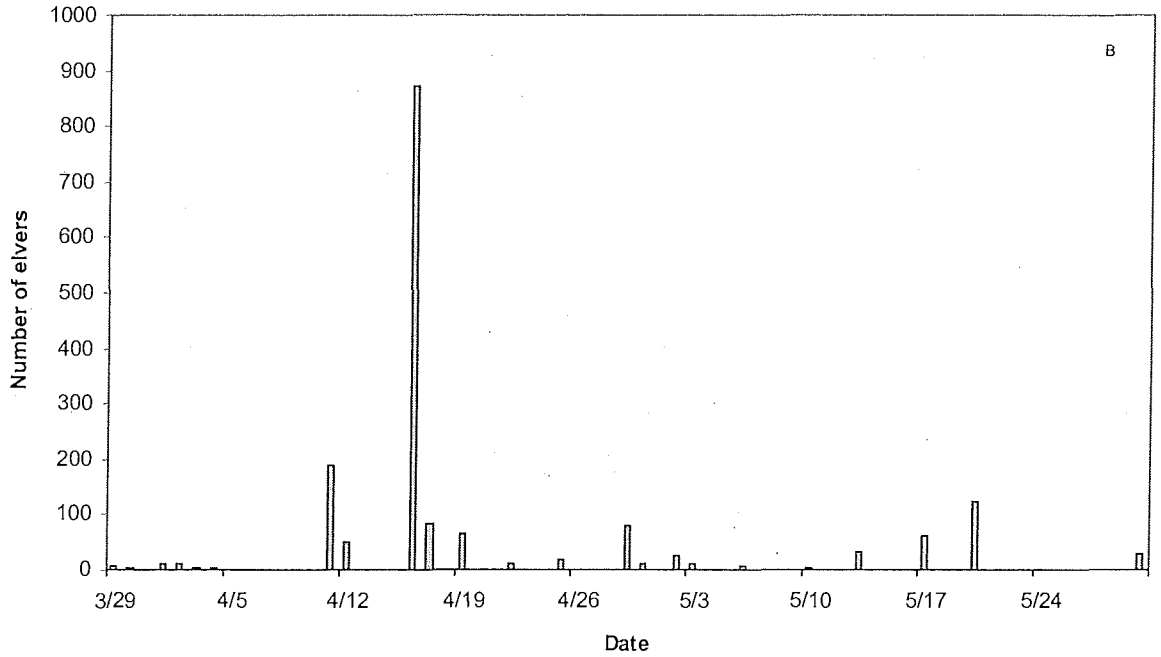


Figure 3. Location of hydropower projects and fishways within the Kennebec River watershed.

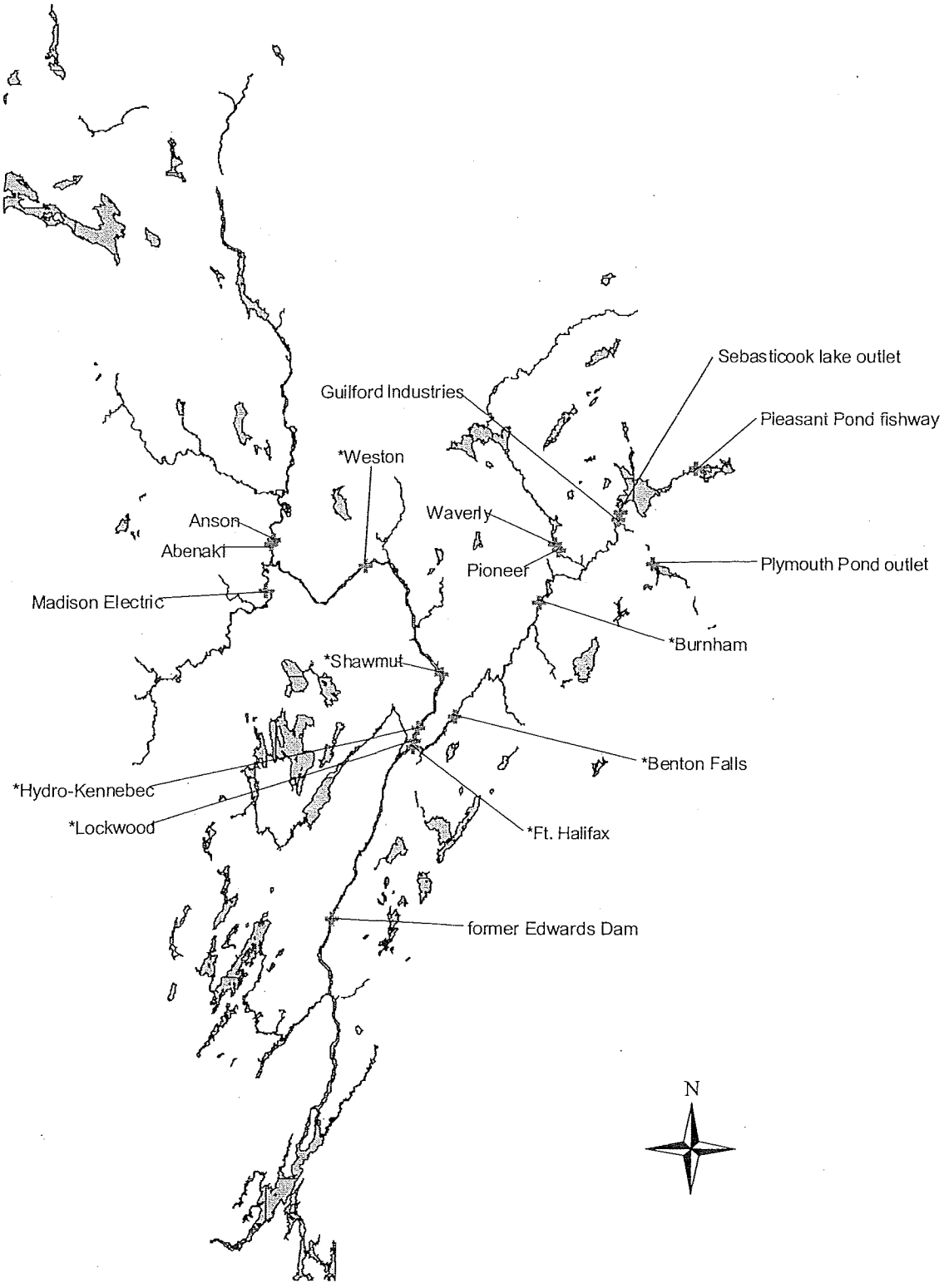
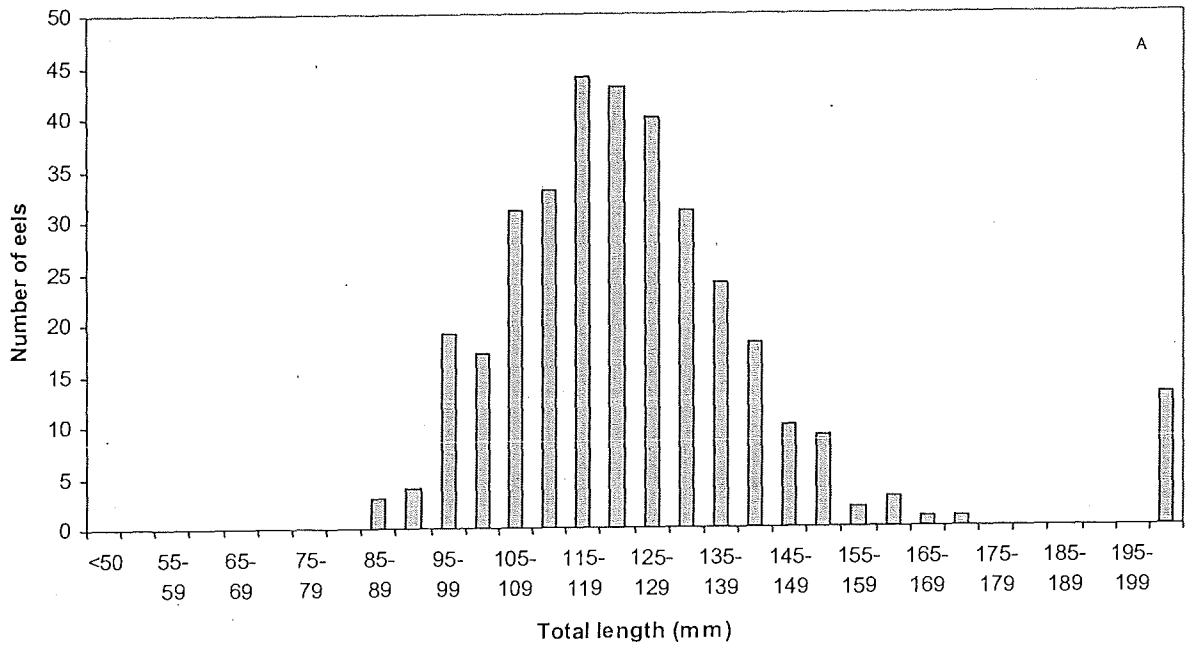
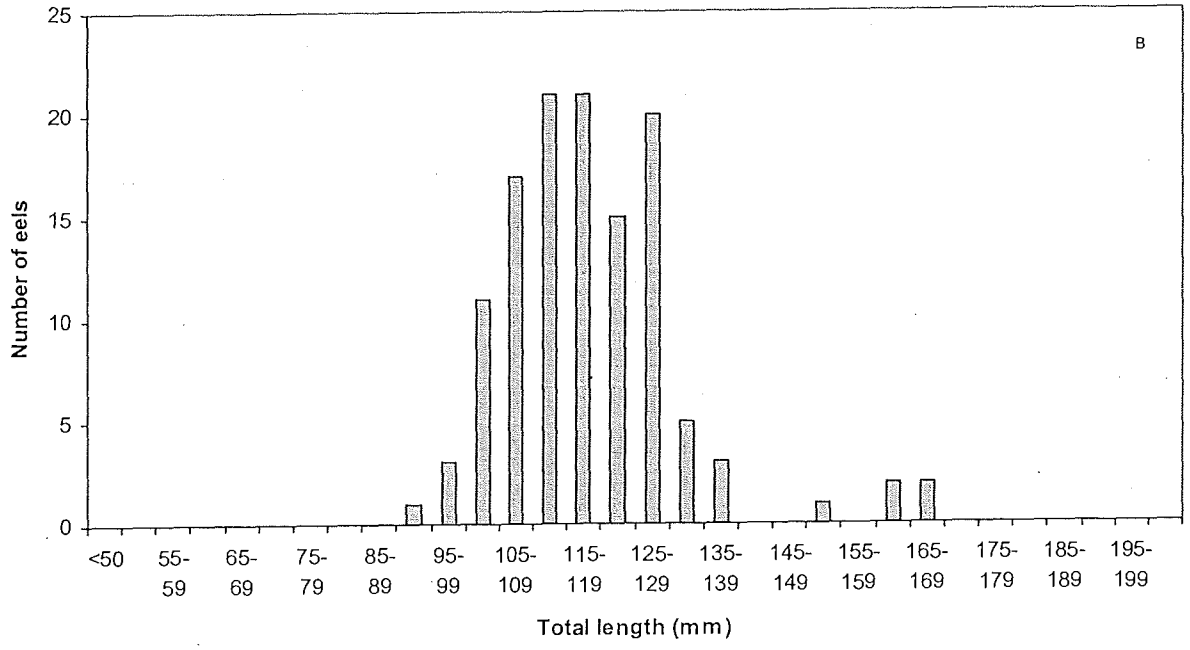


Figure 4. Total length of eels at A) Lockwood, B) Hydro-Kennebec, and C) Weston during the 2002 field season.





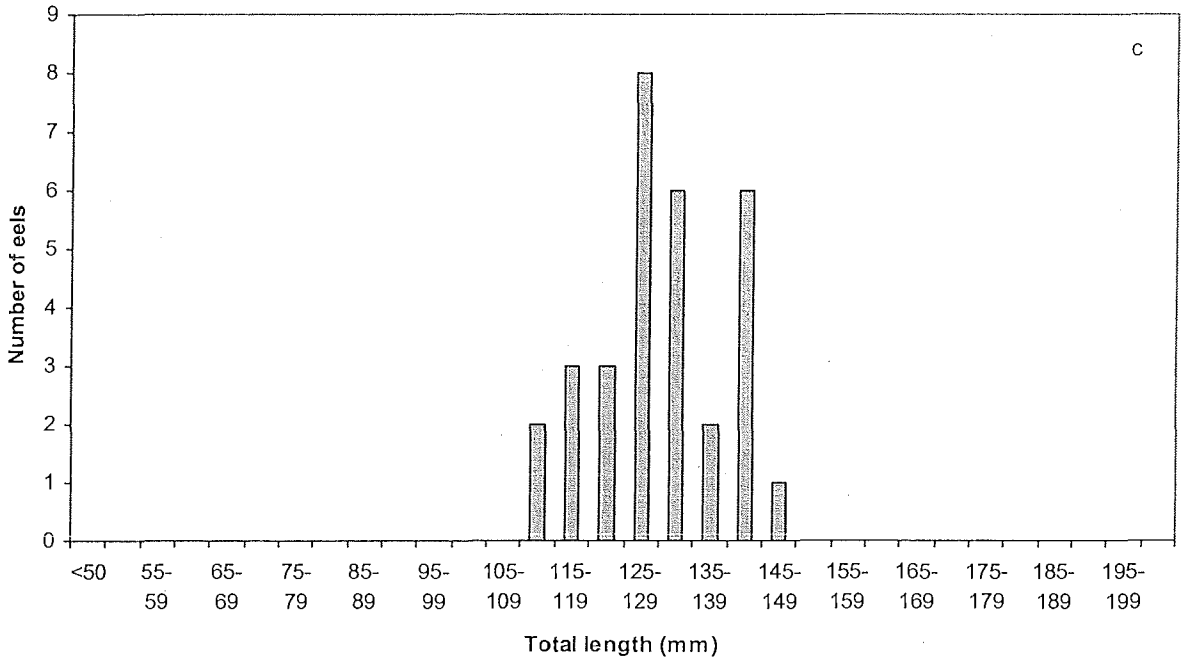
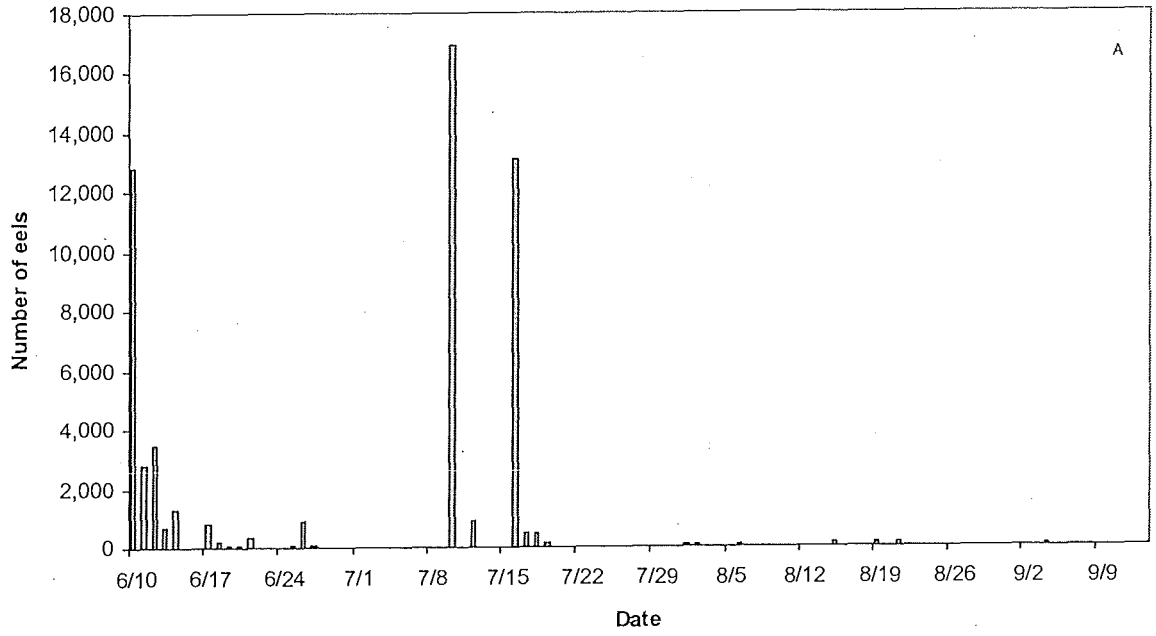

c
Number of eels
0
1
2
3
4
5
6
7
8
9
<50
55-59
65-69
75-79
85-89
95-99
105-109
115-119
125-129
135-139
145-149
155-159
165-169
175-179
185-189
195-199
Total length (mm)

Figure 5. Eel passage at (A) Ft. Halifax Dam and (B) Benton Falls Dam in 2002.



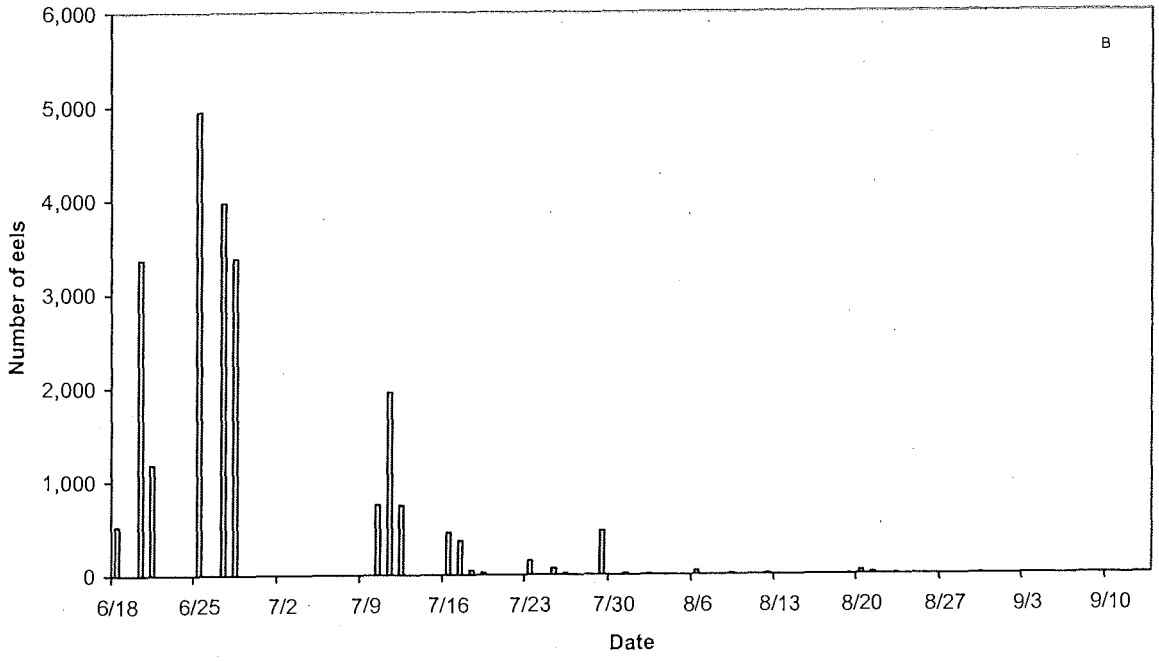
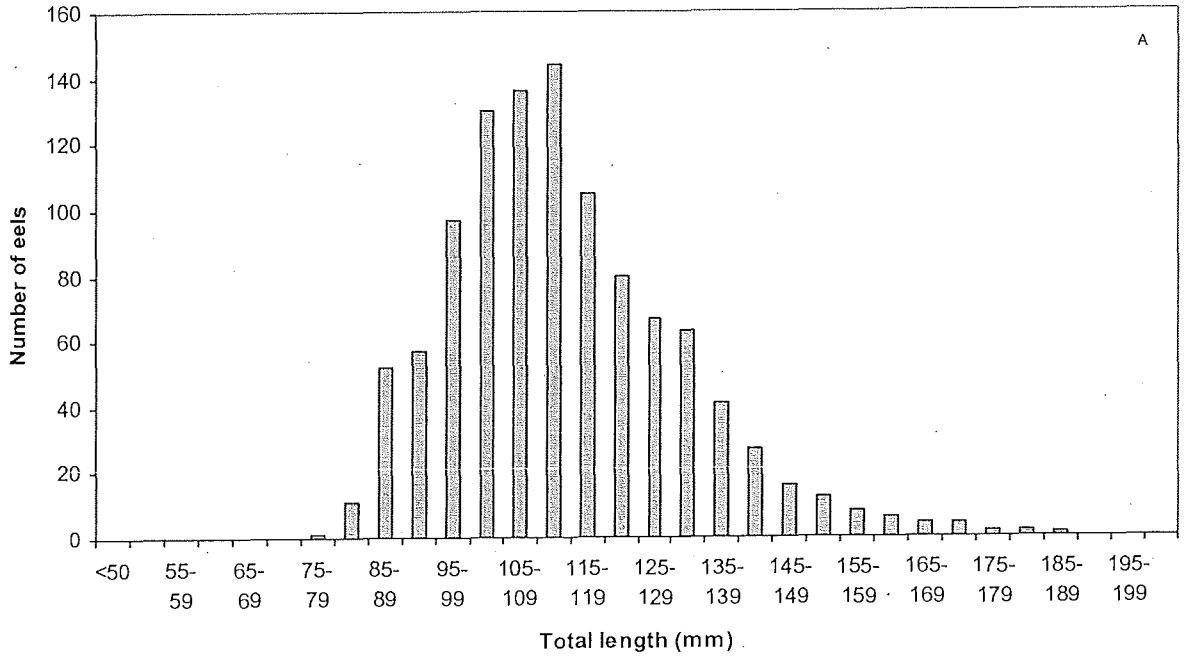


Figure 6. Total length of eels passed at (A) Ft. Halifax and (B) Benton Falls in 2002.



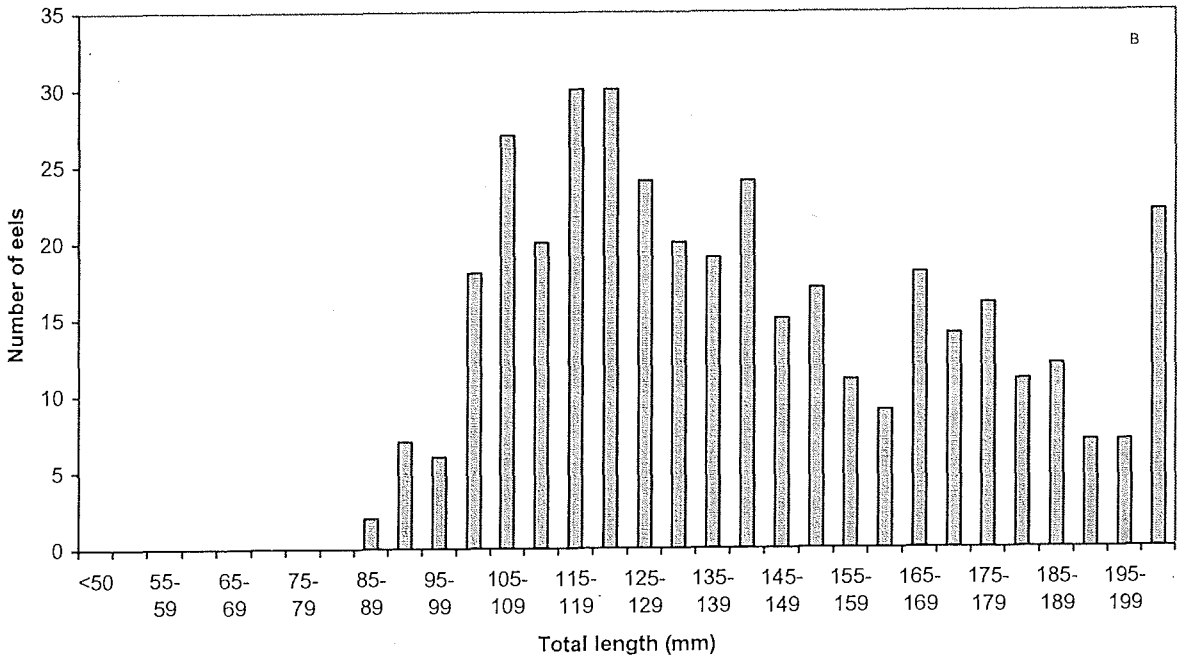


Figure 7. Number of contacts made by time of day in 2002.

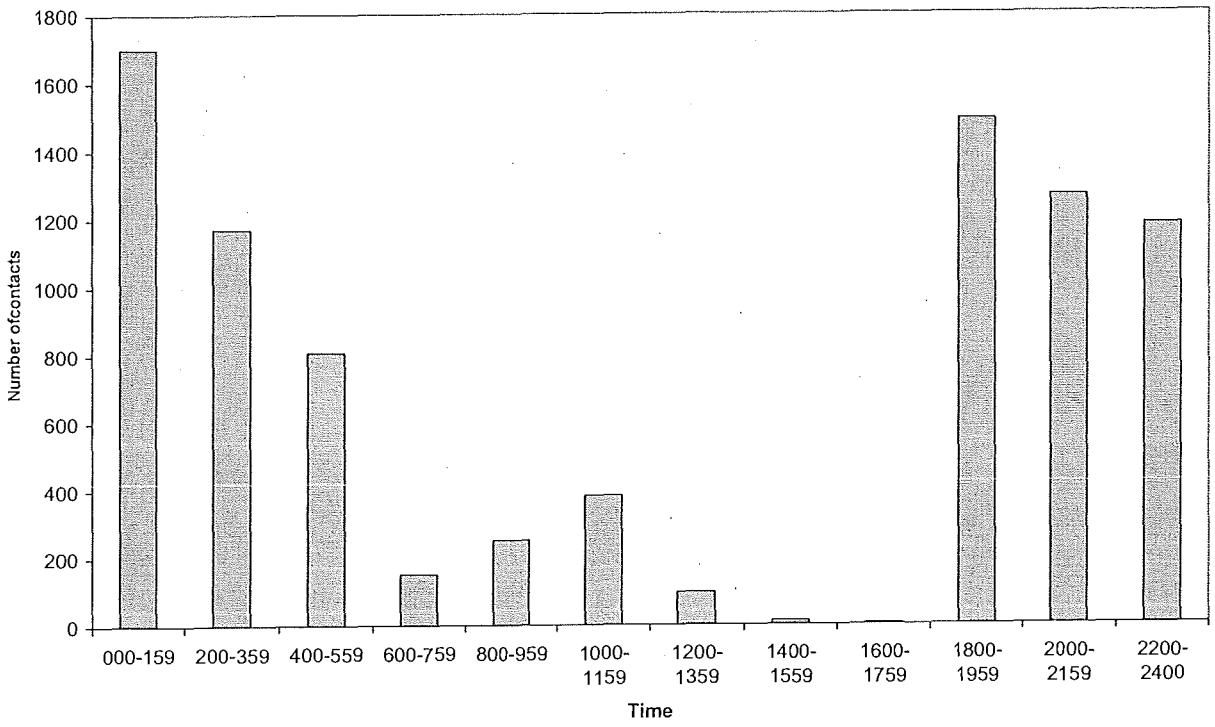


Figure 8. Eel harvest in Maine.