Final Report to the Licensed Elver Fishers on the East River, Chester Project 2008

by:

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Abstract

The Bluenose Coastal Action Foundation (BCAF) was contracted by the Atlantic Canadian elver license holders to implement an abundance study of American eel elvers. The resulting elver productivity study began on May 1st, 2008, on the East River in Chester, Nova Scotia and will continue for 3 consecutive years. This project was a continuation of research previously conducted by Fisheries and Oceans Canada (DFO) in the late 1990s (Table 3). A total of four Irish style elver traps were setup below the falls at the East River, with the falls serving as a natural obstacle for the elvers in their run. Traps were operational between May 1st and June 15th, but there were still elvers migrating up the East River after the 2008 season study ended. The elver count over the entire study was 452,990. Thermographs monitored water temperature above the falls and in the estuary. Biological sampling was conducted three days a week to record elver size, relative condition, and pigmentation stage.

Introduction

The American eel and elver fisheries are unique in that there is little known about the biology of the species (Jessop 2002). Given the lack of knowledge surrounding their populations, it is presently uncertain what effect, if any, the fishing industry has on their numbers. Studies conducted ten years ago, along with results from this project, can be compared to determine whether there has been any change in elver populations entering the East River. This study is an elver count, which will estimate the run size of elvers measured through the traps placed in the East River, Chester (Table 3).

The goal of this study is to (1) determine the number of elvers migrating up the East River, Chester on a daily basis; (2) determine the pigmentation stage, size, and condition of elvers and juveniles; and (3) provide the elver license holders and DFO with a final report based on the results of the study.

Study Area

The East River drains into Mahone Bay, with its watershed located in the Municipality of the District of Chester. The watershed has two main tributaries; Barry's Brook and the Canaan River, with a drainage area of 134 km² (Figure 1). The Canaan River is located 4 km upstream from the mouth of the East River and Barry's Brook a further 0.5 km in the same direction. The acidification of the river has it classified as a Category 2 river with a pH range of 4.8 to 5.0 (Jessop 2002). When sampled weekly by field technicians with an YSI Sonde, the pH ranged between 4.8 and 5.1. The pH of the East River is highly impacted by the natural geology and geography of this area. Bogs, underlying rock types, and poor water drainage all contribute to the acidification of the river water (Jessop 2002).

There has been a history of projects conducted on the East River including limestone being added to the headwaters. This occurred on the East River between 1986 and 1995, and successfully raised the pH levels. During that time, pH measurements reached from 5.3 to 6.7 (Jessop 2002, Watt, and White 1992). Electrofishing was performed on the river between 1983 and 1994, with the predominate species found to be the American eel (Jessop 2002).

Trap placement for the 2008 study saw traps located on the upper side of the Hwy #3 bridge crossing the East River. The traps were set between the bridge and the small falls, which acted as a natural barrier to slow the movement of elvers upstream (Figure 2). This barrier constricted their advancement to the edges of the falls, where the water velocity was slowest. This portion of the river is influenced by the tides, whereas above the falls there is little to no impact. The elevation decreases 1.1 meters from the top of the falls to the mouth of the river (Jessop 2002).

Methods

Trap set-up

Traps used for the 2008 study were Irish style elver traps, placed in the river during the last week of April. Traps were operational from May 1st , through to June 15th. Four traps were used in total, with two placed on each side of the river just below the falls (Figure 2). Cement ramps were either repaired or replaced in April before the study began. Trap numbers were assigned as follows: Trap one was furthest downstream on the Mahone Bay side (true right); Trap two was upstream on the same side; Trap three was the furthest downstream on the Halifax side (true left); and Trap four

was upstream on the left side. High water levels and velocity from the falls were used as an advantage to attract elvers to the traps. The elvers used the edge of the river to find calm water, in which to travel upstream. The ramps used for the elver traps were the path of least resistance for the elvers to follow. Water flow through the traps was provided by hoses that were gravity fed from above the falls. The water was flushed through the hoses to the traps, creating a current down the ramps. Once the elvers climbed the ramps, water flushed them into a holding box, where they were collected. When water levels dropped due to tides and changing water levels, Inca mats were secured to the bottom of the ramps to ensure there was no gap between the water level and the ramps, impeding elver movement. Malfunctioning of the elver traps substantially reduced the accuracy and reliability of counts taken during the first week of operation. The commercial elver license holders obtained a scientific license to dip and release elvers for three nights (May 6-8), allowing time for the traps to become fully operational (Table 2). Under the scientific license, elvers were dipped using the same fishing method as the commercial license holders and measured in kilograms before released above the falls.

Elver Processing

Traps were emptied every morning at 6:00 am into 5 gallon buckets with fresh water, using small nets to reduce damage and stress to the elvers. Each trap was individually counted to obtain a total count. On days when there were fewer elvers in the holding boxes (usually less than 200 individuals), the elvers were hand counted. For larger amounts of elvers, their numbers were calculated volumetrically. This was accomplished by calibrating the number of elvers per 100 milliliters using a graduated cylinder. The number of elvers could then be estimated by measuring out the total number of milliliters per trap. The graduated cylinder count was recalibrated every 3-4 days. Towards the end of the study, the number of elvers per 100 mL increased as pigment stages also advanced. This was due to elvers maturing and physically reducing in size (Jessop, 2000). The elvers that were volumetrically measured were released alive upstream to avoid re-catch.

Biological sampling was completed on Mondays, Wednesdays, and Fridays of each week. A total of 50 elvers were taken from the traps for this purpose. These individuals were euthanized using a 10 percent clove oil and water solution. Elvers were blotted dry and then measured for length using digital calipers. Weight measurements were also included in the study protocol; however, the absence of an accessible power source on which to run the digital scale prevented this data from being collected this season. Elvers were assessed for pigmentation stage and digitally photo-documented with this data. Juveniles were also sampled but not euthanized. The protocol for juveniles called for them to be placed in a reduced amount of the clove oil solution, then once measured, placed in fresh water to recover before being released upstream of the falls. Manually restraining the juveniles proved to be the most effective method for the field crew and ensured no juvenile deaths. Data collected on juveniles was consistent with that of elvers.

Habitat Data

Thermographs were set above the falls at the Louisiana Pacific pumping facility and also at the mouth of the East River on a private wharf (Figure 2) to record the temperature and water height at hourly intervals. The thermographs were placed in the water on May 1st, and were removed the week after the study was concluded (Figure 3). Records of tidal heights were kept to compare with run abundance. ph levels were also monitored using a YSI Sonde, with an average reading between 4.81 and 5.12 above the falls at the study site.

Results

Elver Run & Fishery

Over the first week of May, all four traps became operational. Traps one and two were turned on May 1st, while Traps three and four remained off while waiting for foot valves to be placed on the hoses. Trap two stopped running on May 5th. Problems occurred with keeping the hoses functioning due to air locks and leaky equipment. Air locks reduced or inhibited water flow to the traps and holding boxes. All traps became continuously operational on May 7th, with all air locks being eliminated and the hose length shortened. With the traps not working properly, the commercial elver license holders obtained a scientific license to dip and measure in kilograms the elvers running on May 6th, 7th, and 8th. Once measured, the elvers were released above the falls with an estimated number of 397,800 or 76.5 kg (Table 2).

The first elvers of the study were caught on May 5th by Trap one. The first juveniles were caught on May 8th. Discussions with the commercial elver license holders indicated that the beginning of the first major run was missed, partly due to equipment malfunctions and the timing of the project. Once all four traps were operational, the first major catch reached 18 000 in total numbers. The dates of the larger runs were: May 8-10, May 17, May 20-21, May 29-31, and June 8-11. The project ended on June 15th, with the final count taken that morning and all traps shut off. The success of the traps varied, with Traps one and three, located further downstream, capturing the majority of elvers caught. Trap one, over the 46 day study period, captured 208,471 elvers, while Trap three had 163,548. Trap two had the least total captures with 30,457, and Trap four had 50,514. The total elver count in the East River, Chester this season using the four traps was 452,990 (Table 1, Figure 5).

The elver traps and commercial equipment used during this study did not have a 100 percent efficiency rate, with some elvers being able to bypass the traps / dip nets and maneuver over the falls. This level of escapement was considered to be low compared with the total number of elvers migrating through the site. The total estimated run size included the elver count using the four traps, as well as the commercial harvest numbers and the numbers caught on May 6-8, under the scientific license. The total estimated run size in the East River, Chester for the 2008 season was 1,873,593 elvers (Figure 4&5).

Elver In-stream Movements

Elver numbers could have been influenced by the water levels flowing down the East River. As the water levels decreased, mats were used to extend the ramps of the traps if they did not reach the water. It is unknown whether the mats were as successful as using only the ramps themselves. Tides also had a major impact on the amount of elvers present in the steam, which would affect the daily counts of the holding boxes. Throughout the study large counts were collected when there was a high tide during the night.

Environmental Effects on Run Timing

The river's pH was monitored four times throughout the study. Recorded levels ranged from 4.82 to 5.12. The temperature was monitored hourly using thermographs. Two were placed on site, with one above stream by the Louisiana Pacific intake building (Figure 3). The other was near the estuary at the mouth of the river, hanging from a private wharf. The thermographs were placed in the water on May 1st, and removed on June 23rd.

Date	May 14, 2008	May 22, 2008	June 2, 2008	June 12, 2008
pH	5.07	5.12	4.82	5.12
Temp. (°C)	10.25	10.26	12.69	16.33

* Temp from thermograph at LP plant.

Water temperature on the first day of the project was 11.7°C at the wharf location and 12.2°C at the Louisiana Pacific plant. On the final day, the temperatures were 8.6°C at the wharf and 19.4°C at the other location (Figure 3).

Tidal height and timing had significant effect on the number of elvers entering the river basin. The highest elver counts resulted when high tide was at night with the tide dropping before morning. This had a significant impact on the number of elvers found in the holding boxes in the morning, as well as the size of the runs. The following table shows the dates of the large elver runs in correlation with timing and tidal height.

Date of Significant Elver Runs	High Tide	Tidal Height (m)
May 8	11:13 am, 11:20 pm	1.73 , 1.88
May 9	12:07 pm	1.68
May 10	12:13 am, 1:04 pm	1.8, 1.63
May 17	7:17 am, 7:24 pm	1.57, 1.72
May 20	9:21 am, 9:18 pm	1.62, 1.70
May 21	10:00 am, 9:47 pm	1.60, 1.68
May 29	2:55 am, 3:47 pm	1.44, 1.69
May 30	4:05 am, 4:48 pm	1.44, 1.69
May 31	5:17 am, 5:46 pm	1.47, 1.77
June 8	12:48 pm	1.70
June 9	12:51, 1:40 pm	1.71, 1.67
June 10	1:45, 2:34 pm	1.60, 1.63
June 11	2:26 am, 3:09 pm	1.50, 1.60

Elver Biological Characteristics

The weekly average lengths recorded for both elvers and juveniles are highlighted in the chart below. Pigment stage was also determined using a reference guide from previous reports (Haro and Krueger, 1988). Digital pictures of each individual elver were taken and assigned a reference number to be synced with the length and pigmentation of that elver.

Elvers

Week	May 5-9	May 12-16	May 19-23	May 26-30	June 2-6	June 9-13
Sample Size	120	150	150	150	150	150
Avg. Length (mm)	60.29	63.33	60.11	62.22	61.52	60.17

Juveniles

Week	May 5-9	May 12-16	May 19-23	May 26-30	June 2-6	June 9-13
Sample Size	8	13	2	15	7	2
Avg. Length (mm)	84.75	90.5	99.11	96.0	95.48	93.55

Pigmentation

Pigmentation stages changed throughout the course of the study, with elvers being grouped in the glass stage at the beginning of May, while progressing to stages four and five, on average, during the middle of May. During the last ten days of the study, there was predominantly late stage pigmentation observed, and very few glass eels.

Juvenile Eel Biological Characteristics

Juveniles were also sampled. As per protocol, juveniles were not to be euthanized using the clove oil; they were immersed in a much lower concentration clove oil solution to render them temporarily inactive. This procedure proved too difficult for field staff, as the appropriate clove oil to water ratio was not consistent for maintaining the health of the animals. The juveniles were instead manually restrained to take the necessary measurements. A total of 280 juveniles were sampled. Not all juveniles were counted, as they were extremely difficult to identify during the large runs due to the large number of elvers caught. For the biological sampling, the juvenile elvers were counted, and then only half the sum was measured, due to the difficulty in collecting the necessary data when they were not anaesthetized. The juveniles varied in size from 59.99 mm to 129.36 mm.

Discussion

The elver run timing and size in Nova Scotia differs from more southern areas where it can be earlier and longer. The average run time in Nova Scotia lasts approximately nine weeks, compared to 20 weeks in the more southerly coastlines of the eastern seaboard (Jessop 1998b). These estimated run times account for a heavy influx of elvers into estuaries and rivers, but elvers can migrate into rivers for weeks after the initial rush. The date that elvers arrive at East River, Chester varies from year to year. In 1997, the first elvers were caught on May 22nd, due to unfavorable environmental conditions. In 1996, 1998, and 1999, the run started around May 1st (Jessop 2000). Based on data provided by the commercial elver license holders, the run started early this year, with significant numbers being caught on April 22nd. Traps only became operational May 1st, on the

East River, Chester, meaning accurate recording of the first run of elvers was not included in the 2008 data.

The physical change in appearance of the elvers occurred from glass stage to dark pigmentation. The darker pigmentation became more prominent during the fourth and fifth weeks of the study, starting around May 23rd. This change in pigment stage can spread over weeks or months. It is thought that the elvers' pigmentation changes over the course of the season due to the increasing offshore temperatures, which influences their metamorphosis (Jessop 2002).

The water temperature at the mouth of the river on May 1st, was 5.6°C, while above the falls it was 9.72°C (Figure 3). Looking at past studies the temperature when elvers first entered the river was 9.7°C in 1996, 10.9°C in 1997, 12.3°C in 1998, 11.4°C in 1999, and 9.4°C in 2000 (Jessop 2002). The water temperature of the river has an impact on the run timing of the elvers, with the largest numbers entering the river once the temperature has reached 10°C. Other studies have concluded that temperature is not a parameter in elver migration upstream (Jessop 2002). The appearance of juvenile eels heading upstream is thought to occur because of some elvers becoming residents of the estuary and remaining there for up to four years before entering the freshwater. They can also remain permanent estuarine residents (Jessop 2002).

The challenge of elvers migrating up the East River is that they have to maneuver the barrier of the falls, where the traps are placed. Artificial and natural barriers can easily impede elver movement depending on the conditions (Jessop 2002). In the East River, Chester, low water levels during the summer have been observed at the trap sites, making the falls impassable (Figure 2). The elvers cannot swim in velocities of over 35 $cm \cdot sec^{-1}$ and usually choose not to swim at even lower velocities. To overcome water currents, the elver is adaptable to surface areas, and is able to climb over damp rocks or anything with a rough surface (Jessop 2002). Once the elvers on the East River, Chester have successfully made it over the falls, it is estimated that they migrate less than one kilometer upstream in their first year. In the Atlantic Region, these estimates can be extremely different for particular rivers (Jessop 2002).

During this study, when traps were checked in the early morning, there were elvers still pooling in the area. Migration usually occurred at night with the highest volumes following a high tide, as has been the case in previous studies (Jessop 2002). Water flow out of the holding boxes also attracted the elvers, where they gathered at the base and underneath the box, even during daylight conditions. Environmental elements that have a significant impact on the movement of elvers into the East River include: (1) temperature, which influences the start of the runs; (2) water level and velocity, which affect the elvers ability to maneuver over barriers upstream; and (3) tides, which bring elvers into the estuary and river mouth (Jessop 2002). Although the 2008 season ended on June 15th, partly due to funding, there continued to be a run of elvers migrating up the East River in the following weeks.

Acknowledgements

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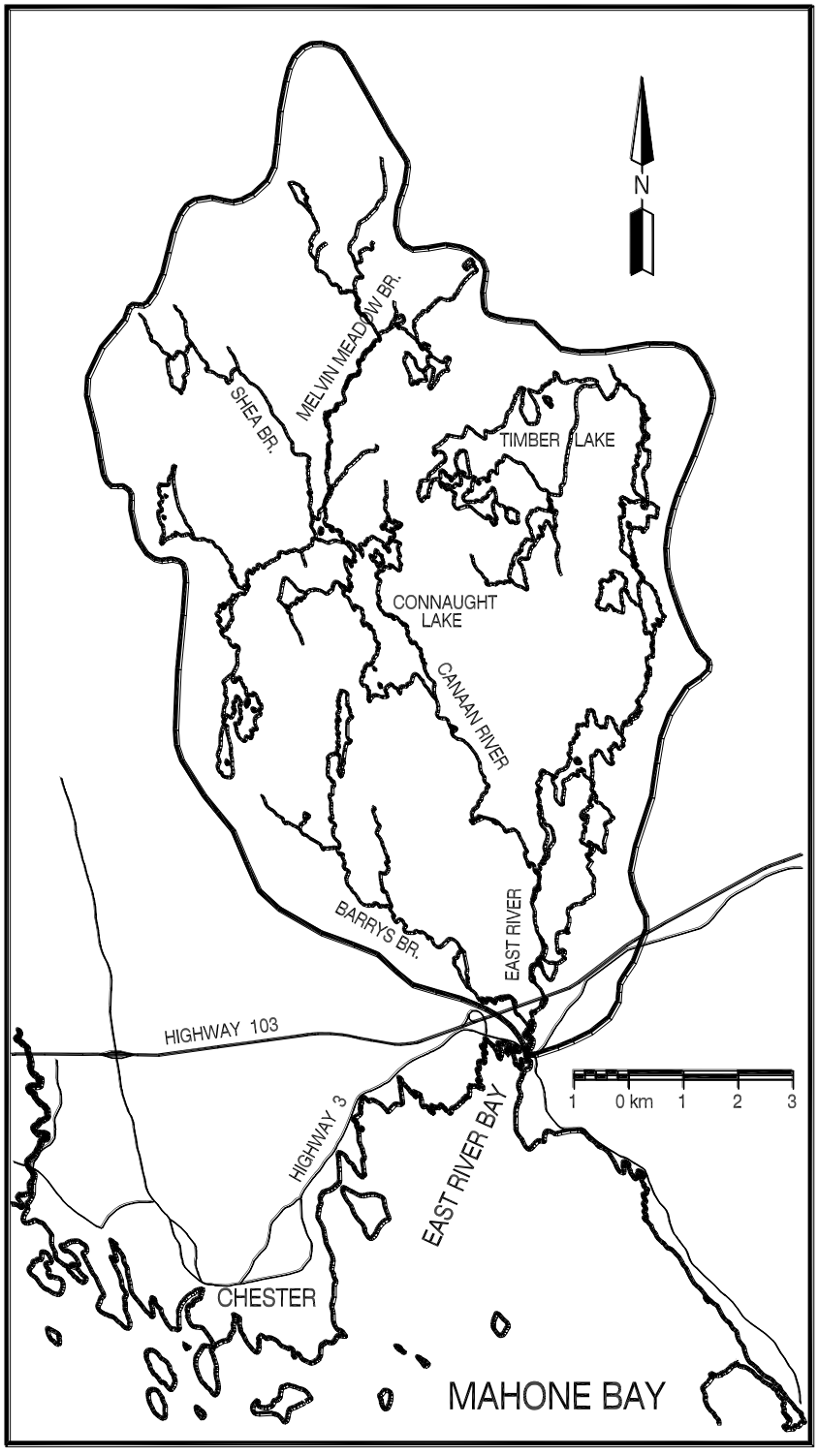

Figure 1. Drainage basin of the East River, Chester, Nova Scotia (area 134.0 km^2) (Jessop 2002).

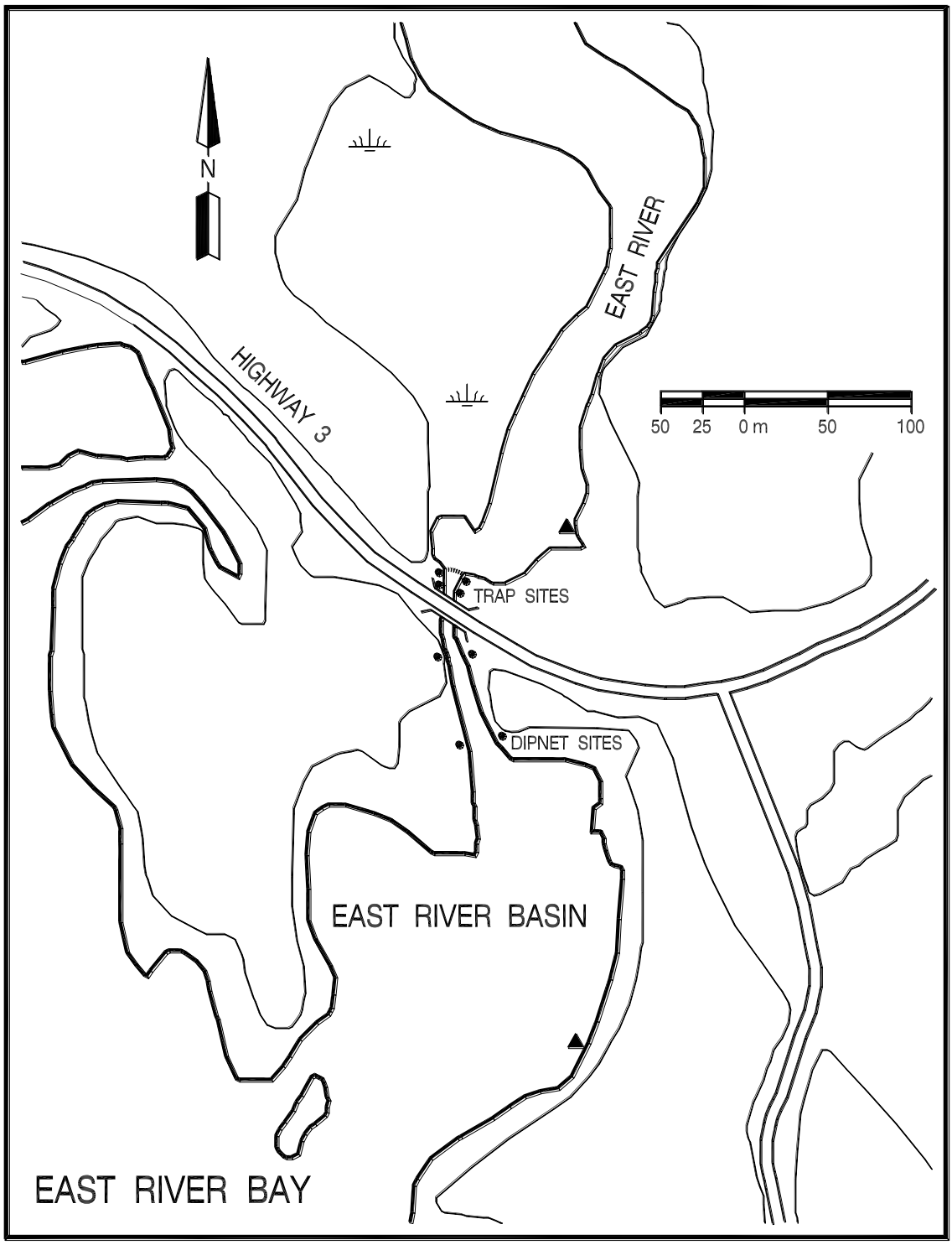

Figure 2. Elver trap and range of dip net fishing locations on the East River, Chester, Nova Scotia. Solid triangles indicate thermograph sites (Jessop 2002).

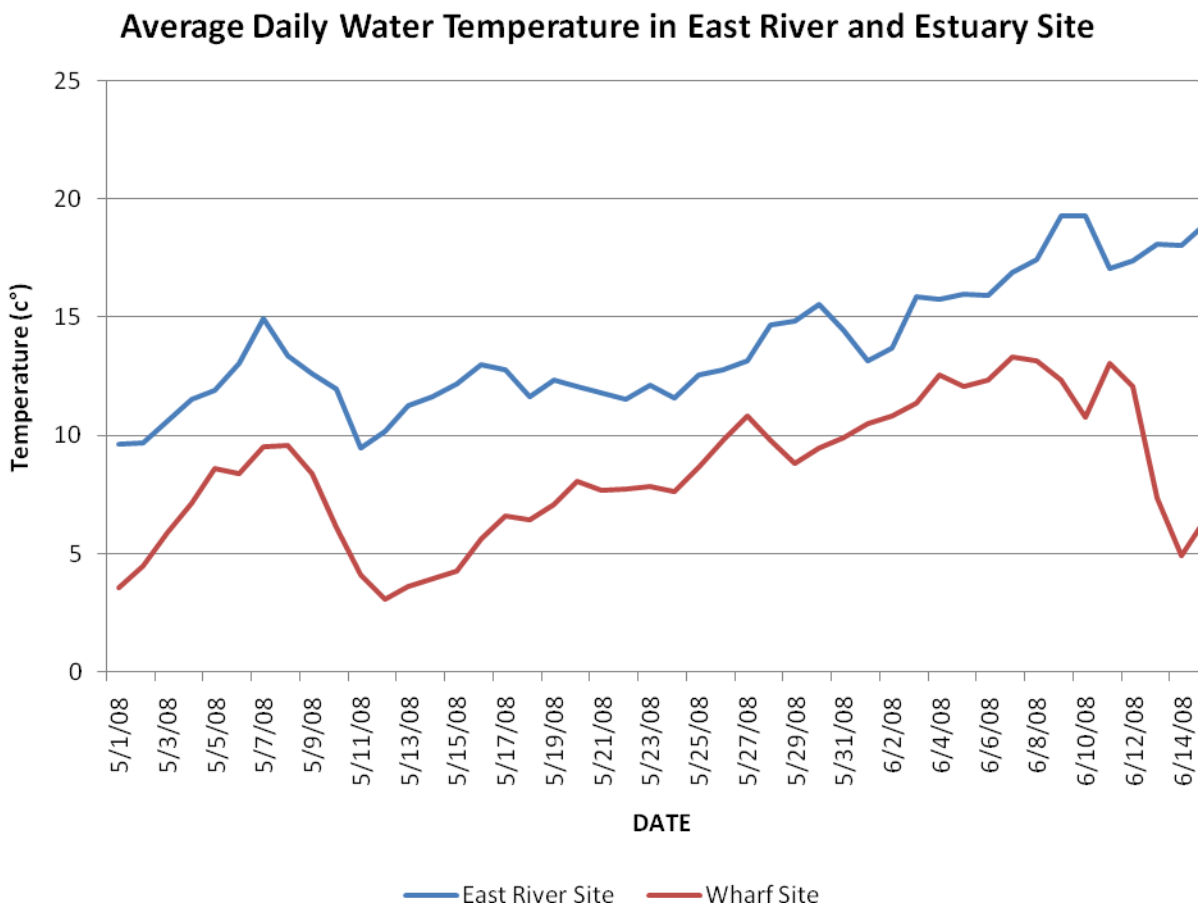

Figure 3: Average daily water temperature from May 1, 2008 to June 15, 2008. Data from thermograph above falls in the East River and private wharf in the estuary in Chester, NS.

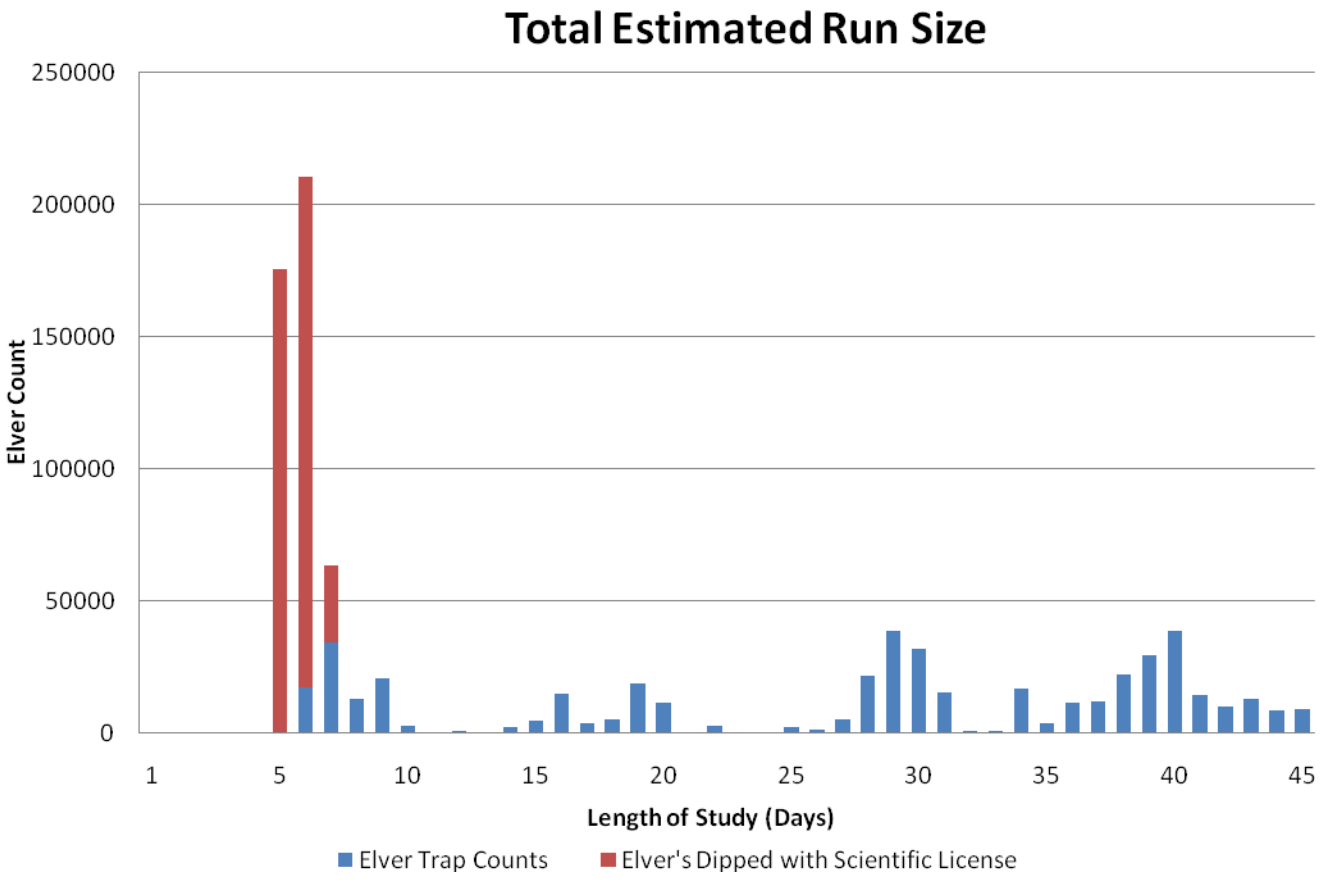

Figure 4: Total estimated run size, which includes the elver count and elvers dipped under scientific license.

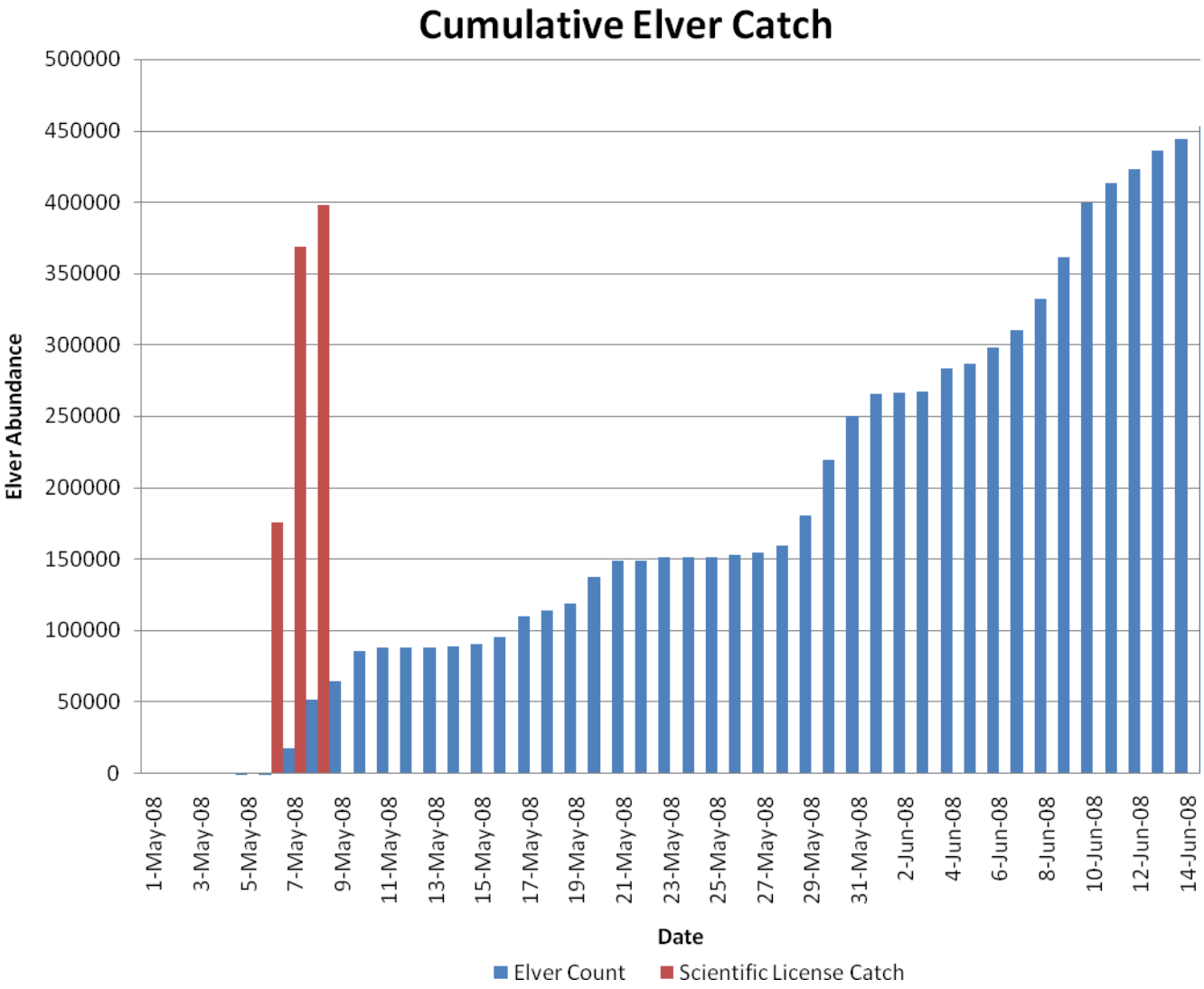

Figure 5: Cumulative elver counts from the East River study, and the three nights of dipping under scientific license (May 6-8, 2008). The last bar of each represented catch, shows the total number of elvers caught from the season.

Table 1. Estimated trap catches of American eel elvers and juveniles, by date, from the East River, Chester, 2008.

DATE	TRAP 1	TRAP 2	TRAP 3	TRAP 4	TOTAL	CUMCT	DAILY %	CUM%
20080501	0	0			0	0	0	
20080502	0	0	0	0	0	0	0	
20080503	0	0	0	0	0	0	0	
20080504	0	0	0	0	0	0	0	
20080505	71	0			71	71	0.01567	0.015673
20080506	79	3			82	153	0.018101	0.033775
20080507	13200	363	44	3917	17524	17677	3.868518	3.902293
20080508	13330	16104	618	4478	34530	52207	7.62268	11.52498
20080509	4308	2112	463	5940	12823	65030	2.83074	14.35572
20080510	10824	1584	7656	528	20592	85622	4.54579	18.90152
20080511	470	176	353	1645	2644	88266	0.583677	19.4852
20080512	51	9	7	33	100	88366	0.022075	19.50727
20080513	55	88	55	226	424	88790	0.0936	19.60087
20080514	41	49	55	142	287	89077	0.063356	19.66423
20080515	768	37	221	921	1947	91024	0.42981	20.09404
20080516	3300	69	275	825	4469	95493	0.986555	21.08059
20080517	6140	307	4605	3684	14736	110229	3.25305	24.33364
20080518	307	614	1842	921	3684	113913	0.81326	25.14691
20080519	996	664	1328	1992	4980	118893	1.07949	26.24627
20080520	4648	83	13280	664	18675	137568	4.1226	30.36888
20080521	3652	249	6640	664	11205	148773	2.47356	32.84244
20080522	138	25	102	3	268	149041	0.059162	32.9016
20080523	377	565	1320	5	2267	151308	0.50045	33.40206
20080524	47	14	106	0	167	151475	0.036866	33.43892
20080525	58	3	25	1	87	151562	0.019205	33.45813
20080526	351	32	1404	88	1875	153437	0.413916	33.87205
20080527	351	27	702	33	1113	154550	0.2457	34.11775
20080528	1053	34	3861	64	5012	159562	1.106426	35.22417
20080529	12441	20	7540	1320	21321	180883	4.70672	39.9309
20080530	23374	377	9048	5655	38454	219337	8.48892	48.41983
20080531	21112	377	9048	943	31480	250817	6.94938	55.36921
20080601	10179	40	3770	1131	15120	265937	3.337822	58.70703
20080602	472	5	79	2	558	266495	0.123181	58.83021
20080603	93	11	465	1	570	267065	0.12583	58.95604
20080604	1302	24	15252	93	16671	283736	3.68021	62.63626
20080605	93	39	2976	186	3294	287030	0.727168	63.36342
20080606	3906	93	5952	1302	11253	298283	2.48416	65.84759
20080607	1674	186	8928	930	11718	310001	2.58681	68.4344
20080608	7440	744	12462	1302	21948	331949	4.84514	73.27954
20080609	17835	870	10223	435	29363	361312	6.48204	79.76158
20080610	26100	435	8700	3045	38280	399592	8.45051	88.2121
20080611	3480	50	7830	2610	13970	413562	3.08395	91.29605
20080612	2610	60	5220	1740	9630	423192	2.12587	93.42192
20080613	4350	2610	4350	1305	12615	435807	2.78482	96.20675
20080614	2610	435	4350	870	8265	444072	1.82454	98.0313
20080615	4785	870	2393	870	8918	452990	1.96869	100
	208471	30457	163548	50514	452990			

Table 2: Commercial elver license holders catch under scientific license on the East River, Chester NS**.**

Date	Fishing Gear	Number of Gear Units	Hours fished per gear unit	Catch in kilograms	Catch in number of elvers	Comments
May6/08	Dip Net	4	3.50	30 buckets = 33.750 kg	175500	scientific lic. 2008-087
May 7/08	Dip Net	4	4.50	33 buckets = 37.125 kg	193050	scientific lic. 2008-087
May 8/08	Dip Net	4	3.75	5 buckets = 5.625 kg	29250	scientific lic. 2008-087
TOTAL				**76.500**	397800	

Table 3: Summary table of elver counts from previous studies conducted by Brian Jessop on the East River, also including the 2008 study numbers (Jessop 1997, 1998, 1999, 2000, 2002)

Study Year	**Date**	**Trap 1**	**Trap 2**	**Trap 3**	**Trap 4**	**Total**
1996	April 26-July 15	206,650	271,790	213,610	100,540	792,590
1997	April 27- July 12	99,670	303,710	295,300	319,940	1,018,620
1998	April 17- Aug 7	40,060	72,230	60,380	35,490	208,264
1999	April 21- July 23	23,700	240,505	112,957	65,287	441,758
2000	April 27-July 23	103,657	301,838	283,206	102,503	791,204
2001						525,096
2002						820,573
2008	May 1- June 15	208,471	30,457	163,548	50,514	452,990