Final Report to the Licensed Elver Fishers on the East River, Chester Project 2009

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 2). A total of four 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 for the 2009 season were operational between May 1st and July 15th. The elver count over the entire study was 509,175. 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, Chester. 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 2).

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 km^2 (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 in 2008 with an YSI Sonde, the pH ranged between 4.8 and 5.1 (Turner 2008). In 2009, the pH ranged from 4.87 to 6.06. 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 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 (Turner 2008). For the 2009 season, the holding boxes of the original traps were redesigned. These boxes were larger in size and also had a removable holding bag inside to make collection of the elvers more efficient. On account of this new bag being introduced to the holding box design, the hose led into the traps through the lid and not the side like in the traditional traps. This set-up had to be changed back to side entry later on in the study as the water level of the river dropped. Traps were operational from May 1st, through to

July 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. They were altered as the elvers began to run to ensure they were catching at full potential. 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. The trap locations were changed slightly based on 2008 results so they fished more efficiently. Trap 4 was moved further down river then Trap 3, which remained in its original position. Trap 2 was also moved slightly further downstream on the Mahone Bay side. Trap 1 is susceptible to becoming non-functioning during high tides, therefore, a wooden ramp was added to this trap to make it more successful during high tides. 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 and moss were secured to the ramps to ensure there was no gap between the water level and the ramps, impeding elver movement.

Elver Processing

Traps were emptied every morning at 6:00 am into 5 gallon buckets with fresh water. Holding bags were removed from the boxes and poured into the buckets unless they were in very small numbers, then small nets were used 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 taken using a digital scale, which was accurate to the hundredth gram. 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 April 28th, 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 an YSI Sonde, with an average reading between 4.87 and 6.06 above the falls at the study site.

Results

Elver Run & Fishery

Traps were made operational on April 30th, 2009. Traps were originally set in the same positions as the 2008 season but were altered over the first couple weeks. Trap four was moved closer to the mouth of the river then Trap three. Trap two, on the Mahone Bay side, was also moved closer to the mouth of the river and Trap one had a wooden ramp added to it making it more efficient in high water conditions. Air locks were not an issue in 2009, as they were in 2008, as new hose was donated to use for the study. The new holding boxes proved to be effective but when water levels lowered in the river, water pressure coming down into the traps was reduced and therefore water flowing through the lid was significantly reduced. The positioning of the hose entering into the holding box was changed to the side so water flow was more consistent.

The first elvers of the study were caught on May 2nd by Trap three. The first juveniles were caught on May 4th. With all traps operational, the first major catch reached 15 000 in total numbers. The elvers had one major run this season with two peaks. The dates of the run were: May 15-19 with a peak of 114,584 elvers in one night, and May 21-24 with a one night peak of 107,144 elvers. The project ended on July 15th, with the final count taken that morning and all traps shut off. The success of the traps varied, with Traps one and four having the most success this season. Both these traps were located furthest down the river. Trap one, over the 75 day study period, captured 123,964 elvers, while Trap three had 112,550. Trap two had the least total captures with 97,453, and Trap four had 175,208. The total elver count in the East River, Chester this season using the four traps was 509,175 (Table 1, Figure 5).

The elver traps used during this study did not have a 100 percent efficiency rate, with some elvers being able to bypass the traps 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. The total estimated run size in the East River, Chester for the 2009 season was 1,131,865 elvers (Figure 4&5).

Elver In-stream Movements

Elver numbers could have been influenced by the water levels flowing down the East River. During low tide, before the study commenced, ramps were repaired and lengthened as much as possible. As the water levels decreased, mats and moss were used to extend the ramps of the traps if they did not reach the water. 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 twice throughout the study. Recorded levels ranged from 4.87 to 6.06. The temperature was monitored hourly using thermographs. Two were placed on site, with one above stream by the Louisiana Pacific intake building (Figure 2). 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 April 28th, and removed on July 25th.

Date	May 13, 2009	May 31, 2009
pH	4.87	6.06
Temp. (°C)	12.1	14.4

* Temp from thermograph at LP plant.

Water temperature on the first day of the project was 5.2°C at the wharf location and 10.4°C at the Louisiana Pacific plant. On the final day, the temperatures were 18.6°C at the wharf and 20.0°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)	
	AM	PM	AM	**PM**
May 14		12:33		**1.53**
May 15	12:34	1:14	1.56	**1.49**
May 16	1:16	1:58	1.50	**1.47**
May 17	2:03	2:47	1.44	**1.47**
May 18	2:58	3:42	1.39	**1.50**
May 19	4:03	4:39	1.37	**1.56**
May 20	5:09	5:32	1.39	**1.64**
May 21	6:07	6:21	1.45	**1.72**
May 22	6:59	7:08	1.52	**1.79**
May 23	7:49	7:56	1.59	**1.85**
May 24	**8:40**	**8:44**	**1.65**	**1.89**

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.

	Elver			Juvenile		
Week	Sample Size	Avg. Length (mm)	Avg. Weight (g)	Sample Size	Avg. Length (mm)	Avg. Weight (g)
May 4-8	30	62.96	0.211	15	89.37	0.814
May 11-15	76	61.37	0.195	27	89.32	0.752
May 18-22	150	60.66	0.164	57	97.57	1.214
May 25-29	150	59.31	0.160	23	92.91	0.941
June 1-5	150	58.88	0.149	33	90.71	0.845
June 8-12	150	58.95	0.140	15	86.51	0.721
June 15-19	150	58.69	0.136	24	81.55	0.621
June 22-26	150	58.21	0.136	36	77.37	0.591
June 29-July 3	150	56.71	0.137	30	79.72	0.556
July 6-10	150	58.00	0.119	27	80.20	0.635
July 13-15	99	58.74	0.118	32	75.74	0.485

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 3 and 4, on average, during the middle of May. Most elvers were classified at stage 5 or 6 by the end of the study.

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 of the 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. This procedure was also followed in the 2008 study. A total of 319 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 with the largest caught being 194.41 mm in length and weighed 8.02 g. The smallest juvenile was 57.2 mm and 0.21 grams.

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). In 2008, based on data provided by the commercial elver license holders, the run started early with significant numbers being caught on April 22nd, before the elver traps running. 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 (Turner 2008). For the 2009 season, traps were set up at the end of April and were functioning on May 1st, and the first significant numbers being caught on May 14th.

The physical change in appearance of the elvers occurred from glass stage to dark pigmentation. At the beginning of the study, the elvers were entering the river in the third stage on average. The darker pigmentation became more prominent during the later weeks of the study. This change in pigment stage can be 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 5.2°C; while above the falls it was 10.4°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 temperature on May 1st, 2008 was 9.72°C above the falls (Turner 2008). 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, Chester 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 at 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). The 2009 season ended on July 15th; however, the large numbers of elver migrating up the East River, Chester had finished by the end of June, with only a couple hundred elvers being caught every few days in July (Table 1).

Acknowledgements

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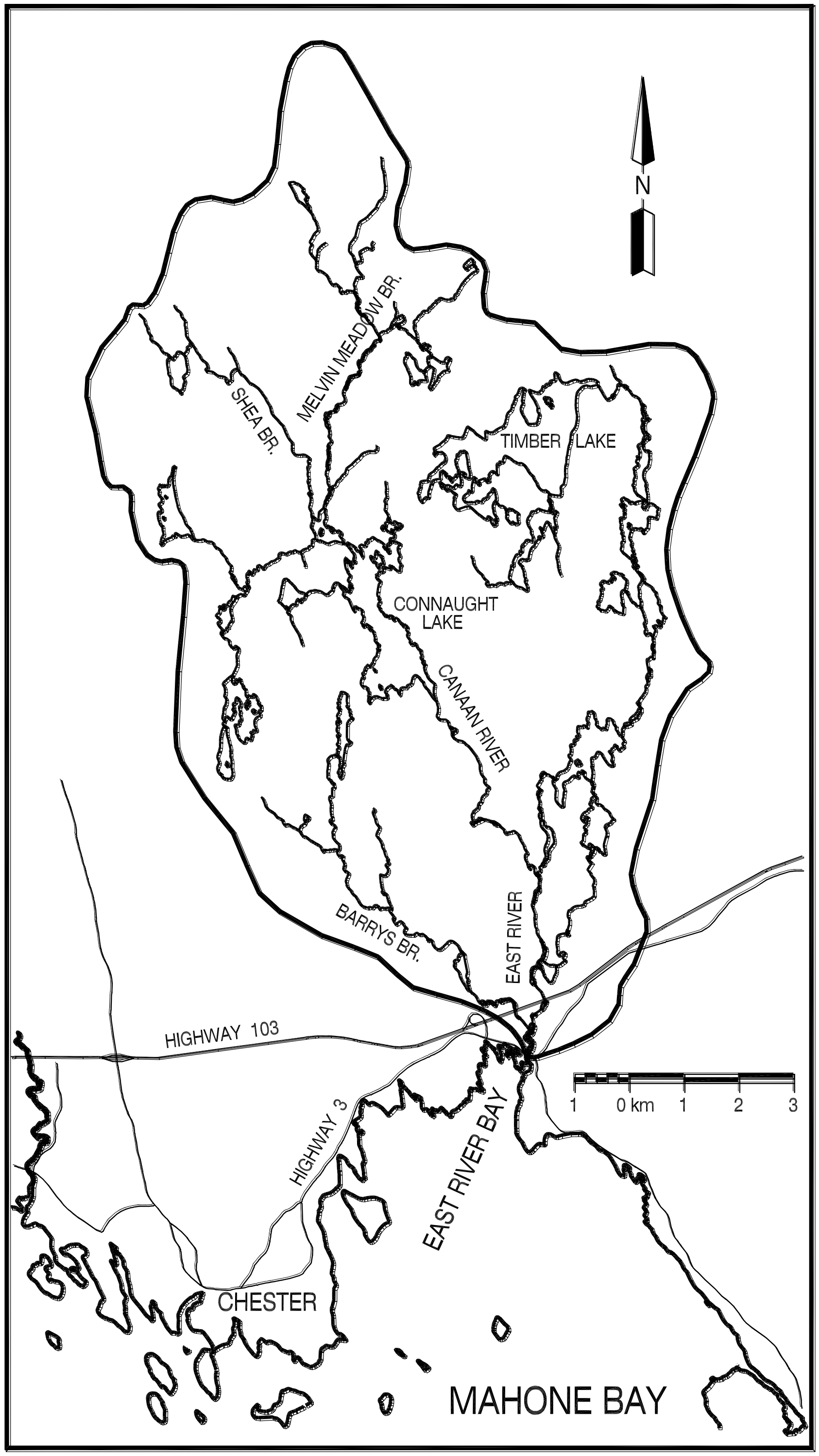

Figure 1: Drainage basin of the East River, Chester, Nova Scotia (area 134.0 km^2) (Jessop 2002).

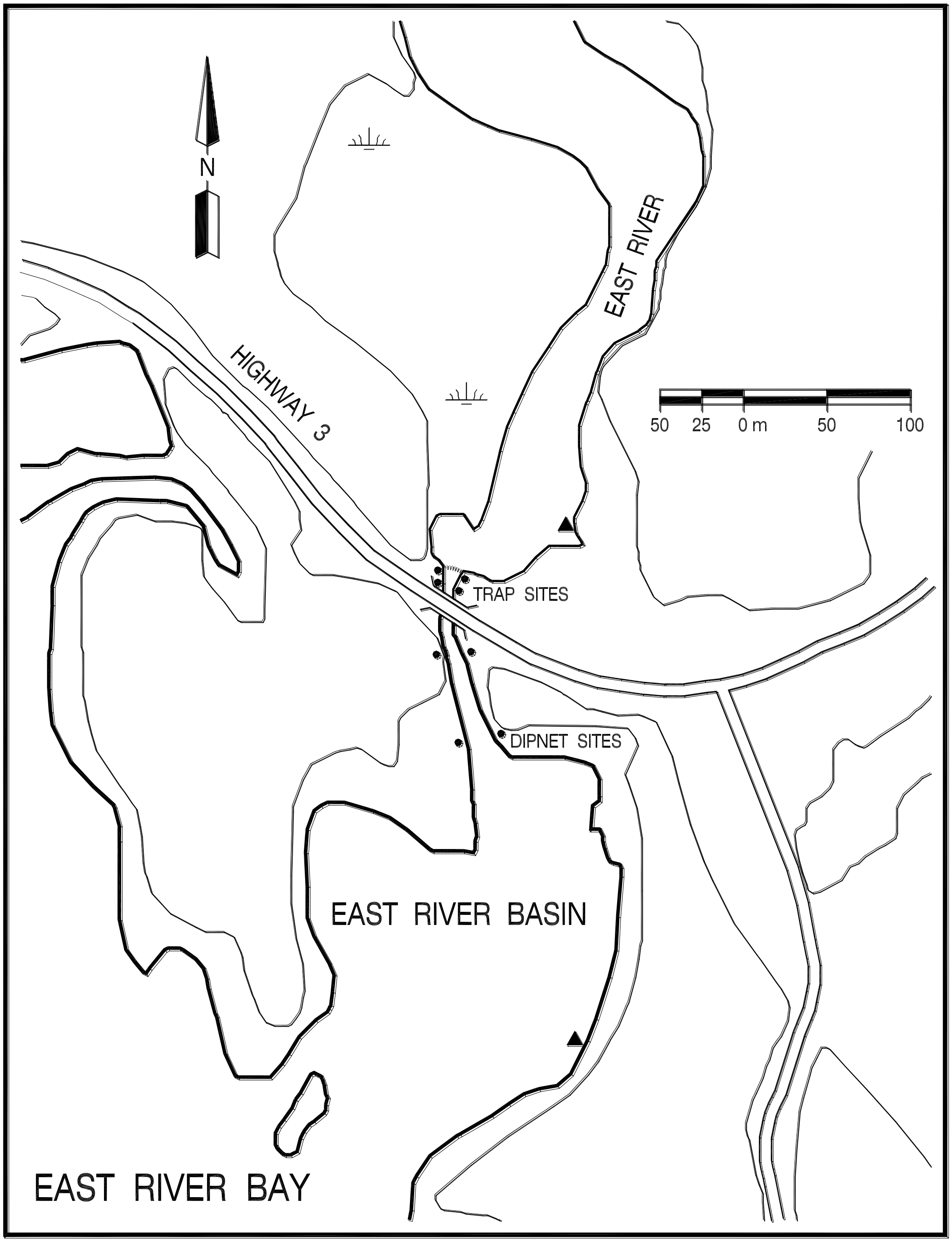

Figure 2: Elver trap and range of dip net fishing locations on the East River, Chester, Nova Scotia. Solid triangles indicate thermograph sites (Jessop 2002).

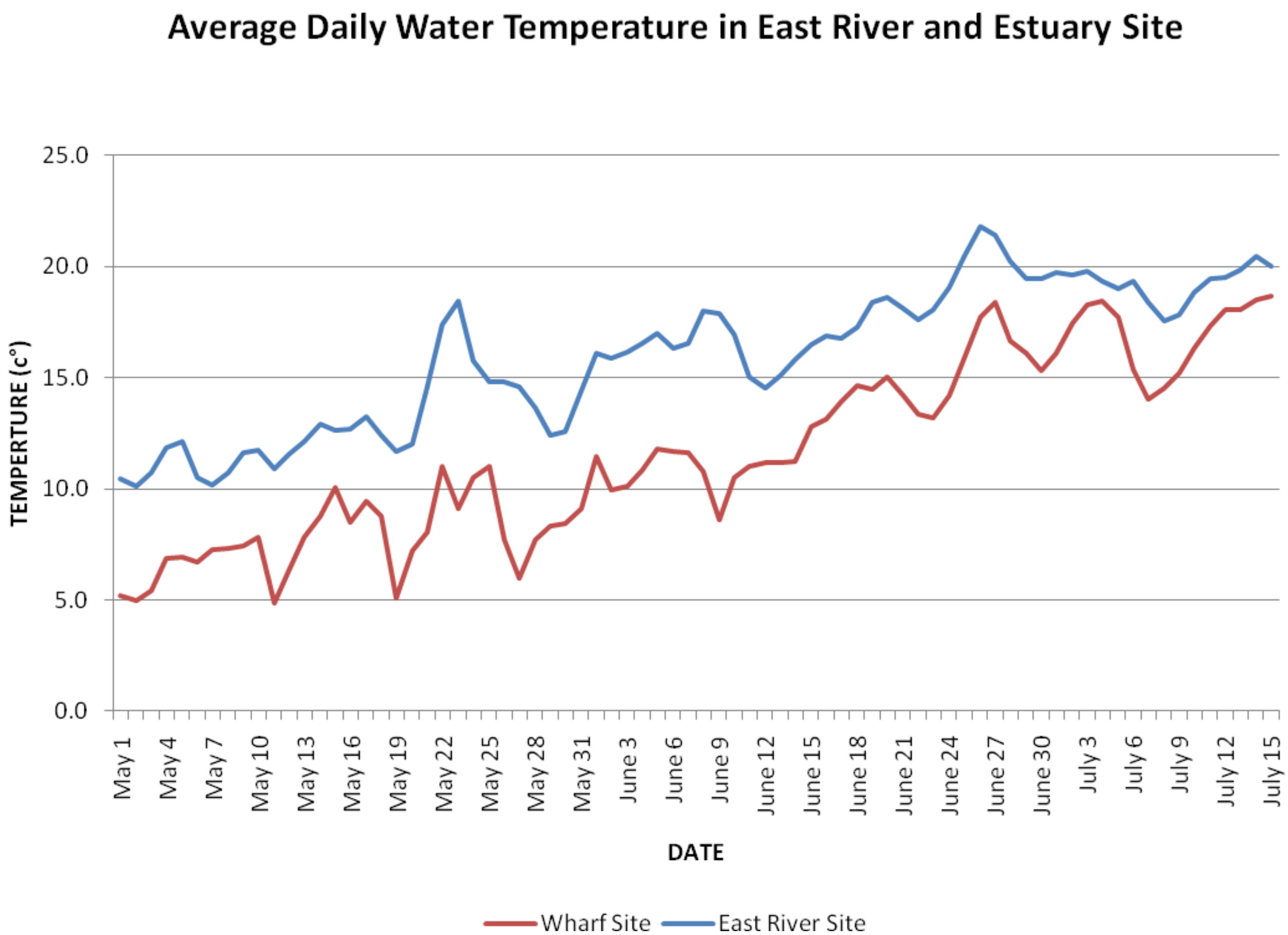

Figure 3: Average daily water temperature from May 1st to July 15th, 2009. Data from thermograph above falls in the East River and private wharf in the estuary in Chester, NS.

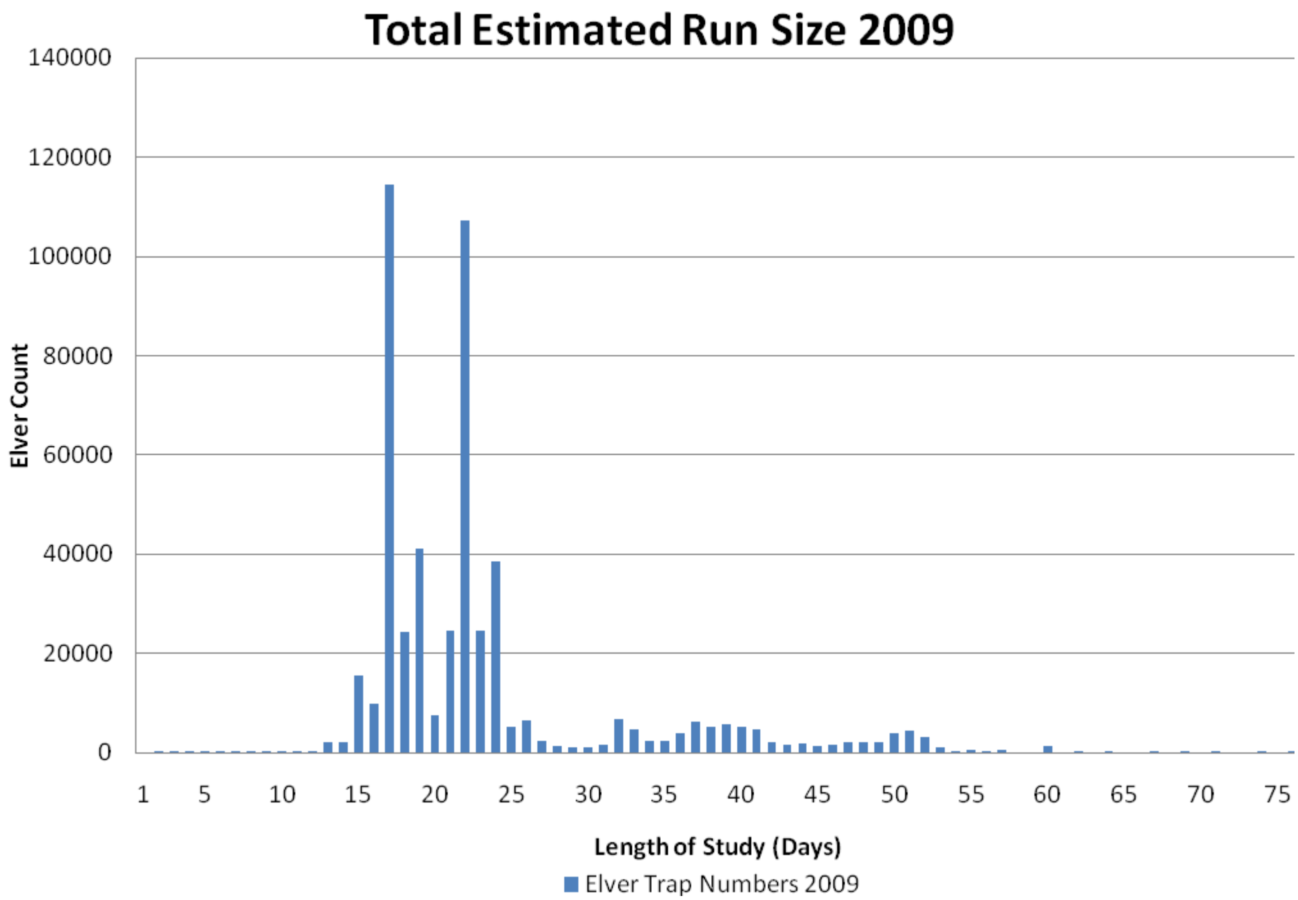

Figure 4: Total estimated run size of the 2009 elver count on the East River, Chester, NS.

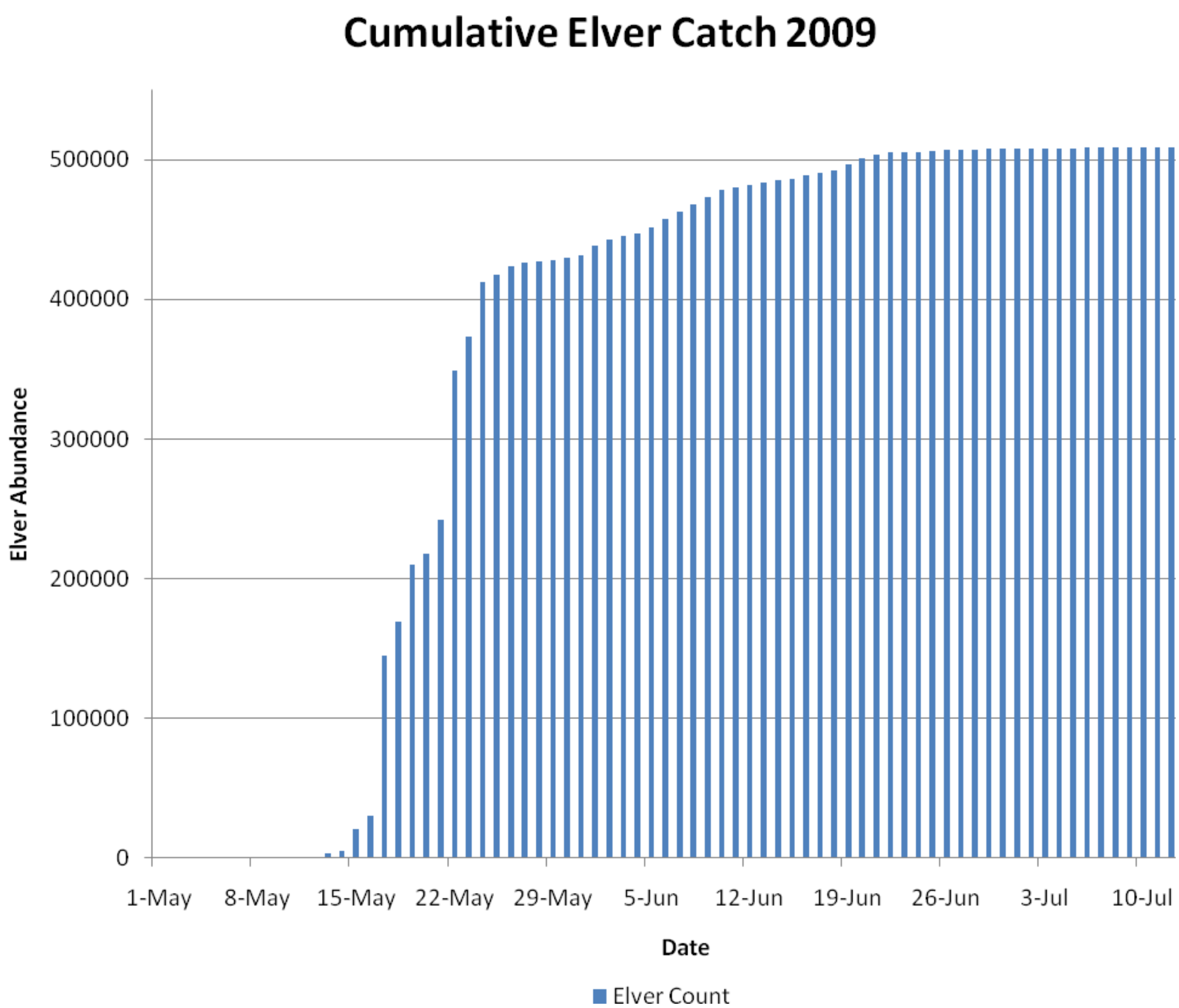

Figure 5: Cumulative elver counts from the East River, Chester study. The last bar represents the total number of elvers caught from the 2009 season.

Table 1: Estimated trap catches of American eel elvers and juveniles, by date, from the East River, Chester, 2009.

DATE	TRAP 1	TRAP 2	TRAP 3	TRAP 4	TOTAL	CUMCT	DAILY %	CUM%
20090501	0	0	0	0	0	0	0	0
20090502	0	0	2	0	2	2	0.000392792	0.000392792
20090503	0	0	3	0	3	5	0.000589188	0.000981981
20090504	0	0	3	0	3	8	0.000589188	0.001571169
20090505	0	0	14	0	14	22	0.002749546	0.004320715
20090506	0	0	10	1	11	33	0.002160357	0.006481072
20090507	0	0	7	1	8	41	0.001571169	0.008052241
20090508	0	1	218	0	219	260	0.043010753	0.051062994
20090509	5	2	3	0	10	270	0.001963961	0.053026955
20090510	4	9	234	0	247	517	0.048509844	0.1015368
20090511	0	0	1	0	1	518	0.000196396	0.101733196
20090512	0	0	318	0	318	836	0.06245397	0.164187166
20090513	4	1	2051	0	2056	2892	0.403790445	0.567977611
20090514	101	3	2028	0	2132	5024	0.418716551	0.986694162
20090515	2788	6760	5915	1	15464	20488	3.03706977	4.023763932
20090516	5155	2366	2197	2	9720	30208	1.908970393	5.932734325
20090517	18083	16733	5239	74529	114584	144792	22.50385427	28.4365886
20090518	5915	5746	15	12675	24351	169143	4.782442186	33.21903079
20090519	7774	6591	16393	10309	41067	210210	8.065399912	41.2844307
20090520	2006	698	1920	2792	7416	217626	1.456473707	42.7409044
20090521	2792	2792	14309	4537	24430	242056	4.79795748	47.53886188
20090522	38565	17276	29491	21812	107144	349200	21.04266706	68.58152894
20090523	9423	6108	3141	5933	24605	373805	4.832326803	73.41385575
20090524	10470	9947	6806	11343	38566	412371	7.574213188	80.98806894
20090525	140	1745	3141	140	5166	417537	1.014582413	82.00265135
20090526	785	2269	2269	1047	6370	423907	1.251043354	83.2536947
20090527	314	1134	698	175	2321	426228	0.45583542	83.70953012
20090528	524	436	262	108	1330	427558	0.261206854	83.97073698
20090529	48	178	323	382	931	428449	0.182844798	84.14572593
20090530	205	76	348	524	1153	429642	0.226444739	84.38002651
20090531	97	166	524	873	1660	431302	0.326017577	84.70604409
20090601	1760	1320	1980	1760	6820	438122	1.339421613	86.0454657
20090602	1100	770	990	1870	4730	442852	0.9289537	86.9744194
20090603	770	206	396	1056	2428	445280	0.476849806	87.45126921
20090604	616	264	550	770	2200	447480	0.432071488	87.8833407
20090605	1452	770	770	880	3872	451352	0.760445819	88.64378652
20090606	2200	1056	880	1980	6116	457468	1.201158737	89.84494525
20090607	1320	968	990	1980	5258	462726	1.032650857	90.87759611
20090608	1701	1652	1094	1117	5564	468290	1.092748073	91.97034418
20090609	1409	1191	1094	1604	5298	473588	1.040506702	93.01085089
20090610	1166	972	1021	1458	4617	478205	0.906760937	93.91761182
20090611	194	267	389	1191	2041	480246	0.400844503	94.31845633
20090612	972	243	158	219	1592	481838	0.312662641	94.63111897

DATE	TRAP 1	TRAP 2	TRAP 3	TRAP 4	TOTAL	CUMCT	DAILY %	CUM%
20090613	389	146	122	1215	1872	483710	0.367653557	94.99877252
20090614	194	39	146	972	1351	485061	0.265331173	95.2641037
20090615	137	214	119	1072	1542	486603	0.302842834	95.56694653
20090616	241	214	128	1447	2030	488633	0.398684146	95.96563068
20090617	241	268	114	1394	2017	490650	0.396130996	96.36176167
20090618	402	134	257	1340	2133	492783	0.418912947	96.78067462
20090619	1018	804	402	1608	3832	496614	0.752589974	97.5330682
20090620	268	1608	1394	1072	4342	500957	0.852752001	98.3860166
20090621	536	965	456	1072	3029	503986	0.594883881	98.98090048
20090622	316	288	146	403	1153	505139	0.226444739	99.20734522
20090623	37	91	75	31	234	505373	0.045956695	99.25330191
20090624	48	158	191	63	460	505833	0.09034222	99.34364413
20090625	58	137	107	65	367	506200	0.07207738	99.41572151
20090626	86	262	191	96	635	506835	0.124711543	99.54043305
20090627	0	0	0	0	0	506835	0	99.54043305
20090628	0	0	0	0	0	506835	0	99.54043305
20090629	31	681	386	76	1174	508009	0.230569058	99.77100211
20090630	0	0	0	0	0	508009	0	99.77100211
20090701	32	108	43	48	231	508240	0.045367506	99.81636962
20090702	0	0	0	0	0	508240	0	99.81636962
20090703	4	70	32	11	117	508357	0.022978347	99.83934796
20090704	0	0	0	0	0	508357	0	99.83934796
20090705	0	0	0	0	0	508357	0	99.83934796
20090706	9	141	4	22	176	508533	0.034565719	99.87391368
20090707	0	0	0	0	0	508533	0	99.87391368
20090708	12	84	0	52	148	508681	0.029066627	99.90298031
20090709	0	0	0	0	0	508681	0	99.90298031
20090710	1	82	0	16	99	508780	0.019443217	99.92242353
20090711	0	0	0	0	0	508780	0	99.92242353
20090712	0	0	0	0	0	508780	0	99.92242353
20090713	11	161	0	64	236	509016	0.046349487	99.96877302
20090714	0	0	0	0	0	509016	0	99.96877302
20090715	35	82	42	0	159	509175	0.031226985	100
	123964	97453	112550	175208	509175			

Table 2: Summary table of elver counts from previous studies conducted by Brian Jessop on the East River, also including the 2009 and 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
2009	May 1- July 15	123964	97453	112550	175208	509175