PROGRESS REPORT

State: **NEW HAMPSHIRE** **Grant**: **F-61-R-21/F16AF00163**

Grant Title: **NEW HAMPSHIRE'S MARINE FISHERIES INVESTIGATIONS**

Project I: **DIADROMOUS FISH INVESTIGATIONS**

Job 3: **AMERICAN EEL YOUNG-OF-THE-YEAR SURVEY**

Objective: To characterize trends in annual recruitment of young-of-the-year American Eel over time in New Hampshire waters.

Period Covered: January 4, 2016 - March 31, 2017

ABSTRACT

The annual American Eel *Anguilla rostrata* young-of-the-year survey was conducted on the Lamprey River in Newmarket, New Hampshire, for the sixteenth consecutive year and on the Oyster River in Durham, New Hampshire, for the fourth consecutive year. A modified Irish elver ramp was installed under an overhanging section of the fish ladder in the Lamprey River below the Macallen Dam at the head-of-tide. A box trap was setup on the fish ladder at the Oyster River below the Mill Pond Dam at the head-of-tide. The survey was conducted for 10 weeks at both monitoring stations. A total of 15,621 young-of-the-year eels (15,567 glass and 54 brown) were caught in the Lamprey River, the third highest in the time series, but catch declined in the Oyster River to 3,608 young-of-the-year eels (3,401 glass and 207 brown). The peak catch per unit effort was 261.8 young-of-the-year eels/hours soak time on the Lamprey River and 31.9 young-of-the-year eels/hours soak time on the Oyster River. At the Lamprey River, the mean length for young-of-the-year glass eels was 60.0 mm (n=1,179) and brown eels averaged 92.3 mm (n=14). At the Oyster River, the mean length for young-of-the-year glass eels was 59.3 mm (n=858) and brown eels averaged 97.3 mm (n=102). High variability in annual counts make characterization of trends over time difficult and data show that migration timing and rate are affected by changes in water temperature, river discharge, and lunar phase.

INTRODUCTION

Worldwide declines of eels have been noted (Stone 2003) and a number of studies have drawn attention to a possible Atlantic coast decline in the American Eel *Anguilla rostrata* population. Castonguay et al. (1994) indicated that juvenile American Eel recruitment to the upper St. Lawrence River declined drastically between 1985 and 1992. Haro et al. (2000) also found evidence of a significant decline in the recruitment of American Eels over the same relative time period at various sites from Virginia to Nova Scotia. The lack of long-term American Eel abundance data caused this problem to be addressed by the Atlantic States Marine Fisheries Commission (ASMFC) where they recommended an annual American Eel young-of-the-year survey be conducted by each state on the east coast to collect baseline population data (ASMFC 2000a). Data from these studies are expected to be used to characterize trends in the annual recruitment of the American Eel on the Atlantic coast of North America.

Due to the mating strategy of the American Eel, where adult eels reproduce in the Sargasso Sea and the offspring migrate to freshwater rivers on the northeast coast of North America, trends in recruitment abundance at individual rivers may reflect abundance trends for the entire eel population (Castonguay et al. 1994). The ASMFC American Eel Technical Committee prepared a standard procedures sampling protocol for the young-of-the-year survey in 2000, which stated an objective to sample two locations per state or jurisdiction, but later noted that the purpose and objective of the survey would not be compromised if only one location was sampled. In 2001 the State of New Hampshire (NH) established an annual survey of young-of-the-year eels migrating up the Lamprey River in Newmarket, NH. The goal of this survey is to help distinguish natural variation in annual recruitment and facilitate an understanding of possible long-term trends in eel numbers. Natural variation may be caused by events such as annual changes in ocean currents, river flow, or water temperature, while an overall decline in eel recruitment may be the result of anthropological impacts such as pollution, commercial harvesting, and habitat modification (Haro et al. 2000).

PROCEDURES

The study was designed according to the ASMFC (2000b) procedures for the American Eel young-of-the-year survey. Sampling methods were updated in 2010 to be standardized with the ASMFC procedures. Each spring, since 2001, a modified Irish elver trap is installed under an overhanging section of the Lamprey River fish ladder below the head-of-tide Macallen Dam (approximately 21 miles from the mouth of the Piscataqua River). As of 2013 a box trap has been installed on the Oyster River fish ladder below the head-of-tide Mill Pond Dam. Due to poor box trap design at the Oyster River in 2013 that prohibited ascending young-of-the-year eels from dropping into collection bucket and a late start date, the 2013 data is not included in the time series. The Irish elver trap at the Lamprey River was placed in the enclosed protected area where young-of-the-year eels have been observed swimming through three holes at the base of a cement support wall. The box trap at the Oyster River is located in a more public location and young-of-the-year eels are protected within a locked plywood box. In both sampling locations young-of-the-year eels are drawn to the freshwater flowing down the trap's ramp. The young-of-the-year eels climb the trap's ramp through Enkamat material (an erosion prevention mat constructed of monofilament) and drop into a sampling bucket at the end of the ramp.

Both sampling stations were monitored daily four times per week, generally Monday through Thursday, when American Eels were first observed arriving. Department biologists monitored the Lamprey River sampling station and a volunteer group monitored the Oyster River station. Every Sunday a biologist passed upstream any eels that dropped into the sampling bucket from the weekend to "begin" the sampling for each week. The sampling design requires a six week minimum sampling period. To assure sampling occurs during peak young-of-the-year migration period additional weeks were sampled.

For the trap to attract young-of-the-year American Eels there must be approximately 1 to 2 mm of consistent freshwater flow down the Enkamat mesh lining the ramp. Freshwater was provided by gravity-feed from a garden hose attached at one end, to a screen-covered funnel submerged in freshwater above each Dam. The hose was attached to a perforated PVC tube placed along the upper horizontal surface of the ramp located at the top of the trap. The perforated PVC tube and hose distributes an even stream of water down the ramp. A long-handled bristle brush was used to clean the PVC pipe if it became clogged with debris or algae.

Each day of sampling, a qualitative judgment was made on the ramp performance. Ramp performance at the time of the survey was rated as good, fair, poor, or void. The ratings were an attempt to account for the effect of ramp performance on the number of captured young-of-the-year American Eels. A rating of good indicated a steady, even flow of water down the ramp. Fair indicated more than 50% of the holes were clogged and flow restricted to one side of the ramp. Poor indicated that more than 90% of the holes were clogged and very little water reached the trap entrance. Void indicated all of the holes were clogged and no water reached the trap entrance or that the trap was knocked over for any reason (e.g. tide, etc). Before the end of each sampling day, every effort was made to return the trap, if necessary, to good performance by cleaning the tube and adjusting the flow.

Young-of-the-year American Eels represent a single year class and are divided into two stages: glass eels and brown eels (elvers). Glass eels generally range from 45 to 70 mm long and elvers range from 65 to 100 mm long. The glass eel stage was then classified further to one of seven pigmentation stages based on the methods of Haro and Krueger (1988). Each sampling day, the young-of-the-year eels were counted and a subsample of 60 eels (preferably glass eels) was measured and weighed twice per week. All eels were characterized as glass eels or elvers. All eels were then released above the head-of-tide dam into freshwater.

If the young-of-the-year American Eels in the bucket were too numerous to count, their numbers were estimated using a volumetric sampling technique recommended by the ASMFC (2000b) and similar to the method used by Jessop (2000). Young-of-the-year eels were placed into a graduated cylinder until an eel volume of 25 mL was reached. The young-of-the-year eels in the graduated cylinder were counted and released to freshwater. This was repeated six times and the mean number of eels per milliliter was calculated. The remaining young-of-the-year eels were then placed into a graduated cylinder and the total remaining volume of young-of-the-year eels was recorded. The final estimated number of young-of-the-year eels equals the total remaining volume of eels (mL) multiplied by the calibrated average number of eels per milliliter plus the number of eels counted in each 25 mL calibration.

Additionally, during each site visit, lunar phase and water temperature was recorded and a note was made if the dam's flood gates were open. Discharge flows, recorded in cubic feet per second, were downloaded from the United States Geological Survey Lamprey River station located upstream from the sampling location to provide daily mean discharge for each sampling day.

RESULTS

Monitoring stations were installed April 15, 2016 on the Lamprey and Oyster rivers. The elver traps were checked daily to note the presence of American Eels and the temperature of the water was recorded. The ramps were also cleaned daily to assure the performance was good. Young-of-the-year eels were first observed on April 19, 2016 at the Oyster River and April 20, 2016 at the Lamprey River. Both sampling sites were monitored until the fourth week of June (Tables 1.3-1 and 1.3-2). A total of 15,621 young-of-the-year eels (15,567 glass and 54 brown) were caught on the Lamprey River and 3,608 young-of-the-year eels (3,401 glass and 207 brown) were caught on the Oyster River, during 10 weeks of monitoring. Peak young-of-the-year eel abundances at both sampling sites occurred near a full moon and declining river discharge flows (Figures 1.3-1 and 1.3-2). Two peaks of the total number of eels were observed during the season at the Lamprey River. The first peak occurred on April 25, with a total of 1,074 eels and a second peak occurred on May 17, with 7,396 eels (Table 1.3-1 and Figure 1.3-1). The Oyster River had three peaks, which occurred on April 21, with 814 eels, May 11, with 167 eels, and May 31, with 258 eels (Table 1.3-2 and Figure 1.3-2).

The peak CPUE (young-of-the-year eels/hours soak time) was 261.8 on the Lamprey River and 31.9 on the Oyster River. The mean annual CPUE on the Lamprey was 17.1 young-of-the-year eels/hour soak time and the Oyster was 3.8 young-of-the-year eels/hour soak time (Tables 1.3-3 and 1.3-4). Daily mean river discharge on the Lamprey River ranged from 18 to 224 ft^3/s and ranged from 1 to 21 ft^3/s on the Oyster River (Tables 1.3-1 and 1.3-2). Before eels were observed, fresh water temperatures on the Lamprey and Oyster rivers ranged between 9°C and 12°C. Freshwater temperature in the Lamprey and Oyster rivers ranged from 9°C to 24°C during the sampling period that eels were present. Ramp performance was good throughout all of the sampling period at both locations.

At the Lamprey River, the mean length for the young-of-the-year glass eels was 60.0 mm (n=1,179) and brown eels averaged 92.3 mm (n=14) (Table 1.3-5). Mean length for the young-of-the-year glass eels at the Oyster River was 59.3 mm (n=858) and brown eels averaged 97.3 mm (n=102) (Table 1.3-6). Glass eel pigmentation stages one through seven were observed at both the Lamprey and Oyster rivers in 2016.

DISCUSSION

Young-of-the-year American Eel surveys typically have high variability (Shepard 2014). In 2016 the total number of young-of-the-year eels captured by the Irish elver ramp at the Lamprey River (15,621) was relatively high, being the third highest observed during the 16 years of monitoring (Table 1.3-3). The total number of young-of-the-year eels captured by box trap at the Oyster River has been declining during the three years of monitoring; 17,609 in 2014 5,266 in 2015, and 3,608 in 2016 (Table 1.3-4). Collections of young-of-the-year eels have been variable and no trend in recruitment is apparent in the Lamprey River; however, there is a declining trend in the Oyster River.

It has been shown that temperature plays an important role on glass eel migration into freshwater. Glass eels are sensitive to water temperature and are capable of detecting 1°C changes in water temperature (Kim et al. 2002). Sorensen and Bianchini (1986), Moriarty (1987), and Haro and Krueger (1988), reported the onset of eel migration into freshwater coinciding with an increase in water temperature. Other studies have also observed a correlation between peaks in eel migrations and increased water temperatures (Gascuel 1986; Tongiorgi et al. 1986; Tosi et al. 1990; Martin 1995; Edeline et al. 2006). However, Sorensen and Bianchini (1986) observed that once water temperature exceeded a threshold of 10–15°C it appeared to have minimal, if any, influence on migration. Similar to these previous findings, elvers were observed in 2016 migrating on the Lamprey and Oyster rivers when freshwater temperatures reached above 10°C (Tables 1.3–1 and 1.3–2). The temperature on the first day eels were observed in both the Lamprey and Oyster rivers was between the threshold range stated by Sorensen and Bianchini (1986). Elver migration at NH monitored rivers typically occurs when reaching a minimum water temperature threshold of 10–15°C.

River discharge and its effects on water velocity have been found to delay or prevent the upstream migration of elvers (Jessop 2000; Jessop and Harvie 2003). High levels of discharge could impede the upstream movement of glass eels in the Lamprey River. Overton and Rulifson (2009) observed higher numbers of eels when discharge was below 150 m^3/s and no eels when discharge went over 650 m^3/s in the Roanoke River, North Carolina. Although the discharge range on the Roanoke River is greater than both study sites in NH, the pattern of young-of-the-year eels decreasing at higher discharge rates is observed in both systems. During 2016, in the Lamprey River the highest number of eels (99.6%) were observed in the trap when discharge levels were below 200 ft^3/s (5.7 m^3/s) while at the Oyster River, 96.8% of eels were observed when discharge levels were below 16 ft^3/s (Figures 1.3–1 and 1.3–2). Heavy flows in April and May that may occur as a result of open flood gates at the dam on the Lamprey River, likely hinder eels from moving upstream in the beginning of their migration. These high flows could impede eels from approaching the entrance to the traps or may cause them to burrow into sediment and halt their upstream migrations. Although flood gates at the Lamprey River did not need to be opened in 2016, observations from both the Lamprey and Oyster rivers in 2016 and in previous monitoring years suggest that increasing river discharge negatively impacts the migration of young-of-the-year eels.

Lunar phase has been shown to impact elver migration. Deelder (1958), in a study of European Eels *Anguilla anguilla*, suggested that phases of the moon act upon the migration of European Eels in an indirect way when higher tides during the full or new moon carry them further upstream. The peaks in young-of-the-year American Eel density occurred near the full moon on both the Oyster and Lamprey rivers (Figure 1.3-1 and 1.3-2). During the beginning of the sampling season, elver densities on the Lamprey and Oyster rivers increased during the first quarter moon, reaching a peak near the full moon, then reaching a low during the new moon. Typically, higher tides associated with a full moon are related to increased densities of young-of-the-year American Eels, but an increase in river discharge before the full moon could prohibit elvers from upstream migration. In early June of this year, the observed increases in river discharge before the full moon could have slowed migration and explain the low American Eel densities in both rivers.

While the density of young-of-the-year American Eels has been highly variable from year to year, mean lengths of young-of-the-year eels are consistent. Mean length of glass eels varies by latitude, with smaller glass eels in the southern portions of the range (Cairns et al. 2014). According to Cairns et al. (2014) the latitude for NH should have a mean length for glass eels around 60 mm. Mean lengths of glass eels on the Lamprey River were consistent with these findings between 2011 and 2016, ranging from 59.8 to 61.9 mm (Table 1.3-5). The mean lengths of glass eels at the Oyster River have also been consistent with Cairns et al. (2014), ranging from 59.3 to 60.9 mm between 2014 and 2016(Table 1.3-6). The constancy of glass eel lengths from year to year can be attributed to latitude and the migration time from spawning grounds in the Sargasso Sea.

In summary, numbers of young-of-the-year American Eels returning were relatively high at the Lamprey River and relatively low at the Oyster River in 2016. The increases in river discharge at both sites in early June may explain the decrease in eels. The high inter-annual variability makes characterization of trends difficult; however, there is a declining trend in the Oyster River. Environmental factors may be influencing the timing and abundance of young-of-the-year eel migration. Temperature plays a role in the timing of migration into freshwater, with movement beginning above a threshold level. River discharge can affect the number of migrating glass eels, with high discharge rates decreasing glass eel densities and peak passage being associated with low flow rates. While many environmental factors influence the abundance of young-of-the-year eels, mean length is associated with latitude. Further annual surveys in NH combined with other states along the east coast of the U.S. will likely characterize trends in the young-of-the-year eel recruitment over time. The combination of these studies should allow the ASMFC to establish a qualitative appraisal of the annual recruitment of eel to the U.S. Atlantic coast.

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Table 1.3-1. Data collected from the American Eel young-of-the-year survey using a modified Irish elver trap in the Lamprey River, Newmarket, New Hampshire, 2016.

Date	Soak time (h)	Freshwater temperature (°C)	Moon phase[a]	Daily mean discharge (ft3/s)[b]	Ramp performance	Number of eels		CPUE (# eels/hr soak time)
						Glass	Brown	
4/20/2016	23.00	12	Full	202	good	1	0	0.0
4/21/2016	25.50	12	Full	181	good	40	0	1.6
4/22/2016	23.00	13	**Full**	165	good	556	2	24.3
4/25/2016	24.00	14	Full	137	good	1,071	3	44.8
4/26/2016	24.00	14	Last	136	good	600	2	25.1
4/27/2016	24.50	13	Last	154	good	159	0	6.5
4/28/2016	23.00	12	Last	153	good	234	0	10.2
5/2/2016	23.75	12	Last	144	good	196	1	8.3
5/3/2016	27.75	12	New	189	good	108	1	3.9
5/4/2016	23.50	10	New	208	good	39	0	1.7
5/5/2016	23.25	11	New	224	good	27	3	1.3
5/9/2016	22.25	12	New	181	good	118	1	5.3
5/10/2016	26.25	13	First	161	good	147	1	5.6
5/11/2016	21.75	13	First	142	good	146	0	6.7
5/12/2016	24.00	14	First	134	good	230	1	9.6
5/16/2016	24.50	16	First	100	good	568	2	23.3
5/17/2016	28.25	17	Full	91	good	7,390	6	261.8
5/18/2016	18.00	16	Full	86	good	1,594	2	88.7
5/19/2016	25.00	17	Full	77	good	492	0	19.7
5/23/2016	24.75	18	Full	58	good	55	3	2.3
5/24/2016	25.50	19	Full	55	good	73	2	2.9
5/25/2016	23.50	18	Last	64	good	131	5	5.8
5/26/2016	24.00	19	Last	62	good	126	2	5.3
5/31/2016	21.50	20	Last	49	good	62	1	2.9
6/1/2016	25.50	21	Last	44	good	76	0	3.0
6/2/2016	23.25	22	New	38	good	42	1	1.8
6/3/2016	26.00	21	New	34	good	96	1	3.7
6/7/2016	22.50	20	New	135	good	258	2	11.6
6/8/2016	24.00	20	New	137	good	166	3	7.0
6/9/2016	23.50	20	First	109	good	158	4	6.9
6/10/2016	27.25	21	First	81	good	235	3	8.7
6/14/2016	24.50	21	First	41	good	102	0	4.2
6/15/2016	23.00	20	First	37	good	17	0	0.7
6/16/2016	24.00	20	First	32	good	16	0	0.7
6/17/2016	24.50	20	Full	28	good	13	1	0.6
6/21/2016	24.00	23	Full	18	good	102	1	4.3
6/22/2016	27.00	22	Full	18	good	87	0	3.2
6/23/2016	20.00	22	Full	18	good	36	0	1.8

[a] Moon phase in bold is the actual day of that moon phase.
[b] Provisional data subject to revision (http://waterdata.usgs.gov/nh/nwis/current/?type=flow).

Table 1.3-2. Data collected from the American Eel young-of-the-year survey using a box trap in the Oyster River, Durham, New Hampshire, 2016.

Date	Soak time (h)	Freshwater temperature (°C)	Moon phase[a]	Daily mean discharge (ft3/s)[b]	Ramp performance	Number of eels		CPUE (# eels/hr soak time)
						Glass	Brown	
4/19/2016	24.50	11	Full	15	good	2	0	0.1
4/20/2016	24.00	11	Full	14	good	146	0	6.1
4/21/2016	25.50	12	Full	13	good	809	5	31.9
4/22/2016	22.00	12	**Full**	12	good	520	6	23.9
4/26/2016	24.00	12	Full	11	good	317	2	13.3
4/27/2016	23.75	10	Last	15	good	28	1	1.2
4/28/2016	22.25	10	Last	12	good	101	1	4.6
4/29/2016	29.50	11	Last	11	good	71	1	2.4
5/3/2016	25.75	10	Last	20	good	44	0	1.7
5/4/2016	23.50	10	New	16	good	40	2	1.8
5/5/2016	23.00	10	New	19	good	27	0	1.2
5/6/2016	23.00	9	New	21	good	2	0	0.1
5/10/2016	25.00	13	New	11	good	46	0	1.8
5/11/2016	24.00	15	First	10	good	165	2	7.0
5/12/2016	30.50	16	First	9	good	56	6	2.0
5/13/2016	18.50	15	First	8	good	80	3	4.5
5/17/2016	24.00	14	First	7	good	3	1	0.2
5/18/2016	25.00	14	Full	6	good	3	0	0.1
5/19/2016	28.25	16	Full	6	good	23	2	0.9
5/20/2016	18.75	16	Full	6	good	7	2	0.5
5/24/2016	25.00	17	Full	5	good	31	18	2.0
5/25/2016	23.00	17	Full	5	good	43	19	2.7
5/26/2016	29.25	20	Last	5	good	110	43	5.2
5/27/2016	18.75	19	Last	4	good	90	20	5.9
5/31/2016	25.25	20	Last	4	good	251	7	10.2
6/1/2016	22.75	20	Last	3	good	97	10	4.7
6/2/2016	30.75	20	New	3	good	113	24	4.5
6/3/2016	18.25	20	New	3	good	86	12	5.4
6/7/2016	23.50	18	New	11	good	11	5	0.7
6/8/2016	24.25	20	New	7	good	22	6	1.2
6/9/2016	28.25	18	First	5	good	8	2	0.4
6/10/2016	19.50	18	First	4	good	6	1	0.4
6/14/2016	26.00	18	First	3	good	9	0	0.3
6/15/2016	23.00	19	First	2	good	13	2	0.7
6/16/2016	28.25	19	First	2	good	9	3	0.4
6/17/2016	20.00	21	Full	2	good	7	1	0.4
6/21/2016	25.25	24	Full	2	good	2	0	0.1
6/22/2016	24.00	22	Full	1	good	2	0	0.1
6/23/2016	23.75	21	Full	2	good	1	0	0.0

[a] Moon phase in bold is the actual day of that moon phase.
[b] Provisional data subject to revision (http://waterdata.usgs.gov/nh/nwis/current/?type=flow).

Table 1.3-3. Annual summary of the American Eel young-of-the-year survey in the Lamprey River, Newmarket, New Hampshire, 2001–2016.

Year	Monitoring period	Date and count first observed in trap	Peak CPUE (# eels/ hour soak time)	Date of peak CPUE	Total number observed during peak	Mean annual CPUE	Total number of eels observed during year
2001	May 1–June 7	May 1 (4)	111.8	May 7	2,655[a]	10.9	6,356[a]
2002	April 19–May 23	April 19 (15)	391.8	April 20	9,600[a]	30.0	17,799[a]
2003	April 22–July 31[b]	April 30 (5)	65.6	July 7	1,559[a]	4.7	6,165[a]
2004	April 13–July 30	April 20 (1)	20.0	July 8,9	490/525	3.5	5,252
2005	April 18–July 28[c]	April 21 (1)	12.7	July 14	314	1.5	2,095
2006	April 11–May 11[d]	April 14 (50)	26.3	April 25	571	5.5	2,637
2007	April 26–July 26	May 8 (6)	18.9	July 26	515[a]	0.9	1,240[a]
2008	April 22–August 1	May 22 (2)	14.4	July 10	231	1.0	1,361
2009	April 21–June 18	April 27 (1)	100.4	June 9	2,559	8.3	6,385
2010	April 26–July 8	April 26 (12)	1.3	May 26	25	0.2	208
2011	May 3–July 29	May 3 (3)	14.4	July 13	285	1.4	1,491
2012	April 3–July 26	April 23 (998)	50.5	April 23	998	2.8	4,213
2013	April 16–June 14	April 19 (1)	244.1	May 9	6,407	40.0	35,036
2014	April 15–June 23	May 5 (3)	65.1	June 11	1,806	12.7	8,449
2015	April 15–June 24	May 5 (4)	13.8	May 15	339	2.7	1,959
2016	April 15–June 23	April 20 (1)	261.8	May 17	7,396	17.1	15,621

[a] Values estimated.
[b] Two of the weeks were checked only once per week.
[c] Irish elver ramp was removed on May 25 and 26 due to high tides and high precipitation.
[d] Irish elver ramp was destroyed due to floods.

Table 1.3-4. Annual summary of the American Eel young-of-the-year survey in the Oyster River, Durham, New Hampshire, 2014–2016.

Year	Monitoring period	Date and count first observed in trap	Peak CPUE (# eels/hour soak time)	Date of peak CPUE	Total number observed during peak	Mean annual CPUE	Total number of eels observed during year
2014	April 15–June 24	April 23 (47)	159.1	May 13	4,151	15.9	17,609
2015	April 15–June 25	May 4 (7)	42.6	May 13	1,034	7.0	5,266
2016	April 15–June 23	April 19 (2)	31.9	April 21	814	3.8	3,608

Table 1.3-5. Mean lengths of sampled young-of-the-year American Eels by life stage in the Lamprey River, Newmarket, New Hampshire, 2011–2016.

		Year											
		2011		2012		2013		2014		2015		2016	
Life stage	Pigmentation stage	Mean length (mm)	Count of length	Mean length (mm)	Count of length	Mean length (mm)	Count of length	Mean length (mm)	Count of length	Mean length (mm)	Count of length	Mean length (mm)	Count of length
Glass	1	66.0	1	–	0	59.5	48	63.1	18	59.0	3	57.9	96
	2	60.2	26	56.4	13	60.4	60	61.4	88	59.9	68	60.3	326
	3	60.6	79	58.6	219	61.0	59	61.2	77	60.6	93	61.0	170
	4	61.7	62	59.1	228	61.4	161	61.4	154	60.9	77	59.9	90
	5	60.2	82	58.9	193	61.2	133	60.0	144	59.8	76	58.9	145
	6	61.2	158	59.7	375	62.3	136	61.7	185	60.9	116	59.4	237
	7	65.1	125	63.0	210	62.1	161	63.4	115	63.4	81	62.2	115
	Combined	61.9	533	59.8	1,238	61.4	758	61.5	781	60.9	514	60.0	1,179
Brown	–	90.1	27	92.0	43	87.2	9	83.9	26	97.0	89	92.3	14
Annual average (all stages)		63.3	560	60.9	1,281	61.8	767	62.2	807	66.3	603	60.4	1,193

Table 1.3-6. Mean lengths of sampled young-of-the-year American Eels by life stage in the Oyster River, Durham, New Hampshire, 2014–2016.

		Year					
		2014		2015		2016	
Life stage	Pigmentation stage	Mean length (mm)	Count of length	Mean length (mm)	Count of length	Mean length (mm)	Count of length
Glass	1	62.1	181	57.9	32	58.3	79
	2	60.8	168	59.6	72	59.5	245
	3	60.4	200	59.4	108	59.3	199
	4	60.4	183	58.9	77	58.6	158
	5	60.0	188	59.2	86	58.4	98
	6	60.3	170	59.5	55	59.3	50
	7	62.0	95	62.6	16	67.0	29
	Combined	60.8	1,209	59.3	446	59.3	858
Brown	–	97.9	8	91.6	95	97.3	102
Annual average (all stages)		61.0	1,217	65.0	541	63.3	960

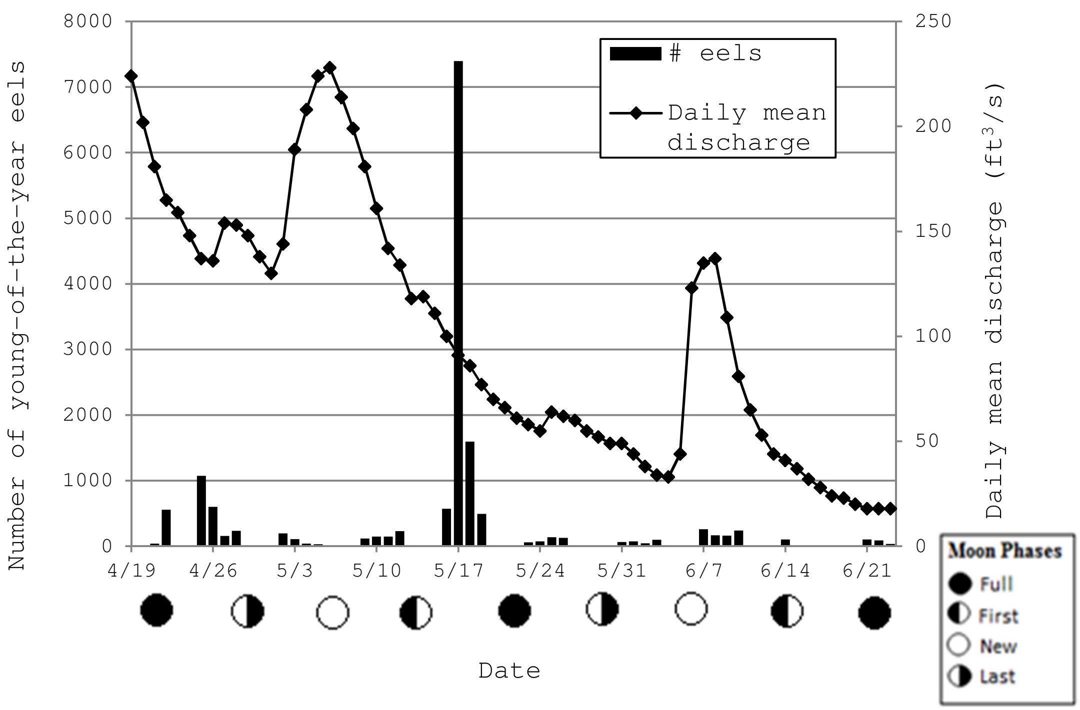

Figure 1.3-1. Daily mean discharge (ft^3/s) in the Lamprey River with the total number of American Eel young-of-the-year observed each sampling day, 2016.

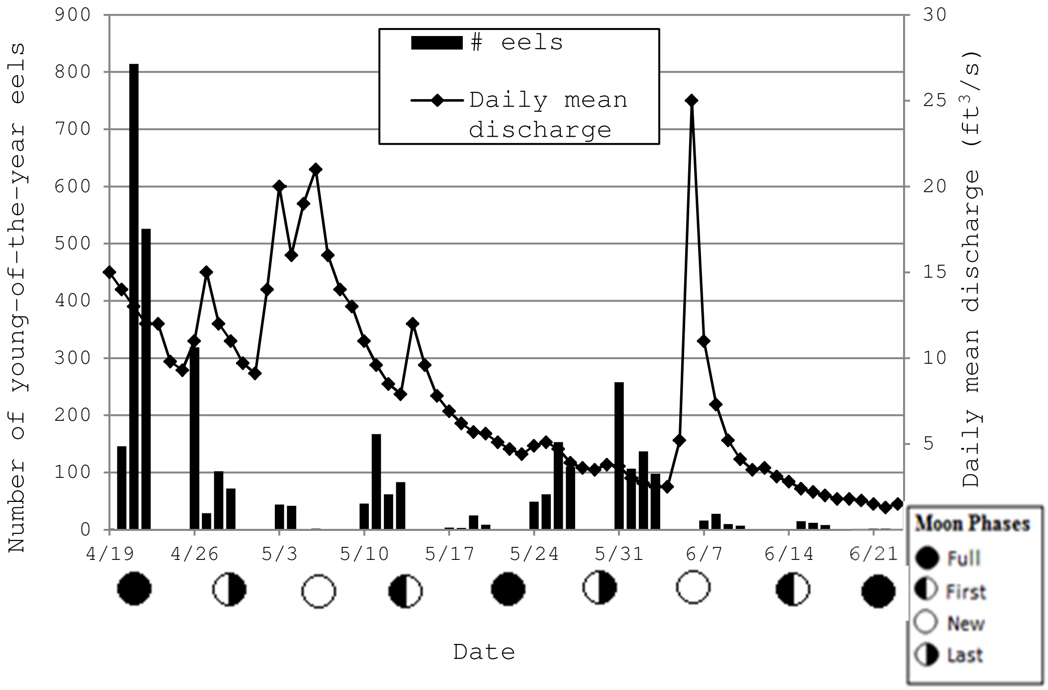

Figure 1.3-2. Daily mean discharge (ft[3]/s) in the Oyster River with the total number of American Eel young-of-the-year observed each sampling day, 2016.