PROGRESS REPORT

State: **NEW HAMPSHIRE** **Grant:** **F-61-R-24/F21AF00591**

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 1, 2021 - December 31, 2021

ABSTRACT

Between January 1, 2021 and December 31, 2021, the New Hampshire Fish and Game Department conducted one investigation to characterize trends in annual recruitment of young-of-year eel over time in New Hampshire waters. The annual American Eel *Anguilla rostrata* young-of-the-year survey was conducted on the Lamprey River in Newmarket, New Hampshire, and on the Oyster River in Durham, New Hampshire. A modified Irish elver ramp was installed under an overhang section of the fish ladder in the Lamprey River below the Macallen Dam at the head-of-tide. A box trap was set on the fish ladder at the Oyster River below the Mill Pond Dam at the head-of-tide. The survey was conducted for eleven weeks at both monitoring stations. A total of 2,289 young-of-the-year eels (2,031 glass and 258 brown) were caught in the Lamprey River; a decrease from the 14,088 observed in 2020. The total number of young-of-the-year eels captured by the box trap at the Oyster River in 2021 has declined considerably compared to the record high count in 2014. The peak catch per unit effort was 16.52 young-of-the-year eels/hours soak time on the Lamprey River and 0.30 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 61.6 mm (n=628) and brown eels averaged 98.1 mm (n=72). At the Oyster River, the mean length for young-of-the-year glass eels was 58.9 mm (n=25) and brown eels averaged 103.6 mm (n=5). 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 led the Atlantic States Marine Fisheries Commission (ASMFC) to 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 in the Lamprey River in Newmarket, NH. A second monitoring station was established on the Oyster River in Durham in 2014. The goal of these surveys 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 in an enclosed protective overhang of the Lamprey River fish ladder where young-of-the-year eels have been observed below the head-of-tide Macallen Dam (approximately 21 miles from the mouth of the Piscataqua River). As of 2014, a box trap has been installed on the Oyster River fish ladder, in a more public location, where young-of-the-year eels are protected within a locked plywood box below the head-of-tide Mill Pond Dam, Durham, NH (approximately 15 miles from the mouth of the Piscataqua River). 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 geotextile fabric, 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. Department biologists monitored the Lamprey River sampling station and a volunteer group has monitored the Oyster River station. American Eels that were collecting in the sampling bucket over the weekend were passed upstream each Sunday to initiate the four-day sampling period 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 may be 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. A garden hose provided the gravity-fed water supply to the ramp by connecting a screen-covered funnel, submerged in freshwater above each dam, to a perforated PVC tube placed along the upper horizontal surface of the ramp. The perforated PVC tube and hose distributed 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; and void indicated all of the holes were clogged and no water reached the trap entrance or the trap was knocked over for any reason (e.g., tide, floods, 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, adjusting the flow, or repositioning the trap.

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 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 characterized as glass eels or elvers, counted, and a subsample of 60 eels (preferably glass eels) was measured and weighed twice per week. 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 methodology by Jessop (2000). Young-of-the-year eels were placed into a graduated cylinder until an eel volume of 25 mL was reached, then 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. These counts along with the known hours the traps operated between sampling are used to determine the catch-per-unit-effort (CPUE).

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

RESULTS

Between January 1, 2021 and December 31, 2021, the New Hampshire Fish and Game Department conducted one investigation to characterize trends in annual recruitment of young-of-year eel over time in New Hampshire waters.

In 2021, monitoring of the stations on the Lamprey and Oyster rivers began on April 27 (Tables 1.3-1 and 1.3-2). Young-of-the-year eels were first observed May 4, 2021, at the Oyster River and May 11, 2021, at the Lamprey River. Both sampling sites were monitored until the second week of July; eleven weeks of monitoring. A total of 2,289 young-of-the-year eels (2,031 glass and 258 brown) were caught in the Lamprey River and 30 young-of-the-year eels (25 glass and 5 brown) were caught in the Oyster River (Tables 1.3-1 through 1.3-4). Peak young-of-the-year eel (i.e., excluding brown eels) abundances at both sampling sites occurred near a new or full moon and declining river discharge flows (Figures 1.3-1 and 1.3-2). The highest peak in the Lamprey River occurred on May 28 (413 total eels) (Table 1.3-1 and Figure 1.3-1). The Oyster River experienced the highest peak on June 10 (6 total eels) (Table 1.3-2 and Figure 1.3-2).

In 2021, the peak CPUE was 16.5 young-of-the-year eels/hour soak time on the Lamprey River and 0.3 young-of-the-year eels/hour soak time on the Oyster River (Tables 1.3-3 and 1.3-4). The mean annual CPUE on the Lamprey was 2.21 young-of-the-year eels/hour soak time and the Oyster was 0.03 young-of-the-year eels/hour soak time. The daily mean river discharge during the sampling period ranged from 15 ft^3/s to 410 ft^3/s on the Lamprey River and 1 ft^3/s to 67 ft^3/s on the Oyster River (Tables 1.3-1 and 1.3-2). Glass eels were first observed when fresh water temperatures reached above 10°C on both the Lamprey and Oyster rivers. Freshwater temperature in the Lamprey River ranged from 9°C to 26°C and from 9°C to 28°C on the Oyster River during the sampling period. Ramp performance was rated good or fair throughout all of the sampling period at both locations.

At the Lamprey River, the mean length of the young-of-the-year glass eels was 61.6 mm (n=628) and brown eels averaged 98.1 mm (n=72) (Table 1.3-5). Mean length for the young-of-the-year glass eels at the Oyster River was 58.9 mm (n=25) and brown eels averaged 103.6 mm (n=5) (Table 1.3-6). Glass eel pigmentation stages one through seven were observed at the Lamprey River in 2021, however, pigmentation stages one and four were not observed at the Oyster River.

DISCUSSION

Young-of-the-year American Eel surveys typically have high variability in the number of American eels observed (Shepard 2014). The total number of young-

of-the-year eels captured by the Irish elver ramp at the Lamprey River (2,289) in 2021 was lower than 2020 (14,088), and below the time series average of 6,570 eels (Table 1.3-3). The total number of young-of-the-year eels captured by the box trap at the Oyster River in 2021 was the lowest in the time series and has declined considerably compared to the record high count in 2014 (Table 1.3-4). The annual totals of young-of-the-year eels have been variable and no trend in recruitment is apparent in the Lamprey River; however, there appears to be 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. Elver migration into NH monitored rivers typically occurs when a minimum water temperature threshold of 10–15°C is reached, as observed in 2021 with the migration in the Lamprey and Oyster rivers (Tables 1.3-1 and 1.3-2).

River discharge and related 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 river systems. During 2021, in the Lamprey River, all eels were observed in the trap when discharge levels were below 250 ft^3/s (7.1 m^3/s), while at the Oyster River, all eels were observed when discharge levels were 16 ft^3/s (0.5 m^3/s) or below (Figures 1.3-1 and 1.3-2).

Pressurized flows through the former vertical-lift flood gate on Macallen Dam in the Lamprey River during high discharge periods likely hindered eels from moving upstream in the beginning of their migration. These turbulent high flows could impede eels from approaching the entrance to the traps or cause

them to burrow into sediment. In 2021, the Town of Newmarket, NH, modified the dam with an Obermeyer crest gate which is designed to adjust height based on discharge to maintain a more constant impoundment level, as well as release from the top of the impoundment as compared to the low-level vertical gate.

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 (i.e., excluding brown eels) American Eel density occurred near the full moon in the Lamprey River and new moon in the Oyster River (Figures 1.3-1 and 1.3-2). 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 hinder elvers from upstream migration.

While the density of migrating 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 2016 and 2021, ranging from 60.0 to 63.1 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 58.9 to 62.4 mm between 2016 and 2021 (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 low in both the Oyster and Lamprey rivers in 2021. The high inter-annual variability of observed American eels makes characterization of trends difficult however, there is a declining trend in the Oyster River. Environmental factors may influence 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 also affect the number of migrating glass eels observed at sampling stations, with high discharge rates decreasing glass eel densities and peak passage being associated with low flow rates. The increases in river discharge at both sites in May and July may in part have affected the eel migration. While many environmental factors influence the abundance of migrating 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 American 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, 2021.

Date	Soak time (h)	Freshwater temperature (°C)	Moon phase[a]	Daily mean discharge (ft^3/s)[b]	Ramp performance	Number of eels		CPUE (# eels/hr soak time)
						Glass	Brown	
4/27/2021	23.50	10	Full	140	good	0	0	0.00
4/28/2021	24.00	9	Full	134	good	0	0	0.00
4/29/2021	24.00	9	Full	160	good	0	0	0.00
4/30/2021	24.00	10	Last	283	good	0	0	0.00
5/3/2021	20.00	10	**Last**	278	good	0	0	0.00
5/4/2021	24.00	12	Last	237	good	0	0	0.00
5/5/2021	24.00	11	Last	298	good	0	0	0.00
5/6/2021	24.75	11	Last	410	good	0	0	0.00
5/11/2021	20.75	13	**New**	208	good	1	0	0.05
5/12/2021	24.25	12	New	178	good	0	0	0.00
5/13/2021	26.25	12	New	158	good	1	0	0.04
5/14/2021	22.25	13	New	140	good	0	0	0.00
5/17/2021	26.50	14	First	99	good	94	14	4.08
5/18/2021	21.75	15	First	90	good	126	25	6.94
5/19/2021	19.75	17	**First**	82	good	184	37	11.19
5/20/2021	27.00	16	First	74	good	202	67	9.96
5/25/2021	25.00	20	Full	46	good	192	27	8.76
5/26/2021	21.00	20	**Full**	43	good	72	15	4.14
5/27/2021	22.00	18	Full	41	good	131	17	6.73
5/28/2021	25.00	17	Full	38	good	393	20	16.52
6/2/2021	21.75	13	**Last**	244	good	0	0	0.00
6/3/2021	27.50	15	Last	186	good	0	0	0.00
6/4/2021	20.00	18	Last	134	good	0	1	0.05
6/5/2021	26.00	19	Last	106	good	0	0	0.00
6/8/2021	23.50	23	New	61	good	8	2	0.43
6/9/2021	18.50	25	New	52	good	6	1	0.38
6/10/2021	25.50	24	**New**	46	good	59	2	2.39
6/11/2021	26.00	23	New	42	good	70	2	2.77
6/14/2021	24.00	22	First	38	good	9	1	0.42
6/15/2021	24.00	23	First	42	good	6	1	0.29
6/16/2021	26.00	23	First	51	good	1	0	0.04
6/17/2021	20.00	23	**First**	49	good	8	1	0.45
6/22/2021	19.00	24	Full	29	good	101	7	5.68
6/23/2021	25.00	24	Full	27	good	64	7	2.84
6/24/2021	22.00	24	**Full**	25	good	82	0	3.73
6/25/2021	25.00	24	Full	22	good	31	0	1.24
6/29/2021	20.00	26	Last	15	good	40	4	2.20
6/30/2021	24.00	26	Last	16	good	71	4	3.13
7/1/2021	29.00	26	**Last**	16	good	46	2	1.66
7/2/2021	20.50	24	Last	34	good	31	0	1.51
7/6/2021	28.50	20	New	264	good	0	0	0.00
7/7/2021	22.50	20	New	215	good	0	0	0.00
7/8/2021	23.50	21	New	166	good	2	1	0.13
7/9/2021	23.50	20	**New**	371	good	0	0	0.00

[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, 2021.

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	
4/27/2021	23.50	10	Full	9	good	0	0	0.00
4/28/2021	24.00	10	Full	9	good	0	0	0.00
4/29/2021	24.00	9	Full	14	good	0	0	0.00
4/30/2021	24.00	10	Last	32	good	0	0	0.00
5/3/2021	23.25	10	**Last**	15	good	0	0	0.00
5/4/2021	28.25	10	Last	15	good	0	1	0.04
5/5/2021	21.00	10	Last	34	good	0	0	0.00
5/6/2021	24.00	10	Last	36	good	0	0	0.00
5/10/2021	24.75	10	New	15	good	0	0	0.00
5/11/2021	24.00	11	**New**	14	good	0	0	0.00
5/12/2021	24.00	12	New	12	good	0	0	0.00
5/13/2021	24.00	12	New	29	good	0	0	0.00
5/18/2021	22.00	16	First	6	good	0	0	0.00
5/19/2021	21.25	16	**First**	7	good	0	1	0.05
5/20/2021	26.00	18	First	6	good	0	0	0.00
5/21/2021	18.75	16	First	5	good	0	1	0.05
5/25/2021	20.50	18	Full	3	good	0	0	0.00
5/26/2021	33.00	20	**Full**	3	good	0	0	0.00
5/27/2021	17.75	20	Full	3	good	0	0	0.00
5/28/2021	24.00	16	Full	3	good	0	1	0.04
6/1/2021	18.00	9	Last	18	good	0	0	0.00
6/2/2021	30.50	16	**Last**	12	good	0	0	0.00
6/3/2021	20.25	17	Last	6	fair	0	0	0.00
6/4/2021	27.75	19	Last	7	fair	0	0	0.00
6/8/2021	22.75	24	New	3	good	0	0	0.00
6/9/2021	26.25	24	New	3	good	1	1	0.08
6/10/2021	19.75	20	**New**	3	good	6	0	0.30
6/11/2021	26.00	20	New	3	good	3	0	0.12
6/15/2021	18.75	19	First	3	good	0	0	0.00
6/16/2021	27.00	19	First	4	good	0	0	0.00
6/17/2021	21.00	17	**First**	3	good	3	0	0.14
6/18/2021	27.00	20	First	2	good	3	0	0.11
6/22/2021	18.25	22	Full	1	good	1	0	0.05
6/23/2021	26.50	21	Full	2	good	1	0	0.04
6/24/2021	19.75	19	**Full**	2	good	3	0	0.15
6/25/2021	26.25	21	Full	1	fair	2	0	0.08
6/29/2021	25.75	26	Last	1	good	2	0	0.08
6/30/2021	27.75	28	Last	1	good	0	0	0.00
7/1/2021	15.50	24	**Last**	1	good	0	0	0.00
7/2/2021	26.75	20	Last	4	good	0	0	0.00
7/6/2021	26.00	20	New	6	good	0	0	0.00
7/7/2021	22.50	20	New	4	good	0	0	0.00
7/8/2021	23.50	20	New	4	good	0	0	0.00
7/9/2021	24.00	20	**New**	67	good	0	0	0.00

[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, 2001–2021.

Year	Monitoring period	Date (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]	11.09	6,356[a]
2002	April 19-May 23	April 19 (15)	391.8	April 20	9,600[a]	31.97	17,798[a]
2003	April 22-July 31[b]	April 30 (5)	65.6	July 7	1,559[a]	4.31	6,165[a]
2004	April 13-July 30	April 20 (1)	20.0	July 8,9	490/525	3.49	5,252
2005	April 18-July 28[c]	April 21 (1)	12.7	July 14	314	1.50	2,095
2006	April 11-May 11[d]	April 14 (50)	26.3	April 25	571	5.17	2,637
2007	April 26–July 26	May 8 (6)	18.9	July 26	515[a]	0.94	1,240[a]
2008	April 22–August 1	May 22 (2)	14.4	July 10	231	0.90	1,361
2009	April 21–June 18	April 27 (1)	100.4	June 9	2,559	8.41	6,385
2010	April 26-July 8	April 26 (12)	1.3	May 26	25	0.21	208
2011	May 3-July 29	May 3 (3)	14.4	July 13	285	1.33	1,491
2012	April 3-July 26	April 23 (998)	50.5	April 23	998	2.67	4,213
2013	April 16-June 14	April 19 (1)	244.1	May 9	6,407	41.11	35,036
2014	April 22-June 23	May 5 (3)	65.1	June 11	1,806	9.89	8,449
2015	April 21–June 24	May 5 (4)	13.8	May 15	339	2.16	1,959
2016	April 19-June 23	April 20 (1)	261.8	May 17	7,396	16.65	15,621
2017	April 18-June 23	April 26 (2)	151.7	May 22	3,185	4.55	4,354
2018	April 24-June 8	April 25 (1)	1.0	May 17	24	0.31	208
2019	May 7-July 19	May 9 (1)	8.0	July 1	159	0.73	755
2020	May 5-July 7	May 8 (41)	215.7	May 19	4,529	14.81	14,088
2021	April 27–July 9	May 11 (1)	16.5	May 28	413	2.21	2,289

[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, 2014–2021.

Year	Monitoring period	Date (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 22-June 24	April 23 (47)	159.7	May 13	4,151	20.10	17,447
2015	April 21-June 25	May 4 (7)	42.6	May 13	1,034	5.19	4,765
2016	April 19-June 23	April 19 (2)	31.9	April 21	814	3.82	3,608
2017	April 18-June 23	April 18 (15)	9.0	May 3	205	0.64	621
2018	April 24-June 14	May 4 (21)	32.1	May 8	754	2.94	2,190
2019	April 30-July 12	May 22 (1)	0.3	June 25	8	0.04	39
2020	May 5-July 10	May 14 (1)	1.9	June 1	39	0.27	253
2021	April 27-July 9	May 4 (1)	0.3	June 10	6	0.03	30

Table 1.3-5. Mean lengths of sampled young-of-the-year American Eels by life stage in the Lamprey River, Newmarket, New Hampshire, 2016–2021.

		Year											
		2016		2017		2018		2019		2020		2021	
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	57.9	96	62.4	16	63.0	1	60.0	13	59.4	39	57.4	16
	2	60.3	326	62.1	39	61.0	24	62.0	7	60.6	117	60.3	91
	3	61.0	170	62.9	36	62.7	29	64.0	3	61.2	168	60.3	88
	4	59.9	90	63.7	37	61.1	20	60.8	35	61.3	160	59.9	68
	5	58.9	145	63.3	50	63.3	12	61.7	56	61.2	190	60.3	130
	6	59.4	237	63.1	18	64.6	7	62.0	160	62.2	127	62.8	167
	7	62.2	115	65.8	9	68.5	2	65.2	117	65.5	69	67.2	68
	Combined	60.0	1,179	63.1	205	62.3	95	62.7	391	61.5	870	61.6	628
Brown	-	92.3	14	95.8	17	95.5	93	94.1	31	89.8	109	98.1	72
Annual average (all stages)		60.4	1,193	65.6	222	78.7	188	65.0	422	64.7	979	65.4	700

Table 1.3-6. Mean lengths of sampled young-of-the-year American Eels by life stage in the Oyster River, Durham, New Hampshire, 2016–2021.

		Year											
		2016		2017		2018		2019		2020		2021	
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	58.3	79	61.2	88	57.4	15	58.0	1	61.6	5	N/A	0
	2	59.5	245	62.8	165	59.3	101	63.5	2	58.2	25	49.5	2
	3	59.2	199	62.6	74	60.7	78	56.6	5	57.8	54	57.1	8
	4	58.6	158	63.3	38	61.3	59	59.6	7	58.9	51	N/A	0
	5	58.4	98	62.1	13	61.2	40	60.6	8	59.1	37	68	1
	6	59.3	50	61.9	8	63.2	26	61.5	2	61.4	20	55.8	6
	7	63.9	26	61.0	7	65.8	9	64.8	4	65.8	5	64.3	8
	Combined	59.2	855	62.4	393	60.6	328	60.4	29	59.0	197	58.9	25
Brown	-	97.2	105	97.4	8	98.2	36	98.0	8	89.6	56	103.6	5
Annual average (all stages)		63.3	960	63.1	401	64.3	364	68.5	37	65.8	253	66.4	30

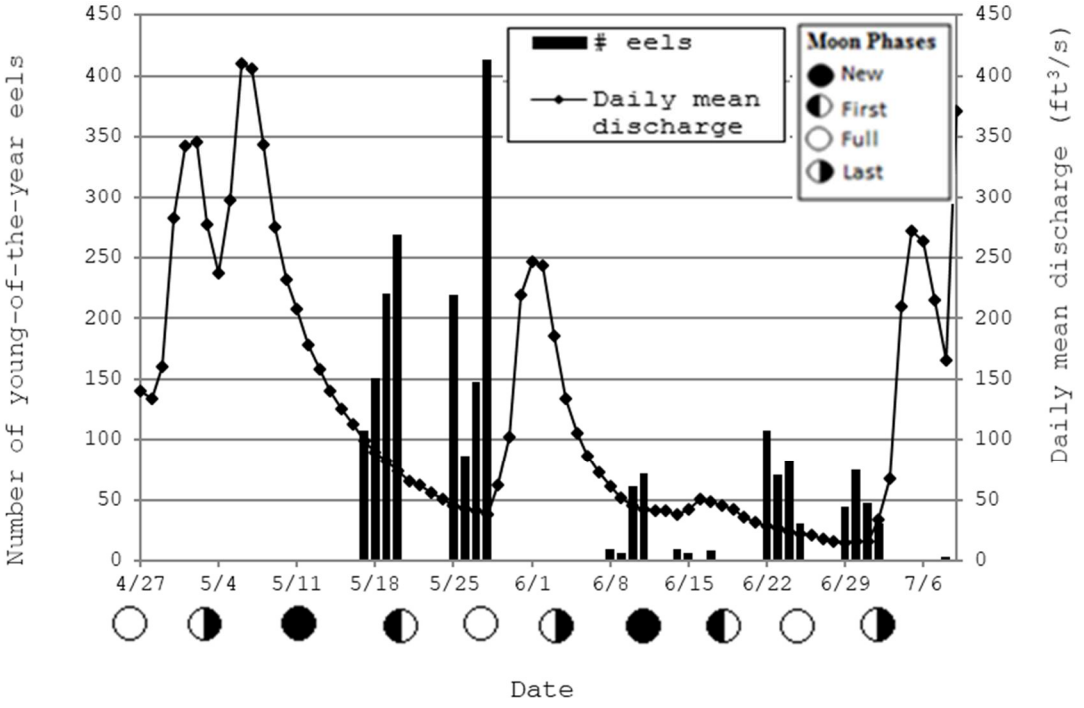

Figure 1.3-1. Daily mean discharge (ft^3/s) in the Lamprey River with the total number of American Eel young-of-the-year observed each sampling day and lunar phase, 2021.

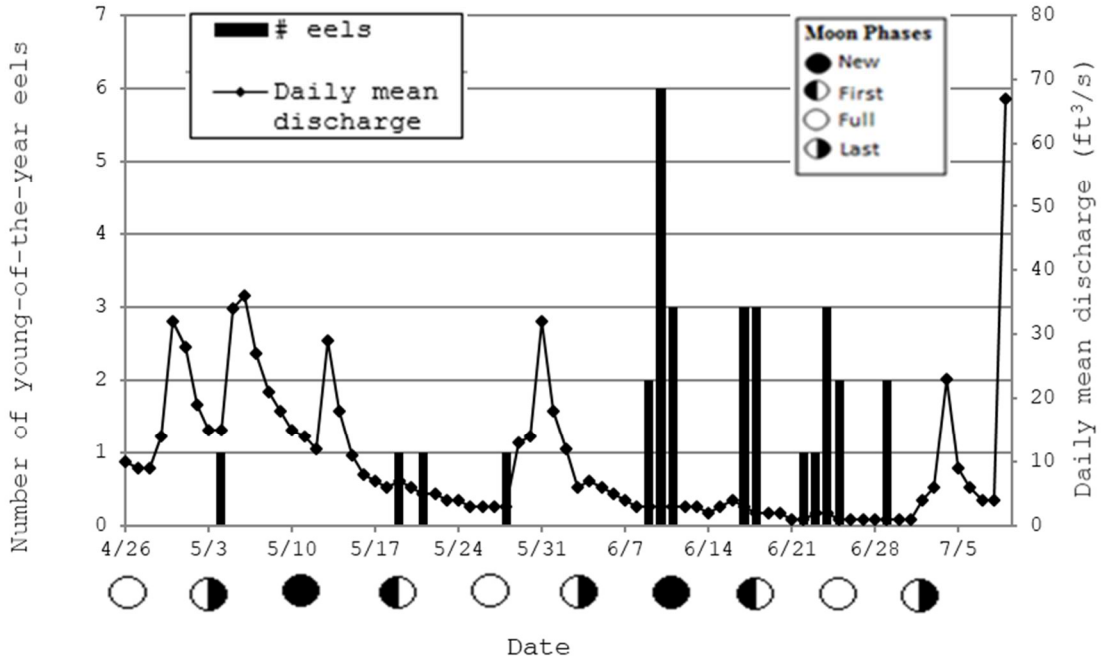

Figure 1.3-2. Daily mean discharge (ft^3/s) in the Oyster River with the total number of American Eel young-of-the-year observed each sampling day and lunar phase, 2021.