FINAL REPORT

State: **NEW HAMPSHIRE** **Grant**: **F-61-R-25/F22AF00514**

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, 2019 – December 31, 2023

ABSTRACT

Between January 1, 2019 and December 31, 2023, the New Hampshire Fish and Game Department conducted one investigation per year to characterize trends in annual recruitment of young-of-year American Eel over time in New Hampshire waters. Since 2001, New Hampshire's annual American Eel *Anguilla rostrata* young-of-the-year survey was conducted for at least six weeks each year on the Lamprey River in Newmarket and since 2013 on the Oyster River in Durham. A modified Irish elver ramp was installed under an overhanging section of the Lamprey River fish ladder 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 total number of young-of-the-year eels captured in the Lamprey River from 2019 to 2023 ranged from 755 eels in 2019 to 94,643 eels in 2022. The total number of young-of-the-year eels captured by the box trap at the Oyster River over the past five years ranged from 30 in 2021 to 484 in 2023. The peak catch per unit effort during the project period ranged from 8.0 to 1,279.1 young-of-the-year eels/hours soak time on the Lamprey River and 0.3 to 10.1 young-of-the-year eels/hours soak time on the Oyster River. The mean length for glass eels ranged from 61.6 mm to 62.9 mm in the Lamprey River and from 58.9 mm to 61.4 mm in the Oyster River. 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 New Hampshire Fish and Game Department established an annual survey of young-of-the-year eels in the Lamprey River in Newmarket, New Hampshire (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 American 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 assessment 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 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 toppled due to 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 "age-1+". Glass eels generally range from 45 to 70 mm long and age-1+ are generally over 70 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 age-1+, 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, 2019 and December 31, 2023, the New Hampshire Fish and Game Department conducted one investigation per year to characterize trends in annual recruitment of young-of-year American Eel over time in New Hampshire waters.

The two locations were sampled four days per week starting in mid-April to early-May, and ending in late-June to mid-July. Young-of-the-year eels were first observed in mid-April to mid-May at the Lamprey River (Table 1.3-1), and mid-April to late-May at the Oyster River (Table 1.3-2). Monitoring at both locations continued for a minimum of six weeks until a continued decline in the occurrence of young-of-the-year eels was observed.

Between 2019 and 2023 a total of 220 sampling trips were conducted and 184,110 young-of-the-year eels (183,222 glass, 888 age-1+) were caught in the trap at the Lamprey River and passed upstream (Table 1.3-3). The Oyster River had a total of 220 sampling trips with 838 young-of-the-year eels (749 glass, 89 age-1+)(Table 1.3-4). In 2022, a total of 94,643 young-of-the-year eels were observed in the trap at the Lamprey River, which was an annual time series high (2001-2023) and comprises 51% of the eels observed in this five-year reporting period. The highest annual total at the Oyster River occurred in 2023 (484 young-of-the-year eels), which comprises 58% of the eels observed in this five-year reporting period. The lowest annual total at the Lamprey River during the report period was 755 eels caught in 2019. The Oyster River had a ten-year time series low of 30 eels in 2021.

The one-day peak catch per unit effort (CPUE) during the five-year reporting period at the Lamprey River ranged from 8.0 young-of-year-eels/hour soak time on July 1, 2019 to a time series high of 1,279.1 young-of-year-eels/hour soak time on April 21, 2023 (Table 1.3-1 and Appendix Tables 1.3-1 through 1.3-10). At the Oyster River, one-day peak CPUE during the five-year reporting period ranged from 0.3 young-of-year-eels/hour soak time on June 10, 2021 to 10.1 young-of-year-eels/hour soak time on April 18, 2023 (Table 1.3-2 and Appendix Tables 1.3-1 through 1.3-10). At the Lamprey River, the mean annual CPUE ranged from 0.7 young-of-year-eels/hour soak time in 2019 to 88.9 young-of-year-eels/hour soak time in 2022 (Table 1.3-1). At the Oyster River, the mean annual CPUE ranged from 0.03 young-of-year-eels/hour soak time in 2021 to 0.42 young-of-year-eels/hour soak time in 2023 (Table 1.3-2).

From 2019 through 2023, the mean length for glass eels at the Lamprey River was 61.9 mm (n=2,697) and age-1+ eels was 93.5 mm (n=301) (Table 1.3-5). Pigmentation stage 6 was the most abundant (19%) and stage 1 was the least abundant (7%). The mean length for glass eels at the Oyster River was 59.6 mm (n=475) and age-1+ eels averaged 94.3 mm (n=87) (Table 1.3-6). Pigmentation stage 2 was the most abundant (24%) and stage 7 was the least abundant (4%).

At the Lamprey River, the daily mean river discharge ranged from 15 ft^3/s to 2,520 ft^3/s during the five-year reporting period (Table 1.3-3 and Figure

1.3-1). The daily mean river discharge at the Oyster River ranged from 1 ft^3/s to 153 ft^3/s during the five-year reporting period (Table 1.3-4 and Figure 1.3-2). The average mean discharge during the five-year reporting period was 221.7 ft^3/s at the Lamprey River and 16.2 ft^3/s at the Oyster River.

DISCUSSION

The total number of young-of-the-year eels captured by the Irish elver ramp at the Lamprey River during the 2019 to 2023 project period was 602% of the total eels captured from the previous five-year period (2014-2018). The two highest annual totals of young-of-the-year eels in the 23-year time series occurred in 2022 and 2023 (Table 1.3-1). The lowest total catch at the Lamprey River during 2019 to 2023 project period was 755 young-of-the-year eels in 2019, which was the third lowest in the time series. In contrast, the total number of young-of-year-eels captured by the box trap at the Oyster River during the 2019 to 2023 project period was 3% of the catch from the previous five-year period. In 2021, the annual total of 30 young-of-the-year eels captured was a time series low. 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. Similar to these previous findings, young-of-the-year eels were observed during the five-year project period migrating in the Lamprey and Oyster rivers when freshwater temperatures were above 10°C (Appendix Tables 1.3-1 through 1.3-10). The temperature on the first day eels were observed in both the Lamprey and Oyster rivers during the past five-years was between the threshold range stated by Sorensen and Bianchini (1986). Young-of-year-eel migration into 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 young-of-year-eels (Jessop 2000; Jessop and Harvie 2003). High levels of discharge could impede the upstream movement of glass eels in the Lamprey and Oyster rivers. 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 the project period in the Lamprey River, 99.6% of eels captured were observed when discharge levels were below 310 ft^3/s (8.5 m^3/s), while at the Oyster River, 97.7% of eels were observed when discharge levels were below 45 ft^3/s (1.3 m^3/s) (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. During the five-year reporting period, the flood gates at the Lamprey River were open during three sampling trips (3 of 44 in 2019) where no eels were observed in the trap; suggesting that increased river discharge negatively impacts the upstream migration of young-of-the-year eels. 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 young-of-the-year eel 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 during the project period occurred near the full or new moon on both the Oyster and Lamprey rivers (Figure 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 prevent eels from upstream migration. In 2019 and 2021, the observed increases in river discharge before the full or new moon could have slowed migration and explain the lower American Eel densities in both rivers compared to years with lower river discharge.

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 New Hampshire 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 2019 and 2023, ranging from 61.6 to 62.9 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 58.9 to 61.4 mm between 2019 and 2023 (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 to the Lamprey River were the highest in the time series in 2022 and 2023 (Table 1.3-1. Sampling in 2023 produced the second highest annual catch and CPUE when compared to the time series, and may have been higher if not for high flows that were concurrent with the full moon phase in early May 2023 (Figure 1.3-1). In contrast, sampling at the Oyster River has shown a decreasing trend in number of young-of-the-year eels captured during the 2019 to 2023 project period when compared to the prior five-year period (Table 1.3-4. A time series low was set in both annual catch and CPUE in 2021. 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. Annual summary of the American Eel young-of-year survey in the Lamprey River, Newmarket, New Hampshire, 2001-2023.

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]	11.1	6,356[a]
2002	April 19-May 23	April 19 (15)	391.8	April 20	9,600[a]	31.0	17,798[a]
2003	April 22-July 31[b]	April 30 (5)	65.6	July 7	1,559[a]	4.3	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	5.2	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	May 22 (2)	14.4	July 10	231	0.9	1,361
2004-2008						**2.0**	
2009	April 21-June 18	April 27 (1)	100.4	June 9	2,559	8.4	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	1.3	1,491
2012	April 3-July 26	April 23 (998)	50.5	April 23	998	2.7	4,213
2013	April 16-June 14	April 19 (1)	244.1	May 9	6,407	41.1	35,036
2009-2013						**8.9**	
2014	April 22-June 23	May 5 (3)	65.1	June 11	1,806	9.9	8,449
2015	April 21-June 24	May 5 (4)	13.8	May 15	339	2.2	1,959
2016	April 19-June 23	April 20 (1)	261.8	May 17	7,396	16.7	15,621
2017	April 18-June 23	April 26 (2)	151.7	May 22	3,185	4.5	4,354
2018	April 24-June 8	April 25 (1)	1.0	May 17	24	0.3	208
2014-2018						**7.1**	
2019	May 7-July 19	May 9 (1)	8.0	July 1	159	0.7	755
2020	May 5-July 7	May 8 (41)	215.7	May 19	4,529	14.8	14,088
2021	April 27-July 9	May 11 (1)	16.5	May 28	413	2.2	2,289
2022	April 19-July 1	April 27 (64)	1,193.4	May 5	27,438	88.9	94,643
2023	April 11-June 30	April 14 (44)	1,279.1	April 21	27,500	63.8	72,335
2019-2023						**35.0**	

[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 1.3-2. Annual summary of the American Eel young-of-year survey in the Oyster River, Durham, New Hampshire, 2014-2023.

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 22-June 24	April 23 (47)	159.7	May 13	4,151	20.1	17,447
2015	April 21-June 25	May 4 (7)	42.6	May 13	1,034	5.2	4,765
2016	April 19-June 23	April 19 (2)	31.9	April 21	814	3.8	3,608
2017	April 18-June 23	April 18 (15)	9.0	May 3	205	0.6	621
2018	April 24-June 14	May 4 (21)	32.1	May 8	754	2.9	2,190
2014-2018						**6.4**	
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
2022	April 19-July 1	May 4 (2)	0.8	May 24	17	0.03	32
2023	April 11-June 30	April 18 (235)	10.1	April 18	235	0.42	484
2019-2023						**0.16**	

Table 1.3-3. Summary of temperature, number of sample trips, total soak time, daily mean discharge in cubic feet per second and total eels from the American eel young-of-year survey in the Lamprey River, Newmarket, New Hampshire, 2001-2023.

Year	Temperature (°C)			# of sample trips	Total soak time (hours)	Daily mean discharge (ft^3/s)[a]			Total # Glass eels	Total # Age-1+	Total eels
	Min	Max	Mean			Min	Max	Mean			
2001	12.5	20.0	15.5	24	573	52	382	128.5	4,335	2,021	6,356
2002	7.0	16.0	11.5	24	575	146	1,020	401.8	3,437	14,361	17,798
2003	8.0	27.0	18.1	54	1,430	11	674	231.8	97	6,068	6,165
2004	7.0	24.5	16.8	64	1,503	39	1,170	348.0	453	4,799	5,252
2005	10.0	26.5	18.3	58	1,394	52	803	361.2	152	1,943	2,095
2006	7.9	15.4	12.1	20	510	129	641	259.9	2,142	495	2,637
2007	11.1	27.5	18.7	55	1,319	36	1,910	339.9	4	1,236	1,240
2008	9.0	28.0	19.3	60	1,507	18	1,160	217.4	27	1,334	1,361
2004-2008								305.3			
2009	12.0	22.6	16.4	31	759	68	814	284.8	238	6,147	6,385
2010	12.0	27.0	18.5	42	1,010	15	327	118.9	110	98	208
2011	11.0	29.3	20.5	46	1,121	11	753	196.9	1,444	47	1,491
2012	9.1	27.9	18.7	65	1,579	14	652	181.7	4,092	121	4,213
2013	7.9	23.2	15.9	36	852	61	788	283.0	34,911	125	35,036
2009-2013								213.0			
2014	8.0	23.3	16.2	37	855	37	402	194.5	8,282	167	8,449
2015	10.0	23.7	16.9	38	907	39	1,230	269.6	1,787	172	1,959
2016	10	22.6	16.6	39	938	18	224	106.2	15,567	54	15,621
2017	10.6	23.0	15.7	40	958	126	898	414.3	4,324	30	4,354
2018	10.0	19.6	16.0	28	672	72	710	252.4	95	113	208
2014-2018								247.4			
2019	11.0	25.0	18.1	44	1,040	40	486	198.7	717	38	755
2020	8.0	25.0	17.6	40	951	16	474	120.4	13,783	305	14,088
2021	9.0	26.3	18.2	44	1,035	15	410	122.4	2,031	258	2,289
2022	6.0	23.0	15.2	44	1,065	19	644	179.2	94,523	120	94,643
2023	9.0	22.0	15.6	48	1,162	114	2,520	457.2	72,168	167	72,335
2019-2023								221.7			

Table 1.3-4. Summary of temperature, number of sample trips, total soak time, daily mean discharge in cubic feet per second and total eels from the American eel young-of-year survey in the Oyster River, Durham, New Hampshire, 2014-2023.

Year	Temperature (°C)			# of sample trips	Total soak time (hours)	Daily mean discharge (ft^3/s)[a]			Total # Glass eels	Total # Age-1+	Total eels
	Min	Max	Mean			Min	Max	Mean			
2014	8	22	14.9	37	868	2	56	15.0	17,280	167	17,447
2015	10	24	16.2	39	919	2	179	20.4	4,320	445	4,765
2016	9	24	15.8	39	944	1	20	7.6	3,401	207	3,608
2017	10	24	14.1	40	967	5	81	31.6	610	11	621
2018	9	20	15.0	31	746	3	90	16.9	2,138	52	2,190
2014-2018								18.3			
2019	9.0	20.0	15.0	44	1,060	4	84	19.5	29	10	39
2020	7.0	23.7	16.7	40	953	1	35	8.9	197	56	253
2021	9.0	28.0	17.0	44	1,040	1	67	9.8	25	5	30
2022	7.0	22.0	14.1	44	1,052	1	89	16.2	22	10	32
2023	9.0	21.0	14.8	48	1,143	5	153	25.3	476	8	484
2019-2023								16.2			

Table 1.3-5. Mean lengths of sampled young-of-year American eels by life stage in the Lamprey River, Newmarket, New Hampshire, 2019-2023.

		Year											
		2019		2020		2021		2022		2023		2019-2023	
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	60.0	13	59.4	39	57.4	16	59.7	55	61.1	77	60.0	200
	2	62.0	7	60.6	117	60.3	91	61.5	202	61.5	62	61.0	479
	3	64.0	3	61.2	168	60.3	88	62.7	122	61.6	47	61.5	428
	4	60.8	35	61.3	160	59.9	68	62.3	64	63.0	52	61.4	379
	5	61.7	56	61.2	190	60.3	130	62.0	27	62.7	37	61.2	440
	6	62.3	160	62.5	127	62.8	167	61.9	35	64.5	15	62.6	504
	7	65.2	117	65.5	69	67.2	68	63.6	10	67.0	3	65.7	267
	Combined	62.9	391	61.6	870	61.6	628	61.8	515	62.0	293	61.9	2,697
Age-1+	-	94.1	31	89.8	109	98.1	72	99.5	42	89.4	47	93.5	301
Annual average (all stages)		65.2	422	64.7	979	65.4	700	64.6	557	65.8	340	65.0	2,998

Table 1.3-6. Mean lengths of sampled young-of-year American eels by life stage in the Oyster River, Durham, New Hampshire, 2019-2023.

		Year											
		2019		2020		2021		2022		2023		2019-2023	
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	58.0	1	61.6	5	N/A	0	N/A	0	59.7	99	59.8	105
	2	63.5	2	58.2	25	49.5	2	62.3	7	59.9	79	59.6	115
	3	56.6	5	57.8	54	57.1	8	62.3	4	60.5	15	58.3	86
	4	59.6	7	58.9	51	N/A	0	60.2	6	59.8	4	59.1	68
	5	60.6	8	59.1	37	68.0	1	62.3	3	61.3	4	59.9	53
	6	61.5	2	61.4	20	55.8	6	59.0	2	N/A	0	60.1	30
	7	64.8	4	65.8	5	64.3	8	N/A	0	57	1	64.4	18
	Combined	60.4	29	59.0	197	58.9	25	61.4	22	59.9	202	59.6	475
Age-1+	-	98.0	8	89.6	56	103.6	5	112.6	10	94.4	8	94.3	87
Annual average (all stages)		68.5	37	65.8	253	66.4	30	77.4	32	61.2	210	65.0	562

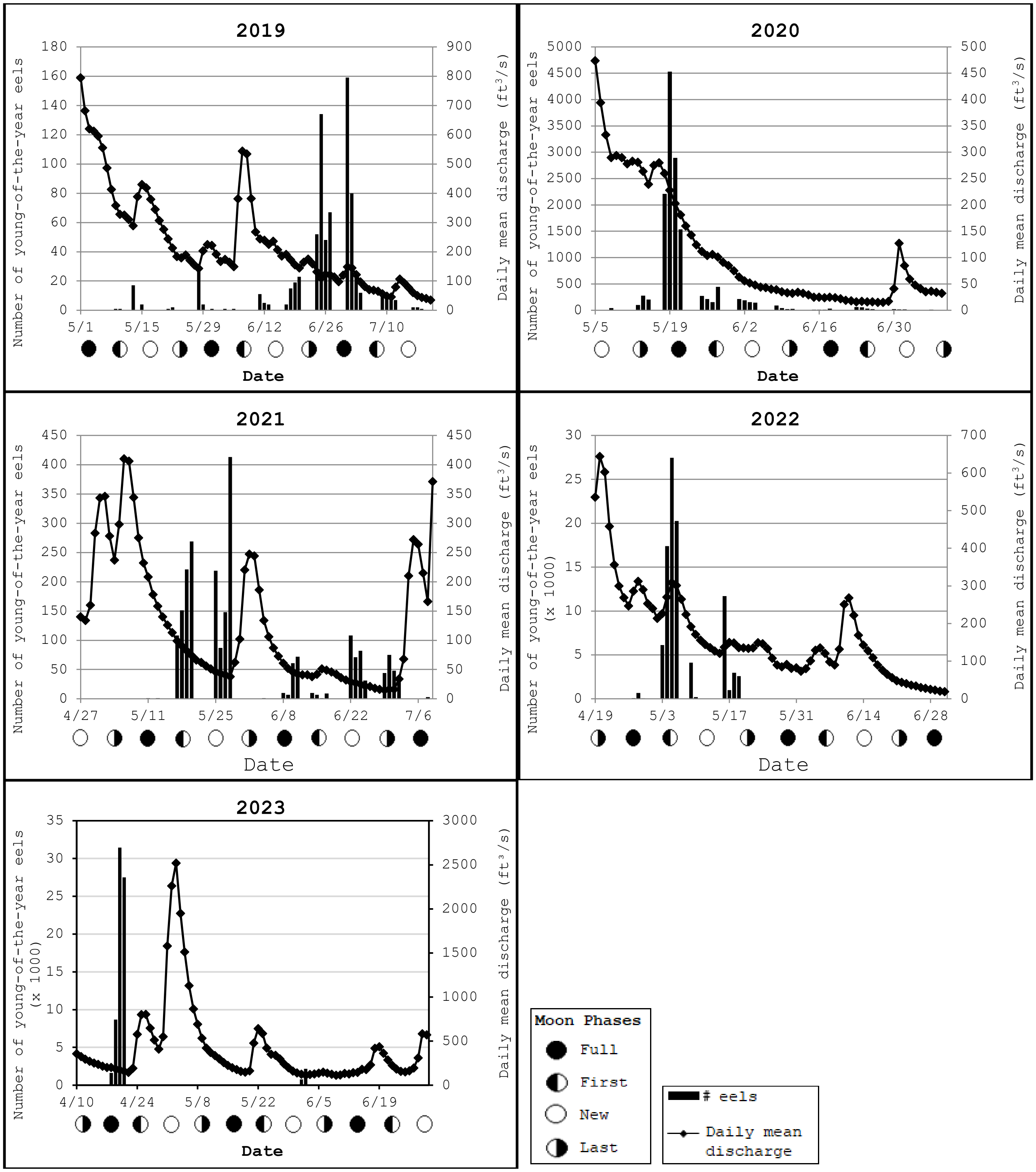

Figure 1.3-1. Daily mean discharge (ft³/s) in the Lamprey River with the total number of American Eel young-of-the-year observed each sampling day, 2019 - 2023.

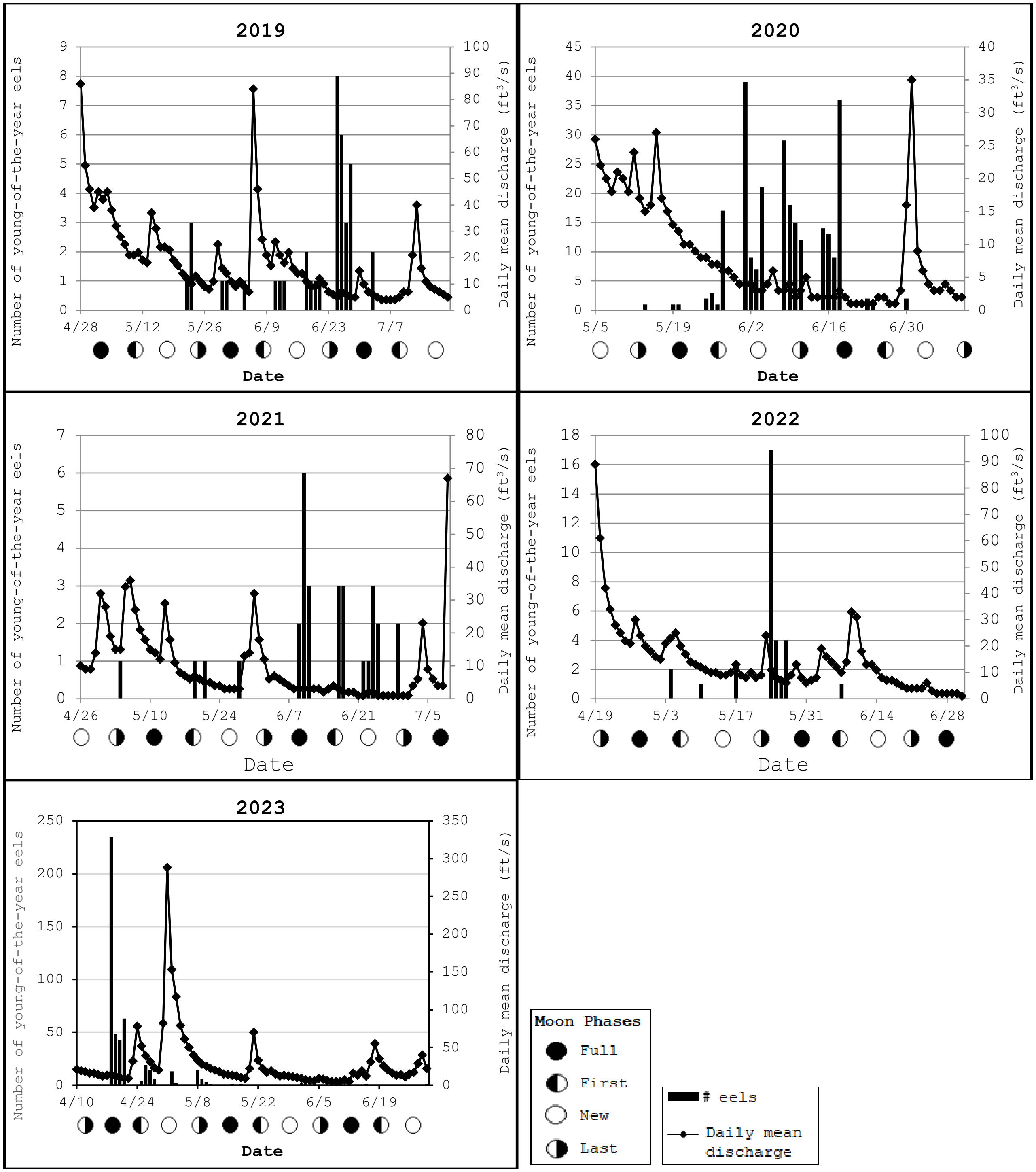

Figure 1.3-2. Daily mean discharge (ft³/s) in the Oyster River with the total number of American Eel young-of-the-year observed each sampling day, 2019 - 2023.