VERMONT YANKEE/CONNECTICUT RIVER SYSTEM
ANALYTICAL BULLETIN 73

Abundance of Juvenile American Shad In the Vernon Pool During 1998

NORMANDEAU ASSOCIATES, INC.
224 OLD FERRY ROAD
BRATTLEBORO, VT

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ABSTRACT

Sampling for juvenile American shad was conducted twice per month by electrofishing and beach seining in Vernon Pool from July through October 1998. Electrofishing was conducted in conjunction with NPDES Permit requirements for sampling of Stations 4NH, 4VT, Vernon Dam log boom, NH Setback, and VY Intake. A total of 37 shocking runs was completed. No shad were collected. Electrofishing was judged an ineffective sampling gear to monitor relative abundance of a sparse juvenile shad population for the second year in a row.

Beach seining was conducted twice per month at five Cersosimo Lake Stations CL1 - CL5 and at two stations in the Retreat Meadows (901 and 902 near the mouth of the West River). Shad were taken at the Cersosimo Lake Stations only. No shad were collected in July. Abundance in Cersosimo Lake increased during August (6 fish), and early September (21 fish), peaking on 24 September (35 fish). Abundance dropped back to 22 fish in early October, and no shad were collected in late October.

Although no shad were taken at the Retreat Meadows Stations, sampling by seine should continue to assist in establishing a juvenile shad index.

INTRODUCTION

One of the stated objectives by the Shad Studies Subcommittee of the Connecticut River Atlantic Salmon Commission in " A Management Plan for American Shad in the Connecticut River Basin" (prepared February 1992) is that population monitoring is required to support the achievement of the management goal of sustaining 1.5 to 2 million shad in the Connecticut River system. Vermont Yankee has participated in the long-term population monitoring in previous years (e.g., Vermont Yankee Analytical Bulletin Nos. 40, 42, and 71), and agreed to evaluate sampling methodologies and locations that can be used to develop a juvenile shad relative abundance index in 1997 (Normandeau 1998, Bulletin No. 71). Sampling via electrofishing and beach seine continued in 1998.

As part of the 1998 objective specific studies of the Vermont Yankee Nuclear Power Corporation's NPDES Permit (NPDES No. VT0000264), juvenile American shad (*Alosa sapidissima*) were sampled at two locations in Vernon Pool. Specifically, sampling locations and gear were investigated to establish a juvenile shad relative abundance index for Vernon Pool. Locations previously sampled in Vernon Pool were relatively unproductive (Downey and Biercevicz 1991) in yielding juvenile shad. The objectives of this study were to obtain relative abundance information and to establish sampling locations and collection gear that were likely to provide consistent catches of juvenile shad. The goal was to establish relatively productive sampling stations for systematic sampling over time that may result in a juvenile shad relative abundance index to assess year class strength in Vernon Pool. This index can be defined in terms of the mean catch per effort (CPE) of juvenile shad (Marcy 1976; Crecco et al. 1981) collected in bi-monthly samples at the sampling stations during a defined time period (July through October). Marcy's (1996) estimation for year class strength in the lower Connecticut River (Essex km 11.3 to Northampton, MA rkm 138) was based on bag seine CPE and trawl CPE at 12 sampling stations. He noted that the strength of each year class was dependent upon the following factors: numbers of adults potentially available to spawn, water temperature, and river discharge. A multiple linear regression model he used revealed a highly significant relationship ($p < 0.05$) between year class strength (CPE) and the combination of available spawners, water temperature, and discharge. He stated that this model can explain 86% of the variability in year class strength and could

therefore be used to predict the production of juvenile shad in a particular year with a high degree of success. However, CPE and abundance of shad in the Vernon Pool has been low to date such that employment of a statistical model would not provide very meaningful results.

METHODS

Electrofishing

Juvenile American shad in Vernon Pool were sampled by electrofishing and beach seining. Electrofishing was conducted during hours of darkness with a boat mounted Coffelt Electronics Model VVP-15 electroshocker. Stations were sampled once every two weeks between July and October in conjunction with NPDES Permit requirements sampling. Stations sampled were NH Setback, Station 4 NH north and south, Vernon Dam log boom, Station 4 VT (north and south), and an additional station in front of the Project cooling water intake structure (Figure 1). Shocking run duration ranged from 8 to 18 minutes in littoral areas of each station. Dependent upon ambient conductivity, from 4 to 6 amps at 240 to 400 V was applied to the water. Typical depths were approximately 1 to 6 ft. Stunned shad would be netted from the river, transferred to a water filled container, and processed upon completion of the sampling run. The total length (TL) would be measured to the nearest millimeter (mm) and recorded. All fish would be released back to the river. Water temperature, dissolved oxygen (DO), pH and water conductivity were measured prior to each sample.

Beach Seine

Two general locations were sampled for juvenile shad by beach seine during daylight hours: Cersosimo Lake (five stations sampled) and an area in the lower reaches of the West River, called the Retreat Meadows (two stations sampled) (Figure 1). Seine samples were conducted twice monthly between July and October 1998. On each sample day, one seine haul was conducted for each station sampled. The seine was set at each sampling location with an 18-ft johnboat powered by a 45 HP motor. The beach seine was 100 ft long, 8 ft deep, with 3/8 in stretch mesh. One end of the seine was attached to the shoreline and the other end was tied to the bow of the boat. With the seine folded on the bow, the boat was motored backward, away from the shoreline, allowing the seine to unfold into the water. Once the seine was stretched perpendicular to the shore, the boat end was pulled in an arc back to the shoreline. Both ends were then pulled in to shore by hand until all but approximately 10 ft of net was on shore. With the remaining net in the water, the catch was inspected and all juvenile shad were gently placed into a bucket filled with river water. All fish other than shad were released back into the river. The total length of each shad was measured to the nearest millimeter and released back to the river. Physicochemical parameters measured for each sample included water temperature, dissolved oxygen, and pH.

Catch per effort (CPE) was calculated for both sampling gears. For each electrofishing sample, CPE was calculated by the equation:

$$CPE = n/T \quad \text{where} \quad n = \text{total number of shad collected per sample}, \; T = \text{time duration in minutes of the sample}$$

The CPE for each beach seine sample was calculated by the equation:

$$CPE = n/S \quad \text{where} \quad n = \text{total number of shad collected}, \; S = \text{total number of hauls per station, per date}$$

RESULTS

Electrofishing

Juvenile shad were sampled by electrofishing one night every two weeks from 9 July to 26 October 1998 for a total of eight sampling dates (Table 1). The Vernon Dam Log Boom Station was not sampled on 9 July and three stations (4 Vermont, North and South and the Vermont Yankee Intake Station), were not sampled on 30 July due to equipment failures. All sampling was conducted during hours of darkness. During the bi-monthly sampling at the seven-electrofishing stations, no shad were collected. During sampling, water temperature ranged from 11.0 to 27.0 C. Dissolved oxygen ranged from 8.2 to 12.8 mg/l. The pH and conductivity ranged from 7.0 to 9.1 and 90 to 110 µS, respectively.

Beach Seine

Two general locations were sampled by beach seine bi-monthly between July and October 1998.
Five Stations were sampled on eight occasions within location Cersosimo Lake: CL1 -CL5, and two Stations were sampled on eight occasions within location Retreat Meadows (Figure 1).

Cersosimo Lake – beach seining

Station CL1 produced a catch of one shad on 9 October 1998. This fish measured 112mm TL. The water temperature, pH, and dissolved oxygen on this date were 14.5° C, 7.7, and 9.6 mg/l, respectively (Table 2).

No shad were collected at Station CL2 on any sampling date. Water temperature ranged from 14.5 – 27.0° C. Dissolved oxygen and pH ranged from 8.7 –12.2 mg/l and 7.3 – 8.6, respectively.
Station CL3 produced a catch of 30 shad on 24 September 1998. Collected shad ranged in length from 108 – 142 mm. Water temperature on that day was 20.2° C, dissolved oxygen was 9.2 mg/l, and pH was 7.7.

The most productive site in Cersosimo Lake was Station CL4. Shad were collected on five of eight occasions, producing a total catch of 47 fish. Total lengths ranged from 90 mm on 17 August to 148 mm on 22 September 1998. Shad collected in October ranged from 112 – 138 mm in total length. Six shad were collected in August, and 20 and 21 were collected in September and October, respectively. Water temperature ranged from a high of 27.0° C in July to 14.5° C in October. Dissolved oxygen ranged from 8.5 – 12.6 mg/l over the eight sampling dates and pH ranged from 7.4 – 8.6.

Station CL5 produced a catch of six shad on 11 September 1998. Water temperature, dissolved oxygen, and pH were 22.9° C, 10.4 mg/l, and 7.4 on that day.

Overall, CPE for Cersosimo Lake Stations combined increased from 0.0 on 13 and 30 July to 1.0 on 17 and 24 August (Table 2). Catch per effort was 4.0 on 11 September and peaked on 24 September at 7.0, then declined to 4.0 and 0.0 on 9 and 26 October, respectively (Table 2).

Length frequency distribution of juvenile shad collected from Cersosimo Lake is presented in Figure 2. The majority of juvenile shad collected were between 105 and 140 mm TL. A slight shift of size composition, indicating growth, was evident in some of the later samples.

Retreat Meadows – beach seining

Station 901 was sampled eight times between July and October 1998. No shad were collected. Station 902 was sampled seven times between July and October 1998. This station was not sampled on 26 October as the water level was too shallow for access. Over all sampling events, water temperature ranged from 14.0 – 26.8° C, dissolved oxygen ranged from 8.2 – 11.9 mg/l, and pH ranged from 7.7 – 8.9.

DISCUSSION

The objective of the study was to monitor relative abundance of juvenile American shad in the Vernon Pool. This objective was accomplished by electrofishing at seven existing Vermont Yankee monitoring stations, and seining two additional locations north of the Vermont Yankee Plant (7 seine stations within 2 locations). In 1997, the seining exercise was designed to locate suitable, productive seining sites in Vernon Pool for future shad indices, and to compare the effectiveness of seining relative to electrofishing. In 1998 two seining stations were added to those sampled in 1997 and again the effectiveness of seining relative to electrofishing was compared.

Data in 1997 indicated that electrofishing, as a sampling gear to assess relative abundance of juvenile American shad in Vernon Pool was not very effective. Over a total of 27 sampling runs at four different Stations, only three shad were collected. Electrofishing data in 1998 support the 1997 indication that electrofishing in the Vernon Pool was minimally effective. Over a total of 37 sampling runs at seven different Stations in 1998, no shad were collected. In-field observations during 1997 suggested that juvenile shad were largely unaffected by the 4 to 6 amp electrical field generated in the Vernon Pool environment. In 1997 shad were observed swimming near the electrodes of the shocker during runs but seemed unaffected. In 1998 no shad were observed above Vernon Dam during electrofishing runs. Voltage, amperage, pulse width, and pulses per second settings used to stun most species of fish can be altered to increase the potential to stun shad. However, changing settings to the levels necessary to stun shad could be detrimental and perhaps lethal to other species inhabiting the waters sampled.

The more effective method to sample juvenile shad proved to be beach seining. Many more juvenile shad were collected by seining specific sites in Vernon Pool. All Stations in Cersosimo Lake were sampled on eight occasions and the data may be sufficient to assess relative abundance over time. Catch per effort increased during August through 11 September, with a peak on 24 September. Abundance then decreased by 9 October, with no shad collected on 26 October. There was a noticeable shift in length frequency between the juvenile shad collected at the Cersosimo Lake stations in 1997 versus 1998. The majority of shad collected in 1997 ranged in length from 75 – 96 mm TL, while the majority of shad collected in 1998 at the same stations ranged from 105 – 148 mm TL. The greatest number of shad collected by seine was in mid-September 1997 and in late September 1998.

The West River location became a candidate for seining during 1997. Although no shad were collected in 1998, if sampled regularly, this location might yield valuable information over the years. It is accessible and easily sampled. The five Cersosimo Lake Stations should continue as juvenile shad index stations. Shad activity has been observed there virtually every year, and numbers collected will be valuable to assess relative abundance. Shad are largely confined, with only a narrow access to the river. They should remain in the area until they become ready to emigrate.

CONCLUSIONS AND RECOMMENDATIONS

For the second year, electrofishing was not an effective sampling gear to monitor relative abundance of juvenile American shad in Vernon Pool. Beach seining was a more effective method; however, shad were taken in only one location of the two locations sampled. Seine sampling was consistent at all locations in 1998 and if continued in 1999 may help establish a meaningful juvenile shad abundance index. Relative abundance within Cersosimo Lake should be reflective of general trends in Vernon Pool.

It is not clear whether the apparent ineffectiveness of electrofishing in the Vernon Pool is due to a lack of juvenile shad in the areas sampled over the last two years (7,384 adults passed above Vernon Dam in 1997 and 8,151 passed in 1998), or for some other reason. Electrofishing conducted above and below Vernon Dam as part of the Vermont Yankee NPDES permit requirements in 1997 and 1998 produce large catches of a variety of fish. Juvenile shad have been collected below Vernon Dam via electrofishing during the 1996 and 1997 NPDES anadromous fish electrofishing sampling (124, and 321 juvenile shad, respectively), indicating the sampling gear functions effectively.

It is premature to draw any substantial conclusions on shad abundance in Vernon Pool. A continuation of annual sampling to acquire a reasonable time series, combined with some analyses perhaps similar to that conducted by Marcy (1976, see Introduction) will hopefully provide meaningful information on the relative abundance of juvenile shad in Vernon Pool. The value of this sampling program should be assessed annually with serious consideration for extension or termination of the program after five years of data are collected and the usefulness of the data with respect to operation impacts of the Vermont Yankee Plant to Connecticut River shad thoroughly evaluated.

LITERATURE CITED

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Table 1. Summary of juvenile American shad collected by electrofishing in Vernon Pool, 1998

STATION: NH Setback

	Sample Date							
	09JUL98	30JUL98	06AUG98	26AUG98	15SEP98	29SEP98	14OCT98	26OCT98
Sample Time	21:40	22:40	22:58	20:50	21:16	21:51	20:34	21:05
Water Temp (degC)	20.5	24.5	26.1	26.5	23.0	19.0	13.0	14.0
DO (ppm)	12.8	8.7	10.2	9.7	10.5	10.2	9.0	10.6
pH	7.0	9.1	8.4	8.6	8.2	8.7	8.0	7.7
CPE (N/minute)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

STATION: Vernon Log Boom

	Sample Date							
	09JUL98	30JUL98	06AUG98	26AUG98	15SEP98	29SEP98	14OCT98	26OCT98
Sample Time	NS	23:37	23:43	22:00	22:42	22:54	21:38	20:29
Water Temp (degC)		24.0		24.5	24.0	19.5		11.0
DO (ppm)		8.2		9.2	9.0	9.8		10.0
pH		8.2		7.9	7.9	8.1		7.7
CPE (N/minute)		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

STATION: Station 4 NH North

	Sample Date							
	09JUL98	30JUL98	06AUG98	26AUG98	15SEP98	29SEP98	14OCT98	26OCT98
Sample Time	22:14	23:14	23:21	21:30	22:01	22:12	21:02	20:09
Water Temp (degC)	22.0	23.9	25.6	24.5	23.2	18.7	13.8	11.0
DO (ppm)	10.1	8.2	9.8	9.5	9.0	9.2	10.2	10.0
pH	7.9	8.2	7.9	8.2	7.9	7.9	7.8	7.7
CPE (N/minute)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

STATION: Station 4 NH South

	Sample Date							
	09JUL98	30JUL98	06AUG98	26AUG98	15SEP98	29SEP98	14OCT98	26OCT98
Sample Time	22:53	23:25	0:11	21:40	22:29	21:25	21:28	20:19
Water Temp (degC)	22.0	23.9	25.9	24.5	23.2	19.5		11.0
DO (ppm)	10.9	8.2	8.3	9.5	9.0	9.8		10.0
pH	7.9	8.2	7.9	8.2	7.9	8.1		7.7
CPE (N/minute)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

NS = Not sampled

(Continued)

Table 1 (Continued).

STATION: Station 4 VT North

	Sample Date							
	09JUL98	30JUL98	06AUG98	26AUG98	15SEP98	29SEP98	14OCT98	26OCT98
Sample Time	22:00	NS	23:31	22:18	23:10	23:14	21:59	20:49
Water Temp (degC)	22.0			27.0	24.0	19.5	13.9	13.5
DO (ppm)	10.0			8.2	9.7	8.9	10.8	10.2
pH	7.9			7.8	7.9	8.0	7.8	7.6
CPE (N/minute)	0.000		0.000	0.000	0.000	0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

STATION: Station 4 VT South

	Sample Date							
	09JUL98	30JUL98	06AUG98	26AUG98	15SEP98	29SEP98	14OCT98	26OCT98
Sample Time	22:38	NS	0:01	22:06	22:52	23:04	21:46	20:39
Water Temp (degC)	21.2		25.9	25.5	24.0	19.5		13.5
DO (ppm)	8.5		8.3	8.6	9.7	9.8		10.2
pH	7.6		7.9	7.9	7.9	8.1		7.7
CPE (N/minute)	0.000		0.000	0.000	0.000	0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

STATION: Vermont Yankee Intakes

	Sample Date							
	09JUL98	30JUL98	06AUG98	26AUG98	15SEP98	29SEP98	14OCT98	26OCT98
Sample Time	22:59	NS	0:24	22:34	23:40	23:25	21:18	19:58
Water Temp (degC)	20.0		25.9	24.0	24.0	19.5		11.0
DO (ppm)	10.0		8.3	9.4	9.7	9.0		10.0
pH	7.5		7.9	7.9	7.9	8.0		7.7
CPE (N/minute)	0.000		0.000	0.000	0.000	0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

NS = Not Sampled

Table 2. Summary of juvenile American shad collected by beach seine in Vernon Pool in 1998.

RETREAT MEADOWS STATIONS

	Sample Date								
	13JUL98	31JUL98	17AUG98	24AUG98	11SEP98	17SEP98	24SEP98	09OCT98	26OCT98
Station 901 (Outlet Pipe)									
Sample Time	12:46	11:15	16:10	15:25	15:00	NS	16:50	14:53	14:45
Water Temp (degC)	26.0	26.5	26.0	25.0	22.2			14.0	
DO (ppm)	8.6	8.4	8.6	11.9	9.9			10.0	
pH	8.1	6.9	8.7	8.9	7.7			8.0	
CPE (N/Effort)	0	0	0	0	0		0	0	0
Min TL (mm)									
Max TL (mm)									
Mean TL (mm)									
Median TL (mm)									
Station 902 (North Side)									
Sample Time	12:30	11:45	15:45	15:08	NS	14:15	16:30	14:48	NS
Water Temp (degC)	26.0	26.8	26.0	26.5		24.0	20.0	14.0	
DO (ppm)	9.4	8.2	8.4	11.7		10.0	9.6	9.4	
pH	8.0	6.5	8.2	8.9		8.2	7.9	8.0	
CPE (N/Effort)	0	0	0	0		0	0	0	
Min TL (mm)									
Max TL (mm)									
Mean TL (mm)									
Median TL (mm)									
RETREAT MEADOWS MEAN CPE	0	0	0	0	0	0	0	0	0

NOTE: On 11 September 1998 Station 902 could not be sampled due to low water level. This missed sample was made-up on 17 September 1998. Station 902 could not be sampled on 26 October 1998, again due to low water.

(CONTINUED)

Table 2 (CONTINUED).

CERSOSIMO LAKE STATIONS

	Sample Date							
	13JUL98	30JUL98	17AUG98	24AUG98	11SEP98	24SEP98	09OCT98	26OCT98
Cersosimo Lake 1 (CL1)								
Sample Time	14:15	16:39	14:08	13:02	13:00	14:50	13:20	13:02
Water Temp (degC)	27.5	25.0	26.0	24.0	22.6	20.2		
DO (ppm)	11.2	9.3	8.7	10.6	10.1	9.1	9.6	
pH	8.3	8.1	8.6	8.2	7.3	7.7	7.7	
CPE (N/Effort)	0	0	0	0	0	0	1	0
Min TL (mm)							112	
Max TL (mm)							112	
Mean TL (mm)							112.0	
Median TL (mm)							112.0	
Cersosimo Lake 2 (CL2)								
Sample Time	14:30	16:53	13:50	13:25	13:20	14:00	13:28	13:20
Water Temp (degC)	27.0	25.0	26.0	24.0	22.6		14.5	
DO (ppm)	12.2	9.3	8.7	10.6	10.1		9.6	
pH	8.2	8.1	8.6	8.2	7.3		7.7	
CPE (N/Effort)	0	0	0	0	0	0	0	0
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								
Cersosimo Lake 3 (CL3)								
Sample Time	14:39	17:07	15:15	13:40	13:40	15:20	13:40	13:35
Water Temp (degC)	27.0	25.0	26.0	24.5			14.5	
DO (ppm)	12.4	9.3	8.6	10.8			10.1	
pH	8.3	8.1	8.6	8.4			7.9	
CPE (N/Effort)	0	0	0	0	0	30	0	0
Min TL (mm)						108		
Max TL (mm)						142		
Mean TL (mm)						125.5		
Median TL (mm)						126.0		
Cersosimo Lake 4 (CL4)								
Sample Time	14:50	16:30	14:44	13:55	13:55	15:35	13:50	13:45
Water Temp (degC)	27.0	25.0	26.0	24.5	22.9	20.2	14.5	
DO (ppm)	12.6	9.3	8.6	10.8	10.4	9.2	10.1	
pH	8.2	8.1	8.6	8.4	7.4	7.9	7.4	
CPE (N/Effort)	0	0	3	3	15	5	21	0
Min TL (mm)			90	100	104	108	112	
Max TL (mm)			106	116	728	132	138	
Mean TL (mm)			98.7	106.0	157.5	119.8	123.0	
Median TL (mm)			100.0	102.0	116.0	124.0	122.0	
Cersosimo Lake 5 (CL5)								
Sample Time	15:05	16:05	14:25	14:15	14:10	15:55	14:00	13:50
Water Temp (degC)	27.0	25.0	26.0	24.5	22.9		14.5	
DO (ppm)	12.2	9.3	8.6	10.8	10.4		10.1	
pH	8.3	8.1	8.6	8.4	7.4		7.4	
CPE (N/Effort)	0	0	0	0	6	0	0	0
Min TL (mm)					93			
Max TL (mm)					116			
Mean TL (mm)					108.7			
Median TL (mm)					110.5			
CERSOSIMO LAKE MEAN CPE	0	0	1	1	4	7	4	0

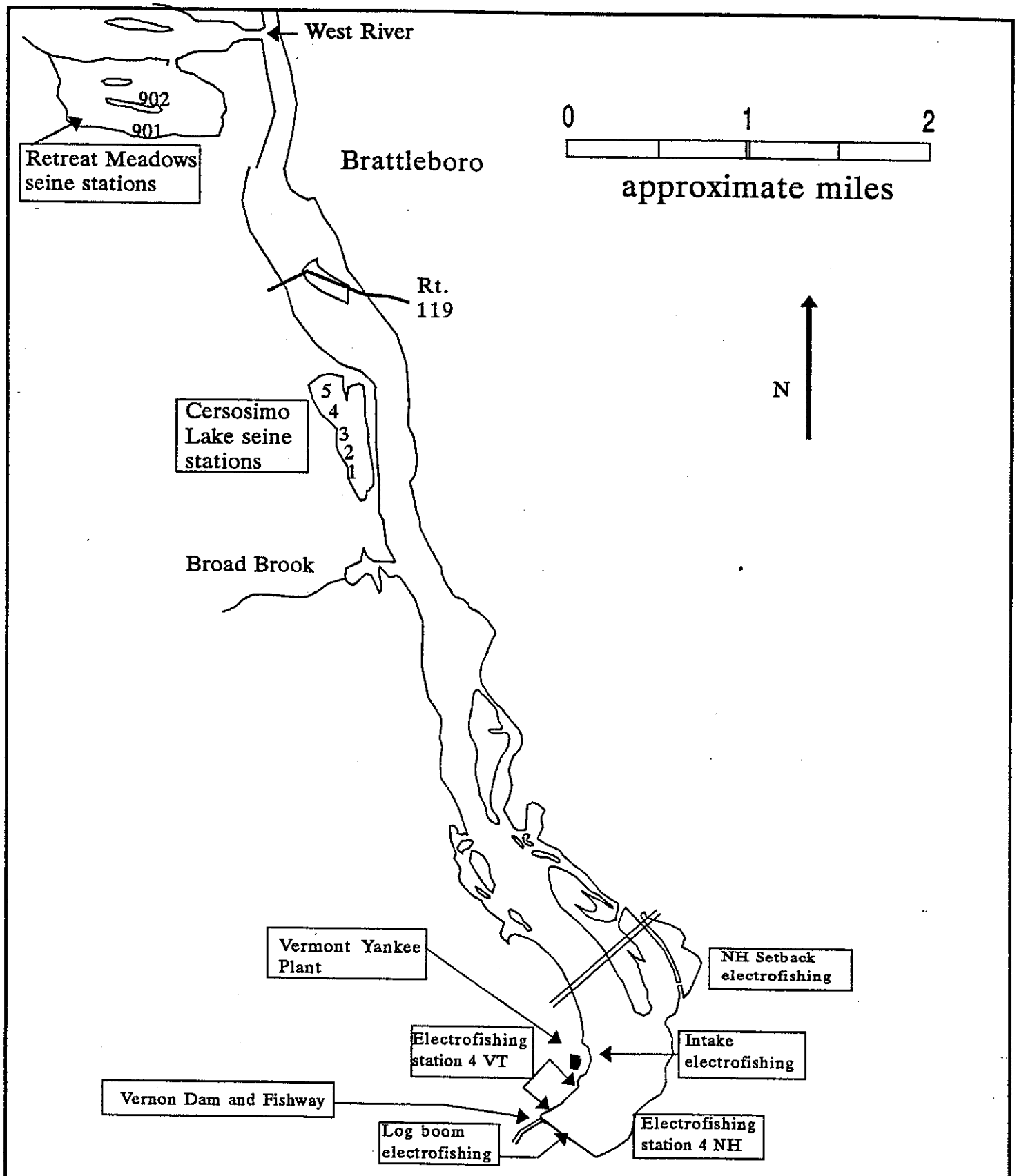

Figure 1. Vermont Yankee shad special studies beach seine and electrofishing stations on the Connnecticut River.

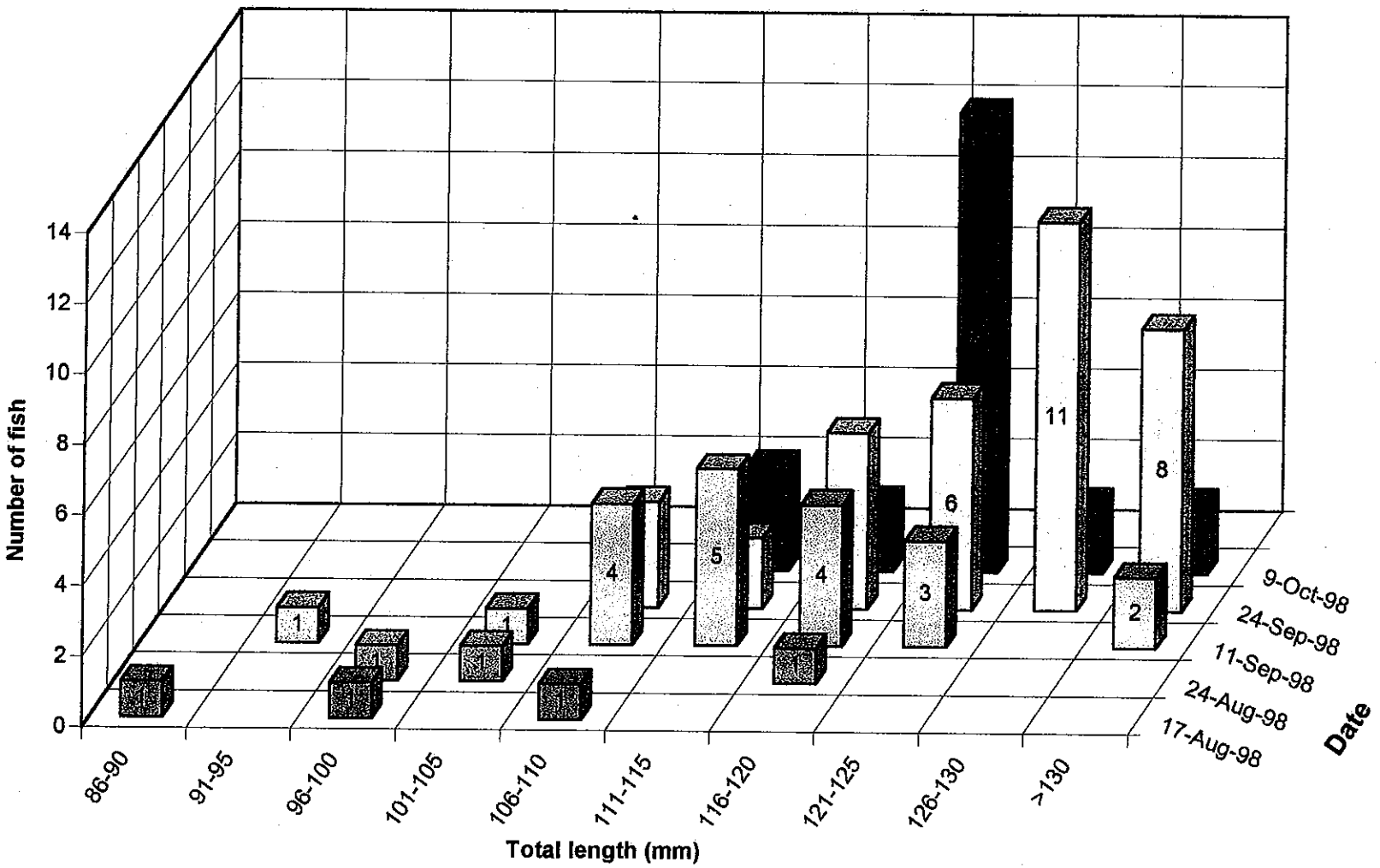

Figure 2. Length frequency distribution of juvenile American shad collected by beach seine in Cersosimo Lake in 1998.