VERMONT YANKEE/CONNECTICUT RIVER SYSTEM
ANALYTICAL BULLETIN 75

Abundance of Juvenile American Shad In the Vernon Pool During 1999

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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 1999. Electrofishing was conducted in conjunction with NPDES Permit requirements for sampling of Stations above Vernon Dam 4NH, 4VT, Vernon Dam log boom, NH Setback, and VY Intake. A total of 54 shocking runs was completed. No shad were collected. After three consecutive years with little success, electrofishing was judged an ineffective sampling gear to monitor relative abundance of a sparse juvenile shad population in the Vernon Pool.

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). Shad were taken at the Cersosimo Lake Stations only. Mean catch per effort (CPE) in July was 2.4. The Cersosimo Lake mean CPE increased during August to 6.3 with a peak on 2 August (mean CPE = 8)). The mean CPE for September was 5.6 and dropped to 0.4 for the month of October.

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 (Normandeau 1999, Bulletin No. 73) and 1999.

As part of the 1999 objective specific studies of the Vermont Yankee Nuclear Power Station's'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 (Downey and Biercevicz 1991) were relatively unproductive 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 (1976) estimation for year class strength in the lower Connecticut River (Essex rkm 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 beginning just upstream of the Project discharge structure, past the Project cooling water intake structure, to Vermont Yankee's boat launch (Figure 1). Shocking run duration ranged from 3 to 11 minutes (average of 9.6 minutes) in littoral areas of each station (Table 1). 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. 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 1999. 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:

$$CPE = n/T$$ where n = total number of shad collected per sample
T = time duration in minutes of the sample

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

$$CPE = n/S$$ where n = total number of shad collected
S = total number of hauls per station, per date

RESULTS

Electrofishing

Juvenile shad were sampled by electrofishing twice a month from 14 July to 27 October 1999 for a total of eight sampling dates (Table 1). The NH Setback Station was not sampled on 25 August and 11 September 1999 because the water level was too shallow for the boat to travel through at that Station. 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 8.0 to 28.8° C. Dissolved oxygen ranged from 7.5 to 16.3 mg/l. The pH and conductivity ranged from 6.7 to 9.3 and 90 to 110 µS, respectively.

Beach Seine

Two general locations were sampled by beach seine bi-monthly between July and October 1999. Five stations were sampled on eight occasions within location Cersosimo Lake: CL1 -CL5, and the two Retreat Meadows Stations (901 and 902) were sampled on seven occasions. Stations 901 and 902 were not sampled on 8 September 1999, as the water level was too shallow to allow boat access to the sampling Station (Figure 1).

Cersosimo Lake – beach seining

Station CL1 produced a total catch of 56 shad on five sampling dates between late July and late September 1999. The shad ranged in length from 72 - 125 mm TL. The water temperature, pH, and dissolved oxygen ranged from 10.0-29.0° C, 7.8-12.0, and 6.5-8.9 mg/l, respectively (Table 2).

Station CL2 produced a total catch of 31 shad, 27 of which were collected on 2 August 1999. The shad ranged in length from 90 - 140 mm TL. Water temperature ranged from 12.8 – 29.0° C. Dissolved oxygen and pH ranged from 8.6 – 11.6 mg/l and 6.3 – 8.3, respectively (Table 2).

Station CL3 produced a total catch of 20 shad, 19 of those were collected between mid-August and early September 1999. Collected shad ranged in length from 93 – 135 mm TL. Water temperature ranged from 10.0 – 29.4° C, dissolved oxygen ranged from 8.7 – 11.8 mg/l, and pH 6.7 – 8.2 (Table 2).

Cersosimo Lake Station CL4 produced a total catch of 13 fish between early August and early September 1999. Total lengths ranged from 99 - 131 mm TL. Water temperature ranged from 10.0 – 29.4° C, dissolved oxygen ranged from 8.5 – 11.8 mg/l over the eight sampling dates and pH ranged from 6.7 – 8.2 (Table 2).

Station CL5 produced a total catch of 27 shad between mid-August and mid-October 1999. Water temperature, dissolved oxygen, and pH ranged from 10.0 – 29.4° C, 8.5 – 11.8 mg/l, and 6.7 – 8.2, respectively (Table 2).

Overall, mean CPE for Cersosimo Lake Stations combined increased from 0 on 6 July to a peak of 8 on 2 August and dropped back to 0 by 26 October (Table 2).

The majority (82%) of juvenile shad collected was between 81 and 120 mm TL (Figure 2). A slight shift of size composition, indicating growth, was evident in some of the later samples.

Retreat Meadows – beach seining

Stations 901 and 902 were sampled seven times between July and October 1999. No shad were collected. Neither station was sampled on 8 September, as the water level was too shallow for access. Overall sampling events, water temperature ranged from 10.0 – 31.6° C, dissolved oxygen ranged from 6.6 – 14.5 mg/l, and pH ranged from 6.3 – 8.9.

DISCUSSION

One objective of the study was to monitor relative abundance of juvenile American shad in the Vernon Pool. This objective was accomplished by the seining effort in the Cersosimo Lake monitoring stations.

The second objective of identifying suitable sampling locations and sampling gear was also accomplished. In 1997, the seining effort was designed to locate suitable, productive seining sites in Vernon Pool for future sampling, 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. Those seven seine stations were sampled again during 1999.

Data collected in 1997, 1998, and 1999 indicate that electrofishing, as a sampling gear to assess relative abundance of juvenile American shad in Vernon Pool is not effective. Juvenile shad have often been collected by electrofishing below Vernon Dam as part of the NPDES anadromous fish collections, but during the last three years, only three juvenile shad have been collected by electrofishing in the Vernon Pool. In-field observations during 1997 and 1999 suggested that juvenile shad were largely unaffected by the 4 to 6 amp electrical field generated in the Vernon Pool environment. In both years 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. 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 three years (7,384 adults passed above Vernon Dam in 1997 and 8,151 passed in 1998, and 5,083 in 1999), or for some other reason. Electrofishing conducted above and below Vernon Dam as part of the Vermont Yankee NPDES permit requirements in 1997, 1998, and 1999 produce large catches of a variety of fish. Juvenile shad have been collected below Vernon Dam via electrofishing during the 1996 – 1999 NPDES anadromous fish electrofishing sampling (124, 321, 62, and 219 collected juvenile shad, respectively), indicating the sampling gear functions effectively.

The more effective of the two methods employed to sample juvenile shad proved to be beach seining. A total of 55 seine hauls resulted in the collection of 147 juvenile shad. All Stations in Cersosimo Lake were sampled on eight occasions and the data may be sufficient as an index of relative abundance if this design is repeated over time. The greatest number of shad collected by seine in Cersosimo Lake over the last three years was in mid-September 1997, late September 1998, and 2 August through 22 September 1999 (Table 2).

Fifteen seine samples were collected at the two West River stations in 1998 and fourteen samples were

collected in 1999. No shad were collected either year from these two stations.

The five Cersosimo Lake Stations should continue as juvenile shad index stations. Shad activity has been observed there virtually every year, and it is feasible that adequate numbers could be collected there to assess relative abundance over time. 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

For the third 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 1999. The information collected may help establish a meaningful juvenile shad abundance index. Relative abundance within Cersosimo Lake should be reflective of general trends in Vernon Pool. If this program is continued, the sampling should focus on beach seining.

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Table 1. Summary of juvenile American shad collected by electrofishing in Vernon Pool, 1999.

STATION: NH Setback

	Sample Date							
	14 JUL99	26JUL99	10AUG99	25AUG99	15SEP99	29SEP99	130CT99	270CT99
Duration (minutes)	10	9	3	NS	NS	10	10	10
Temp (degC)	26.3	28.8	24.3	water level	water level	18.9	13.2	8.6
DO (ppm)	16.3	11.8	10.5			11.6	10.4	11.6
pH	8.6	9.1	9.3	too shallow	too shallow	7.6	7.1	7.9
CPE (N/minute)	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							
	14 JUL99	26JUL99	10AUG99	25AUG99	15SEP99	29SEP99	130CT99	270CT99
Duration (minutes)	11	9	8	10	10	6	5	10
Temp (degC)	25.4	27.9	24.8	23.5	26.0	17.0	14.9	7.5
DO (ppm)	9.4	8.1	7.6	8.4	8.4	8.6	9.9	12.4
pH	7.6	8.3	8.0	7.4	6.7	7.2	7.2	7.9
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 4 NH North

	Sample Date							
	14 JUL99	26JUL99	10AUG99	25AUG99	15SEP99	29SEP99	130CT99	270CT99
Duration (minutes)	10	10	10	10	10	10	10	10
Temp (degC)	25.9	28.0	25.1	25.0	26.0	17.0	12.9	8.0
DO (ppm)	9.8	7.9	8.5	8.3	7.7	8.6	9.8	12.2
pH	7.6	8.4	8.0	7.1	6.7	7.2	7.1	7.8
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 4 NH South

	Sample Date							
	14 JUL99	26JUL99	10AUG99	25AUG99	15SEP99	29SEP99	130CT99	270CT99
Duration (minutes)	11	10	9	10	10	10	10	10
Temp (degC)	25.9	28.0	25.1	25.0	26.0	17.0	14.9	8.0

DO (ppm)		9.8	8.9	8.5	8.3	7.7	8.6	9.9	12.2
pH	7.6	7.4	8.0	7.1	6.7	7.2	7.2	7.8	
C PE (N/minute)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min T L (mm)									
Max T L (mm)									
Mean T L (mm)									
Median T L (mm)									

The sample duration represents one electrofishing transect on the specified date.

NS = Not sampled

(Continued)

T able 1. (C ontinued).

S T A T IO N: S tation 4 V T North

	Sample Date							
	14 JUL99	26JUL99	10A UG 99	25A UG 99	15SEP99	29SEP99	130 C T 99	270 C T 99
Duration (minutes)		7	10	10	10	14	8	10	10
T emp (degC)		23.9			23.5	29.0	17.0	17.0	11.0
DO (ppm)		9.8			8.4	7.5	8.6	9.5	11.8
pH	8.0			7.4	6.9	7.2	7.2	7.9	
C PE (N/minute)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min T L (mm)									
Max T L (mm)									
Mean T L (mm)									
Median T L (mm)									

S T A T IO N: S tation 4 V T S outh

	Sample Date							
	14 JUL99	26JUL99	10A UG 99	25A UG 99	15SEP99	29SEP99	130 C T 99	270 C T 99
Duration (minutes)		9	9	10	10	8	7	10	10
T emp (degC)		25.9			23.5	26.0	17.0	14 .9	7.5
DO (ppm)		9.8			8.4	8.4	8.4	9.9	12.4
pH	7.6			7.4	6.7	7.2	7.2	7.9	
C PE (N/minute)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min T L (mm)									
Max T L (mm)									
Mean T L (mm)									
Median T L (mm)									

S T A T IO N: V erm ont Y ankee Intakes

	Sample Date							
	14 JUL99	26JUL99	10A UG 99	25A UG 99	15SEP99	29SEP99	130 C T 99	270 C T 99
Duration (minutes)		11	12	13	10	12	10	9	10
T emp (degC)		23.9	27.8	24 .9	23.5	23.5	17.0	13.1	8.0
DO (ppm)		9.8	7.6	8.1	8.4	7.5	8.6	10.4	12.4
pH	8.0	8.6	7.9	7.4	7.1	7.2	7.3	7.8	
C PE (N/minute)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min T L (mm)									
Max T L (mm)									
Mean T L (mm)									
Median T L (mm)									

T he sample duration represents one electrofishing transect on the specified date.

NS = Not sampled

Table 2. Summary of juvenile American shad collected by beach seine in Vernon Pool in 1999

RETREAT MEA DOWS STATIONS

	Sample Date								
	06 JUL 1999	21 JUL 1999	02 AUG 1999	17 AUG 1999	08 SEP 1999	22 SEP 1999	13 OCT 1999	26 OCT 1999	1999	1999
Station 901 (Outlet Pipe)										
Time of day	12:30	15:55	15:40	10:15		10:30	15:30	14:20		
Water Temp (degC)	30.5	27.1	27.7	24.8		15.0	13.0	10.0		
DO (ppm)	8.7	10.2	7.8	8.7		8.0	12.0	11.2		
pH	8.0	8.9	8.0	6.7		6.5	7.1	6.7		
CPE (N/Effort)	0	0	0	0		0	0	0		
Min TL (mm)										
Max TL (mm)										
Mean TL (mm)										
Median TL (mm)										
Station 902 (North side)										
Time of day	12:05	15:34	15:15	10:00		10:07	15:20	14:00		
Water Temp (degC)	31.6	27.8	29.4	24.8		15.0	14.0	10.0		
DO (ppm)	11.8	14.5	13.4	6.6		7.6	11.6	11.0		
pH	8.8	8.9	8.4	6.4		6.3	7.0	6.7		
CPE (N/Effort)	0	0	0	0	0	0	0	0		
Min TL (mm)										
Max TL (mm)										
Mean TL (mm)										
Median TL (mm)										
RETREAT MEA DOWS MEA NCPE	0	0	0	0	0	0	0	0		

Each cell within this table represents one seine haul.

(Continued)

Table 2. (Continued).

C ERSO SIMO LA K E ST A T IO NS

	Sample Date								
	06 JUL 1999	21 JUL 1999	02 A UG 1999	17 A UG 1999	08 SEP 1999	22 SEP 1999	13 O C T 1999	26 O C T 1999	1999	1999
C ersosim o Lake 1 (C L1)										
T ime of day		10:20	13:50	12:4 4	11:05	13:15	11:20	13:50	12:35	
W ater T emp (degC)		29.0	27.0	28.4	24 .7	25.5	16.0	12.8	10.0	
DO (ppm)		9.6	9.1	9.4	9.3	8.7	10.0	11.6	11.2	
pH	8.3	7.3	7.0	7.3	7.7	7.0	6.5	6.3		
C PE (N/Effort)		0	24	8	5	2	17	0	0	
Min T L (mm)			72	93	88	100	98			
Max T L (mm)		102	111	121	120	125				
Mean T L (mm)		85.5	100.9	101.8	110.0	111.6				
Median T L (mm)		85.0	100.5	101.0	110.0	115.0				
C ersosim o Lake 2 (C L2)										
T ime of day		10:4 0	14 :10	14 :20	11:20	13:4 0	11:50	14 :05	12:50	
W ater T emp (degC)		29.0	27.0	28.6	24 .7	25.5	16.0	12.8		
DO (ppm)		9.6	9.1	8.6	9.3	8.7	10.0	11.6		
pH	8.3	7.3	7.8	7.3	7.7	7.0	6.5	6.3		
C PE (N/Effort)		0	0	27	0	1	3	0	0	
Min T L (mm)				89		115	113			
Max T L (mm)			107		115	14 0				
Mean T L (mm)			97.4		115.0	122.7				
Median T L (mm)			97.0		115.0	115.0				
C ersosim o Lake 3 (C L3)										
T ime of day		10:4 9	14 :24	13:00	11:4 0	14 :00	12:00	14 :05	13:00	
W ater T emp (degC)		29.4	26.7	29.1	25.1	26.0	16.0	13.0	10.0	
DO (ppm)		9.9	8.8	9.7	9.3	8.7	9.0	11.8	11.4	
pH	8.2	2.6	7.4	7.6	7.6	6.9	7.0	6.7		
C PE (N/Effort)		0	0	0	6	13	1	0	0	
Min T L (mm)					93	105	134			
Max T L (mm)				120	135	134				
Mean T L (mm)				105.3	122.6	134 .0				
Median T L (mm)				104 .5	127.0	134 .0				
C ersosim o Lake 4 (C L4)										
T ime of day		11:15	14 :37	13:4 0	11:50	14 :15	12:20	14 :25	13:10	
W ater T emp (degC)		29.4	26.7	28.6	25.1	26.0	16.0	13.0	10.0	
DO (ppm)		9.9	8.8	8.5	9.3	8.7	9.0	11.8	11.4	
pH	8.2	7.6	7.5	7.6	7.6	6.9	7.0	6.7		
C PE (N/Effort)		0	0	4	1	8	0	0	0	
Min T L (mm)					99	108	103			
Max T L (mm)			105	108	131					
Mean T L (mm)			102.0	108.0	118.9					
Median T L (mm)			102.0	108.0	122.0					
C ersosim o Lake 5 (C L5)										
T ime of day		11:25	14 :50	14 :00	12:00	14 :30	12:35	14 :4 5	13:20	
W ater T emp (degC)		29.4	26.7	28.5	25.1	26.0	16.0	13.0	10.0	
DO (ppm)		9.9	8.8	8.4	9.3	8.7	9.0	11.8	11.4	
pH	8.2	7.6	7.6	7.6	7.6	6.9	7.0	6.7		
C PE (N/Effort)		0	0	0	12	8	3	4	0	

Min T L (mm)						95	105	131	100	
Max T L (mm)				115	133	140	120			
Mean T L (mm)				103.8	116.8	136.3	114.5			
Median T L (mm)				103.5	115.5	138.0	119.0			
CERSOSIMO LAKE MEAN CPE	0	5	8	5	6	5	1	0		

Each cell within this table represents one seine haul.

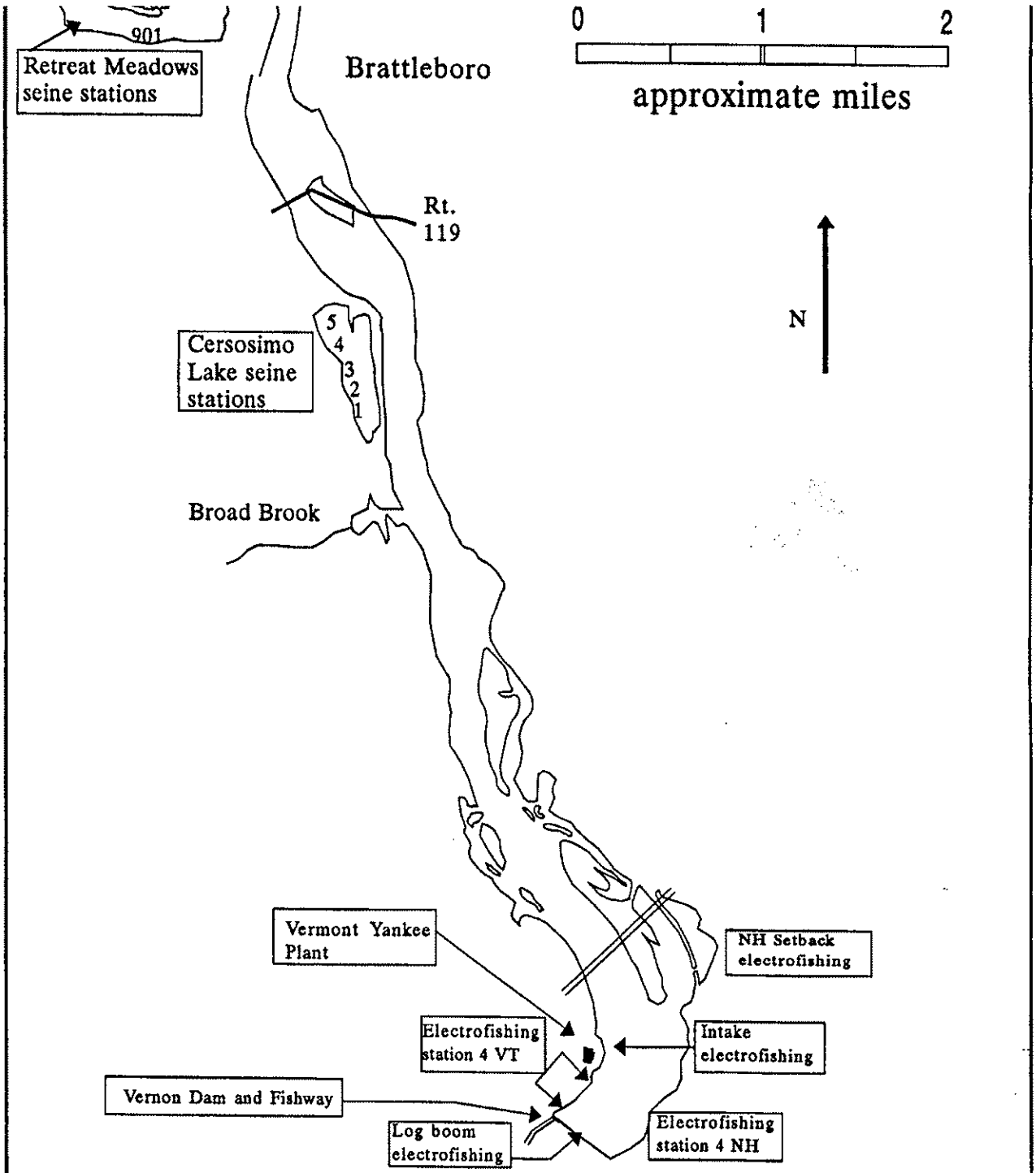

Figure 1. Vermont Yankee shad special studies beach seine and electrofishing stations on the Connnecticut River.

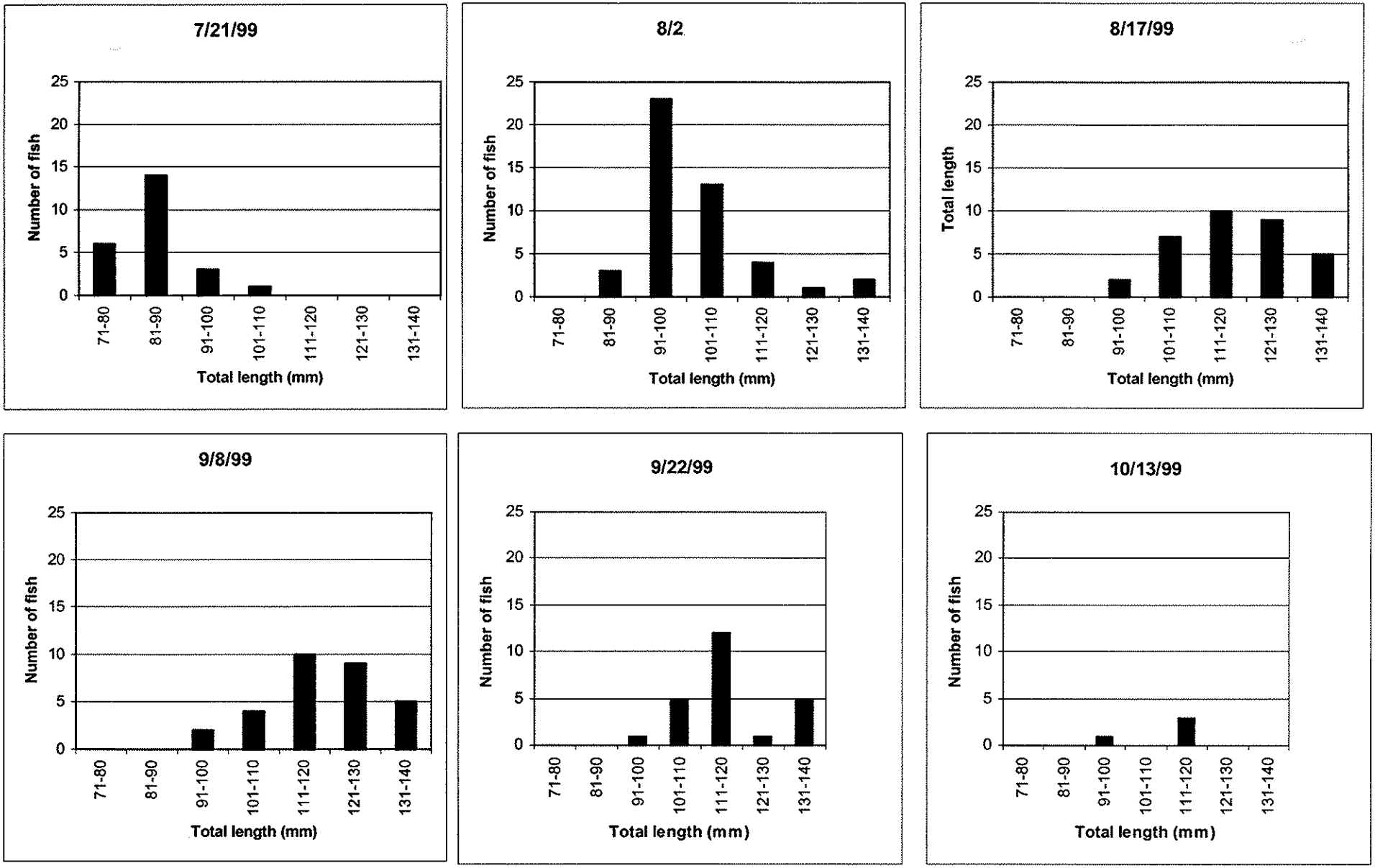

Figure 2. Length frequency distribution of juvenile American shad collected by beach seine in Cersosimo Lake in 1999, by sampling date. Seine sampling completed on 7/6 and 10/26 1999 produced a catch of zero shad.