AQUATIC ECOLOGY

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Abundance of Juvenile American Shad in the Vernon Pool During 1997

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ABSTRACT

Sampling for juvenile American shad was conducted twice per month by electrofishing and beach seining in Vernon Pool from 17 July through 31 October, 1997. Electrofishing was conducted in conjunction with NPDES Permit requirements sampling of Stations 4NH, 4VT, NH Setback, and VY Intake. Of a total 27 shocking runs, only three shad were collected during two of the runs. Electrofishing was judged an ineffective sampling gear to monitor relative abundance of juvenile shad.

Beach seining was conducted regularly at Cersosimo Lake Stations CL1 - CL5. Three other locations, White Birch Pond, NPDES Station 416, and the West River, were each sampled once in an investigation to find four sampling stations for establishment of an annual juvenile shad relative abundance index. Shad were taken at the Cersosimo Lake Stations only. Abundance here increased during 29 July through 19 August, with a peak on 17 September. Abundance then decreased through 22 October, with no shad collected on 31 October.

Although no shad were taken at locations other than Cersosimo Lake, the other seine sampling locations should be investigated further, as well as one or more other locations, in order to find four suitable seine sites for juvenile shad index sampling.

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 agreed to evaluate sampling methodologies and locations that can be used to develop a juvenile shad relative abundance index in 1997.

As part of the 1997 objective specific studies of the Vermont Yankee Nuclear Power Corporation's NPDES Permit (NPDES No. VT0000264), juvenile American shad (*Alosa sapidissima*) were sampled at various 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 four 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 weekly samples at the four sampling stations during a defined time period (August through October). Marcy's estimation for year class strength in the lower Connecticut River (Essex km 11.3 to Northampton MA km 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 other 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.

METHODS

Juvenile American shad in Vernon Pool were sampled by electroshocking 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, Station 4 VT, and an additional station in front of the Project cooling water intake structure (Figure 1). Shocking runs typically lasted 10 min in littoral areas of each station. Dependant upon ambient conditions, 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 were netted from the river, transferred to a water filled container, and processed upon completion of the sampling run. The total length (TL) was measured to the nearest millimeter (mm) and recorded. All fish were then released back to the river. Water temperature, dissolved oxygen (DO), pH and water conductivity were measured.

Four general locations were sampled for juvenile shad by beach seine during daylight hours: Station 416, just upstream of electrofishing Station 4 NH, Cersosimo Lake, White Birch Pond, and an area in the West River (Figure 1). 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 john boat powered by a 45 HP motor. The beach seine was 200 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. The boat was motored backward, with seine folded on the bow, 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 ambient 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 sampling event 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 seining sample was calculated by the equation:

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

RESULTS

Electrofishing

Juvenile shad were sampled by electrofishing one day every two weeks from 17 July to 30 October, 1997 for a total of eight sampling dates (Table 1). All sampling was conducted during hours of darkness. Station NH Setback was sampled five times. No electrofishing runs were conducted on three sampling dates, 6 and 20 August and 30 September, due to heavy aquatic vegetation. No shad were collected. Water temperature ranged from 10.0 to 25.9 C. Dissolved oxygen and pH ranged from 9.3 to 11.0 mg/l and 7.6 to 8.7, respectively. Conductivity ranged from 90 to 140 micro Siemens (μS). Station Vermont Yankee Intakes was sampled six times. Two shad were collected, both on 17 September; Station CPE was 0.17. Total lengths were 76 and 93 mm. Water temperature ranged from 9.0 to 24.3 C; dissolved oxygen ranged from 7.9 to 11.5 mg/l. pH and conductivity ranged from 7.6 to 8.4 and 90 to 110 μS, respectively. No shad were collected during eight sampling events at Station 4 NH. Water temperature and dissolved oxygen at this Station ranged from 11.3 to 24.5 C and 7.0 to 12.5 mg/l, respectively. pH ranged from 7.2 to 9.8; conductivity ranged from 90 to 130 μS. Station 4 VT was sampled eight times, also. One shad (90 mm TL) was collected on 20 August. The Station CPE was 0.07. Over the 8 sampling days, water temperature ranged from 11.2 to 24.8 C. Dissolved oxygen ranged from 7.0 to 12.5 mg/l. The pH and conductivity ranged from 6.5 to 9.0 and 90 to 130 μS, respectively.

Beach Seine

Four general locations were sampled by beach seine among the same eight sampling dates used for the electrofishing survey. Station 416, just upstream of Station 4 NH, was sampled once, on 6 August (Table 2). No shad were collected. Water temperature was 26.5 C. Dissolved oxygen and pH were 8.6 mg/l and 8.7, respectively.

Five Stations were sampled within Cersosimo Lake: CL1 -CL5 (Figure 1). Station CL1 was sampled five times from 24 July through 31 October. Shad were collected on three of those days. Three specimens were taken on 29 July. They ranged from 77 to 86 mm TL; median TL was 82 mm. Water temperature, dissolved oxygen, and pH were 24.0 C, 9.1 mg/l, and 8.4, respectively. On 6 August, 15 shad were collected. Total length ranged from 77 to 100 mm. Mean TL was 88 mm and the median length was 86 mm. Water temperature was 26.0 C; dissolved oxygen and pH were 8.4 and 7.6, respectively. The next sample day at this Station was 30 September. One shad was collected; TL was 98 mm. Water temperature, dissolved oxygen, and pH were 16.0 C, 12.0 mg/l, and 6.9, respectively.

Station CL2 was sampled five times. Shad were taken on only one occasion, 30 September. Seven shad, ranging from 99 to 130 mm TL, were collected. Mean and median lengths were 107 mm and 104 mm TL. Water temperature was 16.0 C. Dissolved oxygen and pH were 12.0 mg/l and 6.9, respectively.

Six sample days at Station CL3 produced shad on four days. On 19 August, two shad (80 and 110 mm TL) were collected. Water temperature, dissolved oxygen, and pH were 25.0 C, 7.5 mg/l, and 7.7, respectively. A total of 51 juvenile shad was taken on 17 September. Total lengths ranged from 80 to 114 mm; mean length was 93 mm TL. Median length was 92 mm. Water temperature and dissolved oxygen were 22.0 C and 8.9 mg/l, respectively. pH was 7.6. On 30 September, three

shad (100, 101, and 105 mm TL) were collected. Water temperature was 16.0 C. Dissolved oxygen and pH were 12.0 mg/l and 6.9, respectively. On 22 October, six shad were collected. Lengths ranged from 94 to 113 mm TL. Mean and median total lengths were 103 and 100 mm, respectively. Water temperature and pH were 10.5 C and 7.5.

Seine sampling was conducted at Stations CL4 and CL5 on 19 August and 17 September. The first sample day at CL4 resulted in the collection of 26 juvenile shad ranging in size from 76 to 111 mm TL. Mean and median total lengths were 87 and 85 mm, respectively. The 17 September sample day yielded nine shad measuring in total length from 89 to 116 mm. Mean was 101 mm TL and the median TL was 103 mm. At Station CL5 on 19 August, 19 shad were taken. Lengths ranged from 75 to 101 mm TL with mean and median values of 85 and 82 mm TL, respectively. A total of 18 juvenile shad was collected on 17 September. Fish size ranged from 80 to 104 mm TL and mean size was 95 mm TL. Median size was 95 mm TL. Water temperature, dissolved oxygen, and pH at both Stations on 19 August were 25.0 C, 7.5 mg/l, and 7.7, respectively. On 17 September at both Stations, water temperature and dissolved oxygen were 22.0 C and 8.9 mg/l, respectively. pH was 7.6.

Overall, CPE for Cersosimo Lake Stations combined increased from 0.00 on 24 July to 15.00 on 6 August (Table 2). Catch peaked on 17 September (CPE=26.00), then declined to 3.00 on 22 October. By 31 October, no shad were collected.

Station WB1 (White Birch Pond) was seined once on 25 September. No juvenile shad were collected. Water temperature was 14.5 C, dissolved oxygen was 8.2 mg/l, and pH was 5.8. On that same date, the three West River Stations (WR1 through WR3) were sampled. No shad were collected at these Stations. Water temperature, dissolved oxygen, and pH were 17.0 C, 8.2 mg/l, and 5.8, respectively.

Length frequency distribution of juvenile shad collected from Cersosimo Lake is presented in Figure 2. The majority of juvenile shad collected were between 75 and 96 mm TL. A slight shift of size composition, indicating growth, was evident in the later samples.

DISCUSSION

The objective of the study was to monitor relative abundance of juvenile American shad in Vernon Pool and to investigate means to facilitate abundance monitoring by developing a juvenile shad index. These objectives were accomplished by utilizing common sampling methods at existing Vermont Yankee monitoring stations, and investigating a seining approach. This 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.

Data indicate that electrofishing as a sampling gear to assess relative abundance of juvenile American shad in Vernon Pool is minimally effective. Over a total of 27 sampling runs at four different locations, only three shad were collected. In-field observations suggest that juvenile shad are largely unaffected by the 4 to 6 amp electrical field generated in the Vernon Pool environment. Shad were observed swimming near the electrodes of the shocker during runs but seemed unaffected. Voltage, amperage, pulse width, and current settings used to stun most species of fish can be altered to increase the potential to stun shad. However, changing settings, i.e. increasing amperage, to the

levels necessary to stun shad could be detrimental and perhaps lethal to other species inhabiting the waters shocked.

The more effective, and less intrusive, method to sample juvenile shad proved to be beach seining. Many more juvenile shad were collected by seining specific sites in Vernon Pool. Although all sites were not uniformly productive, some may be appropriate to sample for the shad index. All Stations other than Cersosimo Lake were only sampled once; some of these may prove productive if sampled regularly. Cersosimo Lake was sampled regularly and data may be sufficient to assess relative abundance over time. Catch per effort, i.e. relative abundance, increased from 29 July through 19 August, with a peak on 17 September. Abundance then decreased through 22 October, with no shad collected on 31 October.

The seining exercise was largely exploratory, so sites, other than Cersosimo Lake, were primarily chosen for shad presence potential and ease of sampling. Cersosimo Lake was previously observed to hold juvenile shad; shad activity had been observed there over many years. Many areas of the river upstream of Vermont Yankee were explored, but very few were judged appropriate for seine sampling. The Stations chosen were all easily seined. Had they produced shad, they would have been sampled on a regular basis. Nevertheless, some of these sampling sites may be appropriate for institution of the shad juvenile abundance index.

The West River location is a candidate for a seine station. Although no shad were collected, if sampled regularly, it might yield valuable information over the years. It is easily accessible and easy to sample. White Birch Pond can be discounted as a seine station. It is virtually isolated from the river, so it is unlikely shad will be collected there. Station 416 may be a likely candidate, as it is easily accessible, relatively easy to seine, and could yield shad. Two or three of the Cersosimo Lake Stations should be established 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 Lake until they become ready to emigrate. Another location, not sampled, may be the area just upstream of the log boom for the Vernon Dam powerhouse forebay. Past observations of the forebay and this area suggest that sampling of shad may be successful here.

CONCLUSIONS AND RECOMMENDATIONS

Electrofishing is not an effective sampling gear to monitor relative abundance of juvenile American shad in Vernon Pool. Beach seining was a much more effective method, however, shad were taken in only one location of the four locations sampled. Consistent sampling at all locations in 1998 may help define representative seine stations for a juvenile shad abundance index. Relative abundance within Cersosimo Lake was monitored and may be reflective of general trends in Vernon Pool. Further investigation of seining locations in Vernon Pool is recommended. Cersosimo Lake and three other locations may be sufficient to establish an annual juvenile shad index.

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Table 1. Summary of juvenile American shad collected by electrofishing in Vernon Pool, 1997.

Station : 4 NH

	Sample Date							
	17JUL97	29JUL97	06AUG97	20AUG97	17SEP97	30SEP97	22OCT97	30OCT97
Sample Time	21:35	21:30	0:08	0:55	17:20	23:20	22:28	20:59
Water Temp (C)	23.8	23.2	24.5	23.7	20.3	20.4	13.0	11.3
DO (ppm)	9.2	10.1	7.0	12.5	8.1	9.8		10.6
pH	7.4	9.4	7.8	9.8	7.9	7.8	7.2	7.4
Conductivity		90.0	120.0	120.0	100.0	100.0	130.0	120.0
Number of shad	0	0	0	0	0	0	0	0
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 VT

	Sample Date							
	17JUL97	29JUL97	06AUG97	20AUG97	17SEP97	30SEP97	22OCT97	30OCT97
Sample Time	21:05	21:05	23:45	0:35	17:39	0:05	23:04	21:16
Water Temp (C)	23.0	23.0	24.8	23.0	20.2	21.0	15.5	11.2
DO (ppm)	8.2	8.4	7.8	8.3	8.0	10.0		10.5
pH	6.5	8.4	7.9	8.2	9.0	7.9	7.7	7.6
Conductivity		90.0	110.0	120.0	90.0	120.0	130.0	120.0
Number of shad	0	0	0	1	0	0	0	0
CPE (N/minute)	0.000	0.000	0.000	0.067	0.000	0.000	0.000	0.000
Min TL (mm)				90				
Max TL (mm)				90				
Mean TL (mm)				90.0				
Median TL (mm)				90.0				

Station : NH Setback

	Sample Date							
	17JUL97	29JUL97	06AUG97	20AUG97	17SEP97	30SEP97	22OCT97	30OCT97
Sample Time	22:20	22:10				22:20	21:39	20:35
Water Temp (C)	25.9	22.2				16.8	10.0	10.8
DO (ppm)	10.4	9.3				10.8		11.0
pH	8.7	8.4				7.9	7.8	7.6
Conductivity		90.0				100.0	140.0	120.0
Number of shad	0	0				0	0	0
CPE (N/minute)	0.000	0.000				0.000	0.000	0.000
Min TL (mm)								
Max TL (mm)								
Mean TL (mm)								
Median TL (mm)								

Station : VY Intake

	Sample Date							
	17JUL97	29JUL97	06AUG97	20AUG97	17SEP97	30SEP97	22OCT97	30OCT97
Sample Time	23:00	22:44	0:30	1:20	17:59			21:32
Water Temp (C)	22.4	21.8	24.3	23.1	21.0			9.0
DO (ppm)	8.3	8.3	7.9	8.3	8.4			11.5
pH	8.4	8.4	7.7	8.4	8.4			7.6
Conductivity		90.0	110.0	110.0	90.0			110.0
Number of shad	0	0	0	0	2			0
CPE (N/minute)	0.000	0.000	0.000	0.000	0.167			0.000
Min TL (mm)					76			
Max TL (mm)					93			
Mean TL (mm)					84.5			
Median TL (mm)					84.5			

Table 2. Summary of juvenile American shad collected by beach seine in Vernon Pool, 1997.

STATION 416

	Sample Date							
	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time			18:15						
Water Temp (C)			26.5						
DO (ppm)			8.6						
pH			8.7						
CPE (N shad)			0						
Min TL (mm)									
Max TL (mm)									
Mean TL (mm)									
Median TL (mm)									

CERSOSIMO LAKE STATIONS

	Sample Date							
STATION CL1	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time	16:10	18:30	16:25				16:45		11:00
Water Temp (C)	22.5	24.0	26.0				16.0		8.0
DO (ppm)	10.0	9.1	8.4				12.0		11.2
pH	8.6	8.4	7.6				6.9		6.1
CPE (N shad)	0	3	15				1		0
Min TL (mm)		77	77				98		
Max TL (mm)		86	100				98		
Mean TL (mm)		81.7	88.4				98.0		
Median TL (mm)		82.0	86.0				98.0		
STATION CL2	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time	16:35	18:45					17:20	14:20	11:20
Water Temp (C)	22.5	23.2					16.0	10.5	8.0
DO (ppm)	9.8	9.5					12.0		
pH	8.6	8.4					6.9	7.9	6.1
CPE (N shad)	0	0					7	0	0
Min TL (mm)							99		
Max TL (mm)							130		
Mean TL (mm)							107.3		
Median TL (mm)							104.0		
STATION CL3	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time		18:00	16:00	18:00	15:48		17:45	14:50	11:35
Water Temp (C)		24.0	22.5	25.0	22.0		16.0	10.5	8.0
DO (ppm)		8.3	9.8	7.5	8.9		12.0		11.2
pH		8.4	8.6	7.7	7.6		6.9	7.5	6.1
CPE (N shad)		0	0	2	51		3	6	0
Min TL (mm)				80	80		100	94	
Max TL (mm)				110	114		105	113	
Mean TL (mm)				95.0	93.2		102.0	102.8	
Median TL (mm)				95.0	93.0		101.0	100.0	
STATION CL4	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time				18:30	15:35				
Water Temp (C)				25.0	22.0				
DO (ppm)				7.5	8.9				
pH				7.7	7.6				
CPE (N shad)				26	9				
Min TL (mm)				76	89				
Max TL (mm)				111	116				
Mean TL (mm)				87.0	101.1				
Median TL (mm)				85.0	103.0				

(CONTINUED)

TABLE 2 (CONTINUED).

CERSOSIMO LAKE STATIONS (continued)

	Sample Date							
STATION CL5	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time				18:45	15:12				
Water Temp (C)				25.0	20.0				
DO (ppm)				7.5	9.1				
pH				7.7	7.4				
CPE (N shad)				19	18				
Min TL (mm)				75	80				
Max TL (mm)				101	104				
Mean TL (mm)				83.1	94.7				
Median TL (mm)				82.0	94.5				
TOTAL CERSOSIMO LAKE CPE	0.000	1.000	7.500	15.667	26.000		3.667	3.000	0.000

STATION WB1

	Sample Date							
	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time						11:20			
Water Temp (C)						14.5			
DO (ppm)						8.2			
pH						5.8			
CPE (N shad)						0			
Min TL (mm)									
Max TL (mm)									
Mean TL (mm)									
Median TL (mm)									

WEST RIVER STATIONS

	Sample Date							
STATION WR1	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time						13:10			
Water Temp (C)						17.0			
DO (ppm)						8.8			
pH						6.1			
CPE (N shad)						0			
Min TL (mm)									
Max TL (mm)									
Mean TL (mm)									
Median TL (mm)									
STATION WR2	24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time						13:40			
Water Temp (C)						17.0			
DO (ppm)						8.8			
pH									
CPE (N shad)						0			
Min TL (mm)									
Max TL (mm)									
Mean TL (mm)									
Median TL (mm)									

(CONTINUED)

TABLE 2 (CONTINUED).

WEST RIVER STATIONS (continued)

STATION WR3	Sample Date 24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
Sample Time						14:00			
Water Temp (C)						18.0			
DO (ppm)						8.8			
pH									
CPE (N shad)						0			
Min TL (mm)									
Max TL (mm)									
Mean TL (mm)									
Median TL (mm)									
TOTAL WEST RIVER CPE						0.000			

TOTAL BEACH SEINE CPE (ALL STATIONS)

	Sample Date 24JUL97	29JUL97	06AUG97	19AUG97	17SEP97	25SEP97	30SEP97	22OCT97	31OCT97
TOTAL CPE	0.000	1.000	7.500	15.667	26.000	0.000	3.667	3.000	0.000

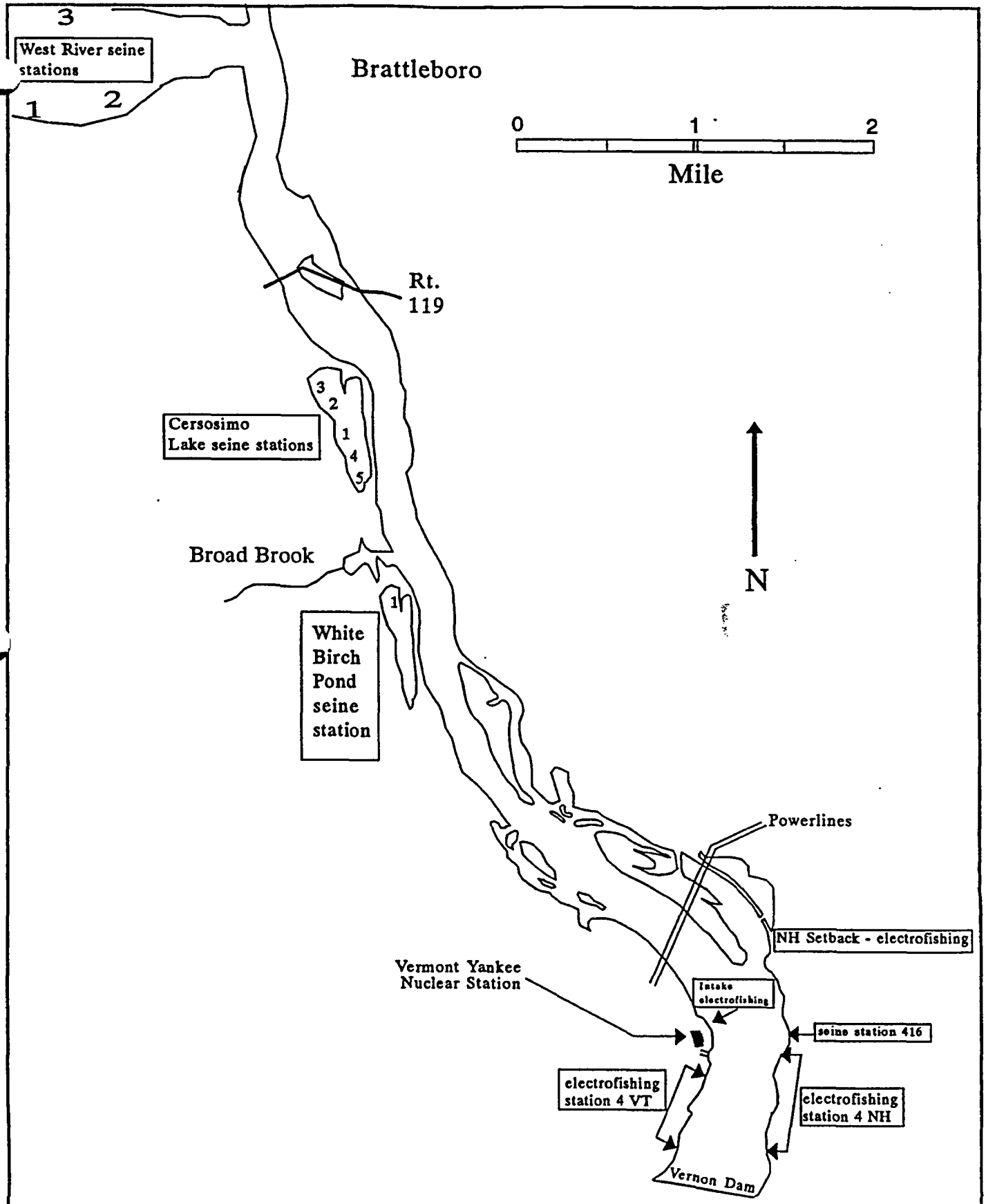

Figure 1. Vermont Yankee shad special studies beach seine and electrofishing stations on the Connecticut River.

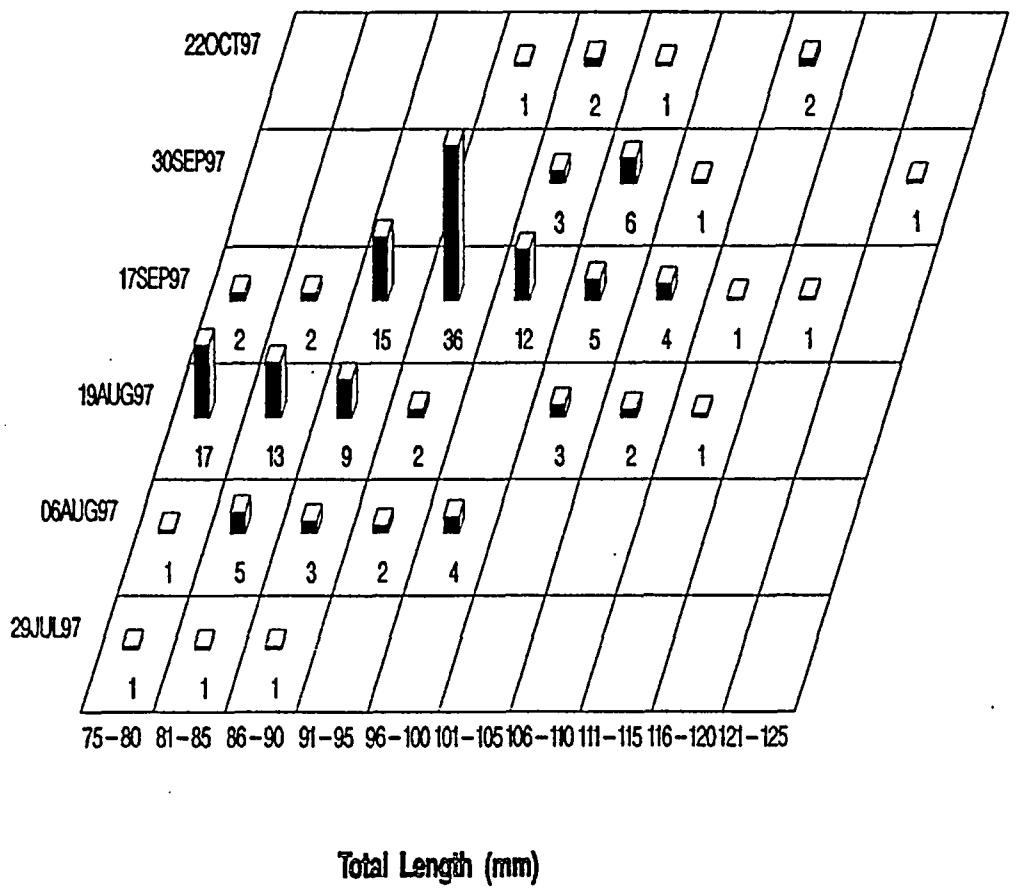

Figure 2. Length-frequency distribution for all juvenile American shad collected by beach seine in Cersosimo Lake, 1997.