

## **AQUATIC ECOLOGY**

**IV.M.(e). Normandeau Associates, Inc. 1998a**

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**VERMONT YANKEE/CONNECTICUT RIVER SYSTEM  
ANALYTICAL BULLETIN 70**

**Composition of Adult American Shad at the Vernon  
Hydroelectric Dam Fishway During Spring 1997**

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### ABSTRACT

Eighty-five adult American shad were collected from the Vernon Dam Fishway on 10, 12, 17, and 20 June 1997. Males dominated the first two of the samples collected, and overall, constituted 63.1% of the fish sampled. Eighty-five percent of the adults sampled at the Vernon Fishway were age IV and V (52% and 33%, respectively). Male shad composition was dominated (62%) by age IV fish, and females at age V were more abundant (58%) than other age classes in the sample. Repeat spawning was evident in 18% of the age V adults and 14% of the age IV adults. In general, the sexual condition of sampled shad was mostly green on the first sampling date, and steadily increased to mostly ripe by the last sample. The 1997 results are consistent with surveys conducted at the Vernon Fishway between 1990 and 1995. There were no adult shad sampled at Vernon in 1996. The slight annual differences seen in age and sex ratios are typical of the characteristics of natural fish populations.

### 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 past years (e.g., Vermont Yankee Analytical Bulletin Nos. 40 & 42), and agreed to continue monitoring adult American shad during the 1997 spawning migration.

As part of the 1997 objective specific studies of the Vermont Yankee Nuclear Power Corporation's NPDES Permit (NPDES No. VT0000264), life history data were collected on a sample of adult American shad (*Alosa sapidissima*) that utilized the Vernon Dam Fishway during the Spring 1997 spawning run. The objective of this study was to examine American shad size, sex ratios, sexual condition, and age structure for a sample of fish over the course of the spawning run, and compare those data with previous years.

### METHODS

The Fishway at Vernon Dam (river km 230, Vernon, Vermont) (Figure 1) is located less than one mile downstream of the Vermont Yankee Nuclear Power Plant. The Fishway operated between 27 May and 7 July 1997, typically between 0600 and 1900 hours. American shad were sampled on June 10, 12, 17, and 20, 1997 at the Fishway. After 20 June 1997, the number of shad utilizing the Fishway was too sporadic to effectively trap more than a few at a time. Beginning on 10 June, shad were randomly trapped by Vermont Division of Fish and Wildlife employees and processed by Normandeau Associates, Inc. (NAI) biologists. Captured shad were weighed to the nearest gram (g) using a calibrated Pesola® precision spring scale, and total length was measured to the nearest millimeter (mm). The sex of each shad was determined by applying pressure ventrally and posterior to the pelvic fins and observing the release of eggs or milt from the vent. Sexual condition was estimated by the quantity and appearance of the milt or eggs extruded. Water temperature in the

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Fishway was recorded at the time of sampling. Scales were taken from each processed shad from above the lateral line near the insertion of the dorsal fin. After processing, those individuals that were stressed beyond recovery were sacrificed. All others were released back into the Fishway.

Shad scales were prepared for age determination in the laboratory. Age and repeat spawning status was determined following the method outlined by Cating (1953). Each scale was soaked in water and gently scrubbed with a soft bristled brush. Three to five scales from each fish were mounted between two microscope slides. Annuli enumeration was conducted by two NAI biologists. One biologist examined scales under 30X magnification utilizing a Swift dissecting microscope. Another biologist independently examined the scales with a Nikon microprojector with 10 - 20X magnification. In instances where the first two investigators disagreed on fish age, a third biologist examined the scales in disagreement, utilizing a Bausch and Lomb microprojector with 20 - 40X magnification. Repeat spawning shad were identified by "spawning checks" on scales.

## RESULTS

Eighty-five adult American shad were sampled and processed over the four sampling events (Table 1). This represents 1.2% of the total shad passed at Vernon. Vernon passed 80.1% of the total American shad known to have passed the Turner's Falls fish ladder. Water temperature in the Fishway ranged from 20 - 22°C over the four sampling events. Flow through the Fishway was maintained at 135 cubic feet per second (cfs) during Fishway operation. Total river flow at Vernon Dam ranged from 4,470 - 11,600 cfs over the four sampling dates.

Males dominated the first two samples, constituting 76% and 64% of shad sexed (Figure 2). Approximately equal numbers of male and female fish were processed in the last two samples with males constituting 50% and 55% of those sexed. Overall, 63.1% of the processed shad were males. The sex of one of the adult shad processed at the Vernon Fishway was not determined. The sexual condition of the males sampled over the four dates, was 68% ripe and 32% green (Table 2). Male shad ranged in weight from 500 - 1200 g, and in length from 305 - 680 mm (Figure 3). The percentages of green (48%) and ripe (45%) females were similar. The remaining 7% of the females were partially spent (Table 2). The sexual condition of the sampled fish showed "green" individuals dominating on the first sample date (23%) which steadily decreased to zero on the last sampling date, while the number of "ripe" individuals increased over the four sampling dates, reaching 21% on the last day (Table 2).

Fifty-two percent of the adult shad processed at the Vernon Fishway were age IV, followed by 33% that were age V. Age III and VI constituted 11% and 4% of the fish sampled, respectively (Table 3).

Fourteen percent of sampled shad were repeat spawners. The age composition of males processed at the Vernon Fishway was dominated (62%) by four-year olds (Table 3). Three and five-year old males contributed 17% and 19% of the total, respectively (Table 3). There was one male shad aged at six years old. Female American shad age composition was dominated (58%) by five-year olds; 36% of the female shad were age IV (Table 3). Two female shad were determined to be age VI. Female shad ranged in weight from 800 - 1700 g, and in length from 449 - 535 mm (Figure 3).

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Repeat spawning was evident in 21% of the age V adults and 14% of the age IV adults (Table 3). Repeat spawning was evident in 18% of age IV females and 11% of age V females (Table 3). Repeat spawning was evident in 12% of age IV males and 30% of age V males (Table 3). There was no evidence of spawning checks on the scales of any of the age III and VI adults.

## DISCUSSION

Historically, the sex ratio of adult American shad sampled at the Vernon Fishway favored males at least in the early part of the spring immigration, and usually overall (Smith and Downey 1995). This trend continued in 1997. Male dominance, particularly during the early and middle stage of spawning runs has also been reported in the Susquehanna River (Susquehanna River Anadromous Fish Restoration Committee 1993 - 1996) and at the Holyoke fish passage facility on the Connecticut River (Mather 1997).

The percentage of male adult American shad sampled in 1997 was lower (63.1%) than that reported during 1990-1995. The range during 1990-1995 was 71 - 91% males; the mean was 83% (Smith and Downey 1995). The dominance of four and five-year old female American shad at the Vernon Fishway was generally consistent with data from previous years. Five-year old females have been reported as being an important component of the population sampled at the Vernon fish in previous years (Downey 1991), and continued that trend in 1997, constituting more than half of the females sampled.

Comparisons of total adult shad passed at Holyoke, Turners Falls, and Vernon fish ladders from 1995 - 1997 show a noticeable drop in the number of shad immigrating from Holyoke to Turners Falls in 1997 compared to the two previous years (Table 4). However, a large majority (80%) of the shad that passed Turners Falls also passed Vernon. Based on the facts that most fish pass Vernon Dam and that the proportion of females increased in 1997 compared to 1990 - 1995 indicates that the Vermont Yankee Nuclear Power Project has no significant impact on the immigration of adult shad up the Connecticut River.

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Table 1. Listing of all adult American shad processed at the Vernon Fishway, Spring 1997.

DATE										
10JUN97						12JUN97				
Fish ID	Sex	Weight (g)	Length (mm)	Age	SC	Sexual Condition	Sex	Weight (g)	Length (mm)	Sexual Condition
1	F	800	485	4		Green	M	750	460	Ripe
2	M	1050	469	5		Ripe	F	900	455	Green
3	M	750	448	4		Ripe	M	800	462	Green
4	M	1000	480	5	2	Green	F	1250	529	1 Green
5	M	900	488	4	1	Green	F	1100	511	5 Green
6	M	1000	479	4	2	Ripe	F	1000	490	5 Ripe
7	M	950	453	4		Green	M	1000	471	4 Ripe
8	M	1000	485	5		Green	M	1100	520	5 Green
9	F	1700	515	5		Green	M	750	450	4 Ripe
10	M	800	474	4	1	Green	F	1000	466	4 Green
11	M	1200	478	4		Green	M	800	471	4 Green
12	M	750	397	4		Green	F	1400	524	5 Ripe
13	M	750	433	4		Ripe	M	800	473	5 Ripe
14	M	650	405	3		Green	M	700	443	3 Ripe
15	M	1100	480	6		Green	M	700	455	4 Ripe
16	F	1200	483	4	1	Green	F	1400	517	5 Green
17	M	950	492	5	2	Green	M	950	522	5 1 Green
18	M	650	435	4		Green	M	700	445	3 Ripe
19	F	1100	485	5		Green	M	500	410	3 Ripe
20	M	800	459	4		Green	M	800	468	4 Ripe
21	F	1450	484	4		Green	M	750	448	3 Ripe
22	F	1350	501	5		Green	F	1000	449	4 Green
23	M	950	461	4		Green	M	700	438	4 Ripe
24	M	850	452	4		Ripe	M	800	460	4 1 Ripe
25	M	950	459	4		Ripe	F	1000	477	4 Green

DATE										
17JUN97						20JUN97				
Fish ID	Sex	Weight (g)	Length (mm)	Age	SC	Sexual Condition	Sex	Weight (g)	Length (mm)	Sexual Condition
1		1300	523	5	1	Green	M	650	440	4 Ripe
2	M	900	466	4		Ripe	F	1150	490	5 Ripe
3	M	600	395	3		Ripe	F	1300	505	4 Partially Spent
4	M	800	435	4		Ripe	M	800	438	4 Ripe
5	F	1400	482	5		Green	M	800	455	4 Ripe
6	M	600	405	3		Ripe	F	1500	500	5 Partially Spent
7	F	1400	524	5	1	Green	F	1400	495	5 Ripe
8	F	1060	504	5		Ripe	M	650	432	4 Ripe
9	M	600	414	4		Ripe	F	1150	460	4 Ripe
10	F	1200	535	6		Ripe	M	700	460	5 Ripe
11	F	900	502	4	1	Ripe	M	900	470	4 Ripe
12	F	1100	472	5		Ripe	F	1200	495	4 Ripe
13	F	1050	502	5		Ripe	F	1300	500	5 Ripe
14	M	650	436	4		Ripe	M	600	390	3 Ripe
15	M	1000	491	4		Ripe	M	900	460	5 Ripe
16							F	1500	505	6 Ripe
17							M	500	305	3 Ripe
18							M	900	480	4 Ripe
19							M	700	460	4 Ripe
20							F	1400	535	5 Ripe
21										
22										
23										
24										
25										

NOTE: SC = Spawning Check.

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Table 2. Summary of adult American shad sexual condition over four sampling dates at the Vernon fishway, June 1997.

	SAMPLING DATE															
	10-Jun				12-Jun				17-Jun				20-Jun			
Sexual Condition	N males	N females	sample total	percent of sample	N males	N females	sample total	percent of sample	N males	N females	sample total	percent of sample	N males	N females	sample total	percent of sample
Green	13	6	19	76	4	7	11	44	0	2	2	14	0	0	0	0
Ripe	6	0	6	24	12	2	14	56	7	5	12	86	11	7	18	90
Partially spent	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	10

Note: Males: N = 53 Females N = 31 (1 shad sex unknown).



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Table 3. Age breakdown and percent repeat spawners for all adult American shad processed at the Vernon Dam Fishway, Spring 1997.

Age Class									
	III		IV		V		VI		
	Total N	%RS	Total N	%RS	Total N	%RS	Total N	%RS	Total by Sex
Males	9	0.0	33	12	10	30	1	0.0	53
Females			11	18	18	11	2	0.0	31
Total	9		44		28		3		84
overall percent repeat spawners		0.0		14		21		0.0	

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**Table 4.** Comparison of adult American shad that passed the Holyoke, Turners Falls, and Vernon Fishways during 1995 - 1997. (Ken Cox VT. Dept. Fish and Wildlife - personal communication).

Year	Approximate number of shad passed at Holyoke	Approximate number of shad passed at Turners Falls	Approximate number of shad passed at Vernon
1995	190,000	18,912	15,771
1996	276,289	18,485	18,884
1997	298,000	9,216	7,384

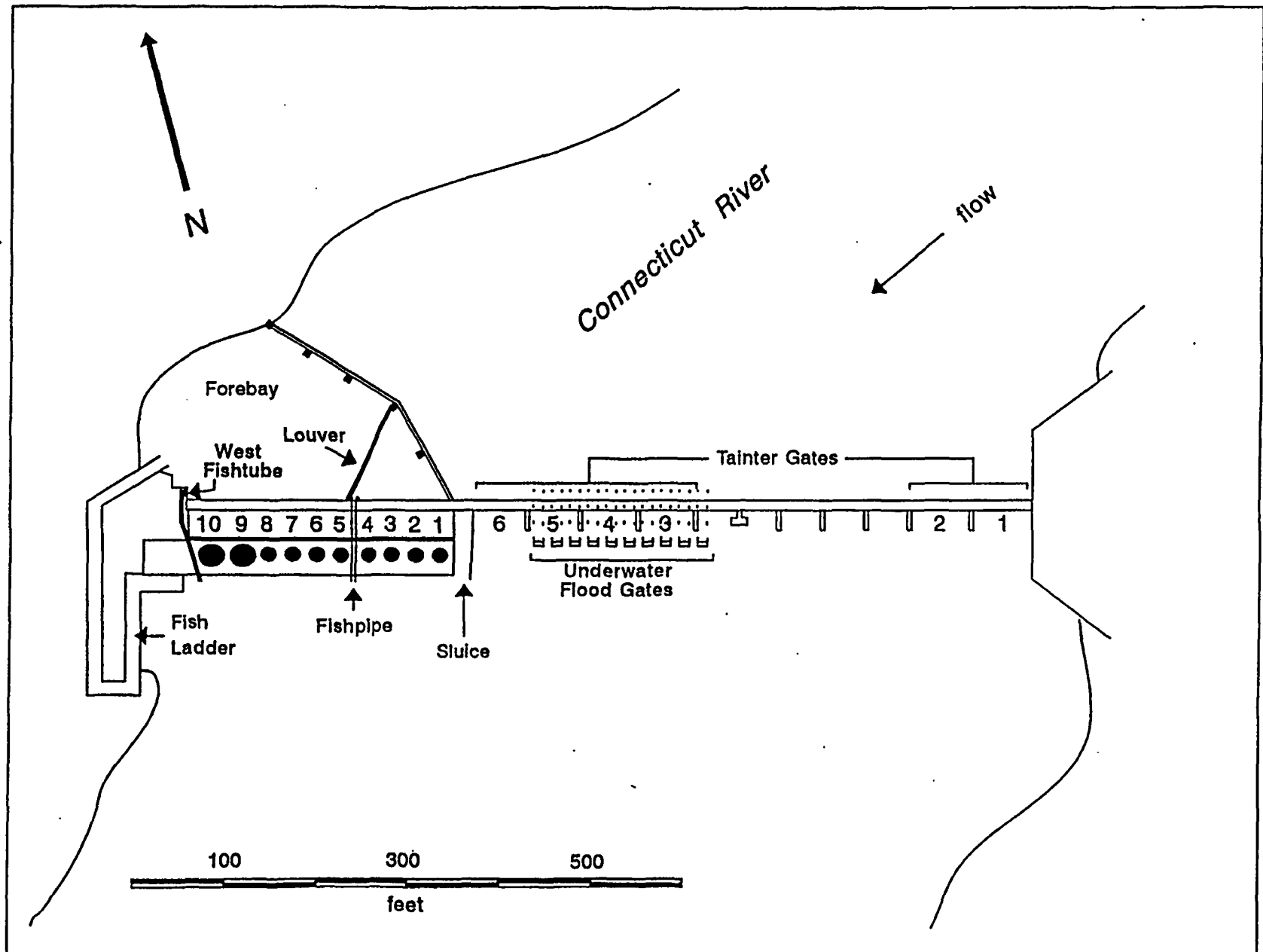


Figure 1. Plan view of the Vernon Project.

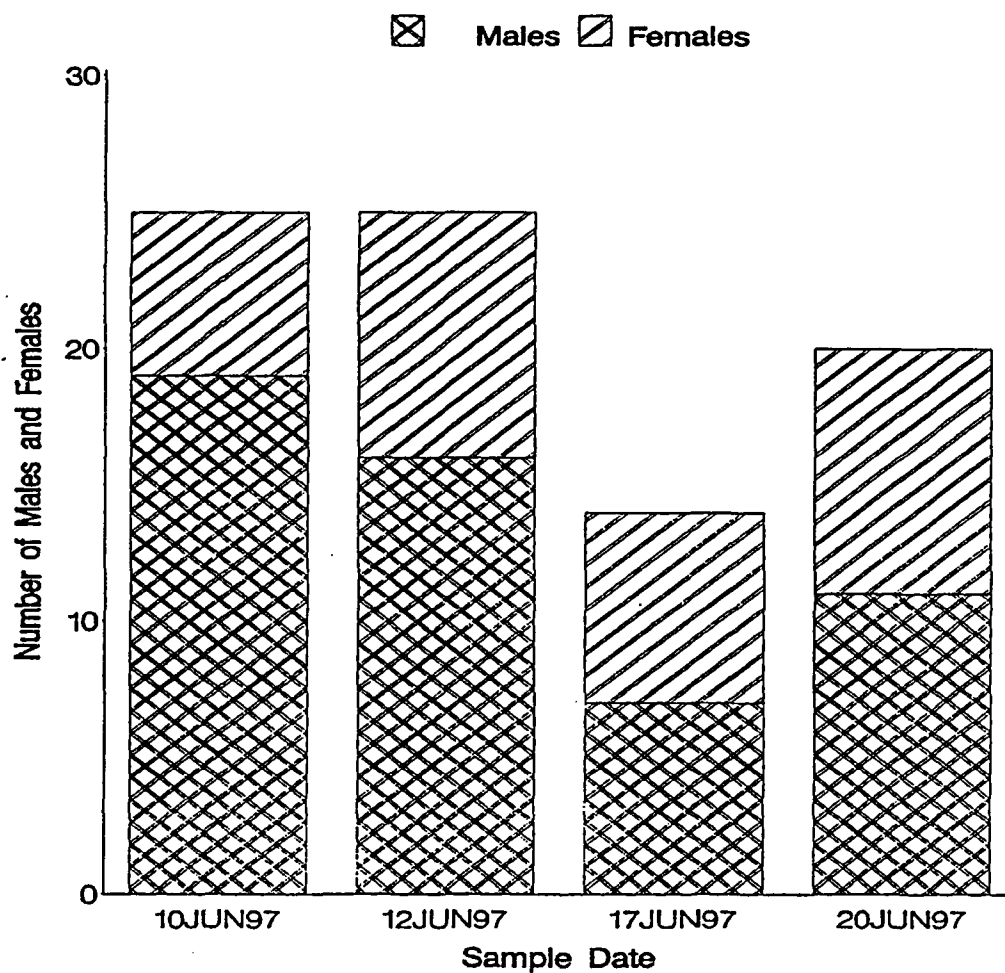


Figure 2. Sex composition by date for all American shad processed at the Vernon fishway, Spring 1997.

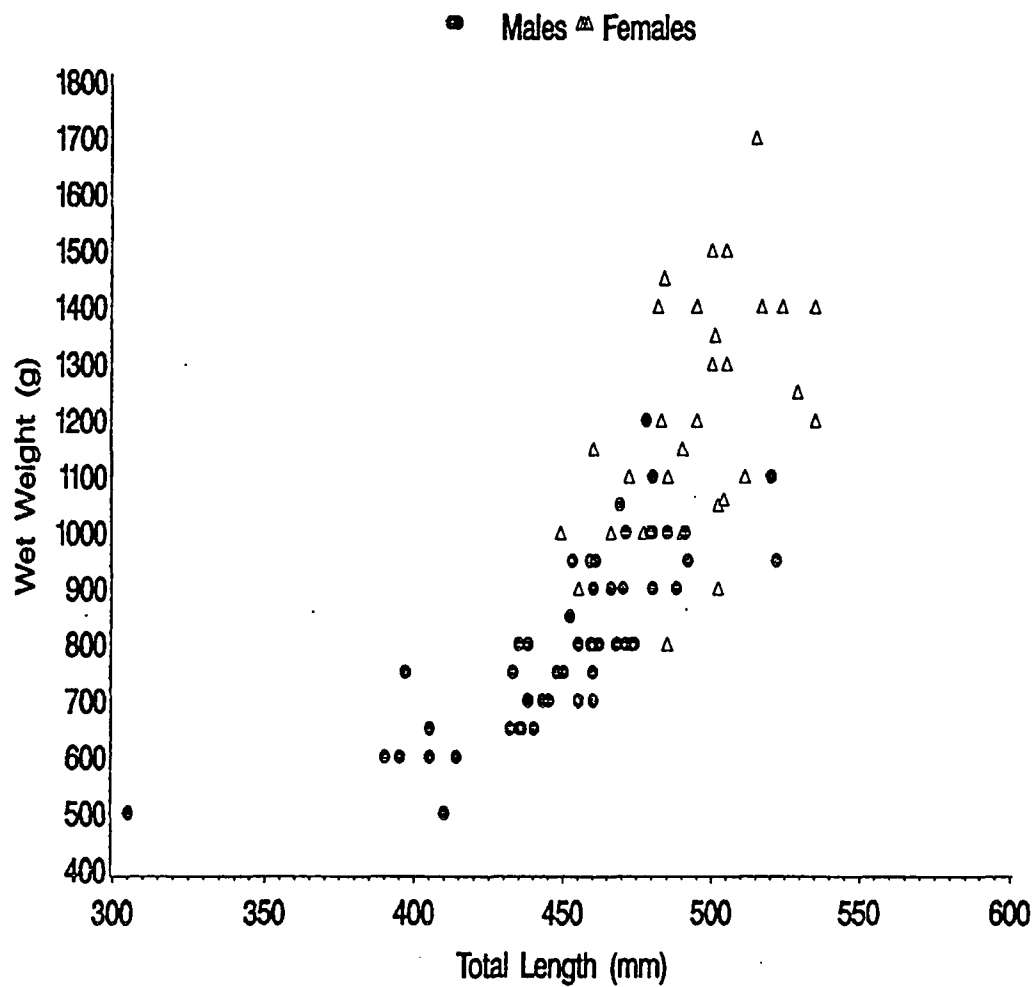


Figure 3. Length-weight plot of male and female adult American shad processed at the Vernon Fishway, Spring 1997.