DRAFT

VERMONT YANKEE/CONNECTICUT RIVER SYSTEM
ANALYTICAL BULLETIN 77

Composition of Adult American Shad at the Vernon Hydroelectric Dam Fishway, During Spring 2001

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DRAFT BULLETIN PREPARED
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ABSTRACT

Sixty-five adult American shad (out of a total of 1,666 passed) were collected from the Vernon Dam Fishway on 25 May, 15 June, and 25 June 2001. Males dominated the collections from each of the three samples collected, and overall, constituted 92% of the fish sampled. Eighty percent of the adults sampled at the Vernon Fishway were age IV, and V (51%, and 29%, respectively). Male shad composition was dominated (46%) by age IV fish, and females at age IV were more abundant (75.%) followed by age VI females (25%). Repeat spawning was evident in 3.0% of the age IV adults, 10.5% of the age V adults, and 50.0% of the age VI adults sampled at the Vernon Fishway. The 2001 results are consistent with surveys conducted at the Vernon Fishway between 1990 and 1995, as well as between 1997 and 1999. There were no adult shad sampled at Vernon in 1996 and 2000. The slight inter-annual differences seen among American shad age and sex ratios are typical of natural variation in 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. 36, 40, 41, 70, 72, and 74), and agreed to continue monitoring adult American shad during the 2002 spawning migration.

As part of the 2001 objective-specific studies of the Vermont Yankee Nuclear Power Corporation's NPDES Permit (NPDES No. VT0000264), life history data were collected from a sample of adult American shad (*Alosa sapidissima*) that used the Vernon Dam Fishway during the spring 2001 spawning run. We determined the size, sex ratios, sexual condition, and age structure for a sample of American shad collected during the 2001 spawning run to contribute to a long term database for evaluating the impacts, if any, of the Vermont Yankee Plant on American shad.

METHODS

The Fishway at Vernon Dam (river km 230, Vernon, Vermont) (Figure 1) is located on the Connecticut River, less than one mile downstream of the Vermont Yankee Nuclear Power Plant. The Fishway operated between 22 May and 28 June 2001. Beginning on 22 May through 28 June, fish passage monitoring was conducted by Vermont Department of Fish and Wildlife employees daily between 0700 and 1900 hours. American shad were sampled on 25 May, 15 June, and 25 June 2001 at the Fishway. American shad were randomly trapped by Vermont Department of Fish and Wildlife employees and processed by Normandeau Associates, Inc. (Normandeau) biologists. During the 2001 spawning migration the number of shad utilizing the Fishway was too sporadic, therefore fish were only processed on three separate dates. Captured shad were weighed to the nearest gram and total length was measured to the nearest millimeter. The sex was determined by applying pressure ventrally and posterior to the pelvic fins and observing the release of eggs or milt from the vent.

The quantity and appearance of the milt or eggs extruded was used to estimate sexual condition. Sexual condition was divided into six categories: green, ripe, running ripe, partially spent, spent, and undetermined. Male and female shad were classified into one of five sexual condition categories by observing the release (or not), and appearance of milt or eggs. If it was early in the run and no milt or eggs were released upon application of gentle pressure, that individual would be considered "green" or not yet ready to spawn. Some "green" females release eggs when pressure is applied, but they are clearly undeveloped. There is a general fullness to the ventral portion of shad that contain milt or eggs but are not ready to spawn. If upon application of pressure, milt or eggs are expelled with ease and volume and there is no blood in the eggs or milt, the fish would be categorized as being sexually "ripe". If upon picking up a shad and the milt or eggs were freely released with little or no pressure, that individual would be considered "running ripe". A "partially spent" male shad exhibits similar characteristics as "ripe" shad except that it takes more pressure to achieve the release of milt, a smaller volume usually results, and there is usually a small amount of blood in the milt. A "partially spent" female shad generally releases a small volume of eggs and there is often a small amount of blood present. The eggs also tend to lack the color relative to eggs released from a ripe or running ripe female. For a shad to be considered "spent", it would be difficult to get milt or eggs from the vent, blood is generally released, and the appearance of the fish suggest they have already spawned. This is usually observed late in the spawning run.

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. Annulus enumeration was conducted independently by two Normandeau biologists, utilizing a Bausch and Lomb microprojector with 20 - 40X magnification. Both biologists determined age and repeat "spawning checks" on scales to identify previously spawned shad. In cases where the biologists disagreed on age or repeat spawning status, the scale in question was reviewed by both biologists together. As described in Cating (1953), spawning marks are scar-like rings extending around the anterior portion of the scale similar to the annuli, but unlike the annuli, they extend only a short distance into the posterior portion of the scale. These marks are caused by absorption or erosion of the scale during the spawning migration into freshwater when little or no food is eaten by the adult shad.

Water temperature in the Fishway was continuously recorded (at15-min intervals) during the sampling period by a WaDaR™ temperature logger.

RESULTS

Sixty-five (3.9%) of the 1,666 total adult American shad passed at the Vernon Fishway in 2001 were sampled and processed during the three sampling events (Table 1). The Vernon Fishway passed more fish than counted at the Turners Falls Dam (1,540). This is due to the fact that the Turners Falls fishway is manned only at night and fish passing through at night are not counted in the daily counts.

Water temperature in the Fishway ranged from 13.3 – 26.1°C over the three sampling events, with an average of 18.9. The Fishway maintained a continuous flow of 65 cfs during the period of operation. Attraction flow of an additional 200 cfs was supplied to the Fishway from the forebay during the daytime period of operation (0600 – 2000 DST, Earl Brissette PG&E Generating, personal communication). Total river flow at Vernon Dam ranged from 1,421 – 36,488 cubic feet per second from 25 May through 25 June. Three sampling periods were conducted during this time.

The sexual condition of 65/65 adults was determined. The scale samples collected from two shad included all regenerated scales, from which age could not be determined. Males dominated the collections from each of the eight sample dates, constituting 92% of all collected shad for which sex was determined (i.e., n = 65, Figure 2). On all sample dates, males constituted more than 87% of the catch and on 25 June, males constituted 96% of the catch. Of the males for which sexual condition was determined (N= 60 males), 87% were sexually running ripe and the remainder were green (Table 2). Male shad ranged in weight from 400 – 1400 g and in length from 388 - 528 mm (Figure 3). Male shad were generally smaller in length and weight than females (Figure 3). Female shad ranged in weight from 700 – 1500g and in length from 473 – 545 mm (Figure 3). The sexual condition of the females sampled (N=5) over the eight dates, was 80% green and 20% running ripe (Table 2).

The age of 63 of the 65 adult shad processed was determined. Fifty-two percent of the 63 adult shad from the Vernon Fishway were age IV, followed by 30% that were age V, and 12% that were age III (Table 3).

The age composition of males processed at the Vernon Fishway was dominated (51%) by age IV, followed by 30% age V and 12 % age III males (Table 3). The remaining 5% comprised age VI and VII males (Table 3). Seventy-five percent of the female adult shad were age IV followed by 25% age VI (Table 3).

Fourteen percent (3/65) of sampled shad for which age was determined were repeat spawners. Repeat spawning was evident in less than 1% of adult shad at ages IV, V, and VI (Table 3). There was no evident of repeat spawning checks on the scales of any females (Table 3) as well as none on any age III adult shad

DISCUSSION

Historically, the sex ratio of adult American shad sampled at the Vernon Fishway has favored males at least in the early part of the spring immigration, and usually overall (Smith and Downey 1995). This trend continued during 1997, 1998, and 1999(Normandeau 1998, and 1999, respectively). Males were also most abundant, particularly during the early and middle stage of spawning runs in the Susquehanna River (Susquehanna River Anadromous Fish Restoration Committee 1993 - 1996) and at the Holyoke fish passage facility downstream from the Vernon Dam on the Connecticut River (Mather 1997).

Whereas 80% of the adult American shad that passed Turners Falls in 1997 passed Vernon Dam, only 65% of the total passed at Turners Falls also passed Vernon Dam in 1998 and 75% of the total passed at Turners Falls also passed Vernon Dam in 1999. Comparisons of total adult shad passed at Holyoke, Turners Falls, and Vernon Fishways from 1995 - 1999 show a noticeable drop in the number of shad immigrating from Holyoke to Turners Falls (Table 4). In 1999 and 1997 a large majority (75 and 80%, respectively) of the shad that passed Turners Falls also passed Vernon Dam.

The percentage was slightly lower (65%) in 1998 (Table 4).

The percentage of male adult American shad sampled at the Vernon Fishway in 2001 was higher (92%) than that reported in 1998 and 1997 (69% and 63.1%, respectively) and similar to the percentage of males reported during 1990-1995. The range during 1990-1999 was 63 - 91% males; the mean was 77% (Table 5).

Between 1990 and 1999, the 373 adult female shad aged at the Vernon Dam Fishway have been age III, IV, V, VI, and VI (Table 5). During 2001 four females were aged, three females were age IV and one was age VI.

The 2001 adult shad data appear to be lower than previous years summarized data with respect to number of adults passed, sex ratios, age, repeat spawning, and the general trends seen in passage between Holyoke and Vernon Dams.

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Normandeau Associates, Inc. 1999. Composition of adult American shad at the Vernon Hydroelectric Dam Fishway During Spring 1997. Vermont Yankee/Connecticut River System Analytical Bulletin 72. Prepared for Vermont Yankee Nuclear Power Corporation, Brattleboro, VT.

Table 1. Listing of adult American shad processed at the Vernon Fishway, Spring 2001. Note: Spawning check: 1= number of spawning checks present, blank = no spawning check present.

25-May							15-Jun						
Fish ID	**Sex**	**Weight (g)**	**Lentgh (mm)**	**Age**	**SC**	**Sexual Condition**	**Fish ID**	**Sex**	**Weight (g)**	**Lentgh (mm)**	**Age**	**SC**	**Sexual Condition**
1	M	900	472	5		Green	1	M	700	451	5		Running Ripe
2	F	1500	545	6		Running Ripe	2	M	1100	513	6	1	Running Ripe
3	M	100	501	4		Green	3	F	1200	500			Green
4	M	700	445	4		Green	4	M	1200	498	7		Running Ripe
5	M	600	434	3		Green	5	M	1100	502	5		Green
6	F	1100	531	4		Green	6	F		543	4		Green
7	M	1400	528	5	1	Running Ripe	7	M	700	445	3		Running Ripe
8	M	700	405	3		Running Ripe	8	M	700	460	3		Running Ripe
9	M	1000	483	4		Running Ripe	9	M	600	433	4		Green
10	M	800	425	4		Running Ripe	10	M	900	486	5		Running Ripe
11	M	1100	475	5		Running Ripe	11	M	600	471	5		Running Ripe
12	M	1100	486	4		Running Ripe	12	M	800	438	5		Running Ripe
13	M	1000	470	5		Running Ripe	13	M	1000	480	4		Running Ripe
14	M	1100	465	4	1	Running Ripe	14	M	700	411	4		Running Ripe
15	M	1000	465	5		Running Ripe	15	M	700	441	5		Running Ripe
16	M	700	460	5		Running Ripe	16	M	800	486	5		Running Ripe
							17	M	700	406	4		Running Ripe

Table 1. Listing of adult American shad processed at the Vernon Fishway, Spring 2001.

25-Jun						
Fish ID	**Sex**	**Weight (g)**	**Lentgh (mm)**	**Age**	**SC**	**Sexual Condition**
1	M	900	480	4		Running Ripe
2	M	700	464	5		Green
3	M	500	399	4		Running Ripe
4	M	800	471	5		Running Ripe
5	M	800	481	4		Running Ripe
6	M	600	396	3		Running Ripe
7	M	800	445	4		Running Ripe
8	M	800	476			Running Ripe
9	M	800	500	4		Running Ripe
10	M	900	469	5		Running Ripe
11	M	800	469	4		Running Ripe
12	M	600	450	4		Running Ripe
13	M	900	490	4		Green
14	M	800	469	5		Running Ripe
15	M	600	461	4		Running Ripe
16	M	1300	540	5		Running Ripe
17	M	400	410	3		Running Ripe
18	M	700	462	4		Running Ripe
19	F	700	473	4		Green
20	M	700	449	3		Running Ripe
21	M	700	473	4		Running Ripe
22	M	700	486	4		Running Ripe
23	M	600	438	4		Running Ripe
24	M	700	489	4		Running Ripe
25	M	500	436	4		Running Ripe
26	M	900	488	4		Running Ripe
27	M	800	497	4		Running Ripe
28	M	900	485	4		Running Ripe
29	M	600	430	4		Running Ripe
30	M	500	420	3		Running Ripe
31	M	700	470	5		Running Ripe
32	M	500	388	4		Running Ripe

Note: SC=Spawning Check: 1=Number of spawning checks present, blank=no spa

Table 2. Summary of adult American shad sexual condition over three sampling dates at the Vernon Dam Fishway, May-June2001.

	Sampling Dates											
	25-May				15-Jun				25-Jun			
Sexual Condition	# Males	# Females	Total	% Sample	# Males	# Females	Total	% Sample	# Males	# Females	Total	% Sample
Green	4	1	5	31.25	2	2	4	23.52	2	1	3	9.37
Ripe	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Running Ripe	10	1	11	68.75	13	0	13	76.47	29	0	29	90.62
Partially Spent	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
Spent	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00

Table 3. Age and percent repeat spawners (% RS) for all adult American shad processed at the Vernon Dam Fishway, May and June 2001.

	Age Class										
	III		IV		V		VI		VII		III - VII
	Total #	%RS	Total #	%RS	Total #	%RS	Total #	%RS	Total #	%RS	Total By Sex
Males	8	0	30	0.033	19	0.052	1	100	1	0	59
Females	0	0	3	0	0	0	1	0	0	0	4
Total	8		33		19		2		1		63
Overall percent repeat spawners		0		3.0		5.3		50		0	

Table 4. Comparison of adult American sahd that passed the Holyoke, Turners Falls, and Vernon Fishways from 1995 through 2001. (Ken Cox VT Dept. of Fish and Wildlife and Caleb Slater MA Division of Fish and Wildlife).

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
1998	311,704	10,527	8,151
1999	193,782	6,756	5,083
2000	225,000	2,590	800
2001	273,000	1,520	1,666

Table 5. Summary of sex composition, sex ratios, dominant age classes, and total number of adult American shad passed at Turners Falls from 1990 through 1995 and passed Vernon Dam 1990 through 2001. Biocharacteristics data from the American shad passing at the Turners Falls Dam was not available after 1995 (Caleb Slater, personnel communication).

Turners Falls	Vernon Dam	Turners Falls	Vernon Dam	Turners Falls	Vernon Dam	No. Males/age class III	IV	V	No. Females/age class III	IV	V	VI	No. Males/age class III	IV	V	VI	VII	No.Females/age class III	IV	V	VI	VII
27908	10894	314	465	86.0:14.0	90.5:9.5	43	123	59			20	10	43	141	42				14	22		
54656	37197	192	395	87.0:13.0	87.1:12.9	65	69			8	9		123	120					13	23		
60089	31155	192	275	73.4:26.6	78.9:21.1	42	89			24	26		75	128					37	14		
10221	3651	179	190	53.6:46.4	71.1:28.9	34	53			42	32		48	68					30	22		
3729	2681	112	168	69.6:30.4	77.2:22.8	30	35			10	22		47	70					10	22		
18369	15771	100	334	80.5:19.5	85.8:14.2	41	38			10	4		116	122					29	28		
9216	7384	0	85		63.1:36.9								9	33	10	1			11	18	2	
10527	8151	0	86		68.6:31.4								5	35	17				13	14		
6756	5083	0	212		75.5:24.5								39	74	36	2		4	19	21	6	1
12300	800		0																			
1540	1666		65		92.3:8.0								8	30	19	1	1		3		1	
215311	124433	1089	2275	75.0:25.0	80.0:20.0	255	407	59	0	94	113	10	513	821	124	4	1	4	179	184	9	1
19574	11312	121	207	75.0:25.0	80.0:20.0	3.7			4.6				3.7					4.5				

Table 6. Daily passage at the Vernon Dam Fishway, May through June 2001.

Date	Daily Count	Cum. Count	Shad Sampling Dates
22-May	68	68	
23-May	123	191	
24-May	100	291	
25-May	107	398	16 shad trapped and processed
26-May	95	493	
27-May	45	538	
28-May	38	576	
29-May	55	631	
30-May	46	677	
31-May	42	719	
01-Jun	41	760	
02-Jun	17	777	
03-Jun	5	782	
04-Jun	0	782	
05-Jun	5	787	
06-Jun	1	788	
07-Jun	10	798	
08-Jun	2	800	
09-Jun	5	805	
10-Jun	0	805	
11-Jun	18	823	
12-Jun	3	826	
13-Jun	24	850	
14-Jun	65	915	
15-Jun	94	1009	17 shad trapped and processed
16-Jun	107	1116	
17-Jun	64	1180	
18-Jun	15	1195	
19-Jun	10	1205	
20-Jun	17	1222	
21-Jun	5	1227	
22-Jun	6	1233	
23-Jun	0	1233	
24-Jun	179	1412	
25-Jun	208	1620	32 shad trapped and processed
26-Jun	19	1639	
27-Jun	13	1652	
28-Jun	14	1666	

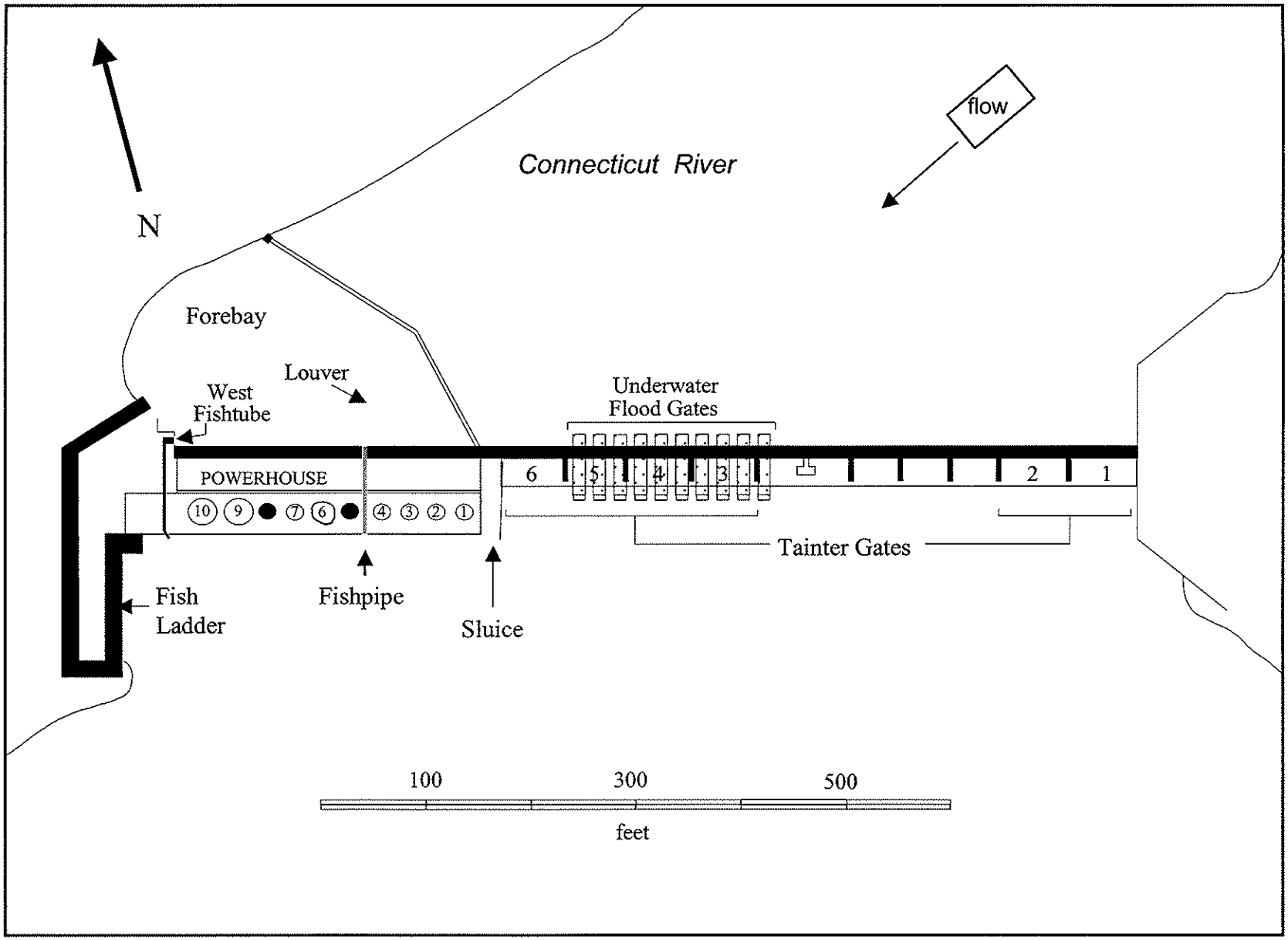

Figure 1. Plan view of the Vernon Project.

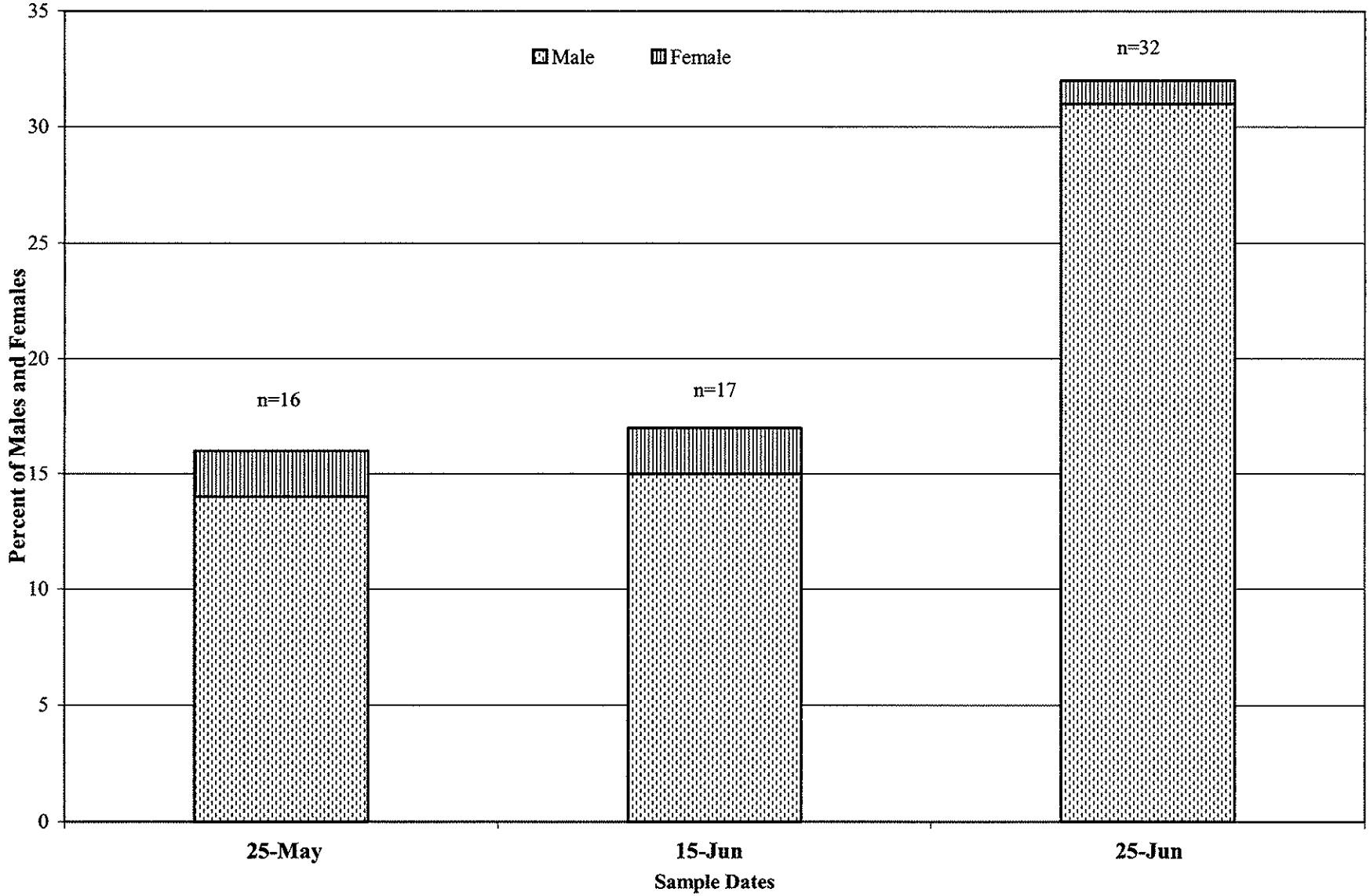

Figure 2. Percent sex composition by date, for all adult American shad processed at the Vernon Fishway, Spring,2001.

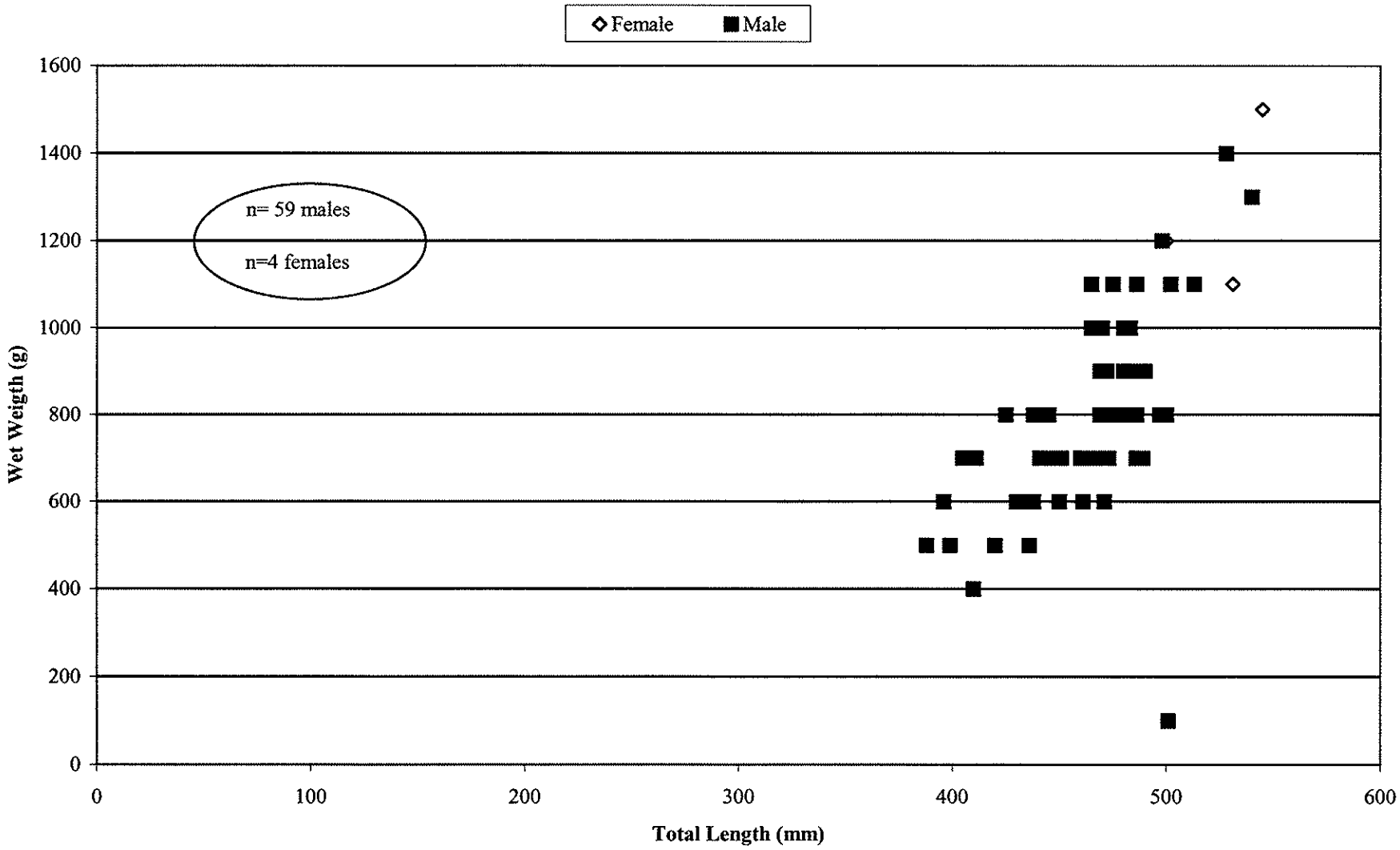

Figure3. Length-weight plot of male and female adult American shad processed at the Vernon Fishway, May-June 2001.

Date: Fri, 20 Dec 2002 08:08:58 -0800
From: William Daigle <wrdaigle@uidaho.edu>
Subject: RE: Report on Willamette Falls Lamprey Passage
To: 'Tim Brush' <tbrush@normandeau.com>
X-Mailer: Microsoft Outlook, Build 10.0.3416
Importance: Normal

Hi Tim,

Thanks for looking into it for me. Right now I m working up the studies that ICFWRU has been doing in the experimental lamprey fishway at Bonneville Dam s Adult Fish Facility. We have data from 1999, 2000 and 2002 that has been tucked away for a while. I m really just starting to get into it (we still have about a year s worth of video tapes to analyze), so it will be several months before the report is available. Basically, we ve been using the fishway to test potential modifications within fishways, at fishway entrances, and count window areas. If you re interested, I will be presenting some of the information at both the Oregon Chapter AFS meeting in Eugene, and the AFS Western Division meeting in San Diego.

I also love to get a copy of the radio telemetry report. NMFS s and ICFWRU just published a couple different papers on lamprey radio telemetry in the Lower Columbia that you might be interested in (if you don t aleady have them).

Moser, M.L., A.L. Matter, L.C. Stuehrenberg, T.B. Bjornn. 2002. Use of an extensive radio receiver network to document Pacific lamprey (*Lampetra tridentata*) entrance efficiency at fishways in the Lower Columbia River, USA. *Hydorbiologia*. 483: 45-53.

Moser, M.L., P.A. Ocker, L.C. Stuehrenberg, and T.C. Bornn. 2002. Passage efficiency of adult Pacific lampreys at hydropower dams on the Lower Columbia River, USA. Transactions *of the American Fisheries Society*. 131: 956-965.

Thanks again,

Bill

-----Original Message-----
From: Tim Brush [mailto:tbrush@normandeau.com]
Sent: Thursday, December 19, 2002 5:03 PM
To: William Daigle
Subject: Re: Report on Willamette Falls Lamprey Passage

Hi Bill,
I'll see what I can do about getting you a copy. We have also done some radio telemetry with lamprey. If that is ready for distribution, I'll include that too. What sort of work are you doing with lamprey? If you have any reports available, I'd like to get copies in return.

Happy Holidays,
Tim Brush
Principal Scientist
Normandeau Associates

At 05:41 PM 19-12-02, you wrote:

Hi,

I work with the Idaho Cooperative Fish and Wildlife Research Unit in Moscow, Idaho. I am currently studying Pacific lamprey and their modes of passage at dams, and I am trying to get a hold of the following report:

Normandeau Associates, Inc. 2001d. Final report on assessment of Willamette Falls Project

operational effects on upstream passage of non-salmonid species, in particular, Pacific

lamprey. Report prepared for PGE, Portland, Oregon, Blue Heron Paper Company, Oregon City, Oregon, and Willamette Falls Project Fisheries, Aquatics, and Terrestrial Workshop.

Any information you could give me as to where I could get a copy of this report would be greatly appreciated.

Sincerely,

Bill Daigle

Research Support Scientist

Idaho Cooperative Fish and Wildlife Research Unit

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Anaylytical Bulletins

Bulletin No.	Title
1	Downey, Philip C. 1984. Notes on the Health of Fishes of the Connecticut River near Vernon, Vermont
2	Johnston, H. Gregory. 1984. Thermal Experience of the Connecticut River near Vernon, Vermont
3	Binkerd, Roger C. 1984. Synopsis of 1983 Environmetnal Programs
4	Johnston, H Gregory, and Roger C. Binkerd, 1984. Determination of Optimal Settings of Condenser Cooling System Facilities
5	Downey, Philip C. 1984 Age and Growth of Walleye (Stizostedion vitreum vitreum (Mitchill)) of the Connecticut River near Vernon, Vermont
6	Downey, Philip C. 1985. Growth of 1984 Juvenile American Shad (Alosa sapidissima (Wilson)) of the Connecticut River near Vernon, Vermont
7	Downey, Philip C. 1985. Age and Growth of Smallmouth Bass (Micropterus dolomieui Lacepede) of the Connecticut River near Vernon, Vermont
8	Downey, Phlip C. 1985. Age and Growth of White Perch (Morone americana (Gmelin)) of the Conenecticut River near Vernon, Vermont
9	Downey, Philip C. 1985. Age and Growth of Yellow Perch (Perca flavescens (Mitchill)) of the Connecticut River near Vernon, Vermont.
10	King, David E. 1985. Vermont Yankee Environmental Temperature System
11	Binkerd, Roger C. 1985. Temperature Patterns near Vernon Dam Fish Passage During High River Discharge
12	Binkerd, Roger C. 1985. Connecticut River Water Quality near Vernon, Vermont 1969-1984
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