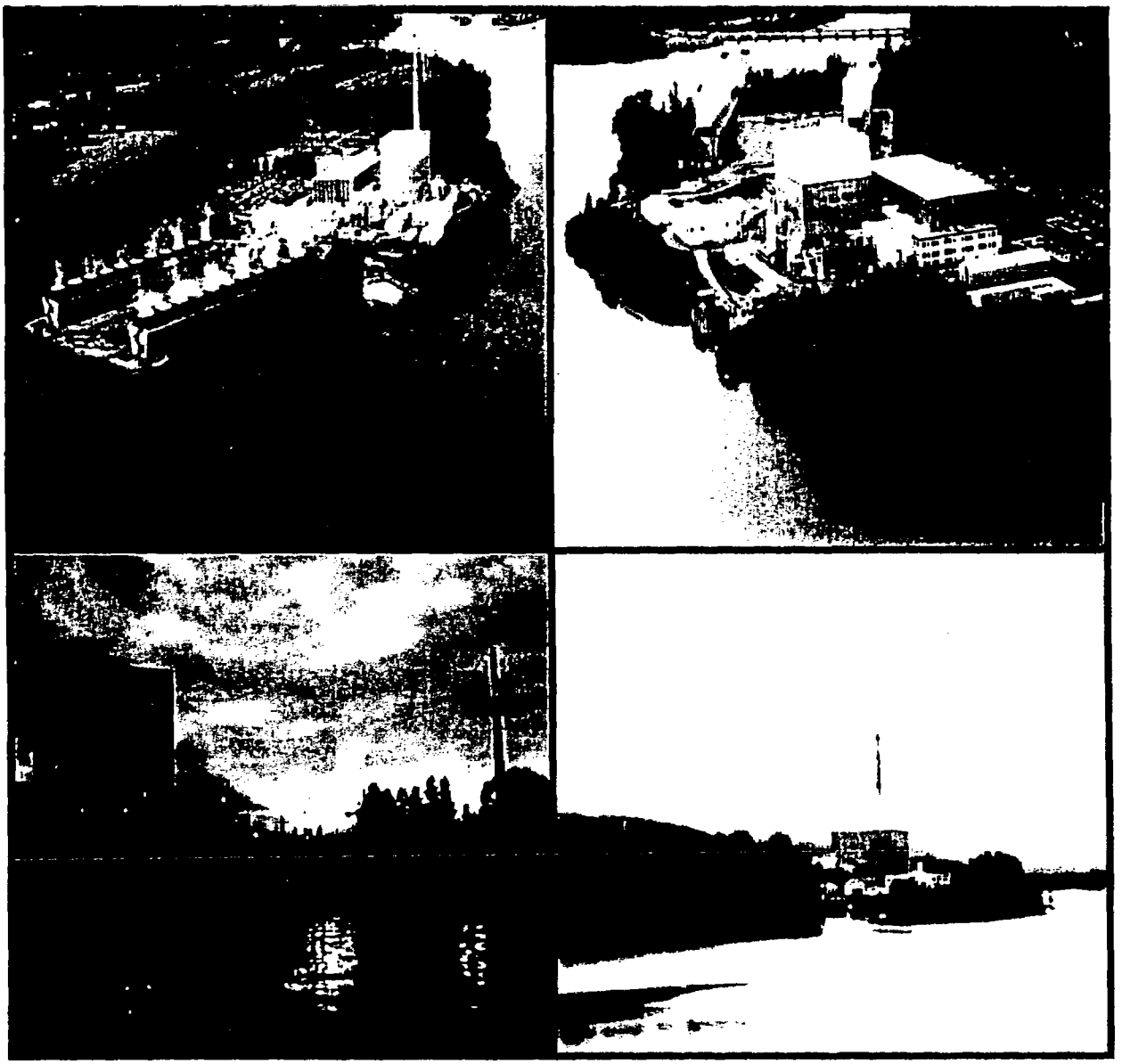
Ecological Studies of the Connecticut River
Vernon, Vermont



Report 30
January - December 2000

Vermont Yankee

Normandeau Associates

ECOLOGICAL STUDIES OF THE CONNECTICUT RIVER VERNON, VERMONT REPORT 30

January - December 2000

VERMONT YANKEE
NUCLEAR POWER CORPORATION
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TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF TABLES CONTINUED

Page

1.0 INTRODUCTION

This report is submitted on behalf of the Vermont Yankee Nuclear Power Corporation, and fulfills the requirements of the Final Discharge Permit #3-1199 (NPDES number VT0000264).

This is the fifth annual report submitted under the five-year discharge permit issued in 1996. Presented in this report are the results of the monthly thermal compliance monitoring and the methods and results of the environmental monitoring program, including water quality, macroinvertebrates, fish, and zebra mussels. The NPDES permit environmental sampling stations referred to in this report are presented on the NPDES sampling stations map (Figure 3-1).

This report was produced as a collaborative effort on the part of Vermont Yankee and Normandeau Associates.

One special study was conducted during 2000 and was submitted to the Environmental Advisory Committee in January 2001 as Draft Analytical Bulletin No. 76. The bulletin was titled "Abundance of Juvenile American Shad in the Vernon Pool During 2000" (Normandeau 2001).

2.0 COMPLIANCE WITH THERMAL STANDARDS

2.1 THERMAL STANDARDS

The operational mode of Vermont Yankee's cooling water system is related to calendar dates and ambient Connecticut River water temperatures as specified in Vermont Yankee's discharge permit (Permit No. 3-1199, NPDES Number VT0000264) effective 21 March 1996. During the 16 May through 14 October period of each year, Vermont Yankee is permitted to discharge heat to the river within the following thermal standards (A.6.b of the NPDES permit):

Connecticut River Temperature at Station 7 (T7)	Calculated Increase in River Temperature above Ambient
T7>63°F	2°F
63°F≥T7>59°F	3°F
59°F≥T7>55°F	4°F
55°F≥T7	5°F

During the period of 15 October through 15 May of each year, Vermont Yankee is permitted to discharge heat to the Connecticut River within the following thermal standards (Section A.6.a of the NPDES permit):

1. The temperature at Monitor Station 3 during open cycle operation shall not exceed 65°F
2. The rate of change of temperature at Monitor Station 3 shall not exceed 5°F per hour, and,
3. The increase in temperature above ambient at Monitor Station 3 shall not exceed 13.4°F.

The river discharge near Vernon is regulated by Vernon Dam Hydroelectric Station to remain at or above 1250 cubic feet per second (cfs) or inflow if less than 1250 cfs. Since the theoretical maximum increase in temperature due to Vermont Yankee's thermal discharge at a river flow of 1250 cfs is 12.9 °F, these standards, in effect, permit open cycle condenser cooling without cooling tower operation when ambient river temperatures are less than 52.1 °F during 15 October through 15 May. If ambient river temperatures are greater than 52.1 °F, the amount of heat discharged to the river can be reduced by using the cooling towers if the river flow is low.

2.2 METHODS OF DEMONSTRATING COMPLIANCE

Compliance with the criterion that limits open cycle operation to times when the downstream temperature is less than 65°F was demonstrated by examination of Connecticut River temperature and plant operating data. Rate of change of temperature is defined in the NPDES permit as the

difference between consecutive hourly average temperatures. Measurements recorded in the Connecticut River below the Vernon Dam (Station 3) were used to calculate these differences.

Increase in temperature above ambient is defined in the NPDES permit as a plant-induced temperature increase as calculated by equation 1-1 in the report 316 Demonstration (Binkerd 1978, Downey and Binkerd 1990). This equation is based on the principle of conservation of energy, a principle which is integral to the computer simulation of the Vermont Yankee/Connecticut River system. Using measured upstream river temperature, plant operating data and core thermal power, the amount of heat discharged to the river was calculated. Then, using thermodynamic and hydrodynamic principles and river discharge information, the mixed river temperature increase was calculated and compared with thermal standards.

Equation 1-1, rearranged for ease of computer computation using input from the plant environmental thermal sensor network, is as follows:

Equation 1: $DELTA\_T = (H\_RIV + H\_TOWER)/Q$

Equation 1a: $H\_TOWER=(TCIT_{T-1}-TCIT_T)*472727.3/3600$

Equation 1b: $H\_RIV = (267.38 *CWP_T) * ((TCO_T - TCI_T) - (CWBP_T/CWP_T)* (TCO_T- (TETO_T+ TWTO_T)/2)))$

where,

$DELTA\_T$ = hourly simulated Connecticut River temperature increase at Station 3 in °F

H_RIV = caloric heat content of the cooling water discharge

H_TOWER = caloric heat content of the circulating water system and cooling towers

Q = hourly Connecticut River discharge (cfs) observed at Vernon Dam

TCI_{T-1} = condenser inlet temperature in °F at time interval t-1

TCI_T = condenser inlet temperature in °F at time interval t

CWP_T = number of circulating water intake pumps operating in time interval t

$CWBP_T$ = number of cooling tower booster pumps operating in time interval t

TCO_T = condenser outlet temperature in °F at time interval t

$TETO_T$ = east cooling tower outlet temperature in °F at time interval t

$TWTO_T$ = west cooling tower outlet temperature in °F at time interval t

Vermont Yankee implemented a design change during the month of May, which linked the Azonics temperature monitoring systems at Stations 3 and 7 to the plant process computer. This allowed Vermont Yankee operators to utilize real time accurate temperature data for thermal compliance. It also allowed Vermont Yankee Environmental Group an opportunity to generate thermal compliance reporting. The WaDaR units remain in the river at Stations 3 and 7 as the back-up temperature recorders to the Azonics. The simulation is based on electronically acquired five-minute river discharge data from the Vernon Dam and Vermont Yankee's five minute observations of thermal temperatures at Stations 3 and 7 and thermal heat discharge to the river.

2.3 THERMAL IMPACT

Figures in this section illustrate the principle of conservation of energy as applied to the Vermont Yankee/Connecticut River system. Figure 2-1 depicts core thermal power produced by Vermont Yankee in 2000. This data was obtained from one minute and five minute records supplied by Vermont Yankee. The licensed maximum reactor core thermal power is limited to 1593 megawatts. About one-third of this power was converted to electrical power, while the remainder was transferred as heat to the atmosphere via the cooling towers, or discharged to the river (Figure 2-2). The plant shutdown on September 13, 2000 at 16:35 due to a reactor scram caused by the loss of the Steam Jet Air Ejectors. The plant startup was initiated after the incident was investigated. The plant reached 100% power on September 16,2000. Otherwise the plant remained at full power throughout 2000, with occasional brief periods of power derating.

Figure 2-3 is a plot of hourly Connecticut River discharge for the Vernon Hydroelectric Station Dam in Vernon, Vermont during 2000. The hourly average Connecticut River discharge was computed using one-minute or five minute observations obtained by Vermont Yankee through their computer system from sensors installed at the Vernon Dam. When the flows were above 32,000 cfs this data was obtained from hourly logs obtained from records at Vernon Dam .

Table 2-1 lists the average daily and monthly Connecticut River discharge computed from the hourly observations obtained for 2000 as described above. For discharge greater than 12,000 cfs, a rating curve was used by Vernon Dam to convert stage height to discharge. The rating curve was the same one used by the USGS prior to abandoning the Vernon gaging station (Aquatec 1995). This curve is believed to be sufficiently accurate because backwater from the Northfield Mountain Pump Storage Facility and the modification at Turners Falls Dam have had little impact on stage height near Vernon Dam during times of high discharge (Aquatec 1995). Below 12,000 cfs, discharge data were obtained from turbine rating curves at Vernon Station. The peak Connecticut River daily average flow for 2000 was 57,943 cfs, which occurred on 05 April 2000. The second highest peak daily average flow (other than in April) was 55,115 cfs on 18 Deeceember 2000. The hourly average flows are represented in Figure 2-3. The peak hourly average Connectcuit River flows occurred on 05 April 2000 at 59,550 cfs and on 18 December 2000 at 59,533 cfs. The lowest flows at Vernon Dam were 1250cfs to 1275 cfs observed for one or more hours during 16-23 July 2000.

The simulated increases in Connecticut River temperature at Station 3 due to Vermont Yankee's operation are plotted for each hour of operation in Figure 2-4. Vermont Yankee's discharged heat remains dependant upon reactor power and plant operational mode. During normal full power operations these values range from 1035 to 1081 mwt. Connecticut River discharge (Figure 2-3), Vermont Yankee daily average discharge flow (Figure 2-2) and river temperature increase (Figure 2-4) illustrates that for a constant heat rejection rate to the river, the temperature increase is inversely proportional to the river discharge. Vermont Yankee's operation remained at or below the permit standards for all of 2000 except in July when there were two instances where the Vernon Dam went to minimum flow. All their generators tripped off line due loss of off-site power caused by a lightening strike. The plant operators took prompt action to mitigate this event and began shifting to Recirculation Gate Position and going to Closed Cycle. These events were:

16 Jul 2000 2200-2259 DST	+2.74degrees F (above permit limit)	Permit Limit + 2.0 degrees F
21 Jul 2000 1900-1959 DST	+0.03 degrees F (above permit limit)	Permit Limit + 2.0 degrees F

During the cold water period when the permit limit was 13.4°F, the maximum simulated river temperature increase observed was 12.6°F on 26 November 2000 at 0700 when the river flow was low at 1275 cfs

Hourly average temperatures are measured at Station 7 and Station 3 are plotted on Figure 2-5. Station 7 is well upstream of the plant, and water temperatures there were unaffected by the plant's thermal discharge. Heat discharged from the plant was well mixed at Station 3, due to passage through the Vernon Dam. Temperatures measured at Station 3 reflected both the natural and plant-induced changes in temperature between the upstream and downstream locations, and never exceeded the 65°F during the periods of 1 January through 15 May 2000 and 15 October through 21 December 2000 (Figure 2-5). At no time during the month did the temperature change observed at Station 3 exceed the ±5°F permitted change per hour.

Figure 2-1 Vermont Yankee Core Thermal Power mwth, 2000

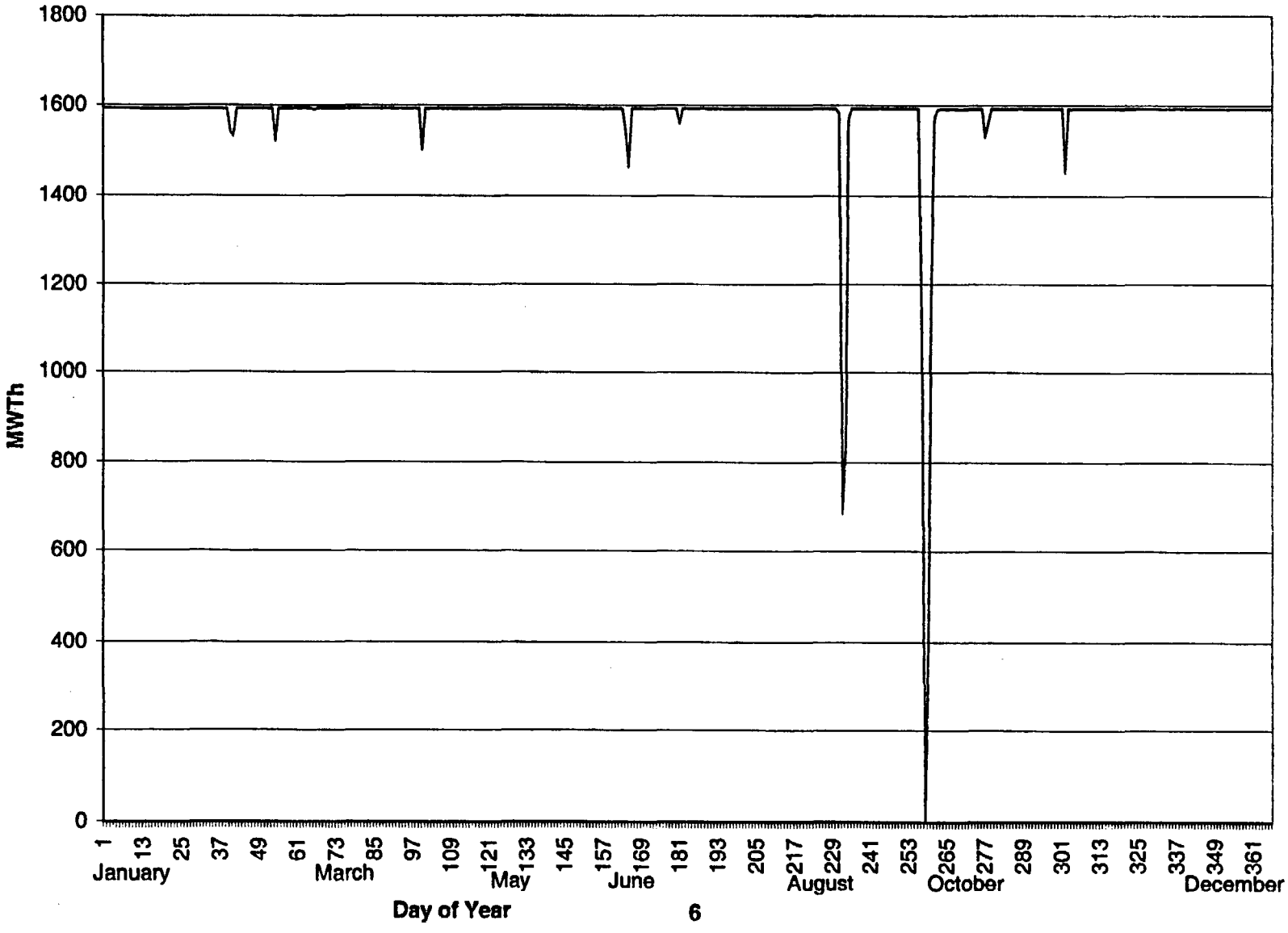


Figure 2.2 Vermont Yankee Plant Discharge Flow

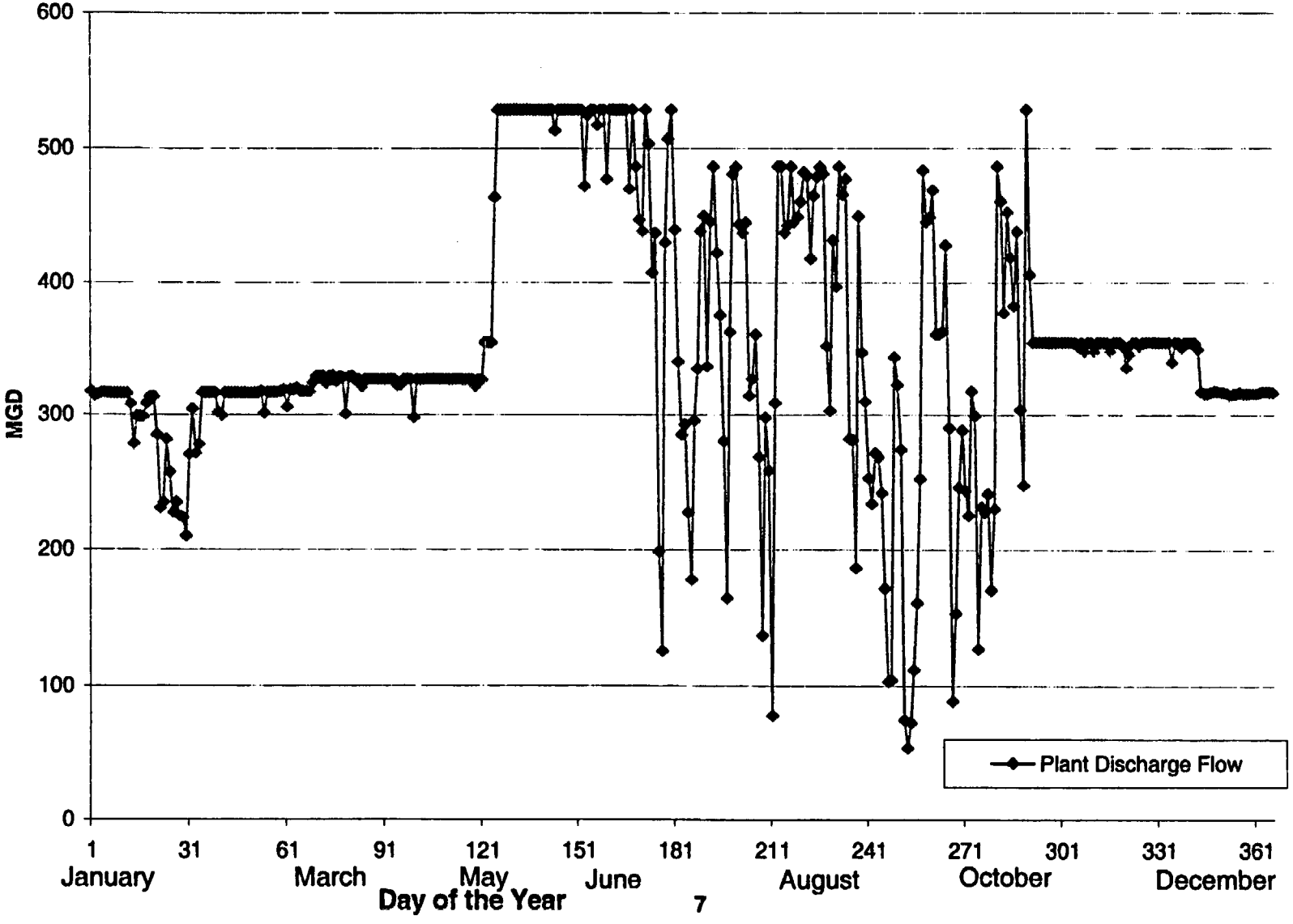


Figure 2-3 Hourly Average Connectcut River Flow Rate for the Year 2000

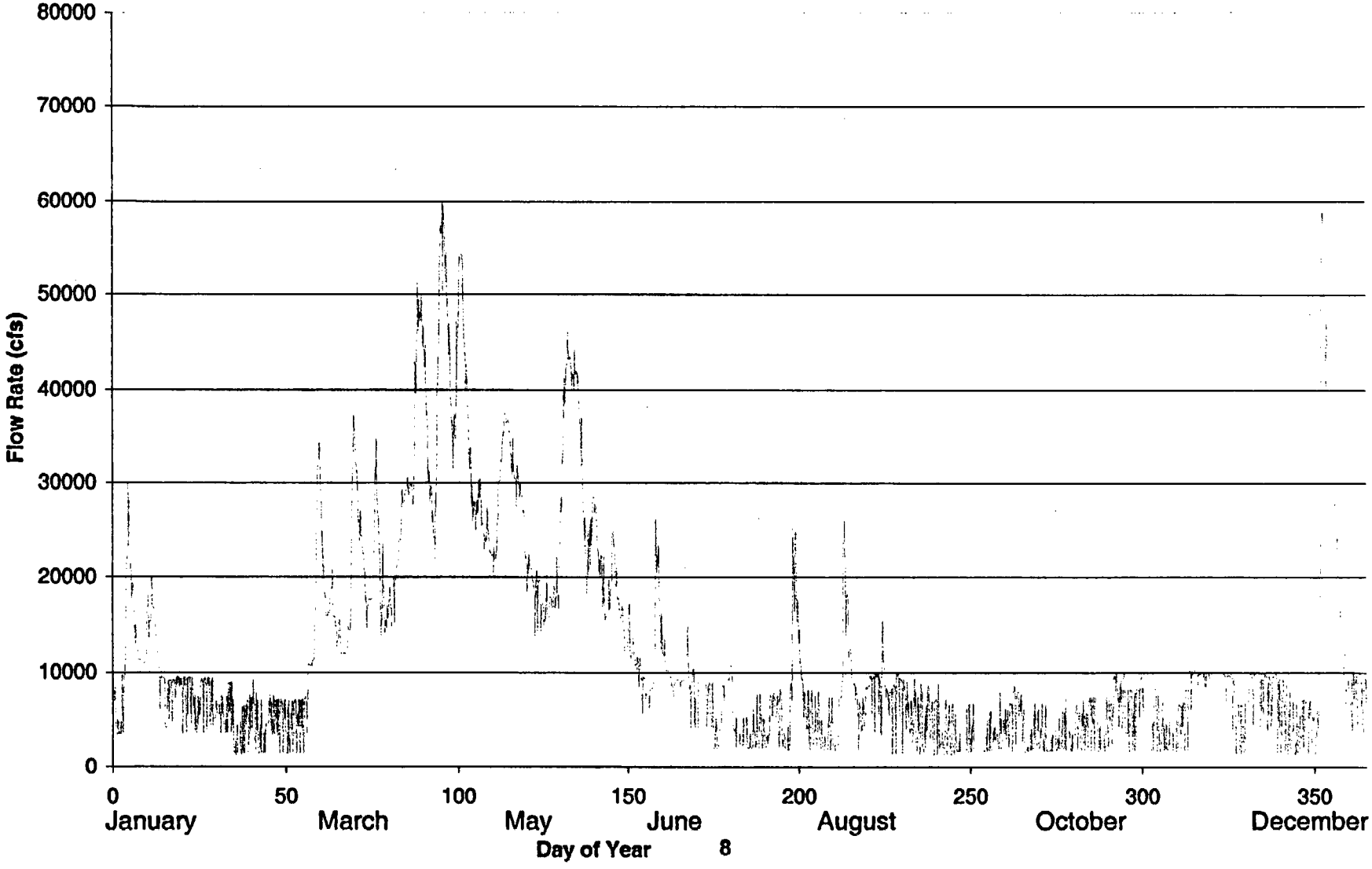


Figure 2-4 Hourly Average Connectcut River Temperature Increase at Monitor 3 for the Year 2000

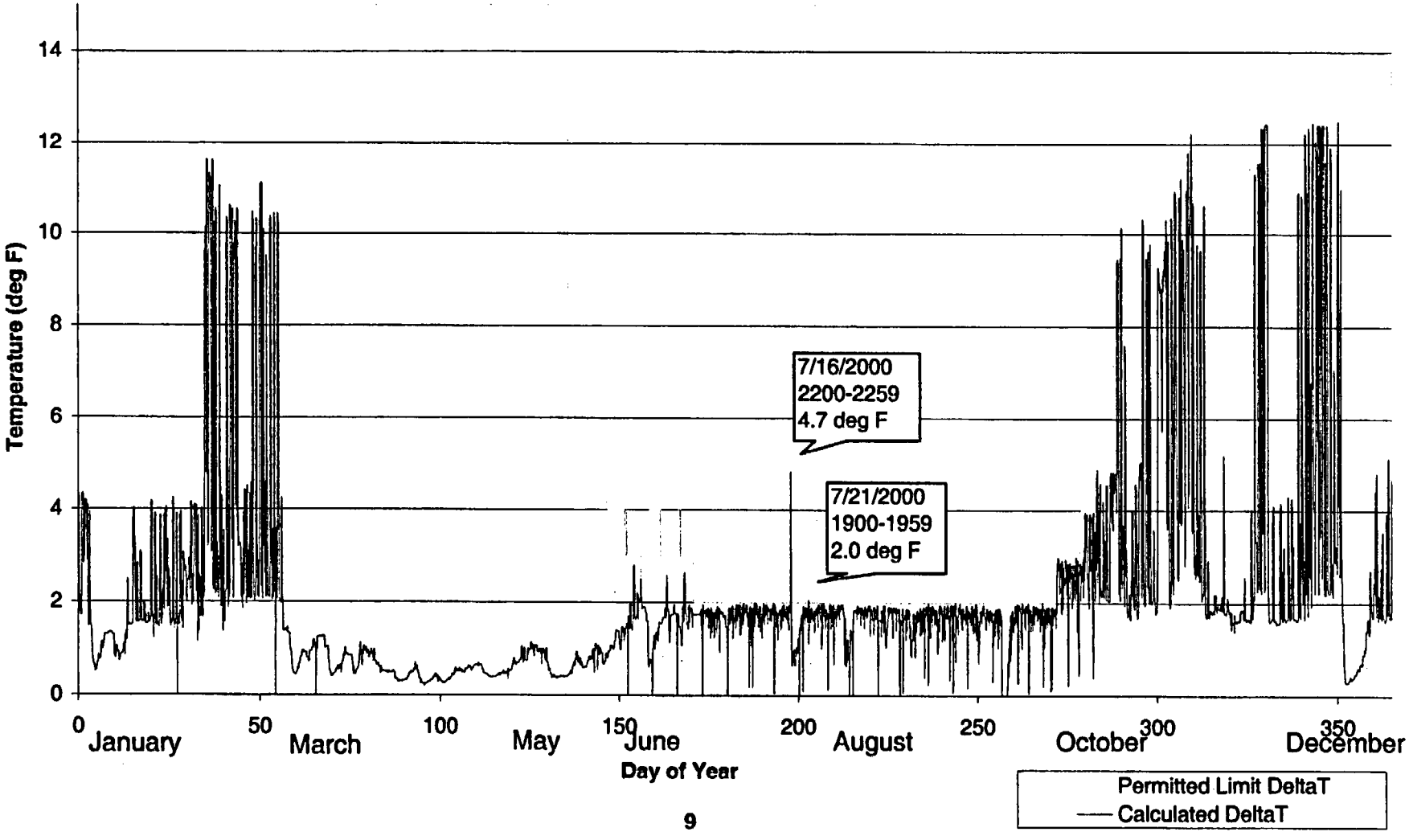


Figure 2-5 Hourly Average Connectcut River Temperature at Monitors 3 &7 for the Year 2000

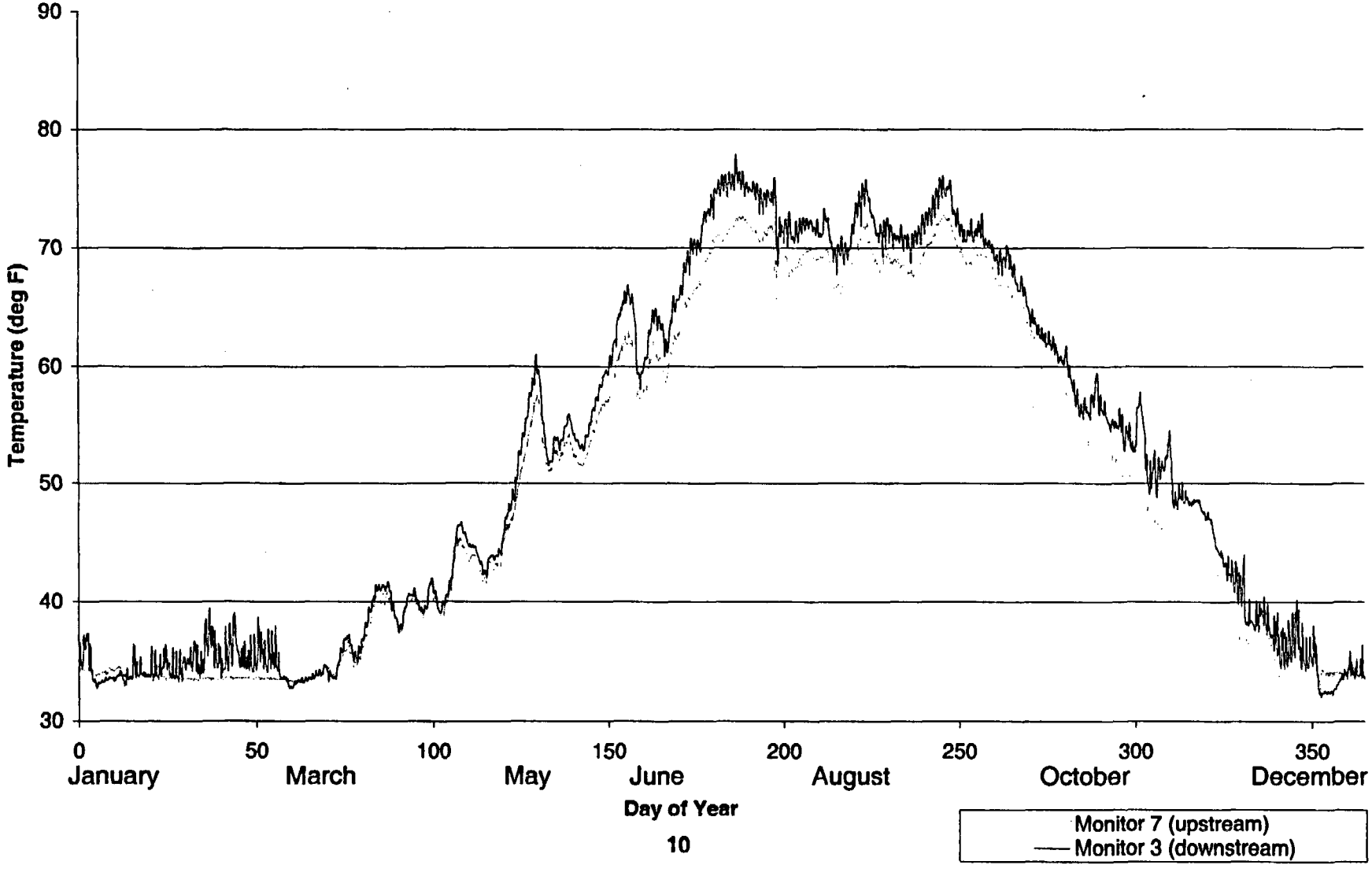


Table 2.1 - Average Connecut River Discharge (cfs) at Vernon Station for the Year 2000

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	6646.17	5378.49	25505.55	31906.96	21250.86	10990.06	2572	20922	3808	1865	3962	8969
2	3984.73	4309.16	17522.57	27749.86	18205.41	9871.95	3117	14617	2694	2489	2997	7992
3	5137.43	6314.67	16631.31	27024.26	18362.55	8429.89	2815	9802	2011	2908	2634	7205
4	9888.03	5508.89	18195.75	46055.21	17663.38	7621.88	2463	8165	1715	3216	2108	9677
5	24771.53	2618.30	14480.80	57942.72	16061.81	7672.20	3359	5652	2338	2331	2074	5729
6	20415.50	2161.59	14097.10	54261.08	16796.92	9218.53	3519	5591	3217	2588	5170	5670
7	14962.50	3204.72	11954.72	44979.13	17135.89	22361.44	4858	7151	3802	4965	4865	4822
8	11585.48	4732.09	12234.06	35361.81	17770.60	16502.21	3575	9047	1600	4482	6277	4098
9	11045.12	5073.63	15110.72	38734.13	18832.48	12293.81	2719	8052	1600	3614	7883	3648
10	11912.75	6231.38	31495.46	51590.92	27179.42	10256.54	6026	9099	1657	3712	9103	2953
11	15953.66	4019.79	31743.66	50699.46	38570.83	9222.08	6629	7745	2526	5343	10146	2324
12	17771.48	3242.44	25537.82	41622.38	43607.13	8570.83	5998	11222	3108	4342	9567	4471
13	14314.70	1993.56	22268.76	33261.42	42544.79	9192.43	6102	8143	2884	5988	10087	5500
14	9697.79	4505.32	17007.04	27568.70	41702.92	9005.68	2892	7379	3226	2581	9351	4795
15	9479.48	5524.63	17588.01	27091.15	40507.88	9727.47	2312	6445	3873	1845	9802	4434
16	5523.26	5340.00	21933.16	29065.98	34419.54	11239.84	6571	7183	3262	4379	10823	3225
17	7804.69	5093.50	29406.67	24842.49	24719.49	7802.42	20035	8674	5061	4880	11268	12982
18	7813.68	5047.28	18644.93	25050.08	21736.22	6878.78	18136	6918	5385	5974	11058	55115
19	9028.06	4664.52	17621.17	22940.88	25459.36	6833.14	11228	6570	6293	9107	9851	45611
20	8840.67	3152.39	15812.55	22092.05	27688.88	9015.48	6833	4673	6151	6903	9391	39166
21	7561.60	3935.71	17178.89	24312.80	22225.48	8321.41	5493	6384	6197	7149	9786	29267
22	7219.06	5344.65	17849.55	31119.94	20154.54	7532.35	4922	3832	3563	4237	7249	23829
23	7976.78	4227.57	21787.01	35099.20	16632.15	5734.02	3944	4979	1778	5602	4531	16182
24	6252.33	4536.25	25786.37	36930.21	17043.75	3120.85	4918	3158	2553	4074	3507	10895
25	5182.17	5350.24	28483.92	35031.25	22510.19	3098.53	3265	6471	3695	6510	3200	8343
26	8146.69	9316.98	29393.14	31648.76	20303.18	6910.47	2233	4839	3570	8232	3440	6434
27	7556.54	10958.99	29238.36	30289.69	16723.69	8648.18	3838	4777	3960	3617	9766	8077
28	7723.87	16859.77	36470.50	29483.27	15719.93	9791.48	3955	4427	3284	1910	8331	7840
29	6683.79	31973.00	47637.50	27133.15	12165.15	7322.35	1826	2503	1851	2689	9874	8531
30	5677.41		47159.13	20527.83	14172.52	3560.68	4521	3930	2170	5604	7723	7516
31	5738.37		42361.00		12330.07		10340	3923		4274		6863
Monthly Avg	9751	6228	23811	34047	23232	8892	5527	7170	3293	4438	7191	12005

3.0 WATER QUALITY

3.1 COPPER, IRON AND ZINC CONCENTRATIONS

Beginning in April 1996, and continuing through 2000, monthly grab samples of Connecticut River water from Stations 3, 7, and the plant discharge (Figure 3-1) were analyzed for total copper, iron, and zinc, as outlined in the NPDES permit #3-1199. Results of the analysis are presented in Table 3-1 and Figures 3-2, 3-3 and 3-4.

Copper concentrations were observed at or below the detection limit of 0.010 mg/l in nearly all months of 2000 at Connecticut River water sampling Station 7 and in the Vermont Yankee discharge (Table 3-1, Figure 3-2). The highest concentration of copper observed at Station 7 was 0.0202 mg/l on 13 December 2000. The highest concentration of copper observed in the Vermont Yankee Station discharge was 0.0134 mg/l on 17 July 2000. Connecticut River water sampling at Station 3, below the Vernon Dam tailrace, had slightly higher copper concentrations during most of the 2000 sampling events, with a maximum copper concentration of 0.0577 mg/l observed on 13 March 2000 (Table 3-1, Figure 3-2).

Station 7 had relatively high iron concentrations during July and December 2000 (Table 3-1, Figure 3-3). Station 3 exhibited relatively high iron concentrations (> 1.000 mg/l) during the March, May, June and July 2000 sampling events, while Iron concentrations were relatively low throughout 2000 in the Vermont Yankee Station discharge. The highest concentrations in Vermont Yankee Discharges occurring in May and July sampling events. The highest iron concentration of 12.20 mg/l was observed at Station 7 on 13 December 2000. The highest iron concentration at Station 3 was 5.799 mg/l observed on 17 July 2000. The highest iron concentration in the Vermont Yankee Station discharge was 4.951 mg/l observed on 17 July 2000.

Zinc concentrations in Connecticut River water samples were generally less than 0.020 mg/l during 2000. (Table 3-1, Figure 3-4). The highest zinc concentration at Station 7 was 0.141 mg/l observed on 16 March 2000.The highest zinc concentration of 0.0537 mg/l was observed at Station 3 on 15 May 2000. The highest zinc concentration in the Vermont Yankee discharge was 2.07 mg/l observed on 16 March 2000, the next highest value occurring on 15 May 2000 equalling 0.0247 mg/l.

A possible explanation for the variability in the results is that turbulence, associated with sampling methodolgy, rain storms and other high flow events, is also a factor which re-suspends sediments and increases the sediment concentration in the samples. Turbulent flow through the Vernon Dam and power station during high flow events may also re-suspend river sediments, contributing to the high metals concentrations generally observed at Station 3 (below the Vernon Dam) compared to Station 7 (upstream) or the Vermont Yankee discharge.

3.2 WATER TEMPERATURE

Water temperature was measured continuously in the Connecticut River at Station 7 and Station 3 during 2000, and at the Vernon Dam fishway during fishway operation. Daily and monthly average temperature data for Station 7 and Station 3 are summarized in Tables 3-2 and 3-3 and were discussed in Section 2.3; the hourly average temperature data for both stations are plotted on Figure 2-5. Hourly and daily average temperature data from the fishway are presented in Table 3-4 and Figure 3-5. The fishway operated daily from 22 May at 0800 DST to 13 July 2000 at 0900 DST. During this 2000 period of fishway operation, the water temperatures increased from an hourly average of 52.7°F at the beginning of operations up to a high of 78.95°F to 04 July 2000 at 1500.

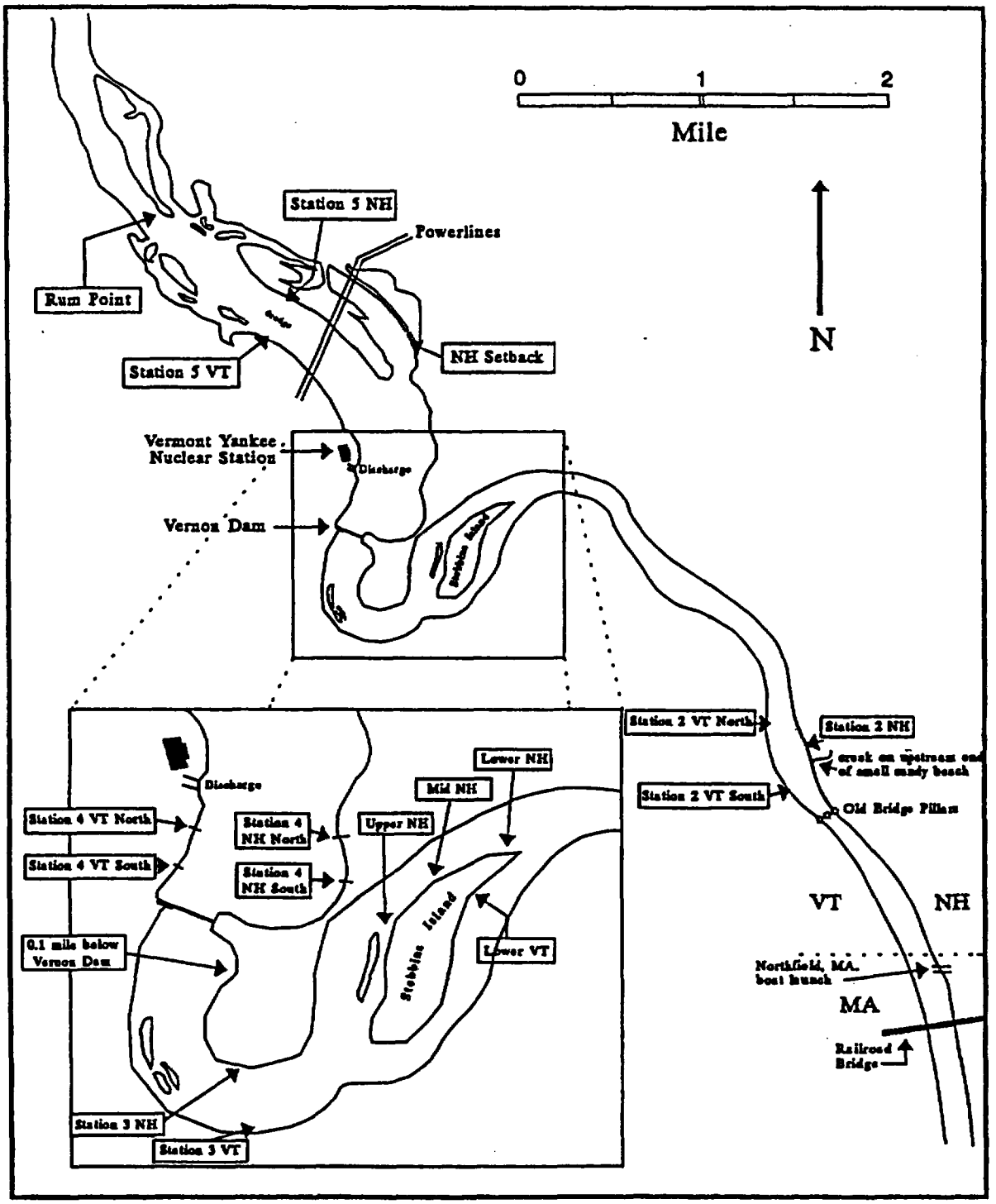


Figure 3-1. Vermont Yankee NPDES Sampling Stations.

Figure 3-2 Conneticticut River Water concentrations of Copper observed in monthly samples in the vicinity of Vermont Yankee, Vernon, Vermont

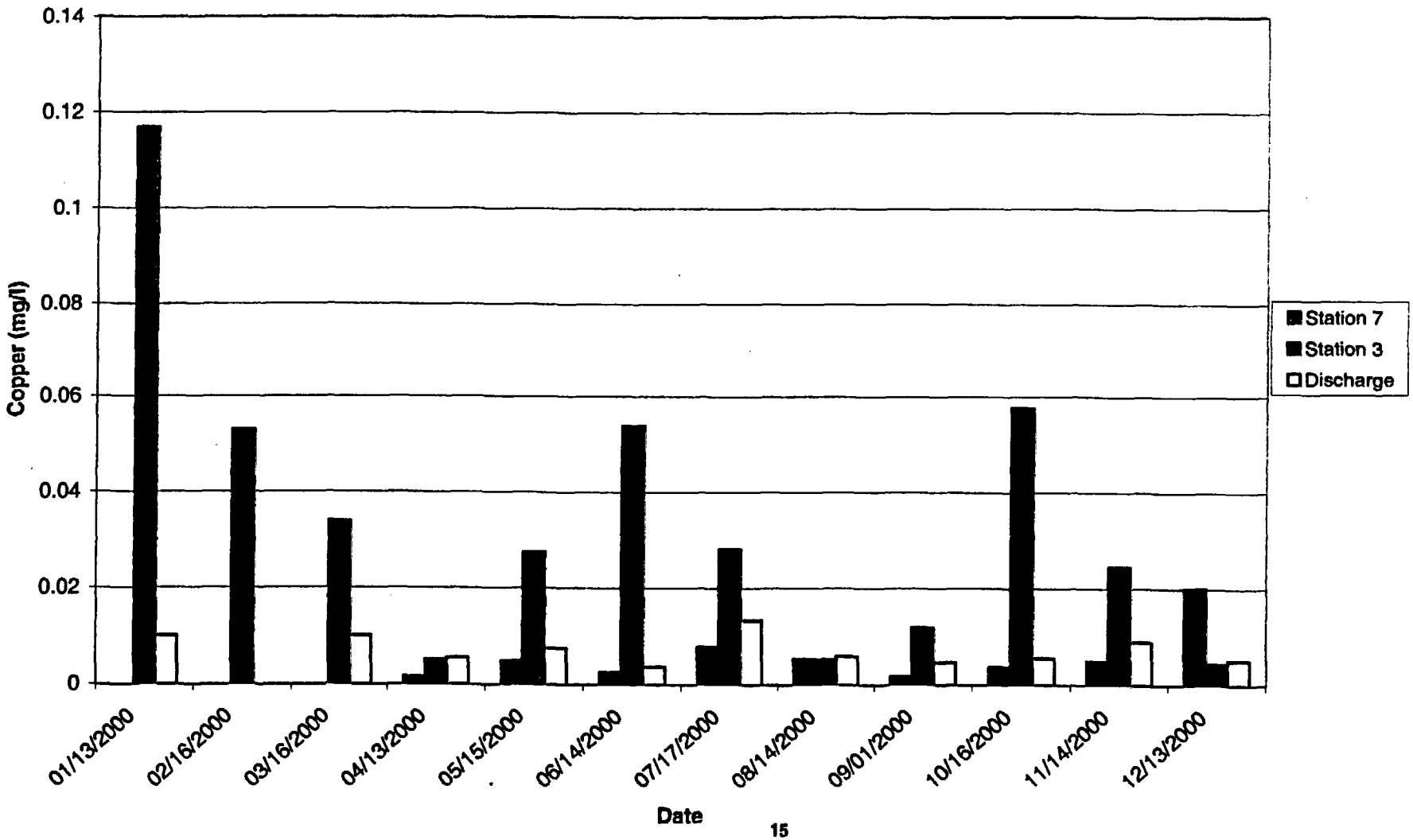


Figure 3-3 Connecticut River Water concentrations of Iron observed in monthly samples from the vicinity of Vermont Yankee, Vernon, Vermont

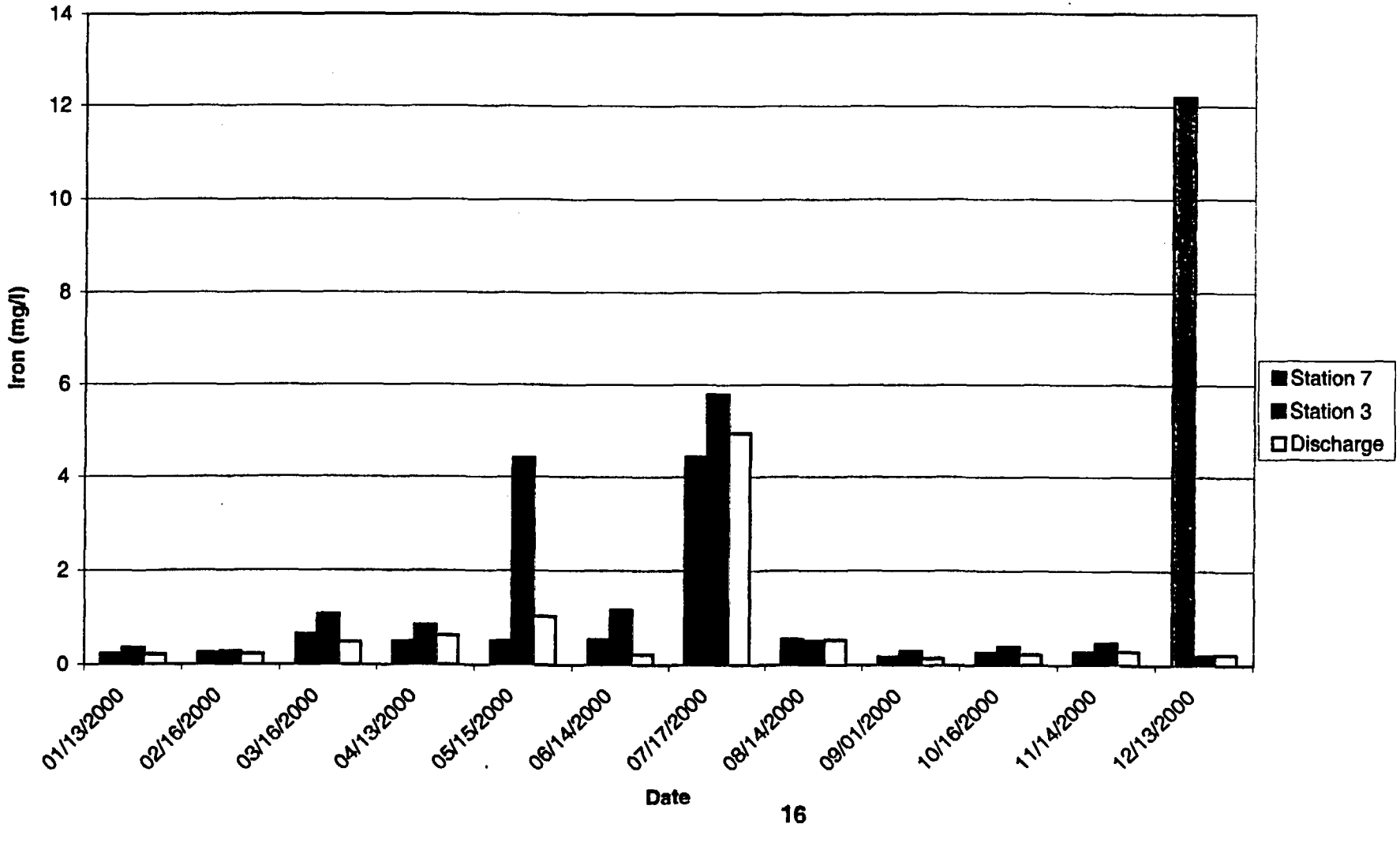
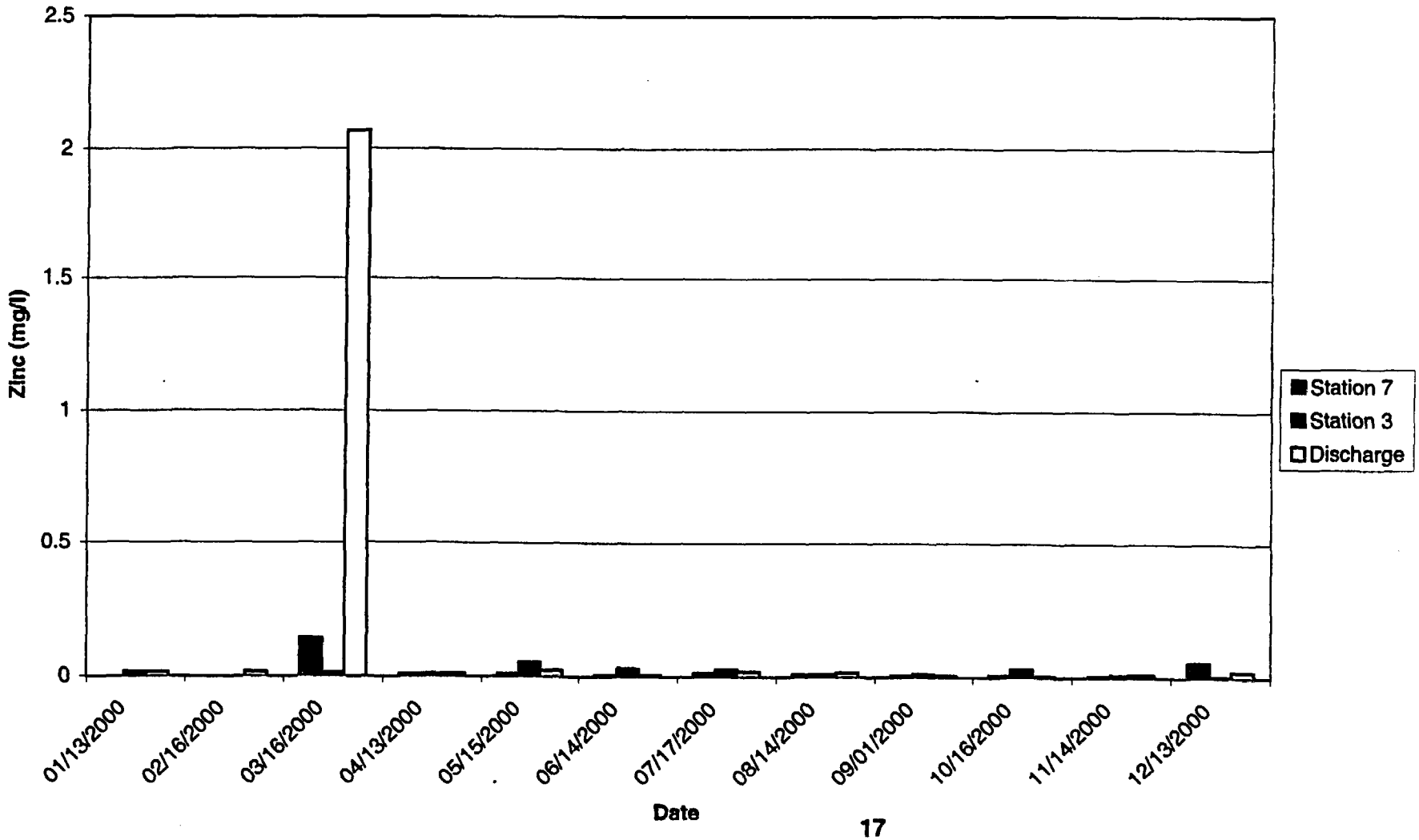


Figure 3-4 Connecticut River Water concentrations of Zinc observed in monthly samples from the vicinity of Vermont Yankee



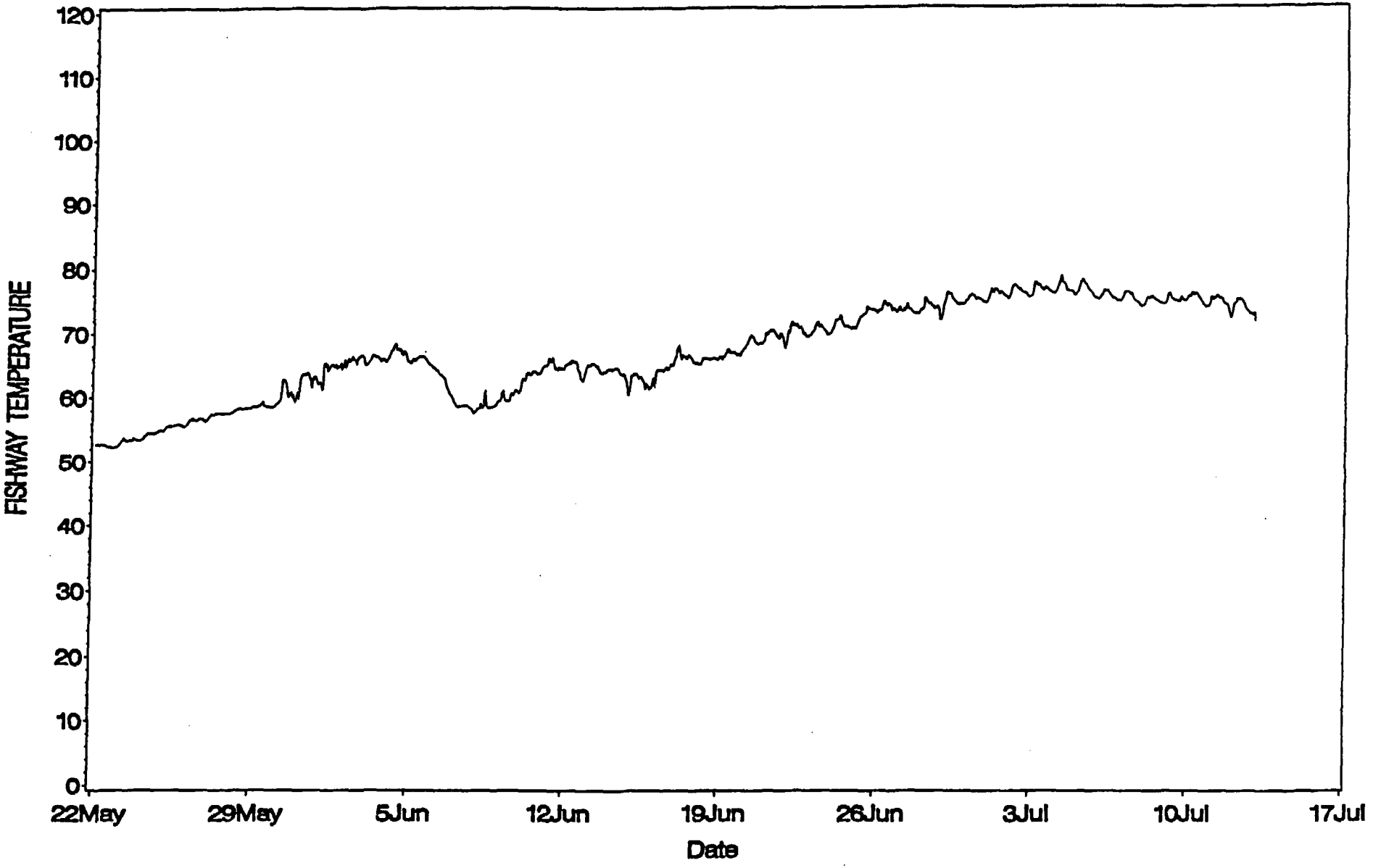


FIGURE 3–5. VERNON DAM FISHWAY TEMPERATURES, 2000.

Table 3-1. Summary of the 2000 Monthly Connecticut River Water Concentrations of Copper (Cu), Iron (Fe) and Zinc (Zn) observed at Vermont Yankee Monitoring Stations 3,7 and Plant Discharge.

NPDES River Water Metals (mg/L)

	Station 7			Station 3			Discharge		
Date	Copper	Iron	Zinc	Copper	Iron	Zinc	Copper	Iron	Zinc
01/13/2000	<0.01	0.231	<0.01	0.117	0.35	0.017	0.01	0.212	0.017
02/16/2000	<0.01	0.248	<0.01	0.053	0.267	<0.01	<0.01	0.227	0.018
03/16/2000	<0.01	0.654	0.141	0.034	1.08	0.015	0.01	0.476	2.07
04/13/2000	0.0016	0.501	0.0099	0.0051	0.852	0.0103	0.0055	0.632	0.0114
05/15/2000	0.0047	0.512	0.011	0.0276	4.42	0.0537	0.0075	1.04	0.0247
06/14/2000	0.0025	0.537	0.0057	0.0539	1.18	0.031	0.0037	0.225	0.0079
07/17/2000	0.0079	4.44	0.0157	0.0283	5.799	0.0298	0.0134	4.95	0.0211
08/14/2000	0.0053	0.556	0.0104	0.0052	0.507	0.0117	0.0059	0.532	0.0189
09/01/2000	0.0017	0.178	0.0068	0.0119	0.299	0.0141	0.0046	0.147	0.006
10/16/2000	0.0037	0.265	0.0075	0.0577	0.388	0.0319	0.0056	0.219	0.0055
11/14/2000	0.0049	0.281	0.004	0.0247	0.473	0.0108	0.009	0.288	0.0118
12/13/2000	0.0202	12.200	0.0568	0.0044	0.205	0.0048	0.0051	0.220	0.0239

January to March river water samples were analyzed by Endyne Inc. of Williston, VT. Laboratory Detection Limits for Total Cu, Fe and Zn are 10 ppb.
April to December river water samples were analyzed by RECRA of Lionville, PA. Laboratory Detection Limits for Total Cu=0.9 ppb, Fe=21.8 ppb and Zn=0.4 ppb.

Table 3.2 - Average Connecut River Temperature (deg F) at Station 7 for the Year 2000

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	34.24	33.58	33.37	38.35	46.32	59.63	70.80	68.67	72.06	59.39	46.62	37.82
2	34.32	33.57	33.43	39.56	46.83	60.89	70.74	67.04	72.49	59.12	46.50	37.33
3	34.23	33.52	33.43	39.95	47.69	61.66	71.33	66.78	72.50	59.24	46.18	36.94
4	34.16	33.58	33.46	40.47	49.38	62.09	71.71	66.49	72.36	59.40	46.19	36.33
5	34.14	33.60	33.44	39.86	50.84	62.31	72.04	66.71	71.47	59.06	46.13	35.16
6	33.91	33.65	33.57	39.15	52.25	61.25	72.48	67.70	70.45	58.55	45.33	34.61
7	34.01	33.59	33.60	39.01	53.74	58.08	72.56	68.38	69.80	57.73	45.85	35.02
8	34.09	33.57	33.83	39.85	55.20	57.41	72.39	69.63	69.09	56.74	46.52	35.37
9	34.23	33.52	34.15	41.50	56.69	57.90	71.80	70.29	68.65	55.49	46.58	35.55
10	34.27	33.48	34.68	40.33	57.09	58.76	71.60	70.88	68.71	54.45	46.93	35.74
11	34.30	33.64	34.41	39.16	54.29	60.56	71.34	71.77	68.81	53.93	46.73	35.61
12	34.51	33.72	33.87	39.21	52.06	61.33	70.76	71.10	69.31	53.66	46.99	35.45
13	34.05	33.58	34.04	39.57	51.06	60.73	70.94	69.64	69.52	53.19	46.90	35.30
14	33.82	33.63	34.79	40.45	51.88	60.25	71.22	68.86	69.34	52.96	46.24	35.00
15	33.74	33.65	35.56	41.83	52.67	59.05	71.78	68.37	68.91	53.74	45.88	35.14
16	33.73	33.63	36.13	44.20	52.23	59.48	70.14	69.15	68.27	53.89	45.87	34.84
17	33.82	33.64	35.99	45.12	52.81	61.13	69.00	69.38	67.55	53.76	45.22	34.67
18	33.89	33.54	34.94	44.85	53.63	62.34	69.48	69.05	66.99	53.89	43.54	33.86
19	33.77	33.55	34.99	44.19	53.64	62.74	69.37	68.81	66.87	52.95	42.54	34.28
20	33.78	33.68	35.53	43.53	52.54	63.96	68.34	68.94	66.99	52.49	41.86	34.11
21	33.74	33.61	36.51	43.88	51.99	65.22	68.09	68.45	66.64	52.29	41.14	34.07
22	33.73	33.61	37.77	43.34	51.60	65.74	68.21	68.48	66.05	51.59	40.40	34.04
23	33.65	33.60	38.83	42.57	51.84	66.20	68.71	67.86	66.15	50.62	38.99	34.10
24	33.68	33.59	39.94	41.93	52.76	66.61	68.95	67.92	65.60	50.55	37.97	34.02
25	33.65	33.53	40.12	42.30	54.04	66.98	69.62	67.88	64.93	50.54	37.22	34.01
26	33.64	33.50	40.26	43.28	54.77	68.12	69.81	68.57	63.80	51.02	36.83	34.07
27	33.62	33.52	40.27	42.90	55.59	69.08	69.49	68.95	62.93	51.51	36.72	34.01
28	33.62	33.48	40.41	43.30	56.57	69.78	68.95	69.76	62.43	51.27	36.77	33.90
29	33.60	33.42	39.26	43.57	56.92	70.70	69.15	70.24	61.01	49.61	36.44	34.05
30	33.55		38.56	45.28	57.28	71.05	69.38	70.55	60.18	47.90	36.99	34.04
31	33.60		40.05		58.31		69.82	71.27		47.57		33.86
Monthly Avg	33.91	33.58	36.10	41.75	53.05	63.03	70.32	68.95	67.66	53.81	43.13	34.91

Table 3.3 - Average Connecut River Temperature (deg F) at Station 3 for the Year 2000

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	34.86	35.01	33.04	38.58	47.72	62.87	75.25	70.78	74.57	62.26	51.28	39.12
2	36.15	35.73	33.35	40.01	48.58	64.47	75.50	69.58	75.17	62.19	50.58	38.72
3	36.43	34.68	33.4	40.59	49.66	65.59	75.34	69.42	74.74	61.86	51.11	38.29
4	34.56	34.53	33.42	40.75	51.49	66.12	75.54	69.94	75.26	61.51	51.68	37.24
5	33.29	36.74	33.54	40.15	53.27	65.73	76.24	69.49	73.30	60.71	53.37	36.94
6	33.04	37.18	33.68	39.42	54.77	64.59	76.02	69.59	72.53	60.52	50.09	36.20
7	33.25	36.65	33.84	39.35	56.59	60.25	75.72	70.99	71.67	60.98	48.39	35.76
8	33.42	35.41	34.02	40.25	58.19	59.14	75.05	72.72	71.02	59.58	48.86	35.65
9	33.54	35.15	34.06	41.74	59.68	60.25	74.94	73.60	71.02	58.28	48.79	36.34
10	33.56	34.31	34.48	40.84	59.32	61.78	75.13	73.98	71.46	57.22	48.78	37.01
11	33.6	35.32	33.86	39.53	55.88	63.79	74.80	74.73	70.96	56.25	48.27	37.84
12	33.93	36.28	33.69	39.53	52.96	64.3	74.27	74.05	71.52	56.41	48.44	36.40
13	33.51	37.26	34.08	40.17	51.77	63.75	74.03	72.75	71.79	56.15	48.51	35.46
14	33.56	36.52	35.57	41.14	52.89	63.32	74.29	71.46	70.55	56.56	48.09	35.02
15	33.58	35.07	36.35	42.57	53.77	61.99	74.24	71.32	70.38	57.54	47.44	35.49
16	35.08	35.24	37.02	45.02	53.37	62.2	74.86	71.15	69.98	57.99	47.14	35.94
17	33.95	34.9	36.47	46.39	54.32	64.83	70.68	71.64	69.16	56.49	46.75	34.27
18	34.25	34.85	35.47	46.13	55.37	65.14	71.67	71.47	68.91	56.18	45.34	32.34
19	33.9	35.01	35.59	45.41	55.2	66.09	71.82	70.83	68.72	55.08	44.25	32.48
20	33.81	36.39	36.37	44.7	54.01	67.33	71.83	70.81	69.42	55.06	43.83	32.47
21	34.23	35.72	37.55	44.61	53.52	68.73	71.03	71.02	69.10	55.00	42.99	32.48
22	34.32	35.08	38.78	44.16	53.11	69.4	71.27	70.52	68.16	55.31	42.46	32.68
23	34.07	35.38	39.75	43.27	53.5	70.14	71.48	70.62	66.90	54.22	42.17	33.23
24	34.53	35.22	40.86	42.53	54.52	70.15	71.93	69.91	66.82	54.05	41.79	33.65
25	35.26	35.03	41.12	42.83	55.82	70.37	72.02	70.76	66.48	53.82	41.09	33.97
26	34.18	34.15	41.27	43.81	56.85	72.54	72.04	71.02	65.22	52.99	41.45	34.43
27	34.04	33.65	41.23	43.72	57.87	72.96	71.84	71.54	64.15	55.07	38.32	34.26
28	33.97	33.42	41.2	44.09	58.66	73.52	71.75	72.23	63.91	56.90	38.55	34.16
29	34.35	32.87	39.64	44.53	59.5	73.9	71.09	72.60	63.15	54.63	38.03	34.08
30	34.91		38.64	46.48	60.05	75.05	72.06	73.09	62.60	50.66	38.44	34.32
31	34.85		37.84		61.12		72.37	73.91		50.19		34.58
Monthly Avg	34.19	35.27	36.43	42.41	54.95	66.35	73.42	71.53	69.62	56.83	45.87	35.19

Table 3-4. Hourly Average Temperature of the Vernon Station Fishway during 2000.

Day	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May
Hour										
0		52.27	53.85	54.54	55.92	56.81	57.52	58.29	58.6	60.73
1		52.36	53.64	54.63	55.92	56.8	57.55	58.33	58.61	60.85
2		52.26	53.62	54.69	55.9	56.74	57.63	58.36	58.61	59.98
3		52.29	53.58	54.77	55.82	56.6	57.6	58.38	58.58	60.39
4		52.31	53.53	54.91	55.67	56.46	57.57	58.38	58.51	59.64
5		52.34	53.39	54.9	55.55	56.38	57.56	58.4	58.53	59.31
6		52.36	53.42	54.96	55.57	56.45	57.6	58.47	58.6	59.41
7		52.43	53.39	54.95	55.56	56.58	57.62	58.55	58.72	60.22
8	52.7	52.53	53.47	54.83	55.69	56.74	57.64	58.62	58.93	60.83
9	52.71	52.71	53.55	54.9	55.87	56.97	57.71	58.62	59.07	59.81
10	52.73	52.92	53.63	55.14	56.1	57.13	57.76	58.66	59.16	61.4
11	52.72	53.07	53.78	55.26	56.34	57.36	57.92	58.57	59.33	62.84
12	52.68	53.28	54.07	55.42	56.42	57.41	58.03	58.67	59.44	63.23
13	52.83	53.45	54.09	55.61	56.56	57.36	58.12	58.63	59.59	63.53
14	52.84	53.7	54.18	55.72	56.65	57.42	58.14	58.68	60.17	63.66
15	52.79	53.5	54.42	55.65	56.73	57.49	58.28	58.81	62.36	63.61
16	52.78	53.35	54.53	55.67	56.76	57.54	58.29	58.94	62.82	63.71
17	52.68	53.27	54.47	55.65	56.66	57.57	58.32	59.06	62.82	63.54
18	52.61	53.32	54.48	55.63	56.56	57.59	58.31	59.39	62.69	63.81
19	52.57	53.38	54.45	55.69	56.51	57.63	58.29	58.83	62.49	63.88
20	52.48	53.43	54.46	55.73	56.51	57.63	58.26	58.76	61.69	63.78
21	52.38	53.48	54.44	55.74	56.6	57.63	58.27	58.67	60.65	63.13
22	52.42	53.45	54.35	55.82	56.71	57.55	58.26	58.61	60.06	62.88
23	52.41	53.4	54.39	55.88	56.8	57.51	58.32	58.63	60.47	61.64
Daily Avg	52.64563	52.9525	53.96583	55.27875	56.22417	57.13958	57.94042	58.63792	60.02083	61.90875

Table 3-4. Hourly Average Temperature of the Vernon Station Fishway during 2000.

Day	01-Jun	02-Jun	03-Jun	04-Jun	05-Jun	06-Jun	07-Jun	08-Jun	09-Jun	10-Jun
Hour										
0	62.37	65.05	66.16	65.71	66.72	66.13	61.57	58.58	58.49	60.44
1	63.09	65.16	66.42	65.79	67.31	66.04	61.24	58.44	58.59	60.88
2	63.32	64.59	66.46	66.08	67.04	65.69	60.98	58.29	58.62	61.26
3	63.34	64.82	66.63	66.11	66.9	65.52	60.67	58.21	58.68	61.19
4	62.96	64.89	66.62	66.08	66.06	65.33	60.47	57.9	58.77	61.06
5	62.41	64.99	66.61	65.77	65.67	65.17	60.2	57.7	58.87	60.94
6	62.16	65.37	66.41	65.63	65.65	65.11	59.88	57.71	59.05	60.69
7	62.37	64.36	65.48	65.93	65.45	64.95	59.52	57.91	59.47	60.98
8	62.42	64.69	65.17	66.2	65.44	64.81	59.22	58.04	59.49	61.7
9	61.96	65.19	65.25	66.55	65.61	64.7	59.03	58.3	59.61	62.62
10	61.19	65.87	65.4	66.84	65.91	64.59	58.77	58.35	59.7	62.97
11	61.34	64.67	65.58	67.28	66.08	64.54	58.61	58.42	60	62.86
12	65.17	65.01	65.86	67.41	65.98	64.28	58.69	58.48	60.98	62.75
13	65.32	65.72	65.96	67.63	65.83	64.29	58.68	59.12	61.14	62.99
14	65.29	66.13	66.32	68.09	66.06	64.15	58.69	58.55	60.3	63.69
15	65.1	65.62	66.68	68.43	66.23	63.87	58.67	58.43	59.66	63.9
16	64.2	65.72	66.7	68.32	66.27	63.69	58.74	58.69	59.54	64
17	64.29	66.06	66.71	67.49	66.47	63.59	58.72	60.02	59.6	63.71
18	64.57	66.45	66.48	67.59	66.51	63.54	58.69	61.15	59.56	63.63
19	65.04	66.06	66.52	67.75	66.48	63.46	58.81	59.16	59.59	63.69
20	65.22	65.86	66.48	67.41	66.44	63.24	58.85	58.49	59.55	64.04
21	65.15	65.93	66.38	67.67	66.5	63.1	58.79	58.53	60.3	64.15
22	65.07	65.28	66.12	67.03	66.47	62.89	58.75	58.47	60.67	64.07
23	64.83	66.03	66.12	66.66	66.39	62.19	58.73	58.44	60.51	64.15
Daily Avg	63.67417	65.39667	66.18833	66.89375	66.22792	64.36958	59.37375	58.5575	59.61417	62.59833

Table 3-4. Hourly Average Temperature of the Vernon Station Fishway during 2000.

Day	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun
Hour										
0	64.1	64.37	64.08	63.89	63.74	62.24	64.47	66.36	66.3	67.12
1	63.84	64.82	63.07	63.84	63.66	62.09	64.77	66.1	66.36	66.96
2	63.76	64.68	62.98	63.98	63.02	61.93	65.32	65.92	66.32	66.75
3	63.82	64.71	62.72	64.02	62.78	61.32	65.34	65.5	66.19	66.91
4	63.78	64.79	62.7	64	61.75	61.73	65.08	65.44	66.06	66.92
5	63.92	64.43	63.22	64.01	60.6	61.55	65.21	65.47	66.01	66.72
6	64.29	64.65	63.9	64.39	60.48	62.01	65.94	65.61	66.2	66.73
7	64.45	64.51	64.35	64.35	61.77	62.65	66.24	65.55	66.44	67.28
8	64.93	65.13	64.92	64.48	63.53	63.12	66.65	65.35	66.41	67.39
9	65.01	65.24	65.24	64.61	63.59	61.73	67.56	65.37	66.44	67.59
10	65	65.28	65.13	64.63	63.63	63.08	67.84	65.51	66.06	67.76
11	65.1	65.4	65.07	64.28	63.86	64.11	68.21	65.34	66.56	67.89
12	65.07	65.4	65.34	64.47	63.71	64.28	67.82	65.76	66.5	68.29
13	65.33	65.67	65.44	64.59	63.84	64.43	66.16	66.26	66.68	68.51
14	66.22	65.48	65.45	64.58	63.7	64.33	66.09	66.2	67.14	68.86
15	65.83	65.97	65.37	64.63	63.43	64.25	66.86	66.33	67.18	69.22
16	65.69	65.92	65.3	64.77	63.1	64.31	66.7	66.28	67.61	69.56
17	65.58	65.75	65.09	64.63	63.36	64.38	66.42	66.3	67.63	69.89
18	66.33	65.59	65.06	64.57	63.36	64.12	66.54	66.32	67.53	69.64
19	65.46	65.78	65.04	64.18	63.17	64.15	66.2	66.15	67.1	69.74
20	65.06	65.63	64.62	63.94	62.96	64.36	66.22	66.08	67.25	69.26
21	64.63	65.33	64.52	63.77	62.66	64.74	66.56	66.06	67.23	68.91
22	64.66	64.7	64.09	63.7	62.5	64.88	66.77	66.15	67.21	68.81
23	64.71	64.19	63.89	63.63	61.41	64.55	66.52	66.27	67.28	68.55
Daily Avg	64.85708	65.1425	64.44125	64.2475	62.90042	63.3475	66.31208	65.90333	66.73708	68.13583

Table 3-4. Hourly Average Temperature of the Vernon Station Fishway during 2000.

Day	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun
Hour										
0	68.52	69.99	70.49	70.63	71.4	74.11	73.76	73.39	74.26	74.71
1	68.47	70.17	70.1	70.45	71.19	74.04	74.05	73.35	74.39	74.77
2	68.61	69.74	70.25	70.01	71.19	74	74.12	73.33	74.37	74.7
3	68.67	69.64	69.87	69.97	71.01	74.02	74.11	73.43	73.93	74.73
4	68.55	68.65	69.7	70.07	70.89	74.01	73.85	73.41	72.39	74.78
5	68.57	68.16	69.55	70.13	70.98	73.8	73.59	73.24	72.3	74.8
6	68.81	67.78	69.6	70.2	71.12	73.82	73.65	73.54	72.38	74.76
7	68.98	68.63	69.82	70.53	71.01	73.68	74.02	73.89	73.33	74.85
8	69.52	69.78	69.97	70.73	70.89	73.46	74.32	73.79	74.43	75.21
9	70.19	70.57	70	70.97	71.01	73.82	74.39	74.1	74.8	75.3
10	70.22	70.27	70.39	71.19	71.29	73.75	73.81	74.05	75.25	75.4
11	70.07	70.87	70.46	71.91	71.63	73.97	73.67	74.65	75.92	75.73
12	70.49	71.46	70.7	72.22	71.99	73.8	73.63	75.71	76.44	75.9
13	70.42	71.84	70.91	72.26	72.31	74.03	74.08	75.63	76.4	76.01
14	70.58	71.89	71.32	72.32	72.78	74.55	73.81	75.46	76.28	76.15
15	70.57	71.31	71.66	72.46	72.81	75.06	74.01	74.93	76.26	76.13
16	70.69	71.61	71.86	73.05	72.93	75.18	74.47	74.83	76.35	76.06
17	70.63	71.42	71.94	72.89	73.17	74.96	74.79	74.93	75.79	75.89
18	70.4	71.52	71.14	72.38	73.17	74.62	74.28	74.92	75.48	75.62
19	70.1	71.62	71.36	71.78	73.23	74.46	74.03	74.62	75.4	75.34
20	69.81	71.04	71.53	71.53	73.49	74.82	74.04	74.5	75.16	75.59
21	69.58	71.06	71.32	71.3	74.38	74.77	73.93	74.4	75.06	75.7
22	69.34	71.11	71.01	71.29	74.31	74.56	73.7	74.1	74.92	75.61
23	69.19	71.21	70.74	71.26	74.1	74.53	73.58	74.25	74.79	75.5
Daily Avg	69.62417	70.4725	70.65375	71.31375	72.17833	74.2425	73.98708	74.26875	74.83667	75.385

Table 3-4. Hourly Average Temperature of the Vernon Station Fishway during 2000.

Day	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul	06-Jul	07-Jul	08-Jul	09-Jul	10-Jul
Hour										
0	75.46	76.38	76.45	77.14	76.74	76.46	75.63	75.12	75.2	75.56
1	75.36	76.15	76.44	76.96	76.72	76.16	75.62	74.95	75.03	75.78
2	75.2	76.06	76.29	76.8	76.73	75.95	75.36	74.98	75	75.51
3	75.09	75.97	76.08	76.68	76.6	75.81	75.25	74.79	74.93	75.31
4	75.02	75.85	75.88	76.59	76.41	75.72	75.23	74.5	74.87	75.21
5	74.96	75.8	75.83	76.48	76.15	75.63	75.21	74.45	74.8	75.15
6	74.93	75.59	75.93	76.43	76.09	75.57	75.25	74.35	74.79	75.27
7	75.09	75.71	75.92	76.34	76.23	75.5	75.24	74.36	74.82	75.47
8	75.39	76.05	76.1	76.4	76.47	75.65	75.42	74.48	74.9	75.76
9	75.8	76.39	76.49	76.57	76.66	75.77	75.67	74.64	75.14	75.96
10	76.24	77.08	77.59	76.75	77.23	76.08	75.87	74.93	75.57	75.81
11	76.56	77.45	78.13	77.21	77.51	76.02	76.33	75.32	76.26	75.84
12	76.99	77.57	78.09	77.53	78.03	76.46	76.56	75.59	76.34	76.25
13	76.61	77.74	77.85	77.98	78.46	76.85	76.63	75.7	76.28	76.4
14	76.44	77.58	77.54	78.77	78.48	76.8	76.66	75.71	75.8	76.18
15	76.93	77.47	77.73	78.95	78.21	76.74	76.6	75.67	75.53	76.17
16	77.02	77.25	77.62	78.2	78.02	76.78	76.53	75.67	75.43	76.29
17	77	77.19	77.33	77.95	77.77	76.79	76.39	75.93	75.28	76.33
18	76.78	76.99	77.12	78.04	77.58	76.47	76.19	75.86	75.25	76.14
19	76.53	77.08	76.98	77.82	77.3	76.35	76.36	75.7	75.24	75.86
20	76.28	76.83	76.8	77.41	77.05	76.1	75.92	75.57	75.21	75.65
21	76.4	76.64	77	76.84	76.85	75.93	75.52	75.44	75.2	75.45
22	76.64	76.59	77.26	76.89	76.7	75.76	75.36	75.32	75.04	75.14
23	76.47	76.57	77.25	76.75	76.56	75.59	75.26	75.29	75.09	74.99
Daily Avg	76.04958	76.66583	76.90417	77.22833	77.10625	76.1225	75.83583	75.18	75.29167	75.72833

Table 3-4. Hourly Average Temperature of the Vernon Station Fishway during 2000.

Day	11-Jul	12-Jul	13-Jul
Hour			
0	74.62	74.76	73.84
1	74.55	74.71	73.69
2	74.42	74.62	73.49
3	74.29	74.36	73.38
4	74.34	73.69	73.38
5	74.35	73.12	73.28
6	74.33	72.66	73.17
7	74.7	72.96	73.09
8	75.05	73.65	73.44
9	75.81	74.55	72.2
10	75.81	74.77	
11	75.49	74.99	
12	75.5	75.06	
13	75.72	75.54	
14	75.81	75.43	
15	76.02	75.47	
16	76.03	75.6	
17	75.84	75.43	
18	75.6	75.42	
19	75.65	75.22	
20	75.65	74.89	
21	75.52	74.61	
22	75.02	74.21	
23	74.85	73.98	
Daily Avg	75.20708	74.57083	73.296

4.0 MACROINVERTEBRATE COLLECTIONS

4.1 METHODS OF COLLECTION AND PROCESSING

4.1.1 Dredge Collections

Benthic macroinvertebrates were collected with a 9-inch ponar dredge in June, August, and October 2000 at Stations 2, 3, 4, and 5 (Figure 4-1). Dredge samples were collected at three locations per Station (near the New Hampshire shore, mid-stream, and near the Vermont shore) and three replicates were collected at each location (for a total of 108 dredges). All dredge samples were sieved through a standard USGS number 30 sieve in the field, prior to being preserved in 70% ethanol for later identification in the lab.

In the laboratory, the three preserved replicate macroinvertebrate ponar dredge samples for each quarter point per location (NH, mid-stream, and VT), per station (2, 3, 4, and 5) were combined and the contents mixed (for a total of 36 dredge samples). All samples were sorted in entirety under low magnification (2x), and specimens were removed from the combined sample residue. Permit conditions were met with respect to macroinvertebrate dredge sampling.

4.1.2 Macroinvertebrate Rock Basket Collections

Rock baskets used in 2000 were made of one-inch square, 14 gauge galvanized wire with PVC coating. The cylindrical basket measured 6.5 inches in diameter and 11 inches in length. Each rock basket was filled with clean rocks from the Connecticut River. Two rock baskets were deployed at Stations 2 Vermont south and 3 Vermont in June and August (Figure 4-1). The Station 2 rock baskets deployed in June were retrieved in July after 50 days of sampling. The rock baskets deployed in June at Station 3 Vermont could not be located upon attempting retrieval in July and were considered lost. Therefore, there is no rock basket data for June at Station 3-Vermont. The Station 2 and 3 rock baskets deployed in August sampled for 42 days prior to retrieval in September.

Although the NPDES Permit states that macroinvertebrate rock basket sampling shall consist of two samples between June and October, this was not strictly followed at the upstream sampling Stations (4 and 5) during 2000. Two rock baskets were deployed at Stations 4 Vermont north and 5 Vermont in May, July, and August (Figure 4-1). Rock baskets prematurely deployed in May (5/9/00) at the upstream Stations were retrieved in June (6/28/00) after sampling for 51 days. Due to the premature deployment of the upstream rock baskets, the baskets were re-deployed in early July (7/6/00). This redeployment was done to accomplish sampling during the period that would otherwise have been missed due to the early May deployment coupled with the NPDES permit specified sampling duration of 30-60 days. The July deployed rock baskets were retrieved in August (8/11/00) after 37 days of sampling. The Station 4 and 5 rock baskets were immediately re-deployed in August (8/11/00) and sampled for 42 days prior to retrieval in September (9/21/00).

Upon retrieval, the rock baskets were placed into individual coolers and returned to the lab. The rocks were washed into a number 30 sieve and examined for attached organisms. Rock basket samples were preserved in 70% ethanol for later identification in the lab.

In each case, one of the two preserved replicate macroinvertebrate rockbasket samples collected at Stations 2, 3, 4, and 5 was randomly selected and examined in entirety under low magnification (2x) (for a total of nine rock basket samples examined).

Identification of organisms to the lowest possible taxonomic level, given their life stage and condition, was accomplished using dissecting (45x) and compound (1,000x) microscopes. Chironomids and oligochaetes were separated by subfamily, tribe, or recognizable type prior to identification to the genus/species level. All or representative subsamples from each grouping were prepared, by clearing and mounting, and identified with a compound microscope. Where subsampled, the number of specimens identified to genus/species was used to proportion the remaining individuals from each group into specific taxa. In instances where chironomid or oligochaete specimens could be identified to genus or species without the aid of a compound microscope, no preparation was necessary. Taxonomic keys used to identify all specimens in addition to chironomids and oligochaetes, were: Burks (1953), Hitchcock (1974), Burch (1975), McCafferty (1975), Brown (1976), Simpson and Bode (1980), Wiederholm (1983), Klemm (1985), Roback (1985), Brinkhurst (1986), Peckarsky (1990), Jokinen (1992), Merritt and Cummins (1996), Wiggins (1996).

4.2 SUMMARY

During 2000, 36 dredge samples and nine rock basket samples were processed. From these samples, 3,820 macroinvertebrates were identified (Table 4-1). Organisms collected by dredge and cage samples made up 64% and 36% of the total, respectively (Tables 4-2 and 4-3a).

Dipterans, oligochaetes, and gastropods accounted for 83% of the invertebrates collected by dredge at the downstream Stations 2 and 3 (Table 4-2). Dipterans, oligochaetes, gastropods, isopods, and amphipods accounted for 87% of the invertebrates collected by dredge at the upstream Stations 4 and 5 (Table 4-2). As in previous years, isopods accounted for 27% of the invertebrates collected by dredge at the upstream Station 5 (Table 4-2). Some of the other taxa collected by dredge upstream of Vernon Dam included ephemeropterans, bivalves, and trichopterans; contributing a combined relative abundance of 8% (Table 4-2). In general, more invertebrates were collected by dredge upstream (1918) of the Vernon Dam, than by dredge downstream (511) of the dam.

The downstream Stations rock baskets were sampled according to the NPDES stipulated sampling schedule. However, because the upstream Stations rock baskets deviated from that stipulated in the Permit, the results of the upstream rock basket collections are presented in two tables. Table 4-3a displays the composition of macroinvertebrates collected by rock basket at all Stations (upstream and downstream) over all sampling dates. Table 4-3b contains data from only the upstream sampling stations, by the three sampling events.

In general, the number of invertebrates collected by rock basket was greater upstream of Vernon Dam (897) than downstream of the Dam (94) (Table 4-3a). Rock basket collections at downstream Stations 2 and 3 resulted in the collection of 42 and 52 organisms, respectively (Table 4-3a).). Overall, sixty-seven percent of the organisms collected at Station 2 were dipterans (Table 4-3a). The organisms collected in the downstream Station 3 rock basket samplers were predominantly amphipods, constituting 81% of the total Station 3 catch (Table 4-3a). Over all sampling events, the upstream Stations 4 and 5 rock baskets collected a total of 489 and 408 organisms, respectively (Table 4-3a). Forty-seven percent of the macroinvertebrate composition collected at Station 4

consisted of Turbellarian worms (Table 4-3a). The organisms collected in the Station 5 rock baskets across all collections were dominated by decapods (41%), followed by gastropods (20%) (Table 4-3a).

9 May – 28 June 2000 Rockbasket Collection

The rock baskets deployed at the upstream Stations in early May resulted in the collection of similar taxa as was collected by rock basket during the rest of the year. Oligochaetes contributed 30.9% of the relative abundance of all organisms collected at Station 4 (Table 4-3b). Dipterans and amphipods contributed 26% and 23 % to the Station 4 relative abundance, respectively (Table 4-3b). The Station 5 rock basket was dominated by the collection of decapods (85%) (Table 4-3b).

6 July – 11 August 2000 Rockbasket Collection

Amphipods and mayflies (ephemeropterans) contributed equally to the relative abundance at Station 4 (30% each) (Table 4-3b). Other organisms contributing less than 6% to the over all Station 4 abundance during this time period included turbellarian worms, gastropods, isopods, dipterans, and caddisflies (trichopterans) (Table 4-3b).

Over half of the organisms collected at Station 5 during this sampling period consisted of gastropods (57%) with an additional 25% of the collection comprised of amphipods (Table 4-3b).

11 August – 21 September 2000 Rockbasket Collections

During this late summer rock basket collection, turbellarian worms constituted 61% of the relative abundance of the Station 4 rock basket sample, and 20% of the Station 5 sample (Table 4-3b). Amphipods contributed and additional 25% to the total catch at Station 4, while gastropods, trichopterans, and oligochaetes contributed an additional 19% or less to the station 5 abundance (Table 4-3b).

Table 4-1. Checklist of Macroinvertebrates Collected from The Connecticut River Near Vernon, Vermont In 2000.

Species	Downstream		Upstream					
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Hydrozoa								
Hydra sp.			1	100				
Totals			1	100				
Platyhelminthes								
Turbellaria								
Dugesia tigrina			1	100	233	100	28	100
Totals			1	100	233	100	28	100
Nematoda					4	100	4	100
Totals					4	100	4	100
Nemertinea								
Anopla								
Prostoma graescense			3	100	4	100		
Totals			3	100	4	100		
Annelida								
Hirudinea								
Batracobdella phalera							1	16.7
Gloiobdella elongata							2	33.3
Helobdella fusca							1	16.7
Helobdella sp.					1	25		
Helobdella triseralis					1	25		
Mooreobdella sp.					2	50	2	33.3
Totals					4	100	6	100
Oligochaeta								
Arcteonais lomondi					8	5.7	2	1.3
Aulodrilus americanus	1	1.9					3	2
Aulodrilus pluriseta			6	10	3	2.1	4	2.6
Aulodrilus sp.			2	3.3	19	13.5		
Branchiura sowerbyi			3	5	2	1.4	11	7.2
Enchytraeidae			1	1.7	1	0.7	3	2
Ilyodrilus templetoni	2	3.8					4	2.6
Limnodrilus sp.	1	1.9	21	35	37	26.2	56	36.6
Lumbricidae	2	3.8	5	8.3	10	7.1	22	14.4
Lumbriculidae			12	20			3	2
Lumbriculus variegatus	2	3.8			23	16.3	7	4.6
Nais simplex					14	9.9		
Nais sp.							1	0.7
Piquetiella michiganensis	2	3.8						
Ripistes parasita			2	3.3				

Table 4-1 (Continued).

Species	Downstream				Upstream			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Stylaria lacustris			1	1.7			7	4.6
Tubificidae imm. w/ capilliform chaetae	31	58.5			8	5.7	2	1.3
Tubificidae imm. w/o capilliform chaetae	12	22.6	7	11.7	16	11.3	28	18.3
Totals	53	100	60	100	141	100	153	100
Polychaeta								
Manayunkia speciosa			2	100				
Totals			2	100				
Mollusca								
Gastropoda								
Amnicola limosa			9	14.3	93	69.9	177	92.2
Ferrissia rivularis			50	79.4				
Ferrissia sp.	1	100	3	4.8				
Gyraulus parvus					22	16.5	6	3.1
Gyraulus sp.					7	5.3	2	1
Helisoma trivolvis							1	0.5
Menetus dilatatus					1	0.8		
Physa sp.			1	1.6	10	7.5	6	3.1
Totals	1	100	63	100	133	100	192	100
Bivalvia								
Elliptio complanata	2	50						
Pisidium sp.	2	50	11	84.6	12	75	69	100
Sphaeriidae					3	18.8		
Sphaerium striatinum			1	7.7	1	6.3		
Unionidae			1	7.7				
Totals	4	100	13	100	16	100	69	100
Arachnida								
Acarina								
Hydrachnidia			1	100	1	100		
Totals			1	100	1	100		
Crustacea								
Brachiopoda								
Cladocera			400	100				
Totals			400	100				
Isopoda								
Caecidotea sp.					59	100	295	100
Totals					59	100	295	100
Amphipoda								
Hyalella azteca	1	100	46	100	260	100	109	100
Totals	1	100	46	100	260	100	109	100

Table 4-1 (Continued).

Species	Downstream				Upstream			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Decapoda								
Crangonyx pseudogracilis					4	66.7	15	7.8
Crangonyx sp.							13	6.7
Orconectes sp.			1	100	2	33.3	165	85.5
Totals			1	100	6	100	193	100
Insecta								
Ephemeroptera								
Caenis punctata					5	10.6	1	4.3
Caenis sp.			1	14.3	6	12.8	1	4.3
Centroptilum sp.					1	2.1		
Hexagenia limbata					16	34	6	26.1
Stenacron sp.			2	28.6	19	40.4	15	65.2
Stenonema sp.	1	33.3	4	57.1				
Stenonema terminatum	2	66.7						
Totals	3	100	7	100	47	100	23	100
Odonata								
Boyeria sp.							1	25
Boyeria vinosa							1	25
Enallagma sp.			1	100	6	75	2	50
Stylurus sp.					2	25		
Totals			1	100	8	100	4	100
Coleoptera								
Dineutus sp.					1	10		
Dubiraphia sp.	1	100			8	80	24	88.9
Optioservus sp.					1	10	1	3.7
Oreodytes sp.							1	3.7
Peltodytes sp.							1	3.7
Stenelmis sp.			1	100				
Totals	1	100	1	100	10	100	27	100
Megaloptera								
Sialis sp.					1	100	2	100
Totals					1	100	2	100
Trichoptera								
Ceraclea sp.			2	4				
Ceratopsyche sp.			40	80				
Cheumatopsyche sp.	1	12.5	3	6	1	2.5		
Cyrnellus sp.	1	12.5						
Hydroptila sp.							2	5.1
Macronychus glabratus					1	2.5	1	2.6
Macrostemum zebratum			1	2				
Molanna sp.							1	2.6

Table 4-1 (Continued).

Species	Downstream				Upstream			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Mystacides sp.					2	5		
Neureclipsis sp.			3	6				
Oecetis sp.					14	35	2	5.1
Phylocentropus sp.					16	40	22	56.4
Polycentropodidae					1	2.5		
Polycentropus sp.	6	75			5	12.5	10	25.6
Pycnopsyche sp.							1	2.6
Triaenodes sp.			1	2				
Totals	8	100	50	100	40	100	39	100
Diptera								
Ablabesmyia sp.	1	0.6	1	0.8	5	1.2	2	0.7
Acricotopus sp.							3	1
Apedilum sp.							3	1
Chironomini					2	0.5	1	0.3
Chironomus sp.	30	18.1	2	1.7	17	4.1	1	0.3
Chrysops sp.			1	0.8	3	0.7	1	0.3
Cladopelma sp.					1	0.2		
Cladotanytarsus sp.			4	3.4	54	13	9	3.1
Clinotanypus sp.	1	0.6			1	0.2	11	3.8
Corynoneura sp.					1	0.2		
Cricotopus brevipalpis gr.							1	0.3
Cricotopus sp.	1	0.6					12	4.2
Cricotopus sylvestris gr.					4	1	3	1
Cryptochironomus fulvus gr.	7	4.2	5	4.2	27	6.5	5	1.7
Cryptotendipes sp.			2	1.7	3	0.7	14	4.9
Culicoides sp.	1	0.6					3	1
Demicryptochironomus sp.					2	0.5	4	1.4
Dicrotendipes modestus					1	0.2		
Dicrotendipes sp.	2	1.2	1	0.8	16	3.8	8	2.8
Endochironomus nigricans							1	0.3
Endochironomus sp.					4	1	4	1.4
Eukieferriella sp.	3	1.8			1	0.2		
Glyptotendipes sp.	1	0.6			2	0.5	1	0.3
Harnischia gr.	1	0.6						
Hemerodromia sp.					1	0.2		
Larsia sp.							1	0.3
Mallachohelea sp.	1	0.6						
Microtendipes sp.					1	0.2		
Monodiamesa sp.					7	1.7	3	1
Nanocladius sp.					1	0.2	1	0.3
Orthocladiinae	1	0.6			5	1.2		

Table 4-1 (Continued).

Species	Downstream				Upstream			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Orthocladius sp.	1	0.6	6	5.1	6	1.4	4	1.4
Pagastiella sp.	2	1.2						
Palpomyia gr.					2	0.5	2	0.7
Parachironomus arcuatus							1	0.3
Parachironomus sp.							1	0.3
Paracladopelma sp.							1	0.3
Paralauterborniella sp.					1	0.2		
Paratanytarsus sp.					1	0.2	15	5.2
Paratendipes sp.			3	2.5				
Phaenopsectra sp.							5	1.7
Polypedilum fallax			1	0.8				
Polypedilum halterale gr.	19	11.4			33	7.9	8	2.8
Polypedilum scalaenum gr.	2	1.2	13	11	1	0.2	2	0.7
Polypedilum sp.			5	4.2	11	2.6	9	3.1
Polypedilum tritum	1	0.6	4	3.4	3	0.7	5	1.7
Potthastia longimanus gr.					1	0.2		
Procladius sp.	1	0.6			38	9.1	19	6.6
Prodiamesa olivacea	1	0.6						
Psectrocladius sp.			3	2.5	5	1.2	4	1.4
Pseudochironomus sp.			2	1.7	33	7.9	2	0.7
Rheosmittia sp.							1	0.3
Rheotanytarsus sp.			35	29.7				
Sphaeromias sp.	81	48.8	27	22.9	53	12.7	67	23.3
Stempellina sp.					3	0.7		
Stenochironomus sp.	1	0.6			1	0.2	2	0.7
Stictochironomus sp.	6	3.6					2	0.7
Tanytarsus sp.	1	0.6	1	0.8	12	2.9	32	11.1
Thienemanniella sp.					8	1.9		
Tribelos sp.			2	1.7	45	10.8	14	4.9
Totals	166	100	118	100	416	100	288	100
Grand total (all taxa)	**237**	**100**	**768**	**100**	**1383**	**100**	**1432**	**100**

Table 4-2. Composition Of Macroinvertebrates Collected By Ponar Grab In 2000 Downstream And Upstream Of Vernon Dam.

	Downstream		Upstream					
	Station 2		Station 3		Station 4		Station 5	
	Count	% of total	Count	% of total	Count	% of total	Count	% of total
Hydrozoa			1	0.3				
Nematoda					4	0.4	4	0.4
Turbellaria			1	0.3	3	0.3	3	0.3
Hirudinea					2	0.2	4	0.4
Oligochaeta	48	24.6	60	19	109	12.2	135	13.2
Polychaeta			2	0.6				
Gastropoda	1	0.5	60	19	108	12.1	111	10.8
Bivalvia	2	1	13	4.1	16	1.8	67	6.5
Acarina			1	0.3	1	0.1		
Isopoda					49	5.5	282	27.5
Amphipoda			4	1.3	174	19.5	76	7.4
Decapoda			1	0.3			27	2.6
Ephemeroptera	3	1.5	2	0.6	23	2.6	8	0.8
Odonata			1	0.3	5	0.6	3	0.3
Coleoptera	1	0.5	1	0.3	5	0.6	21	2.1
Megaloptera							1	0.1
Trichoptera	2	1	50	15.8	27	3	16	1.6
Diptera	138	70.8	116	36.7	365	40.8	266	26
Anopla			3	0.9	3	0.3		
Totals	195	100	316	100	894	100	1024	100

Table 4-3a. Composition Of Macroinvertebrates Collected By Rock Baskets In 2000 Downstream And Upstream Of Vernon Dam.

	Downstream				Upstream			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Turbellaria					230	47	25	6.1
Hirudinea					2	0.4	2	0.5
Oligochaeta	5	11.9			32	6.5	18	4.4
Gastropoda			3	0.7	25	5.1	81	19.9
Bivalvia	2	4.8					2	0.5
Isopoda					10	2	13	3.2
Amphipoda	1	2.4	42	9.3	86	17.6	33	8.1
Decapoda					6	1.2	166	40.7
Ephemeroptera			5	1.1	24	4.9	15	3.7
Odonata					3	0.6	1	0.2
Coleoptera					5	1	6	1.5
Megaloptera					1	0.2	1	0.2
Trichoptera	6	14.3			13	2.7	23	5.6
Diptera	28	66.7	2	0.4	51	10.4	22	5.4
Anopla					1	0.2		
Totals	**42**	**100**	**52**	**100**	**489**	**100**	**408**	**100**

Table 4-3b. Composition Of Macroinvertebrates Collected By Rock Baskets Set In May, July and August of 2000 At The Upstream Stations Only.

	May - June				July - August				August - September			
	Station 4		Station 5		Station 4		Station 5		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Turbellaria	2	2.5			2	5.4			226	60.9	25	20.3
Hirudinea	1	1.2	1	0.5	1	2.7	1	1.1				
Oligochaeta	25	30.9			1	2.7			6	1.6	18	14.6
Gastropoda	3	3.7	4	2.1	2	5.4	53	57.0	20	5.4	24	19.5
Bivalvia											2	1.6
Isopoda	4	4.9	2	1.0	2	5.4	4	4.3	4	1.1	7	5.7
Amphipoda	19	23.5	5	2.6	11	29.7	23	24.7	56	15.1	5	4.1
Decapoda	1	1.2	163	84.9	1	2.7	2	2.2	4	1.1	1	0.8
Ephemeroptera	1	1.2	1	0.5	11	29.7	4	4.3	12	3.2	10	8.1
Odonata							1	1.1	3	0.8		
Coleoptera	2	2.5	1	0.5	1	2.7	1	1.1	2	0.5	4	3.3
Megaloptera					1	2.7					1	0.8
Trichoptera	2	2.5	3	1.6	2	5.4	1	1.1	9	2.4	19	15.4
Diptera	21	25.9	12	6.3	2	5.4	3	3.2	28	7.5	7	5.7
Anopla									1	0.3		
Totals	**81**	**100.0**	**192**	**100.0**	**37**	**100.0**	**93**	**100.0**	**371**	**100.0**	**123**	**100.0**

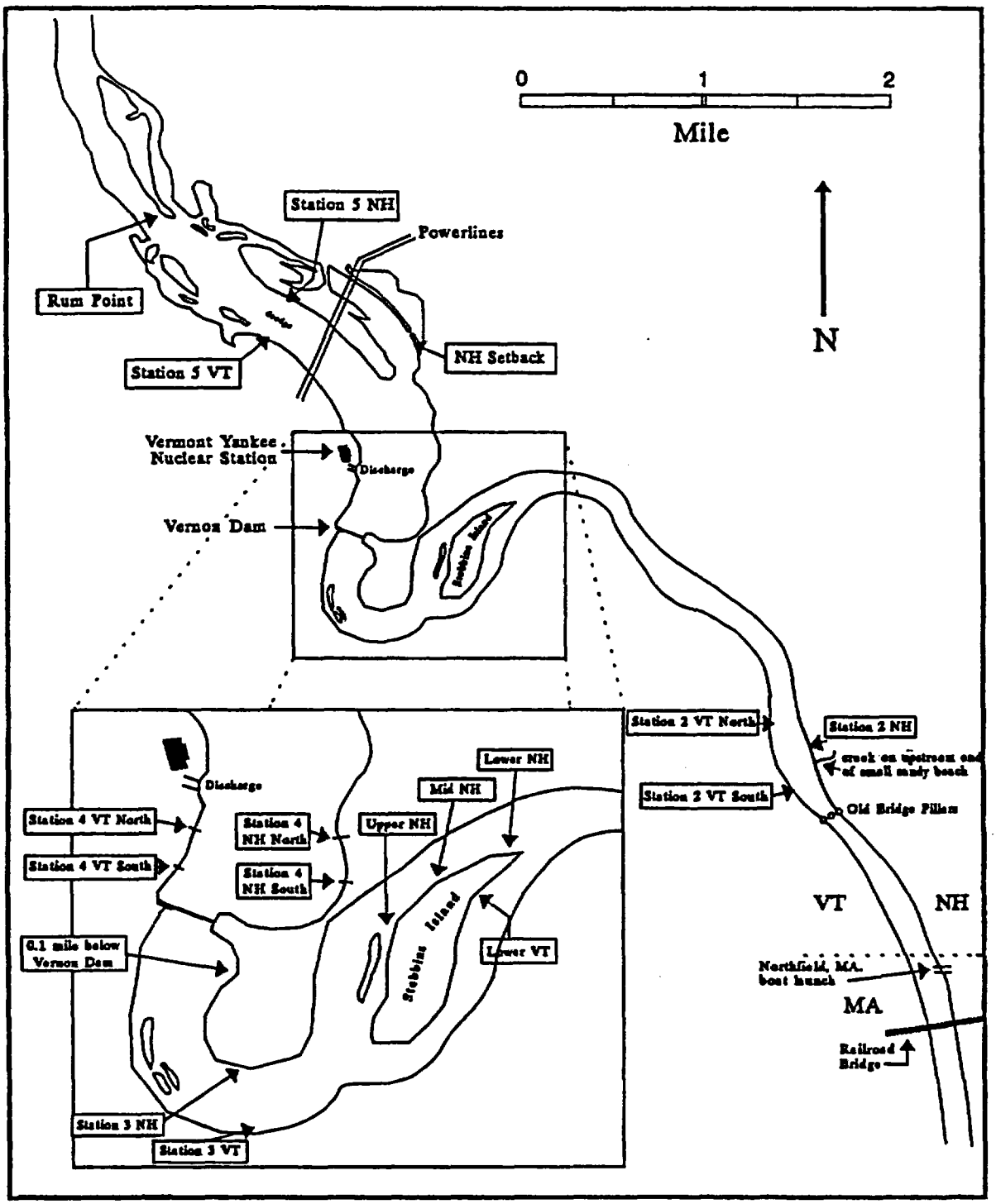


Figure 4-1. NPDES Macroinvertebrate dredge and rock basket sampling stations 2, 3, 4, and 5.

5.0 FISH COLLECTIONS

During the annual Environmental Advisory Committee meeting on 18 April 2000, the trapnet portion of the current NPDES permit was removed from the sampling program due to concerns raised by the participating State agencies over the potential impact trap netting could pose to a new nesting pair of bald eagles. Fluctuating river flows regularly resulted in the partial exposure of the trapnets above the water surface during the four 48-hour sampling periods in May, June, September, and October. The agencies' concern centered on the possible entanglement of an eagle in a partially exposed trapnet full of fish. Therefore, unlike previous year's reports no trapnet data is reported herein.

The electrofishing samples were collected at the Stations specified in the NPDES permit and outlined in Figure 5-1. Larval fish were collected weekly from 2 May through 11 July 2000 in the vicinity of the Vermont Yankee intakes, and fish impinged on the circulating water traveling screens were collected weekly from 1 April through 15 June, and again from 28 July through 26 October. Electrofishing specifically for anadromous fish was conducted twice a month in July through October, at the specified Stations.

5.1 METHODS OF COLLECTION AND PROCESSING

5.1.1 Electrofishing - General Sampling

Electrofishing was conducted utilizing a boat-mounted Coffelt Electronics Model VVP-15 electroshocker. Monthly sampling was conducted during May, June, September, and October in the evening beginning approximately 0.5 h after sunset at the following Stations: Rum point, Station 5, Station 4, NH Setback, 0.1 mi. below Vernon Dam, Station 3, Stebbin Island, and Station 2 (Fig. 3-1). All fish collected were identified to species, weighed to the nearest gram (wet weight), and measured to the nearest millimeter (total length). NPDES permit conditions were met with respect to the general fisheries electrofishing program.

5.1.2 Electrofishing - Anadromous Fish

Juvenile American shad electrofishing collections were conducted twice a month during July through October at Stations 0.1 mi. south of Vernon Dam, Station 3, and Stebbins Island (Figure 5-1). Non-target fish (non-clupeids) were not collected during the juvenile American shad electrofishing runs. Collected juvenile shad were weighed (to the nearest gram wet weight) and measured (mm total length). All anadromous fish electrofishing samples were successfully collected as outlined in the NPDES permit.

5.1.3 Impingement

Weekly and 24 hour spring and fall impingement samples were collected on each Monday and Tuesday, respectively, between 1 April and 15 June, and 28 July through 26 October 2000. Weekly samples (i.e., Monday collections) consisted of back-washing the traveling screens into the collection bin. The debris was then examined for Atlantic salmon and American shad. The screens were again back-washed approximately 24 hours later (i.e., Tuesday collections) and all fish were removed, identified to species, weighed (to the nearest gram wet weight), and measured (mm total

length). The Atlantic salmon and American shad impingement limits of 301 salmon and 5,083 shad were not exceeded during 2000. Permit compliance was met with respect to impingement sampling.

5.1.4 Larval Fish

Larval fish samples were collected weekly from 2 May through 11 July in the vicinity of the Vermont Yankee intake structure (Fig. 3-1). A 50-cm diameter, 363-μm nitex nylon plankton net was towed along side the boat, at surface (approx. 0.3 m), mid (approx. 1.8 m), and near bottom (approx. 3.7 m) depths. A flume-calibrated, General Oceanics Inc. Model 2030R mechanical flowmeter was mounted in the net mouth and used to estimate the volume of each tow.

The contents of the retrieved plankton nets were washed into a collection cup on the end of the net. Larval fish samples were preserved in 5% formalin for laboratory sorting and identification. Ichthyoplankton was separated from debris using an 8x to 80x variable magnification dissecting microscope. Larval fish were identified to the lowest feasible taxonomic level utilizing the following published larval keys: Fish (1930), Lippson and Moran (1974), Jones et al. (1978), and Auer (1982). All larval fish samples were collected in compliance with the NPDES permit requirements.

5.1.5 Scale Samples for Age Determination

Scale samples, used for age determination, were removed from yellow perch, largemouth bass, smallmouth bass, and walleye collected by electrofishing. No white perch were collected via electrofishing; therefore, no scale samples were collected for this species. Scale samples taken from the four species were removed from an area ventral to the lateral line at the tip of the depressed pectoral fin. All fish were released back to the river near the point of capture.

5.2 SUMMARY

Twenty-six species of fish were collected during 2000 (Table 5-1). This total number is similar to recent years (Aquatec 1993, 1995, and Normandeau Associates 1997, 1998, and 1999). All collected species were typical of the Connecticut River drainage; no federally listed threatened or endangered species were collected.

5.2.1 Fish - NPDES General Electrofishing, and Impingement

During 2000, a total of 40 electrofishing collections were completed at the ten locations within the eight NPDES permit designated Stations (Fig. 5-1). The total number of fish collected by electrofishing was 980 (Table 5-2). The average catch per unit effort (CPUE) for the 40-electrofishing collections was 153.1. The total electrofishing effort was 6.4 hours.

There were 1,938 fish collected in 2000 during impingement and general electrofishing (Table 5-3). Numerically, the most abundant species were yellow perch (30.8%), Bluegill (26.5%), rock bass (8.8%), pumpkinseed (5.4%), and spottail shiner (5.2%). Yellow perch (18.9%), bluegill (17.1%), smallmouth bass (11.3%), and largemouth bass (11.0%) accounted for the majority of the biomass of collected fishes (Table 5-3).

Upstream of Vernon Dam, yellow perch, bluegill, and rock bass, accounted for 71.5% of all fish collected (Table 5-4). Seven American shad were collected upstream of Vernon Dam from the circulating water traveling screens at the Plant Intake structure and one was collected by electrofishing. American shad contributed 0.5% to the total upstream catch. Other fish contributed 5.5% (pumpkinseed) or less to the total relative abundance. Yellow perch (22.3%), bluegill (17.9%), largemouth bass (13.2%), and white sucker (11.3%) accounted for the majority of the biomass of the fish collected at the upstream Stations (Table 5-4).

Downstream of Vernon Dam, spottail shiner, smallmouth bass, fallfish, bluegill, and rock bass accounted for 77.0% of the total catch (Table 5-5). Twelve American shad were collected downstream of Vernon Dam during the general electrofishing collections (i.e., not including anadromous species electrofishing collections conducted specifically for American shad). Smallmouth bass (47.8%), bluegill (13.2%), and fall fish(7.8%), contributed the greatest biomass to the downstream collections.

Seven American shad were collected on the traveling screens in October (Table 5-6). Nine Atlantic salmon were collected on the traveling screens, one the last day of March, five in April, and three in May 2000. The American shad and Atlantic salmon impingement limits of 5,083 shad and 346 salmon were not exceeded during 2000. The June, August, and September impingement samples consisted of a total of 20, 14, and 15 fish collected, respectively. Pumpkinseed and rock bass were numerically the most abundant species in the impingement samples during those three months.

Up to 20 scale samples collected from the electrofishing sampling programs were analyzed for age determination of smallmouth bass, largemouth bass, yellow perch, and walleye (Tables 5-8, 5-9, 5-10, and 5-11).

5.2.2 Anadromous Fish Electrofishing

In fulfillment of the NPDES permit requirements for anadromous fish sampling, electrofishing samples were collected twice a month during July through October 2000 at Stebbins Island, Station 3, and 0.1 mile below Vernon Dam (Fig. 3-1). Results reported in this section include American shad collected during the anadromous fish collections only and not those shad reported above in the general electrofishing section.

A total of 57 American shad was collected via electrofishing between July and 2 November (the last scheduled October 2000 anadromous fish electrofishing trip was postponed until 2 November due to a shortage of qualified personnel in late October), (Table 5-12). August yielded the highest catch of shad (31) compared to the other three months. Shad lengths recorded in August ranged from 54 – 83 mm total length and weight ranged from 1 – 4 g (Table 5-12). The twice-monthly collections during July, September, and October resulted in the collection of 1, 20, and 5 American shad, respectively. The American shad collected in July measured 41 mm total length. The American shad collected during September ranged in length from 78 - 106 mm. October shad collections produced a catch

ranging in length from 101 – 110 mm. The CPUE in August was highest at Station 3 (24) followed by Stebbins Island (16.5) (Table 5-12). The CPUE in September was highest at Stebbins Island (12.8) and the CPUE in October was highest at Station 3 (12). No shad were collected on 2 November 2000 (Table 5-12).

5.2.3 Ichthyoplankton

Thirty-three ichthyoplankton samples were collected near the Vermont Yankee intakes between 2 May and 11 July 2000 (Table 5-13). A total of 490 ichthyoplankters were identified (Table 5-14). Irrespective of the volume sampled, of the ichthyoplankton captured, spottail shiner represented 39.8% of the ichthyoplankton captured, followed by white perch (28.8%), yellow perch (14.7) and white sucker (14.5%). Other species collected included walleye, pumpkinseed, common carp and Clupeidae. Table 5-15 provides a breakdown of extrapolated ichthyoplankton estimates presented as density (no./100 cubic meters). Most fish were collected at the 0.3 meters depth; with respect to time, most fish were collected in May and the first two weeks of July

Table 5-1. Checklist of Fishes (AFS 1991) Collected During 2000.

CHORDATA	
AGNATHA	
PETROMYZONTIFORMES	
Petromyzontidae	
Petromyzon marinus	Sea lamprey
OSTEICHTHYES	
ANGUILLIFORMES	
Anquillidae	
Anguilla rostrata	American eel
SILURIFORMES	
Ictaluridae	
Ameiurus sp.	Ameiurus sp.
Ameiurus natalis	Yellow bullhead
Ameiurus nebulosus	Brown bullhead
SALMONIFORMES	
Salmonidae	
Salmo salar	Atlantic salmon
Esocidae	
Esox lucius	Northern pike
Esox niger	Chain pickerel
Diaphanus fundulus	Banded killifish
CYPRINIFORMES	
Cyprinidae	
Catostomidae	
Catostomus commersoni	White sucker
Cyprinidae	Cyprinidae
Cyprinus carpio	Common carp
Hybognathus regalis	Eastern silvery minnow
Notemigonus crysoleucas	Golden shiner
Notropis hudsonius	Spottail shiner
Notropis sp.	Notropis sp.
Semotilus corporalis	Fallfish
CLUPEIFORMES	
Clupeidae	
Alosa sapidissima	American shad
Dorosoma cepedianum	Gizzard shad
PERCIFORMES	
Percidae	
Perca flavescens	Yellow perch
Stizostedion vitreum	Walleye
Percicthyidae	
Morone americana	White perch
Centrarchidae	
Ambloplites rupestris	Rock bass
Lepomis gibbosus	Pumpkinseed
Lepomis macrochirus	Bluegill
Micropterus dolomieu	Smallmouth bass
Micropterus salmoides	Largemouth bass
Pomoxis nigromaculatus	Black crappie
Etheostoma olmstedi	Tesselated darter

Table 5-2. Catch per unit of effort (CPUE) for electrofishing collections in the Connecticut River in the vicinity of Vernon Vermont for Section I of the NPDES Permit in 2000.

Electrofishing Stations	Number of Collections	Hours	Fish	CPUE
Station 3 - Vermont	4	0.7	61	91.5
Station 5 - New Hampshire	4	0.5	89	178.0
Station 5 - Vermont	4	0.7	101	151.5
New Hampshire Setback	4	0.7	190	285.0
Rum Point	4	0.7	125	187.5
Station 2 - New Hampshire	4	0.7	27	41.5
Station 4 - New Hampshire	4	0.7	161	241.5
Station 4 - Vermont	4	0.7	113	165.4
Stebbin Island - New Hampshire Side	4	0.7	81	121.5
0.1 Miles south of Vernon Dam	4	0.6	32	56.5
TOTAL	**40**	**6.4**	**980**	**153.1**

Table 5-3. **Number and weights of fishes collected in the Connecticut River upstream and downstream of Vernon Dam in 2000 (electrofishing and impingement samples).**

Species	Total (#)	Relative Number (%)	Total Weight (g)	Relative Weight (%)
Sea lamprey	13	0.7	29	0.04
American eel	2	0.1	455	0.56
American shad	20	1.0	158	0.20
Gizzard shad	2	0.1	840	1.04
Atlantic salmon	9	0.5	238	0.29
Northern pike	4	0.2	3510	4.34
Chain pickerel	15	0.8	2130	2.63
Banded killifish	1	0.1	1	0.00
Cyprinidae	1	0.1	1	0.00
Common carp	3	0.2	1568	1.94
Eastern silvery minnow	11	0.6	51	0.06
Golden shiner	39	2.0	568	0.70
Spottail shiner	101	5.2	216	0.27
Notropis sp.	11	0.6	40	0.05
Fallfish	26	1.3	1019	1.26
White sucker	18	0.9	8250	10.20
Ameiurus sp.	1	0.1	1	0.00
Yellow bullhead	7	0.4	1187	1.47
Brown bullhead	16	0.8	1385	1.71
White perch	28	1.4	230	0.28
Rock bass	171	8.8	5522	6.82
Pumpkinseed	105	5.4	4075	5.04
Bluegill	513	26.5	13836	17.10
Smallmouth bass	62	3.2	9099	11.25
Largemouth bass	67	3.5	8925	11.03
Black crappie	83	4.3	803	0.99
Tesselated darter	2	0.1	3	0.00
Yellow perch	596	30.8	15252	18.85
Walleye	11	0.6	1520	1.88
TOTAL	**1938**	**100.0**	**80912**	**100.00**

Table 5-4. **Numbers and weights of fishes captured upstream of Vernon Dam in 2000 in impingement and general electrofishing.**

Species	Electrofishing		CWTS		Summary			
	Number	Total Weight (g)	Number	Total Weight (g)	Total (#)	Relative Number (%)	Total (g)	Relative Weight (%)
Sea lamprey	1		12	29	13	0.7	29	0.0
American shad	1	7	7	66	8	0.5	73	0.1
Gizzard shad			1	40	1	0.1	40	0.1
Atlantic salmon			9	238	9	0.5	238	0.4
Northern pike	4	3510			4	0.2	3510	5.2
Chain pickerel	12	1974	2	16	14	0.8	1990	2.9
Banded killifish	1	1			1	0.1	1	0.0
Common carp	2	1568			2	0.1	1568	2.3
E.silvery minnow	5	28	6	23	11	0.6	51	0.1
Golden shiner	24	284	12	82	36	2.1	366	0.5
Spottail shiner	50	111			50	2.9	111	0.2
Notropis sp.			10	39	10	0.6	39	0.1
White sucker	11	7654	1	14	12	0.7	7668	11.3
Ameiurus sp.			1	1	1	0.1	1	0.0
Yellow bullhead	7	1187			7	0.4	1187	1.7
Brown bullhead	3	1145	13	240	16	0.9	1385	2.0
White perch			28	230	28	1.6	230	0.3
Rock bass	24	1667	134	3216	158	9.1	4883	7.2
Pumpkinseed	70	3170	25	646	95	5.5	3816	5.6
Bluegill	221	8205	269	3908	490	28.2	12113	17.9
Smallmouth bass	10	2201	10	653	20	1.2	2854	4.2
Largemouth bass	47	8848	20	77	67	3.9	8925	13.2
Black crappie	12	533	71	270	83	4.8	803	1.2
Tesselated darter			2	3	2	0.1	3	0.0
Yellow perch	272	11572	322	3569	594	34.2	15141	22.3
Walleye	2	352	3	465	5	0.3	817	1.2
Total	**779**	**54017**	**958**	**13825**	**1737**	**100.0**	**67842**	**100.0**

Table 5-5. **Numbers and weights of fishes captured downstream of Vernon Dam in 2000 in general electrofishing (i.e. non-anadromous fish specific electrofishing runs).**

Species	Electrofishing		Summary			
	Number	Total Weight (g)	Total (#)	Relative Number (%)	Total (g)	Relative Weight (%)
American eel	2	455	2	1.0	455	3.5
American shad	12	85	12	6.0	85	0.7
Gizzard shad	1	800	1	0.5	800	6.1
Chain pickerel	1	140	1	0.5	140	1.1
Cyprinidae	1	1	1	0.5	1	0.0
Common carp	1		1	0.5		
Golden shiner	3	202	3	1.5	202	1.5
Spottail shiner	51	105	51	25.4	105	0.8
Notropis sp.	1	1	1	0.5	1	0.0
Fallfish	26	1019	26	12.9	1019	7.8
White sucker	6	582	6	3.0	582	4.5
Rock bass	13	639	13	6.5	639	4.9
Pumpkinseed	10	259	10	5.0	259	2.0
Bluegill	23	1723	23	11.4	1723	13.2
Smallmouth bass	42	6245	42	20.9	6245	47.8
Yellow perch	2	111	2	1.0	111	0.8
Walleye	6	703	6	3.0	703	5.4
Total	**201**	**13070**	**201**	**100.0**	**13070**	**100.0**

Table 5-6. Monthly impingement of fish on Vermont Yankee's circulating water travelling screens in 2000.

Species	March		April		May		June		August		September		October	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Atlantic salmon	1	23	5	160	3	55								
E. silvery minnow			2	10	4	13								
Golden shiner			3	25	8	47			1	10				
Rock bass			30	279	62	1853	10	17	5	67	5	88	22	912
Pumpkinseed			3	18	12	504							10	124
Bluegill			48	572	131	1605	2	3	3	350	7	1200	78	178
Smallmouth bass			1	5	3	149	3	131	1	300	1	35	1	33
Black crappie			2	12	4	15							65	243
Yellow perch			93	1154	219	2328	5	11	2	14			3	62
Walleye			1	250	1	130							1	85
Sea lamprey					11	25			1	4				
Notropis sp.					10	39								
White sucker					1	14								
Brown bullhead					9	65							4	175
White perch					1	90							27	140
Ameiurus sp.									1	1				
Tesselated darter											2	3		
American shad													7	66
Gizzard shad													1	40
Chain pickerel													2	16
Largemouth bass													20	77
Total	**1**	**23**	**188**	**2485**	**479**	**6932**	**20**	**162**	**14**	**746**	**15**	**1326**	**241**	**2151**

Note: weight is in grams.

Table 5-7. **Age-specific length and weight statistics for random subsample of white perch collected in 2000.**

No adult white perch were collected in 2000.

Table 5-8. **Age-specific length and weight statistics for random subsample of smallmouth bass collected in 2000.**

	Number of Fish	Total Length (mm)				Total Weight (g)			
		Avg.	SD	MIN	MAX	Avg.	SD	MIN	MAX
Annuli									
2	6	154	17	136	185	43	15	30	69
3	12	176	31	141	250	70	45	35	185
4	4	215	51	160	280	126	97	45	265
5	3	333	73	250	389	508	300	200	800
7	5	418	42	350	464	984	247	610	1300

Table 5-9. **Age-specific length and weight statistics for random subsample of largemouth bass collected in 2000.**

	Number of Fish	Total Length (mm)				Total Weight (g)			
		Avg.	SD	MIN	MAX	Avg.	SD	MIN	MAX
Annuli									
3	1	239		239	239	165		165	165
4	3	272	14	259	286	377	280	210	700
5	4	256	29	230	289	240	74	140	315
6	5	319	39	288	379	422	169	295	690
7	2	406	49	371	440	990	438	680	1300
8	1	491		491	491	1400		1400	1400

Table 5-10. **Age-specific length and weight statistics for random subsample of yellow perch collected in 2000.**

	Number of Fish	Total Length (mm)				Total Weight (g)			
		Avg.	SD	MIN	MAX	Avg.	SD	MIN	MAX
Annuli									
3	6	162	18	141	187	49	20	25	79
4	8	177	16	152	195	62	17	31	79
5	17	213	28	170	259	106	41	39	170
6	4	220	33	171	241	117	45	51	145
7	4	232	33	205	280	145	73	95	250

Table 5-11. **Age-specific length and weight statistics for random subsample of walleye collected in 2000.**

	Number of Fish	Total Length (mm)				Total Weight (g)			
		Avg.	SD	MIN	MAX	Avg.	SD	MIN	MAX
Annuli									
2	1	227		227	227	87		87	87
4	4	275	48	221	326	172	75	87	265

Table 5-12. Summary of 2000 Anadromous Fish Collections (American shad) at Stebbins Island, Station 3, and 0.1 Mile Below Vernon Dam.

Month and Station	No. of Fish	Hours	Catch per Unit Effort	Minimum Length (mm)	Maximum Length (mm)	Minimum Weight (g)	Maximum Weight (g)
July							
Station 3	0	0.32	0.0	-	-	-	-
Stebbin Island	1	1.22	0.8	41	41	-	-
0.1 Miles south of Vernon Dam	0	0.32	0.0	-	-	-	-
August							
Station 3	8	0.33	24.0	56	70	2	3
Stebbin Island	22	1.33	16.5	54	83	1	4
0.1 Miles south of Vernon Dam	1	0.33	3.0	65	65	3	3
September							
Station 3	3	0.33	9.0	78	94	1	5
Stebbin Island	17	1.33	12.8	88	106	2	9
0.1 Miles south of Vernon Dam	0	0.33	0.0	-	-	-	-
October							
Station 3	2	0.17	12.0	101	102	8	8
Stebbin Island	3	0.67	4.5	101	110	8	10
0.1 Miles south of Vernon Dam	0	0.17	0.0	-	-	-	-
November							
Station 3	0	0.17	0.0	-	-	-	-
Stebbin Island	0	0.63	0.0	-	-	-	-
0.1 Miles south of Vernon Dam	0	0.17	0.0	-	-	-	-

Table 5-13. Vermont Yankee Ichthyoplankton Sampling Effort In 2000.

	May	June	July	Total
Depth (m)				
0.3	5	4	2	11
1.8	5	4	2	11
3.7	5	4	2	11
Totals	**15**	**12**	**6**	**33**

Table 5-14. Collection Dates And Total Number Of Ichthyoplankton Collected Near The Vermont Yankee Intake In 2000.

Species	Earliest Capture	Latest Capture	Volume Sampled (Cubic Meters)	Number	Percent
Clupeidae	06Jun00	06Jun00	286.17	1	0.2
Common carp	28Jun00	28Jun00	509.78	2	0.4
Spottail shiner	29May00	11Jul00	2242.15	195	39.8
White sucker	29May00	13Jun00	870.56	71	14.5
White perch	22May00	06Jul00	2235.98	141	28.8
Pumpkinseed	22May00	11Jul00	2503.42	6	1.2
Yellow perch	02May00	29May00	1552.56	72	14.7
Walleye	15May00	22May00	564.63	2	0.4
				490	100.0

***Volume sampled is sum of volumes between earliest and latest capture date**

Table 5-15. Ichthyoplankton Density per 100 Cubic Meters at the Vermont Yankee Intakes By Depth in 2000.

Date and Taxon		DEPTH (m)			TOTALS
		0.3	1.8	3.7	
02May00	Yellow perch		0.76	1.80	2.56
09May00	Yellow perch		50.66	14.21	64.86
15May00	Walleye			1.07	1.07
	Yellow perch		3.09	1.07	4.15
22May00	Pumpkinseed	0.89			0.89
	Walleye			2.03	2.03
	White perch	0.89	1.00	2.03	3.93
	Yellow perch	1.79	2.99		4.78
29May00	Spottail shiner	0.85			0.85
	White perch		25.52	29.60	55.13
	White sucker	44.03			44.03
	Yellow perch	0.85			0.85
06Jun00	Clupeidae		1.13		1.13
	Spottail shiner	0.87			0.87
	White perch		10.21	19.38	29.59
	White sucker	15.59			15.59
13Jun00	White perch	1.10		1.23	2.33
	White sucker	1.10			1.10
22Jun00	Spottail shiner	4.27	0.96		5.23
	White perch		10.61	5.77	16.38
28Jun00	Common carp			0.64	0.64
	Spottail shiner	4.45	1.17	0.32	5.94
	White perch	1.78	10.49	7.38	19.65
06Jul00	Pumpkinseed		0.98	2.99	3.98
	Spottail shiner	22.48	0.98	2.00	25.46
	White perch			6.98	6.98
11Jul00	Pumpkinseed	0.83			0.83
	Spottail shiner	116.54	12.08	5.56	134.18
Totals		**218.30**	**132.64**	**104.07**	**455.01**

6.0 2000 ZEBRA MUSSEL AND ASIATIC CLAM MONITORING

6.1 METHODS OF COLLECTION AND PROCESSING

Larval (veliger) sampling was conducted bi-weekly between 15 June and 17 October 2000. Collections were made at quarter points (NH and VT shores, and mid-river) at Vermont Yankee stations 4 and 5 (Fig 3). Approximately 1,000 liters of river water was pumped through 64-micron plankton net at each quarter point. Six samples were collected during each bi-weekly collection trip for a total of 66 veliger samples. Samples were preserved in 70% ethanol for examination in the lab.

Juvenile/adult (settling stage) zebra mussel sampling was conducted between 22 May and 3 November 2000 near the New Hampshire and Vermont shores at Vermont Yankee stations 4 and 5 (Fig 3). Two settlement plate samplers were deployed at each station for a total of eight samplers. Settlement plates were made of six, 6 in X 6 in plates of PVC strung onto a bolt with approximately 0.5 in between plates. The sampler was suspended in the water column at 2-3 m below the surface, depending on river depth at the sampling station. The plate sampler at each Station was examined approximately every two weeks with a hand-held magnifying lens for newly settled zebra mussels. One plate from each sampler was then randomly selected and cleaned into a number 64-micron sieve. The sample was then preserved in 70% ethanol for examination in the lab.

One plate sampler deployed at Station 4 Vermont on 11 July 2000, could not be located two weeks later when retrieval was attempted. A new plate sampler was deployed at that location on the day the plate sampler was determined to be gone and was checked approximately 2 weeks later for settlement. Therefore, one zebra mussel settling plate sample was not collected between 11 July and 11 August 2000.

Asiatic clam samples were collected with a 9 inch ponar dredge in June, August, and October 2000 at Stations 2, 3, 4, and 5 (Figure 6-1). Dredge samples were collected at three locations per Station (near the New Hampshire shore, mid-stream, and near the Vermont shore) and three replicates were collected at each location (for a total of 108 dredges). All dredge samples were sieved through a standard USGS number 30 sieve in the field, prior to being preserved in 70% ethanol for later identification in the lab.

6.1.1 Laboratory Identification Procedures

Zebra mussel veliger samples were emptied into a petri dish and examined in entirety with cross-polarized light on a dissecting microscope with 40x magnification. The use of cross polarized light allows zebra mussel veligers to be distinguished from other planktonic organisms that are also collected in the samples, as the larval shells stand out as bright spots against a dark background (Johnson 1996).

In the laboratory, the three preserved replicate corbicula ponar dredge samples for each quarter point per location (NH, mid-stream, and VT), per station (2, 3, 4, and 5) were combined and the contents mixed (for a total of 36 dredge samples), then examined in entirety under low magnification (2x).

6.2 SUMMARY

River water temperatures ranged from 11.5° to 26.6° C, dissolved oxygen ranged from 7.4 to 10.4 mg/l, and pH ranged from 6.2 to 8.2 during veliger and settlement plate sampling in the vicinity of the Vermont Yankee Plant (Stations 4 and 5). Water temperature ranged between 11.2 to 24° C, dissolved oxygen ranged from 6.4 to 9.0 mg/l, and pH ranged from 6.6 to 8.0 during dredge collections of Asiatic clams in June, August, and October.

There were no Asiatic clams or any life stages of zebra mussels found in any samples collected during the 2000 Vermont Yankee monitoring program.

In addition to the zebra mussel sample collections, 13 zebra mussel awareness programs were presented during 2000 to a variety groups in Massachusetts, New Hampshire and Vermont, including local high schools, rotary clubs, lake homeowners associations, environmental education centers, and the Fairbanks museum.

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