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Subject: Report 31 attached

Jason, Hope this helps. Lynn

Lynn DeWald

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ECOLOGICAL STUDIES OF THE CONNECTICUT RIVER VERNON, VERMONT REPORT 31

January - December 2001

VERMONT YANKEE
NUCLEAR POWER CORPORATION
Brattleboro, Vermont

Prepared by:

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APRIL 2002

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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 first annual report submitted under the five-year discharge permit issued in 2001. 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).

On March 19, 2001 at 12:27 PM the plant turbine tripped and reactor scram occurred due to faulty auxiliary contacts in a Reactor Protection System relay. Following a complete investigation into this event the plant began a reactor start-up on March 20, 2001at 22:55. On March 21, 2001 at 17:53 the plant turbine was phased onto the grid and return to 100% power was initiated.
On April 27, 2001 at 11:00 AM the plant was shut down for a maintenance and refueling outage. The plant start up progressed as scheduled. The circulating water system was started up on May 18, 2001 at 1000. The reactor went critical on May 19, 2001 at 1247. On May 20, 2001 at 1639 the turbine-generator was phased to the grid and a return to full power was initiated. Larval fish and impingement sampling was not conducted during the outage.

Prior to the issuance of the current NPDES Permit in August 2001, the monitoring was completed as outlined in the previous Permit (1996-2000). Following are the changes of Part IV – Environmental Monitoring Studies, Connecticut River: reflected in the current Permit:

A. Macroinvertebrate cage (rock basket) sampling at the upstream stations (4 and 5) in the Vernon pool was discontinued. Sampling below Vernon Dam will continue once a month at Stations 2 and 3 in June, August, and October.

B. Macroinvertebrate dredge sampling was discontinued.

C. Juvenile American shad collections via seine and trawl and adult American shad monitoring at the Vernon Dam Fish ladder (with direction from the Vermont Department of Fish and Wildlife), are included in the Permit required monitoring.

D. One task-oriented macroinvertebrate study is identified to occur during 2002 and 2003.

E. Age determination of fishes was discontinued.

The juvenile and adult American shad studies were conducted during 2001, the final reports outlining these studies are submitted under separate cover to the Environmental Advisory Committee in spring 2001 as Analytical Bulletin Nos. 77 and 78. The bulletins were titled "Composition of Adult American Shad at the Vernon Dam Fishway during 2001," Vermont Yankee/Connecticut River System Analytical Bulletin 77, and "Abundance of Juvenile American Shad in the Vernon pool during 2001"Vermont Yankee/Connecticut River System Analytical Bulletin 78. There were no special studies conducted during 2001.

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

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 29 August 2001. 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 2000, 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 and plant discharge flow by Vermont Yankee in 2001. This data was obtained from 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 March 19, 2001 at 12:27 PM. The plant turbine tripped and reactor scram occurred due to faulty auxiliary contacts in a Reactor Protection System relay. Following a complete investigation into this event the plant began a reactor start-up on March 20, 2001at 22:55. On March 21, 2001 at 17:53 the plant turbine was phased onto the grid and return to 100% power was initiated. On April 27, 2001 at 11:00 AM the plant was shut down for a maintenance and refueling outage. The plant start up progressed as scheduled. The circulating water system was started up on May 18, 2001 at 1000. The reactor went critical on May 19, 2001 at 1247. On May 20, 2001 at 1639 the turbine-generator was phased to the grid and a return to full power was initiated. Otherwise the plant remained at full power throughout 2001, 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 2001. The hourly average Connecticut River discharge was computed using 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 2001 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 daily Connecticut River average flow for 2001 was 69,762 cfs, which occurred on 23 April 2001 compared to 57,943 cfs on 05 April 2000. The second highest peak daily average flow (other than in April) was 35,013 cfs on 2 May 2001. The hourly average flows are represented in Figure 2-3. The peak hourly average Connectcuit River flow occurred on 23 April 2001 at 71,544 cfs. The lowest daily Connecticut River flows at Vernon Dam was 1275 cfs observed on 11, 12 and 27 August 2001.

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 2001 except in July when there was one instance where Vermont Yankee operators did not respond promptly to changing river conditions by quickly shifting the Recirculation Gate Position and going to Closed Cycle. This event was:
5 Jul 2001 2300-2359 DST, +0.12 degrees F (above permit limit), Permit Limit + 2.0 degrees F.

During the cold water period when the permit limit was 13.48F, the maximum simulated river temperature increase observed was 12.668F on 21 December 2001 at 0400 when the river flow was low at 1250 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 measures at Station 3 reflected both the natural and plant-induced changes in temperature between the upstream and downstream locations, and never exceeded the 658F during the periods of 1 January through 15 May 2001 and 15 October through 21 December 2001 (Figure 2-5). At no time during the month for all of the data available did the temperature change observed at Station 3 exceeded the ±5°F permitted change per hour.

Figure 2.1 Vermont Yankee Core Thermal Power and Plant Discharge Flow 2001

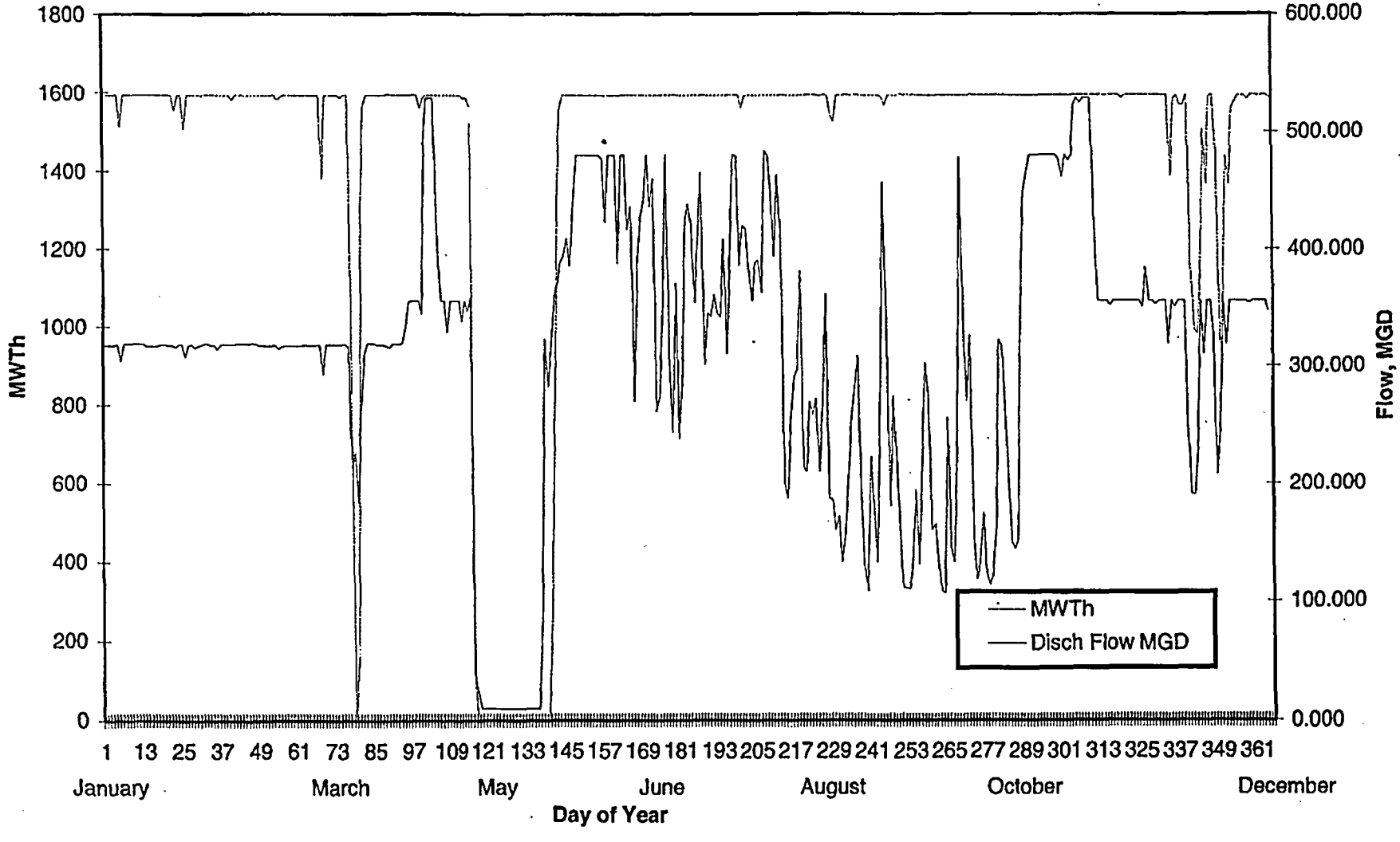


Figure 2-2 Hourly Average Heat Rejected by the Condenser for the Year 2001

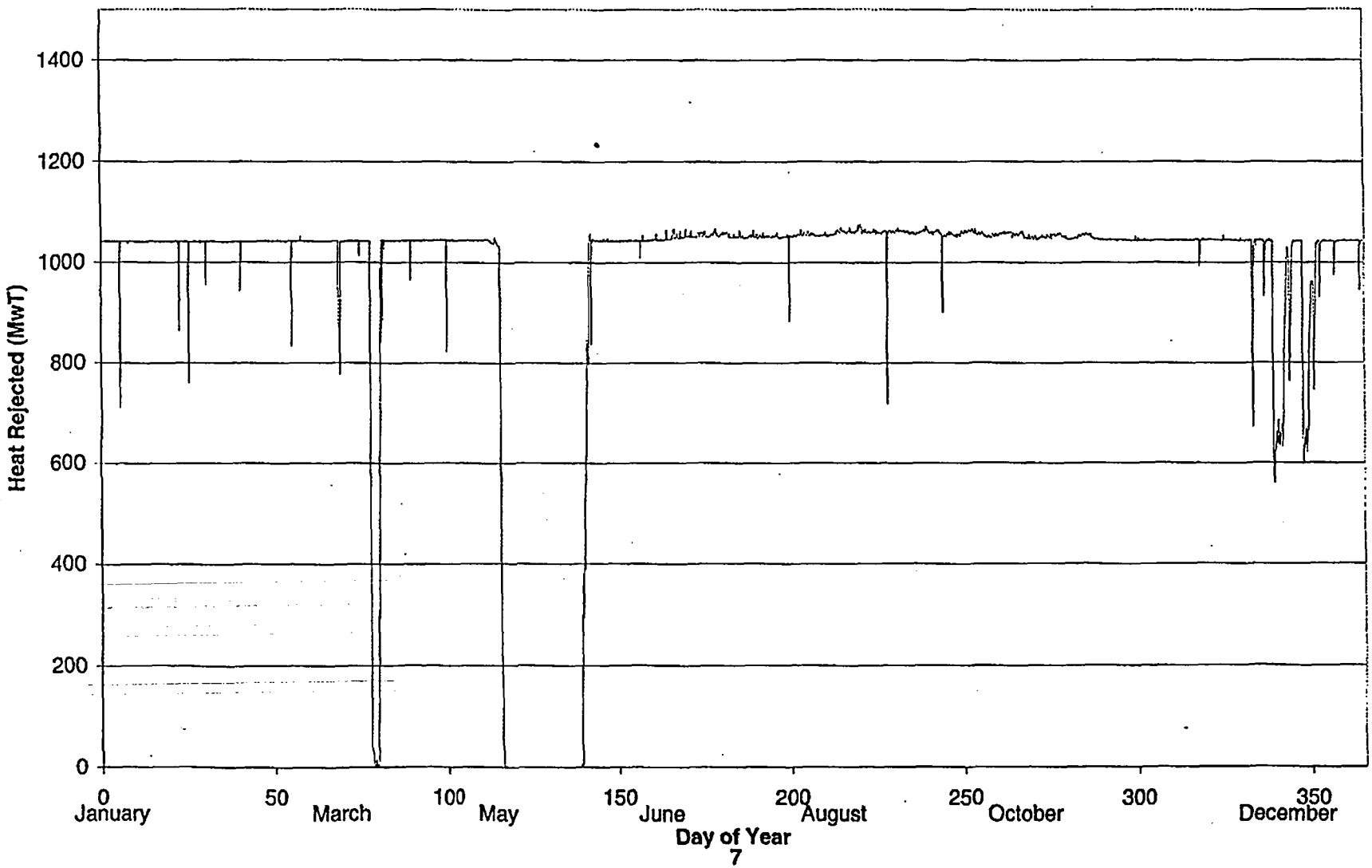


Figure 2-3 Hourly Average Connectcut River Flow Rate for the Year 2001

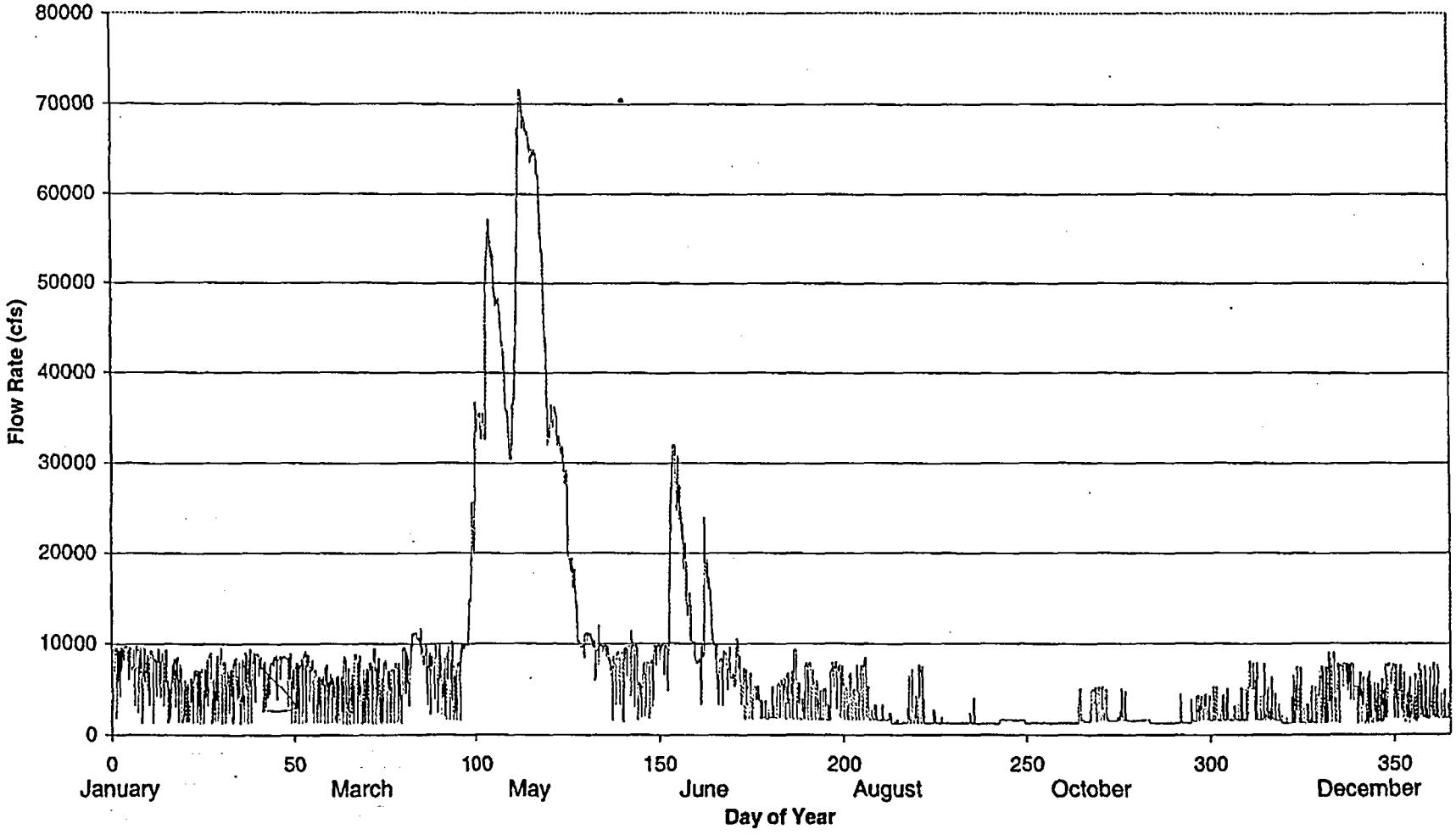


Figure 2-4 Simulated Connecticut River Temperature Increase at Monitor 3 2001

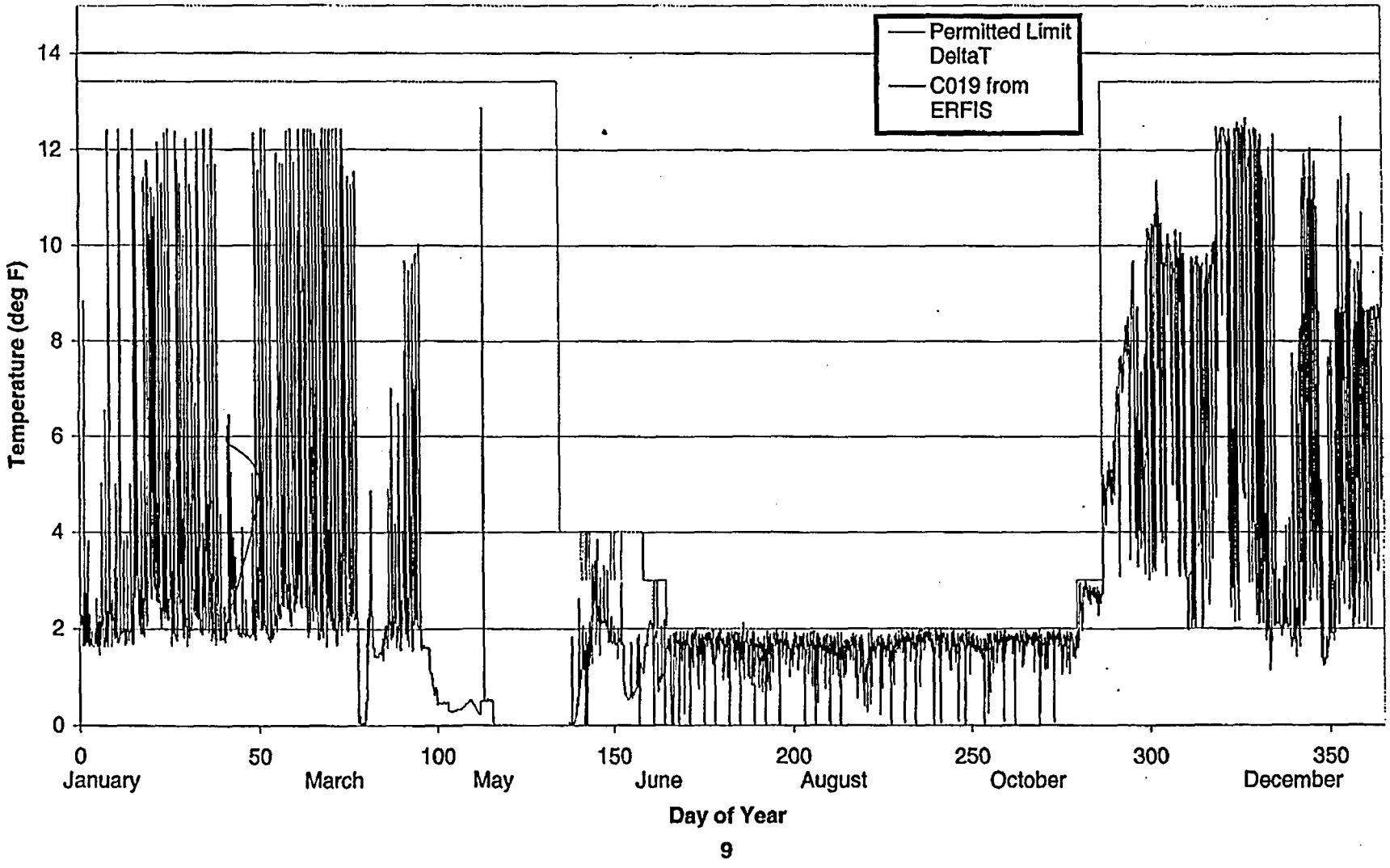


Figure 2-5 Hourly Average Connectcut River Temperature at Monitors 3 and 7 for the Year 2001

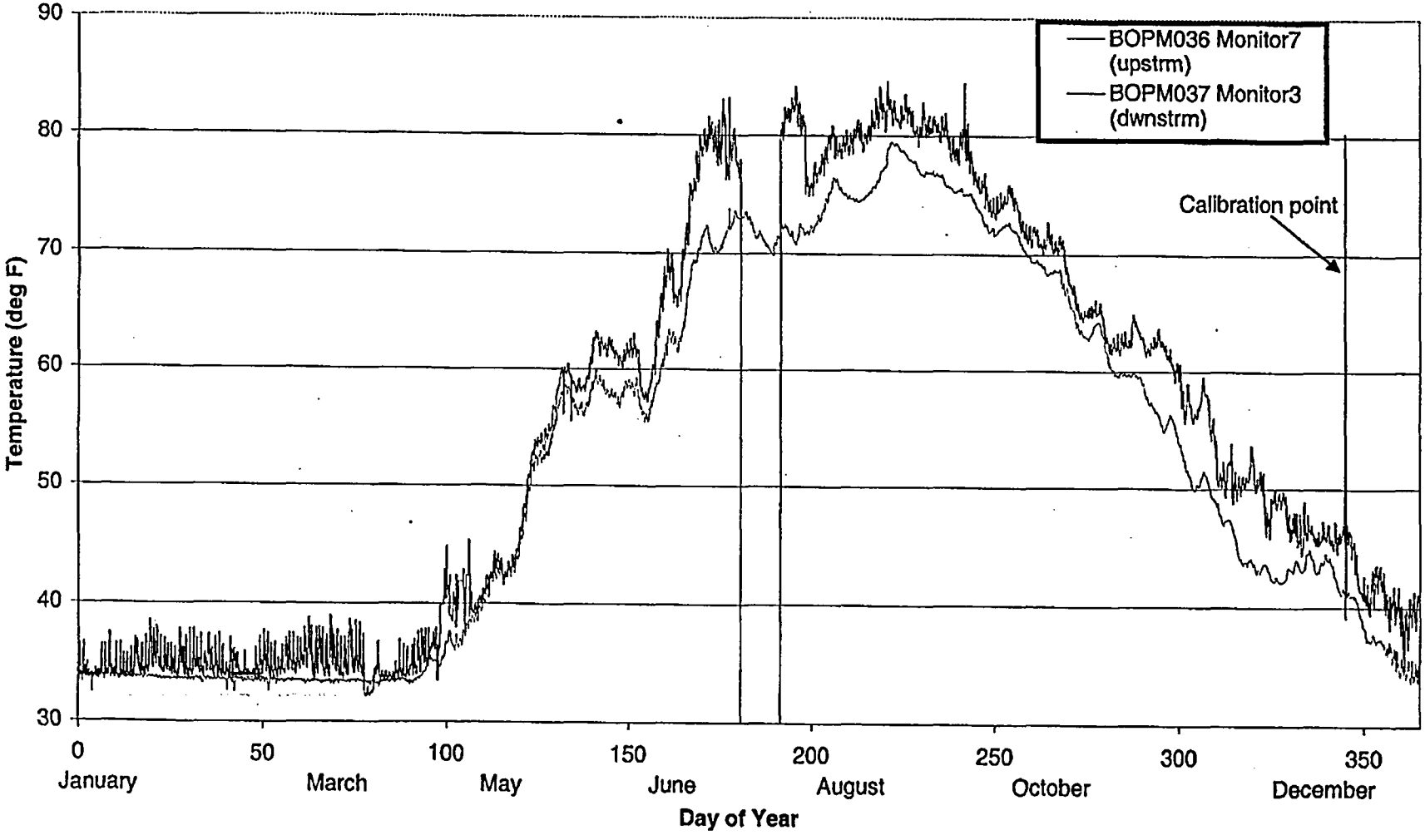


Table 2.1 - Average Connecut River Discharge (cfs) at Vernon Station for the Year 2001

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day												
1	6786	4605	4470	4983	34204	8766	2958	1809	1675	1572	2379	4810
2	6692	5275	4341	5475	35013	11209	4393	1309	1665	1625	1616	5757
3	8476	6095	3830	5326	33369	27870	5218	1322	1670	2570	1866	7165
4	9274	5193	2770	4111	31417	28926	3978	1285	1628	1998	1734	6951
5	8597	3923	5947	6043	28540	26436	3923	1314	1610	1614	2944	6795
6	7582	6046	3361	7675	19940	21232	6829	2157	1598	1595	2074	4886
7	7392	5357	3441	9802	17700	15918	3456	2940	1404	1580	5358	3928
8	6796	6291	6695	10816	13373	12624	2550	2117	1297	1571	5401	4348
9	5193	7518	4974	16801	9853	9109	5338	3966	1328	1609	3893	3240
10	7332	7534	2718	23513	10102	8053	5278	2842	1332	1630	1848	2933
11	7548	4851	3973	34621	11045	7609	4467	1275	1333	1433	3343	2126
12	6124	4656	5531	34178	10443	17137	3820	1275	1350	1337	2874	2472
13	7574	7109	6523	34178	8465	16751	2643	1754	1357	1329	2391	3127
14	7303	8228	5620	53405	9700	11262	3784	1319	1325	1343	1964	3914
15	6989	7437	2620	54044	9643	7738	2003	1362	1334	1329	1735	5894
16	3008	8317	5736	49524	9585	7001	5629	1306	1331	1322	1426	6781
17	6503	8478	4263	47553	7714	7183	6963	1302	1314	1324	1331	4810
18	6454	6181	5005	43501	5895	7193	6154	1297	1325	1321	1282	5361
19	4708	4827	5883	36919	7324	6674	4914	1288	1327	1725	2369	3433
20	3260	4909	4544	32086	6939	6925	3564	1312	1315	1359	3920	2669
21	3030	6094	6971	36119	7199	8259	4118	1325	1327	1356	3532	2645
22	4095	6884	6572	51227	8780	4757	3178	1327	2813	1677	1758	3129
23	5303	6605	7221	69762	8462	3640	4170	1644	1571	1571	2186	4403
24	4874	6263	11027	68212	7202	3563	4405	1854	1467	2618	1884	3509
25	5034	5224	10727	66856	4163	4186	6035	1279	2731	2861	1722	3373
26	5743	4249	9726	64434	5478	4441	3228	1276	4456	2988	3479	3056
27	7198	4591	8604	64492	5805	2570	2003	1275	3488	2315	4314	4125
28	3088	5275	6528	61191	6851	2202	2224	1286	2716	2723	3959	3410
29	5224		6188	52807	8105	1896	1611	1306	3399	3435	5659	2331
30	6003		7023	40757	9147	2607	1748	1277	1578	1628	6329	2471
31	5549		6549		9754		1633	1451		2334		2026
Monthly Av	6089	6001	5786	36431	12942	10124	3942	1609	1805	1824	2886	4058

3.0 WATER QUALITY

3.1 COPPER. IRON AND ZINC CONCENTRATIONS

Beginning in April 1996, and continuing through 2001, 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. Additionally, as discussed at the EAC meeting in 2001 additional samples were monitored for soluable copper, iron and zinc. These values are included on Table 3-1 and are depicted Figures 3-2a, 3-3a, and 3-4a.

Copper concentrations were observed at or below the detection limit of 0.010 µg/1 in nearly all months of 2001 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 0.0093 mg/1 on 16 February 2001. The highest concentration of copper observed in the Vermont Yankee Station discharge was 0.064 mg/1 on 17 September 2001. Connecticut River water sampling at Station 3, below the Vernon Dam tailrace, had slightly higher copper concentrations during most of the 2001 sampling events, with a maximum copper concentration of 0.308mg/1 observed on 14 March 2001, when there was noted on the chain of custody that heavy sediment wa present in the sample. (Table 3-1, Figure 3-2).

Stations 3 and 7 had relatively high iron concentrations during 2001 (Table 3-1, Figure 3-3). Iron concentrations were relatively low throughout 2001 in the Vermont Yankee Station discharge. The highest concentrations in Vermont Yankee Discharge was 1.23 mg/L occurring on 17 April 2001. The highest iron concentration of 5.02 mg/1 was observed at Station 7 on 16 February 2001. The highest iron concentration at Station 3 was 12.2 mg/L mg/1 observed on 17 April 2001, during the high flow events.

Zinc concentrations in Connecticut River water samples were generally less than 0.020 mg/1 during 2001. (Table 3-1, Figure 3-4). The highest zinc concentration at Station 7 was 0.0286 mg/1 observed on 16 February 2001.The highest zinc concentration of 2.89 mg/l was observed at Station 3 on 16 February 2001. The highest zinc concentration in the Vermont Yankee discharge was 0.0129 mg/1 observed on 16 January 2001.

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. This is evident in the total metals data versus the soluable metals data.

3.2 WATER TEMPERATURE

Water temperature was measured continuously in the Connecticut River at Station 7 and Station 3 during 2001, 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 3-5 and Figure 3-5. The fishway operated daily from 22 May at 1400 DST to 5 July 2001 at 0900 DST. During this 2001 period of fishway operation, the hourly water temperature ranged from a low of 52.04°F on 23 May 2001 at 0400 and 0500 to a high of 79.70°Fon 30 June 2001 at 1100.

Calibration of the primary temperature probes linked to the Azonix boxes occurred on April 24th from 0800 to 1600 and on December 12 from 0700-1300. Temperature probe calibrations on December 12th created a spike on Figure 2-5 due to the probes being taken out of the water and placed into the calibration equipment. No WaDaR data was available due to Normandeau swapping calibrated WaDaR temperature monitor at the same time. Review of the plant operations logs indicates no plant setting changes were made during this calibration

Additionally, WaDar data was used form Station 3 was used from April 8 at 0700 to April 18 at 1300, due to the modem loss from a thunderstorm. The data obtained from the WaDar at Station 3 was very erratic and required manual interpretation. There were many data points that were completely unusable. Points that were used were hand selected based on upstream river water temperatures, plant condenser outlet temperatures and hourly average river flows. There is also a data gap for Station 3 from 30 June at 0700 to 11 July at 1200 due to a lightening storm, which caused a modem failure to the Azonix temperature probe system. WaDar data was not available for this period; there was an equipment malfunction, which caused all data to be lost.

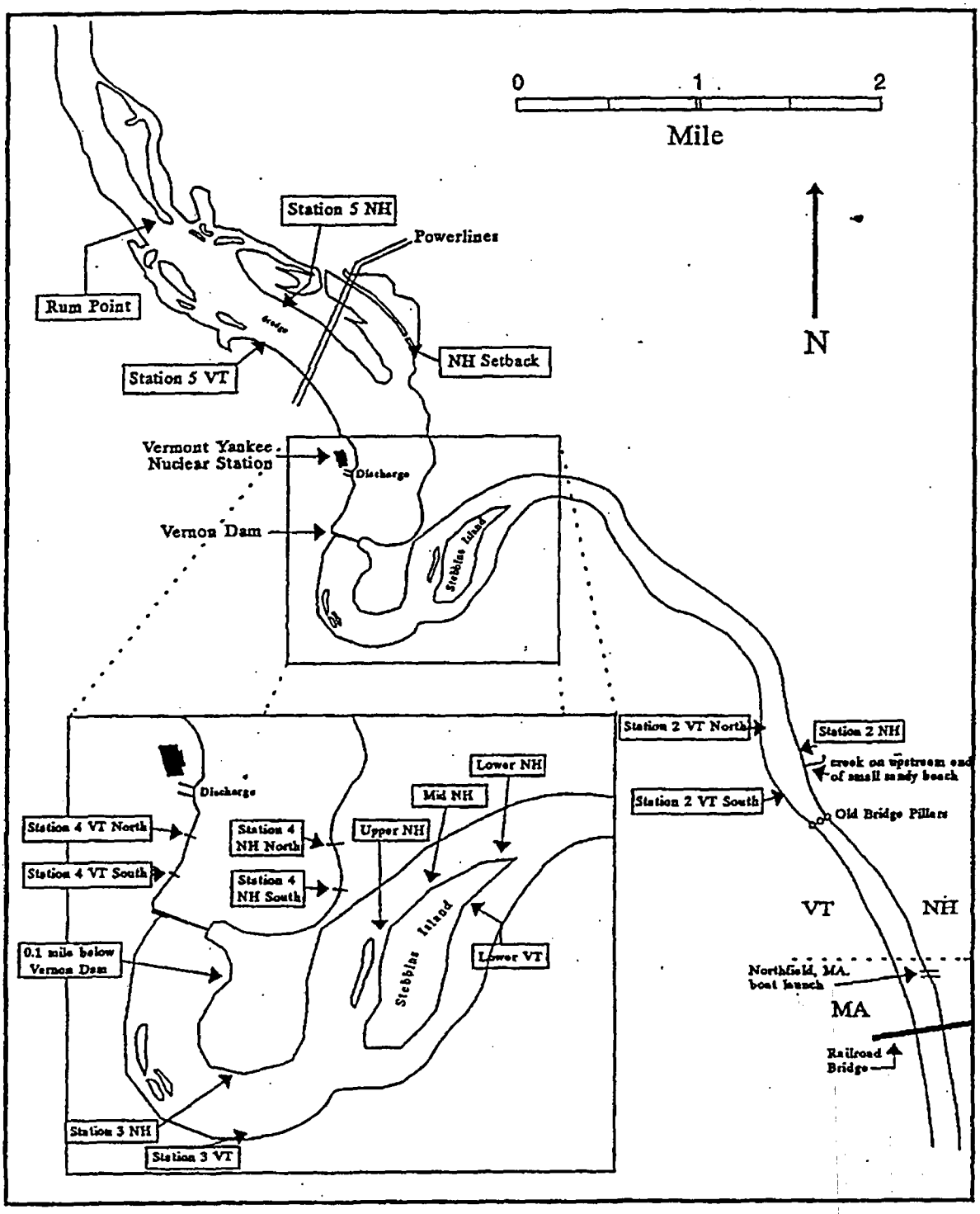


Figure 3-1. Vermont Yankee NPDES Sampling Stations.

Table 3.1 2001 NPDES River Water Metals (mg/L)

Total Metals	Station 7			Station 3			Discharge			
Date	Copper	Iron	Zinc	Copper	Iron	Zinc	Copper	Iron	Zinc	
01/16/2001	0.0009	0.223	0.0026	0.0026	0.362	0.0106	0.0041	0.23	0.0129	
02/16/2001	0.0093	5.02	0.0286	0.283	0.152	2.89	0.0058	0.227	0.0137	
03/14/2001	0.0015	0.215	0.0046	0.308	1.77	1.56	0.0044	0.209	0.0088	Heavy Sediment in the samples
04/17/2001	0.0026	0.567	0.0086	0.0639	12.2	0.134	0.0059	1.23	0.014	Flows high
05/14/2001	0.0007	0.458	0.0044	0.0007	0.315	0.006	0.0011	0.314	0.0038	
06/14/2001	0.0024	0.332	0.0029	0.0033	0.362	0.0029	0.0109	0.369	0.0029	
07/13/2001	0.0024	0.278	0.0007	0.0064	0.274	0.0269	0.0078	0.169	0.0063	
08/13/2001	0.0022	0.158	0.0062	0.0063	0.146	0.0124	0.019	0.139	0.01	
09/17/2001	0.0021	0.103	0.0189	0.0191	0.163	0.0636	0.0164	0.0982	0.0091	
10/16/2001	0.0018	0.614	0.0059	0.0077	0.142	0.0109	0.0091	0.146	0.0044	
11/13/2001	0.00059	0.152	0.0017	0.0034	0.172	0.006	0.0054	0.147	0.0052	
12/14/2001	0.0018	0.217	0.01	0.0039	0.255	0.0097	0.0045	0.185	0.0109	

Soluable Metals	Station 7			Station 3			Discharge		
Date	Copper	Iron	Zinc	Copper	Iron	Zinc	Copper	Iron	Zinc
05/14/2001	0.0007	0.12	0.0056	0.0007	0.0451	0.0036	0.0007	0.0852	0.0041
06/14/2001	0.0024	0.0779	0.0029	0.0071	0.0483	0.0029	0.0008	0.0472	0.0029
07/13/2001	0.0024	0.0561	0.0073	0.0035	0.0435	0.007	0.0049	0.0532	0.007
08/13/2001	0.0018	0.034	0.0117	0.0033	0.0239	0.0079	0.0126	0.0221	0.0057
09/17/2001	0.0005	0.0269	0.0032	0.0058	0.0257	0.0174	0.0122	0.0188	0.0079
10/16/2001	0.0026	0.16	0.0052	0.0067	0.0432	0.0103	0.0083	0.0457	0.0051
11/13/2001	0.0017	0.0634	0.006	0.0032	0.0571	0.0049	0.0049	0.051	0.0076
12/14/2001	0.00093	0.084	0.0104	0.0026	0.104	0.0142	0.0043	0.0749	0.0094

[ ] equals concentrations below detection limits.

Figure 3-2 Connecticut River water concentrations of Total Copper observed in monthly samples from the vicinity of Vermont Yankee, Vernon, Vermont

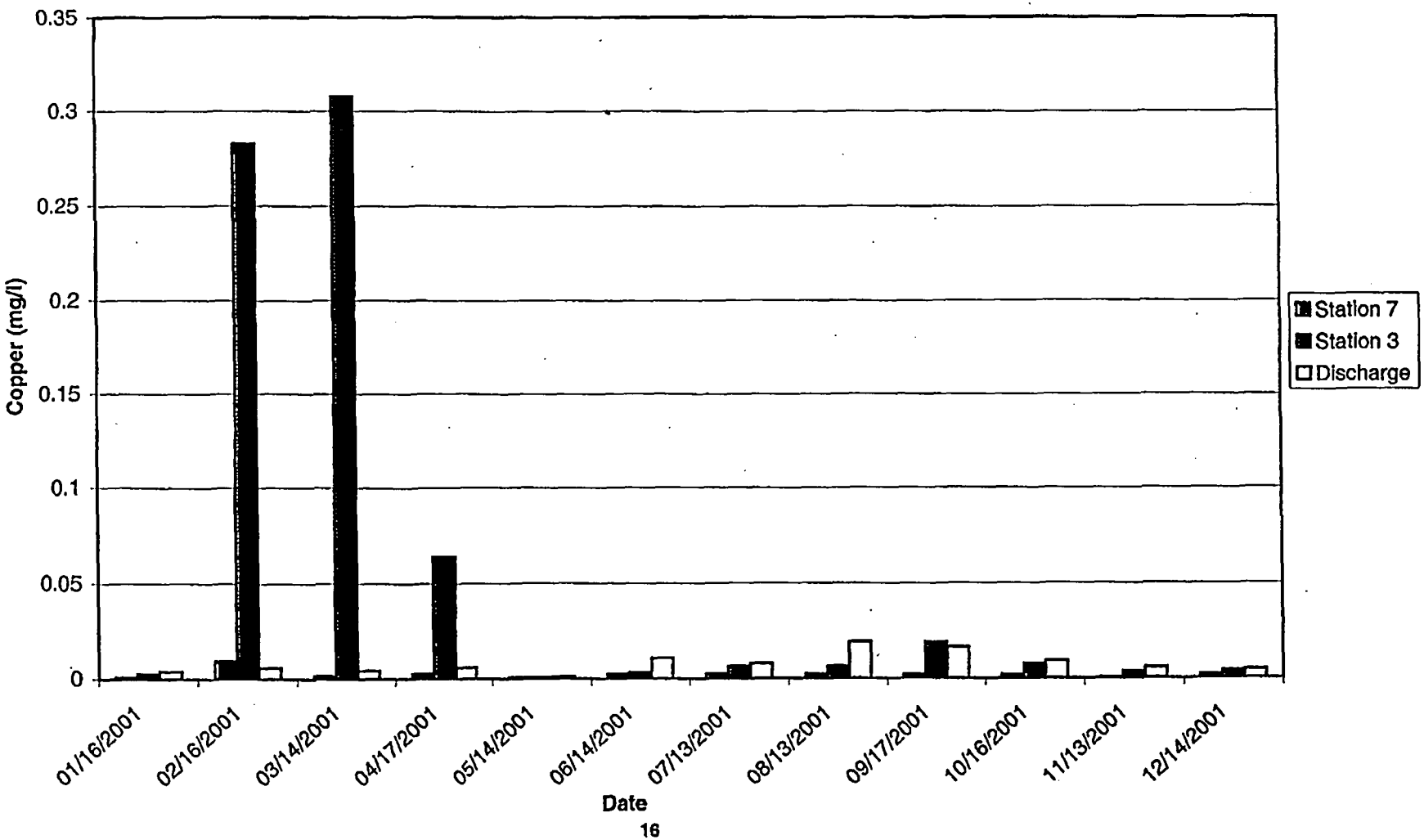


Figure 3-2a Connetictlcut River water concentrations of SoluableCopper observed in monthly samples in the vicinity of Vermont Yankee, Vernon, Vermont

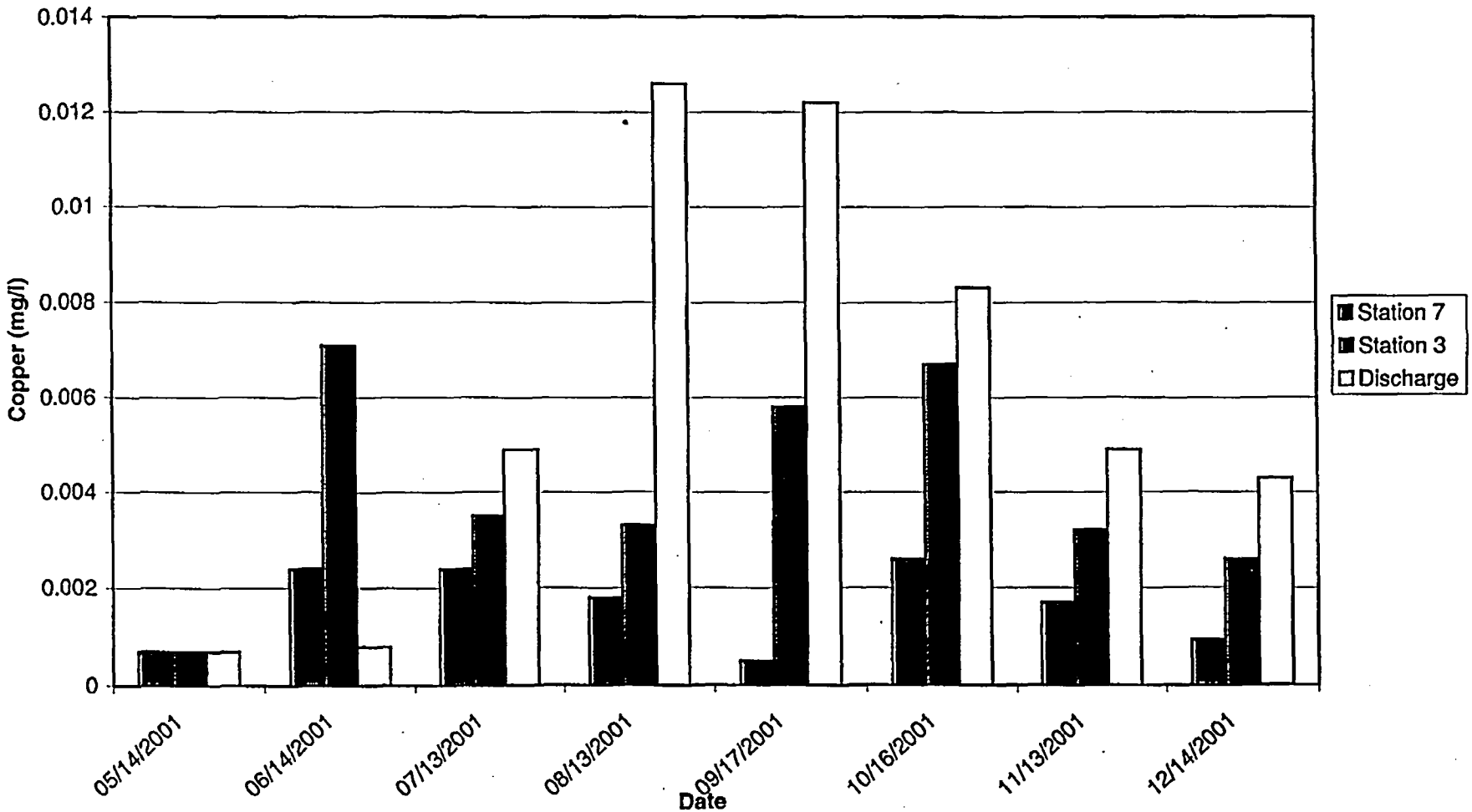


Figure 3-3 Connecticut River water concentrations of Total Iron observed in monthly samples from the vicinity of Vermont Yankee, Vernon, Vermont

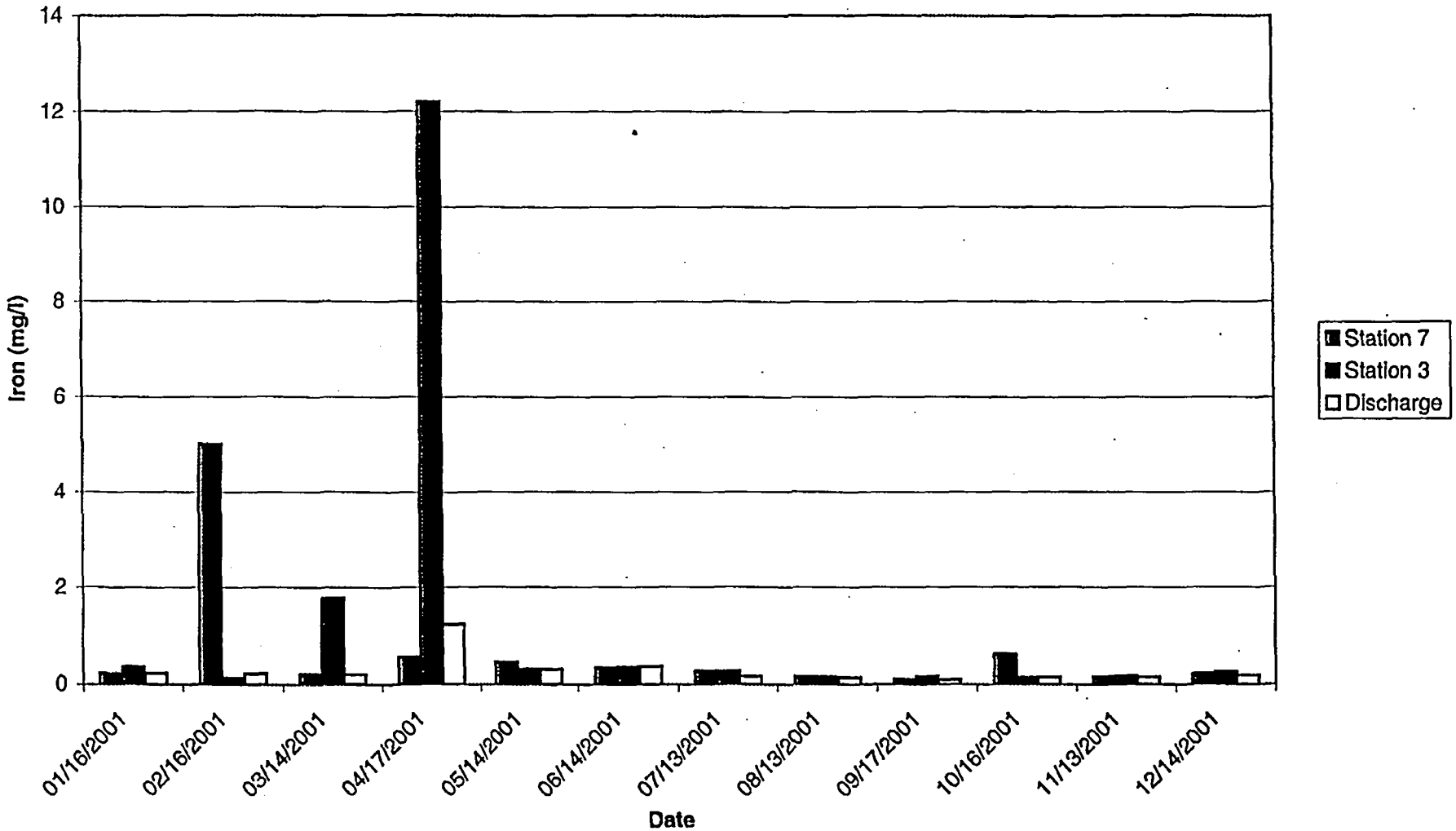


Figure 3-3a Conneticticut River water concentrations of Soluable Iron observed in monthly samples in the vicinity of Vermont Yankee, Vernon, Vermont

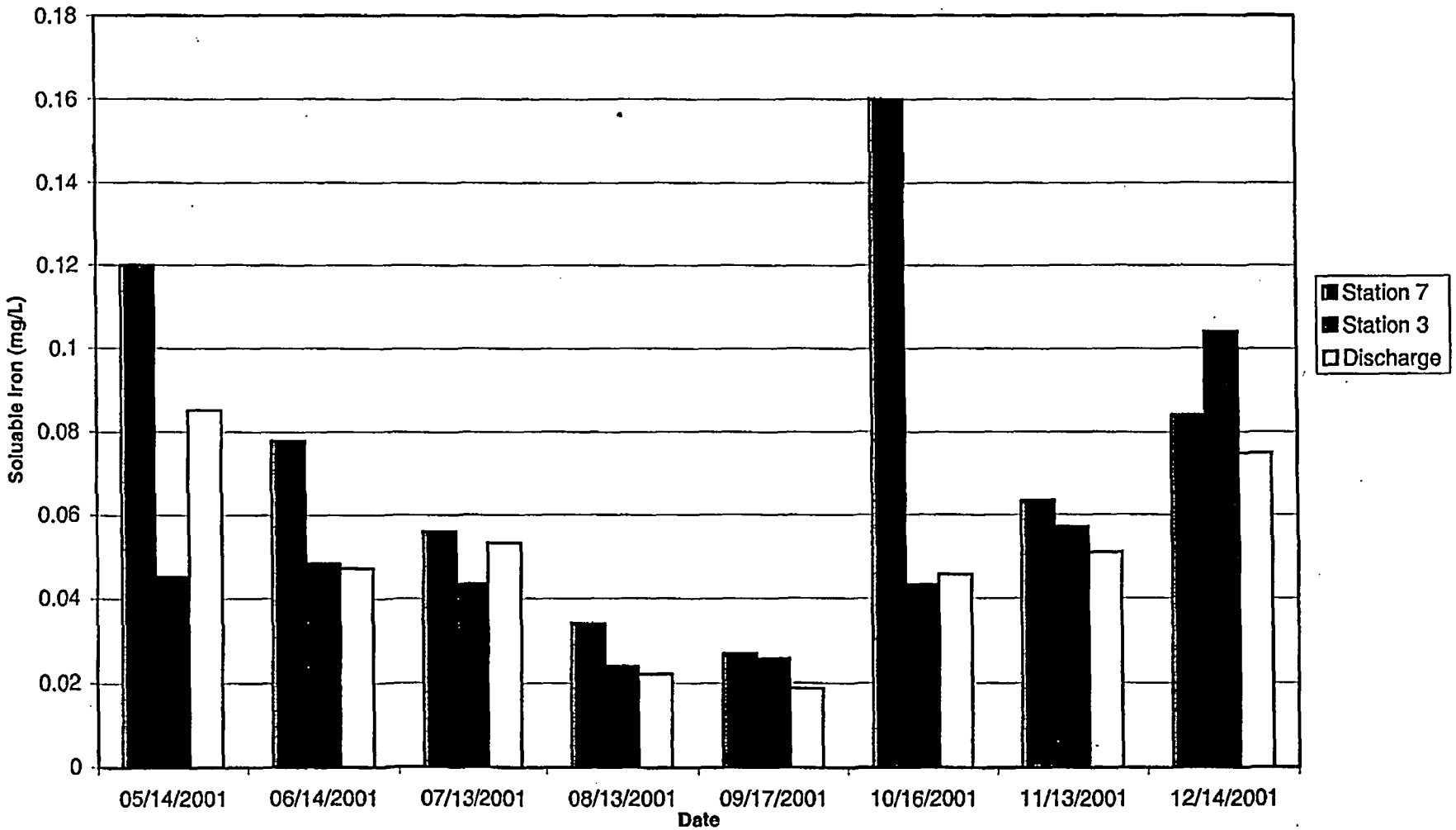


Figure 3-4 Conneticticut River water concentrations of Total Zinc observed in monthly samples in the vicinity of Vermont Yankee, Vernon, Vermont

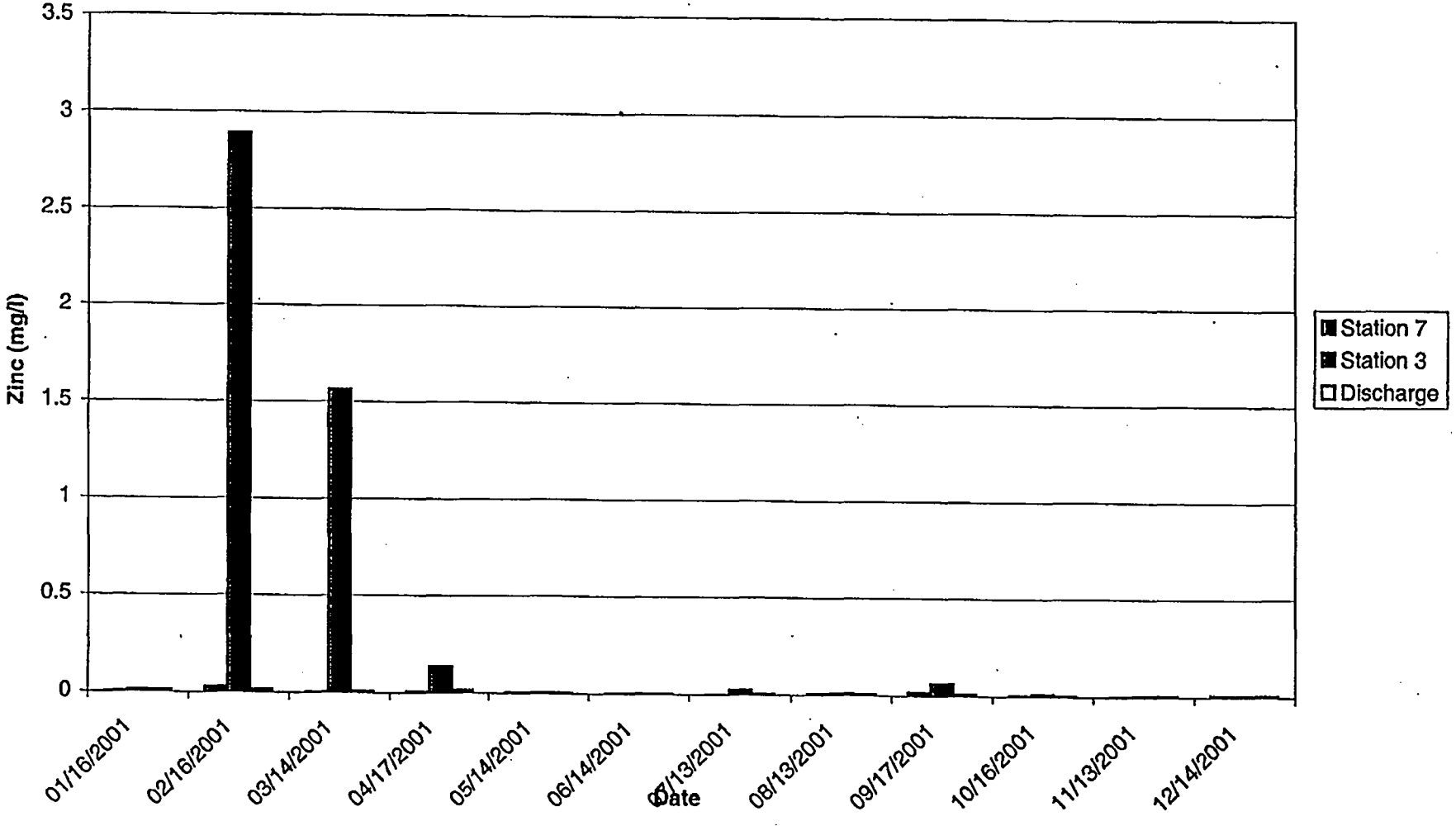


Figure 3-4a Connecticticut River water concentrations of Soluable Zinc observed in monthly samples in the vicinity of Vermont Yankee, Vernon, Vermont

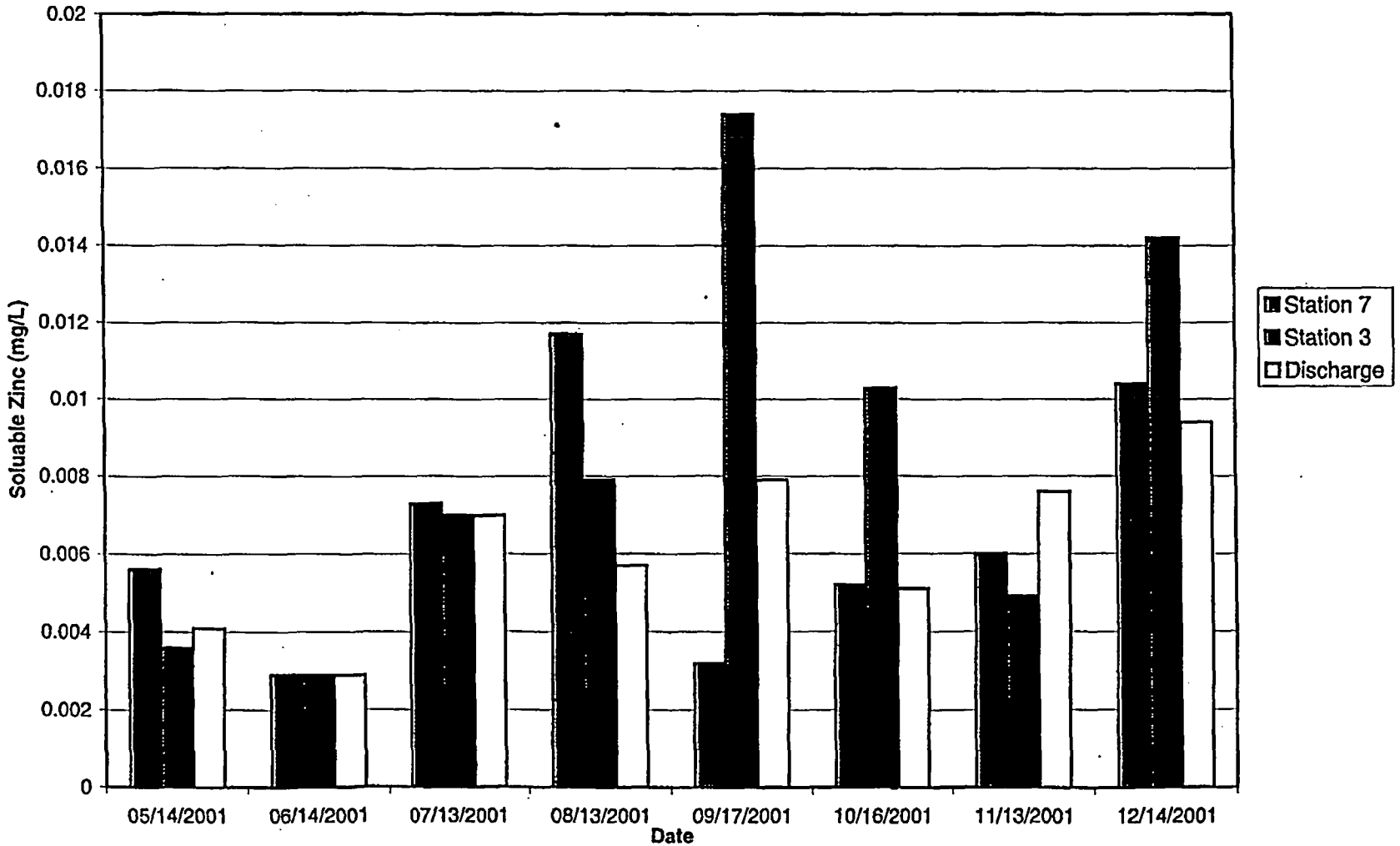


Table 3.2 - Average Connecticut River Temperature (deg F) at Station 7 for the Year 2001

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day												
1	33.96	33.61	33.50	33.35	44.54	58.21	73.18	74.52	75.07	63.40	49.94	43.61
2	33.96	33.63	33.48	33.49	46.34	58.26	73.16	74.53	74.42	63.02	50.27	44.62
3	33.91	33.50	33.34	33.71	48.11	56.59	72.65	74.75	73.83	62.80	51.03	44.01
4	33.90	33.62	33.42	33.97	50.25	55.93	71.64	75.05	73.28	63.17	51.15	43.02
5	33.87	33.64	33.45	34.46	51.89	55.91	71.51	75.47	72.55	63.90	50.25	43.48
6	33.90	33.58	33.50	35.27	52.21	57.18	71.39	75.85	71.94	64.09	49.22	44.00
7	33.91	33.58	33.41	35.20	52.33	58.43	70.83	76.43	72.00	63.07	48.80	44.05
8	33.92	33.60	33.36	35.01	52.51	59.43	70.39	77.15	71.74	61.63	47.83	43.63
9	33.87	33.55	33.44	34.92	52.99	60.77	70.13	77.87	72.08	60.39	47.16	42.50
10	33.85	33.33	33.40	35.80	54.30	61.90	71.00	79.14	72.38	59.94	47.36	41.52
11	33.79	33.52	33.39	37.01	55.68	62.79	71.71	79.34	72.55	59.62	47.04	41.27
12	33.82	33.20	33.47	36.83	57.32	62.62	72.23	79.26	72.21	59.82	45.83	42.75
13	33.74	33.61	33.48	36.51	58.07	61.92	72.00	78.82	71.94	59.73	44.38	41.06
14	33.76	33.52	33.42	36.64	58.22	62.79	71.58	78.59	71.64	59.67	43.80	40.91
15	33.73	33.48	33.44	37.05	57.67	64.45	70.97	78.14	70.76	59.73	43.73	40.32
16	33.78	33.48	33.50	37.73	56.87	67.06	71.62	77.87	70.12	59.66	43.97	39.01
17	33.78	33.43	33.49	38.22	56.37	69.02	72.18	77.58	69.77	59.49	43.61	37.88
18	33.77	33.49	33.48	38.64	56.51	69.37	71.74	76.96	69.32	58.87	43.06	37.23
19	33.77	33.49	33.39	38.74	56.50	70.43	71.91	76.72	69.36	57.79	43.15	37.46
20	33.78	33.56	33.35	39.01	57.33	71.57	72.04	76.91	69.11	57.24	43.62	37.16
21	33.75	33.15	33.37	39.78	58.57	72.02	72.70	76.90	68.78	56.80	43.15	37.28
22	33.70	33.61	33.35	40.60	59.09	70.76	73.04	76.77	68.27	56.37	42.39	36.75
23	33.64	33.53	33.23	41.46	58.89	70.26	73.91	76.73	68.40	55.47	42.33	36.33
24	33.64	33.49	33.44	42.33	58.29	70.15	74.74	76.63	68.54	55.04	42.14	36.35
25	33.63	33.48	33.52	42.52	57.83	70.65	75.68	75.95	68.54	55.87	42.13	35.77
26	33.60	33.49	33.48	42.59	57.78	71.56	76.29	75.75	67.63	55.88	42.75	35.12
27	33.60	33.49	33.53	42.09	57.51	72.24	75.78	75.50	66.90	54.93	43.20	34.96
28	33.64	33.52	33.53	42.53	57.06	72.70	75.22	75.32	65.98	53.68	43.36	34.83
29	33.62		33.60	42.82	57.89	73.26	74.93	75.48	65.21	52.67	43.76	34.65
30	33.57		33.60	43.10	58.68	72.98	74.75	75.17	64.02	51.50	43.11	34.46
31	33.59		33.45		58.67		74.63	75.07		50.72		34.47
Monthly Av	33.77	33.51	33.44	38.06	55.36	65.37	72.76	76.65	70.27	58.60	45.45	39.36

Table 3.3 - Average Connecticut River Temperature (deg F) at Station 3 for the Year 2001

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day												
1	34.45	35.28	35.17	34.75	45.32	61.85	0.00	80.44	78.01	64.82	56.09	46.81
2	34.14	34.92	35.27	34.73	47.12	61.12	0.00	80.03	76.53	64.67	56.52	46.58
3	33.96	34.78	35.91	35.24	49.16	58.42	0.00	79.53	75.87	64.93	58.11	46.40
4	33.72	34.84	36.64	35.76	51.51	57.71	0.00	80.08	75.71	65.09	58.28	45.62
5	33.86	35.54	35.31	35.42	53.15	57.93	0.00	80.77	75.58	65.32	56.90	45.64
6	33.99	34.78	35.42	35.86	53.70	59.70	0.00	81.68	74.17	65.21	54.91	46.30
7	34.49	34.91	35.87	36.76	53.83	62.02	0.00	82.38	73.79	64.71	52.49	46.27
8	34.30	34.67	34.97	36.14	53.85	64.38	0.00	82.14	73.74	62.86	50.78	45.51
9	34.87	34.31	34.72	38.04	54.56	66.81	0.00	82.26	74.22	61.94	50.82	45.72
10	34.15	34.23	36.53	40.75	55.71	68.56	0.00	82.48	74.38	62.16	51.14	45.42
11	34.35	34.92	35.48	41.21	57.19	68.70	80.25	82.12	75.13	62.20	51.92	46.22
12	34.25	35.13	34.97	38.73	59.14	66.56	80.91	81.35	75.24	62.29	50.18	47.79
13	34.16	34.75	34.41	40.32	59.51	66.10	81.77	81.44	74.37	62.53	50.15	45.91
14	34.33	34.07	35.01	41.24	59.88	68.12	82.24	82.31	73.89	62.29	50.26	44.73
15	34.23	34.38	36.33	41.86	59.01	70.66	82.76	81.96	72.42	63.40	50.53	43.01
16	35.63	34.06	35.43	40.36	58.54	72.82	82.39	81.33	71.91	64.12	51.41	41.33
17	34.86	34.11	35.41	43.24	58.50	75.33	80.90	80.37	71.52	63.30	52.29	40.99
18	34.48	34.43	35.24	40.16	58.30	76.82	78.18	80.13	71.49	62.74	50.21	40.60
19	34.79	34.79	34.03	39.47	58.63	78.11	75.61	81.44	71.81	61.68	50.76	41.27
20	36.41	35.37	32.45	39.85	59.96	79.16	76.20	80.65	70.78	61.92	49.34	42.23
21	35.68	34.88	32.42	40.58	61.72	79.48	76.78	80.62	70.65	62.33	47.06	42.53
22	35.63	34.48	33.86	41.53	62.79	80.28	77.40	81.11	71.70	62.86	47.83	41.95
23	34.82	34.50	34.83	42.04	62.08	79.74	77.93	80.68	71.18	62.42	49.17	40.18
24	34.87	34.41	33.88	43.05	61.87	79.11	79.06	80.54	70.62	61.87	49.09	39.74
25	34.75	34.81	33.87	43.65	61.85	80.26	80.02	80.80	70.64	61.32	49.12	40.19
26	34.95	35.56	33.84	43.36	61.89	79.23	79.42	79.48	70.86	60.52	48.43	40.22
27	34.33	35.28	33.86	42.35	61.28	78.16	78.88	78.64	68.91	59.88	46.59	38.36
28	35.68	35.00	34.19	42.91	60.89	79.17	78.92	78.40	67.55	59.65	46.79	37.80
29	35.12		34.53	43.30	60.79	78.25	79.49	79.03	66.94	57.12	46.21	38.96
30	34.63		34.21	43.76	61.42	54.57	79.20	80.41	65.69	57.29	45.57	39.80
31	34.80		34.44		61.74		79.69	79.67		57.04		39.78
Monthly Av	34.67	34.76	34.79	39.89	57.58	70.99	79.41	80.78	72.50	62.29	50.96	43.02

Table 3.4 - Average Heat Rejected by the Condenser (Mwt) for the Year 2001

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day												
1	1041	1042	1042	1043	0	1043	1057	1055	1053	1050	1043	1037
2	1042	1042	1042	1043	0	1043	1050	1061	1036	1050	1043	1043
3	1041	1041	1042	1043	0	1042	1050	1063	1054	1051	1044	1026
4	1041	1041	1042	1044	0	1042	1050	1061	1057	1054	1043	1027
5	1042	1041	1041	1044	0	1043	1053	1061	1054	1055	1043	1046
6	991	1041	1042	1044	0	1041	1049	1061	1054	1054	1043	756
7	1041	1041	1042	1044	0	1044	1049	1060	1057	1049	1043	652
8	1041	1041	1042	1044	0	1043	1052	1065	1060	1046	1044	658
9	1041	1041	1042	1044	0	1044	1053	1066	1062	1046	1044	763
10	1041	1034	897	1024	0	1045	1052	1062	1063	1048	1044	987
11	1041	1040	1041	1040	0	1046	1051	1060	1059	1051	1044	900
12	1041	1040	1041	1044	0	1045	1052	1060	1056	1053	1043	1040
13	1041	1041	1042	1044	0	1045	1052	1061	1057	1055	1043	1042
14	1041	1041	1042	1043	0	1047	1050	1059	1052	1055	1044	971
15	1041	1041	1041	1043	0	1047	1052	1058	1051	1049	1039	641
16	1041	1041	1039	1044	0	1056	1051	1015	1052	1046	1044	731
17	1041	1042	1041	1044	0	1051	1050	1031	1054	1045	1044	943
18	1041	1042	1042	1044	0	1051	1051	1060	1054	1045	1045	895
19	1041	1042	558	1044	0	1052	1030	1061	1057	1044	1045	1020
20	1041	1041	5	1044	199	1052	1051	1063	1058	1045	1044	1031
21	1041	1042	112	1044	504	1052	1053	1062	1059	1045	1043	1042
22	1041	1042	861	1045	881	1051	1054	1060	1054	1045	1044	1041
23	1015	1042	1027	1044	1023	1055	1055	1059	1055	1045	1044	1042
24	1041	1033	1042	1040	1044	1055	1056	1057	1056	1045	1044	1035
25	1041	1037	1042	1041	1043	1054	1056	1056	1056	1044	1043	1042
26	988	1042	1043	1026	1043	1051	1055	1059	1047	1044	1043	1042
27	1041	1042	1043	90	1043	1057	1053	1063	1048	1044	1043	1042
28	1041	1042	1043	0	1042	1058	1053	1064	1048	1044	1043	1042
29	1041		1043	0	1042	1053	1054	1059	1047	1043	1046	1042
30	1041		1043	0	1042	1057	1055	1058	1048	1043	909	1042
31	1038		1037		1042		1054	1062		1043		1036
Monthly Avg	1037	1041	960	1013	909	1049	1052	1058	1054	1048	1039	957

Table 3.5 - Hourly and Daily Average Temperature at the Vernon Dam Fishway During 2001

Day	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May	31-May	01-Jun	02-Jun	03-Jun
Hour													
0		55.04	61.29	61.07	61.98	60.98	61.26	60.52	61.01	61.51	60.39	61.02	58.62
1		54.73	60.78	61.50	61.92	60.95	61.22	60.35	60.98	60.89	61.21	61.38	58.68
2		54.42	61.07	61.37	61.79	61.17	61.06	60.33	60.93	61.29	61.32	61.47	58.58
3		54.16	61.12	61.36	61.54	61.19	60.88	60.33	61.22	60.36	61.24	61.49	58.41
4		54.02	61.15	61.40	61.67	61.28	61.03	60.25	61.24	60.45	61.35	61.55	57.98
5		54.02	61.27	61.36	62.04	61.44	61.00	60.47	61.27	60.98	61.30	61.46	57.66
6		54.15	60.89	61.45	62.06	61.50	60.46	60.77	60.94	61.09	61.38	61.60	57.38
7		54.38	61.22	61.41	61.89	61.38	61.10	60.99	60.94	61.42	62.07	61.72	57.21
8		54.80	61.00	61.20	61.95	61.27	61.71	61.19	60.94	61.41	62.17	61.55	57.12
9		55.54	60.76	61.48	62.18	61.04	61.74	60.74	61.43	61.70	62.43	60.94	57.08
10		55.94	61.21	61.55	62.24	61.21	62.00	61.05	61.89	61.97	62.34	60.70	57.15
11		56.41	61.37	61.73	62.25	61.15	62.14	61.21	61.81	61.60	63.65	60.55	57.34
12		57.66	62.08	62.00	62.53	61.47	62.04	61.44	61.60	62.19	63.79	60.89	57.44
13		61.23	62.10	62.25	62.08	61.57	61.42	61.72	62.08	62.34	64.31	60.97	57.63
14	64.30	61.11	61.35	62.82	61.86	61.62	61.37	62.06	62.49	62.57	64.25	61.13	57.73
15	63.51	61.30	62.28	63.24	61.87	61.59	61.52	62.35	62.44	62.48	63.58	60.88	57.82
16	62.41	62.12	62.06	63.20	61.49	61.45	61.74	62.15	62.14	62.51	62.82	60.15	57.85
17	61.11	61.55	62.07	63.53	61.28	61.54	61.36	62.04	61.94	62.17	62.40	59.69	57.73
18	59.71	61.99	62.08	62.95	61.42	61.65	61.09	62.14	61.49	62.42	62.35	59.38	57.55
19	58.47	62.09	61.90	63.21	61.47	61.75	61.06	61.83	61.49	61.93	62.42	59.07	57.35
20	57.47	62.30	61.79	63.10	61.35	61.68	61.14	61.45	61.57	61.88	62.16	58.85	57.22
21	56.61	61.53	61.88	62.77	61.41	61.52	61.24	61.50	61.51	61.49	62.02	58.73	57.24
22	55.90	61.93	61.37	62.42	61.31	61.41	61.10	61.09	61.63	61.07	61.77	58.69	57.22
23	55.40	61.50	60.95	62.49	61.31	61.34	60.87	61.09	61.47	60.45	61.59	58.60	57.27
Monthly Avg	59.49	58.08	61.46	62.12	61.79	61.38	61.31	61.21	61.52	61.59	62.26	60.52	57.64

Table 3.5 - Hourly and Daily Average Temperature at the Vernon Dam Fishway During 2001

Day	04-Jun	05-Jun	06-Jun	07-Jun	08-Jun	09-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun
Hour													
0	57.41	57.10	57.94	58.80	60.30	63.64	64.79	65.63	66.28	64.08	64.13	68.08	69.59
1	57.47	56.90	57.96	58.83	60.23	63.39	64.83	65.27	66.02	64.05	64.17	67.80	69.36
2	57.31	56.78	58.01	58.87	60.18	62.98	64.80	65.69	65.63	63.92	64.21	67.72	69.35
3	57.12	56.68	58.07	58.80	60.15	62.83	64.65	65.89	64.79	63.85	64.17	67.55	69.29
4	56.98	56.63	58.12	58.64	60.09	62.67	64.59	65.46	64.25	63.86	64.01	67.50	69.40
5	56.92	56.59	58.14	58.67	60.06	62.22	64.69	64.74	63.93	63.74	63.98	67.65	69.31
6	56.92	56.58	58.22	58.96	60.14	62.37	65.02	64.24	64.20	63.58	64.01	67.85	69.79
7	56.83	56.69	58.35	59.38	60.23	62.74	65.51	65.51	64.46	63.42	64.59	67.82	70.18
8	56.77	56.87	58.47	59.57	60.41	63.14	65.70	65.98	64.66	63.25	65.66	67.49	70.02
9	56.82	57.13	58.54	59.86	60.66	63.74	66.63	66.32	64.66	63.27	65.99	67.73	70.17
10	56.88	57.19	58.64	60.09	60.83	65.22	67.51	66.68	64.67	63.28	66.69	68.80	71.01
11	56.85	57.19	58.74	60.36	61.12	65.42	67.33	67.21	64.45	63.49	67.02	69.79	71.83
12	56.85	57.17	58.79	60.58	62.17	64.94	66.75	67.07	64.27	63.64	67.18	70.63	73.39
13	56.90	57.30	58.87	60.87	62.92	65.34	67.10	67.36	64.28	63.92	68.43	70.80	74.40
14	56.95	57.29	59.02	61.07	62.91	65.44	66.87	67.65	64.32	64.67	68.86	70.68	74.49
15	57.10	57.33	59.09	61.18	63.27	66.15	66.84	67.52	64.33	64.74	69.02	71.17	74.76
16	57.14	57.31	59.02	61.08	63.46	65.66	66.86	67.57	64.27	64.76	68.99	72.26	74.43
17	57.26	57.32	58.96	60.95	63.39	65.93	66.80	67.51	64.32	64.00	68.99	72.44	74.18
18	57.28	57.30	58.87	60.86	63.57	66.15	67.01	67.27	64.40	63.96	68.47	71.30	74.15
19	57.18	57.36	58.81	60.84	64.02	65.71	66.79	66.95	64.40	64.02	68.05	70.47	74.16
20	57.17	57.43	58.73	60.66	64.11	65.77	66.42	66.79	64.41	64.08	68.04	70.25	74.00
21	57.22	57.56	58.71	60.57	63.81	65.26	66.11	66.59	64.39	64.14	67.44	71.06	73.94
22	57.24	57.73	58.70	60.47	63.69	64.91	65.82	66.56	64.28	64.14	67.97	70.81	73.59
23	57.20	57.87	58.77	60.40	63.20	64.75	65.80	66.29	64.13	64.12	68.34	70.33	73.19
Monthly Avg	57.0736	57.14	58.56	60.01	61.87	64.43	66.05	66.41	64.57	63.92	66.60	69.50	72.00

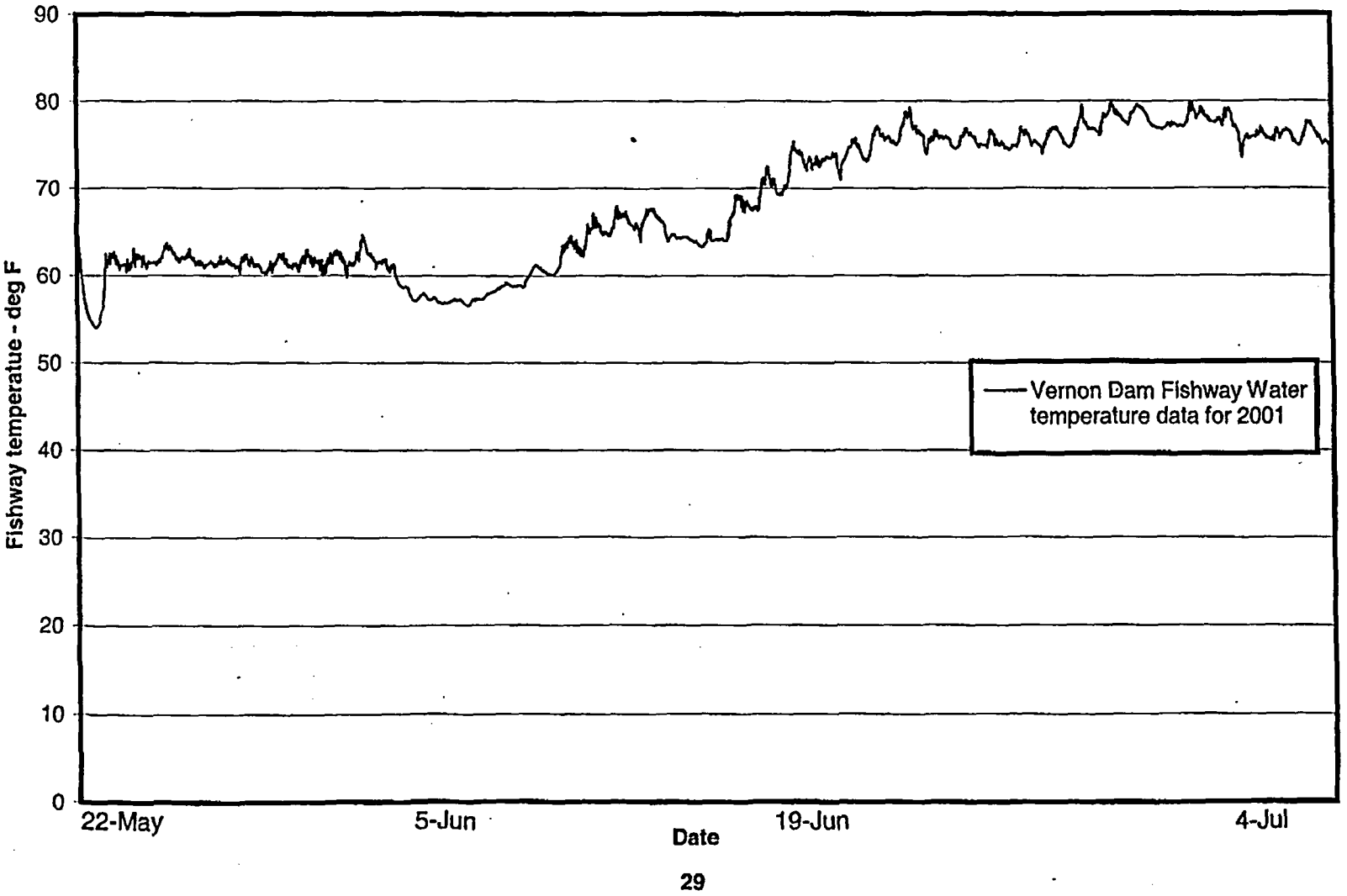
Table 3.5 - Hourly and Daily Average Temperature at the Vernon Dam Fishway During 2001

Day	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun
Hour													
0	72.64	73.84	73.81	75.42	76.50	75.74	75.18	74.60	75.42	75.41	76.77	78.29	77.74
1	72.44	73.64	73.55	75.19	76.31	75.66	74.88	74.62	75.37	75.15	76.81	78.07	77.51
2	72.40	73.76	73.34	75.36	76.13	75.45	74.70	74.50	75.19	75.06	76.71	77.82	77.33
3	73.04	73.30	73.28	75.28	75.97	74.99	74.98	74.37	75.04	74.86	76.76	77.69	77.20
4	73.43	72.22	73.24	75.09	75.58	74.79	75.01	74.52	74.94	74.79	76.52	77.59	77.07
5	73.41	71.44	73.22	75.00	74.18	74.65	74.98	74.61	74.76	74.72	76.48	77.50	77.04
6	72.48	71.19	73.62	75.11	73.94	74.56	74.96	74.87	74.45	74.79	76.22	77.37	76.97
7	72.79	72.36	73.98	75.46	74.25	74.59	74.96	74.88	74.12	74.91	76.14	77.36	76.91
8	72.85	72.92	74.84	75.95	75.35	74.66	74.87	74.91	74.88	75.18	77.07	77.76	76.89
9	72.91	73.16	75.78	76.64	75.37	74.76	74.85	74.72	75.06	75.70	77.57	78.39	76.88
10	73.47	73.43	76.07	77.11	75.53	75.13	75.38	74.88	75.57	76.26	78.31	78.59	76.81
11	72.97	73.78	76.37	77.29	75.69	75.87	76.45	75.42	75.95	76.69	78.30	78.73	76.77
12	72.86	74.14	76.75	77.71	75.51	75.87	76.52	76.11	76.27	76.76	78.18	78.92	76.86
13	72.64	74.55	77.04	78.71	75.97	76.08	76.40	76.78	76.45	77.39	78.34	79.28	76.90
14	72.94	74.69	76.79	78.51	76.30	76.26	76.14	76.45	76.65	78.01	78.56	79.45	76.95
15	73.25	74.76	76.51	78.10	76.43	76.72	75.25	76.41	76.77	78.62	78.81	79.50	77.11
16	73.34	75.28	76.03	78.39	75.95	76.77	75.28	76.17	76.89	79.22	79.52	79.37	77.38
17	73.30	75.28	76.04	78.93	75.75	76.33	75.33	76.46	76.88	77.99	79.68	79.23	77.44
18	73.49	75.39	76.03	78.08	75.92	76.13	75.01	76.24	76.98	77.62	79.39	79.20	77.17
19	73.62	75.34	75.59	77.01	75.85	76.26	74.91	76.04	76.88	77.50	78.78	79.05	77.31
20	73.59	74.82	75.64	76.93	75.79	75.96	75.06	75.67	76.51	77.19	78.73	78.79	77.49
21	73.47	74.97	75.79	77.12	75.71	75.83	75.19	75.11	76.31	76.91	78.64	78.63	77.38
22	73.46	74.54	75.80	76.70	75.90	75.83	75.08	74.93	76.03	76.81	78.64	78.44	77.29
23	73.64	74.25	75.72	76.32	75.87	75.54	74.76	75.18	75.77	76.71	78.35	78.14	77.22
Monthly Avg	73.10	73.88	75.20	76.73	75.66	75.60	75.25	75.35	75.80	76.43	77.89	78.46	77.15

Table 3.5 - Hourly and Daily Average Temperature at the Vernon Dam Fishway During 2001

Day	30-Jun	01-Jul	02-Jul	03-Jul	04-Jul	05-Jul
Hour						
0	77.13	78.19	77.14	76.23	75.96	75.49
1	77.03	78.15	77.12	76.03	75.38	75.24
2	77.15	77.82	76.67	75.90	75.44	75.06
3	77.18	77.83	76.31	75.73	75.29	75.22
4	77.08	77.63	75.46	75.67	75.03	75.44
5	77.03	77.60	74.31	75.69	74.91	75.33
6	77.14	77.58	73.74	75.65	74.86	75.10
7	77.34	77.55	74.75	75.56	75.04	74.92
8	77.65	77.57	75.50	75.84	75.49	75.52
9	78.10	77.70	75.81	75.51	75.95	76.64
10	79.13	77.87	76.00	76.07	76.00	
11	79.70	77.95	75.83	76.69	76.73	
12	79.14	77.83	75.73	76.60	77.13	
13	79.45	77.48	75.76	76.06	77.56	
14	79.00	77.43	75.83	75.81	77.46	
15	78.73	78.37	75.92	76.16	77.48	
16	78.22	79.07	75.94	76.44	77.28	
17	78.29	78.42	75.86	76.49	76.97	
18	78.35	78.92	76.28	76.61	76.77	
19	78.89	79.11	76.39	76.69	76.48	
20	79.17	78.80	76.10	76.64	76.26	
21	78.86	78.47	76.23	76.54	75.99	
22	78.76	77.71	76.68	76.45	75.86	
23	78.32	77.19	76.58	76.17	75.84	
Monthly Avg	78.20	78.01	75.91	76.13	76.13	75.40

Figure 3-5 Vernon Dam Fishway Temperatures, 2001



4.0 MACROINVERTEBRATE COLLECTIONS

4.1 METHODS OF COLLECTION AND PROCESSING

4.1.1 Dredge Collections

Although dredge sampling is discontinued in the current Permit, Vermont Yankee and Normandeau Associates conducted sampling as outlined in the previous Permit until the current Permit was issued in August 2001. Therefore, benthic macroinvertebrates were collected with a 9-inch ponar dredge in June 2001 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 36 samples. 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 laboratory. Sampling of benthic macroinvertebrates, by dredge, was not continued after June, as permit modifications eliminated the task.

In the laboratory, the three preserved replicate 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 yielding a total of 12 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 2001 were made of one-inch square, 14-gauge galvanized wire with a 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.

The previous Permit required the deployment of two rock baskets in June, August, and October at each of stations 2 and 3 (downstream of Vernon Dam), and stations 4 and 5 (upstream of Vernon Dam). The current Permit requires the deployment of three rock baskets at downstream stations 2 and 3, with no required rock basket sampling at the upstream stations. Normandeau Associates conducted monitoring as stipulated in the previous Permit until the current Permit was issued in August 2001.

Two rock baskets were deployed along the Vermont shore in June at each Station (2, 3, 4, and 5) and sampled for 38 days. On 2 August 2001, Doug Burnham (Vermont Department of Environmental Conservation) and Lynn DeWald (Normandeau Associates) conducted a site visit to reexamine the downstream rock basket sampling stations and to deploy the August samplers. During this site visit, the sample duration of approximately 30 days in June, August, and October was established and implemented. After examination of the potential sampling sites below Vernon Dam, two sampling stations were identified. Station 2 near the Vermont shore will remain, as it was in previous Permits, the most downstream rock basket sampling station. The sampling site is approximately 10-12 ft deep with a substrate of cobble, boulders, and mud. Station 3 has been relocated from a deep pool area on the Vermont shore to more of a swift-water riffle area on the New Hampshire shore.

On 2 August and again on 27 September, three rock baskets were deployed each at stations 2 VT and 3 NH. The August and September rock baskets sampled for 37 days.

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 laboratory.

The contents of all macroinvertebrate rock basket samples collected from each sampling period in June, August, and October were examined, in their entirety, under low magnification (2x), yielding a total of 20 rock basket samples. Eight samples from June (two cages each at Stations 2, 3, 4,and 5), and six samples each from August and October for a total of 12 samples from Stations 2 and 3 only.

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 June 2001, 12 dredge samples and 8 rock basket samples were processed after sampling at stations 2, 3, 4, and 5. From these samples, 789 macroinvertebrates were identified (Table 4-1a). Organisms collected by dredge and cage sampling in June at Stations 2, 3, 4, and 5, comprised 39% and 61% of the total, respectively (Tables 4-2 and 4-3a).
In August and October, 12 cage samples were processed from downstream stations 2 and 3. From these samples 3,186 macroinvertebrates were identified (Table 4-1b).

June 2001 Dredge Collections – Stations 2, 3, 4, and 5

Dipterans and oligochaetes accounted for 90% of the invertebrates collected by dredge downstream of the Vernon Dam at Stations 2 and 3 combined (Table 4-2). Dipterans, oligochaetes, isopods, and trichopterans accounted for 88% of the invertebrates collected by dredge upstream of the dam, at Stations 4 and 5 combined (Table 4-2). In general, a larger variety of invertebrates was collected at the upstream stations than at the downstream stations, including amphipods, gastropods, and bivalves which contributed an additional 8% to the total upstream abundance (Table 4-2). More invertebrates were collected by dredge upstream (268) of the Vernon Dam, than by dredge downstream (40) of the dam. The small numbers of invertebrates collected overall is likely due to the limited collection of only one sample in the month of June, prior to the Permit modifications which excluded macroinvertebrate dredge sampling.

Rock Basket Collections

Because the upstream and downstream rock basket samples are not comparative for all three months, the results are presented in two tables. Table 4-3a displays the composition of macroinvertebrates collected in rock baskets at all stations (upstream and downstream) in June. Table 4-3b contains data from the downstream stations 2 and 3, in August and October, which are now the only sampling sites required per the modified Permit.

June 2001 Rock Basket Collections – Stations 2, 3, 4, and 5

The number of invertebrates collected by rock basket during June, was greater upstream of Vernon Dam (387) than downstream of the Dam (95) (Table 4-3a). Overall, 81% of the organisms collected from the downstream Stations consisted of gastropods, dipterans, oligochaetes, and amphipods (Table 4-3a). The upstream Stations 4 and 5 rock baskets collected a total of 192 and 195 organisms, respectively (Table 4-3a). Eighty-one percent of the June upstream rock basket collections were comprised of Turbellaria, oligochaetes, gastropods, dipterans, and trichopterans (Table 4-3a). Ephemeropterans and amphipods contributed an additional15% to the overall total collected upstream in June.

August and October 2001 Rock basket Collections – Stations 2 and 3

During August and October 2001, 12 rock basket samples were processed. From these samples, 3,186.3 macroinvertebrates were identified (Table 4-1b). Most of those organisms (3,008) were collected from Station 3 (55% of the total were collected in August and 45% in October). Seventy-nine percent of the macroinvertebrates collected at Station 3 during these two sampling periods consisted of trichopterans (Table 4-1b, 4-3b). Trichopterans, ephemeropterans, gastropods, amphipods, and dipterans contributed 95.0% to the relative abundance at Station 2 in August and October combined (Table 4-3b).

During August, 79% of the total catch at Station 2 was comprised of ephemeropterans, dipterans, and trichopterans while at Station 3, 86% of the collection were comprised of trichopterans.

During October, greater than half of the organisms collected at Station 2 were amphipods (Table 4-3b). Ninety-four percent of the organisms collected at Station 3 in October were trichopterans (70%) and turberllirian worms (24%) (Table 4-3b).

Table 4-1a. **Checklist of Macroinvertebrates Collected From the Connecticut River Near Vernon, Vermont in June of 2001. Abundance reflects an average over dredge (one replicate) and rockbasket (two or three replicates) samples.**

	Taxon	Downstream				Upstream			
		Station 2		Station 3		Station 4		Station 5	
		Count	% Of Total	Count	% Of Total	Count	% Of Total	Count	% Of Total
Platyhelminthes									
Turbellaria	Dugesia tigrina	0.5	100.0			21.0	100.0	86.5	100.0
	Totals	**0.5**	**100.0**			**21.0**	**100.0**	**86.5**	**100.0**
Nematoda									
Nematoda	Nematoda			1.0	100.0				
	Totals			**1.0**	**100.0**				
Annelida									
Hirudinea	Batracobdella phalera					0.5	100.0		
	Gloiobdella elongata							2.0	100.0
	Totals					**0.5**	**100.0**	**2.0**	**100.0**
Oligochaeta	Aulodrilus americanus					1.0	0.9	10.0	27.8
	Aulodrilus piqueti							1.0	2.8
	Aulodrilus pluriseta	5.0	33.3					5.5	15.3
	Branchiura sowerbyi	0.5	3.3						
	Ilyodrilus templetoni	1.0	6.7						
	Limnodrilus hoffmeisteri					1.0	0.9		
	Limnodrilus sp.	7.0	46.7			86.5	75.9	13.0	36.1
	Lumbricidae							3.0	8.3
	Lumbriculidae	1.0	6.7						
	Nais sp.			5.5	64.7	3.0	2.6	1.5	4.2
	Ripistes parasita			3.0	35.3			1.0	2.8
	Stylaria lacustris					2.5	2.2		
	Tubificidae imm. w/ capilliform chaetae					19.0	16.7	1.0	2.8
	Tubificidae imm. w/o capilliform chaetae	0.5	3.3			1.0	0.9		
	Totals	**15.0**	**100.0**	**8.5**	**100.0**	**114.0**	**100.0**	**36.0**	**100.0**
Mollusca									
Gastropoda	Amnicola grana					1.0	3.0		
	Amnicola limosa							18.5	67.3
	Amnicola sp.			35.5	100.0	32.5	97.0	6.0	21.8
	Gastropoda	1.5	60.0						
	Physa sp.	1.0	40.0					2.0	7.3
	Planorbidae							1.0	3.6
	Totals	**2.5**	**100.0**	**35.5**	**100.0**	**33.5**	**100.0**	**27.5**	**100.0**
Bivalvia	Bivalvia					1.0	33.3		
	Pisidium sp.					2.0	66.7	0.5	100.0
	Totals					**3.0**	**100.0**	**0.5**	**100.0**
Arachnida									
Acarina	Hydrachnida					1.0	100.0	1.0	100.0
	Totals					**1.0**	**100.0**	**1.0**	**100.0**

(Continued)

Table 4-1a (Continued).

Taxon		Downstream				Upstream			
		Station 2		Station 3		Station 4		Station 5	
		Count	% Of Total	Count	% Of Total	Count	% Of Total	Count	% Of Total
Crustacea									
Brachiopoda	Cladocera[1]	P		P		P		P	
	Totals	P		P		P		P	
Isopoda	Caecidotea sp.	0.5	100.0			6.0	100.0	17.0	100.0
	Totals	0.5	100.0			6.0	100.0	17.0	100.0
Amphipoda	Hyalella azteca	1.5	100.0	10.0	100.0	25.0	100.0	15.5	100.0
	Totals	1.5	100.0	10.0	100.0	25.0	100.0	15.5	100.0
Decapoda	Crangonyx sp.					1.0	50.0	0.5	100.0
	Orconectes sp.	0.5	100.0			1.0	50.0		
	Totals	0.5	100.0			2.0	100.0	0.5	100.0
Insecta									
Ephemeroptera	Baetidae					1.0	4.8		
	Caenis sp.					2.0	9.5		
	Ephoron sp.					1.0	4.8		
	Eurylophella sp.	0.5	100.0						
	Leucrocuta sp.			2.5	29.4	0.5	2.4		
	Stenacron sp.			6.0	70.6	16.0	76.2	6.5	86.7
	Stenonema sp.					0.5	2.4	1.0	13.3
	Totals	0.5	100.0	8.5	100.0	21.0	100.0	7.5	100.0
Odonata	Aeshna sp.							0.5	33.3
	Boyeria sp.			1.5	50.0			0.5	33.3
	Coenagrionidae			1.0	33.3				
	Enallagma sp.	0.5	100.0			1.0	100.0		
	Libellulidae			0.5	16.7			0.5	33.3
	Totals	0.5	100.0	3.0	100.0	1.0	100.0	1.5	100.0
Plecoptera	Acroneuria lycorias			0.5	100.0				
	Totals			0.5	100.0				
Coleoptera	Dineutus sp.							0.5	14.3
	Dubiraphia sp.			1.0	100.0	1.5	42.9	2.5	71.4
	Haliplus sp.					2.0	57.1	0.5	14.3
	Peltodytes sp.	1.0	100.0						
	Totals	1.0	100.0	1.0	100.0	3.5	100.0	3.5	100.0
Megaloptera	Sialis sp.					1.0	100.0	0.5	100.0
	Totals					1.0	100.0	0.5	100.0
Trichoptera	Cheumatopsyche sp.					1.0	2.8		
	Hydropsyche sp.					0.5	1.4		
	Hydroptila sp.					2.0	5.6	2.0	4.9
	Lepidostoma sp.	1.0	40.0						
	Mystacides sp.			1.0	66.7				
	Neureclipsis sp.	0.5	20.0						
	Oecetis sp.					0.5	1.4	1.0	2.5
	Phylocentropus sp.					18.0	50.7	19.0	46.9
	Polycentropus sp.	1.0	40.0	0.5	33.3	13.5	38.0	18.5	45.7
	Totals	2.5	100.0	1.5	100.0	35.5	100.0	40.5	100.0

Table 4-1a (Continued).

	Taxon	Downstream				Upstream			
		Station 2		Station 3		Station 4		Station 5	
		Count	% Of Total	Count	% Of Total	Count	% Of Total	Count	% Of Total
Insecta									
Diptera	Ablabesmyia janta					0.5	0.5	1.0	2.3
	Ablabesmyia mallochi					0.5	0.5		
	Ablabesmyia sp.			0.5	2.9			1.5	3.4
	Bezzia/palpomyia sp.					1.0	1.0	1.0	2.3
	Chironomini			1.0	5.9			1.0	2.3
	Cladotanytarsus sp.					52.0	50.5	1.0	2.3
	Cricotopus sp.	4.0	17.4						
	Cryptochironomus fulvus gr.	0.5	2.2					2.0	4.6
	Cryptochironomus sp.					3.5	3.4		
	Demicryptochironomus sp.					8.0	7.8		
	Dicrotendipes sp.			1.0	5.9	6.5	6.3	1.5	3.4
	Endochironomus sp.					4.5	4.4	4.0	9.2
	Eukiefferiella sp.			1.0	5.9				
	Glyptotendipes sp.							6.5	14.9
	Micropsectra sp.			1.0	5.9			3.5	8.0
	Microtendipes pedellus gp.							2.0	4.6
	Microtendipes sp.	2.0	8.7	1.0	5.9	2.0	1.9	0.5	1.1
	Nilothauma sp.					1.0	1.0	0.5	1.1
	Orthocladiinae					2.5	2.4	0.5	1.1
	Paratendipes sp.	1.0	4.3	1.0	5.9				
	Polypedilum fallax			1.0	5.9				
	Polypedilum flavum	2.0	8.7						
	Polypedilum halterale gr.							0.5	1.1
	Polypedilum scalaenum gr.	1.0	4.3						
	Polypedilum sp.	1.0	4.3			0.5	0.5	1.5	3.4
	Polypedilum tritum	1.5	6.5	0.5	2.9				
	Procladius sp.					2.0	1.9	3.5	8.0
	Pseudochironomus sp.			1.0	5.9	1.0	1.0		
	Rheotanytarsus sp.	2.0	8.7	0.5	2.9				
	Sphaeromias sp.			1.0	5.9	6.0	5.8	8.0	18.4
	Stempellinella sp.							0.5	1.1
	Synorthocladius sp.	5.0	21.7	1.5	8.8	2.5	2.4	0.5	1.1
	Tanytarsini					2.0	1.9		
	Tanytarsus sp.			4.0	23.5	4.0	3.9		
	Thienemannimyia gr.	1.0	4.3						
	Tribelos sp.	2.0	8.7	1.0	5.9	3.0	2.9	2.5	5.7
	Totals	**23.0**	**100.0**	**17.0**	**100.0**	**103.0**	**100.0**	**43.5**	**100.0**
Grand Total (all taxa)		**48.0**	**100.0**	**86.5**	**100.0**	**371.0**	**100.0**	**283.5**	**100.0**

[1] Zooplankton taxon that was present but not enumerated.

Table 4-1b. **Checklist of Macroinvertebrates Collected from the Connecticut River Near Vernon, Vermont in August and October of 2001 Downstream of Vernon Dam. Abunance reflects an average over dredge (one replicate) and rockbasket (two or three replicates) samples.**

	Taxon	Station 2		Station 3	
		Count	% Of Total	Count	% Of Total
Cnidaria					
Hydrida	Hydra sp.	0.7	100.0		
	Totals	**0.7**	**100.0**		
Platyhelminthes					
Turbellaria	Dugesia tigrina	2.0	100.0	328.0	100.0
	Totals	**2.0**	**100.0**	**328.0**	**100.0**
Nematoda					
Nematoda	Nematoda			0.3	100.0
	Totals			**0.3**	**100.0**
Nemertinea					
Anopla	Prostoma graescense			2.7	100.0
	Totals			**2.7**	**100.0**
Annelida					
Oligochaeta	Limnodrilus sp.	0.3	100.0		
	Naididae			1.3	100.0
	Totals	**0.3**	**100.0**	**1.3**	**100.0**
Mollusca					
Gastropoda	Amnicola sp.	0.7	3.8	0.3	100.0
	Ferrissia sp.	0.7	3.8		
	Physa sp.	16.0	92.3		
	Totals	**17.3**	**100.0**	**0.3**	**100.0**
Bivalvia	Elliptio complanata			0.7	100.0
	Totals			**0.7**	**100.0**
Crustacea					
Brachiopoda	Cladocera	0.0			
	Totals	**0.0**			
Amphipoda	Hyalella azteca	32.0	100.0	5.3	100.0
	Totals	**32.0**	**100.0**	**5.3**	**100.0**
Decapoda	Crangonyx sp.			2.7	80.0
	Orconectes sp.			0.7	20.0
	Totals			**3.3**	**100.0**
Cyclopoida	Argulus sp.			0.3	100.0
	Totals			0.3	100.0
Insecta					
Ephemeroptera	Baetidae	1.3	2.8		
	Baetis sp.			0.3	0.3
	Caenis sp.			0.3	0.3
	Ephemerellidae			0.3	0.3
	Eurylophella sp.			1.3	1.0

(Continued)

Table 4-1b (Continued)

Taxon		Station 2		Station 3	
		Count	% Of Total	Count	% Of Total
Insecta					
Ephemeroptera					
	Isonychia sp.			5.7	4.4
	Stenacron interpunctatum			1.3	1.0
	Stenacron sp.	12.3	25.9	1.7	1.3
	Stenonema interpunctatum	2.7	5.6		
	Stenonema sp.	31.3	65.7	101.3	79.2
	Tricorythodes sp.			15.7	12.2
	Totals	**47.7**	**100.0**	**128.0**	**100.0**
Odonata	Argia sp.	1.7	29.4		
	Coenagrionidae	0.3	5.9		
	Neurocordulia sp	3.7	64.7		
	Totals	**5.7**	**100.0**		
Plecoptera	Acroneuria abnormis			0.3	20.0
	Acroneuria lycorias			1.0	60.0
	Acroneuria sp.			0.3	20.0
	Totals			**1.7**	**100.0**
Coleoptera	Ancyronyx variegata	0.3	100.0		
	Optioservus sp.			1.3	12.9
	Stenelmis humerosa-sinuata gr.			4.0	38.7
	Stenelmis sp.			5.0	48.4
	Totals	**0.3**	**100.0**	**10.3**	**100.0**
Trichoptera	Ceraclea sp.			9.3	0.4
	Ceratopsyche bronta			14.3	0.6
	Ceratopsyche phalerata			9.3	0.4
	Cheumatopsyche sp.	4.7	15.6	1839.7	77.6
	Helicopsyche sp.			0.3	0.0
	Hydatophylax sp.	0.3	1.1		
	Hydropsyche frisoni			1.7	0.1
	Hydropsyche phalerata	1.3	4.4	68.3	2.9
	Hydropsyche valanis			4.7	0.2
	Hydroptila sp.	0.7	2.2		
	Lepidostoma sp.			7.0	0.3
	Leptoceridae	0.3	1.1	0.7	0.0
	Macrostemum carolina			254.0	10.7
	Mystacides sp.			1.3	0.1
	Neureclipsis sp.	0.3	1.1	94.7	4.0
	Oecetis avara			24.0	1.0
	Oecetis sp.	2.0	6.7	38.3	1.6
	Orthotrichia sp.	0.3	1.1		
	Oxyethira sp.	1.0	3.3		
	Polycentropus sp.	19.0	63.3	2.0	0.1
	Protoptila sp.			1.3	0.1
	Totals	30.0	100.0	2371.0	100.0

Table 4-1b (Continued)

	Taxon	Station 2		Station 3	
		Count	% Of Total	Count	% Of Total
Insecta					
Diptera	Ablabesmyia mallochi	7.3	17.3	1.3	0.9
	Ablabesmyia sp.	1.0	2.4		
	Demicryptochironomus sp.	0.3	0.8		
	Dicrotendipes neomodestus			1.3	0.9
	Dicrotendipes sp.	9.3	22.0	23.7	15.3
	Eukiefferiella sp.			2.0	1.3
	Nanocladius sp.			0.7	0.4
	Orthocladiinae			3.3	2.2
	Orthocladius sp.			5.3	3.4
	Paratanytarsus sp.	1.7	3.9	2.7	1.7
	Polypedilum flavum	2.7	6.3	83.3	53.9
	Polypedilum sp.	0.7	1.6		
	Procladius sp.			0.3	0.2
	Rheotanytarsus sp.			2.0	1.3
	Sphaeromias sp.	0.3	0.8		
	Stenochironomus sp.			1.3	0.9
	Synorthocladius sp.	8.3	19.7	4.0	2.6
	Tanytarsini			1.7	1.1
	Tanytarsus sp.	4.3	10.2		
	Thienemanniella sp.			0.3	0.2
	Thienemannimyia gr.			17.7	11.4
	Tribelos sp.	6.3	15.0	2.0	1.3
	Tvetenia sp.			1.7	1.1
	Totals	**42.3**	**100.0**	**154.7**	**100.0**
Bryozoa					
Bryozoa	Bryozoa			0.0	
	Totals			**0.0**	
Grand total (all taxa)		**178.3**	**100.0**	**3008.0**	**100.0**

4-2. Composition of macroinvertebrates collected by ponar dredge in June 2001 upstream and downstream of Vernon Dam.

Taxonomic Group	DOWNSTREAM				UPSTREAM			
	STATION 2		STATION 3		STATION 4		STATION 5	
	COUNT	% OF TOTAL	COUNT	% OF TOTAL	COUNT	% OF TOTAL	COUNT	% OF TOTAL
Nematoda			1	10				
Hirudinea							2	2.2
Oligochaeta	10	33.3	1	10	66	36.9	22	24.7
Gastropoda					3	1.7	8	9.0
Bivalvia					3	1.7		
Brachiopoda[1]	P				P		P	
Isopoda					5	2.8	15	16.9
Amphipoda					6	3.4	4	4.5
Decapoda					1	0.6		
Ephemeroptera					1	0.6		
Odonata					1	0.6		
Coleoptera	1	3.3			2	1.1	2	2.2
Trichoptera	1	3.3	1	10	10	5.6	19	21.3
Diptera	18	60.0	7	70	81	45.3	17	19.1
Totals	**30**	**100.0**	**10**	**100.0**	**179**	**100.0**	**89**	**100.0**

[1] Colonial taxon that was present but not enumerated.

Table 4-3a. **Composition of macroinvertebrates collected by rock baskets in June 2001, downstream and upstream of Vernon Dam (counts reflect the mean of two rock baskets that were deployed at each station sampled as stipulated in previous NPDES Permit).**

Taxonomic Group	Downstream				Upstream			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% Of Total	Count	% of Total	Count	% of Total
Turbellaria	0.5	2.8			21.0	10.9	86.5	44.5
Hirudinea					0.5	0.3		
Oligochaeta	5.0	27.8	7.5	9.8	48.0	25.0	14.0	7.2
Gastropoda	2.5	13.9	35.5	46.4	30.5	15.9	19.5	10.0
Bivalvia							0.5	0.3
Acarina					1.0	0.5	1.0	0.5
Brachiopoda[1]	P		P		P		P	
Isopoda	0.5	2.8			1.0	0.5	2.0	1.0
Amphipoda	1.5	8.3	10.0	13.1	19.0	9.9	11.5	5.9
Decapoda	0.5	2.8			1.0	0.5	0.5	0.3
Ephemeroptera	0.5	2.8	8.5	11.1	20.0	10.4	7.5	3.9
Odonata	0.5	2.8	3.0	3.9			1.5	0.8
Plecoptera			0.5	0.7				
Coleoptera			1.0	1.3	1.5	0.8	1.5	0.8
Megaloptera					1.0	0.5	0.5	0.3
Trichoptera	1.5	8.3	0.5	0.7	25.5	13.3	21.5	11.1
Diptera	5.0	27.8	10.0	13.1	22.0	11.5	26.5	13.6
Totals	**18.0**	**100.0**	**76.5**	**100.0**	**192.0**	**100.0**	**194.5**	**100.0**

[1] Zooplankton taxon that was present but not enumerated.

Table 4-3b. **Composition of macroinvertebrates collected by rock baskets in August and October at downstream stations 2 and 3 (counts reflect the mean of three rock baskets that were deployed at each station sampled as stipulated in the current NPDES Permit issued in August 2001).**

Taxonomic Group	Time period							
	August				October			
	Station 2		Station 3		Station 2		Station 3	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Bryozoa[1]							P	
Hydrida					0.7	2.0		
Nematoda			0.3	<0.1				
Turbellaria	0.3	0.2	1.3	0.1	1.7	5.1	326.7	24.0
Oligochaeta	0.3	0.2	1.3	0.1				
Gastropoda	12.0	8.3	0.3	<0.1	5.3	16.2		
Bivalvia			0.3	<0.1			0.3	<0.1
Brachiopoda[2]	P				P			
Amphipoda	12.0	8.3	1.3	0.1	20.0	60.6	4.0	0.3
Decapoda							3.3	0.2
Cyclopoida			0.3	<0.1				
Ephemeroptera	45.0	31.0	102.7	6.2	2.7	8.1	25.3	1.9
Odonata	5.0	3.4			0.7	2.0		
Plecoptera			1.7	0.1				
Coleoptera	0.3	0.2	10.3	0.6				
Trichoptera	28.3	19.5	1420.3	86.4	1.7	5.1	950.7	69.7
Diptera	42.0	28.9	104.0	6.3	0.3	1.0	50.7	3.7
Anopla							2.7	0.2
Totals	**145.3**	**100.0**	**1644.3**	**100.0**	**33.0**	**100.0**	**1363.7**	**100.0**

[1] Colonial taxon that was present but not enumerated.
[2] Zooplankton taxon that was present but not enumerated.

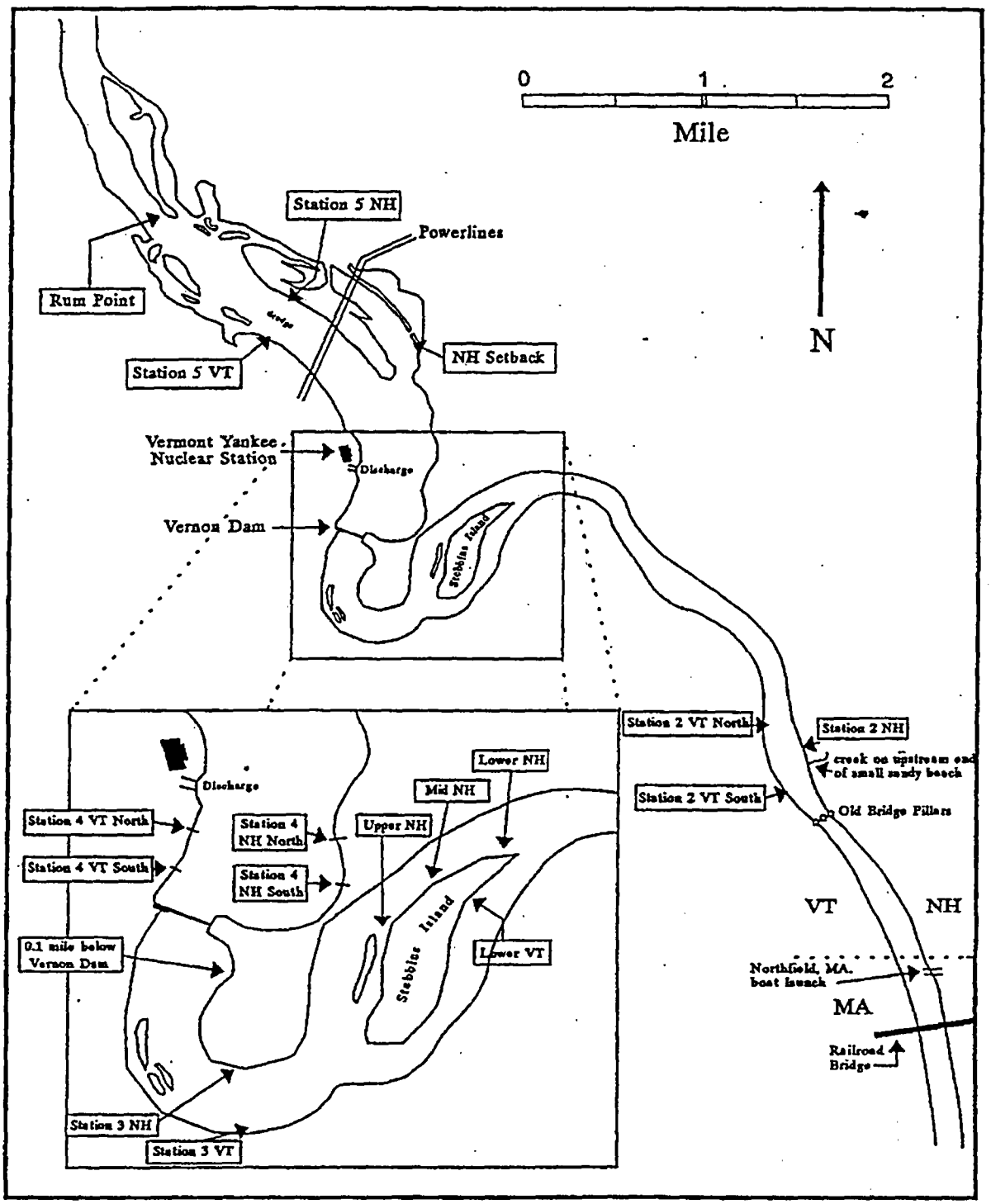


Figure 4-1. NPDES Macroinvertebrate dredge and rock basket sampling stations 2, 3, 4, and 5.

5.0 FISH COLLECTIONS

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 21 May through 18 July 2001 in the vicinity of the Vermont Yankee intakes, and fish impinged on the circulating water traveling screens were collected weekly from 2 April through 12 June, and again from 30 July through 30 October. A refueling outage occurred from 30 April through 18 May. No impingement or larval fish samples were collected during the Plant outage. 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. 5-1). 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 Stebbin 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 h spring and fall impingement samples were collected on each Monday and Tuesday, respectively, between 2 April and 30 April, 21 May and 12 June, and 30 July through 30 October 2001. During the refueling outage (30 April – 18 May), impingement sampling was not conducted. 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 (spring) or American shad (fall). 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 231 Atlantic salmon and 1,666 shad were not exceeded during 2001. Permit compliance was met with respect to impingement sampling.

5.1.4 Larval Fish

Larval fish sampling is required annually per the NPDES Permit starting in May through July 15th, when Vermont Yankee is in an operational mode.. When the plant is non-operational (i.e. in an outage), larval fish sampling is not required. During 2001, larval fish sampling commenced three days after the spring Plant outage ended, and were collected weekly thereafter between 21 May and18 July in the vicinity of the Vermont Yankee intake structure (Fig. 5-1). No larval fish were collected during the first two weeks of May 2001.

A 50-cm diameter, 363-μm nitex nylon plankton net was towed behind 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 flow meter 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

Collection of scale samples for use in age determination was removed from the permit in 2001.

5.2 SUMMARY

Twenty-seven. species of fish were collected during 2001 (Table 5-1). This total number is similar to recent years (Aquatec 1993, 1995, and Normandeau Associates 1997- 2000). 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 2001, a total of 40 electrofishing collections were completed at the ten locations within the eight NPDES permit designated Stations (Fig. 5-1, Table 5-2). The total number of fish collected by electrofishing was 1,760 (Table 5-2). The average catch per unit effort (CPUE) for the 40-electrofishing collections was 264.0. The total electrofishing effort was 7.0 hours.
There were 2,460 fish collected in 2001 during impingement and general electrofishing (including electrofishing stations above and below Vernon Dam) (Table 5-3). Numerically, the most abundant species were bluegill (24.5%), yellow perch (24.3%), and sea lamprey (10.1%). Largemouth bass (22.7%, bluegill (20.3%), white sucker (14.3%), yellow perch (12.5%), and smallmouth bass (11.9%) accounted for the majority of the biomass of collected fishes (Table 5-3)

Upstream of Vernon Dam, yellow perch, bluegill, and sea lamprey, accounted for 69.6% of all fish collected (Table 5-4). Twenty-five American shad and nine Atlantic salmon were collected upstream of Vernon Dam from the circulating water traveling screens at the Plant Intake structure. American shad and Atlantic salmon contributed 1.3% and 0.5%, respectively, to the total upstream catch. Other fish contributed 7.2% (spottail shiner) or less to the total relative abundance. Largemouth bass (28.1%), bluegill (25.3%), yellow perch (16.0%), and white sucker (11.4%) accounted for the majority of the biomass of the fish collected at the upstream Stations (Table 5-4).

Downstream of Vernon Dam, smallmouth bass, rock bass, spottail shiner, bluegill, and American shad accounted for 82.0% of the total catch (Table 5-5). Thirty-four 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 (48.6%), white sucker (23.8%), and rock bass (6.0%), contributed the greatest biomass to the downstream collections.

Nineteen American shad were collected on the traveling screens in September and six in October (Table 5-6). Nine Atlantic salmon were collected on the traveling screens, five in April, and four in June 2001. The American shad and Atlantic salmon impingement limits of 1,666 shad and 231 salmon were not exceeded during 2001. The June, the first half of July, and the August, and September impingement samples consisted of a total of 130, 6, 16, and 25 fish collected, respectively. Sea lamprey, bluegill, and American shad were numerically the most abundant species in the impingement samples during those three and one half months (Table 5-6).

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 2001 at Stebbin Island, Station 3, and 0.1 mile below Vernon Dam (Fig. 5-1). 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 476 American shad was collected via electrofishing between July and October (Table 5-7). September yielded the highest catch of shad (282) compared to the other three months. Shad lengths recorded in September ranged from 65 – 108 mm total length and weight ranged from 4 - 10 g (Table 5-7). The twice-monthly collections during July, August, and October resulted in the collection of 1, 118, and 75 American shad, respectively. The American shad collected in July measured 46 mm total length. The American shad collected during August ranged in length from 49 - 103 mm. October shad collections produced a catch ranging in length from 80 – 117 mm. The CPUE in September was highest at the Station 0.1 Miles south of Vernon Dam (168.0) followed by Station 3 (153.0) and Stebbin Island (131.3)(Table 5-7). The CPUE in August was highest at 0.1 miles south of Vernon Dam (134.0) and the CPUE in October was highest at Stebbin Island (51.3).

5.2.3 Ichthyoplankton

Twenty-seven ichthyoplankton samples were collected near, but outside of the Vermont Yankee intakes between 21 May and 18 July 2001 (Table 5-8). A total of 1,690 ichthyoplankters were identified (Table

5-9). Irrespective of the volume sampled, spottail shiner represented 57.9% of the ichthyoplankton captured, followed by white sucker (37.9%), white perch (1.8%) and unidentified centrarchidae (1.8%) (Table 5-9). Other species collected included walleye, tesselated darter, common carp, yellow perch and golden shiner. Table 5-10 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 June.

Table 5-1. Checklist of fishes (AFS 1991) collected during 2001.

Scientific Name	*Common Name*
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 in 2001.**

Electrofishing Stations	Number of Collections	Hours	Fish	CPUE
Station 3 - Vermont	4	0.7	256	384.0
Station 5 - New Hampshire	4	0.7	143	214.5
Station 5 - Vermont	4	0.7	191	286.5
New Hampshire Setback	4	0.7	228	342.0
Rum Point	4	0.7	390	585.0
Station 2 - New Hampshire	4	0.7	76	114.0
Station 4 - New Hampshire	4	0.7	155	232.5
Station 4 - Vermont	4	0.7	189	283.5
Stebbin Island - New Hampshire Side	4	0.7	69	103.5
0.1 Miles south of Vernon Dam	4	0.7	63	94.5
TOTAL	**40**	**7.0**	**1760**	**264.0**

Table 5-3. **Number and weights of fishes collected in the Connecticut River upstream and downstream of Vernon Dam in 2001 (electrofishing and impingement sampling).**

Species	Total (#)	Relative Number(%)	Total Weight (g)	Relative Weight (%)
Carps and Minnows	6	0.2	10	0.01
Banded Killifish	4	0.2	7	0.01
Sea lamprey	248	10.1	711	0.56
American shad	59	2.4	500	0.39
Atlantic salmon	9	0.4	233	0.18
Northern pike	2	0.1	1290	1.01
Chain pickerel	15	0.6	2129	1.66
Silvery minnow	1	0.0	1	<0.01
Common Shiner	2	0.1	5	<0.01
Golden shiner	71	2.9	1116	0.87
Spottail shiner	191	7.8	694	0.54
Notropis sp.	3	0.1	13	0.01
Fallfish	24	1.0	286	0.22
White sucker	34	1.4	18350	14.34
Yellow bullhead	5	0.2	630	0.49
Brown bullhead	4	0.2	129	0.10
White perch	1	0.0	360	0.28
Rock bass	114	4.6	4145	3.24
Pumpkinseed	121	4.9	5973	4.67
Bluegill	602	24.5	25912	20.25
Smallmouth bass	206	8.4	15179	11.87
Largemouth bass	103	4.2	28971	22.65
Black crappie	22	0.9	699	0.55
Tesselated darter	6	0.2	23	0.02
Yellow perch	597	24.3	15988	12.50
Walleye	10	0.4	4575	3.58
TOTAL	**2460**	**100.0**	**127929**	**100.00**

Table 5-4. **Numbers and weights of fishes captured upstream of Vernon Dam in 2001 in impingement and general electrofishing.**

Species	Electrofishing		CWTS *		Summary			
	Number	Total Weight (g)	Number	Total Weight (g)	Total (#)	Relative Number (%)	Total (g)	Relative Weight (%)
Banded Killifish	4	7			4	0.2	7	<0.1
Sea lamprey	4	19	241	680	245	12.3	699	0.7
American shad			25	303	25	1.3	303	0.3
Atlantic salmon			9	233	9	0.5	233	0.2
Northern pike	1	500			1	0.1	500	0.5
Chain pickerel	11	1726	3	263	14	0.7	1989	2.0
Silvery minnow			1	1	1	0.1	1	<0.1
Common Shiner			1	1	1	0.1	1	<0.1
Golden shiner	55	801	15	308	70	3.5	1109	1.1
Spottail shiner	141	449	2	9	143	7.2	458	0.5
White sucker	21	11179	2	7	23	1.2	11186	11.4
Yellow bullhead	5	630			5	0.3	630	0.6
Brown bullhead	2	14	2	115	4	0.2	129	0.1
Rock bass	21	1217	33	1108	54	2.7	2325	2.4
Pumpkinseed	104	5457	12	412	116	5.8	5869	6.0
Bluegill	360	15803	201	8925	561	28.1	24728	25.3
Smallmouth bass	2	9	7	515	9	0.5	524	0.5
Largemouth bass	91	27336	4	144	95	4.8	27480	28.1
Black crappie	9	454	12	241	21	1.1	695	0.7
Tesselated darter	4	15	2	8	6	0.3	23	<0.1
Yellow perch	454	11918	128	3720	582	29.2	15638	16.0
Walleye	7	3245			7	0.4	3245	3.3
Total	**1296**	**80779**	**700**	**16993**	**1996**	**100.0**	**97772**	**100.0**

***CWTS = Circulating Water Travelling Screens**

Table 5-5. **Numbers and weights of fishes captured downstream of Vernon Dam in 2001 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 (%)
Carps and Minnows	6	10	6	1.3	10	<0.1
Sea lamprey	3	12	3	0.6	12	<0.1
American shad	34	197	34	7.3	197	0.7
Northern pike	1	790	1	0.2	790	2.6
Chain pickerel	1	140	1	0.2	140	0.5
Common Shiner	1	4	1	0.2	4	<0.1
Golden shiner	1	7	1	0.2	7	<0.1
Spottail shiner	48	236	48	10.3	236	0.8
Notropis sp.	3	13	3	0.6	13	<0.1
Fallfish	24	286	24	5.2	286	0.9
White sucker	11	7164	11	2.4	7164	23.8
White perch	1	360	1	0.2	360	1.2
Rock bass	60	1820	60	12.9	1820	6.0
Pumpkinseed	5	104	5	1.1	104	0.3
Bluegill	41	1184	41	8.8	1184	3.9
Smallmouth bass	197	14655	197	42.5	14655	48.6
Largemouth bass	8	1491	8	1.7	1491	4.9
Black crappie	1	4	1	0.2	4	<0.1
Yellow perch	15	350	15	3.2	350	1.2
Walleye	3	1330	3	0.6	1330	4.4
Total	**464**	**30157**	**464**	**100.0**	**30157**	**100.0**

Table 5-6. Monthly impingement of fish on Vermont Yankee's circulating water traveling screens in 2001.

Species	April		May		June		July		August		September		October	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Sea lamprey	126	338	2	6	113	336								
Atlantic salmon	5	233			4									
Chain pickerel	2	240	1	23										
Silvery minnow	1	1												
Common Shiner	1	1												
Golden shiner	14	289			1	19								
Spottail shiner	2	9												
White sucker	2	7												
Brown bullhead	2	115												
Rock bass	20	807	1	10	3	36	1	115	2	75	1	45	5	20
Pumpkinseed	8	397											4	15
Bluegill	87	6427	4	45	5	65	4	665	12	1136	4	346	85	241
Smallmouth bass	6	462			1	53								
Largemouth bass	2	122									1	17	1	5
Black crappie	5	206											7	35
Yellow perch	122	3641			3	65			1	3			2	11
Tesselated darter							1	4	1	4				
American shad											19	241	6	62
Total	405	13295	8	84	130	574	6	784	16	1218	25	649	110	389

Note: weight is in grams.

Table 5-7. Summary of 2001 anadromous fish collections (American shad) at Stebbin Island, Station 3, and 0.1 mile below Vernon Dam.

Month and Station	No. Fish	Hours	CPUE	Minimum Length (mm)	Maximum Length (mm)	Minimum Weight (g)	Maximum Weight (g)
July							
Station 3	0	0.33	0.0	-	-	-	-
Stebbin Island	1	0.67	1.5	46	46	1	1
0.1 Miles south of Vernon Dam	0	0.33	0.0	-	-	-	-
August							
Station 3	44	0.50	88.0	49	93	1	7
Stebbin Island	7	2.00	3.5	72	85	3	5
0.1 Miles south of Vernon Dam	67	0.50	134.0	57	103	1	9
September							
Station 3	51	0.33	153.0	81	108	4	9
Stebbin Island	175	1.33	131.3	65	97	4	7
0.1 Miles south of Vernon Dam	56	0.33	168.0	74	106	4	10
October							
Station 3	6	0.33	18.0	90	103	6	7
Stebbin Island	65	1.27	51.3	80	117	4	10
0.1 Miles south of Vernon Dam	4	0.33	12.0	80	94	4	6

Table 5-8. Vermont Yankee ichthyoplankton sampling effort in 2001.

	Number of samples collected, by month			
Depth (m)	**May**	**June**	**July**	**Total**
0.3	2	4	3	9
1.8	2	4	3	9
3.7	2	4	3	9
Totals	**6**	**12**	**9**	**27**

Table 5-9. **Collection dates and total number of ichthyoplankton collected near the Vermont Yankee Intake in 2001.**

Species	Earliest Capture	Latest Capture	Volume Sampled (Cubic Meters)	Number	Percent
Common carp	22-Jun-01	26-Jun-01	390.68	3	0.2
Golden shiner	31-May01	31-May-01	257.95	1	0.1
Spottail shiner	04-Jun-01	18-Jul-01	1952.72	978	57.9
White sucker	31-May01	22-Jun-01	1106.81	640	37.9
White perch	21-May01	03-Jul-01	1676.4	31	1.8
Centrarchidae	22-Jun-01	18-Jul-01	1373.88	31	1.8
Tesselated darter	04-Jun-01	04-Jun-01	284.46	2	0.1
Yellow perch	21-May01	04-Jun-01	713.23	2	0.1
Walleye	21-May01	21-May-01	170.82	2	0.1
				1690	100.0

Table 5-10. Ichthyoplankton density per 100 cubic meters at the Vermont Yankee Intakes by depth in 2001 (An outage occurred from 30 April – 18 May).

Date and Taxon		DEPTH (m)			TOTALS
		0.3	1.8	3.7	
21-May-01	Walleye		1.15	1.20	2.34
	White perch		1.15		1.15
	Yellow perch			1.20	1.20
	Golden shiner			0.86	0.86
31-May-01	White perch	0.71			0.71
	White sucker	1.42			1.42
	Spottail shiner		2.21		2.21
04-Jun-01	Tesselated darter			1.93	1.93
	White sucker	706.35			706.35
	Yellow perch	1.11			1.11
12-Jun-01	Spottail shiner			0.90	0.90
	White perch	2.21	17.17	3.61	22.99
	Centrarchidae	3.10	2.21	1.21	6.52
	Common carp	1.03			1.03
22-Jun-01	Spottail shiner	558.78	69.47	1.21	629.46
	White perch		1.10		1.10
	White sucker	1.03			1.03
	Common carp		4.38		4.38
26-Jun-01	Spottail shiner	174.79	19.69		194.48
	White perch		10.94		10.94
	Centrarchidae		3.90		3.90
03-Jul-01	Spottail shiner	2.48	5.85	11.59	19.92
	White perch			1.05	1.05
11-Jul-01	Centrarchidae	1.68	0.93		2.61
	Spottail shiner	26.06	2.79	0.88	29.73
18-Jul-01	Centrarchidae	8.75	3.45	0.99	13.19
	Spottail shiner	117.79	1.72		119.51
Totals		**1607.31**	**148.09**	**26.62**	**1782.02**

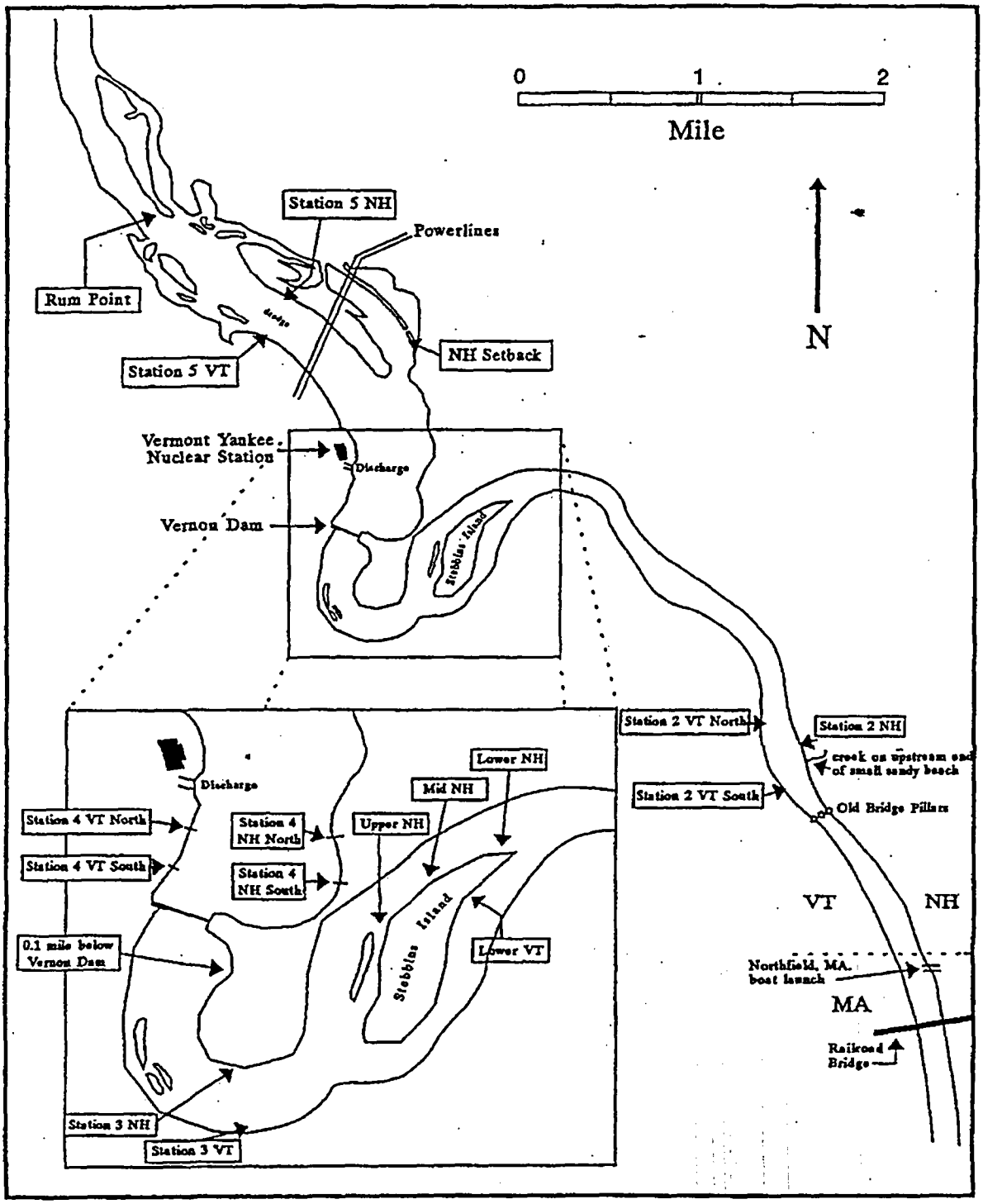


Figure 5-1. NPDES Sampling Sations

6.0 2001 ZEBRA MUSSEL AND ASIATIC CLAM MONITORING

6.1 METHODS OF COLLECTION AND PROCESSING

Larval (veliger) sampling was conducted bi-weekly between 25 May and 24 October 2001. Collections were made at quarter points (NH and VT shores, and mid-river) at Vermont Yankee stations 4 and 5 (Fig 6-3). Approximately 1,000 liters of river water was pumped through a 64 micron plankton net at each quarter point. Six samples were collected during each bi-weekly collection trip for a total of 60 veliger samples. Samples were preserved in 70% ethanol for examination in the lab.

Juvenile/adult (settling stage) zebra mussel sampling was conducted between 25 May and 24 October 2001 near the New Hampshire and Vermont shores at Vermont Yankee stations 4 and 5 (Fig 6-3). 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 laboratory.

One plate sampler deployed at Station 4 New Hampshire on 4 June 2001, 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 25 May and 5 June 2001.

Asiatic clam samples were collected with a 9 inch ponar dredge in June 2001 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 36 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.

Samples were not collected after June because dredging was dropped from the program, however additional sampling for Asiatic clams will be conducted during the 2002 sampling season.

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 12 dredge samples), then examined in entirety under low magnification (2x).

6.2 SUMMARY

River water temperatures ranged from 15.3° to 29.0° C, dissolved oxygen ranged from 6.8 to 10.8 mg/l, and pH ranged from 6.9 to 8.2 during veliger and settlement plate sampling in the vicinity of the Vermont Yankee Plant (Stations 4 and 5).

There were no Asiatic clams or any life stages of zebra mussels found in any samples collected during the 2001 Vermont Yankee monitoring program.

In addition to the zebra mussel sample collections, 5 zebra mussel awareness programs were presented during 2001 to groups in New Hampshire and Vermont including Rotary clubs, Kiwinas and Lions clubs, the Ascutney Mountain Audubon Society, and to members of the New Hampshire Fish and Game Department. One program was presented at a quarterly meeting in February 2002 to board members and guests of the Connecticut River Joint Commission.

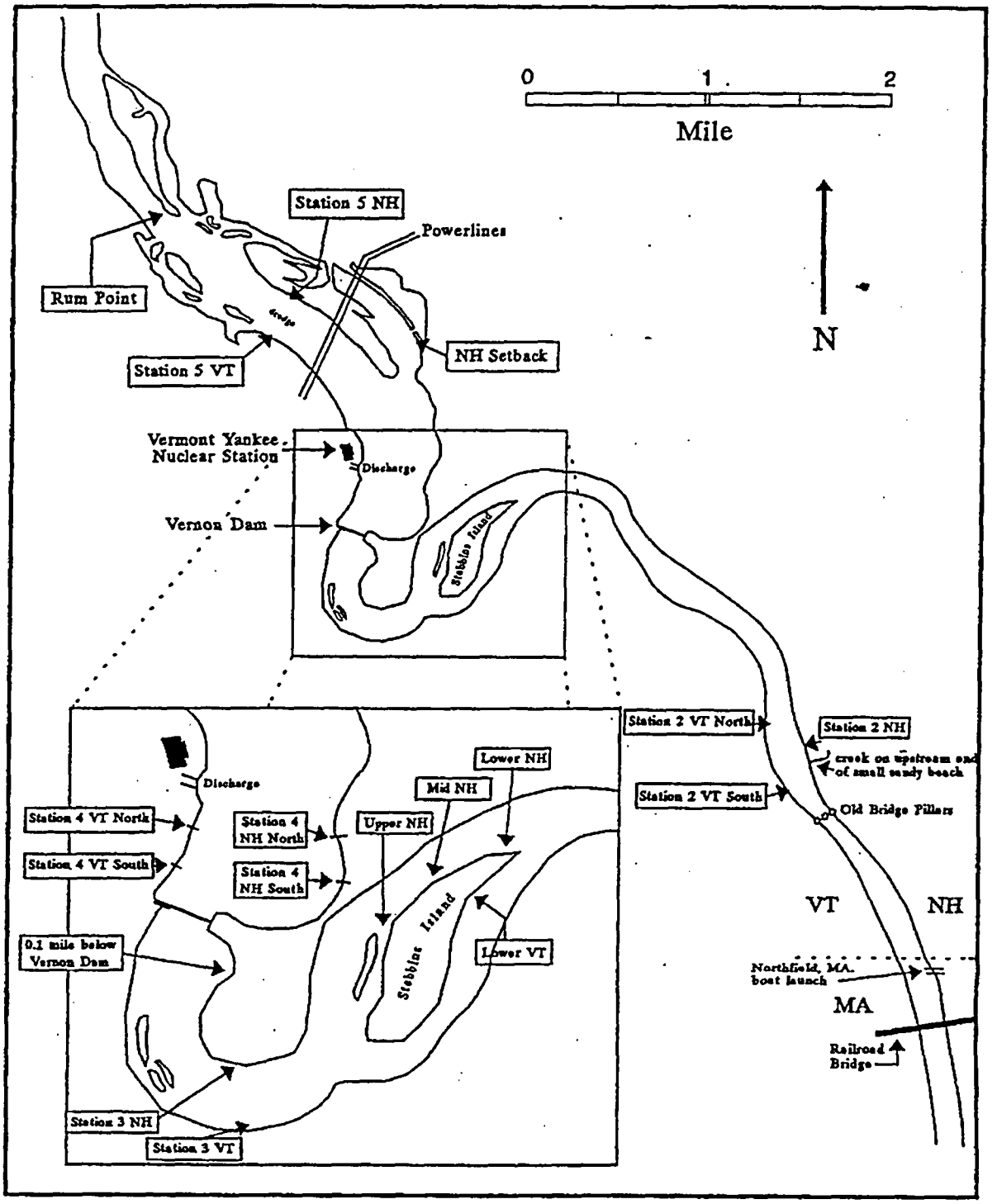


Figure 6-1. Zebra mussel and Asiatic clam monitoring Stations 2, 3 (downstream of Vernon Dam), and Stations 4 and 5 (upstream of Vernon Dam).

7.0 LITERATURE CITED

AFS (American Fisheries Society) 1991. Common and scientific names of fishes: Special Publication 20. Bethesda, Maryland.

Aquatec. 1993. Ecological studies of the Connecticut River, Vernon, Vermont. Report 22, January December 1992. Report prepared for Vermont Yankee Nuclear Power Corp., Brattleboro, VT.

Aquatec. 1995. Ecological studies of the Connecticut River, Vernon, Vermont. Report 24, January December 1994. Report prepared for Vermont Yankee Nuclear Power Corp., Brattleboro, VT.

Auer, N.A. (ed.). 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fishery Commission, Ann Arbor, MI. Special Publication. 744 pp.

Binkered, R.C. 1978. 316 Demonstration, Engineering, Hydrological & Biological Information and Environmental Impact Assessment. Aquatec, Inc. for Vermont Yankee Nuclear Power Corporation.

Brinkhurst, R.O. 1986. Guide to the freshwater aquatic microdrile oligochaetes of North America. Department of Fisheries and Oceans. Canadian Special Publication of Fisheries and Aquatic Sciences Vol. 84. Ottawa, Canada.

Brown, H.P. 1976. Aquatic dryopoid beetles (Coleoptera) of the United States. U.S. Environmental Protection Agency, Office of Research and Development. Water Pollution Control Research Series 18050 EID04/72. Cincinnati, OH.

Burch, J.B. 1975. Freshwater unionacean clams (Mollusks: Pelecypoda) of North America. Revised edition. Malacological Publications. Hamburg, Michigan.

Burks, B.D. 1953. The mayflies of Ephemeroptera of Illinois. Bull. Ill. Nat. Hist. Survey 26(1).

Downey, P.C. and R.C. Binkered. 1990. 316 Demonstration, Engineering, Hydrological & Biological Information and Environmental Impact Assessment. Aquatec, Inc. for Vermont Yankee Nuclear Power Corporation.

Fish, M.P. 1930. Contributions to the early life histories of sixty-two species of fishes from Lake Erie and its tributary waters. U.S. Bur. Fish. Bull. 47(10): 293-398.

Hitchcock, S.W. 1974. Guide to the insects of Connecticut, part VII. The Plecoptera, or stoneflies of Connecticut. State Geological and Natural History Survey of Connecticut. Department of Environmental Protection. Bulletin Number 107. Hartford, CT.

Johnson, L.E. 1996. Enhanced early detection and enumeration of zebra mussel (Dreissena spp.) veligers using cross-polarized light microscopy. Hydrobiologia. 312(2). pp. 139.

Jokinen, E.H. 1992. The freshwater snails (Mollusks: Gastropoda) of New York State. New York State Museum Bulletin 482.

Jones, P.W., F.D. Martin, and J.D. Hardy, Jr. 1978. Development of fishes of the mid-Atlantic bight. An atlas of egg, larval, and juvenile stages. Volume I. Acipenseridae through Ictaluridae. U.S. Fish and Wildlife Service. FWS/OBS - 78/12.

Klemm, D.J. led.). 1985. A Guide to the freshwater Annelida (Polychaeta, Naidid, and Tubificid Oligochaeta, and Hirudinea) of North America. Kendall/ Hunt Publishing Company. Dubuque, Iowa.

Lippson, A.J., and R.L. Moran. 1974. Manual for identification of early developmental stages of fishes of the Potomac River estuary. Power plant-siting proj. MD Dept. Nat. Res. 282 pp.

McCafferty, W.P. 1975. The burrowing mayflies (Ephemeroptera: Ephemeroidea) of the United States. Transactions of the American Entomological Society, Vol. 101: 447-504.

Merritt, R.W., and K.W. Cummins. (eds.). 1997. An introduction to the aquatic insects of North America (third edition). Kendall/Hunt Publishing Company. Dubuque, Iowa.

Normandeau Associates, Inc. 1997. Ecological studies of the Connecticut River Vernon, Vermont. Report 26, January - December 1996.

Normandeau Associates, Inc. 1998. Ecological studies of the Connecticut River Vernon, Vermont. Report 27, January - December 1997.

Normandeau Associates, Inc. 1999. Ecological studies of the Connecticut River Vernon, Vermont. Report 28, January - December 1998.

Normandeau Associates, Inc. 2000. Ecological studies of the Connecticut River Vernon, Vermont. Report 29, January - December 1999.

Normandeau Associates, Inc. 2000a. Composition of Adult American Shad at the Vernon Hydroelectric Dam Fishway During Spring 1999. Vermont Yankee/Connecticut River System Analytical Bulletin 72. Prepared for Vermont Yankee Nuclear Power Corporation, Brattleboro, VT.

Normandeau Associates, Inc. 2000b. Abundance of juvenile American shad in the Vernon pool during 1999. Vermont Yankee/Connecticut River System Analytical Bulletin 73. Prepared for Vermont Yankee Nuclear Power Corporation, Brattleboro, VT.

Normandeau Associates, Inc. 2001. Abundance of juvenile American shad in the Vernon pool during 2000. Vermont Yankee/Connecticut River System Analytical Bulletin 74. Prepared for Vermont Yankee Nuclear Power Corporation, Brattleboro, VT.

Peckarsky, B.L. 1990. Freshwater macroinvertebrates of northeastern North America. Cornell University Press. Ithaca, NY.

Roback, S.S. 1985. The immature chironomids of the eastern United States VI. Pentaneurini Genus *Ablabesmyia.* Proceedings of the Academy of Natural Sciences of Philadelphia, PA. 137(2): 153-212.

Simpson, K.W., and R.W. Bode. 1980. Common larvae of Chironomidae (Diptera) from New York state streams and rivers, with particular reference to the fauna of artificial substrates. New York State Museum Bulletin No. 439. Albany, NY.

Vermont Yankee & Normandeau Associates, Inc. 2001. Ecological studies of the Connecticut River Vernon, Vermont. Report 30, January - December 2000.

Wiederholm, T. led.). 1983. Chironomidae of the holarctic region, Keys and diagnoses. Supplement No. 19. Entomologica Scandinavica. Lund, Sweden.

Wiggins, G.B. 1996. Larvae of the North American caddisfly genera (Trichoptera). University of Toronto Press Incorporated. Toronto, Canada.