ECOLOGICAL STUDIES OF THE CONNECTICUT RIVER VERNON / VERMONT

REPORT 22

SUMMARY AND DATA

JANUARY 1992 - DECEMBER 1992

prepared for

VERMONT YANKEE NUCLEAR POWER CORPORATION
BRATTLEBORO, VERMONT

by

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SOUTH BURLINGTON, VERMONT
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1.0 INTRODUCTION

This report fulfills requirements of Vermont Yankee Nuclear Power Plant's discharge permit, NPDES No. VT0000264, issued on 1 January 1991 and in effect until 31 December 1995.

Material in this report demonstrates compliance with thermal criteria defined in Part I, Effluent Limitations and Monitoring Requirements, of the NPDES permit. Results of the environmental monitoring program defined in Appendix A of the permit, Section I, Routine Monitoring, are also reported in this document.

This is the second annual report produced under requirements of the 1991 five-year permit. This report discusses thermal standards, water quality, plankton, macroinvertebrates, and fish. Environmental sample stations referred to in the following sections of this report are presented in Figures 1.1 and 6.1.

Goal-oriented studies of the fisheries near Vernon, Vermont were conducted during 1992. These studies and analysis of environmental impact relevant to the Vermont Yankee/Connecticut River system will be presented separately in the following Analytical Bulletins:

46 Composition of Adult American Shad at Turners Falls and Vernon Dam Fishways, 1992.

47 Sexual Maturity and Bioenegetics of Migrating Adult Female American Shad, 1992.

48 Relative Density and Growth of Juvenile American Shad in the Connecticut River near Vernon, Vermont, 1992.

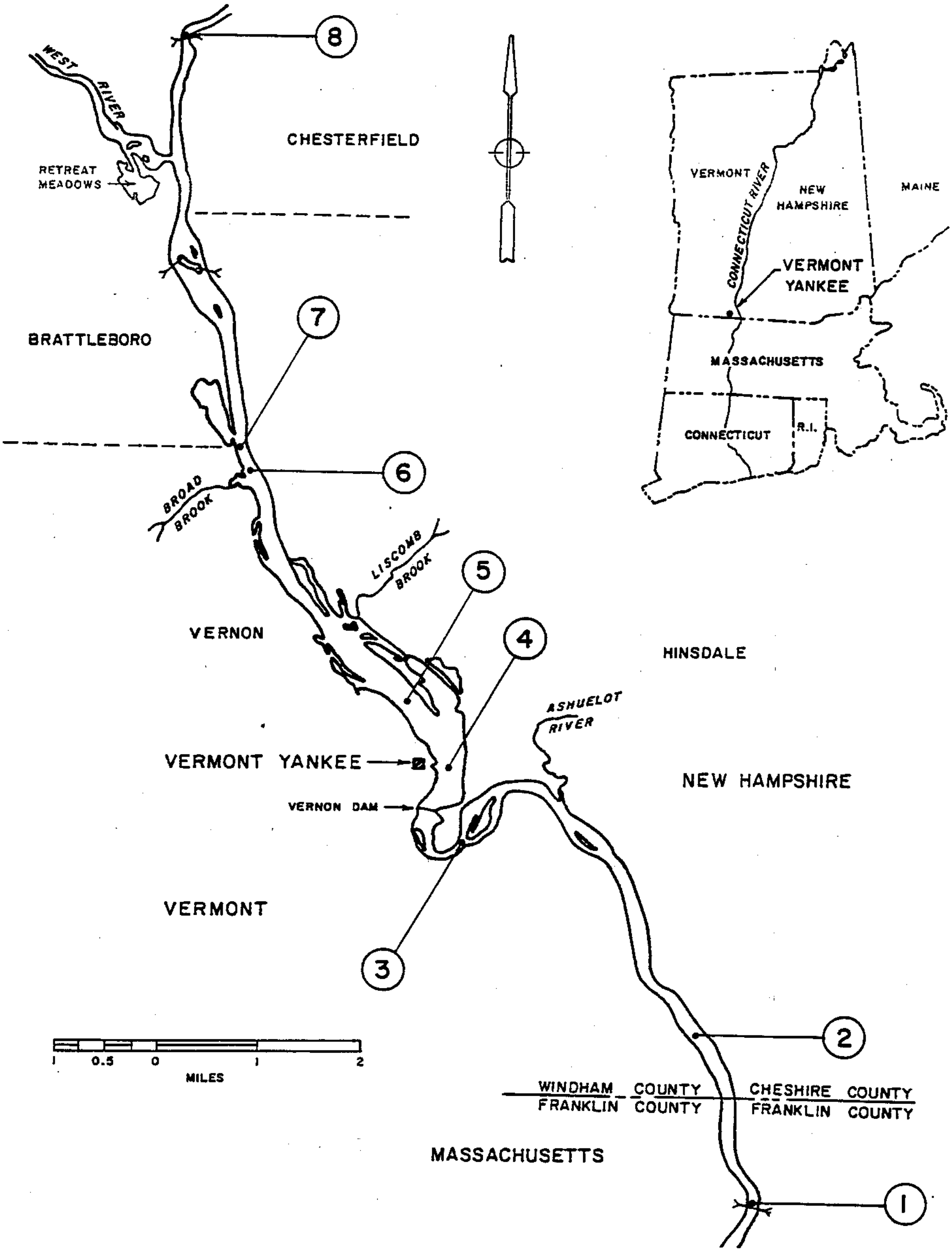

Figure 1.1 Environmental sample stations

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 temperatues, as specified in Vermont Yankee's discharge permit. Effective 1 January 1991, during the 16 May through 14 October period, Vermont Yankee is permitted to discharge heat to the river within the following thermal standards (A.5.b. of the NPDES permit):

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

During the period of 15 October through 15 May, Vermont Yankee is permitted to discharge heat to the Connecticut River within the following thermal standards (section A.5.a. of the NPDES permit).

1. The temperature at Monitor 3 during open cycle operation shall not exceed 65°F.

2. The rate of change of temperature at Monitor 3 shall not exceed 5°F per hour.

3. The increase in temperature above ambient at Monitor 3 shall not exceed 13.4°F.

The river discharge near Vernon is regulated to remain at or above 1250 cubic feet per second (cfs). Since the theoretical 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 utilizing the cooling towers.

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 river temperature and plant operating records.

Rate of change of temperature is defined in the NPDES permit as the difference between consecutive hourly average temperatures. Measurements at 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, et al. 1978). 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 records and core thermal power, the amount of heat discharged to the river was calculated. Then, using thermodynamic and hydrodynamic principles and the river discharge information, the mixed river temperature increase was calculated and compared with thermal standards.

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, gross, and net power produced by Vermont Yankee in 1991. These data were obtained from hourly records supplied by Vermont Yankee. Gross and net electrical power records were obtained from Meter Data Sheets, VYAPF 0158.01. Core thermal power data were obtained from Core Exposure Log Work Sheets, VYDPF 0415.02. 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 to the river. Figure 2.2 depicts heat discharged to the river.

Figure 2.3 is a plot of hourly Connecticut River discharge near Vernon, Vermont. These data were obtained from records at Vernon

Station. Table 2.1 lists the average daily and monthly river discharge. For discharge greater than 12,000 cfs, a rating curve was used to convert stage height to discharge. The rating curve was that used by the USGS prior to abandoning the Vernon gaging station. 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 a small impact on stage height near Vernon Dam for high discharge. Below 12,000 cfs, discharge data were obtained from turbine rating curves at Vernon Station. The peak flow for 1992 was 59,095 cfs which occurred at 1900 hours on 25 April as depicted in Figure 2.3.

Increases in river temperature due to Vermont Yankee's operation are plotted in Figure 2.4. Comparison of Vermont Yankee's discharge heat (Figure 2.2), Connectuicut River discharge (Figure 2.3), 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 river discharge. At no time during 1992 did Vermont Yankee's operation cause an exceedance of the permitted increase in river temperature. The computer simulation of heat balance resulted in a maximum simulated temperature increase of 8.3°F, which occurred on 27 December 1992 at 1745 hours.

Hourly average temperatures 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 primarily to passage through Vernon Station. Temperatures measured at Station 3 reflected both the natural and plant-induced changes in temperature between the upstream and downstream locations. The maximum difference between temperatures measured at Station 3 and Station 7 was 7.8°F and occurred on 9 February 1992 at 1300. The maximum rate of temperature increase at Station 3 was 1.8°F per hour and occurred on 12 December 1992. The maximum rate of decrease was 1.8°F per hour and occurred on 27 December 1992.

Table 2.1 Daily and monthly average Connecticut River discharge at Vernon Station during 1992

Day	January	February	March	April	May	June	July	August	September	October	November	December
1	11280	6762	3049	18051	21572	15233	2752	4100	2349	3435	5262	15313
2	9692	5936	4293	17460	22876	24842	1738	4409	1662	2975	5637	15145
3	9554	6257	4507	16356	40852	16220	1956	3387	2270	2581	7113	13061
4	9611	5435	5195	14673	33782	11394	2184	4134	3630	2107	8359	11905
5	10968	5710	4159	12517	28705	9367	3094	3437	2729	3051	7992	9718
6	10283	5184	6251	12137	24793	14015	2674	5641	3112	2111	8513	9024
7	10737	5246	6736	11412	20468	14536	4734	3123	2163	2158	9037	6777
8	9843	3844	8516	11265	12488	10715	3022	2974	2800	2344	8955	6543
9	9719	3701	9274	14792	15221	10354	4317	2670	3063	2392	8265	5339
10	10271	5649	11132	18238	17389	8296	5967	4168	4078	5891	7707	5525
11	9865	4872	34007	17969	17103	8238	4054	3218	3933	4752	7261	6062
12	5959	4453	47667	18335	12853	5678	3769	2194	4438	3338	7909	5738
13	6259	4531	36696	17474	12006	3980	5095	2170	3126	2595	9304	6528
14	8280	4529	25116	16281	11254	3694	2853	2214	2707	3015	14617	6539
15	11609	3999	19360	13574	11201	4511	6092	1532	2111	2905	13531	4029
16	11604	4864	12122	12253	11398	4671		2828	2103	3091	15494	5297
17	10947	3793	11591	15683	11494	3531	6027	1600	1801	3802	11574	5154
18	7233	6136	11394	13540	10842	3517	2631	2115	1863	3219	8978	6245
19	6526	6202	11277	11659	8674	3866	3735	1974	2005	4543	8919	8165
20	6964	6431	10965	18212	9435	3126	5391	1877	2402	4222	7715	5451
21	7340	7460	10752	34132	9255	2800	6183	2627	1916	5742	5807	7423
22	6352	6693	10350	42656	7352	4195	5953	2057	2209	4279	7452	6769
23	7598	4643	10098	45746	4740	4225	3503	1885	5735	3803	11174	5730
24	8708	4918	10339	48293	5043	4299	3561	2734	4613	3708	21893	6086
25	10834	4455	8501	54004	4467	4302	2924	2662	6178	5941	21902	5043
26	10843	5046	8807	54658	5826	3893	2652	2770	5194	6987	22041	3995
27	7274	5003	20151	46567	5202	3066	2125	2805	3245	6763	22478	2984
28	8717	3969	39636	38722	5144	3158	1791	1523	5312	6556	22924	3722
29	7340	3559	25625	30549	5799	3233	1583	1593	3532	6173	18469	5436
30	6998		16421	24558	5760	3102	1716	2294	3310	7491	15547	6357
31	6208		17347		5219		2185	2020		9203		8447
Ave.	8884	5148	14882	24075	13491	7202	3542	2733	3186	4231	11721	7084

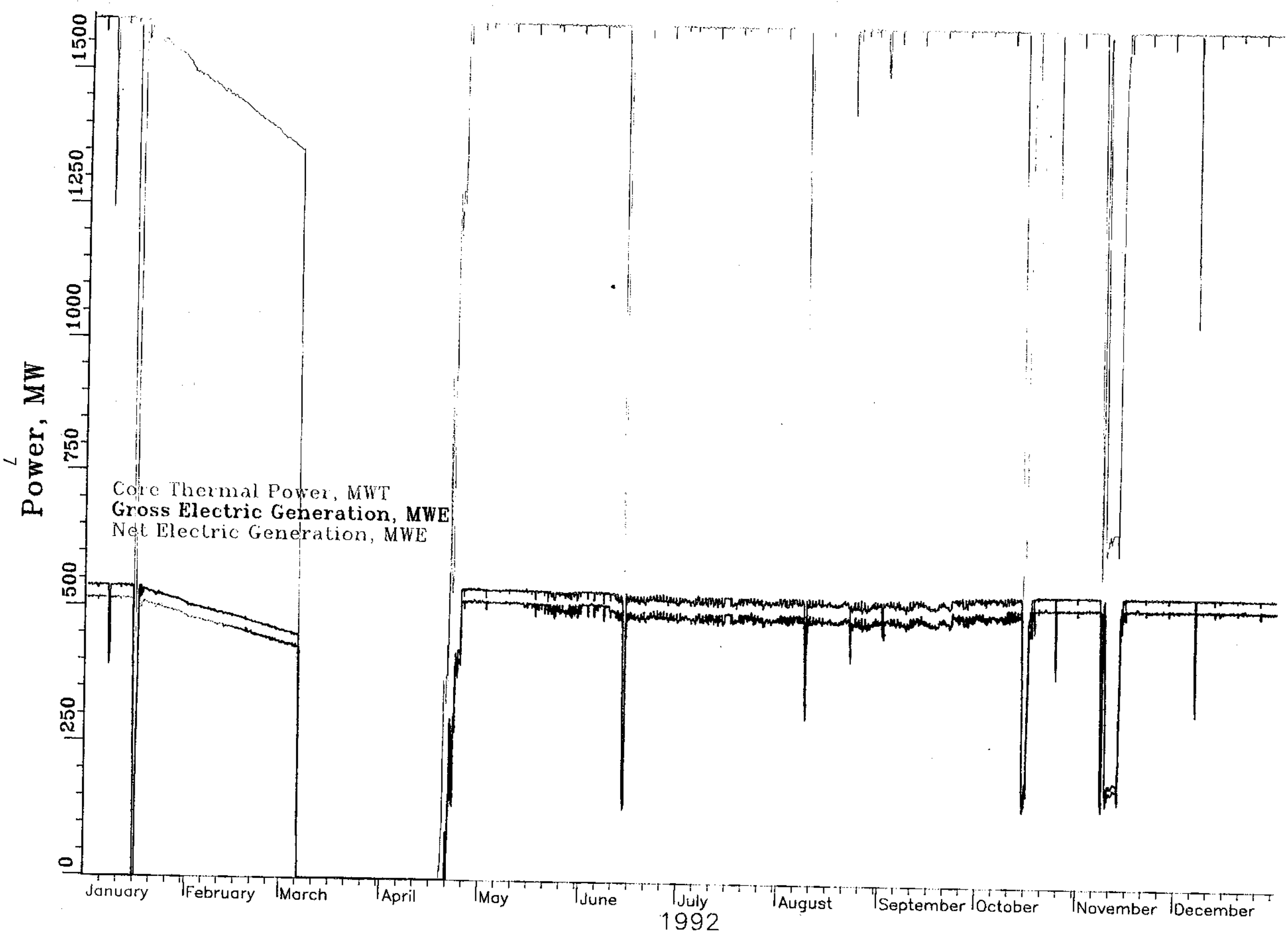

Figure 2.1 Vermont Yankee Power, 1992

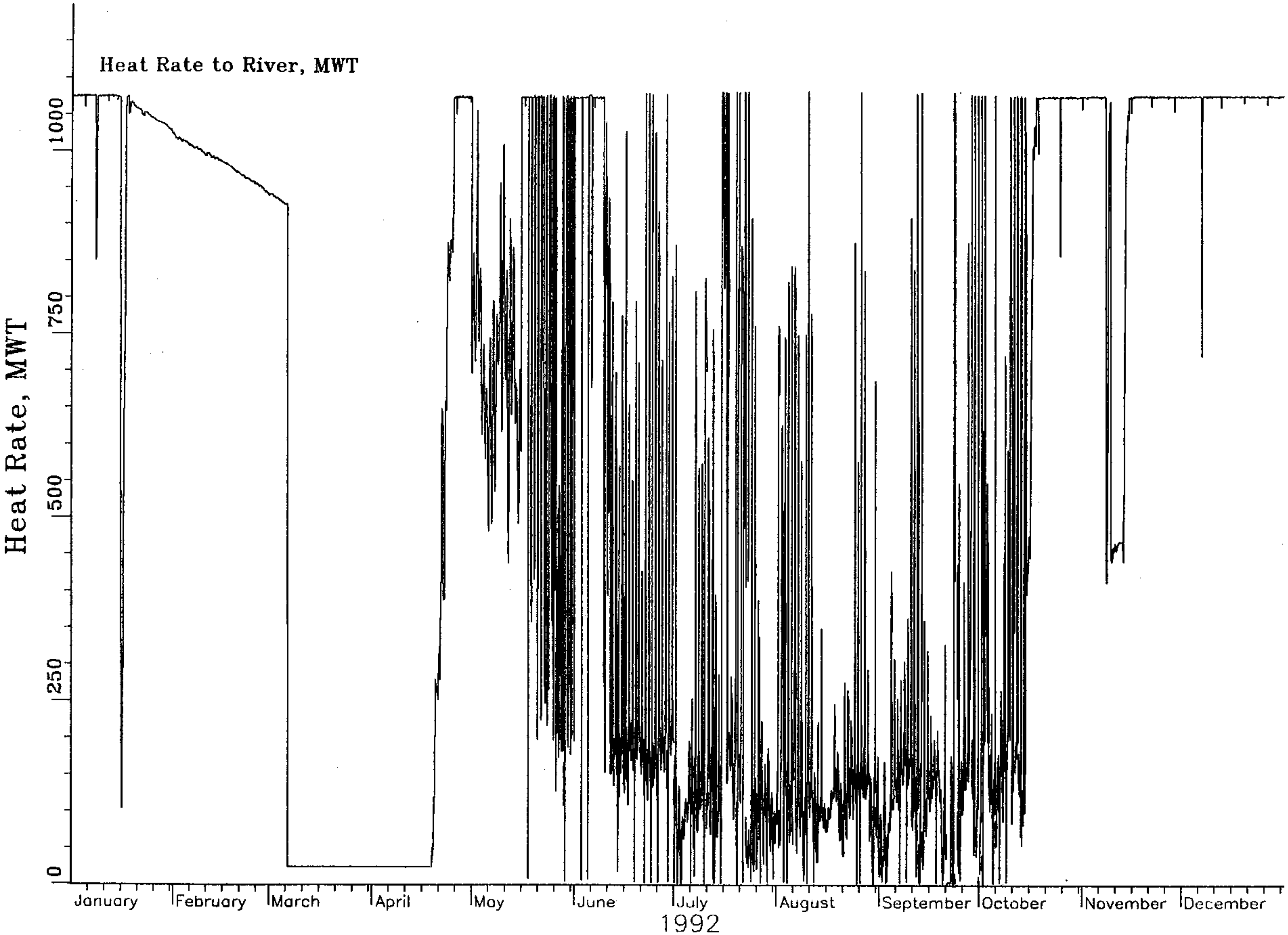

Figure 2.2 Vermont Yankee Discharged Heat, 1992

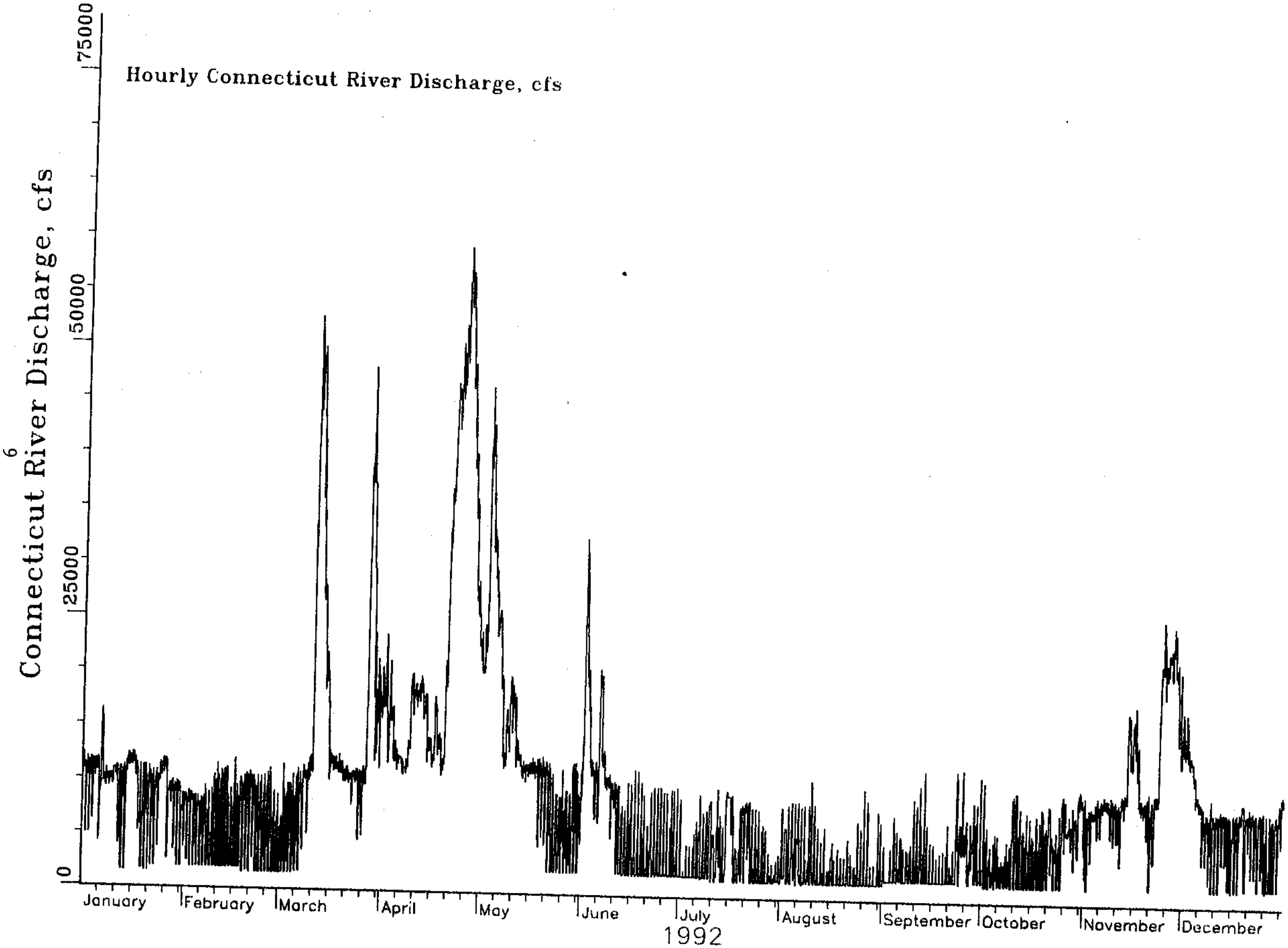

Figure 2.3 Connecticut River Discharge, 1992

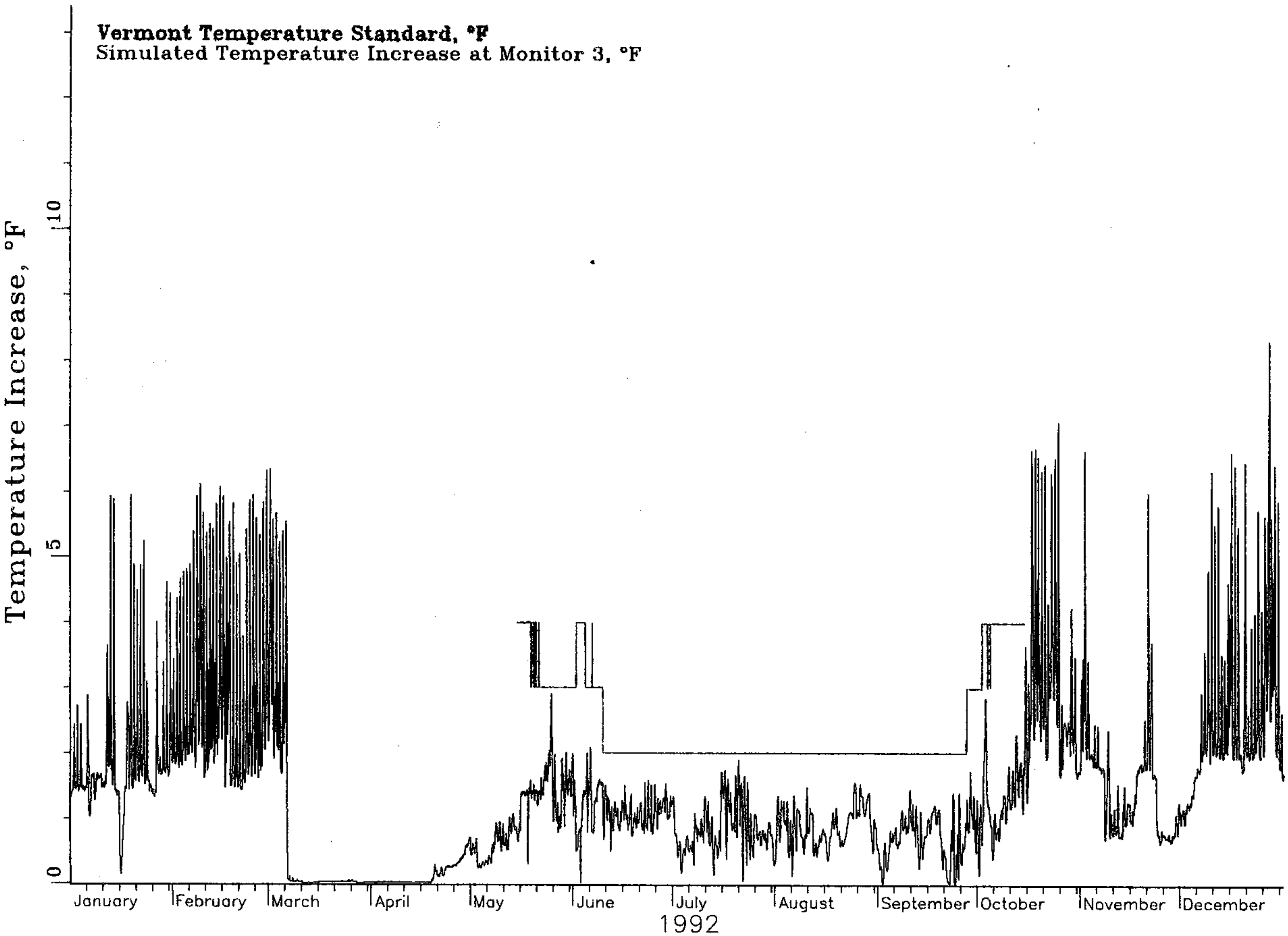

Figure 2.4 Connecticut River Temperature Increase, 1992

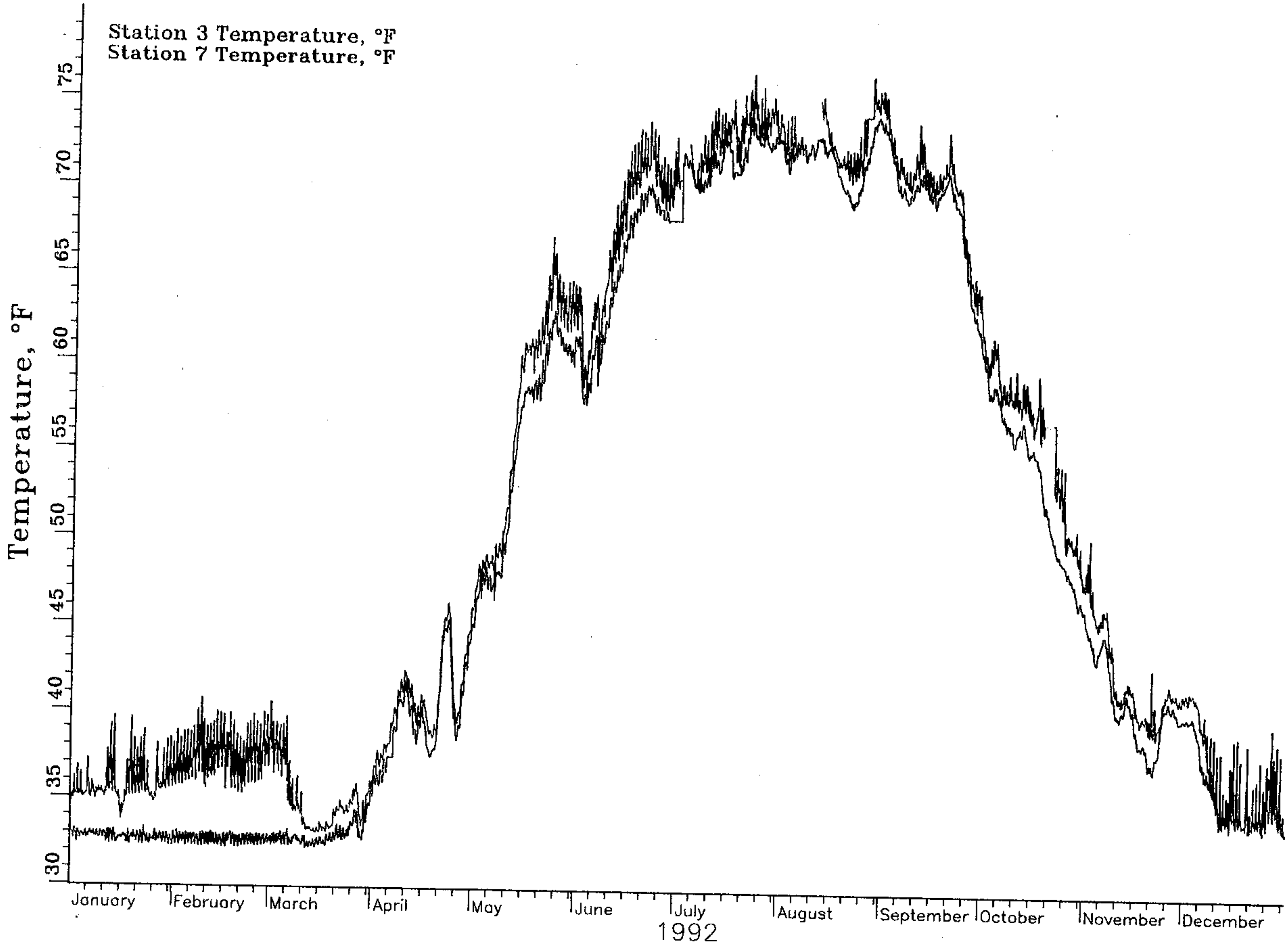

Figure 2.5 Connecticut River Temperatures, 1992

3.0 Water Quality Studies

Water temperature was measured continuously at Stations 7 and 3 and at the Vernon Dam fishway during fishway operation. Daily and monthly average temperature data from Stations 7 and 3 are summarized in Tables 3.1 and 3.2; hourly average temperature data for both locations are plotted on Figure 2.5. Hourly and daily average temperature data from the fishway are tabulated in Table 3.3.

Chemical analyses were conducted monthly during 1992 on grab samples of river water collected at Stations 7 and 3 and at the plant discharge when the plant was operating; no sample was collected from the plant discharge in March as the plant was not operating during this month. All samples at Stations 7 and 3 were collected directly from the Connecticut River. A yearly analysis of the plant discharge for volatile and semivolatile acid extractable organic compounds was collected on 14 May 1992 and is attached; no compounds were detected at detection levels of 0.005 - 0.010 milligrams/liter (mg/l) for volatile compounds and 0.010 - 0.050 mg/l for semivolatile compounds.

The range of water quality values measured monthly at each sampling location is tabulated in Table 3.4. The nonparametric Wilcoxon signed rank test was utilized to evaluate if any significant differences were found between the three sampling locations (Ryan, 1985). This test did not find any significant difference (probability greater than 95 percent) among the tabulated water quality parameters between Station 3 and Station 7 during 1992. This test calculated significant differences between the plant discharge and Stations 7 and 3; the plant discharge was lower in dissolved oxygen (average of about 1.2 mg/l) and higher in copper and zinc (median difference of at least 0.006 and 0.005 mg/l respectively) as compared to both Stations 7 and 3. This test also calculated significant differences between the plant discharge and Station 3; the plant discharge was higher in total solids, total suspended solids, and iron (median differences of about 5.6, 0.9, and 0.03 mg/l respectively) as compared to Station 3. Total solids and total suspended solids content at Station 7 were also higher than that at Station 3 by similar amounts, although these difference were not calculated to be significant. It is believed that the only consistently significant differences between the plant discharge and Stations 7 or 3 observed during 1992 are in dissolved oxygen and metals content.

The lower dissolved oxygen content in the plant discharge compared to Station 3 and 7 is most likely due a combination of elevated water temperature of the discharge, thus lowering its capacity to retain dissolved oxygen, and turbulence at the discharge outlet, driving off excess dissolved oxygen. The higher concentrations of copper, zinc, and, to a lesser extent, iron are possibly due to corrosion by-products and/or increased biological solids from the circulating water system piping. As already stated, none of these differences appeared to significantly change water quality at Station 3 relative to that at Station 7 based on the 1992 water quality data.

Table 3.1 Daily and monthly average temperatures at Station 7 during 1992

Day	January	February	March	April	May	June	July	August	September	October	November	December
1	32.8	32.6	32.6	35.8	45.4	60.1	71.7	71.7	73.0	60.0	45.4	40.1
2	32.8	32.7	32.6	36.1	46.7	58.1	71.6	71.5	72.1	58.7	44.8	40.1
3	32.8	32.6	32.6	36.2	47.5	58.2	71.4	71.9	71.4	58.5	44.2	40.2
4	32.7	32.6	32.8	36.6	47.8	59.3	70.7	72.3	70.2	58.8	43.4	39.8
5	32.8	32.6	32.6	36.9	47.5	60.7	70.2	72.6	69.9	58.2	44.0	39.1
6	32.7	32.7	32.7	0.0	47.3	60.5	69.9	72.5	69.8	57.3	44.6	37.7
7	32.9	32.7	32.5	39.0	47.5	60.6	70.2	72.0	69.4	56.9	44.4	37.0
8	32.8	32.6	32.6	39.6	48.0	61.6	70.4	72.2	69.7	56.6	43.1	36.8
9	32.8	32.6	32.8	40.6	48.4	62.5	71.1	72.3	70.2	56.3	41.5	36.5
10	32.8	32.6	32.6	40.9	49.7	63.7	71.7	72.5	70.4	55.8	40.5	36.3
11	32.8	32.6	32.5	41.1	51.4	64.5	71.5	72.9	70.7	56.4	40.2	36.2
12	32.7	32.6	32.3	40.1	53.4	65.2	71.2	72.7	70.5	56.6	40.4	36.2
13	32.7	32.6	32.4	39.1	55.3	65.7	72.3	72.2	70.0	56.3	41.1	36.1
14	32.7	32.6	32.4	38.7	56.9	66.8	72.6	72.4	69.7	55.3	41.0	35.9
15	32.5	32.5	32.5	39.6	57.9	67.7	72.3	72.1	69.4	55.3	40.5	35.9
16	32.6	32.6	32.5	39.6	58.5	67.9	71.1	71.6	69.7	55.1	39.4	35.8
17	32.7	32.6	32.5	38.3	58.4	68.5	70.9	70.8	70.0	54.6	38.6	35.6
18	32.6	32.7	32.6	37.5	58.4	69.0	71.0	70.3	70.4	53.7	38.5	35.5
19	32.6	32.6	32.7	37.8	58.6	69.3	71.6	70.0	70.9	52.2	38.4	35.4
20	32.7	32.5	32.7	39.0	58.9	69.6	72.2	69.7	70.1	51.8	37.6	35.3
21	32.7	32.5	33.0	41.9	59.8	69.9	73.4	69.2	69.5	50.8	37.3	35.1
22	32.7	32.6	33.1	44.5	60.8	69.8	73.6	69.3	69.0	50.1	37.7	35.2
23	32.7	32.6	33.0	44.9	62.0	69.1	73.1	69.8	68.4	49.4	38.4	35.0
24	32.5	32.6	33.0	43.6	62.6	68.8	72.7	70.6	66.7	49.1	40.2	35.0
25	32.5	32.6	33.3	40.1	61.9	68.4	72.7	71.5	65.5	48.8	40.7	34.9
26	32.7	32.6	33.7	38.8	61.4	68.6	73.0	72.1	64.1	48.4	40.9	34.9
27	32.6	32.6	34.1	39.8	60.9	68.2	72.4	73.1	63.1	48.1	40.7	35.1
28	32.7	32.6	33.1	41.7	60.7	--	72.5	73.8	62.6	47.6	40.6	35.0
29	32.6	32.6	33.1	43.1	60.6	--	72.8	74.1	62.0	46.8	40.1	34.9
30	32.6		34.1	44.4	60.7	--	72.8	73.7	60.8	46.6	40.1	34.8
31	32.5		34.9		61.3		72.6	73.5		46.2		34.6
Average	32.7	32.6	32.9	39.8	55.4	65.0	71.9	71.8	68.6	53.4	41.0	36.3

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Table 3.2 Daily and monthly average temperatures at Station 3 during 1992

Day	January	February	March	April	May	June	July	August	September	October	November	December
1	34.9	36.4	38.8	36.4	46.5	62.1		72.6	73.5	60.5	48.0	41.4
2	35.3	36.8	37.9	37.2	47.9	59.2		72.4	72.5	60.2	47.6	41.4
3	35.4	36.7	37.9	37.2	48.2	59.6	72.1	72.8	71.9	60.9	46.5	41.5
4	35.3	37.0	37.7	37.6	48.6	61.4	70.8	72.2	71.3	60.9	45.6	41.3
5	35.1	36.9	38.0	37.9	48.5	62.8	70.4		71.2	59.3	45.5	40.7
6	35.7	37.1	37.3	38.9	48.6	62.5	70.9		70.7	58.6	45.9	39.5
7	35.3	37.4	35.4	39.7	48.8	62.3	71.8		70.4	58.4	46.0	39.2
8	35.1	38.4	34.8	40.4	49.2	63.9	71.5		70.5	58.6	44.2	37.9
9	35.3	38.6	34.8	41.3	49.5	65.4	71.9		71.4	58.2	43.3	37.1
10	35.2	37.1	34.3	41.6	51.1	66.1	73.2		72.2	58.7	41.6	36.3
11	35.2	37.6	33.8	41.7	52.8	67.3	73.5	75.0	72.1	57.9	41.1	35.5
12	36.5	37.6	33.3	41.2	54.9	67.4	72.9	74.6	71.2	58.4	41.1	34.8
13	36.8	37.7	33.2	40.3	57.2	68.6	73.0	73.9	70.6	58.2	41.7	34.7
14	36.4	37.9	33.1	39.7	59.4	69.2	73.0	72.9	70.4	57.8	41.9	34.8
15	35.0	38.1	33.1	40.3	60.2	70.6	73.4	72.4	70.2	57.0	41.6	35.1
16	34.1	37.9	33.3	40.5	60.8	70.7	74.1	72.0	70.4	56.8	40.7	35.5
17	34.8	38.0	33.3	39.4	60.9	70.7	72.8	71.5	70.6	58.0	40.0	35.2
18	36.1	37.4	33.3	38.8	60.7	71.3	72.5	71.7	71.1	56.7	40.0	34.9
19	36.8	37.0	33.3	38.8	61.1	71.7	73.6	71.6	72.0	56.5	40.0	34.2
20	36.0	36.8	33.8	39.6	61.5	71.5	74.3	71.3	71.3		39.7	35.4
21	36.1	36.5	34.2	42.5	62.3	72.1	74.8	71.3	70.3		39.9	34.1
22	36.4	36.5	34.5	45.0	63.5	72.3	74.9	71.4	70.0	52.9	39.8	34.6
23	36.4	37.4	34.4	45.7	64.8	71.2	74.3	71.7	69.5	53.4	39.6	34.6
24	35.4	37.6	34.4	44.3	65.4	70.5	73.5	72.4	67.2	53.0	40.4	34.8
25	35.0	37.8	34.6	40.8	63.8	70.2	73.7	72.7	66.3	51.8	41.3	34.8
26	34.9	37.6	35.0	39.6	63.5	69.7	73.6		65.0	50.1	41.7	35.4
27	36.2	37.5	35.4	40.7	62.9	69.9	73.9	75.8	64.2	50.2	41.4	36.5
28	35.5	38.1	34.1	42.4	63.1	70.2	74.5	74.9	63.9	49.8	41.4	35.5
29	36.0	38.2	34.1	43.9	63.3	71.1	73.8	75.0	63.6	49.6	41.1	35.4
30	36.4		34.8	45.3	63.3	70.2	73.4	75.1	61.8	48.8	41.2	35.0
31	36.6		35.6		63.3		73.3	74.7		47.6		34.0
Average	35.7	37.4	34.9	40.7	57.2	67.6	73.1	72.9	69.6	55.9	42.4	36.5

Table 3.3 Hourly and daily average temperature at the Vernon Station Fishway during 1992.

AVERAGE HOURLY TEMPERATURE IN DEGREES F

Vernon Fishway

May 1992

DAY	HOUR. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
1											FISHWAY INOPERATIVE														
2											FISHWAY INOPERATIVE														
3											FISHWAY INOPERATIVE														
4											FISHWAY INOPERATIVE														
5											FISHWAY INOPERATIVE														
6											FISHWAY INOPERATIVE														
7											FISHWAY INOPERATIVE														
8											FISHWAY INOPERATIVE														
9											FISHWAY INOPERATIVE														
10											FISHWAY INOPERATIVE														
11											FISHWAY INOPERATIVE														
12											FISHWAY INOPERATIVE														
13											FISHWAY INOPERATIVE														
14											FISHWAY INOPERATIVE														
15											FISHWAY INOPERATIVE														
16											FISHWAY INOPERATIVE														
17											FISHWAY INOPERATIVE														
18				FISHWAY INOPERATIVE							60.9	60.9	60.7	60.5	60.8	61.3	60.8	61.0	61.1	61.0	60.9	60.8	60.8	62.4	61.0
19	62.7	61.7	61.6	61.6	61.4	61.3	61.2	61.3	61.2	61.0	60.9	61.2	61.5	61.5	62.0	63.9	65.2	64.9	64.2	63.8	62.3	61.4	62.4	62.7	62.2
20	62.2	61.9	61.7	61.6	61.6	61.6	61.4	61.3			61.6	61.7	62.2	63.3	64.6	66.3	66.7	66.1	64.6	64.1	62.6	62.0	61.6	62.6	62.9
21	62.9	62.3	61.9	62.1	62.0	62.1	62.0	62.2	62.0	62.0	62.6	62.7	63.4	64.7	64.3	65.1	66.3	66.8	66.3	65.8	65.7	64.7	63.5	64.2	63.6
22	64.4	63.9	63.4	63.3	63.6	63.8	63.9	64.1	64.1	64.0	64.5	65.2	66.5	67.6	67.7	68.1	68.3	67.8	67.9	67.4	66.9	66.4	66.2	65.7	65.6
23	65.6	65.2	65.0	64.7	65.2	65.3	65.3	65.4	65.6	65.8	65.9	66.0	68.1	68.3	67.9	68.2	67.8	68.6	69.0	68.7	68.9	68.3	67.9	67.5	66.8
24	67.7	67.6	67.7	67.9	67.8	67.6	67.5	67.8	67.8	67.4	67.2	67.0	66.6	66.0	65.9	66.3	66.1	65.8	66.2	65.8	65.6	65.5	65.1	64.6	66.7
25	64.3	64.3	64.3	64.4	64.3	64.2	64.2	64.3	64.5	64.6	64.8	65.1	65.6	66.2	66.9	66.1	66.4	66.1	65.9	65.6	65.3	65.1	65.3	65.0	65.1
26	64.8	64.2	64.1	64.2	64.2	64.1	64.0	64.0	64.0	65.3	63.9	65.0	66.1	65.3	66.0	65.6	65.4	65.8	65.7	65.2	65.0	64.9	64.6	64.4	64.8
27	64.0	64.0	63.7	63.4	63.5	64.0	64.1	64.0	64.0	64.4	64.6	64.9	64.7	64.9	65.0	64.3	63.9	63.9	63.6	63.9	63.5	63.1	63.3	63.9	64.0
28	63.7	63.5	63.3	63.0	63.2	63.3	63.3	63.4	63.6	63.7	64.6	65.1	65.0	65.6	65.7	66.1	66.1	65.8	65.4	64.9	65.0	65.5	65.4	65.3	64.6
29	64.6	64.1	63.7	63.6	63.8	63.8	63.7	63.7	63.5	63.2	64.2	65.2	66.2	66.7	67.6	67.5	67.1	66.2	66.3	66.2	66.3	66.2	65.4	64.9	65.2
30	64.5	64.0	64.2	64.6	64.5	64.3	64.2	64.3	64.3	64.3	64.7	66.6	66.1	65.7	66.2	65.6	65.1	65.3	65.0	65.0	64.8	65.0	65.1	64.7	64.9
31	64.4	64.1	63.8	63.6	63.8	64.3	64.2	64.3	64.7	64.7	64.7	65.0	65.9	66.4	66.2	66.1	66.1	66.8	66.6	65.9	65.5	65.2	65.1	64.7	65.1

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Table 3.3 Hourly and daily average temperature at the Vernon Station Fishway during 1992 (continued).

AVERAGE HOURLY TEMPERATURE IN DEGREES F

Vernon Fishway

June 1992

	HOUR																								
DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	DAILY AVERAGE
1	64.1	63.8	62.9	63.0	62.9	63.0	63.2	63.1	63.5	63.6	63.1	62.5	62.3	62.0	61.8	61.5	61.1	61.1	61.3	61.2	60.9	60.5	60.2	60.0	62.2
2	59.9	59.7	59.6	59.6	59.6	59.6	59.6	59.5	59.4	59.4	59.5	59.6	59.8	60.1	60.1	60.2	60.3	60.2	60.0	59.9	59.8	59.6	59.5	59.4	59.8
3	59.4	59.4	59.4	59.4	59.2	59.2	59.0	58.9	58.9	59.2	59.7	59.8	59.9	60.0	60.3	60.3	60.5	60.7	60.5	60.5	60.7	60.9	61.0	60.5	59.9
4	60.4	60.3	60.2	60.3	60.4	60.6	60.7	60.6	60.7	61.3	62.5	64.5	65.9	66.5	66.1	66.4	65.8	65.1	65.2	64.6	65.1	64.5	63.4	62.4	63.0
5	62.9	64.3	64.3	64.7	64.9	64.6	63.9	62.9	62.3	63.4	65.0	66.1	66.5	65.6	63.9	62.6	62.6	62.4	62.4	62.3	62.3	62.3	62.3	62.4	63.6
6	63.6	64.4	64.2	64.5	64.6	64.7	64.3	64.6	64.2	63.5	63.4	63.4	63.3	63.1	62.7	62.5	62.4	62.0	61.2	60.3	60.2	60.6	61.0	61.4	62.9
7	61.5	61.6	61.7	61.8	61.7	61.6	61.6	61.6	61.7	62.1	62.2	63.5	65.7	66.6	67.1	66.9	66.2	65.8	65.8	66.1	64.5	63.3	63.4	63.0	63.6
8	63.2	63.3	63.5	63.7	64.3	65.6	64.1	63.2	63.7	66.9	67.4	67.5	67.3	67.0	67.3	67.0	66.3	66.9	67.2	65.8	65.8	65.9	66.4	66.5	65.7
9	66.2	66.5	66.9	66.4	66.4	66.3	66.3	66.0	66.4	65.5	65.3	65.4	65.4	65.8	66.1	66.8	68.1	68.4	68.2	67.9	67.9	68.0	67.4	66.4	66.7
10	66.8	66.3	66.0	65.8			65.2	64.7	64.8	65.6	66.7	67.7	67.8	67.5	67.9	68.0	68.5	68.7	69.0	69.0	68.9	67.9	66.9	66.3	67.1
11	66.6	67.2	66.0	66.1	66.2	66.2	66.1	66.2	66.3	66.6	68.0	68.4	68.7	68.8	69.2	70.6	70.8	70.0	69.3	69.8	69.5	69.6	69.1	68.2	68.0
12	68.0	68.1	68.1	67.9	67.8	67.9	67.7	67.4	66.6	66.4	67.7	70.5	71.2	70.7	69.9	69.8	69.7	69.8	70.2	69.9	69.6	69.6	69.6	69.3	68.9
13	69.2	69.1	69.0	69.0	69.4	69.5	69.2	69.2	69.4	69.4	70.1	71.2	70.8	71.3	71.1	71.4	71.5	72.0	71.8	71.5	71.2	71.3	70.9	70.6	70.4
14	70.2	70.1	70.2	70.1	70.4	70.5	69.5	69.5	69.5	69.8	71.0	71.7	72.2	72.5	71.7	72.3	72.0	72.5	72.7	72.8	72.9	73.0	72.8	72.7	71.3
15	72.5	72.4	72.5	72.5	72.4	72.5	72.3	72.3	72.0	71.1	70.9	71.4	71.4	71.4	71.5	71.8	72.2	72.4	72.4	72.4	72.3	72.1	71.7	71.4	72.0
16	71.3	71.3	71.2	71.0	70.9	70.8	70.8	70.7	70.4	70.5	71.3	71.9	72.7	73.0	73.4	74.3	73.8	74.0	73.6	73.6	73.2	72.8	72.4	72.2	72.2
17	72.4	72.2	72.1	72.1	72.0	71.7	71.6	71.6	71.5	71.5	71.7	71.6	73.0	73.6	74.3	74.3	74.2	73.6	72.9	72.5	72.3	72.7	72.8	72.8	72.6
18	72.8	72.7	72.6	72.6	72.6	72.5	72.1	72.0	72.0	72.1	72.3	72.3	72.9	74.0	74.5	74.0	74.1	74.0	73.8	73.6	73.4	73.1	72.8	72.7	73.0
19	72.6	72.5	72.5	72.4	72.5	72.5	72.5	72.6	72.7	72.6	72.4	72.4	72.8	73.1	74.2	74.3	74.0	73.6	73.3	73.2	73.0	73.1	73.4	73.0	73.0
20	72.7	72.6	72.6	72.6	72.4	72.3	72.2	72.3	72.3	72.7	73.3	73.9	74.0	73.5	73.2	73.9	74.0	73.7	73.6	73.4	73.4	73.3	73.2	73.3	73.1
21	73.4	73.6	73.7	73.5	73.5	73.2	72.9	73.0	73.2	73.3	73.6	73.9	73.7	74.6	74.4	73.8	73.7	74.0	74.8	74.9	74.7	74.6	74.3	74.1	73.8
22	73.9	73.7	73.6	73.5	73.4	73.3	73.2	73.1	72.9	72.8	73.1	73.3	73.4	73.3	73.5	73.3	73.6	73.5	72.9	72.9	72.6	72.3	72.1	72.0	73.1
23	71.9	71.8	71.8	71.7	71.6	71.6	71.6	71.8	72.0	72.0	71.9	71.9	71.7	72.3	73.0	73.3	73.5	73.2	72.7	72.6	72.5	72.3	72.0	71.8	72.2
24	72.0	72.1	72.1	72.0	72.0	71.9	71.9	71.8	71.7	71.5	71.3	71.0	71.2	72.2	72.3	72.3	72.5	72.7	71.6	71.6	71.3	70.9	70.6	70.9	71.7
25	71.0	71.1	71.1	71.2	71.2	71.1	71.1	71.2	71.2	71.5	71.4	71.7	72.4	72.3	72.4	72.4	72.4	72.4	72.1	71.9	71.4	71.1	70.9	70.8	71.6
26	70.9	70.8	70.8	70.8	70.8	70.7	70.6	70.6	70.4	70.5	70.6	72.0	73.0	73.3	73.4	73.2	72.5	71.5	71.1	70.7	71.4	71.9	72.0	71.9	71.5
27	71.5	71.2	71.1	71.2	71.3	71.2	70.9	71.0	71.0	71.6	71.8	71.8	73.0	72.8	72.6	72.6	72.3	71.9	71.9	72.3	72.1	71.9	71.7	71.5	71.7
28	71.4	71.3	71.2	71.2	70.9	70.9	70.9	70.8	70.9	71.3	72.0	72.9	73.3	73.2	72.9	72.0	71.5	71.4	71.5	73.8	75.1	74.5	74.9	74.3	72.2
29	73.7	73.3	73.4	72.9	72.9	72.5	72.0	72.0	72.0	72.0	72.1	73.3	74.0	74.8	74.7	74.9	74.4	74.4	73.9	73.2	72.6	73.0	72.9	72.9	73.3
30	72.9	72.9	72.7	72.6	72.6	72.1	71.9	72.2	72.5	72.7	73.0	73.6	73.8	74.9	75.4	75.5	75.5	75.4	74.9		FISHWAY INOPERATIVE				73.5

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Table 3.4 Summary of water quality data collected for Vermont Yankee from Station 7, Station 3, and Plant Discharge during 1992.

Parameter (units in mg/l unless otherwise noted)	Location: Station 7	Station 3	Plant Discharge
Dissolved Oxygen	8.15-14.95	8.3-14.15	6.45-13.65
pH, Std. Units	7.05-7.93	7.07-7.95	7.16-8.17
Alkalinity	19-45	22-46	22-49
Total Solids	37-110	33-96	48-122
Total Suspended Solids	1.0-2.1	1.3-6.5	1.0-6.5
Turbidity, NTU	0.78-7.8	0.70-11.6	0.83-14.0
Sodium	4.9-7.3	4.7-7.5	3.9-7.7
Chloride	8.1-12.8	7.8-13.0	6.2-7.7
Sulfate	5.0-11.4	5.3-9.2	5.3-9.7
Copper	all <0.005	all <0.005	<0.005-0.024
Iron	0.124-0.94	0.095-0.82	0.146-2.4
Zinc	<0.005-0.024	<0.005-0.009	<0.005-0.015

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75 GREEN MOUNTAIN DRIVE
SOUTH BURLINGTON, VT 05403

150 HERMAN MELVILLE BOULEVARD
NEW BEDFORD, MA 02740

ANALYTICAL REPORT

Date: 02 June 1992
Aquatec Lab No.: 159758
ETR No.: 31588; Project No.: 92053
Sample Received On: 14 May 1992; Analyzed On: 28 May 1992
Sample Identification: Vermont Yankee Nuclear Power Corporation, water sample labeled 14215, 05/14/92 at 1020 hours.

Volatile Organic Compounds in ug/l
EPA Method 8240

benzene	5 U
carbon tetrachloride	5 U
chlorobenzene	5 U
1,2-dichloroethane	5 U
1,1,1-trichloroethane	5 U
1,1-dichloroethane	5 U
1,1,2-trichloroethane	5 U
1,1,2,2-tetrachloroethane	5 U
chloroethane	10 U
2-chloroethyl vinyl ether	10 U
chloroform	5 U
1,1-dichloroethene	5 U
1,2-dichloroethenes	5 U
1,2-dichloropropane	5 U
trans-1,3-dichloropropene	5 U
cis-1,3-dichloropropene	5 U
ethylbenzene	5 U
methylene chloride	5 U
chloromethane	10 U
bromomethane	10 U
bromoform	5 U
bromodichloromethane	5 U
dibromochloromethane	5 U
tetrachloroethene	5 U
toluene	5 U
trichloroethene	5 U
vinyl chloride	10 U
acetone	10 U
2-butanone	10 U
carbon disulfide	5 U
2-hexanone	10 U
4-methyl-2-pentanone	10 U
styrene	5 U
vinyl acetate	10 U
total xylenes	5 U

Key to the letters used to qualify the results of the analysis:

U - The compound was analyzed for but not detected. The number is the method specified reporting limit.

LCB - Compound was found but at low concentration, comparable to that in the blank. Quantitation is not possible.

J - The mass spectrum indicates the presence of the compound, but the calculated result is less than the method specified reporting limit.

C - The result has been corrected for the presence of the compound in the blank.

Quality controls were analyzed with the sample as part of Aquatec's standard analytical procedures. The results of these are maintained on file at Aquatec.

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SOUTH BURLINGTON, VT 05403

150 HERMAN MELVILLE BOULEVARD
NEW BEDFORD, MA 02740

ANALYTICAL REPORT

Date: 09 June 1992
Aquatec Lab No.: 159758
ETR No.: 31588; Project No.: 92053
Sample Received On: 05/14/92; Extracted On: 05/19/92; Analyzed On: 06/05/92
Sample Identification: Vermont Yankee Nuclear Power Corporation, water sample labeled 14215, 05/14/92 at 1020 hours.

Acid Extractable Semivolatile Organic Compounds in ug/l
EPA Method 8270

2,4,6-trichlorophenol	10 U
p-chloro-m-cresol	10 U
2-chlorophenol	10 U
2,4-dichlorophenol	10 U
2,4-dimethylphenol	10 U
2-nitrophenol	10 U
4-nitrophenol	50 U
2,4-dinitrophenol	50 U
4,6-dinitro-2-methylphenol	50 U
pentachlorophenol	50 U
phenol	10 U
benzoic acid	50 U
2-methylphenol	10 U
4-methylphenol	10 U
2,4,5-trichlorophenol	50 U

Key to the letters used to qualify the results of the analysis:

U - The compound was analyzed for but not detected. The number is the method specified reporting limit.

LCB - Compound was found but at low concentration, comparable to that in the blank. Quantitation is not possible.

J - The mass spectrum indicates the presence of the compound, but the calculated result is less than the method specified reporting limit.

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4.0 PLANKTON STUDIES

4.1 Phytoplankton Studies

Under the current NPDES permit, monthly phytoplankton collections were required from April through November at the intake and discharge when Vermont Yankee was operating in open or hybrid cycle. Phytoplankton were collected monthly at the intake and discharge April through November during 1992.

4.1.1 Methods of Collection and Processing

Monthly phytoplankton samples were collected by bucket, and concentrated by filtering 40 liters of sample water through a #20 mesh Wisconsin plankton net. Samples were analyzed immediately for living organisms using a Sedgewick-Rafter counting cell and a compound microscope at 150X magnification. Phytoplankton cells were classified as "live" if their chloroplasts were intact and healthy, or if they moved. The portion of each sample not immediately analyzed was preserved with formalin for subsequent confirmation of identifications. All organisms were identified to the lowest feasible taxonomic level. Bold and Wynne (1978), Patrick and Reimer (1966, 1975), Prescott (1962, 1970), and Vinyard (1979) were referred to for phytoplankton identifications.

4.1.2 Summary

Phytoplankton representing seven classes and 34 genera were observed in the 1992 Vermont Yankee intake and discharge samples (Table 4.1).

The proportion of phytoplankton classified as "live" was different in the intake and discharge samples (Table 4.2). On an annual basis, an average of 92% of the intake specimens were live, while 82% of the discharge specimens were live. The lowest proportions of live specimens were observed in November when 78% of the intake specimens and 59% of the discharge specimens were live.

The dominant live organisms present were generally similar in discharge and intake samples (Table 4.2). Various species of diatoms (Bacillariophyceae) were the dominant organisms in most of the samples. Blue green algae (Oscillatoria sp.) were dominant in April and November discharge samples. Asterionella sp. were also the dominant organism in both intake and discharge samples during June and July.

4.2 Zooplankton Studies

Under the 1992 NPDES permit, monthly zooplankton collections were required from April through November at the intake and discharge when Vermont Yankee was operating in open or hybrid cycle. Zooplankton were collected monthly at the intake and discharge April through November during 1992.

4.2.1 Methods of Collection and Processing

Monthly zooplankton samples were collected by bucket, and concentrated by filtering 40 liters of sample water through a #20 mesh Wisconsin plankton net. Samples were analyzed immediately for living organisms using a Sedgewick-Rafter counting cell and a compound microscope at 150X magnification. Individuals were classified as "live" if they moved their appendages or internal organs within a one minute observation time. The portion of the sample not immediately analyzed was preserved with formalin for subsequent confirmation of identifications. Zooplankton were identified to the lowest feasible taxonomic level using Pennak (1989), Stemberger (1979), and Ward and Whipple (1963) as references.

4.2.2 Summary

Zooplankton representing four phyla and 28 genera were observed in the 1992 Vermont Yankee intake and discharge samples (Table 4.3).

Intake samples generally contained a higher proportion of live zooplankters than discharge samples (Table 4.4). On an annual basis, an average of 72% of the intake specimens were live, whereas 40% of the discharge specimens were live. The lowest proportions of live specimens were observed in June and August. In June, 69% of the intake specimens and 59% of the discharge specimens were live. In August, 52% of the intake specimens and 13% of the discharge specimens were live.

The dominant live organisms were similar in discharge and intake samples, but varied over the course of the sample season (Table 4.4). Protozoans (Protozoa, Ciliata, and Vorticella sp.) were dominant in spring and fall in both the intake and discharge samples. Rotifers (eg. Synchaeta sp., Polyartha sp., Asplanchna sp., Keratella sp., and Trichotria sp.) and Crustaceans (Copepoda nauplii and Bosmina sp.) were dominant in both discharge and intake samples from June through September 1992.

Table 4.1 **Checklist of phytoplankton of the Connecticut River near Vernon, Vermont in 1992.**

- CYANOCHLORONTA
  - Cyanophyceae
    - Chroococcales
      - Chroococcaceae
        - *Coelosphaerium* sp.
        - *Gomphosphaeria* sp.
        - *Merismopedia* sp.
    - Nostocales
      - Nostocaceae
        - *Anabaena* sp.
        - *Aphanizomenon* sp.
      - Oscillatoriaceae
        - *Arthrospira* sp.
        - *Oscillatoria* sp.
  - Myxophyceae
    - Hormongonales
- CHLOROPHYCOPHYTA
  - Chlorophyceae
    - Volvocales
      - Volvocaceae
        - *Volvox* sp.
    - Chlorococcales
      - Oocystaceae
        - *Ankistrodesmus* sp.
        - *Closteriopsis* sp.
        - *Selenastrum* sp.
      - Scenedesmaceae
        - *Scenedesmus* sp.
      - Hydrodictyaceae
        - *Pediastrum* sp.
        - *Pediastrum boryanum*
    - Zygnematales
      - Zygnemataceae
        - *Mougeotia* sp.
        - *Spirogyra* sp.
      - Desmidiaceae
        - *Closterium* sp.
        - *Cosmarium* sp.
        - *Mircasterias* sp.
        - *Staurastrum* sp.
    - Ulotrichales
      - Ulotrichaceae
        - *Ulothrix* sp.
    - Chaetophorales
      - Chaetopgoraceae
        - *Stigeoclonium* sp.
    - Microsporales
      - Microsporaceae
        - *Microspora* sp.
- CHRYSOPHYCOPHYTA
  - Chrysophyceae
    - Ochromonadales
      - Dinobryaceae
        - *Dinobryon* sp.
      - Synuraceae
        - *Mallomonas* sp.
        - *Synura* sp.
- BACILLARIOPHYCOPHYTA
  - Bacillariophyceae
    - Fragilariales
      - Fragilariaceae
        - *Asterionella* sp.
        - *Fragilaria* sp.
        - *Hannaea* sp.
        - *Synedra* sp.
        - *Tabellaria* sp.
    - Naviculales
      - Naviculaceae
      - Cymbellaceae
        - *Cymbella* sp.
    - Surirellales
      - Surirellaceae
        - *Surirella* sp.
    - Coscinodiscales
      - Coscinodiscaceae
        - *Melosira* sp.
- PYRROPHYCOPHYTA
  - Dinophyceae
    - Peridiniales
      - Ceratiaceae
        - *Ceratium* sp.
- CRYPTOPHYCOPHYTA
  - Cryptophyceae
- INDETERMINATE
- RHODPHYCOPHYTA
  - Rhodophyceae
    - Rhodochaetales

Table 4.2 Summary of phytoplankton entrainment in 1992.

INTAKE

Date	Collection	Units Counted	% Live	Dominant Live Organism(s)
04/28/92	14156	47	100	Bacillariophyceae
04/28/92	14157	53	91	Oscillatoria sp.
05/13/92	14195	160	96	Chlorococcales
05/13/92	14196	186	97	Chlorococcales
06/15/92	14381	163	94	Asterionella sp.
06/15/92	14382	168	92	Asterionella sp.
07/13/92	14431	151	94	Asterionella sp.
07/13/92	14432	132	91	Asterionella sp.
08/13/92	14538	135	90	Fragilaria sp.
08/13/92	14539	110	88	Melosira sp.
09/14/92	15567	169	100	Fragilaria sp.
09/14/92	15568	171	100	Fragilaria sp.
10/12/92	15793	139	88	Melosira sp.
10/12/92	15794	115	91	Melosira sp.
11/11/92	14563	66	85	Bacillariophyceae
11/11/92	14564	66	70	Bacillariophyceae

DISCHARGE

Date	Collection	Units Counted	% Live	Dominant Live Organism(s)
04/28/92	14158	54	57	Oscillatoria sp.
04/28/92	14159	53	70	Oscillatoria sp.
05/13/92	14197	147	93	Asterionella sp.
05/13/92	14198	148	88	Asterionella sp.
06/15/92	14383	347	91	Asterionella sp.
06/15/92	14384	214	92	Asterionella sp.
07/13/92	14433	231	82	Asterionella sp.
07/13/92	14434	122	79	Asterionella sp.
08/13/92	14540	201	78	Melosira sp.
08/13/92	14541	268	82	Melosira sp.
09/14/92	15569	129	100	Fragilaria sp.
09/14/92	15570	211	100	Fragilaria sp.
10/12/92	15795	101	88	Melosira sp.
10/12/92	15796	263	89	Melosira sp.
11/11/92	14565	117	57	Oscillatoria sp.
11/11/92	14566	204	61	Oscillatoria sp.

Table 4.3 Checklist of zooplankton of the Connecticut River near Vernon, Vermont in 1992.

PROTOZOA
- Sarcodina
- Mastigophora
- Ciliata
  - Hymenostomatida
    - Parameciidae
      - *Paramecium* sp.
  - Peritrichida
    - Vorticellidae
      - *Vorticella* sp.

NEMATODA

ROTATORIA
- Digononta
  - Bdelloida
    - Philodinidae
      - *Rotaria* sp.
- Monogononta
  - Flosculariacea
    - Conochilidae
      - *Conochiloides* sp.
      - *Conochilus* sp.
      - *Conochilus unicornis*
    - Hexarthridae
      - *Hexarthra* sp.
    - Testudinellidae
      - *Filinia* sp.
  - Collothecacea
    - Collothecidae
      - *Collotheca* sp.
  - Ploima
    - Synchaetidae
      - *Polyarthra* sp.
      - *Synchaeta* sp.
    - Ploesomatidae
      - *Ploesoma* sp.
    - Gastropodidae
      - *Gastropus* sp.
    - Trichocerca
      - *Trichocerca* sp.
    - Asplanchnidae
      - *Asplanchna* sp.
    - Brachionidae
      - *Brachionus* sp.
      - *Euchlanis* sp.
      - *Kellicottia* sp.
      - *Kellicottia bostoniensis*
      - *Kellicottia longispina*
      - *Keratella* sp.
      - *Lecane* sp.
      - *Lepadella* sp.
      - *Monostyla* sp.
      - *Notholca* sp.
      - *Platyias* sp.
      - *Trichotria* sp.

ARTHROPODA
- Crustacea
  - Cladocera
    - Leptodoridae
      - *Leptodora kindtii*
    - Daphnidae
      - *Ceriodaphnia* sp.
      - *Daphnia* sp.
    - Bosminidae
      - *Bosmina* sp.
      - *Bosmina longirostris*
    - Chydoridae
    - Polyphemidae
      - *Polyphemus* sp.
  - Ostracoda
  - Eucopepoda
    - Copepoda
      - Copepoda nauplii
    - Calanoida
    - Cyclopoida
- Insecta
  - Diptera
    - Chironomidae
  - Trichoptera

Table 4.4 Summary of zooplankton entrainment in 1992.

INTAKE

Date	Collection	Units Counted	% Live	Dominant Live Organism(s)
04/29/92	14161	37	89	PROTOZOA
04/29/92	14162	46	85	PROTOZOA
05/14/92	14211	30	83	PROTOZOA
05/14/92	14212	50	68	PROTOZOA
06/16/92	14393	137	72	Synchaeta sp.
06/16/92	14394	179	65	Synchaeta sp.
07/14/92	14444	108	81	Polyarthra sp.
07/14/92	14445	124	85	Polyarthra sp.
08/14/92	14542	69	65	Conochilus unicornis
08/14/92	14543	103	39	Copepoda nauplii
09/15/92	15598	34	53	Polyarthra sp.
09/15/92	15599	39	69	Trichotria sp.
10/13/92	15797	29	86	Copepoda nauplii
10/13/92	15798	56	77	Ciliata
11/12/92	14567	24	71	PROTOZOA
11/12/92	14568	30	70	PROTOZOA

DISCHARGE

Date	Collection	Units Counted	% Live	Dominant Live Organism(s)
04/29/92	14163	45	27	Asplanchna sp.
04/29/92	14164	42	36	Ciliata
05/14/92	14213	41	61	Copepoda nauplii
05/14/92	14214	64	38	Copepoda nauplii
06/16/92	14395	169	62	Synchaeta sp.
06/16/92	14396	117	56	Synchaeta sp.
07/14/92	14446	139	14	Keratella sp.
07/14/92	14447	94	31	Keratella sp.
08/14/92	14544	64	11	NEMATODA
08/14/92	14545	126	14	ROTATORIA
09/15/92	15600	40	28	Keratella sp.
09/15/92	15601	58	9	PROTPZPA/Asplanchna sp. /Bosmina sp.
10/13/92	15799	21	48	Synchaeta sp.
10/13/92	15800	26	42	Asplanchna sp./Kaeratella sp. /Synchaeta sp./Copepoda nauplii
11/12/92	14569	26	85	PROTOZOA
11/12/92	14570	27	81	PROTOZOA

5.0 MACROINVERTEBRATE STUDIES

As specified by the conditions of Vermont Yankee's 1991 NPDES permit, benthic macroinvertebrates were sampled in 1992 by Ekman dredge in June, August, and October at Stations 2, 3, 4, and 5. A total of eight cage samples were collected during 1992: 2 at each of Stations 2, 3, 4, and 5.

5.1 Methods of Collection and Processing

Macroinvertebrates were collected by nine inch (81 square inches) Ekman dredge and cage samples made from modified minnow traps (1/4 inch wire mesh) filled with clean rocks (2-3 inches in diameter) obtained from the river. Ekman dredge samples were taken in June, August, and October at river quarter points (Vermont, mid-stream, and New Hampshire) of each station. Each dredge sample was composed of three Ekman dredge hauls. Three samples were collected at each of the quarter points. Three replicates (14324, 14327, 14329) were not completely processed due to laboratory error. In those instances, one replicate at Station 3-VT and two replicates from Station 4-NH were used.

Duplicate cage samplers were set near the Vermont shore of Stations 2, 3, 4, and 5 in June and August. A cage set in June at Station 4 was successfully recovered in August, after 55 days in the river. Cages set in June were not recovered from Stations 2, 3, or 5. One cage set in August at each of these stations was retrieved in September, after 36 or 37 days in the river. Other cages set in August were successfully recovered from Stations 2, 4, and 5 in October, after 58 or 59 days in the river. Cages set at Station 3 were not found in October. Immediately upon their retrieval, each of the seven cages were placed in dishpans containing river water, opened, and organisms removed.

Materials collected in the field by Ekman dredge or cage samplers were concentrated through a set of standard sieves to reduce the amount of debris. Large debris and rocks retained by the sieves were washed and thoroughly examined for attached organisms before discarding. A #30 USGS standard sieve was used to concentrate the final portion of the sample. Material retained by this sieve was preserved in a 70% alcohol solution.

In the laboratory, preserved samples were examined under low magnification (2x) in glass pans and organisms were separated from sample debris. If the sample contained large numbers (e.g. >100) of chironomid larvae, the total number of larvae was determined and a subsample of these organisms was identified below the family level. Bryozoans, which were quantified by their relative abundance in a sample (light, moderate, or heavy), were also not included in the macroinvertebrate summaries.

Identification of organisms to the lowest feasible taxonomic level was accomplished using a dissecting microscope (8-80x) and a compound microscope (100-1000x). Representative subsamples of chironomid larvae were mounted on slides using a clearing mountant and examined under higher magnifications (80-1000x). Identification and taxonomic classification of the invertebrates were consistent with Pennak (1989), Merritt and Cummins (1984), or Peckarsky et al. (1990). Identifications were supplemented with the following keys: Burks (1975), Wiggins (1978), and Simpson and Bode (1980).

5.2 Summary

During 1992, 105 Ekman dredge samples and seven cage samples were completely processed. From these samples, 13,278 macroinvertebrates were identified, representing seven invertebrate phyla (Table 5.1). Organisms collected by dredge and cage samples comprised 74% and 26% of the total, respectively (Table 5.2).

Oligochaetes and pelecypods (clams) were relatively more abundant in Ekman dredge samples than in cage samples, whereas trichopterans (caddisflies) and crustaceans were relatively more abundant in cage samples than Ekman samples (Figure 5.1). The relative abundance of ephemeropterans was higher in cage samples. More than 75% of the organisms collected by Ekman dredge were oligochaetes, pelecypods, or dipterans. The organisms collected from the cage samplers were predominantly dipterans, hydrozoans and trichopterans.

The composition of macroinvertebrates in Ekman dredge samples was similar at Stations 4 and 5; oligochaetes (35.3% and 37.4%), pelecypods (35.8% and 18.5%), and dipterans (22.1% and 30.4%) were the dominant taxa collected at both stations. The composition of macroinvertebrates in Ekman samples from Stations 2 and 3 were not as similar. Gastropods, triclads (flatworms), and oligochaetes were relatively more dominant at Station 2 than at Station 3, whereas triclads, pelecypods, and oligochaetes were more dominant at Station 3. Over three times as many organisms were collected from Ekman dredge samples at Station 2 (1,877) than from Station 3 (581). Oligochaetes were more dominant in the soft sediments of upstream Ekman samples, whereas triclads (flatworms) and trichopterans were more dominant in downstream Ekman samples.

Macroinvertebrate found in station 4 cage samples were fairly evenly distributed betweeen oligochaetes, crustaceans, ephemeropterans, and dipterans (Table 5.3). At Station 5, dipterans dominated the collection, representing 59% of the total (Table 5.3). More than twice as many organisms were collected from Station 5 (1,383) than from Station 4 (671).

Trichopterans were in greater relative abundance at Station 2 than at Station 3, whereas hydrozoans were relatively abundant (45.4%) at Station 3 (Table 5.3). Triclads (flatworms) were similar in relative abundance at both Stations. Trichopterans were also a consistent component at both Stations 2 and 3 representing about 25% and 9% of the totals, respectively.

Table 5.1 Checklist of macroinvertebrates of the Connecticut River near Vernon, Vermont in 1992.

COELENTERATA
- Hydrozoa
  - Hydroida
    - Hydridae
      - _Hydra_ sp.

PLATYHELMINTHES
- Turbellaria
  - Tricladida
    - Planariidae
      - _Dugesia_ sp.
      - _Dugesia tigrina_

NEMATODA

BRYOZOA
- Phylactolaemata
  - Plumatellidae
    - _Plumatella_ sp.
  - Lophopodidae
    - _Lophopodella_ sp.

ANNELIDA
- Oligochaeta
  - Haplotaxida
    - Napididae
      - _Pristina_ sp.
      - _Stylaria_ sp.
    - Tubificidae
      - _Branchiura sowerbyi_
- Hirudinea
  - Rhynchobdellida
    - Glossiphonidae
      - _Helobdella_ sp.
      - _Helobdella papillata_

ARTHROPODA
- Arachnoidea
  - Acariformes
    - Hydrachnidae
    - Arrenuridae
      - _Arrenurus_ sp.
    - Oxidae
  - Hydracarina
- Crustacea
  - Cladocera
    - Daphnidae
      - _Daphnia_ sp.
    - Leptodoridae
      - _Leptodora_ sp.
    - Sididae
      - _Sida_ sp.
      - _Sida crystallina_
  - Isopoda
    - Asellidae
      - _Caecidotea_ sp.
  - Amphipoda
    - Gammaridae
      - _Crangonyx_ sp.
    - Talitridae
      - _Hyalella_ sp.
      - _Hyalella azteca_
  - Decapoda
    - Cambaridae
      - Cambarinae
        - _Orconectes_ sp.
  - Ostracoda
- Insecta
  - Collembola
  - Plecoptera
    - Nemouridae
    - Perlidae
      - _Acroneuria_ sp.
      - _Neoperla_ sp.
    - Chloroperlidae
      - _Utaperla_ sp.
  - Ephemeroptera
    - Baetidae
      - _Baetis_ sp.
    - Caenidae
      - _Brachycercus_ sp.
      - _Caenis_ sp.
    - Ephemerellidae
      - _Attenella_ sp.
      - _Dannella_ sp.
      - _Eurylophella_ sp.
    - Ephemeridae
      - _Hexagenia_ sp.
    - Heptageniidae
      - _Stenacron_ sp.
      - _Stenonema_ sp.
    - Leptophlebiidae
      - _Paraleptophledia_ sp.
    - Oligoneuriida
      - _Isonychia_ sp.
    - Polymitarcidae
      - _Ephoron_ sp.
    - Tricorythidae
      - _Tricorythodes_ sp.
  - Odonata
    - Aeschnidae
      - _Basiaeschna_ sp.
      - _Boyeria_ sp.
    - Aeshnidae
      - _Aeshna_ sp.
    - Coenagrionidae

Table 5.1 (Continued)

Enallagma sp.
Corduliidae
Neurocordulia sp.
Somatochlora sp.
Tetragoneuria sp.
Gomphidae
Dromogomphus sp.
Gomphus sp.
Stylurus sp.
Libellulidae
Erythemis sp.
Tramea sp.
Megaloptera
Corydalidae
Nigronia sp.
Sialidae
Sialis sp.
Trichoptera
Helicopsychidae
Helicopsyche sp.
Hydropsychidae
Cheumatopsyche sp.
Hydropsyche sp.
Hydroptilidae
Hydroptilinae
Agraylea sp.
Hydroptila sp.
Lepidostomatidae
Lepidostoma sp.
Leptoceridae
Ceraclea sp.
Mystacides sp.
Oecetis sp.
Triaenodes sp.
Polycentropodidae
Neureclipsis sp.
Phylocentropus sp.
Polycentropus sp.
Coleoptera
Elmidae
Ancyronyx sp.
Dubiraphia sp.
Promoresia sp.
Stenelmis sp.
Haliplidae
Haliplus sp.
Hydrophilidae
Berosus sp.
Psephenidae
Psephenus sp.
Diptera
Ceratopogonidae
Dasyhelea sp.
Mallochohella sp.
Culicoidinae
Bezzia sp.
Probessia sp.
Chironomidae
Tanypodinae
Ablabesmyia sp.
Clinotanypus sp.
Ceolotanypus sp.
Djalmabatista sp.
Procladius sp.
Thienemannimyia sp.
Prodiamesinae
Monodiamesa sp.
Orthocladiinae
Cricotopus sp.
Eukiefferiella sp.
Orthocladius sp.
Parorthocladius sp.
Synorthocladius sp.
Thienemanniella sp.
Chironominae
Asheum sp.
Axarus sp.
Chironomus sp.
Cladopelma sp.
Cladotanytarsus sp.
Cryptochironomus sp.
Cryptotendipes sp.
Demicrytochironomus sp.
Dicrotendipes sp.
Glyptotendipes sp.
Parachironomus sp.
Paracladopelma sp.
Paralauterborniella sp.
Paratendipes sp.
Phaenopsectra sp.
Polypedilum sp.
Pseudochironomus sp.
Rheotantarsus sp.
Tanytarsus sp.
Tribelos sp.
Xenochironomus sp.
Empididae
Psychodidae
Tabanidae
Chrysops sp.
Tipulidae
Hemiptera
MOLLUSCA
Gastropoda
Basommatophora
Ancylidae
Ferrissia fragilis

Table 5.1 (Continued)

Lymnaeidae
Lymnaea sp.
Physidae
Physa sp.
Planorbidae
Gyraulus sp.
Helisoma sp.
Menetus sp.
Mesogastropoda
Hydrobiidae
Amnicola sp.
Birgella sp.
Birgella subglobosa
Pelecypoda
Prionodesmacea
Sphaeriidae
Musculium sp.
Pisidium sp.
Sphaerium sp.
Unionidae
Elliptio sp.

Table 5.2 Composition of macroinvertebrates collected by Ekman dredge in 1992.

	DOWNSTREAM OF VERNON DAM				UPSTREAM OF VERNON DAM			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Hydrozoa	11	0.6	3	0.5	0	0.0	0	0.0
Tricladida	359	19.1	276	47.5	46	1.3	0	0.0
Oligochaeta	315	16.8	81	13.9	1267	35.3	1410	37.4
Crustacea	185	9.9	4	0.7	85	2.4	36	1.0
Ephemeroptera	35	1.9	12	2.1	46	1.3	209	5.5
Trichoptera	134	7.1	49	8.4	26	0.7	93	2.5
Diptera	234	12.5	57	9.8	794	22.1	1145	30.4
Pelecypoda	68	3.6	79	13.6	1283	35.8	698	18.5
Gastropoda	522	27.8	8	1.4	10	0.3	111	2.9
Other	14	0.7	12	2.1	29	0.8	64	1.7
TOTALS	1,877	100.0	581	100.0	3,586	100.0	3,766	100.0

Table 5.3 Composition of macroinvertebrates collected by cage sampler in 1992.

	DOWNSTREAM OF VERNON DAM				UPSTREAM OF VERNON DAM			
	Station 2		Station 3		Station 4		Station 5	
	Count	% of Total	Count	% of Total	Count	% of Total	Count	% of Total
Hydrozoa	19	3.4	391	45.4	0	0.0	36	2.6
Tricladida	51	9.2	96	11.1	0	0.0	5	0.4
Oligochaeta	28	5.1	16	1.9	112	16.7	48	3.5
Crustacea	67	12.1	94	10.9	129	19.2	14	1.0
Ephemeroptera	58	10.5	59	6.8	110	16.4	42	3.0
Trichoptera	132	23.9	76	8.8	45	6.7	122	8.8
Diptera	38	6.9	91	10.6	166	24.7	815	58.9
Pelecypoda	26	4.7	0	0.0	0	0.0	1	0.1
Gastropoda	29	5.3	18	2.1	8	1.2	46	3.3
Other	104	18.8	21	2.4	101	15.1	254	18.4
TOTALS	552	100.0	862	100.0	671	100.0	1,383	100.0

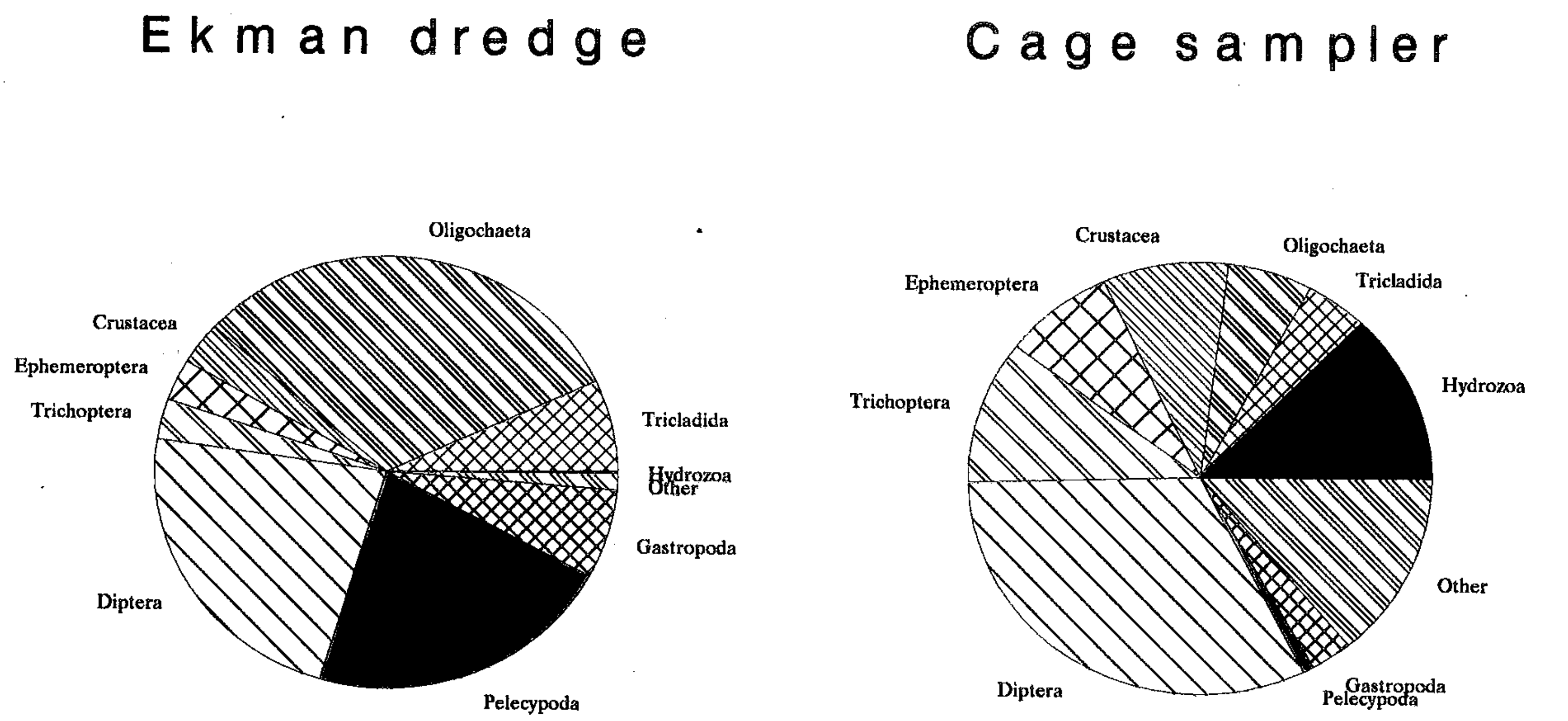

Figure 5.1 Composition of Macroinvertebrates by Sampling Gear, 1992

6.0 FISH STUDIES

Fish were collected in 1992 on a defined schedule and at specified stations in accordance with Vermont Yankee's permit. Fish collected were weighed and measured, and scales from selected game species removed for the determination of the number of annuli. Monitoring of fish impingement on the circulating water traveling screens was conducted April through June and August through October. Larval fish were monitored weekly at the intake during open or hybrid cycle operation, from 1 May to 15 July.

6.1 Methods of Collection and Processing

Fish were collected in 1992 by trapnets and electrofishing. The required monthly sets of trapnets were made at the eight designated stations near Vermont Yankee (Figures 1.1 and 6.1). Trapnets were constructed of a steel frame covered with a 1.3 cm knotless bar mesh nylon with a 1 meter by 2 meter front opening. Each net had two 8 meter wings and leads approximately 33 meters long. The nets were checked daily for two consecutive days at each sample location.

Electrofishing was conducted in the evening beginning around dusk at the eight designated stations. Electrofishing utilized a boat-mounted Coffelt Electronics Model VVP-15 electroshocker. Samples of fish were collected in accordance with the permit. Additional electrofishing collections were made in 1992 to collect juvenile American shad. Since non-target (non clupeid) fish were not captured during juvenile American shad sampling, these data were not utilized in the following summaries.

The standard procedure for processing fish was to weigh and measure each fish captured. When a large number of fish were captured, the sample was separated and subsampled by species, while the remaining fish of that species were weighed collectively.

Representative scale samples for annuli enumeration were taken from five resident species: white perch, yellow perch, walleye, smallmouth bass, and largemouth bass. White perch scales were taken dorsal to the lateral line and below the insertion of the dorsal fin. Scale samples from other species were taken ventral to the lateral line near the tip of the pectoral fin.

Fish impinged on the circulating water traveling screens (CWTS) were sampled weekly from 1 April through 15 June and from 1 August through 31 October during plant operation in the open or hybrid cycle mode (Since plant operation was shut down for refueling during the first part of April, impingement sampling did not begin until 23 April). Weekly sampling of all operating CWTS consisted of backwashing the screens into a collection bin. The resultant debris was examined for Atlantic salmon and American shad. The screens were again backwashed after approximately 24 hours and collected debris examined for all species of fish. Fish impinged on traveling screens were preserved and later individually weighed and measured. When an Atlantic salmon or juvenile American shad was impinged, the CWTS sampling was continued daily until a period of three consecutive days elapsed without further impingement of Atlantic salmon or American shad. Sampling then reverted to a weekly frequency.

Ichthyoplankton samples were collected with a one-half meter conical Nitex nylon plankton net. Mesh size was 363 microns, providing a 46% open area in the net body. A 114 mm diameter straining bucket covered with 369 micron mesh (stainless steel or Nitex) was affixed to the cod-end. Flow through the net was determined with an Interocean Systems Model 313 recording flow meter.

Sampling of ichthyoplankton at the Vermont Yankee intake was accomplished by pushed nets attached to rigid structures on a boat. Samples were collected weekly from 1 May through 15 July and consisted of a sample at the surface, mid-depth, and bottom strata.

Retrieved nets were washed immediately and the contents preserved in 5% formalin. Ichthyoplankters were later separated from debris using an eight to eighty variable magnification dissecting microscope. Larval fish were identified to the lowest feasible taxonomic level with the aid of published larval keys: Norden (1961), Mansueti and Hardy (1967), Lippson and Moran (1974), Hogue and Buchanan (1976), Jones et al. (1978), Wang and Kernehan (1979), and Auer (1982).

6.2 Summary

6.2.1 Fish

Twenty-four species of fish were identified in fish collections obtained in 1992 (Table 6.1). No new species were identified for 1992.

There were 223 fish collections made in 1992 to meet the conditions of the permit requirements (Table 6.2). Forty-four electrofishing collections at the eleven stations yielded 1,273 fish. The average catch per unit effort (CPE) was 90 fish per hour.

Trapnet collections represented about half of the collections, 112 total. These trapnets were set for a total of 2,369 hours and yielded 1,078 fish. An average trapnet CPE for 1992 was 0.5 fish per hour.

The remaining fishing effort for compliance with the permit requirements was at the Vermont Yankee intake's circulating water traveling screens. A total of 67 collections were made in 1992. The total number of samples and methods employed fulfilled the permit fishing requirements for 1992.

There were a total of 3,033 fish collected in 1992 (Table 6.3). Numerically, the most common fishes were yellow perch, rock bass, pumpkinseed, and bluegill comprising 20.0, 15.4, 10.5, and 10.2, percent respectively. Biomass was comprised mainly of white suckers (30.3%), common carp (9.8%), rock bass (8.4%), smallmouth bass (8.2%), and largemouth bass (8.2%).

Upstream of Vernon Dam (lower Vernon pool), yellow perch accounted for more than one quarter of all fish captured (Table 6.4). Other numerically abundant species included Pumpkinseed (13.1%), Bluegill (12.8%), and Rock Bass (9.7%). American shad (primarily juveniles) were captured throughout the lower Vernon pool and represented about 3 percent of the upstream catch. Two esocids, northern pike (11) and chain pickerel (44), were captured in 1992. Three species of fish, white suckers, common carp and largemouth bass accounted for more than one-half of the fish biomass collected upstream.

Downstream of Vernon Dam (upper Turners Falls pool) rock bass was numerically the most common fish collected (260 fish), which represented about 28.4 percent of the catch (Table 6.5). Spottail shiners (13.1%) and smallmouth bass (12.3%) were well represented, with 112 smallmouths being sampled. Remaining species consisted of white suckers (8.4%), yellow perch (6.0%), and American Shad (5.4%). Northern pike and chain pickerel were also captured several times in upper Turners Falls pool. White suckers, rock bass, and smallmouth bass were the largest contributors to the total biomass captured, 28.9, 15.7, and 15.3 percent, respectively.

Age determinations were examined for white perch, yellow perch, walleye, smallmouth bass, and largemouth bass (Tables 6.6, 6.7, 6.8, 6.9, and 6.10).

6.2.2 Impingement

Impingement samples were collected from April through June and August through October (Table 6.11). Plant operation was shut down for refueling during the first part of April. Fourteen Atlantic salmon smolts were captured on the circulating water traveling screens (CWTS). Twelve of these smolts were collected on one day, 28 April. Single smolts were impinged on 29 April and 5 May. A total of 26 American shad were also captured on the CWTS. Juvenile American shad were captured in September and October, with the first impinged on 14 September and the last on 28 October. The collection of impinged juvenile American shad were distributed somewhat evenly during this time period, with juveniles being found in fifteen separate collections.

Resident fish impinged during nominal 24-hour impingement collections were predominantly bluegills and rock bass, with numerical percentages of 24 and 19, respectively. Twenty-one separate species were impinged on the CWTS during 1992, comprising of 682 total fish.

6.2.3 Ichthyoplankton

A total of 33 ichthyoplankton samples were collected in front of the Vermont Yankee intake structure (Table 6.12). The collections were taken over an eleven week period. A total of 867 ichthyoplankton were identified (Table 6.13). Minnow (Notropis spp.) represented 60 percent of these ichthyoplankters while white perch accounted for nearly 25 percent of the total. Sunfish larvae (Lepomis spp.) were an important component of the ichthyoplankters collected, representing nearly 14 percent of the catch. Walleye, yellow perch and common carp were also collected in samples in 1992. One American shad was sampled on 29 June.

Notropis spp. were collected at all three depths although surface samples (0.3m) contained 92 percent of this species (Table 6.14). White perch were generally found in deeper strata, 3.7 m and 1.8 m, representing 58% and 37% respecitvely. Approximately 70% of the Lempomis spp. were captured in surface (0.3 m) samples.

Yellow perch were the earliest ichthyoplankton captured (5 May) and Lepomis spp., Notropis spp. were the latest (14 July). White perch were the most represented species in six collections over a 34 day period (Table 6.14).

Table 6.1 Checklist of fishes collected during 1992.

Taxon	Common name
CHORDATA	
AGNATHA	
PETROMYZONTIFORMES	
Petromyzontidae	
Petromyzon marinus Linnaeus	Sea lamprey
OSTEICHTHYES	
ANGUILLIFORMES	
Anguillidae	
Anguilla rostrata (Lesueur)	American eel
CLUPEIFORMES	
Clupeidae	
Alosa aestivalis (Mitchill)	Blueback herring
Alosa sapidissima (Wilson)	American shad
SALMONIFORMES	
Salmonidae	
Salmo salar Linnaeus	Atlantic salmon
Salvelinus fontinalis (Mitchill)	Brook trout
Esocidae	
Esox lucius Linnaeus	Northern pike
Esox niger Lesueur	Chain pickerel
CYPRINIFORMES	
Cyprinidae	
Cyprinus carpio Linnaeus	Common carp
Notemigonus crysoleucas (Mitchill)	Golden shiner
Notropis hudsonius (Clinton)	Spottail shiner
Semotilus corporalis (Mitchill)	Fallfish
Catostomidae	
Catostomus commersoni (Lacepede)	White sucker
SILURIFORMES	
Ictaluridae	
Ictalurus natalis (Lesueur)	Yellow bullhead
Ictalurus nebulosus (Lesueur)	Brown bullhead
PERCIFORMES	
Percichthyidae	
Morone americana (Gmelin)	White perch
Centrarchidae	
Ambloplites rupestris (Rafinesque)	Rock bass
Lepomis gibbosus (Linnaeus)	Pumpkinseed
Lepomis macrochirus Rafinesque	Bluegill
Micropterus dolomieui Lacepede	Smallmouth bass
Micropterus salmoides (Lacepede)	Largemouth bass
Percidae	
Etheostoma olmstedi Storer	Tessellated darter
Perca flavescens (Mitchill)	Yellow perch
Stizostedion vitreum vitreum (Mitchill)	Walleye

Table 6.2 Electrofishing and trapnet fishing effort conducted for Section I of the NPDES permit, 1992. CPE - catch per unit effort expressed as number of fish per hour.

Station	Electrofishing				Trapnet			
	# of Collections	Hours	Fish	CPE	# of Collections	Hours	Fish	CPE
0.1 Miles South of Vernon Dam	4	1.0	58	56.1	8	176.2	122	0.7
New Hampshire Setback	4	1.2	153	124.1	8	163.7	61	0.4
Rum Point	4	1.4	165	120.7	8	164.9	63	0.4
Station 2	4	1.3	61	45.8	16	339.8	22	0.1
Station 3	4	1.0	97	93.9	8	174.7	105	0.6
Station 4-New Hampshire	4	1.6	188	115.1	16	335.9	226	0.7
Station 4-Vermont	4	1.3	99	75.2	16	340.6	96	0.3
Station 5-New Hampshire	4	1.4	103	76.3	8	163.7	59	0.4
Station 5-Vermont	4	1.4	164	115.8	8	163.5	60	0.4
Stebbin Island-New Hampshire Side	4	1.1	59	51.3	8	171.8	68	0.4
Stebbin Island-Vermont Side	4	1.4	126	91.1	8	173.8	196	1.1

Table 6.3 Numbers and weights of fishes collected upstream and downstream of Vernon Dam in 1992.

Species	Total (#)	Number (%)	Total Weight (g)	Weight (%)
Sea lamprey	13	0.4	8,187	1.5
American eel	6	0.2	2,012	0.4
Blueback herring	5	0.2	815	0.1
American shad	104	3.4	12,447	2.2
Atlantic salmon	14	0.5	1,190	0.2
Brook trout	2	0.1	147	0.0
Northern pike	19	0.6	12,126	2.2
Chain pickerel	65	2.1	15,165	2.7
Common carp	16	0.5	54,526	9.8
Golden shiner	113	3.7	3,332	0.6
Notropis spp.	3	0.1	2	0.0
Spottail shiner	253	8.3	1,776	0.3
Fallfish	23	0.8	3,619	0.6
White sucker	193	6.4	169,073	30.3
Yellow bullhead	15	0.5	1,415	0.3
Brown bullhead	93	3.1	14,442	2.6
White perch	86	2.8	24,687	4.4
Rock bass	466	15.4	46,608	8.4
Lepomis spp.	18	0.6	63	0.0
Pumpkinseed	317	10.5	21,947	3.9
Bluegill	309	10.2	22,662	4.1
Smallmouth bass	151	5.0	45,846	8.2
Largemouth bass	94	3.1	45,684	8.2
Tessellated darter	6	0.2	22	0.0
Yellow perch	608	20.0	29,520	5.3
Walleye	41	1.4	20,067	3.6
TOTALS	3,033		557,380	

Table 6.4 Numbers and weights of fishes captured upstream of Vernon Dam in 1992. CWTS - circulating water traveling screen.

Species	CWTS Number	CWTS Total Weight (g)	Electrofishing Number	Electrofishing Total Weight (g)	Trapnet Number	Trapnet Total Weight (g)	Summary Total (#)	Summary Number (%)	Summary Total (g)	Summary Weight (%)
Sea lamprey	2	14					2	0.1	14	0.0
American eel	1	726	2	651	1	492	4	0.2	1,869	0.6
American shad	26	77	29	110			55	2.6	187	0.1
Atlantic salmon	14	1,190					14	0.7	1,190	0.4
Brook trout	2	147					2	0.1	147	0.1
Northern pike			11	3,544			11	0.5	3,544	1.1
Chain pickerel			29	5,794	15	4,642	44	2.1	10,436	3.3
Common carp			6	18,032	8	22,930	14	0.7	40,962	12.8
Golden shiner	11	150	70	2,085	14	747	95	4.5	2,982	0.9
Notropis sp.	2	1	1	1			3	0.1	2	0.0
Spottail shiner	49	173	73	267	11	92	133	6.3	532	0.2
White sucker	6	1,041	86	78,396	24	21,244	116	5.5	100,681	31.4
Yellow bullhead	10	71	4	1,231			14	0.7	1,302	0.4
Brown bullhead	52	1,394	19	8,187	7	2,269	78	3.7	11,850	3.7
White perch	16	609	11	3,336	44	14,705	71	3.4	18,650	5.8
Rock bass	131	1,642	26	3,304	49	4,478	206	9.7	9,424	2.9
Lepomis spp.	17	44	1	19			18	0.8	63	0.0
Pumpkinseed	57	483	94	8,038	126	10,800	277	13.1	19,321	6.0
Bluegill	167	7,579	56	4,891	49	5,712	272	12.8	18,182	5.7
Smallmouth bass	14	344	10	3,371	15	5,913	39	1.8	9,628	3.0
Largemouth bass	2	14	83	42,872	2	24	87	4.1	42,910	13.4
Tessellated darter	6	22					6	0.3	22	0.0
Yellow perch	96	913	260	12,917	197	10,376	553	26.1	24,206	7.6
Walleye	1	43	1	74	3	2,258	5	0.2	2,375	0.7
TOTALS	682	16,675	872	197,120	565	106,682	2,119		320,477	

Table 6.5 Numbers and weights of fishes captured downstream of Vernon Dam in 1992.

Species	Electrofishing Number	Electrofishing Total Weight (g)	Trapnet Number	Trapnet Total Weight (g)	Summary Total (#)	Summary Number (%)	Summary Total (g)	Summary Weight (%)
Sea lamprey	1	11	10	8,162	11	1.2	8,173	3.4
American eel	1	71	1	72	2	0.2	143	0.1
Blueback herring	2	343	3	472	5	0.5	815	0.3
American shad	37	7,001	12	5,259	49	5.4	12,260	5.2
Northern pike	7	5,217	1	3,365	8	0.9	8,582	3.6
Chain pickerel	6	1,211	15	3,518	21	2.3	4,729	2.0
Common carp	1	5,473	1	8,091	2	0.2	13,564	5.7
Golden shiner	2	34	16	316	18	2.0	350	0.1
Spottail shiner	104	566	16	678	120	13.1	1,244	0.5
Fallfish	22	3,135	1	484	23	2.5	3,619	1.5
White sucker	62	56,619	15	11,773	77	8.4	68,392	28.9
Yellow Bullhead			1	113	1	0,1	113	0.0
Brown bullhead	1	248	14	2,344	15	1.6	2,592	1.1
White perch	1	327	14	5,710	15	1.6	6,037	2.5
Rock bass	25	3,410	235	33,774	260	28.4	37,184	15.7
Pumpkinseed	3	141	37	2,485	40	4.4	2,626	1.1
Bluegill	12	1,528	25	2,952	37	4.0	4,480	1.9
Smallmouth bass	85	25,397	27	10,821	112	12.3	36,218	15.3
Largemouth bass	5	1,717	2	1,057	7	0.8	2,774	1.2
Yellow perch	11	2,010	44	3,304	55	6.0	5,314	2.2
Walleye	13	5,044	23	12,648	36	3.9	17,692	7.5
TOTALS	401	119,503	513	117,398	914		236,901	

Table 6.6 Length and weight statistics for yellow perch collected in 1992.

UPSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
0	96	90	11	57 - 122	7	3	2 - 18
1	110	127	13	86 - 155	20	7	4 - 42
2	65	162	19	121 - 215	42	16	7 - 97
3	57	194	17	134 - 236	76	22	19 - 134
4	65	215	16	178 - 282	108	26	56 - 226
5	19	240	21	182 - 279	153	41	69 - 261
6	2	277	5	273 - 280	225	37	199 - 251

DOWNSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
0	27	107	8	90 - 125	13	4	6 - 22
1	3	170	6	165 - 177	62	19	40 - 75
2	3	194	26	174 - 224	87	28	58 - 114
3	2	202	6	198 - 206	80	11	72 - 88
4	6	220	16	204 - 239	122	29	87 - 161
5	6	261	8	251 - 270	247	46	202 - 310
6	5	300	12	288 - 317	349	58	273 - 424
7	1	284		284 - 284	338		338 - 338

Table 6.7 Length and weight statistics for white perch collected in 1992.

UPSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
2	5	222	31	181 - 260	153	66	81 - 237
3	14	261	22	217 - 302	259	77	135 - 437
4	7	279	17	250 - 299	337	69	219 - 423
5	16	292	10	273 - 312	376	51	288 - 468
6	10	296	15	283 - 335	392	80	306 - 586
7	3	307	7	299 - 312	452	116	377 - 586

DOWNSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
3	5	266	6	258 - 274	280	25	252 - 320
4	3	290	6	284 - 295	402	1	401 - 403
5	2	289	23	273 - 305	422	134	327 - 516
6	1	320		320 - 320	635		635 - 635
7	1	291		291 - 291	377		377 - 377
8	1	333		333 - 333	676		676 - 676

Table 6.8 Length and weight statistics for walleye collected in 1992.

UPSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
1	1	211		211 - 211	74		74 - 74
4	3	450	21	428 - 469	753	85	661 - 829

DOWNSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
0	1	157		157 - 157	26		26 - 26
1	15	291	45	195 - 345	213	82	48 - 326
2	3	357	26	333 - 385	389	95	306 - 492
3	3	414	10	408 - 425	357	255	62 - 508
4	10	450	24	418 - 490	810	151	593 - 1012
5	4	494	35	446 - 530	1035	244	702 - 1282

Table 6.9 Length and weight statistics for smallmouth bass collected in 1992.

UPSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
1	2	130	54	91 - 168	30	33	6 - 53
2	4	233	50	200 - 308	165	100	107 - 314
3	3	299	44	268 - 350	340	158	247 - 523
4	8	296	14	270 - 312	340	57	235 - 422
5	8	355	26	328 - 408	603	184	433 - 997

DOWNSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
0	10	80	14	54 - 99	9	5	2 - 16
1	11	136	33	88 - 179	37	22	11 - 70
2	9	215	13	198 - 242	129	31	93 - 194
3	17	251	22	199 - 276	210	51	98 - 286
4	31	305	22	257 - 365	373	97	258 - 634
5	21	350	18	314 - 401	536	135	84 - 765
6	8	380	27	344 - 417	635	271	120 - 981
7	2	446	16	434 - 457	1226	314	1004 - 1448

Table 6.10 Length and weight statistics for largemouth bass collected in 1992.

UPSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
0	11	100	18	79 - 135	17	8	9 - 35
1	12	209	32	147 - 240	127	58	41 - 190
2	12	258	14	241 - 286	231	45	176 - 324
3	9	320	35	250 - 371	485	150	226 - 749
4	19	362	18	328 - 419	650	139	443 - 1106
5	15	399	35	355 - 495	901	271	640 - 1741
6	2	415	43	384 - 445	1105	433	798 - 1411
8	1	579		579 - 579	3236		3236 -3236

DOWNSTREAM OF VERNON DAM

Number of Annuli	Number of Fish	Total Length (mm)			Total Weight (g)		
		Avg.	SD	Range	Avg.	SD	Range
0	2	87	23	70 - 103	14	6	9 - 18
1	1	160		160 - 160	33		33 - 33
3	1	294		294 - 294	281		281 - 281
4	2	385	13	375 - 394	693	108	616 - 769
5	1	425		425 - 425	1048		1048 - 1048

Table 6.11 Monthly impingement of fish on Vermont Yankee's circulating water traveling screens, 1992. Note that the number of collections represent both 24 hour collections as well as backwashed samples examined for anadromous fishes.

	April		May		June		August		September		October	
Number of Collections	5		12		6		8		13		25	
Species	#	Wgt(g)	#	Wgt(g)	#	Wgt(g)	#	Wgt(g)	#	Wgt(g)	#	Wgt(g)
Sea lamprey	2	14										
American eel											1	726
American shad									3	9	23	67
Atlantic salmon	13	1110	1	80								
Brook trout	1	51			1	96						
Golden shiner	4	33	2	10	1	6					4	101
Notropis sp.									2	1		
Spottail shiner	28	95	9	21	8	34			1	2	3	21
White sucker	2	40			3	49					1	952
Yellow bullhead	4	25	5	42							1	4
Brown bullhead	22	228	25	1059	4	33					1	73
White perch	9	89			2	502	1	2			4	17
Rock bass	15	68	6	22	18	667	5	120	14	171	73	595
Lepomis sp.	5	7	1	1	11	36						
Pumpkinseed	3	27	7	25	7	337			1	15	39	79
Bluegill	23	770	7	52	5	672	6	1294	11	4469	115	323
Smallmouth bass			1	8	3	25	5	199	3	97	2	16
Largemouth bass			1	11							1	3
Tessellated darter	6	22										
Yellow perch	31	163	18	124	39	597			3	11	5	17
Walleye	1	43										
TOTALS	169	2785	83	1454	102	3052	17	1614	38	4776	273	2993

Table 6.12 Vermont Yankee ichthyoplankton sampling effort, 1992.

Station	Depth (meters)	Number of Collections: May	June	July	Total
Vermont Yankee Intake	0.3	4	5	2	11
Vermont Yankee Intake	1.8	4	5	2	11
Vermont Yankee Intake	3.7	4	5	2	11
TOTALS		12	15	6	33

Table 6.13 Collection dates and total numbers of ichthyoplankton captured at Vermont Yankee's intake, 1992.

Species	Earliest Capture	Latest Capture	Numbers
American Shad	29 June	29 June	1
Common Carp	16 June	23 June	3
Notropis sp.	11 June	14 July	515
White perch	20 May	23 June	212
Lepomis sp.	23 June	14 July	121
Yellow perch	5 May	20 May	11
Walleye	20 May	20 May	1
INDETERMINATE	27 May	23 June	3
TOTAL			867

Table 6.14 Ichthyoplankton captured at Vermont Yankee's intake by depth, in 1992.

Collection Date	Species	0.3 Meters	1.8 Meters	3.7 Meters	Totals
5 May	Yellow perch		3	2	5
14 May	Yellow perch	2	2	1	5
20 May	White perch	2	16	3	21
	Yellow perch	1			1
	Walleye		1		1
27 May	White perch		37	61	98
	INDETERMINATE			2	2
2 June	White perch	2	3	4	9
11 June	*Notropis* sp.	1			1
	White perch	4	8	29	41
16 June	Common Carp			1	1
	Notropis sp.	31	3	2	36
	White perch	2	13	24	39
23 June	Common Carp		1	1	2
	Notropis sp.	85	20	7	112
	White perch		1	3	4
	Lepomis sp.	8	9	3	20
	INDETERMINATE			1	1
29 June	American Shad		1		1
	Notropis sp.	187	5	1	193
	Lepomis sp.	46	21		67
8 July	*Notropis* sp.	114	3		117
	Lepomis sp.	30	1		31
14 July	*Notropis* sp.	56			56
	Lepomis sp.			3	3

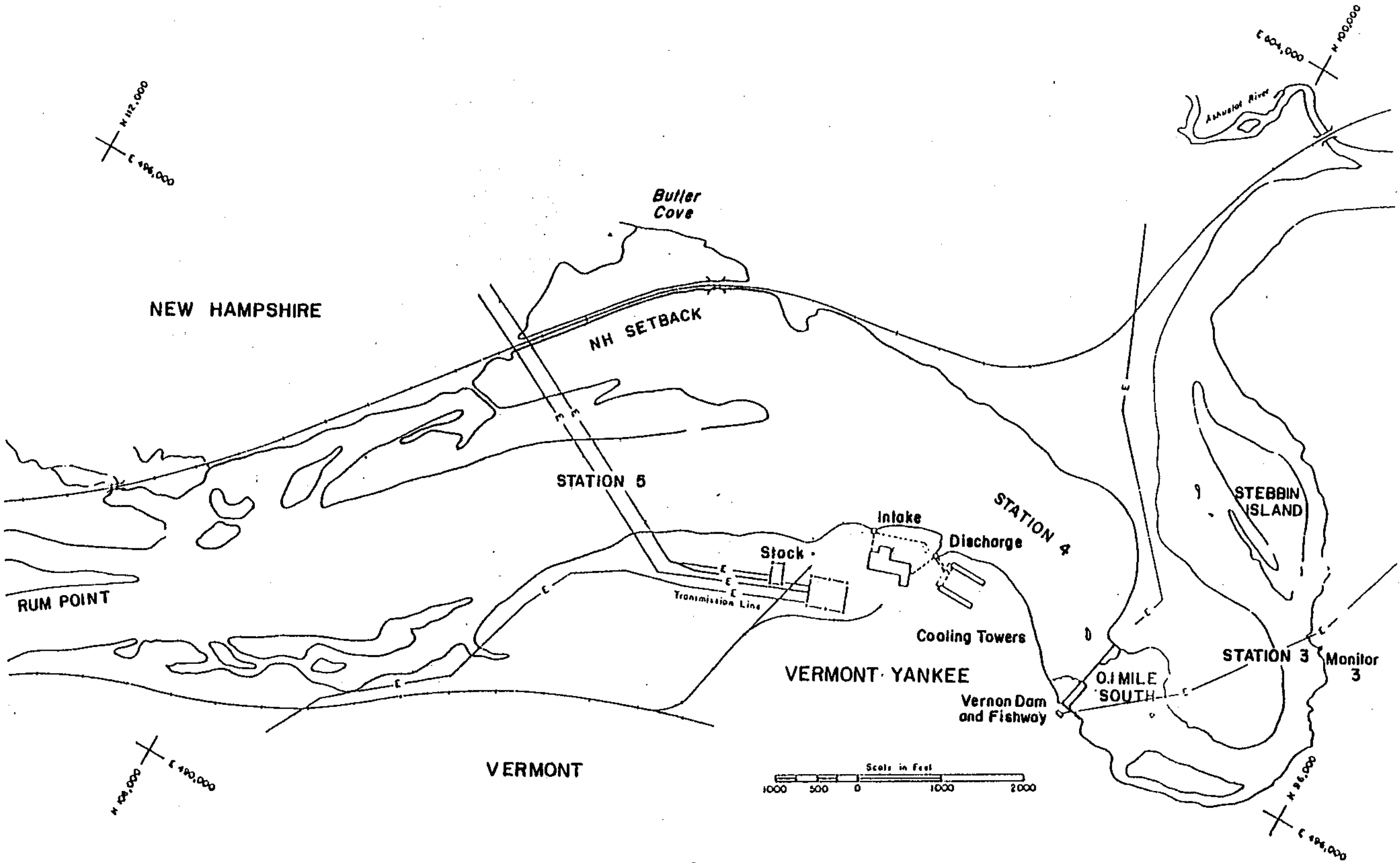

Figure 6.1 Fish sampling locations

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