Dominion Nuclear Connecticut, Inc.
Millstone Power Station
Rope Ferry Road
Waterford, CT 06385

Dominion

APR 30 2001

Docket No. 50-423
B18397

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station, Unit No. 3
2000 Annual Environmental Protection Plan Operating Report

Section 5.4.1 of the Environmental Protection Plan (EPP) requires Dominion Nuclear Connecticut, Inc. (DNC) to submit an Annual Environmental Protection Plan Operating Report to the U.S. Nuclear Regulatory Commission (NRC), describing implementation of the EPP for the previous year. The enclosed report fulfills this requirement for 2000.

There are no regulatory commitments contained within this letter.

Should you have any questions or require further information, please call, Ms. Kathleen M. McMullin, Environmental Services - Nuclear, at (860) 447-1791 ext. 2067.

Very truly yours,

DOMINION NUCLEAR CONNECTICUT, INC.

Raymond P. Necci
Vice President - Nuclear Technical Services

Enclosure
Attachment

cc: See next page

IE25

cc: A. J. Rocque, Jr., Commissioner
State of Connecticut
Department of Environmental Protection
79 Elm Street
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cc: w/enclosure, w/o attachment

H. J. Miller, Region I Administrator
V. Nerses, NRC Senior Project Manager, Millstone Unit No. 3
A. C. Cerne, Senior Resident Inspector, Millstone Unit No. 3

Docket No. 50-423
B18397

Enclosure 1

Millstone Nuclear Power Station, Unit No. 3

Annual Environmental Protection Plan Operating Report
January 1 - December 31, 2000

Annual Environmental Protection Plan Operating Report
January 1 - December 31, 2000

Millstone Unit 3 Environmental Protection Plan

prepared by
Dominion Nuclear Connecticut, Inc.
Millstone Power Station
Rope Ferry Road
Waterford, Connecticut 06385

April 2001

Annual Environmental Protection Plan Operating Report
January 1 - December 31, 2000

Millstone Unit 3 Environmental Protection Plan

Prepared by: Jim Foertch

Reviewed by: Milan Keser

Annual Environmental Protection Plan Operating Report - 2000

1. Introduction

This report covers the period January 1 - December 31, 2000. During 2000, Unit 3 continued a very successful seventh fuel cycle; capacity factors for 2000 and for the fuel cycle through December were both above 99%.

As required by the Millstone Unit 3 Environmental Protection Plan, this Annual Environmental Protection Plan Operating Report (AEPPOR) includes:

1) summaries and analyses of the results of environmental protection activities,
2) a list of EPP noncompliances,
3) a list of all changes in station design or operation which involved a potentially significant unreviewed environmental question, and
4) a list of non-routine reports, describing events that could result in significant environmental impact.

2. Environmental Protection Activities

2.1 Annual National Pollutant Discharge Elimination System (NPDES) Report of Ecological Monitoring (EPP Section 4.2)

Paragraph 5 of the Station's NPDES permit requires continuation of biological studies of Millstone Power Station (MPS) supplying and receiving waters, entrainment studies, and intake impingement monitoring. These studies include analyses of intertidal and subtidal benthic communities, finfish communities, entrained plankton, lobster populations, and winter flounder populations. Paragraph 7 of the permit requires an annual report of these studies to the Commissioner of Environmental Protection. The report that fulfills these requirements for 2000, Monitoring the Marine Environment of Long Island Sound at Millstone Power Station, Waterford, Connecticut - Annual Report, 2000 (Annual Report), presents results from studies performed during construction and operation of MPS, emphasizing those of the latest sampling year. Past reports have indicated that the added cooling water flow for Unit 3 affects impingement and entrainment, causes sediment scouring near the MPS discharges, and alters the characteristics of thermal effluent plume. The extended shutdown of MPS from 1996-1998 has also caused some changes to the physical environment in the vicinity of the station discharge, and additional changes were documented since restart of Unit 3 in July 1998 (and of Unit 2 in May 1999). Unit 1 will not restart; it is scheduled for decommissioning. The biological effects of these changes are summarized in the Executive Summary section of the Annual Report (Attachment 1) and further discussed in the Annual Report itself (submitted under separate cover).

2.2 Effluent Water Quality Monitoring

Paragraph 3 of the referenced NPDES permit requires monitoring and recording of many water quality parameters at MPS intakes and at multiple monitoring points within the plant, including outfalls of each unit to the effluent quarry, and outfall of the quarry to Long Island Sound. Paragraph 11 of the permit requires a monthly report of this monitoring to the Commissioner of the Connecticut Department of Environmental Protection (DEP). The report that fulfills these requirements, Monthly Discharge Monitoring Report (DMR), includes data from all three Millstone units. Consistent with prior annual AEPPOR submissions, water flow, temperature and chlorine data pertaining to Unit 3 are summarized in Table 1.

Each monthly DMR identifies NPDES permit exceedances (i.e., events where a parameter value was beyond permitted limits) or exceptions (i.e., events where permit conditions were not met) for the month. Two events of note are described below:

- Millstone Unit 3 is authorized to discharge up to 100,000 gallons per day of condenser hotwell water (condensate) as a batch discharge via DSN 001C-8. These discharges would normally occur during plant maintenance (refueling) outages, when the condenser is drained, following lay-up conditions. On February 10, 2000, a flow measuring instrument was installed on the discharge pipe for DSN 001C-8, and indicated a flow rate of 0.7 gallons per minute. Subsequently, it was discovered that two isolation valves were open, and a third was "leaking by", resulting in a continuous (rather than batch) release of condensate. This matter was discussed in correspondence with the DEP on February 16.

- There is a permit condition requiring that "free available chlorine shall not be discharged in the condenser cooling water for more than two hours in any one day." The following event description was submitted to the DEP as part of the May DMR (D16071). "On May 6, 2000, circulating water at Unit 3 was chlorinated for a total of 2 hours and 6 minutes due to a procedural inconsistency. A modification was made to the Unit 3 chlorination procedure which inadvertently increased total chlorination time in excess of 2 hours. Personnel identified and corrected this inconsistency prior to the next chlorination cycle on May 13, 2000."

Over the past several years, Millstone Power Station had submitted several requests to the DEP for Emergency Authorizations (EAs) for various discharges. On October 13, 2000, the DEP consolidated these requests and issued EA0100176, authorizing certain discharges and containing various reporting requirements. Millstone Power Station submitted the first of these reports, for fourth quarter 2000, on January 30, 2001, and noted that all results reported for that quarter were within specified limits.

3. Environmental Protection Plan Noncompliances

During 2000, no EPP noncompliances were identified for Unit 3.

4. Environmentally Significant Changes to Station Design or Operation

During 2000, no Unit 3 Design Change Records (DCRs) or changes to System Operating Procedures met the acceptance criteria for inclusion in this report, i.e.,

a) were initiated during the report year, and
b) included a determination that an unreviewed environmental impact could occur.

5. Non-Routine Reports of Environmentally Significant Events

During 2000, no events occurred at Unit 3 that met the acceptance criteria for inclusion in this report, i.e., required submittal of a Licensee Event Report (LER) from Unit 3, and involved a situation that could result in a significant environmental impact. Three (3) events constituted reportable occurrences at Unit 3 in 2000: LER 2000-001-00: "Ultimate Heat Sink Below Minimum Design Temperature," LER 2000-002-00: "Technical Specification 3.0.3 Entry with both Hydrogen Recombiner Trains Being Inoperable Due to a Radiation Monitor Failure," and LER 00-003-00: "Cable Routing for 3CHS*P3B Does Not Meet Fire Safe Shutdown Analysis." None were determined to cause a significant environmental impact.

Table 1. Millstone Unit 3 NPDES Data Summary, Jan. 1 - Dec. 31, 2000. Selected water quality parameters for Unit 3[(1)].

	discharge flow range (10^3 gpm)	discharge pH range	discharge temp. range (°F)	discharge temp. (avg) (°F)	avg ΔT (°F)	max FAC (ppm)	max TRC (ppm)	max SWS FAC (ppm)
Jan.	790-948	7.65-8.43	56.3-68.9	58.0	17.9	0.12	0.04	0.20
Feb.	790-954	7.72-7.93	53.3-62.0	54.2	17.6	0.09	<0.03	0.18
Mar.	790-948	7.48-7.98	56.5-67.7	57.7	16.6	0.11	0.04	0.19
Apr.	790-948	7.34-7.95	60.7-70.8	62.1	16.7	0.09	<0.03	0.22
May	790-948	7.48-7.86	67.4-80.8	69.0	16.4	0.12	<0.03	0.21
June	790-942	7.15-7.76	75.5-85.3	77.1	15.8	0.11	<0.03	0.19
July	790-942	7.57-8.01	82.0-90.0	83.3	15.9	0.06	<0.03	0.19
Aug.	790-954	7.79-7.99	84.6-92.5	85.7	16.0	0.07	0.04	0.23
Sep.	790-954	7.63-8.19	80.2-92.0	85.1	16.4	0.09	<0.03	0.17
Oct.	790-948	7.69-8.06	71.6-86.7	78.4	15.7	0.14	<0.03	0.21
Nov.	790-948	7.82-8.14	62.1-82.7	70.8	15.6	0.13	<0.03	0.20
Dec.	790-942	7.71-8.20	52.9-73.7	61.6	15.7	0.15	<0.03	0.17

Notes:

[(1)] Parameters are measured at Unit 3 discharge (DSN 001C), except for TRC, which is measured at MPS discharge (quarry cuts; DSN 001) and SWS FAC (service water system; DSN 001C-5).

Abbreviations used: temp.=water temperature, ΔT=delta-T (difference between discharge and intake water temperature), FAC=free available chlorine, TRC=total residual chlorine, and SWS=service water system.

ATTACHMENT 1

to the

Millstone Unit 3 Environmental Protection Plan
Annual Environmental Protection Plan Operating Report

January 1 - December 31, 2000

Executive Summary Section

"Monitoring the Marine Environment of Long Island Sound at Millstone Power Station, Waterford , Connecticut. Annual Report, 2000"

Winter Flounder Studies

The local Niantic River population of winter flounder (*Pseudopleuronectes americanus*) is potentially affected by the operation of MNPS, particularly by entrainment of larvae through the cooling-water systems of the operating units. As a result, extensive studies of the life history and population dynamics of this important sport and commercial species have been undertaken since 1976.

During the 2000 adult winter flounder spawning season, Δ-mean trawl catch-per-unit-effort (CPUE) of fish larger than 15 cm in the Niantic River was 3.0, which was similar to the value of 2.7 in 1999. Successively small annual increases in CPUE have occurred since 1996, but overall abundance in the Niantic River remains low. Abundance peaked in the early 1980s and decreased thereafter due to stock and recruitment effects (*i.e.*, decreased per-capita recruitment at high stock sizes), a generally warming winter trend, and increased rates of exploitation. Niantic River CPUE was significantly correlated with several other indices from Southern New England. The Jolly stochastic model was applied to mark and recapture data to estimate the absolute abundance of the Niantic River adult spawning population. The abundance estimate for 1999 was 6.7 thousand for all winter flounder larger than 20 cm. This was considerably less than estimated population sizes during 1984-91, which ranged between 33 and 80 thousand, but was similar to estimates made since 1995, which were between 5.7 and 8.5 thousand. Annual female spawner abundance estimates since 1976 ranged from about 2.6 (1996) to 76 thousand (1982), with corresponding total egg production estimates from about 2.2 to 44 billion for the same years. Since 1994, annual sex ratios of spawners has been highly skewed (>1.7) in favor of females, but were mostly less than 1.6 from 1977 through 1993.

A post-spawning abundance survey was made from mid-April through mid-May of 2000. Although less reliable because of non-random sampling, the CPUE of 11.8 for this survey was considerably higher than found during the regular spawning survey and indicated that more adult winter flounder were available for capture during late spring. It was not known whether or not most of these fish had been present during the spawning season in areas not sampled, or if they were from other stocks and entered the river after spawning elsewhere. These fish were marked with a unique brand, and recapture rates in forthcoming years may provide some insights into their origin.

An unusual pattern for the abundance and distribution of winter flounder larvae was observed in 2000, as for the first time since 1983, larvae were more numerous in Niantic Bay than the Niantic River. Abundance of newly-hatched (Stage 1) larvae was considerably below average in the river. From 1983 through 1994, abundance of Stage 1 larvae in the river was significantly correlated with independent estimates of female spawner egg production. However, from 1995 through 1999, when egg production estimates were at their lowest, Stage 1 abundance was greater than expected. This was attributed to higher egg survival, which may have been as much as four times greater than in earlier years and represented a potentially important compensatory mechanism. Stage 1 abundance in 2000 was consistent with estimated egg production for this year. Stage 2 larval abundance was low in the river, but densities were at or near record high levels in the bay, as they were for Stage 4 larvae in Niantic Bay. This indicated potentially high rates of flushing in 2000 and perhaps higher survival this year in the bay and Long Island Sound, which is discussed below.

Rates of larval growth and development were positively correlated with water temperature, but other factors such as density and prey abundance probably also affected growth. Growth rate of larvae in the bay was among the highest found in 18 years, but it was only near average in the river. Based on spring water temperatures in each area, growth rate in the bay was greater than expected, but growth in the river was less. Larval mortality rate could not be estimated this year as there were about as many larger, older larvae as those newly hatched. Density-dependence was examined by comparing mortality and egg production estimates (a measure of yolk-sac larval stage abundance) at various monthly and seasonal water temperatures. Results of this analysis suggested that larval mortality decreased with declining egg production and increasing April water temperatures. Based on estimates made in 2000 for the latter two parameters, larval mortality was predicted to have been among the lowest rates estimated since 1983, probably contributing to the high abundance of older larvae found this year.

The late summer beam trawl median CPUE of demersal age-0 winter flounder indicated that the 2000 year-class was one of the strongest produced since 1983, which reflected the high calculated rates of survival found for these fish in summer. The 1999-2000 Δ-mean CPUE calculated for young winter flounder taken during late fall and early winter at the trawl monitoring program stations represented an increase of about 50% relative to the previous year. These two age-0 abundance indices were significantly correlated and the relative magnitude of these indices suggested that the 1988, 1992, and 1994 year-classes of winter flounder were relatively strong, whereas the 1993 and 1997 year-classes were weak. Regardless of these values, however, fewer age-1 juveniles have been taken during each year of the Niantic River adult spawning population surveys since the early 1980s, with a CPUE for fish taken in the lower river navigational channel particularly low. This abundance decrease was much less when a CPUE was calculated for fish taken just in the upper river. The relative distribution of age-1 fish in Niantic River and Bay also may have changed over the years due to environmental factors.

Young-of-the-year abundance indices were either not significantly correlated or were negatively correlated with the abundance of female adult spawners 3 to 5 years later. Conversely, positive correlations were found between age-1 abundance indices and these older fish. However, the forms of the significant relationships were unclear and none of the early life stages were considered to be a highly reliable predictor of potential future year-class strength. Unknown processes that occur after winter flounder become age-1 may be operating to produce fewer adult recruits from more abundant year-classes of juveniles.

The number of larvae entrained through the condenser cooling-water system at MNPS is a measure of potential impact to winter flounder. Entrained larvae likely come from a number of sources, including stocks associated with the Connecticut and Thames Rivers, as well as from the Niantic River. Annual estimates of entrainment were related to both larval densities in Niantic Bay and plant operation. The 2000 entrainment estimate of 332.7 million was the second highest of estimates made since 1976. This was a result of the second highest larval density in Niantic Bay during the same period. As in previous years, Stage 3 larvae predominated (59%) in entrainment collections. The entrainment rate (annual abundance index divided by total flow) has varied since 1976 without trend, indicating that larval production and availability in Niantic Bay remained stable despite increased water use during the 1986-95 period of three-unit operation. Correlations between entrainment estimates and abundance indices of age-0 juveniles were positive, implying no entrainment effect and that the more larvae that were available for entrainment, the more that metamorphosed and settled in Niantic River and Bay. This was also illustrated by a comparison of annual entrainment and juvenile year-class strength, which indicated that entrainment reflected emerging year-class strength rather than being the most important factor in setting numerical abundance.

To date, efforts of regulatory agencies to control fishing mortality have not resulted in large increases in abundance for the Niantic River and other regional winter flounder stocks. Even so, the remaining small adult spawning stock continues to produce relatively large numbers of larvae and young fish, which are a likely result of population compensatory mechanisms. The effective retirement of Unit 1 in late 1995 was followed by an immediate reduction of about one-quarter of the MNPS cooling-water flow, which has permanently lessened plant impact, but has not resulted in stronger year-classes and subsequent enhanced recruitment to the spawning stock. Despite relatively good abundance of post-entrainment immature winter flounder, significant recruitment to the adult spawning population has not occurred in recent years, due to as yet unknown factors removing these fish from the population. Environmental effects, including changes to the Niantic River and interactions with other species, especially during early life history, also are important factors likely affecting the winter flounder recruitment process.

Fish Ecology Studies

The objective of the fish ecology monitoring program at Millstone Nuclear Power Station (MNPS) is to determine whether operation of the electrical generating units has adversely affected the occurrence, distribution, and abundance of local fishes. Potential MNPS impacts include entrainment of fish eggs and larvae through the condenser cooling-water system; impingement of juvenile and adult fish on intake screens, which has been mitigated by the installation of fish return sluiceways; and changes in distribution or abundance attributable to the thermal discharge. Trawl, seine, and ichthyoplankton monitoring programs were established in 1976 to provide the basis for identifying taxa potentially affected, as well as information on long-term abundance trends used to measure changes in the local populations.

This report summarizes data collected in the monitoring programs from June 1999 through May 2000 (report year 1999-00). During the 1999-00 report period, MNPS Units 2 and 3 were both operating most of the time and Unit 1 was shut down.

The potential effects of MNPS were assessed by conducting detailed analyses on seven taxa most susceptible to MNPS operational impact from entrainment or thermal effects. Analyses of these species generally focused on comparing temporal trends over the past 24 years. No significant long-term trends were detected for juvenile and adult silversides collected by seine in Jordan Cove (JC), all life stages of grubby, cunner eggs and larvae, and tautog and sand lance larvae. Atlantic menhaden larvae showed a significantly increasing trend in abundance during the past 24 years. A significant negative trend was observed for silversides at the Intake (IN) trawl station. However, during 1999-00, trawl CPUE was similar to the 5-year moving average at Niantic River (NR) and IN, and was above the moving average at JC. Since the mid-1980s, cunner and tautog have become less abundant at IN, exhibiting a significant negative trend, which may be related to the removal of the Unit 3 rock-cofferdam, a preferred habitat for these two species. Tautog eggs also exhibited a negative trend in abundance. Despite the negative trend in abundance for cunner at trawl station IN, their abundance at JC was at a historic high. The large numbers of tautog and cunner eggs entrained at MNPS did not appear to affect the spawning stocks of these two fishes, because the proportion of juvenile recruits relative to adults has increased.

Densities of both anchovy eggs and larvae exhibited significant negative trends. This year the Δ-mean density for anchovy eggs was the lowest recorded. However, the Δ-mean density of larvae was within the range of abundances found during the past 5 years. Information from Rhode Island waters and Chesapeake Bay indicated that bay anchovy is experiencing a regional decline in abundance along the Atlantic coast. None of the long-term abundance trends determined for various life stages of selected species could be directly related to the operation of MNPS.

Lobster Studies

Several aspects of MNPS operation could potentially impact the local population of American lobster (*Homarus americanus*). Upon hatching in early summer, lobster larvae swim to the surface to begin the 6- to 8-week planktonic phase of their life cycle and are susceptible to entrainment through cooling water systems. Juvenile and adult lobsters can be impinged on intake travelling screens or be exposed to the heated effluent in the discharge area. Because of the regional economic value of the Connecticut lobster fishery ($12-15 million annually) and the ecological importance of this species, lobsters have been monitored from May through October since 1978, using wire lobster traps set at three stations around MNPS. Since 1984, entrainment studies have been conducted during the hatching season, to estimate the number of lobster larvae drawn through the cooling water system. The objective of the lobster monitoring program is to determine if operation of MNPS has caused changes in local lobster abundance and population characteristics beyond those expected from changes in the fishery and natural variability.

Despite intense and increasing fishing effort on the species, landings made in the commercial fishery throughout New England have increased markedly over the last three decades. Commercial landings of lobsters in Connecticut waters of LIS increased from 0.7 million pounds in 1979 to a record 3.7 million pounds in 1998. However, landings declined 35% between 1998 and 1999 to only 2.4 million pounds. Landings declined even further in 2000 when only 1.4 million pounds were harvested. The recent decline in lobster abundance has been attributed to a significant lobster mortality event in western LIS. Beginning in the fall of 1998 and throughout the summer of 1999, an unexplained highly virulent illness emerged in lobsters harvested from western LIS. Lobstermen reported that more than half of the lobsters caught in traps were dead or died before arriving at port. In some areas of western LIS landings have declined more than 90% over the past two years. Comprehensive examinations of water quality parameters and bottom sediments failed to identify environmental conditions or toxins that could explain the lobster deaths. More recently, histologic examinations of lobsters revealed a systemic inflammatory disease affecting multiple tissues. The nervous system was markedly inflamed and the lesions were associated with a parasitic amoeboid protozoan. Many researchers suspect that the die-off in western LIS was caused by multiple disease pathogens exacerbated by environmental stressors, such as increased seawater temperature, anoxia and contaminants. In response to the die-off, the U.S. Secretary of Commerce declared a failure of the LIS commercial lobster fishery in January 2000. Early this year, Congress released $13.9 million in federal disaster funds for the LIS lobster industry.

At present, the die-off and subsequent catastrophic decline in lobster abundance observed in western LIS has not been observed in our study area in eastern LIS. Catch-per-unit-effort for all sizes of lobster averaged 1.849 lobster/pot during 2000, which was about 28% lower than the record high CPUE of 2.560 observed in 1999. The catch of legal-size lobster is highly dependent on the number of recruit-size lobsters one or two molts below minimum legal size. The 28% decline in total CPUE from 1999 to 2000 corresponded to a 39% decline in legal-size lobster CPUE (0.151 in 1999 to 0.092 in 2000). These declines could be attributed to an outbreak of shell disease syndrome, first observed in our area in the fall of 1998, which continues to plague local lobsters and has spread to other coastal areas of southern New England. Despite the recent decline in lobster abundance, results from our studies over the past 23 years indicate an increasing trend in total CPUE and no significant long-term trend in legal-size lobster CPUE.

The most notable changes in the population characteristics of local lobsters were observed in the proportion of egg-bearing females and their size structure. Between 3.1% and 7.5% of the females collected annually in the early study period were egg-bearing and average carapace lengths ranged between 79.1 mm and 80.5 mm. In recent years, the annual proportion of ovigerous females increased to between 10.4 and 16.0%, annual average size ranged between 75.2 and 76.8 mm and more than 90% of the egg-bearing females were sublegal-sized. These changes suggest that size at sexual maturity of female lobsters has recently decreased. It is presently unclear whether decreases in female size at maturity resulted from changes in environmental conditions or from selection pressures related to intense fishing pressure. The benefits of earlier maturation may be significant to lobster population dynamics. Small size at maturity and subsequent egg production from sublegal-sized females may explain why LIS lobsters are so resilient in the face of intense exploitation. Currently, the smaller size at sexual maturity allows females to spawn once or twice before reaching the legal size and could maintain current population levels into the future.

The density of lobster larvae collected in samples of the MNPS cooling water was 0.725 per 1000 m^3 during 2000. An estimated 327,300 lobster larvae were entrained during the May to July hatching period, which was within the range of previous years when 2 or 3 units operated (74,400-659,400). The potential effect of larval entrainment on subsequent legal lobster abundance is difficult to assess due to the uncertainty concerning the source of entrained larvae, their survival rate, and the relatively long period of time between larval settlement and recruitment to the fishery (6-8 years). For the same reasons, the effects on recruitment in our area due to the recent outbreak of shell disease and events of mass mortality in western LIS are difficult to assess. The increasing trend in total catch-per-unit-effort of lobsters in traps and the fact that no significant long-term trend in legal lobster abundance has been observed over the past 23 years suggests that entrainment of lobster larvae at MNPS has not adversely affected the local lobster population. Continued monitoring will help determine if operation of MNPS has caused changes in the abundance and population characteristics of local lobsters beyond those expected from natural factors such as disease and the intense exploitation of this species in coastal waters.

Rocky Intertidal Studies

Several important operational events during more than 20 years of rocky intertidal monitoring have resulted in identifiable ecological changes to the shore community near the MNPS discharge. While measurable, these changes are not widespread, but remain restricted to approximately 150 m of shoreline on the east side of the power plant discharge to Long Island Sound. Thermal impacts to the shore community at Fox Island were first observed in 1983, after the opening of the second quarry cut. Thermal addition to this site was modified when Unit 3 began commercial operation in 1986, and 3-unit operating conditions over the next eleven years allowed for long-term successional community development under a relatively consistent thermal regime. This community exhibited some changes during the extended shutdown of all three reactors from March 1996 through June 1998. Results of studies conducted since restart (including 2000) showed that the thermally adapted community at FE was highly resilient because as units returned to service, the characteristic components of this community quickly recovered.

Qualitative algal sampling had documented seasonal shifts in annual species at Fox Island-Exposed (FE) during 3-unit operation, and following Unit 3 restart in 1998. These shifts included abbreviated season for cold-water species (*e.g., Monostroma grevillei, Spongomorpha arcta* and *Dumontia contorta*) and extended season for warm-water species (*e.g., Grinnellia americana, Dasya baillouviana,* and *Bryopsis hypnoides*). Seasonality of these species at

FE during the recent shutdown period was more typical of other sites. Initial establishment of perennial populations of *Graciliaria tikvahiae* and *Sargassum filipendula* at FE was also detected through qualitative studies during early 3-unit years. These populations were not observed during many collections at FE during the shutdown period, but returned after Unit 3 restart in 1998.

Dominant species abundance and distribution patterns at FE, established during 3-unit operation, were more resilient to the return of ambient conditions. Thermal impacts had been most notable in the low intertidal during 3-unit operation, due to tidal currents in the discharge area. The low intertidal *Chondrus* population and associated seasonal epiphytes at FE were replaced by a population of the opportunistic green alga *Codium fragile* supporting a perennial *Polysiphonia* spp. population and periodically heavy sets of the blue mussel *Mytilus edulis*. Winter declines in *Polysiphonia* abundance typical of other sites was observed at FE during the shutdown period, but otherwise, little change in low intertidal community composition was observed, relative to recent years when MNPS was operating. Many characteristics of the impacted low intertidal community at FE (sparse, fluctuating populations of barnacles and *Chondrus,* heavy mussel sets) were probably related to the dominance of the *Codium* population, which persisted through the shutdown period, rather than to direct thermal effects. This would explain the quick reversal of minor shutdown-related changes following unit restarts.

Ascophyllum growth enhancement at FN, thought to be related to elevated temperatures from the 3-unit MNPS discharge, was observed during two recent growing seasons (1996-97 and 1997-98) while all three units were shutdown, but was not evident in 1998-99 following Unit 3 restart. *Ascophyllum* growth at FN in the latest growing season (1999-2000) was again higher than at control stations (although FN and WP were not significantly different). It is apparent that natural temperature increases (related to tidal flushing of water from nearby shallow flats susceptible to solar warming or other natural influences) play a more important role in determining *Ascophyllum* growing conditions at FN than does any thermal plume incursion from the MNPS discharge.

In addition to the localized changes noted for rocky intertidal communities in close proximity to the MNPS discharge, the rocky intertidal monitoring program has documented patterns and modifications unrelated to MNPS operation, including the introduction and spread of an exotic red alga, *Antithamnion pectinatum*, and a region-wide increase in abundance of the common brown rockweed, *Fucus vesiculosus*.

Eelgrass

Eelgrass is an ecologically important component of shallow water habitats. Eelgrass population monitoring has been part of marine environmental studies in the vicinity of MNPS since 1985. Eelgrass populations at three locations were monitored during 2000; Jordan Cove (JC), White Point (WP) and Niantic River (NR). The JC and WP sites have been consistently sampled since 1985, while the NR station has been changed several times because of declines in the overall abundance of eelgrass in the Niantic River.

Eelgrass shoot density and standing stock biomass estimates have been most variable during the study period in the Niantic River, where reference stations have been monitored. A new sampling site was established in the Niantic River in 2000 within the only remaining viable eelgrass bed found in this estuary. Site relocation was necessitated by the 1999 die-off of the eelgrass bed where the previous site had been located. This was the fifth time since 1985 that we have documented loss of an eelgrass bed in the Niantic River. The condition of the present bed is in question, as standing stock and shoot density estimates were low at this site in 2000. Because the Niantic River is located well away from any influence of the MNPS thermal plume, declines at NR sites have been, and continue to be, related to other environmental factors such as water quality or disease.

Eelgrass beds at the two monitoring sites nearest MNPS (JC and WP) have exhibited slight, but statistically significant, long-term declines in most population parameters. However, compared to the Niantic River, they have generally supported healthy populations, based on parameters monitored throughout the 16-year study. In fact, parameter estimates at both stations in 2000 were generally above average. These two populations are considered potentially impacted by the MNPS thermal plume, but temperature monitoring suggest that variability in water temperatures is most indicative of natural solar warming and hydrodynamic conditions in Jordan Cove rather than the MNPS discharge. These natural factors are particularly influential at the JC sampling site, which is the most shallow of the study sites, and is immediately adjacent to extensive shallow sand flats vulnerable to solar warming. In addition to temperature data, there does not appear to be any relationship between WP and JC population fluctuations and power plant discharge flow and heat output. With Unit 1 permanently retired, the likelihood of thermal plume incursion at JC and WP in the future is further reduced.

Benthic Infauna

Monitoring studies of sedimentary environments and associated benthic infaunal communities in the vicinity of MNPS have been ongoing for more than 20 years. Analysis of long-term data compiled over this period has allowed us to document spatial relationships and temporal trends, and distinguish between causal mechanisms that are either related to power plant construction and operation or other, presumably natural, factors. The three study sites within 0.5 km of MNPS (IN, JC, and EF) have community composition that has been modified by construction and operation activities. Data from the reference site (GN) 7 km to the west and well beyond any MNPS influence continued to provide a baseline for natural variability in local infaunal communities.

Highest community stability was observed at GN, which is not influenced by MNPS. No long-term trends were apparent for sedimentary characteristics at GN over the study period. The GN infaunal community has generally been dominated by three taxa over the study period (*Tharyx* spp., oligochaetes and *Aricidea catherinae*); however, some long-term trends in abundance of these taxa were noted. Specifically, *Aricidea* abundance has declined and *Tharyx* spp. abundance has increased over the 21-year study period. Some species at GN have exhibited relatively high year-to-year fluctuations that have proved useful in substantiating area-wide shifts in species abundance and community structure unrelated to MNPS operation. Most notable of these species was the opportunistic polychaete *Mediomastus ambiseta*, which exhibited large population increases at GN (and at stations near MNPS) during 1983-88, 1994, and 1998-99. Abundance of *Mediomastus* in 2000 was low at GN and all other sites. Other widespread population shifts in past study years included large increases in abundance of the amphipods *Leptocheirus pinguis* and *Ampelisca* spp., and of the polychaetes *Prionospio steenstrupi* and *Pygospio elegans*.

Infaunal community changes associated with MNPS were first observed at IN and were caused by dredging and cofferdam removal during Unit 3 construction from 1983 to 1985. Since then, sediments (primarily silt/clay content levels) have stabilized and become more similar to sediments of pre-impact years. Evidence of some infaunal community stabilization and recovery was also apparent. In particular, numbers of individuals and species richness at IN have increased over the study period, as have abundances of organisms typically more common in early study years or at other sites, such as *Aricidea catherinae* and *Tharyx* spp. These trends, along with concomitant decreases in abundance of *Nucula annulata* and other opportunistic species (*e.g.*, the amphipods *Leptocheirus pinguis* and *Ampelisca* spp.), indicate some degree of recovery at IN. Recovery at IN is not complete, however, as other organisms which have established post-impact community dominance, such as oligochaetes and *Protodorvillea gaspeensis*, maintained or increased their degree of dominance in recent years and may persist indefinitely

Sediment scour from the MNPS discharge directly impacted both the sediments and the infaunal community 100 m from the discharge at EF, particularly after Unit 3 startup in 1986. Relatively coarse sediment with low silt/clay levels were characteristic of the 3-unit benthic habitat at EF. While sediment characteristics remain different from those observed prior to 1986, the altered sedimentary environment at EF, and the infaunal community it supports, stabilized under the new environmental conditions created by the 3-unit discharge. The relative stabilization of the sediments at EF has allowed for rebounds of *Tharyx* spp. and *Aricidea catherinae*, taxa common prior to Unit 3 startup. In addition, oligochaete and *Protodorvillea gaspeensis* abundances in recent years have generally decreased from high abundances during the early 3-unit period. Oligochaete abundance estimates in 2000 were among the lowest observed during the study period, possibly related to the heavy mussel set observed in the discharge area in 2000.

Silt deposition at JC was observed shortly after sediment scouring began at EF and resulted in increased sediment silt/clay content and abrupt infaunal community changes. Abundances of the previously dominant oligochaetes and the polychaetes *Aricidea catherinae, Tharyx* spp. and *Polycirrus eximius* initially decreased. This depositional event occurred over a short period (less than one year) at the beginning of the 3-unit operational period, and its impact has lessened since 1986. For example, *A. catherinae* and *Tharyx* spp. abundances both rebounded to levels observed during 2-unit years within a few years of Unit 3 start-up, and were near record highs by 1996. However, continued trends toward recovery noted in previous years (*e.g.*, reduced silt/clay content during 1994 and 1995, and rebounding abundances of oligochaetes and *P. eximius* through 1993; NUSCO 1994, 1995) turned out to be short-term community changes not reflected in recent data. Additionally, the opportunistic mollusc *Nucula annulata* has maintained a population at JC through 2000 that is still well above pre-Unit 3 levels. Elevated silt/clay levels in sediments at JC continued to be observed through the shutdown period and following the MNPS restart to the present.