Annual Environmental Protection Plan Operating Report
January 1 - December 31, 1993

Millstone Unit 3 Environmental Protection Plan

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Annual Environmental Protection Plan Report - 1993

1. Introduction

This report cov rs the period January 1 - December 31, 1993. During 1993, Unit 3 was shut down for about two weeks in early April, following a reactor trip caused by a low steam generator level alarm and subsequent repair of a steam generator safety valve, and from August to early November for a refueling outage. Unit 3 was at full power (nominal 1150 MWe) for most of the rest of the year. During 1993, Unit 3 operated at an annual capacity factor of 65.0%.

As required by Millstone Unit 3 EPP, 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 NPDES Report of Ecological Monitoring (EPP Section 4.2)

Paragraph 5 of the referenced NPDES permit requires continuation of biological studies of MNPS 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 13 of the permit requires an annual report of these studies to the Commissioner of Environmental Protection. The report that fulfills these requirements for 1993, Monitoring the Marine Environment of Long Island Sound at Millstone Nuclear Power Station, Waterford, Connecticut - Annual Report, 1993, presents results from studies performed during 3-unit operation, and compares them to those from 2-unit operation. The added cooling water flow for Unit 3 affects impingement and entrainment, causes sediment scouring near the MNPS discharges, and alters the characteristics of thermal effluent plume. The biological effects of these changes are summarized in the Executive Summary section of the above-named report (Attachment 1) and further discussed in the report itself (Attachment 2).

2.2 Effluent Water Quality Monitoring

Paragraph 6 of the referenced NPDES permit requires monitoring and recording of many water quality parameters at MNPS intakes and at 37 discharge 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 Environmental Protection. The report that fulfills these requirements, Monthly Discharge Monitoring Report, includes data from all three Millstone units. Those data that pertain to Unit 3 are summarized in Table 1a.

During 1993, four NPDES exceptions were reported from discharges associated with Unit 3 (Table 1b). The first, on 12 February, was the report of total residual chlorine (TRC) concentration of 0.15 ppm (permit limit 0.10 ppm) at DSN 001, the common outfall of all three Units to Long Island Sound. Investigation concluded that the measurement was probably a sampling anomaly, as only Unit 1 had performed circulating water chlorination (the procedure that uses sodium hypochlorite most rapidly) on that day; Unit 2 was only chlorinating service water (a procedure that uses hypochlorite at a much lower rate), and Unit 3 was not chlorinating even service water on that day, because the injection equipment was being relocated and modified. The three other NPDES exceptions, free available chlorine (FAC) exceedances at Unit 3 service water discharge (DSN 001C-5), were associated with these modifications, and were attributed to operator unfamiliarity and procedural deficiency. The Unit 3 service water discharge is diluted approximately 30-fold by circulating water before it enters the effluent quarry, and even the highest chlorine levels measured were well less than those of domestic city water; therefore, the environmental impacts associated with these NPDES exceptions are negligible. However, station management will take the appropriate steps to correct the deficiencies, to minimize the chance that the incidents will recur.

Sampling for hydrazine (N_2H_4), biological oxygen demand (BOD), and chemical oxygen demand (COD) is required only when discharging wastewater containing hydrazine. The major hydrazine discharges at Unit 3 are from DSN 001C-1a, releases following wet lay-up of steam generators during extended outages; during 1993, these events occurred in August. Maximum hydrazine concentration was 61 ppm (permit limit 125 ppm); concurrent samples taken at the quarry cuts (DSN 001C) were all <0.1 ppm.

3. Environmental Protection Plan Noncompliances

During 1993, no EPP noncompliances were identified for Unit 3.

4. Environmentally Significant Changes to Station Design or Operation

During 1993, no Unit 3 Plant Design Change Records (PDCRs) 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. Of the 227 PDCRs initiated during 1993, none involved unreviewed environmental issues.

Unit 3 has 158 System Operating Procedures; of these, 141 were added or revised during 1993. In addition, many procedures were modified to reflect small changes, of insufficient magnitude to require the issuance of a new revision. However, each of these changes, as part of the review/approval process, included an environmental evaluation; none were determined to involve an unreviewed environmental impact.

5. Non-Routine Reports of Environmentally Significant Events

During 1993, 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. Of the 23 events that constituted reportable occurrences in 1993, none were determined to cause a significant environmental impact.

Table 1. Millstone Unit 3 NPDES Data Summary, Jan. 1 - Dec. 31, 1993.

a). Selected water quality parameters for Unit 3[1] (any exceptions are in bold type).

	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)	SWS FAC (ppm)
Jan.	790-948	7.9-8.1	52.0-61.2	57.3	16.6	<0.05	<0.05	0.19
Feb.	630-942	7.8-8.1	51.1-59.9	55.3	18.1	<0.05	**0.15**	0.24
Mar.	638-942	6.0-8.1	38.1-59.9	54.9	17.8	<0.05	<0.05	0.15
Apr.	480-948	7.5-8.1	37.9-66.0	55.1	12.9	0.05	<0.05	0.17
May	790-948	7.5-8.0	61.5-73.8	68.5	17.1	0.07	0.10	0.16
June	790-942	7.1-7.9	71.2-81.9	76.4	17.4	0.08	<0.05	**0.85**
July	790-948	6.2-8.1	67.1-86.7	81.8	16.6	0.08	0.08	0.18
Aug.	15-942	7.1-8.0	66.9-76.5	70.6	0.7	<0.05	<0.05	0.18
Sep.	30-486	7.2-7.9	63.1-72.7	67.9	0.2	<0.05	<0.05	**0.37**
Oct.	30-942	7.5-7.9	55.9-64.4	59.7	0.3	<0.05	<0.05	0.15
Nov.	486-948	7.4-8.0	50.0-74.8	64.3	11.5	<0.05	<0.05	0.12
Dec.	790-948	7.5-7.9	55.8-73.8	65.0	17.9	0.20	0.10	**0.65**

b). Number of NPDES exceptions during year[2].

pH	temp.	FAC	TRC	Susp. Sol.	BOD[3]	COD[3]	hydrazine[3]	Boric acid	conduct.	lithium	oil & grease	metals
0	0	3	1	0	0	0	0	0	0	0	0	0

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

[2]Some parameters are measured at more than one point within Unit 3 or only under certain operating conditions. Values represent number of NDPES exceptions for all discharge points.

[3]Sampling for BOD, COD, and hydrazine is required only when discharging wastewater containing hydrazine; data for these events are presented in the text.

ATTACHMENT 1 to the

Millstone Unit 3 Environmental Protection Plan

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Executive Summary

Lobster Studies

The American lobster, *Homarus americanus*, is one of the most valuable species in the Connecticut fishing industry. Between 0.8 and 2.7 million pounds have been landed annually since 1978 yielding between 2.4 and 8.4 million dollars to lobstermen employed in the fishery. Lobsters are highly exploited throughout their range; in the Connecticut lobster fishery, more than 90% of legal-sized lobsters are harvested each year. New fishery regulations have been implemented throughout the lobster range to reduce the high fishing mortality rates and to increase larval production and subsequent recruitment. Since 1984, Connecticut lobstermen have been required to install escape vents in traps; the escape vents allow sublegal-sized lobsters to escape from traps and thereby reduce injury and mortality to this portion of the population. The minimum legal size (carapace length) of lobster was gradually increased in Connecticut from 81.0 mm ($3\ ^{3}/_{16}$ in) in 1988 to 82.6 mm ($3\ ^{1}/_{4}$ in) in 1990. Because of the regional economic importance of lobsters, the local population of lobsters in the Millstone Point area have been sampled annually from May through October since 1978 to determine if operation of Millstone Nuclear Power Station (MNPS) has caused changes in local lobster abundance beyond those expected from natural variability and high fishing mortality rates. Some changes were observed in abundance and population characteristics of lobsters during 1993, but they were most likely related to high fishing levels and changes in fishery regulations (escape vents, minimum legal size increase) rather than to power plant impacts.

The total number of lobsters caught and catch per unit effort (CPUE) of all sizes of lobster reached record levels in 1992 and remained high during 1993. Total number caught (10,195) and CPUE (2.301) in 1993 were the second highest reported (previous ranges were 6,376-11,438 and 0.904-2.457). While a significant increasing trend was observed in total CPUE from 1978 to the present, legal lobster catches (those individuals ≥ 82.6 mm carapace length) have significantly declined since the study began in 1978. The CPUE of legal-sized lobsters was 0.080 during 1993 and within the range reported in previous 3-unit studies, but lower than the range reported during 2-unit studies (0.098-0.173).

The mean carapace length of lobsters caught during 1993 (70.8 mm) was larger than previous 3-unit values (69.5-70.2 mm), but within the range of values reported in 2-unit study years. Only 3.3% of the catch was of legal-size during 1993, within the range of 3-unit years but below the range of 2-unit years (5.9-9.1%). Percentage of females carrying external eggs (berried) during 1993 was 12.2% and higher than in any previous study year (3.1-12.1%). Berried females were, however, smaller during 3-unit years (76.5 mm) than during 2-unit years (79.4 mm), reflecting the high proportion (90%) of berried females below the minimum legal size of 82.6 mm.

The most important factor regulating molting and growth of lobsters is water temperature. Water temperatures during the 3-unit study years were, on average, slightly warmer than during 2-unit study years. As a result, the peak in catches of molting lobsters in 3-unit years occurred earlier (by 9 days) than during 2-unit years. Lobster growth per molt, as determined by tag and recapture studies, averaged 13.7% for both males and females in 3-unit studies, and was slightly higher than growth per molt observed during 2-unit studies (males 13.3% and females 13.0%).

Results from tag and recapture studies indicate that the overall percentage of recaptures in our traps was similar during 2- and 3-unit years (19% vs. 20%), whereas the percentage of recaptures by commercial lobstermen declined from 33% during 2-unit years to 18% during 3-unit years. This decline of recaptures in commercial traps was related to the 1984 escape vent regulation and not to MNPS operation. Installation of escape vents, coupled with the fact that most of our tagged lobsters are sublegal, resulted in fewer tagged lobsters retained in commercial traps. Conversely, our traps did not have escape vents and retained similar numbers of tagged sublegal lobsters. Lobster tagging also indicated that local individuals are predominantly nonmigratory. Over 90% of the tagged lobsters recaptured in commercial traps were caught within 5 km of Millstone Point. The average distance traveled by lobsters before they were caught in commercial pots was similar during 2- and 3-unit years (2.4 vs. 2.9 km). Although a predominance of localized movement was observed in our study, a number of lobsters (113) were reported caught outside LIS along the Rhode Island and Massachusetts coasts, and in offshore deep water canyons on the edge of the continental shelf.

Since 1984, lobster larvae have been sampled from May to August at the discharges of Units 1, 2 or 3.

The average density of larvae collected during 1993 was 1.081 per 1000 m^3 of cooling water, which was the second highest value reported (previous ranges were 3-unit 0.525-1.334; 2-unit 0.409 and 0.504). Estimates of total lobster larvae entrained through the plants cooling water system were based on sample density of larvae and total MNPS cooling water demand during the May to August hatching period. During 1993 an estimated 389,767 larvae were entrained, within the range of previous 3-unit years (296,173-615,285), but higher than the 2-unit estimates of 77,458 and 128,550. Entrainment numbers have been substantially higher since Unit 3 began operating because the cooling water demand of Unit 3 alone is about the same as that of Units 1 and 2 combined. The potential impact of lobster larvae entrainment is difficult to assess because of the uncertainty that exists concerning larval origin and larval survival and recruitment rates to legal size. Since lobsters require 4-5 years of growth before they are vulnerable to capture, and an additional 2 years of growth to reach legal size, a decline in local lobster abundance caused by larval entrainment would not be apparent for several years.

At present, fishery regulations implemented in 1984 (escape vents) and 1988 (increased minimum size) to preserve the LIS lobster resource appear to be effective. The percentage of berried females has increased each year since the minimum legal size was first increased and lower incidence of claw loss and reduced retention of sublegal sized lobsters in commercial traps were attributed to the use of escape vents. However, fishing effort has more than doubled since 1978 and further increases may offset some of the benefits of the new regulations.

Eelgrass

Eelgrass is the predominant marine flowering plant in estuaries and lagoons of temperate and warm boreal coasts in the Atlantic and Pacific Oceans. In the vicinity of Millstone Point, eelgrass populations can exhibit wide temporal and spatial variability in shoot length, plant density, standing stock biomass and other population parameters. During 1993, these parameters were measured at three sites in the MNPS area: Jordan Cove (JC), White Point (WP) and Niantic River (NR).

Eelgrass population parameters (plant density, shoot length, standing stock biomass and percentage of reproductive shoots) and sedimentary characteristics (mean grain size, organic content and silt/clay percentage) measured in 1993 were generally within the ranges of previous years; the only exceptions were annual biomass at WP, which was the highest yet reported, and percentage of reproductive shoots at JC and NR, which were also maxima.

The eelgrass population at WP remains unaffected by MNPS operation, as population parameters have been generally stable since 1985. At NR, wide fluctuations of abundance have occurred, including localized elimination of plants from NR #1 (1986-87), from NR #2 (1987), and from NR #3 (1987-93). These abundance fluctuations, however, are related to factors other than MNPS operation because the Niantic River is not impacted by the thermal effluent. Furthermore, in recent years NR #1 has been recolonized and the eelgrass population has apparently recovered completely. At JC, changes in eelgrass abundance may be related to changes in water temperature, but, at least to date, these changes appear to be the result of natural variability rather than an impact of 3-unit operation.

Rocky Intertidal Studies

Attached rocky shore communities, as described by the NUSCO monitoring program, continue to serve as effective integrators of local environmental conditions in the vicinity of MNPS. Conditions resulting in much of the variability among communities at sampling sites outside the influence of MNPS were related to natural factors including site orientation to prevailing wind-generated waves, the ability of available substratum (slope) to dissipate the horizontal force of those waves, and the character of that substratum (e.g., boulders, bedrock ledge, etc.). Community differences beyond those attributed to natural factors occurred within the thermal plume area at sites located on Fox Island (FE and FN), and were directly attributed to MNPS operation. Various aspects of the impact-related community changes at Fox Island were identified through separate studies which included qualitative algal sampling, estimation of intertidal organism abundance, and studies of local *Ascophyllum nodosum* populations.

Elevated temperature conditions caused by the 3-unit thermal plume allowed development of a unique flora at FE. The most notable shifts in species occurrence, revealed by qualitative algal sampling, were the presence of warm water-tolerant species not typical of other sites (*Agardhiella subulata, Gracilaria tikvahiae* and *Sargassum filipendula*), absence of common cold water species (*Mastocarpus stellatus, Dumontia*

contorta and *Polysiphonia lanosa*) and extended or reduced periods of occurrence of seasonal species with warm or cold water affinities, respectively.

During 1993, power plant impacts on dominant species abundance patterns, caused by 2-cut water circulation patterns and by 3-unit operations, were observed only at FE, and were most pronounced in the low intertidal, where temperature conditions were most severe. The low intertidal community at FE, which prior to 1983 had been unimpacted and characterized by perennial populations of *Fucus*, *Chondrus* and *Ascophyllum* and predictable seasonal peaks in barnacle abundance, has been replaced by a persistent community dominated by *Codium*, *Ulva*, *Enteromorpha* and *Polysiphonia*. Also, populations of species observed in undisturbed transects only at FE (*Sargassum*, *Gracilaria*) persisted during 1993.

Ascophyllum populations at three stations in the vicinity of MNPS continued to be monitored in 1993. Elevated temperatures (2-3°C above ambient) at our station nearest the discharge (FN) caused *Ascophyllum* to grow longer and more rapidly at this site, relative to stations farther away. A moderate level of growth enhancement was observed at FN during 1992-93, when compared to previous years, attributed to lessened thermal plume incursion resulting from an extended outage of Unit 2 for much of the peak growing season. As in previous years, *Ascophyllum* mortality, or loss of tagged plants and tips, at our present sampling sites was not related to proximity to the power plant but rather to degree of exposure to prevailing winds and waves.

Benthic Infauna

During 1993, infaunal communities inhabiting soft-bottom subtidal habitats in the vicinity of MNPS were sampled quarterly as part of a long-term monitoring program. These communities were characterized in terms of species composition, abundance, and sedimentary parameters in order to identify spatial and temporal patterns in community structure and to assess whether observed changes can be attributed to construction or operation of the power plant.

Changes in sediments resulting from Unit 3 construction and initial operation events have resulted in alterations to associated infaunal communities in recent years. During 1993, the effluent site (EF) continued to show evidence of sediment scour, and Jordan Cove (JC) sediment deposition. The intake site (IN) exhibited continued recovery from dredging activities near the intakes in the early 1980s, and Giants Neck (GN), as the control site, continued to show little temporal variation and no effect of MNPS operation.

The dominant taxa collected during 1993 at subtidal stations included the polychaete species *Aricidea catherinae*, *Tharyx* spp., *Prionospio steenstrupi*, *Polycirrus eximius*, *Scoletema tenuis*, *Protodorvillea gaspeensis*, *Mediomastus ambiseta*, *Pygospio elegans*, the arthropods *Ampelisca vadorum*, *A. verrilli* and *Leptocheirus pinguis* and representatives of the class Oligochaeta. The top four ranked taxa at each station in 1993 accounted for 50% or more of all individuals. In most cases, these organisms have been the dominant subtidal taxa in both 2-unit and 3-unit operational periods. Most stations were characterized by one or more clearly dominant taxon (oligochaetes at EF, GN and JC, *Aricidea catherinae* at GN and JC and *Tharyx* spp. at GN) during both operational periods. There has been no single dominant taxon at IN during either operational period, where mean relative abundance of any single taxon rarely exceeded 10%. Analyses of local benthic communities have identified changes and long-term trends in community parameters, and have permitted distinction between changes related to natural variability, and those caused by power plant operation.

Marine Woodborer Study

The Marine Woodborer Study report describes the local distribution of *Teredo bartschi*, a semitropical shipworm common from Texas to South Carolina, but capable of establishing isolated populations near thermal discharges in more northern climates. *T. bartschi* remains in MNPS discharge waters and, in 1993, it was collected for the first time in panels 500 m from the quarry cuts. Reduced currents around the rock outcroppings at this new site may trap discharge water and increase the probability of collecting this immigrant species. The absence of *T. bartschi* at EF in 1993 is probably related to unusual conditions resulting from Unit 3 being off-line from August to November, during the peak recruitment period for this species. The distribution of *T. bartschi* remains closely associated with the discharge waters of MNPS, suggesting that the discharge population has not adapted to ambient temperature conditions at White Point, 1700 m from the quarry cuts. Even though the current program represents a large reduction in sampling effort relative to previous study years, it continues to effectively monitor the abundance of *T. bartschi* in the Millstone area.

Fish Ecology Studies

Studies of fish assemblages inhabiting the area around MNPS were conducted to determine the effects of station operations. These effects have been defined as power-plant related changes in the occurrence, distribution and abundance of fish species which would affect the community structure. Fish assemblages could be adversely affected by losses due to impingement of juvenile and adult fish on the intake screens, entrainment of fish eggs and larvae through the cooling water system or by changes in thermal regime or physical habitats.

Trawl, seine and ichthyoplankton monitoring programs were established in 1976 to determine the impact of MNPS on local fish assemblages. Of the 120 different fish taxa that have been collected since then in these programs, seven taxa (American sand lance, anchovy, grubby, silversides, tautog, cunner and winter flounder) have been identified as having the potential to be impacted by MNPS either by entrainment or because of their susceptibility to thermal impacts.

Abundence data were analyzed separately for two-unit (1976-1985) and three-unit (1986-1992) operational periods and for the entire 17-year data series (both periods combined) to determine if changes in fish abundance have occurred. Larvae of sand lance and anchovy have declined as have adult tautog and cunner. Because so many factors affect the abundance of these taxa the reasons for these declines are difficult to ascertain. American sand lance larvae has ranked third among fish larvae entrained and it has significantly decreased in abundance in the entrainment and offshore samples. The bay anchovy is typically the most abundant ichthyoplankton species collected in estuaries within its range and it was the dominant larval taxa entrained at MNPS. Similar to the sand lance, this fish also exhibits large natural abundance fluctuations. Along the Connecticut coast, the Atlantic silverside and the inland silverside are among the most common shore-zone species. Typical of short-lived species, the catches of Atlantic silverside by trawl and seine were highly variable and annual catch indices ranged over two orders of magnitude. The trawl CPUE of Atlantic silversides was at a 17-year high at the two Niantic Bay Stations (NB and IN), and all 1992-93 trawl catches were above the two-unit annual averages. The catches of Atlantic and inland silversides in seines were all within historic ranges and above the two-unit period average, except for Atlantic silversides at JC. The grubby is unique because unlike the other potentially impacted fishes it experiences no fishing pressure. Both larval and adult grubby abundance indices have been stable throughout the 17 years of monitoring. Tautog has been the second-most abundant egg taxon entrained and has accounted for more than 30% of the total eggs collected since 1979. The tautog egg entrainment estimate for this report year was the lowest since three-unit operation began and the average density of eggs at the entrainment site (EN) was the second lowest since sampling began. Larval tautog average densities at EN were within their historic range. The cunner egg entrainment estimate also was the lowest since Unit 3 began operating. Cunner larval densities were within their historic range. Prior to 1992-93, the trawl catch of cunner had been decreasing at all six stations. This year's trawl catches were below the two-unit operational catches at two inshore stations, but were at a historic high in Niantic Bay. Both tautog and cunner young-of-the-year have accounted for a high proportion of the fish caught in the trawl since three-unit operation began.

Because over 80% of the eggs entrained at MNPS were tautog and cunner eggs, special studies were conducted in 1993 to determine the entrainment mortality of these eggs. The average hatching rate was 4%. To examine daily fluctuations of egg abundance, samples were collected every two hours during three 24-hour periods. Examination of the geometric mean for each 2-hour sampling period showed that on the average, daily peak spawning for cunner and tautog occurred at about 1800 hours and then declined rapidly. Estimated mortality rate during this rapid decline was 44% per hour for cunner and 47% per hour for tautog. These very high egg mortality rates may account for the low numbers of cunner and tautog larvae collected compared to the large number of eggs of these two fishes.

Winter Flounder Studies

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

The median trawl catch-per-unit-effort (CPUE) of fish larger than 15 cm collected in the Niantic River

during the February-April 1993 spawning season was 1.9. This value was only about 30% of the CPUE of 6.2 for last year, and it was the smallest CPUE in the 18-year time-series. The Jolly stochastic model was used with mark and recapture data to estimate the absolute abundance of the adult spawning population (all winter flounder larger than 20 cm, which includes some immature fish). The most recent abundance estimate of 12,178 fish for 1992 was only 19% of the 1991 estimate and further illustrated the severe decline of winter flounder abundance in recent years.

Each year, about one-third to one-half of the winter flounder found in the Niantic River during the spawning period have been mature females. Using available information on sex, age, and size composition, the annual female winter flounder parental stock sizes have been estimated for the past 17 years. These estimates have ranged from 7,821 (1993) to 78,629 (1982) fish, with corresponding total egg deposition ranging from about 6.4 (1993) to 45.6 billion (1982).

Estimates of larval winter flounder abundance at the MNPS discharge (entrainment sampling) have been obtained since 1976, at a station in mid-Niantic Bay since 1979, at three stations in the Niantic River since 1983, and at the mouth of the Niantic River during 1991-93. The low abundance of newly-hatched larvae in Niantic Bay compared to the Niantic River suggested that most local spawning occurred in the river. Larval abundance in 1993 was the lowest in both the Niantic Bay and River since sampling began in 1976 and 1983, respectively. Annual larval abundances in the bay for 1976-93 appeared to reflect region-wide trends, because they were highly correlated to abundance indices in Mount Hope Bay, MA and RI.

Larval developmental stage and length were closely related. Smaller larval size-classes predominated in the river and larger size-classes were more prevalent in the bay. In Niantic Bay, growth and development were correlated with water temperature, and in the river growth appeared to be related to both water temperature (positively) and larval density (negatively). Estimated mortality of larvae in the Niantic River for 1984-93 ranged from about 82 to 98%. Mortality was consistently highest during Stage 2 of development (3- to 4-mm size-classes), which is when feeding first occurs; larval abundance declined about 90% during this stage in 1993. This stage may include a "critical period" for winter flounder as survival rates generally improve progressively for larger size-classes.

Young-of-the-year winter flounder have been collected during late spring and summer in the Niantic River since 1983 and in Niantic Bay since 1988. In 1993, abundance of newly metamorphosed young was relatively low, particularly in the Niantic River. Mortality was once again apparently quite high in the bay, with no fish caught there by mid-summer. Late-season median densities at two stations in the river were among the lowest found since 1983.

An index of abundance was calculated for young-of-the-year fish taken during the late fall and early winter at the trawl monitoring program stations. The 1992-93 abundance index (1992 year-class) was 31.1, the highest in the 17-year series. This was consistent with the high abundance of these fish found during the summer of 1992 and was indicative of the strength of the 1992 year-class. However, relatively few of these fish were taken within the Niantic River during the adult spawning population surveys in early 1993. Young-of-the-year abundance indices were not significantly correlated with those for age-4 and 5 female adult spawners. Therefore, none of the early life stages could be used as a reliable index of year-class strength for Niantic River winter flounder stock.

Egg production estimates from annual spawning surveys were scaled to numbers of spawning females and used as recruitment indices. These indices together with adult female spawning stock estimates and mean annual February water temperatures were used to fit a three-parameter Ricker stock-recruitment relationship (SRR). Additionally, the indirect estimate of the winter flounder theoretical rate of increase (the SRR α parameter) derived by the Connecticut Department of Environmental Protection (DEP) was used for modeling the dynamics of the winter flounder population for impact assessment purposes. The value of α, re-scaled to units of fish numbers from biomass units, was estimated as 5.42 and described the inherent potential for increase of the Niantic River winter flounder stock. The estimate of β (the second SRR parameter), which describes the annual rate of compensatory mortality as a function of stock size, has shown little annual variation since 1988. The third and last parameter in the SRR described a negative relationship between winter flounder recruitment and water temperatures in February, the month when most spawning, egg incubation, and hatching occur.

The number of larvae entrained through the condenser cooling-water system at MNPS is the most direct measure of potential impact on winter flounder. Annual estimates of entrainment were related to larval densities in Niantic Bay, as well as to plant operation. The entrainment estimate for 1993 of 41.1

million was the lowest since three-unit operation began in 1986 and was one of the lowest in the 18-year series. Low entrainment was attributed to low larval abundance, as all MNPS units operated throughout much of the larval winter flounder season during 1993.

The impact of larval entrainment on the Niantic River stock depends upon the fraction of its production that is entrained each year. Empirical mass-balance calculations for 1984-93 indicated that a large number of entrained larvae came from areas of Long Island Sound other than the Niantic River. An estimated 11 to 35% of the larvae entrained at MNPS appeared to have originated from the Niantic River during these years. Percentages of the river production that were entrained annually ranged from about 4 to 21% and the estimated fraction of Niantic River winter flounder production that would be entrained under full (100% capacity) three-unit operation ranged from about 5 to 24%.

A computer simulation model (SPDM) was used for long-term assessments of MNPS impact. Input data used by the model included basic life-table parameters, the three-parameters of the SRR, February water temperature statistics, and simulation parameters specific to each model run, including a random variability component. Conditional mortality rates corresponding to postulated larval entrainment and juvenile and adult impingement at MNPS were simulated according to historical information and projections. Fishing mortality rates (F) were provided by the DEP. Initially, F was set at 0.40 and remained unchanged through the 1960s, increased gradually to 0.62 by 1988 and thereafter more rapidly to a maximum of 1.30 in 1991. Based on proposed regulatory changes, F was projected to decrease substantially through the late 1990s, dropping to 0.50 by 2001 and remaining unchanged through the rest of the simulated years. The winter flounder stock was simulated as female spawner biomass (lbs), which is more directly related to reproductive potential than fish numbers. Annual rates of Niantic River winter flounder larval entrainment were based on actual or estimated MNPS cooling-water flow and estimated or projected entrainment as derived from mass-balance calculations. All SPDM runs were stochastic and consisted of 100 Monte Carlo replicates for each yearly stock projection over a 100-year period (1960-2060).

An initial stock size of 97,075 lbs was used to represent the theoretical (no fishing assumed) maximum spawning potential (MSP) of the Niantic River female spawning stock. When fishing effects were simulated, the annual projections of the initially unfished stock become the baseline time series of annual spawning biomass for Niantic River winter flounder subjected to fishing, but in the absence of any plant impact. Under the exploitation rates simulated, the stochastic mean stock size of the baseline declined to about 48,300 lbs in 1971 and to 12,300 lbs in 1993. The latter value was about one-half of a generally accepted critical stock size, defined as 25% of MSP. Following simulated reductions in fishing, however, the stock rapidly recovered. A new series of stock size projections were then simulated by adding the effect of larval entrainment at MNPS. The lowest projected stock biomass under simultaneous fishing and effects of MNPS occurred in 1993 (10,600 lbs), whereas the greatest absolute decline relative to the baseline occurred in 2001 (a difference of 7,800 lbs). Generally, however, greater reductions in stock biomass resulted from fishing than from larval entrainment, because fishing tends to remove larger fish and reduce average weight of the remaining spawners. The simulated spawning stock returned to near-baseline levels about 6 years after the scheduled termination of Unit 3 operation in 2025.

The probabilities that the Niantic River female spawning stock biomass would fall below selected reference sizes (25, 30, and 40% of MSP) were determined to help assess the long-term effects of MNPS operation. A stock less than 25% of MSP is considered overfished, whereas one that is at 40% of MSP can maximize yield to the fisheries while remaining stable. For both baseline and MNPS-impact simulations, it was likely ($p \geq 0.87$) that the stocks were greater than 40% of MSP in 1970. At the lowest point of both stock projections in 1993, all replicates were less than 25% of MSP. Simulated reductions in fishing allowed for a rapid increase in spawner biomass and it was likely greater than 30% of MSP by 2010 ($p \geq 0.97$) and had a better than even ($p = 0.56$) chance of being greater than 40% of MSP by 2020. These increases, however, assumed that changes in fishing regulations would be implemented as scheduled and that they would achieve the expected reductions in fishing mortality.

ATTACHMENT 2 to the

Millstone Unit 3 Environmental Protection Plan

Annual Environmental Protection Plan Operating Report
January 1 - December 31, 1993