Boston Edison
Pilgrim Nuclear Power Station
Rocky Hill Road
Plymouth, Massachusetts 02360-5599

October 9, 1998
BECo Ltr. 5.98.092

Mass. Department of Enviornmental Protection
Regulatory Branch - 7th Floor
One Winter Street
Boston, MA 02108

NPDES PERMIT MARINE ECOLOGY MONITORING REPORT

Dear Sirs:

In accordnace with Part 1, Paragraphs A.8.b &e, and Attachment A, Paragraph 1.F, of the Pilgrim Nuclear Power Station NPDES Permit No. MA0003557 (federal) and No. 359 (state), Semi-Annual Marine Ecology Report No. 52 is submitted. This covers the period from January through June, 1998.

J.F. Alexander
Regulatory Relations
Group Manager

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RDA/dcg
598092

Attachment: Semi-Annual Marine Ecology Report No. 52

Boston Edison
Pilgrim Nuclear Power Station
Rocky Hill Road
Plymouth, Massachusetts 02360-5599

October 9, 1998
BECo Ltr. 5.98.092

Planning and Administration (SPA)
U. S. Environmental Protection Agency
P. O. Box 8127
Boston, MA 02114-8127

NPDES PERMIT MARINE ECOLOGY MONITORING REPORT

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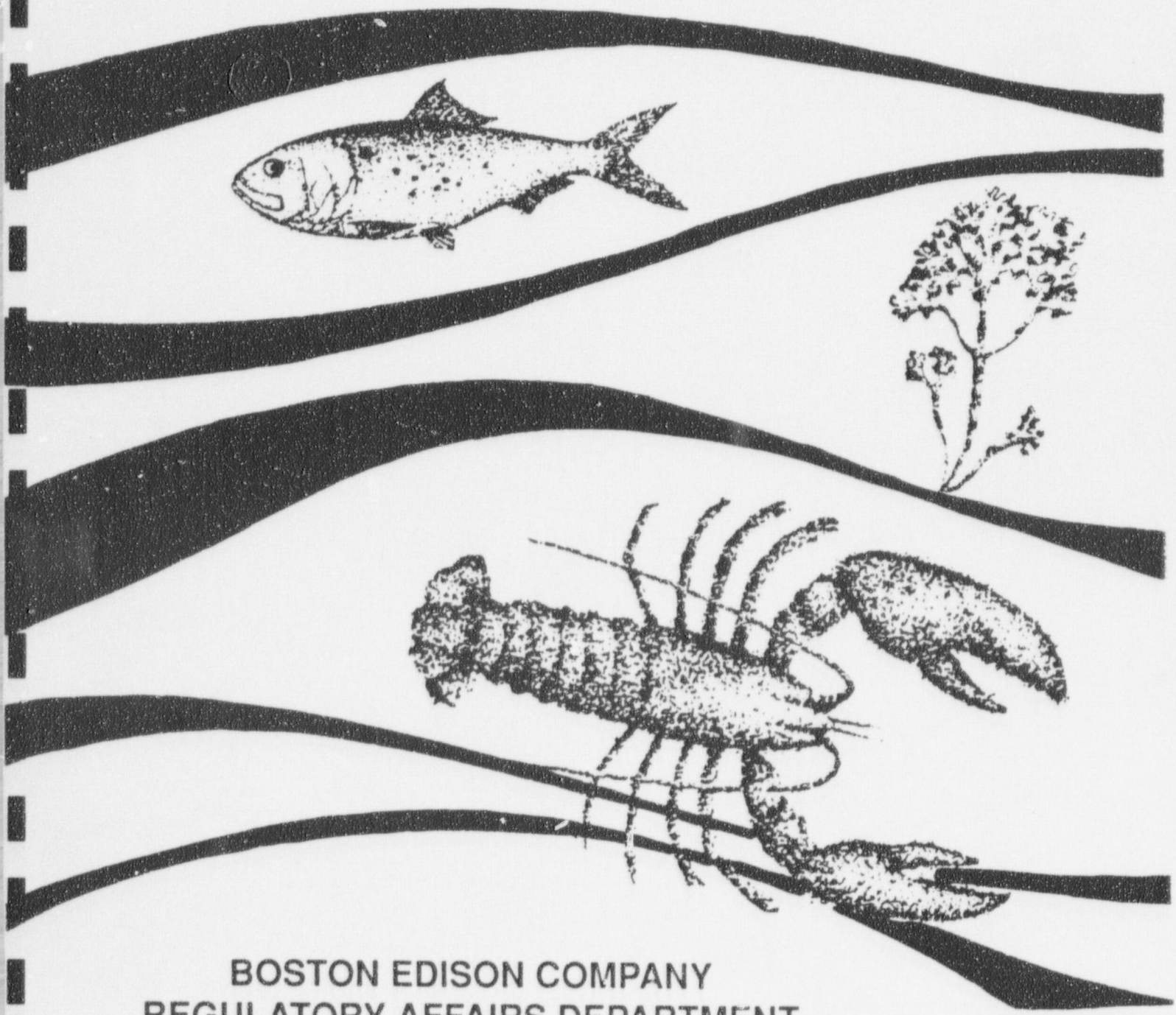
marine ecology studies

Related to Operation of Pilgrim Station

SEMI-ANNUAL REPORT NUMBER 52
JANUARY 1998 - JUNE 1998



BOSTON EDISON COMPANY
REGULATORY AFFAIRS DEPARTMENT

Boston Edison

MARINE ECOLOGY STUDIES

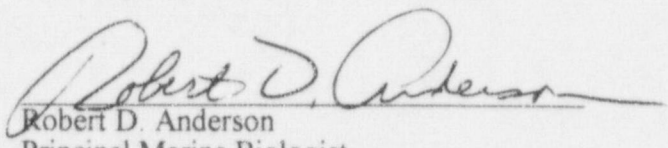
RELATED TO OPERATION OF PILGRIM STATION

SEMI-ANNUAL REPORT NO. 52

REPORT PERIOD: JANUARY 1998 THROUGH JUNE 1998

DATE OF ISSUE: OCTOBER 31, 1998

Compiled and Reviewed by:



Robert D. Anderson
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Boston Edison Company
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SUMMARY

Highlights of the environmental surveillance and monitoring program results obtained over this reporting period (January - June 1998) are presented below. (Note: PNPS was in high power operation during all of this period)

Marine Fisheries Monitoring:

1. Yankee trawls (366) during March-May 1998, in northwestern Cape Cod Bay, for winter flounder stock assessment work were performed to determine population parameters with 7,500 fish($\geq$ 280 mm TL) marked. Four hundred and ninety-eight recaptures (6.6%) have been recorded for 1998 tagged flounder. Techniques for sampling young-of-the-year winter flounder for spawning success/year class strength studies were terminated previously due to lack of success with them.

2. In the April to June 1998, shorefront recreational fishery creel survey, 1,004 anglers were recorded in 50 fishing days. Striped bass (269+ sublegal, 16 legal) and bluefish (165) were the species recorded. Discharge area observation diving noted all species showed no physical or behavioral problems.

3. Rainbow smelt spawning habitat enhancement of the Jones River (Kingston), to mitigate for PNPS smelt impingements in recent years, accounted for an increased egg set and ultimately hatching success to supplement the River's spawning population of this species which in 1998 appeared to be relatively high. This effort also determined that the Jones River was the Plymouth Bay area's primary smelt spawning tributary the last couple of years.

4. The cunner study which had concentrated on aging and trap catch per unit effort (CPUE) for population information, as well as recruitment dynamics to estimate impact, was terminated in 1998.

Impingement Monitoring:

1. The mean January - June 1998 impingement collection rate was 1.86 fish/hr. The rate ranged from 0.10 fish/hr (June) to 5.22 fish/hr (March) with Atlantic silverside comprising 63.5% of the catch, followed by winter flounder, 11.5%, and rainbow smelt, 6.6%.

2. For March 1998, when the fish impingement rate was 5.22, Atlantic silverside accounted for 87% of the fishes collected. Fish impingement rate was notably higher in 1989-1998 than in 1988 (0.30), primarily because Pilgrim Station had much less circulating water pump capacity than normal that year.

3. The mean January - June 1998 invertebrate collection rate was 1.54/hr with sevenspine bay shrimp (90.9%), green crabs (2.4%) and longfin squid (1.8%) dominating the catch. Eight American lobsters were caught.

4. Impinged fish initial survival at the Pilgrim Station intake sluiceway was approximately 31% for static washes and 62% for continuous washes.

Benthic Monitoring

March and June 1998 mappings of the discharge effluent, near-shore acute impact zones were performed. The denuded (~1,600m^2) and total affected (~2,100m^2) areas were comparable to historical baselines in March and June indicating continuing impact since the 1986 - 1988 PNPS outage. In June, a dense mat of juvenile blue mussels (5-30mm length) blanketed large portions of the Chondrus (Irish moss) sparse/stunted zones as was also apparent in June of 1990 and 1992-1997, possibly because of consistent thermal discharge during these periods.

Entrainment Monitoring:

1. A total of 31 species of fish eggs and/or larvae were found in the January - June 1998 entrainment collections: 14 eggs, 29 larvae.

2. Egg collections for January - April 1998 (winter-early spring spawning) were dominated by yellowtail flounder, fourbeard rockling, American plaice and Atlantic cod eggs. May and June (late spring - summer spawning) egg samples were most representative of Atlantic mackerel and labrids.

3. Larval collections for January - April 1998 were dominated by rock gunnel, sand lance and sculpin. For May and June larvae, mackerel, winter flounder, and cunner dominated.

4. No lobster larvae were collected in the entrainment samples for January - June 1998.

5. On several occasions unusually high densities of ichthyoplankton were found, some involving Atlantic menhaden eggs and larva in June 1998.

radmisc/fishjob

INTRODUCTION

A. Scope and Objective

This is the fifty-second annual report on the status and results of the Environmental Surveillance and Monitoring Program related to the operation of Pilgrim Nuclear Power Station (PNPS). The monitoring programs discussed in this report relate specifically to the Western Cape Cod Bay ecosystem with particular emphasis on the Rocky Point area. This is the fortieth semi-annual report in acco rdance with the environmental monitoring and reporting requirements of the PNPS Unit 1 NPDES Permit from the U.S. Environmental Protection Agency (#MA0003557) and Massachusetts Department of Environmental Protection (#359). A multi-year (1969-1977) report incorporating marine fisheries, benthic, plankton/entrainment and impingement studies was submitted to the NRC in July 1978, as required by the PNPS Appendix B Tech. Specs. Programs in these areas have been continued under the PNPS NPDES permit. Amendment #67 (1983) to the PNPS Tech. Specs. deleted Appendix B non-radiological water quality requirements as the NRC felt they are covered in the NPDES Permit.

The objectives of the Environmental Surveillance and Monitoring Program are to determine whether the operation of the PNPS results in measurable effects on the marine ecology and to evaluate the significance of any observed effects. If an effect of significance is detected, Boston Edison Company has committed to take steps to correct or mitigate any adverse situation.

These studies are guided by the Pilgrim Administrative-Technical Committee (PATC) which is chaired by a member of the Mass. Department of Environmental Protection in 1998 and whose membership includes representatives from the University of Massachusetts, the Mass. Department of Environmental Protection, the Mass. Division of Marine Fisheries, the National Marine Fisheries Service (NOAA), the Mass. Office of Coastal Zone Management, the U.S.

Environmental Protection Agency and Boston Edison Company. Copies of the Minutes of the Pilgrim Station Administrative-Technical Committee meetings held during this reporting period are included in Section IV.

B. Marine Biota Studies

1. Marine Fisheries Monitoring

Marine Fisheries studies in 1998 focus on winter flounder population parameters to develop an understanding of PNPS impact on this indicator species. Population estimates and adult equivalency analyses are conducted on this key species to help assess the impact of PNPS entrainment. Winter flounder are studied by techniques including trawling and tagging. Cunner population impact and rainbow smelt spawning enhancement efforts have been terminated in 1998.

Finfish observational dive surveys continue in 1998 for the Pilgrim Station thermal plume area. This monitoring involves periodic diving from May through October to document fish behavior and condition at various stations in close proximity to the discharge canal, and two discharge area dives in late December to record any heated water overwintering fishes.

Results of the marine fisheries monitoring during the reporting period are presented in Section IIIA.

2. Benthic Monitoring

The benthic monitoring described in this report was conducted by ENSR Consulting and Engineering, Woods Hole, Massachusetts.

Qualitative transect sampling off the discharge canal to determine the extent of the denuded and stunted zones is conducted three times in 1998 (March, June, and September). Results of the benthic monitoring reported during this period are discussed in Section IIIB.

3. Plankton Monitoring

Marine Research, Inc. (MRI) of Falmouth, Massachusetts, has been monitoring entrainment in Pilgrim Station cooling water of fish eggs and larvae, and lobster larvae (from 1973-1975 phytoplankton and zooplankton were also studied). Information generated through these studies has been utilized to make periodic modifications in the sampling program to more efficiently address the question of the effect of entrainment. These modifications have been developed by the contractor, and reviewed and approved by the Pilgrim A-T Committee on the basis of the program results. Plankton monitoring in 1998 emphasized consideration of ichthyoplankton entrainment and selected species adult equivalency analyses. Results of the ichthyoplankton entrainment monitoring for this reporting period are discussed in Section IIIC.

4. Impingement Monitoring

The Pilgrim Station impingement monitoring and survival program speciates, quantifies and determines viability of the organisms carried onto the four intake traveling screens. Since January 1979, Marine Research, Inc. has been conducting impingement sampling with results being reported by Boston Edison Company.

A new screen wash sluiceway system was installed at Pilgrim in 1979 at a total cost of approximately $150,000. This new sluiceway system was required by the U.S. Environmental Protection Agency and the Mass. Division of Water Pollution Control as a part of NPDES Permit #MA0003557.

Results of the impingement monitoring and survival program for this reporting period are discussed in Section IIID.

C. Station Operation History

PNPS was in a high operating stage from January - June 1998 (98% capacity). Cumulative capacity factor from 1973 - 1997 is 54.4%. Capacity factors for the past 15 years are summarized in Table 1.

D. 1998 Environmental Programs

A planning schedule bar chart for 1998 environmental monitoring programs related to the operation of Pilgrim Station, showing task activities and milestones from December 1997 - June 1999, is included.

Table 1. PILGRIM NUCLEAR POWER STATION UNIT 1 CAPACITY FACTOR USING MDC NET% (Roughly approximates thermal loading to the environment 100%=32 Degrees F Δ T)

Month	1997	1996	1995 *	1994 *	1993	1992	1991	1990	1989	1988 *	1987 *	1986	1985	1984 *	1983
January	92.5	92.1	99.1	98.8	99.0	96.6	95.4	99.4	0.0	0.0	0.0	79.5	54.0	0.0	98.0
February	42.1	99.4	96.3	72.5	96.7	99.4	88.9	97.4	0.0	0.0	0.0	97.7	59.3	0.0	90.0
March	0.0	99.3	74.4	79.5	83.2	80.4	84.6	30.0	10.7	0.0	0.0	26.9	81.8	0.0	97.3
April	21.4	75.9	0.0	63.3	6.4	53.5	92.7	5.4	10.5	0.0	0.0	11.9	90.8	0.0	89.7
May	97.4	98.2	0.0	94.5	0.4	97.8	0.0	77.9	4.6	0.0	0.0	0.0	94.3	0.0	97.3
June	98.1	94.3	65.1	97.2	77.5	97.8	0.0	96.3	16.4	0.0	0.0	0.0	85.0	0.0	66.2
July	95.5	95.3	95.7	97.6	80.3	97.4	0.0	55.1	28.6	0.0	0.0	0.0	96.9	0.0	80.5
August	96.4	92.3	97.7	88.2	86.9	97.4	28.5	94.5	50.8	0.0	0.0	0.0	96.5	0.0	83.1
September	97.4	51.4	96.7	0.0	84.8	94.1	96.4	21.6	52.5	0.0	0.0	0.0	71.4	0.0	86.5
October	98.7	94.0	94.3	0.0	98.0	72.8	94.2	98.7	30.1	0.0	0.0	0.0	95.4	0.0	79.0
November	69.5	94.9	99.5	0.2	80.0	13.7	23.7	96.8	66.0	0.0	0.0	0.0	88.1	0.0	78.6
December	68.8	97.7	98.8	87.7	94.8	65.2	98.1	94.5	77.1	0.0	0.0	0.0	99.1	0.7	18.1
ANNUAL%	73.4	90.5	76.4	65.2	74.0	80.6	58.4	72.3	28.9	0.0	0.0	17.5	84.4	0.1	80.3

CUMULATIVE CAPACITY FACTOR (1973-1997) -= 54.4%

_____ = outages >2 months

*= NO CIRCULATING SEAWATER PUMPS IN OPERATION FROM 27 MARCH - 13 AUGUST, 1984
= NO CIRCULATING SEAWATER PUMPS IN OPERATION FROM 18 FEBRUARY - 8 SEPTEMBER, 1987
= NO CIRCULATING SEAWATER PUMPS IN OPERATION FROM 14 APRIL - 5 JUNE, 1988
= NO CIRCULATING SEAWATER PUMPS IN OPERATION FROM 9 OCTOBER - 16 NOVEMBER, 1994
= NO CIRCULATING SEAWATER PUMPS IN OPERATION FROM 30 MARCH - 15 MAY, 1995

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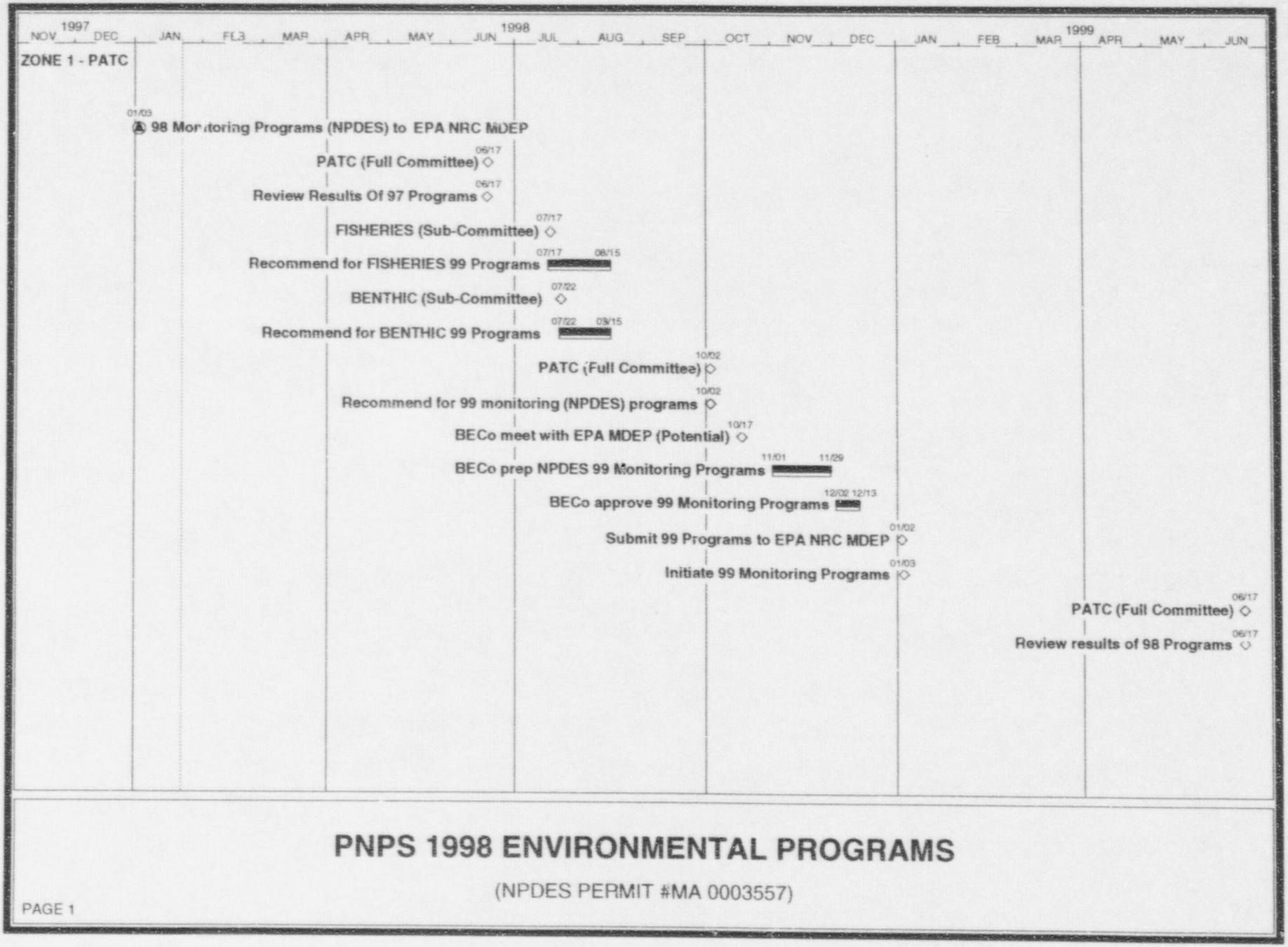
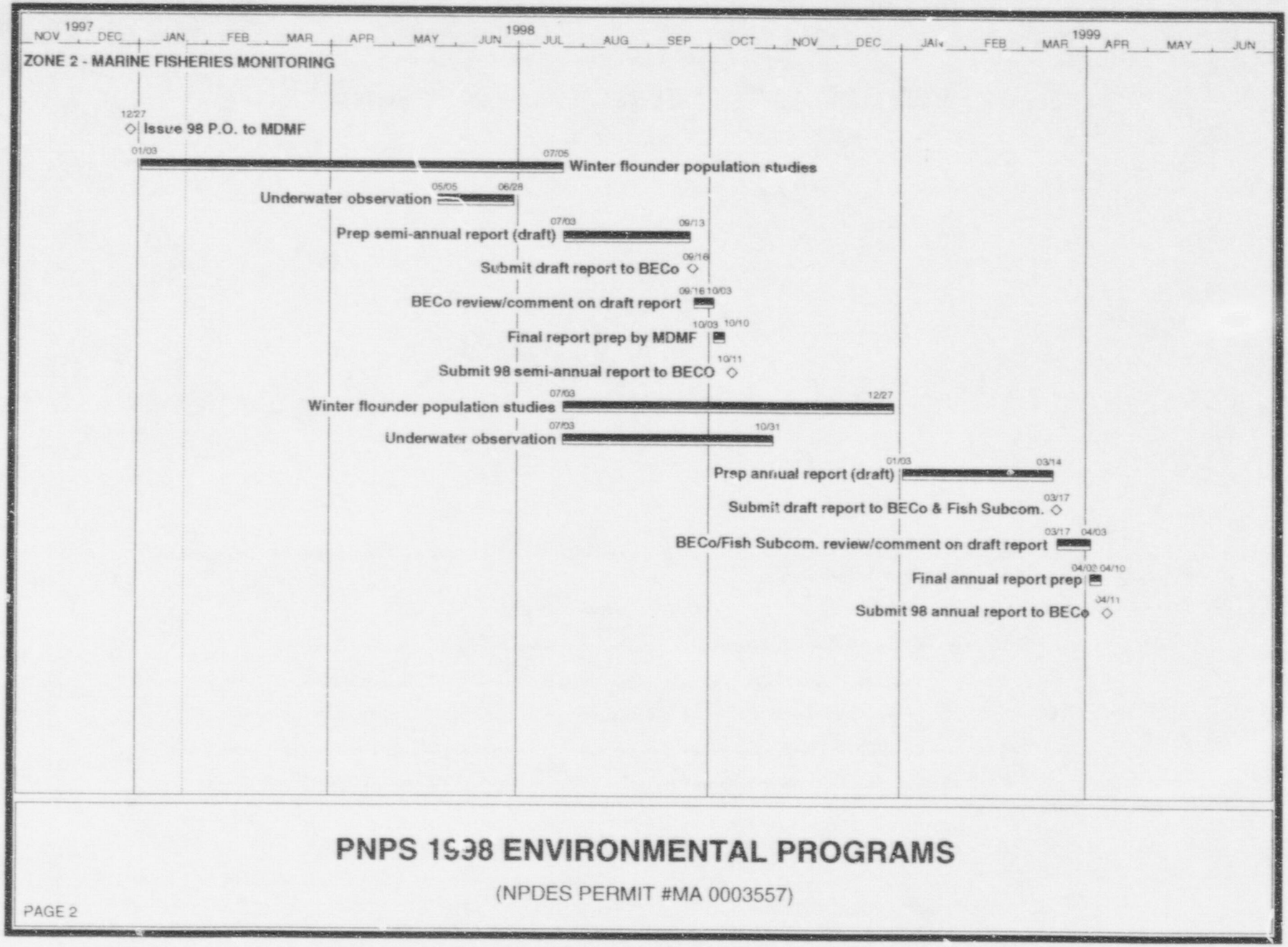


PNPS 1998 ENVIRONMENTAL PROGRAMS

(NPDES PERMIT #MA 0003557)



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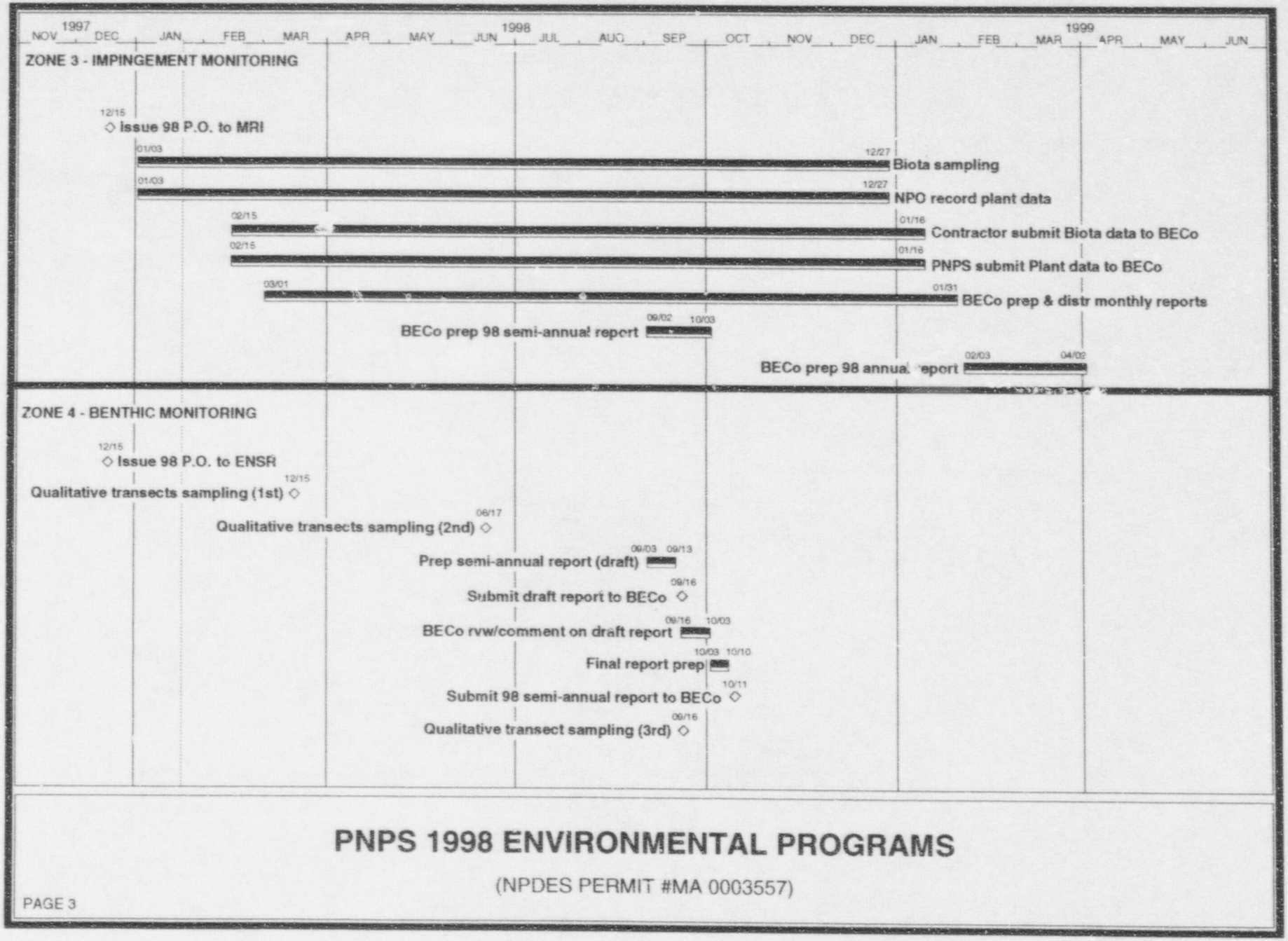

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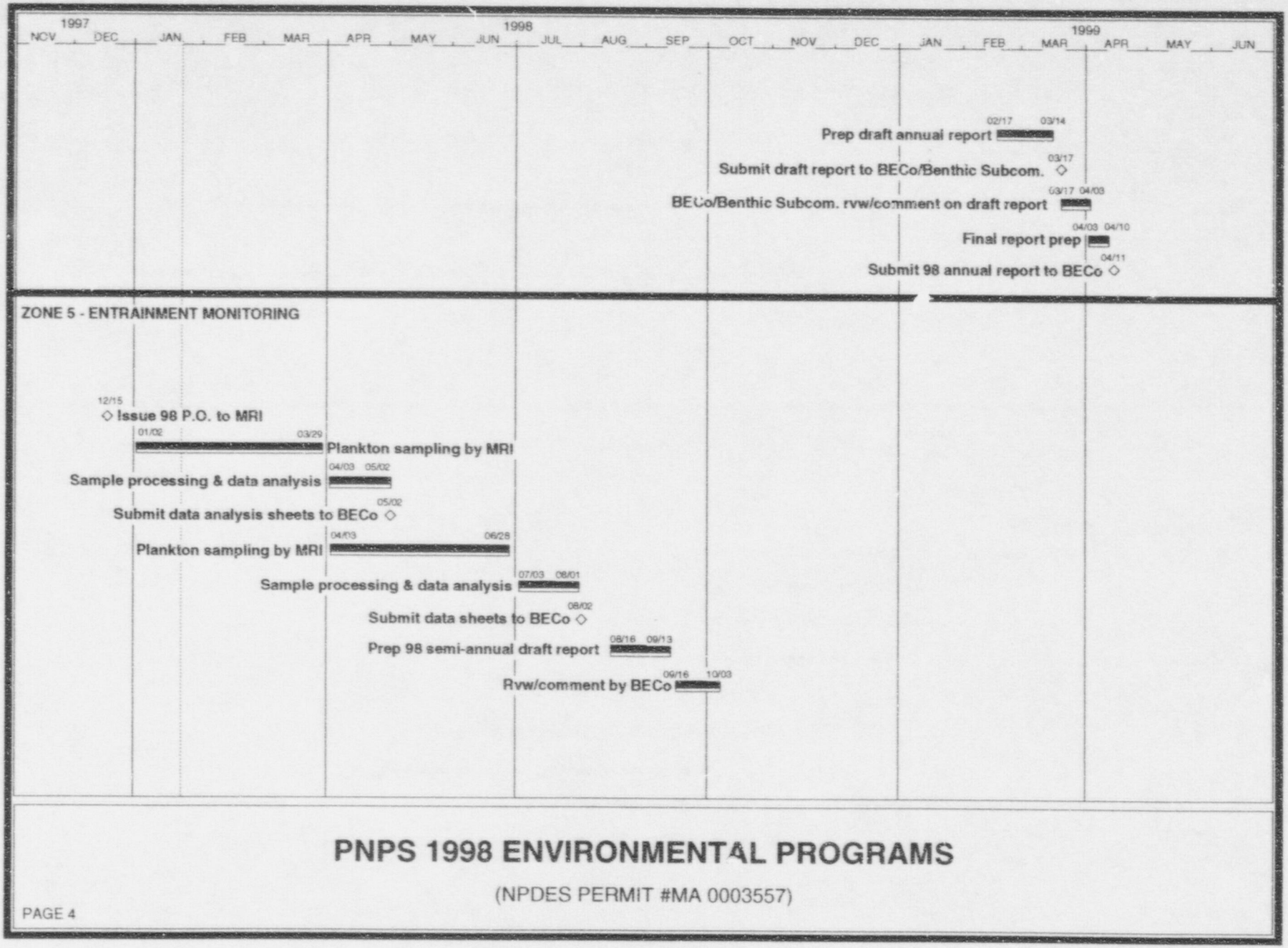

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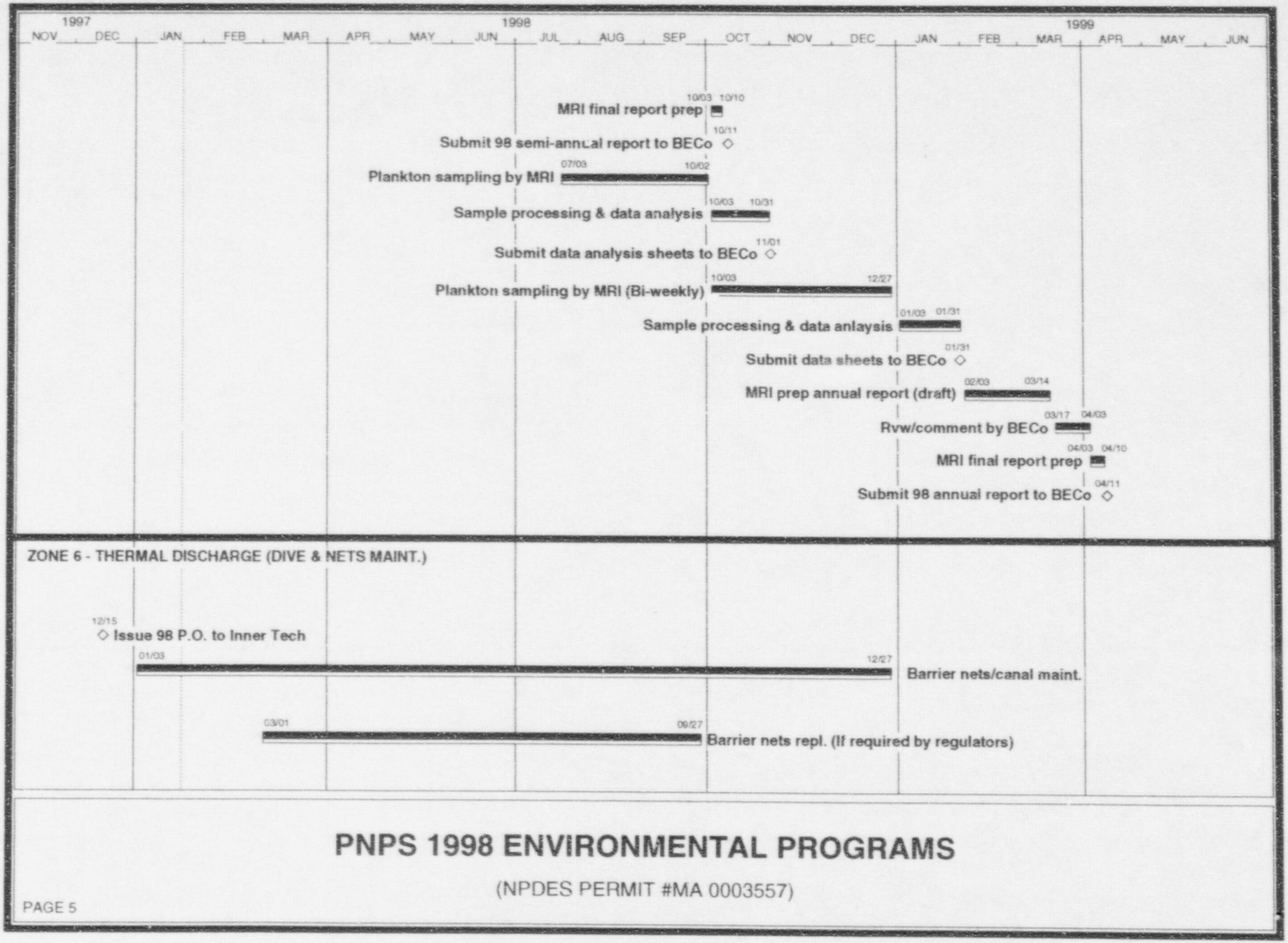

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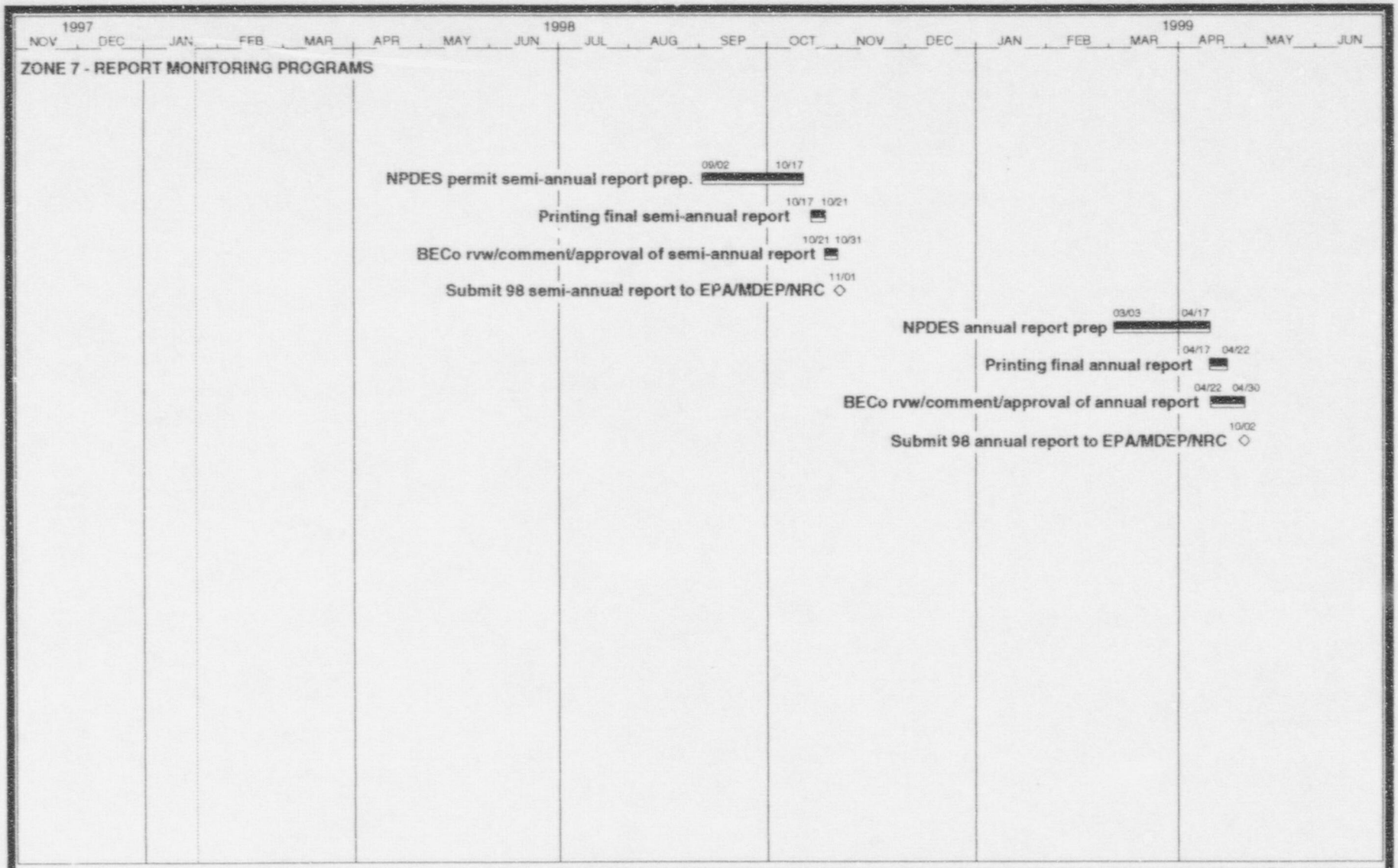

PNPS 1998 ENVIRONMENTAL PROGRAMS

(NPDES PERMIT #MA 0003557)

SEMI-ANNUAL REPORT ON ASSESSMENT AND MITIGATION OF IMPACT OF THE PILGRIM NUCLEAR POWER STATION ON FINFISH POPULATIONS OF WESTERN CAPE COD BAY

Project Report No. 65 (January to June 1998)

By

Robert Lawton, Brian Kelly,
Vincent Malkoski, John Boardman

1 October 1998
Massachusetts Department of Fisheries,
Wildlife, and Environmental Law Enforcement
Division of Marine Fisheries
100 Cambridge Street
Boston, Massachusetts 02202

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I. EXECUTIVE SUMMARY

Winter Flounder Population Study

We continued studies to characterize the local winter flounder (*Pleuronectes americanus*) population. Our objectives have been to define discreteness (fidelity to natal waters) of the local population and to estimate absolute abundance.

Between 17 March and 9 May 1998, we completed 366 trawl tows employing two contracted commercial fishing vessels, the F/V *Frances Elizabeth* and the F/V *Alosa*. A total of 30,307 winter flounder was sampled and about 7,500 were tagged. Of 631 tagged fish recaptured during our field sampling, 498 were tagged in 1998, 116 in 1997, 14 from 1996, and 3 from 1994/95.

Smelt Restoration

The Division of Marine Fisheries continued smelt restoration work without funding from Boston Edison Company. The objective was to enhance the quality of spawning habitat in the Jones River, which hosts the major smelt spawning run in the Plymouth area. We placed 69 egg collecting trays (filled with sphagnum moss) into the Jones River to collect the naturally spawned smelt eggs. Past studies have shown that smelt egg deposition is higher on vegetation, and egg survival to hatching can be up to ten times higher on plant material than on hard bottom.

Recreational Fishery

Creel data for 50 sampling days were collected at the Pilgrim Station Shorefront to monitor the sportfishery there. Striped bass (Morone saxatilis) and bluefish (Pomatomus saltatrix) were caught, totaling 450 individuals.

Observational Dive

There were no observational dives completed in the discharge prior to July 1, 1998.

II. INTRODUCTION

Ecological work in the marine environment off Pilgrim Nuclear Power Station is being conducted to assess and remediate negative impacts of power plant operation. Investigations are being conducted by the Power Plant Team of the Massachusetts Division of Marine Fisheries (MDMF), focusing on two key finfish populations (winter flounder and rainbow smelt) in the waters (coastal zone) of lower Massachusetts and Cape Cod Bays. Funded by Boston Edison Company under Purchase Order No. LSP009110 in 1998, this work is ongoing.

In this half-year report, methodology and progress on existing programs undertaken from January through June 1998 are discussed. Measurements, counts, indices, and visual observations are used to report preliminary results and accomplishments through the first half of 1998.

III. METHODS AND PRELIMINARY FINDINGS

1. WINTER FLOUNDER POPULATION STUDY

To assess the magnitude of impact of larval winter flounder entrainment at Pilgrim Station, we are studying winter flounder. Our objectives are to define discreteness (fidelity to natal waters) of the local population and to estimate absolute abundance of adults.

We contracted two commercial fishing vessels, the F/V *Frances Elizabeth* and the F/V *Alosa*, to sample winter flounder, both for mark and recapture purposes and to estimate flounder density. The study area , which is partially depicted in Figure 1, extended from Boston Harbor to Provincetown, from nearshore (9.2 m MLW) out to the 36.6 m (MLW) depth contour. The trawl gear used on the two vessels will be described in the 1998 annual report.

Winter flounder were enumerated, measured (length), and sub-samples assessed for sex and reproductive state (maturity) before being released near capture sites. In addition, flounder ≥ 280 mm in total length (TL) on the spawning grounds were marked with green Petersen disc tags. Data also were collected on net geometry and the trawl distance of each tow. We will generate independent estimates of population size via mark and recapture and by an area-swept approach (density extrapolation).

Between 17 March and 9 May 1998, we completed 366 trawl tows in the field portion of the study. Tow duration averaged 30 minutes. A total of 30,307 winter flounder was sampled, with about 7,500 tagged. Of the 631 tag returns we obtained during our own field sampling, 498 were 1998 fish, 116 were fish at large one year, 14 were at large two years, and 3 were tagged in the 1994-95 period.

An in-depth analysis of recaptures is being undertaken and will be completed when tag return data have been collected through the end of 1998. The results will appear in the next annual report, which will include information on movements, recapture locations, discreteness of the local population, and population estimates derived from both density extrapolation and mark and recapture techniques.

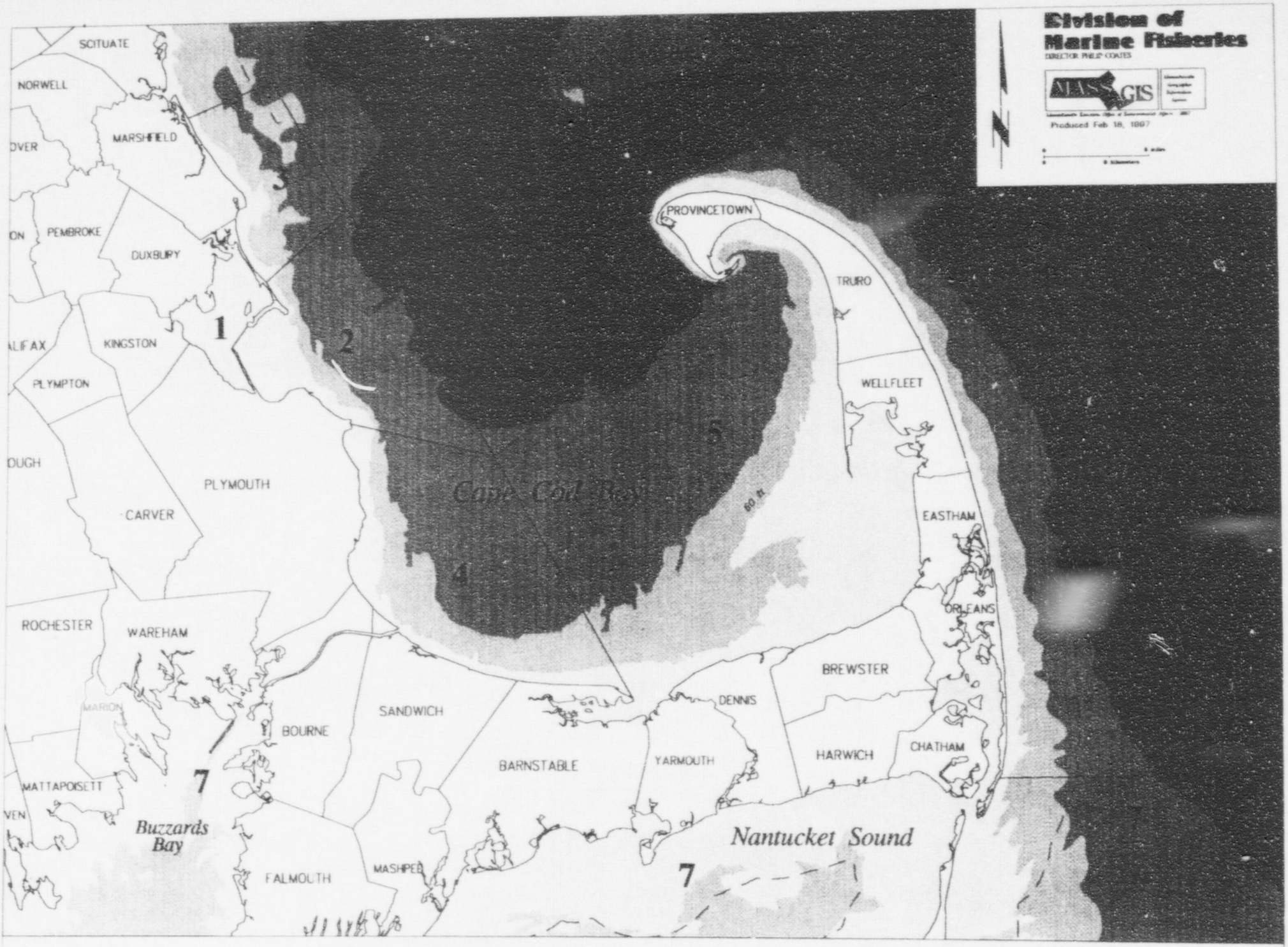

Figure 1. Recapture zones of winter flounder (Pleuronectes americanus) tagged in areas 1 – 3 by the MA Division of Marine Fisheries in the decade of the 1990's.

2. SMELT RESTORATION

The goal of our 1998 smelt project was to enhance the quantity of quality smelt spawning habitat in the Jones River, a tributary to Plymouth, Kingston, Duxbury Bay (PKDB). We placed 69 egg collecting trays in the upper smelt spawning area of the Jones River for the period March 24 through May 20, 1998. The trays collect the naturally spawned, demersal, adhesive smelt eggs, providing an ideal habitat for egg protection and development. The sphagnum moss filling the trays provides a three dimensional depositional surface. The moss represents a micro-environment that offers protection for the developing embryos, reducing 'egg turnover' loss. Water can seep into the moss, carrying away metabolic wastes and providing a continuous supply of oxygen to the eggs.

Sphagnum has consistently collected higher egg sets than natural hard abiotic bottom. The smelt spawning ground in the Jones River is comprised largely of hard substrate (sand, gravel, and cobble). Natural aquatic vegetation provides ideal substrate for egg development but only covers a small portion of the spawning ground. In addition, Sutter (1980) reported smelt egg survival to hatching was about 10% on vegetation but only 1% on hard surfaces. .

The 1998 smelt egg set in the Jones River most likely was the best of the decade. Areas containing more than 50 eggs per square inch would be considered heavy sets, while 20 to 50 per square inch would be considered moderate sets. The majority of available spawning habitat in Zone A and upper third of Zone B was utilized for egg deposition (Figure 2). This section of the river generally was covered by moderate to heavy egg

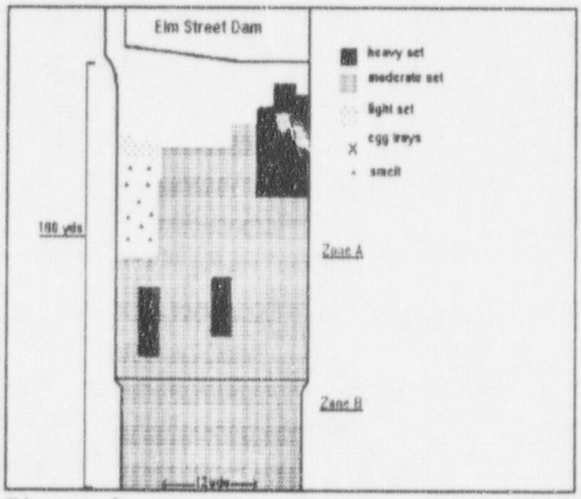

Figure 2. Smelt egg density within Zones A&B of the Jones River habitat enhancement area 1998.

sets. Egg patches of varying densities also could be found throughout the lower two thirds of Zone B down to the Route 6A bridge. Most of our egg collecting trays in Zone A were covered with a single layer of eggs. With no major storms occurring, conditions in the Jones River were favorable for successful spawning. The river was free of obstructions, and a good flow existed with many riffle areas observed, which dispersed the eggs and prevented their aggregation in one area. The long filamentous macro-algae, which likely reduces water flow to the developing eggs and has been a problem in years past, was not prevalent this year.

A large aggregation of adult smelt was observed in the Jones River during two of our daytime trips to the river (April 14 and 17). The fish were congregated in a pool in Zone A (Figure 2). Based on past observations, this occurrence is usually indicative of a relatively strong spawning run. These fish were likely males, with females moving onto the spawning ground during the evening hours (Lawton et al. 1990).

During the 1998 spawning season, Eel River, Town Brook, and Smelt Brook (other tributaries in the PKDB complex) were inspected weekly for egg deposition. We sampled areas of known spawning activity based on past observations. Town Brook and Smelt Brook contained small patches of light egg sets. We did not find any eggs in Eel River for the second year in a row. The majority of smelt spawning activity for the local PKDB smelt population again occurred in the Jones River.

3. RECREATIONAL FISHERY

Creel data were collected from April to June 1998 by seasonal public relations' personnel of Boston Edison Company at the Pilgrim Station Shorefront. Data were obtained primarily on weekends in April and May, then daily through June. Information was recorded on survey forms for 50 sampling days to assess sportfishing effort, catch by species, and areas where fish were landed. As to fishing location, the major concentration of anglers occurred on the north and south discharge canal jetties.

Between 4 April and 30 June, 1,004 anglers were recorded at Pilgrim Shorefront, of which 662 were interviewed. Shorefront personnel interviewed all anglers up to a total of 20 individuals in the course of a day.

If there were more than 20 anglers, the estimated numbers of fish caught that particular day were obtained by expanding the catch of the anglers interviewed. Only two species reportedly were caught: striped bass (*Morone saxatilis*) and bluefish (*Pomatomus saltatrix*). There were 450 recorded catches of these species during the spring survey- 165 bluefish and 285 striped bass [269 sublegal and 16 legal ($\geq$ 28 inches T.L.)]. However, landings of sublegal striped bass were not always recorded prior to June 7; thus, the total catch of striped bass is under-reported.

4. OBSERVATIONAL DIVE

There were no observational dives completed in the discharge area prior to July 1, 1998.

IV. ACKNOWLEDGMENTS

We appreciate the guidance of Robert D. Anderson of Boston Edison Company, W. Leigh Bridges of the Division of Marine Fisheries (DMF), and the Pilgrim Administrative-Technical Committee, specifically for their input on study programs. We also are grateful to the crews of the commercial fishing boats F/V *Frances Elizabeth* and the F/V *Alosa* for their expertise and assistance with the flounder tagging program, and to numerous DMF employees for assistance, especially Steven Correia. In addition, we wish to thank Mr. Al Hardy and his Conservation Engineering students at Silver Lake Regional High School for clearing obstructions from the Jones River to provide unobstructed passage for smelt and other anadramous fish on their spawning runs.

VI. LITERATURE CITED

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Sutter, F. C. 1980. Reproductive biology of anadromous rainbow smelt, *Osmerus mordax*, in the Ipswich Bay area, Massachusetts. M.S. Thesis, Univ. of Mass., Amherst. 49 pp.

EXECUTIVE SUMMARY

This report presents results of qualitative surveys of benthic algae in the thermal effluent of the Pilgrim Nuclear Power Station (PNPS) that were completed in March and June 1998. These investigations represent the most recent phase of long-term efforts to monitor effects of the thermal effluent on the benthic algal communities within and just offshore of the PNPS discharge canal. Field survey techniques were identical to those used in previous investigations.

The underwater profile of the jetties has changed somewhat over the years. Storms have moved some boulders away from the jetty to positions closer to the central transect line. For the sake of maintaining consistency in calculations of the area of the *Chondrus* denuded zone, the same base dimensions of the jetty that have been used in figures for this report for many years, are continued for the current surveys. A few boulders normally encountered by the divers near the 30-m mark are indicated in both survey maps.

The qualitative transect studies performed to evaluate the *Chondrus crispus* community in the thermal plume area indicated that the March 1998 denuded (1437 m^2) and totally affected zones (2112 m^2) were both still slightly larger than the historical baselines (maximum size recorded for all spring surveys through 1995). This is not surprising, considering how widespread the affected areas were last year, even in December. However, the size of the denuded zone in March was smaller than in either of the two preceding spring surveys. By June 1998, both the denuded and totally affected zones were smaller than those seen in June 1996 or 1997, and smaller or equal to the baselines. The *Chondrus* denuded zone (1738 m^2) was 5% smaller than the June 1990 baseline (1835 m^2) and the totally affected area (2136 m^2) was approximately equal to the June 1990 baseline (2135 m^2). The *Chondrus* denuded and totally affected areas seem to have recovered from the enormous impact seen last year, particularly in the fall, but remain large possibly due to a combination of enormous numbers of juvenile mussels settling in the area in late winter, a warm winter, and the high plant capacity in effect from May 1997 through May 1998 when the plant operated at over 95% capacity for ten out of thirteen months (mean = 93%).

As in many prior summer surveys (1990 and 1992-1997), a dense mat of juvenile blue mussels (*Mytilus edulis*) was seen throughout the monitoring area. Mussels settled very early this year, prior to the March 2 survey, and by June had grown to 5-30 mm in length and covered most of the totally affected area.

1.0 INTRODUCTION

This report represents a continuation of long-term (25 yr) benthic studies at Pilgrim Nuclear Power Station (PNPS) that are intended to monitor the effects of the thermal effluent. The 1998 qualitative monitoring program is identical to that performed since 1980 and consists of SCUBA surveys of algal cover in the thermal plume of the effluent within and beyond the discharge canal (Figure 1). Surveys are conducted quarterly during March, June, September, and December. This Semi-Annual Report includes qualitative observations recorded in March and June 1998. Work was performed under Boston Edison Co. (BECo) Purchase Order LSP009647 in accordance with requirements of the PNPS NPDES Permit No. MA 0003557.

2.0 METHODS

The qualitative algal survey is performed by SCUBA divers in the same location and with the same techniques that have been used since the present monitoring program began, approximately 17 years ago. The effluent area is surveyed by two or three SCUBA-equipped biologists operating from a small boat. To ameliorate the effect of the powerful outflowing current upon the divers it is critical that the survey occur near the time of high tide; the divers generally begin the survey at or within an hour of high tide and are finished an hour later. For the qualitative transect survey, observations are made along the axis of the discharge canal. A line is stretched across the mouth of the discharge canal (Figure 2). A weighted central transect line (CTL), marked at 10-m intervals, is then attached to the center of this line and deployed along the central axis of the canal to a distance of 100 m offshore. Using a compass, divers extend a 45-m (increased from 30-m for the 1997 dive season) measuring line, marked at 1-m intervals, perpendicular to the CTL at each 10-m mark. A diver swims along this third line, recording changes in algal cover from the CTL through the denuded and stunted *Chondrus* areas, until the algal cover looks normal.

The terminology established by Taxon (1982) and followed in subsequent years uses the growth morphology of *Chondrus crispus* to distinguish between "denuded" and "stunted" zones. The **denuded zone** is the area in which *Chondrus* occurs only as stunted plants restricted to the sides and crevices of rocks. In this area, *Chondrus* is found on the upper surfaces of rocks only where the microtopography of the rock surfaces creates small protected areas. In the **stunted zone**, *Chondrus* grows on the upper surfaces of rocks but is noticeably inferior in height, density, and frond development compared to plants growing in unaffected areas. In 1991 the divers began to discriminate between a stunted zone and a "sparse" zone. The **sparse zone** is an area with normal-looking *Chondrus* plants that are very thinly distributed. The **normal zone** begins at the point where *Chondrus* height is fully developed and density reaches the ambient concentration.

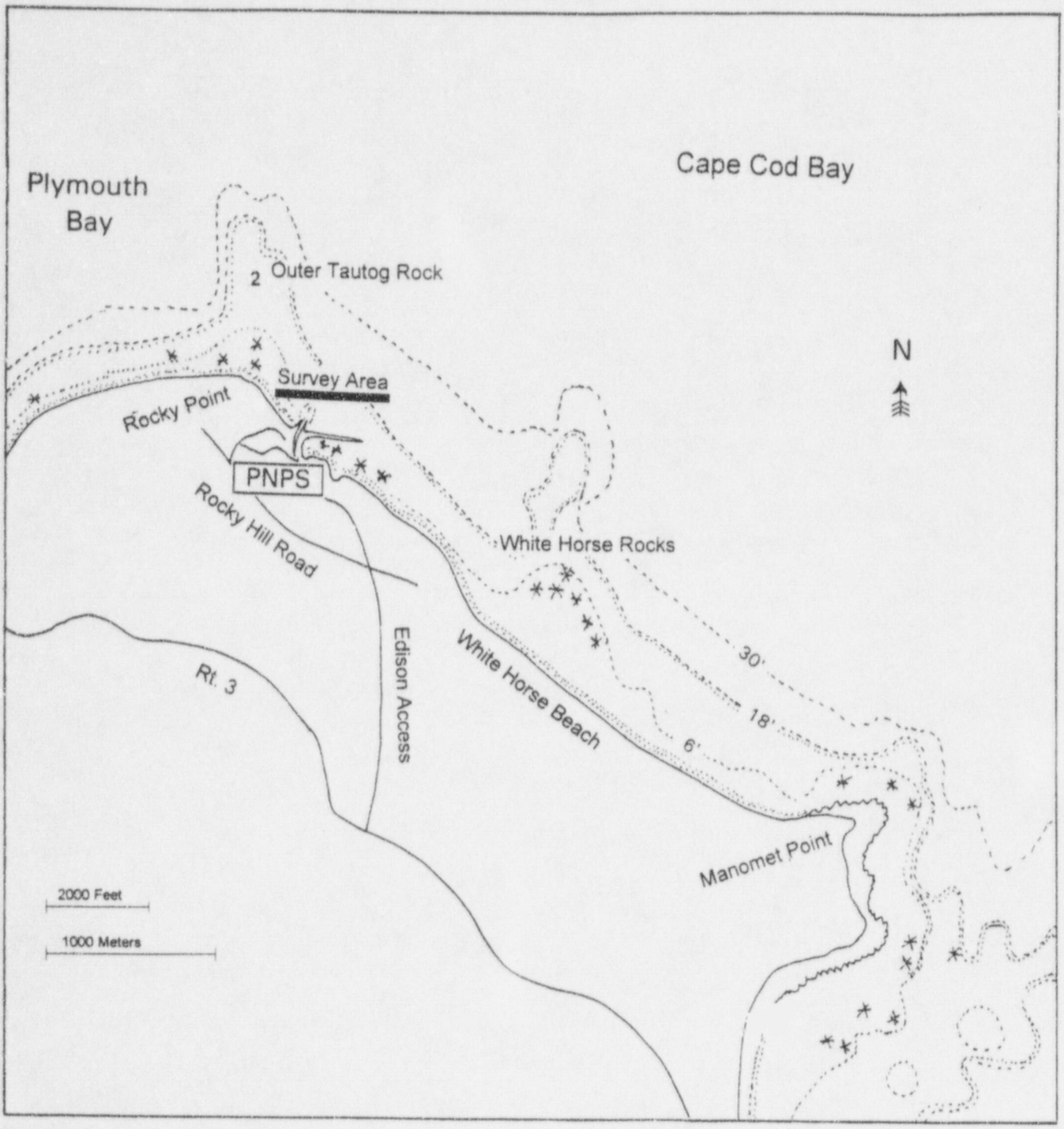

Figure 1. **Location of Pilgrim Nuclear Power Station Qualitative Algal Survey Area.**

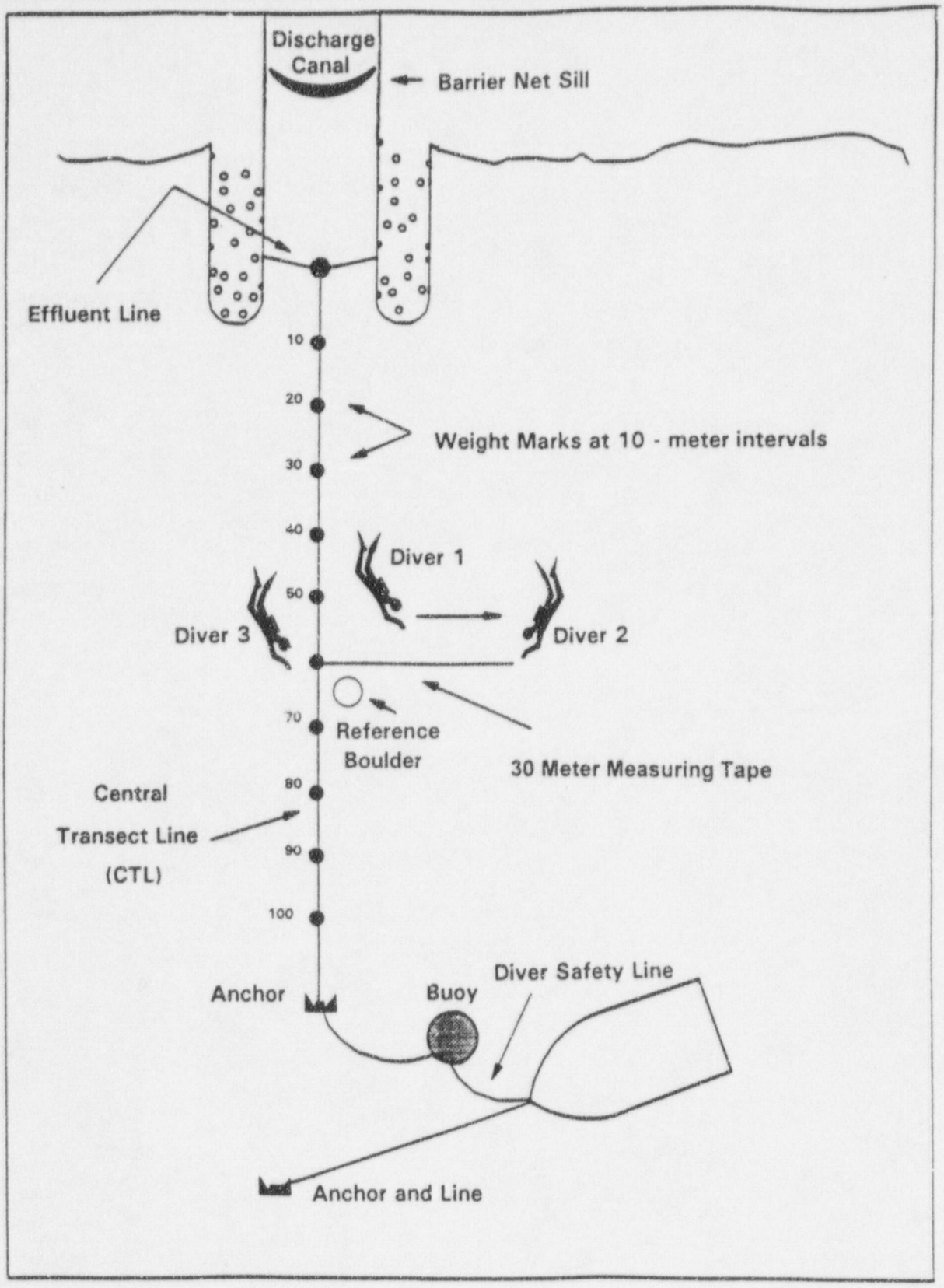

Figure 2. Design of the Qualitative Transect Survey.

The dive team must keep in mind while taking measurements that the shallow depths northwest of the discharge canal hamper normal *Chondrus* growth. In addition to evaluating algal cover, the divers record any unusual occurrences or events in the area, such as results of unusually strong storms, and note the loc tion of any distinctive algal or faunal associations.

3.0 RESULTS

Qualitative transect surveys of acute nearfield impact zones began in January 1980 and have been conducted quarterly since 1982. Two surveys were performed (March 2 and June 11) during the current reporting period, bringing the total number of surveys conducted since 1980 to 68. Results of surveys conducted from January 1980 to June 1983 were reviewed in Semi-Annual Report 22 to BECo (BECo, 1983). A summary of surveys conducted between 1983 and 1997, including a review of the four surveys performed in 1996, was presented in Semi-Annual Report No. 51 (BECo, 1997). Detailed results of the mapping surveys conducted in March and June 1998 are presented in the next two sections.

3.1 MARCH 1998 TRANSECT SURVEY

The denuded and sparse *Chondrus crispus* areas mapped on March 2, 1998, immediately offshore of the PNPS, are shown in Figure 3. The extent of mussel coverage is indicated by **M**'s placed at the outside border of the mussel encrusted area; the percentage of substrate covered is indicated in parentheses. A large boulder that is nearly exposed at mean low water, and that is used as a landmark by both the ENSR and Massachusetts Division of Marine Fisheries dive teams, is plotted in the figure. The denuded zone is essentially devoid of *Chondrus*, whereas sparse zones have normal-looking *Chondrus* that is thinly distributed.

In March 1998, the *Chondrus* denuded zone (1437 m^2) was 23% smaller than in spring 1996 and 14% smaller than in March 1997 but still larger than measured during all other previous spring surveys. The *Chondrus* denuded area was 8% larger than the historical spring baseline of 1321 m^2 seen in March 1991. The typical asymmetrical distribution of the denuded zone around the central transect line was seen with a pronounced bulge to 24 m north of the CTL at the 70-m mark on the transect line; 56% of the denuded *Chondrus* area was north of the transect line. At its furthest extent the denuded zone extended to 93 m along the transect line. The sparse and stunted *Chondrus* zones measured in March 1998 (675 m^2) together were 57% larger than in March 1997 but still well within the range (90 - 901 m^2) encountered during prior spring surveys. The sparse and stunted areas occurred as thin strips southeast of the denuded zone but formed a thicker band north of the denuded zone. The totally affected area (2112 m^2) was 40% smaller than it had

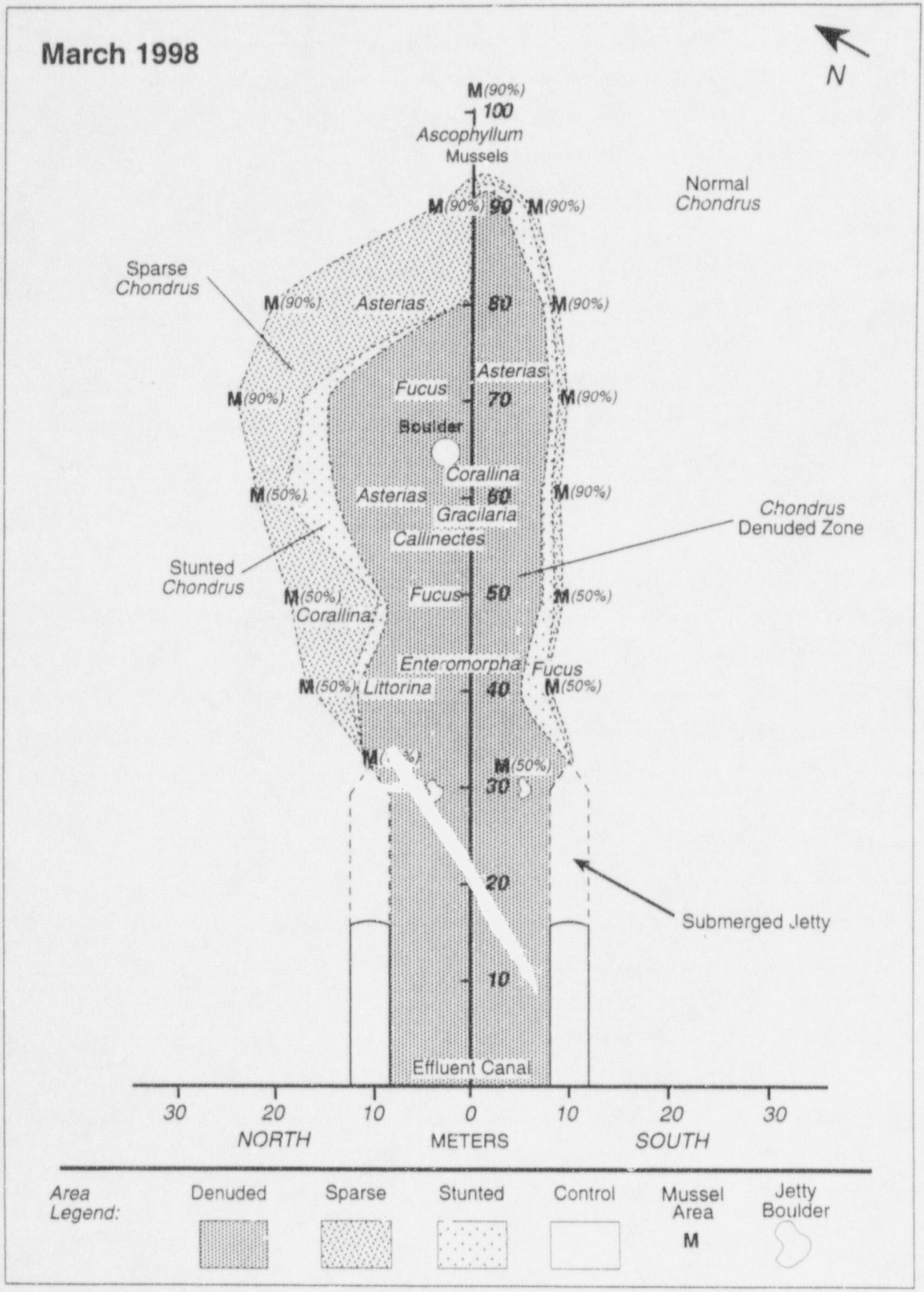

Figure 3. Denuded, Sparse, and Stunted *Chondrus* Zones Observed in March 1998.

been during the previous survey in December 1997, 1% larger than in the 1997 spring survey, and 4% larger than measured in April 1983, the historical spring baseline for the total affected zone.

The *Chondrus* plants that occurred outside of the affected area were colorful and healthy. *Gracilaria*, an alga indicative of warmer water, was seen at the 60-m mark. A variety of other algal species were seen along the CTL, including *Enteromorpha*, *Fucus*, and *Corallina*. *Ascophyllum* was present beyond the affected zone near the 100-m mark on the CTL. An extensive set of the blue mussel, *Mytilus edulis*, had already taken place by March 2, earlier than in previous years, a phenomenon perhaps accelerated by our anomalously warm winter. Juvenile mussels, from 1-5 mm in length, were common over the entire length of the CTL, covering about 10% of available hard substrate near the 30-m mark, and increasing to cover about 90% of hard substrates and open sandy bottom toward the distal end of the transect. These mussels were responsible for the almost complete epiphytization of *Chondrus*, in contrast to the coverage seen in April 1996 when the mussels only epiphytized the base and edges of the plants. Juvenile (3-8 cm diameter) starfish, *Asterias forbesii*, a naturally co-occurring mussel predator were abundant throughout the affected region. Other invertebrates seen included: the common periwinkle, *Littorina littorea*; one blue crab, *Callinectes sapidus*; and the colonial anemone, *Epizoanthus incrustatus*. No fish or lobsters were seen.

3.2 JUNE 1998 TRANSECT SURVEY

Results of the divers' survey for June 11, 1998 are mapped in Figure 4. The 30-m line could not be surveyed due to surface turbulence. The extent of coverage by juvenile (5-30 mm long) mussels is indicated by **M**'s placed at the outside border of the mussel encrusted area; the region with 100% mussel coverage was very nearly coincident with the totally affected *Chondrus* area. Large mussels sets have been observed in many prior June surveys (e.g. every year, except 1991, since 1990).

The *Chondrus* denuded zone and totally affected areas were smaller this summer than observed during the past two summer surveys. The area (1738 m^2) of the denuded zone was 21% larger than that measured in March 1998, 31% smaller than that seen in June 1997, and 5% less than the summer historical baseline of 1835 m^2 observed in June 1990. The pattern of denudation was anomalous. The denuded zone extended relatively much further to the south than usual with three-quarters of the denuded zone and totally affected areas south of the CTL. The demarcation between the denuded zone and normal *Chondrus* was also different on the two sides of the CTL. The southern edge had a sharp border between denuded and normal *Chondrus* everywhere beyond the 50-m mark on the CTL while the entire northern border had a strip of stunted and sparse *Chondrus* dividing denuded and normal *Chondrus*. At its furthest, the denuded zone extended out to the 92-m mark on the CTL and laterally reached to 26 m from the transect line at the 60-m

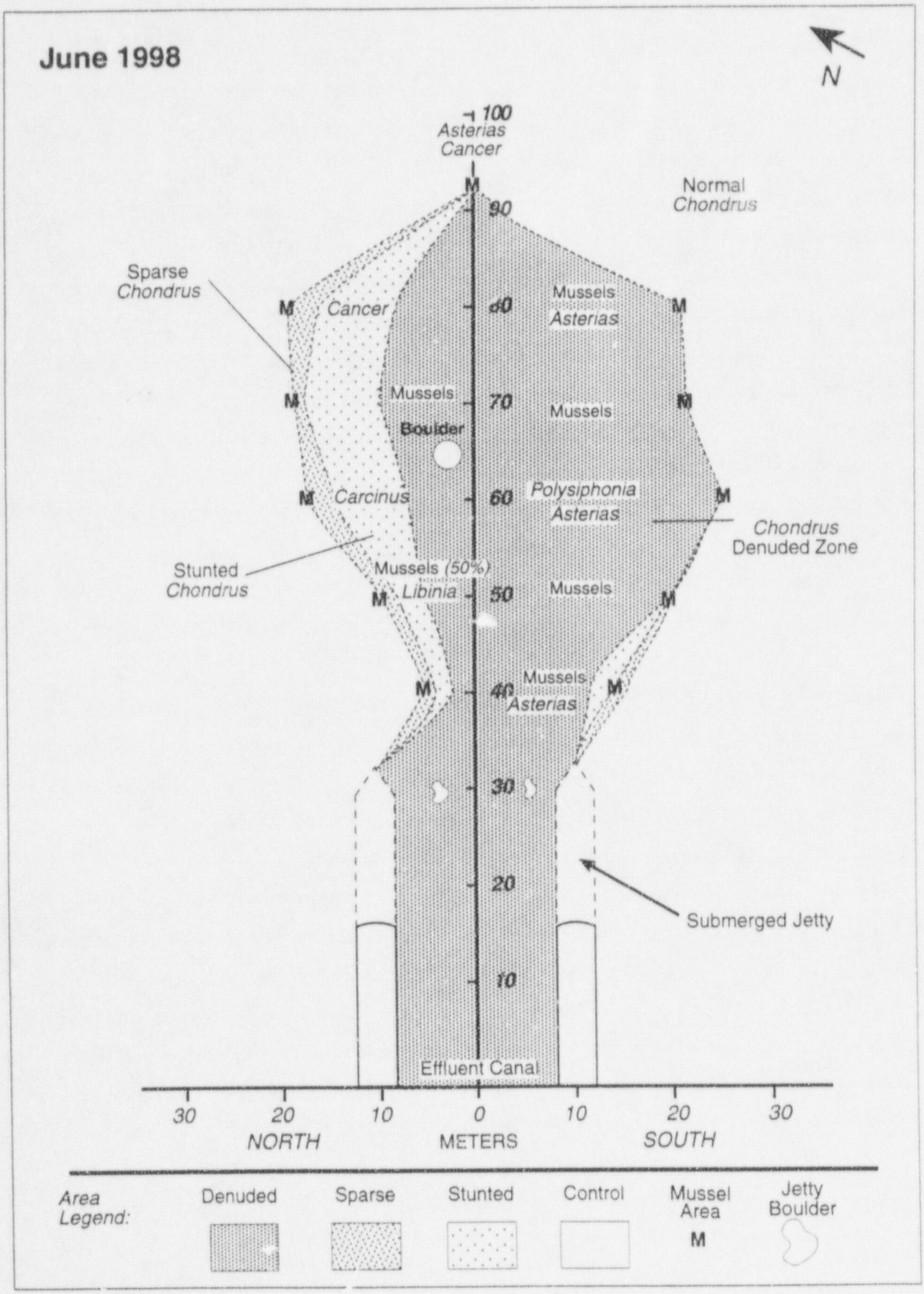

Figure 4. Denuded, Sparse, and Stunted *Chondrus* Zones Observed in June 1998.

mark to the southeast. The area occupied by sparsely distributed and stunted *Chondrus* plants (398 m^2) was 41% smaller than seen in March 1998 (675 m^2) and 73% smaller than recorded for June 1997. The total affected area (2136 m^2) was 1% larger than in March 1998, was nearly half the size measured the previous June, and approximately the same size as the historical summer baseline of 2135 m^2 measured in June 1990.

Very few algal plants were seen. Even identification of *Chondrus* plants could be verified only after removing the mussels. One area of the red alga, *Polysiphonia*, was seen along the 60-m transect line. Juvenile blue mussels were common out to about the 90-m mark, covering nearly 100% of the available hard substrate from the 30 to 90-m marks. At the distal end of the survey the mussels also covered all of the open sandy bottom with the basal threads securing each mussel to its' nearest neighbor(s). The mussel mat was described by the divers as a shag carpet that was not fastened to the flooring, a thick and only loosely secured mat that in places had been torn away by the outflowing current. The common starfish, *Asterias forbesii*, a mussel predator, was abundant throughout the affected area, represented by juveniles ranging from 5-10 cm in diameter. Fish seen included: winter flounder (*Pleuronectes americanus*) and a school of striped bass (*Morone saxatilis*). Several species of crabs were present: rock crabs (*Cancer borealis*), green crabs (*Carcinus maenas*), and spider crabs (*Libinia* sp.).

4.0 DISCUSSION

The configuration of the *Chondrus crispus* denuded zone that may extend more than 100 m beyond the discharge canal is readily apparent to SCUBA divers and is easily mapped for the qualitative transect survey. The stunted and sparse zones are somewhat less obvious but in March and June 1998 were readily delineated. The areal dimensions of the *Chondrus* denuded zone for the 1998 spring survey was reduced in size compared to those measured in the springs of 1996 and 1997 but still somewhat larger (8%) than the historical baseline. The sizes of the *Chondrus* denuded and totally affected zones for the 1998 June survey were both smaller than observed in the June surveys of 1996 and 1997. The totally affected area in June was approximately the same as the June 1990 historical baseline while the denuded zone was 5% smaller than the June 1990 baseline. As has often been observed in previous summer surveys (e.g. every year since 1990 except for 1991), a dense mussel mat was present in June 1998; the juveniles settled prior to March 2 and by June 11 had reached 5 to 30 mm in length and covered nearly 100% of the totally affected *Chondrus* zone.

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FINAL
SEMI-ANNUAL REPORT
Number 52

BENTHIC ALGAL MONITORING AT THE PILGRIM NUCLEAR POWER STATION (QUALITATIVE TRANSECT SURVEYS)

January-June 1998

to

BOSTON EDISON COMPANY
Regulatory Affairs Department
Pilgrim Nuclear Power Station
Plymouth, Massachusetts 02360

From

ENSR
89 Water Street
Woods Hole, MA 02543
(508) 457-7900

1 October 1998

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ICHTHYOPLANKTON ENTRAINMENT MONITORING

AT PILGRIM NUCLEAR POWER STATION

JANUARY - JUNE 1998

Submitted to

Boston Edison Company

Boston, Massachusetts

by

Marine Research, Inc.

Falmouth, Massachusetts

September 15, 1998

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*Available upon request.

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SECTION I

SUMMARY

Entrainment sampling at PNPS during the first half of 1998 was completed on six occasions per month during January and February, and three times per week from March through June with the exception of three storm dates. Standard netting was 0.333-mm mesh except from late March through late May during the larval winter flounder season when 0.202 mesh was used.

A total of 31 species was represented in the January-June 1998 samples. Winter-early spring collections (January-April) were dominated by yellowtail flounder, American plaice, fourbeard rockling, and Atlantic cod among the eggs; sculpin, sand lance, and rock gunnel among the larvae. Collections completed in May and June, which combined with July compose the late spring-summer spawning season, were dominated by eggs of Atlantic mackerel and the tautog/cunner group. At that time winter flounder, mackerel, and cunner contributed the majority of larvae.

Comparison of January-June 1998 egg and larval densities with those recorded from 1982 through 1997 suggested that densities of most species were within the range of values observed over the previous 16 years. Exceptions involved yellowtail flounder eggs, larval fourbeard rockling, larval hake, larval mackerel, larval cunner, and larval winter flounder. Each of these species was relatively abundant during at least one month compared with corresponding values from past years..

No larval lobsters were encountered through the month of June, a total of five having been taken through that month dating back to 1974.

SECTION II

INTRODUCTION

This progress report briefly summarizes results of ichthyoplankton entrainment sampling conducted at the Pilgrim Nuclear Power Station (PNPS) from January through June 1998 by Marine Research, Inc. (MRI) for Boston Edison Company (BECo) under Purchase Order No. LSP009086. As a result of studies completed in 1994, conversion from 0.333 to 0.202-mm mesh was initiated from late March through late May 1998 to improve retention of early-stage larval winter flounder. A more detailed annual report covering all 1998 data will be prepared following the July-December collection periods.

SECTION III

METHODS AND MATERIALS

Monitoring

Entrainment sampling at PNPS had historically been completed twice per month during January and February, weekly during March through June. Following a PNPS fisheries monitoring review workshop in early 1994, the sampling regime was modified beginning April 1994. In January and February during two alternate weeks each month single samples were taken on three separate occasions. Beginning with March single samples were taken three times every week. To minimize costs, sampling was linked to the impingement schedule so that collections were made Monday morning, Wednesday afternoon, and Friday night regardless of tide. All sampling was completed with a 60-cm diameter plankton net streamed from rigging mounted approximately 30 meters from the headwall of the discharge canal (Figure 1). Standard mesh was 0.333-mm except from late March through late May when 0.202-mm mesh was employed to improve retention of early-stage larval winter flounder *(Pleuronectes americanus)*. Sampling time in each case varied from 8 to 30 minutes depending on tide, higher tide requiring a longer interval due to lower discharge stream velocities. In most cases, a minimum quantity of 100 m^3 of water was sampled although at astronomical high tides it proved difficult to collect that amount even with long sampling intervals since the net would not inflate in the low velocity encountered near high tide. Exact filtration volumes were calculated using a General Oceanics Model 2030R digital flowmeter mounted in the mouth of the net. Near times of high water a 2030 R2 rotor was employed to improve sensitivity at low velocities.

Sampling also was not possible on January 21, February 25, and May 11 due to stormy seas. Sampling under such conditions results in such heavy detrital loads that processing the samples is all

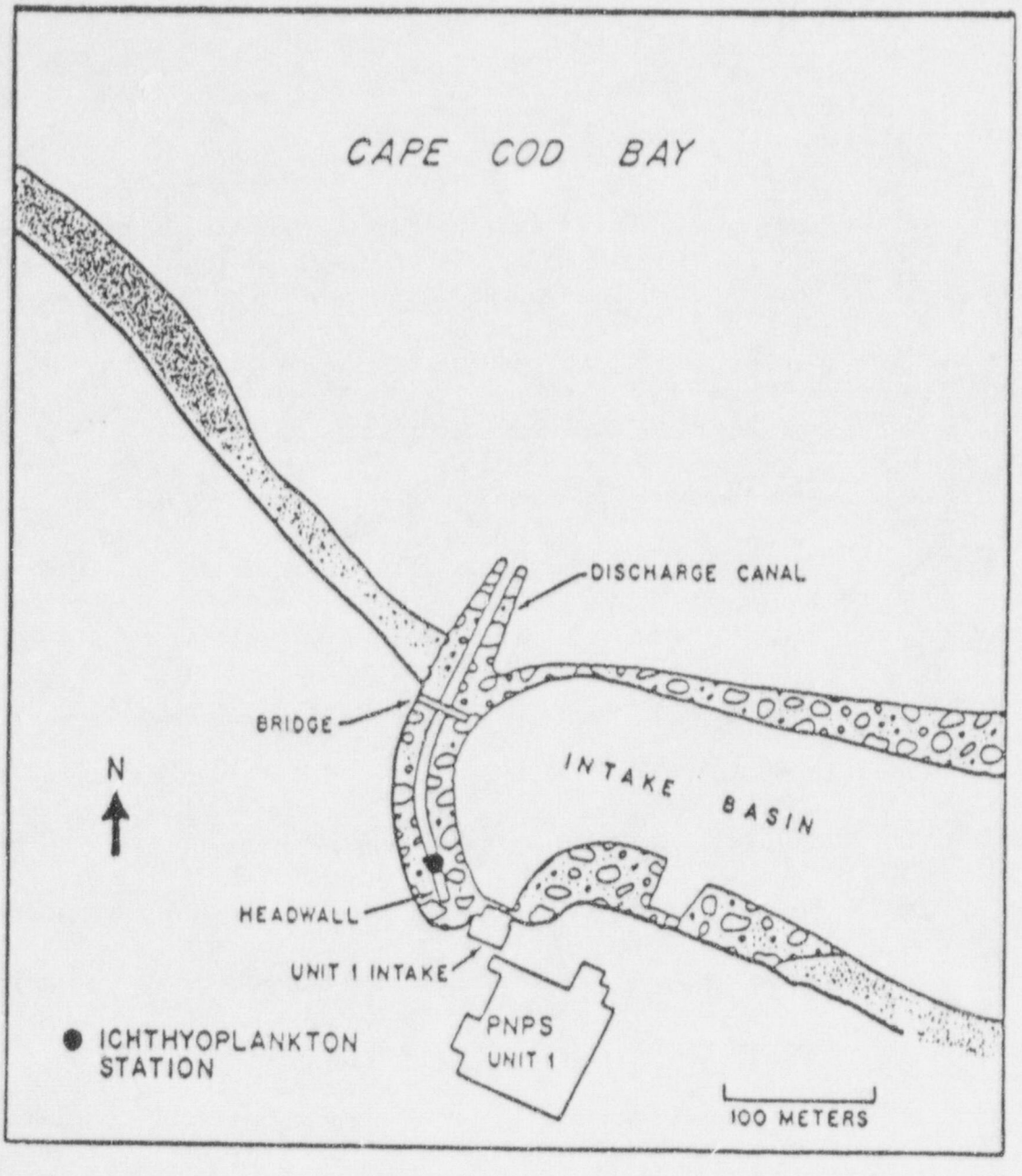

Figure 1. Entrainment sampling station for PNPS discharge canal.

but impossible. (In the past when storm samples have been processed, ichthyoplankton has been uncommon.) Sampling also was not possible on April 17 since a backwash was in progress.

All samples were preserved in 10% Formalin-seawater solutions and returned to the laboratory for microscopic examination. A detailed description of the analytical procedures appears in MRI (1988). As in past years, larval winter flounder were enumerated in four developmental stages as follows:

Stage 1 - from hatching until the yolk sac is fully absorbed (2.3-2.8 mm TL).

Stage 2 - from the end of stage 1 until a loop or coil forms in the gut (2.6-4 mm TL).

Stage 3 - from the end of stage 2 until the left eye migrates past the midline of the head during transformation (3.5-8 mm TL).

Stage 4 - from the end of stage 3 onward (7.3-8.2 mm TL).

Similarly larval cunner *(Tautogolabrus adspersus)* were enumerated in three developmental stages:

Stage 1 - from hatching until the yolk sac is fully absorbed (1.6-2.6 mm TL).

Stage 2 - from the end of stage 1 until dorsal fin rays become visible (1.8-6.0 mm TL).

Stage 3 - from the end of stage 2 onward (6.5-14.0 mm TL).

Samples were examined in their entirety for larval American lobster (*Homarus americanus*). When collected these were staged following Herrick (1911).

Notification Provisions

When the Cape Cod Bay ichthyoplankton study was completed in 1976, provisions were added to the entrainment monitoring program to identify unusually high densities of fish eggs and larvae. Once identified and, if requested by regulatory personnel, additional sampling could be conducted to monitor the temporal and/or spatial extent of the unusual occurrence. An offshore array of stations was established which could be used to determine whether circumstances in the vicinity

of Rocky Point, attributable to PNPS operation, were causing an abnormally large percentage of ichthyoplankton populations there to be entrained or, alternatively, whether high entrainment levels simply were a reflection of unusually high population levels in Cape Cod Bay. The impact attributable to any large entrainment event would clearly be greater if ichthyoplankton densities were particularly high only -close to the PNPS shoreline. In past years when high densities were identified, additional entrainment sampling was requested by regulatory personnel and the unusual density in most cases was found to be of short duration (<2 days). With the change in 1994 to Monday, Wednesday, Friday sampling the temporal extent of any unusual density can be more clearly discerned without additional sampling effort.

Until 1994 "unusually abundant" was defined as any mean density, calculated over three replicates, which was found to be 50% greater than the highest mean density observed during the same month from 1975 through to the current year. Restricting comparisons to monthly periods damped the large seasonal variation so readily apparent with ichthyoplankton. Starting with 1994 "unusually abundant" was redefined. On a month-by-month basis for each of the numerically dominant species all previous mean densities over three replicates (1974-1993; to be updated each year) were examined and tested for normality following logarithmic transformation. Single sample densities obtained from 1994-1997 were added to the pool within each month. Where data sets (for example, mackerel eggs taken in June) fit the lognormal distribution, then "unusually large" was defined by the overall log mean density plus 2 or 2.58 standard deviations.[1] Log densities were back-

[1]Normal distribution curve theory states that 2.5% of the measurements in a normally distributed population exceed the mean plus 1.96 standard deviations (= s, we rounded to 2 for simplicity), 2.5% lie below the mean minus 1.96 standard deviations. Stated another way 95% of the population lies within that range and 97.5% lies below the mean plus 1.96s. Likewise 0.5% of measurements exceed the mean plus 2.58s, 99% lie within the range of the mean ± 2.58s, 99.5% lie above the mean + 2.58s.

transformed to make them easier to interpret thus providing geometric means. In cases where data sets did not fit the lognormal distribution (generally months when a species was frequently but not always absent, i.e., many zeros occurred), the mean and standard deviation was computed using the delta-distribution (see for example Pennington 1983). The same mean plus standard deviation guideline was applied.

The decision to rely on 2 standard deviations or 2.58 standard deviations was based on the relative importance of each species. The more critical criterion was applied to species of commercial, recreational, or biological interest, the less critical to the remaining species (i.e., relatively greater densities were necessary to trigger notification). Species of commercial, recreational, or biological interest include Atlantic menhaden *(Brevoortia tyrannus)*, Atlantic herring *(Clupea harengus)*, Atlantic cod *(Gadus morhua)*, tautog and cunner (the labrids; *Tautoga onitis/Tautogolabrus adspersus)*, sand lance *(Ammodytes* sp.), Atlantic mackerel *(Scomber scombrus)*, windowpane (*Scophthalmus aquosus)*, American plaice *(Hippoglossoides platessoides)*, and winter flounder. Table 1 provides summary data for each species of egg and larva by month within these two categories showing the 1998 notification level.

A scan of Table 1 will indicate that, in cases where the long-term mean amounts to 1 or 2 eggs or larvae per 100 m^3, the critical level is also quite small. This situation occurred during months when a given species was obviously uncommon and many zeros were present in the data set with an inherent small standard deviation. The external reference distribution methodology of Box et al. (1975) was also employed. This procedure relies on a dotplot of all previous densities for a species within month to produce a reference distribution. Densities exceeding either 97.5 or 99.5% of the reference set values were considered unusually high with this procedure.

Table 1. PNPS ichthyoplankton entrainment notification levels for 1998 by species category and month. See text for details.

Densities per 100 m^3 of water:	Long-term Mean[1]	Mean + 2 std.dev.	Mean + 2.58 std.dev.
January			
LARVAE			
Atlantic herring[2]	0.2	1	
Sculpin			
Rock gunnel	0.8		1.4
Sand lance[2]	5	11	
February			
LARVAE			
Atlantic herring[2]	0.1	0.8	
Sculpin	2		65
Rock gunnel	3		99
Sand lance[2]	16	29	
March			
EGGS			
American plaice[2]	2	3	
LARVAE			
Atlantic herring[2]	0.9	1.3	
Sculpin	17		608
Seasnails	0.6		1
Rock gunnel	10.7		723
Sand lance[2]	7	164	
Winter flounder[2]	0.4	0.7	
April			
EGGS			
American plaice[2]	3	32	
LARVAE			
Atlantic herring[2]	1	2	
Sculpin	15		391
Seasnails	6		10
Radiated shanny	3		6
Rock gunnel	4		142
Sand lance[2]	21	998	
Winter flounder[2]	7	12	

Table 1 (continued).

Densities per 100 m^3 of water:	Long-term Mean[1]	Mean + 2 std.dev.	Mean + 2.58 std.dev.
May			
EGGS			
Labrids[2]	36	3514	
Atlantic mackerel[2]	18	4031	
Windowpane[2]	9	147	
American plaice[2]	2	15	
LARVAE			
Atlantic herring	0.7	1.1	
Fourbeard rockling	2		5
Sculpin	3		4
Radiated shanny	7		236
Sand lance[2]	37	59	
Atlantic mackerel	2	4	
Winter flounder[2]	9	123	
Seasnails	7		208
June			
EGGS			
Atlantic menhaden[2]	10	16	
Searobins	3		4
Labrids[2]	958	21599	
Atlantic mackerel[2]	63	3515	
Windowpane[2]	27	261	
American plaice[2]	1	2	
LARVAE			
Atlantic menhaden[2]	6	10	
Fourbeard rockling	9		634
Hake	0.3		1
Cunner[2]	6	265	
Radiated shanny	1		15
Atlantic mackerel[2]	91	155	
Winter flounder[2]	7	10	

[1]Geometric or Delta Mean.

[2]Species of commercial, recreational, or biological interest for which a more critical notification level will be used.

SECTION IV

RESULTS

Population densities per 100 m^3 of water for each species listed by date, station, and replicate are presented for January-June 1998 in Appendix A (available upon request). The occurrence of eggs and larvae of each species by month appears in Table 2.

Ichthyoplankton entrained during January through April generally represent winter-early spring spawning fishes. Many of these species employ a reproductive strategy which relies on demersal, adhesive eggs not normally entrained. As a result, more species are typically represented by larvae than by eggs. Over both life stages number of species represented in the catch increased from 5 in January to 18 in April. Considering the season as a whole, 9 species were represented by eggs, yellowtail flounder (*Pleuronectes ferrugineus*), American plaice, fourbeard rockling (*Enchelyopus cimbrius*), and Atlantic cod being numerically dominant. Yellowtail eggs first appeared in the collections early in April at which time they represented 46% of the month's total with a geometric mean density of 8 per 100 m^3 of water. American plaice eggs appeared at low densities in February and March, then increased in number in April when a geometric mean density of 4 per 100 m^3 accounted for 24% of the month's total. A single rockling egg was collected in February with the remainder of the seasonal total being taken in April. During that month they accounted for 19% of all eggs with a monthly geometric mean density of 3 per 100 m^3 of water. Atlantic cod eggs were present in the collections each month reaching a high geometric mean density of 2 per 100 m^3 in February. That density accounted for 77% of the month's egg catch.

Larval collections during the winter-early spring season contained 19 species of fish. Numerical dominants consisted of sculpin (*Myoxocephalus spp.)*, sand lance, and rock gunnel (*Pholis gunnellus*). Sculpin, a group actually consisting of three species, represented 16% of the January catch, 72% of the February catch, 48% of the March catch, declining to 19% in April. Respective monthly geometric mean densities for the group as a whole amounted to 0.2, 13, 18, and 9 per 100 m^3 of water. Among the three species of larval sculpin the grubby (*M. aenaeus*) was most abundant over the season as a whole accounting for 96.5% of the group total. The shorthorn sculpin (*M. scorpius*) followed at 2.5% and the longhorn sculpin (*M. octodecemspinosus*) at 1%. Larval sand lance were collected throughout the January-April period accounting for 33% of the seasonal total and reaching a peak monthly geometric mean density of 19 per 100 m^3 of water in April. Rock gunnel were also collected throughout the period adding 14% to the seasonal larval total. They reached a peak geometric mean density of 7 per 100 m^3 of water in both February and March

May and June collections (along with July) represent the late spring-summer ichthyoplankton seasonal period. Egg and larval densities, particularly among species with pelagic eggs, typically increase with expanding day length and rising water temperature. Considering both eggs and larvae, 18 species were represented in May, increasing to 21 species in June. Atlantic mackerel eggs contributed most to the egg collections in May representing 59% of the total with a geometric mean density of 196 per 100 m^3 of water. They ranked third among eggs in June, contributing less than 1% to that month's total with a geometric mean density of 11 per 100 m^3 of water. Tautog/cunner eggs ranked second in May, first in June. They contributed 38% to the May total with a geometric mean density of 52 per 100 m^3 and 95% of the June egg catch with a geometric mean density of 1,297 per 100 m^3.

Larval collections during May and June as a whole were dominated by winter flounder, mackerel, cunner, and radiated shanny. Larval flounder accounted for 45% of the May total with a monthly geometric mean of 28 per 100 m^3 and 18% of the June total with a geometric mean of 12 per 100 m^3. Atlantic mackerel contributed an additional 21% to the May catch, dropping to 15% in June; monthly geometric mean densities were 3 and 8 per 100 m^3, respectively. Larval cunner showed geometric mean densities of 0.2 in May increasing to 14 per 100 m^3 in June, values which accounted for 0.2 and 50% of those respective monthly totals. Lastly, larval radiated shanny accounted for 24% of the larvae taken in May, declining to 4% in June. Monthly geometric mean densities were 13 and 4 per 100 m^3, respectively.

Appendix B (available upon request) lists geometric mean monthly densities along with 95% confidence limits for each of the numerical dominants collected over the January-June period dating back to 1982. Geometric means are reported because they more accurately reflect the true population mean when the distribution of sample values are skewed to the right as is commonly the case with plankton data. Generally low values obtained for both eggs and larvae during April-June 1984 and 1987 were shaded because low through-plant water volumes during those months probably affected densities of ichthyoplankton (MRI 1994); shaded values were omitted from the following discussion. Entrainment data collected from 1975-1981 remain in an outdated computer format requiring conversion before geometric mean densities can be generated. These years were therefore excluded from comparison. Because densities of each ichthyoplankton species rise from and fall to zero over the course of each respective season, inter-year comparisons are most conveniently made within monthly periods. A general review of the data through the first six months of 1998 suggests that most egg

and larval densities were within the range of values observed over the previous 16 years. The following exceptions, each involving relatively high densities, were noted.

- Yellowtail flounder eggs were relatively abundant in April for the second year in a row. The observed monthly mean density of 8 per 100 m^3 of water in 1998 exceeded all previous May mean values. The previous high of 5 per 100 m^3 was recorded in 1997. Assessments of yellowtail stock size, available through 1995, do not suggest an increasing trend (NFSC 1996) so the increase in numbers of eggs may represent a localized increase in production or reflect an increase in number of spawning individuals subsequent to 1995.
- Larval fourbeard rockling were also relatively abundant in May 1998 as well as during May 1997. Monthly mean densities of 5 per 100 m^3 were recorded in both cases, values which exceeded the previous May high of 2 per 100 m^3 noted in 1995. Since rockling have no commercial or recreational value, stock size information is not available for the species.
- Larval hake were relatively abundant in June, the 1998 monthly mean density of 2 per 100 m^3 exceeding the previous high of 0.7 per 100 m^3 recorded in 1997. On five occasions June 1998 densities exceeded the notification level for that month (1 larva per 100 m^3 of water) and two of the five densities exceeded all previous June values (18 on the 22nd and 51 per 100 m^3 on the 29th).
- Although Atlantic mackerel larvae are not typically numerous during May (they are most common in June), the May 1998 mean density was the highest yet observed during that month. The mean value of 3 per 100 m^3 exceeded the 1 per 100 m^3 recorded in 1991 and 1993. Two individual densities, recorded in May 1998, identified under the high density notification program (the 25th with 88 per 100 m^3 and the 27th with 378 per 100 m^3), exceeded

all previous May values dating back to 1974 (Table 3). In general, over their occurrence season, mackerel eggs have been more abundant since 1988 when compared with 1975-1987 collections, consistent with a sharp rise in stock biomass (see MRI 1988).

- Larval cunner were relatively abundant in June 1998, the mean density for that month of 14 per 100 m^3 ranking second behind 1989 with 36 per 100 m^3. The relatively high ranking of the 1998 value was attributable to a large degree to a single high density of 2,216 per 100 m^3 recorded on the 22nd of June, a figure which exceeded the previous high June value of 1,249 per 100 m^3 by a factor of 1.8 (Table 3).
- Larval winter flounder densities also averaged relatively high in June. With a value of 12 per 100 m^3 of water, June's geometric mean density clearly exceeded all previous June values which ranged from 0.1 in 1990 to 7 per 100 m^3 in 1996. Nine of the 13 samples collected during June 1998 contained larval winter flounder densities which exceeded the notification level for that month. One of those samples contained the highest density of larval flounder yet observed during the month of June (814 per 100 m^3), five times the previous high value of 154 recorded in 1996 (Table 3).

In several instances, as commonly happens each year, respective monthly geometric mean densities were within the range of values established over past years yet individual mean densities exceeded notification levels (Table 3). These occurred for tautog/cunner eggs, radiated shanny larvae, Atlantic menhaden eggs, and Atlantic menhaden larvae, in each case during the month of June. Tautog/cunner eggs, on one occasion in June (36,017 per 100 m^3 of water), exceeded all previous June values except for the 37,282 eggs per 100 m^3 observed in 1995. On three occasions radiated shanny densities exceeded the notification level for that species (15 per 100 m^3), one of those three occasions

(90 per 100 m^3 on the 12th) exceeding all but the previous high density (262 per 100 m^3) and another (53 per 100 m^3 on the 5th) exceeding all but the two highest values (262 and 83 per 100 m^3). Menhaden eggs exceeded their notification level three times and menhaden larvae did so twice. The most noteworthy among these occurred on June 22 when a density of 800 menhaden eggs per 100 m^3 was recorded, exceeding the previous June high of 425 per 100 m^3 by a factor of two.

No larval lobster were found in the 1997 samples through the end of June. This is not atypical as only five larvae have been taken through the month of June dating back to 1974.

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Table 2. Species of fish eggs (E) and larvae (L) obtained in ichthyoplankton collections from the Pilgrim Nuclear Power Station discharge canal, January-June 1998.

Species		Jan	Feb	Mar	Apr	May	June
American eel	*Anguilla rostrata*			L			
Atlantic menhaden	*Brevoortia tyrannus*					E/L	E/L
Atlantic herring	*Clupea harengus*	L		L	L	L	
Rainbow smelt	*Osmerus mordax*					L	L
Cusk	*Brosme brosme*						L
Fourbeard rockling	*Enchelyopus cimbrius*		E		E/L	E/L	E/L
Atlantic cod	*Gadus morhua*	E	E	E/L	E/L	L	E/L
Haddock	*Melanogrammus aeglefinus*				L	L	
Silver hake	*Merluccius bilinearis*						E/L
Atlantic tomcod	*Microgadus tomcod*		L	L			
Hake	*Urophycis* spp.					L	E/L
Northern pipefish	*Syngnathus fuscus*						L
Searobins	*Prionotus* spp.						E
Sea raven	*Hemitripterus americanus*			L			
Grubby	*Myoxocephalus aenaeus*	L	L	L	L	L	L
Longhorn sculpin	*M. octodecemspinosus*		L	L	L		
Shorthorn sculpin	*M. scorpius*		L	L	L		
Seasnail	*Liparis atlanticus*			L	L	L	L

Table 2 (continued).

Species		Jan	Feb	Mar	Apr	May	June
Wrasses	Labridae				E	E	E
Tautog	*Tautoga onitis*				L	L	L
Cunner	*Tautogolabrus adspersus*					L	L
Radiated shanny	*Ulvaria subbifurcata*				L	L	L
Rock gunnel	*Pholis gunnellus*	L	L	L	L		
Wrymouth	*Cryptacanthodes maculatus*			L			
Sand lance	*Ammodytes* sp.	L	L	L	L	L	
Atlantic mackerel	*Scomber scombrus*				E	E/L	E/L
Fourspot flounder	*Paralichthys oblongus*						E/L
Windowpane	*Scophthalmus aquosus*				E	E/L	E/L
Witch flounder	*Glyptocephalus cynoglossus*				E/L		E/L
American plaice	*Hippoglossoides platessoides*		E	E	E/L	L	E/L
Winter flounder	*Pleuronectes americanus*			E/L	E/L	E/L	L
Yellowtail flounder	*P. ferrugineus*				E	E	E/L
Number of species		5	9	14	18	18	21

Table 3. Ichthyoplankton densities (number per 100 m^3 of water) for each sampling occasion during months when notably high densities were recorded, January-June 1998. Densities marked by + were unusually high based on values in Table 1. Number in parentheses indicates percent of all previous values during that month which were lower.

Atlantic mackerel larvae[1]			Winter flounder larvae		
May 1	0		May 1	1.8/1.1	
4	0		4	52.8/32.6	
6	0		6	10.8/6.7	
8	0		8	7.3/4.5	
11	STORM		11	STORM	
13	0		13	2.7/1.7	
15	0		15	25.6/15.8	
18	0		18	19.8/12.2	
20	16.8/15.0	+ (96)	20	16.1/9.9	
22	0.9		22	49.9/30.8	
25	88.4	+ (100)	25	6.7	
27	377.6	+ (100)	27	573.8	+ (100)
29	1.3		29	283.2	+ (100)
Previous high:	59	(1996)	Previous high:	148	(1974)
Notice level:	4		Notice level:	123	
June 1	16.8		June 1	58.2	+ (97)
3	1.6		3	813.5	+ (100)
5	112.4		5	39.1	+ (96)
8	304.0	+ (94)	8	18.5	+ (92)
10	49.7		10	18.8	+ (92)
12	2.8		12	52.7	+ (97)
15	0		15	22.8	+ (92)
17	0		17	1.0	
19	0.8	+ (95)	19	16.3	+ (92)
22	362.2	+ (95)	22	0	
24	3.2		24	14.3	+ (89)
26	0.8		26	9.3	
29	20.0		29	2.7	
Previous high:	2700	(1981)	Previous high:	154	(1996)
Notice level:	155		Notice level:	10	

[1]0.202 mesh densities adjusted to 0.333 mesh. Both are shown as follows: 0.202/0.333.

Table 3 (continued).

Atlantic menhaden					
		EGGS		LARVAE	
June	1	11.5		0	
	3	10.1		0	
	5	2.0		0	
	8	1.5		2.3	
	10	32.9	+ (94)	0	
	12	20.4	+ (88)	0	
	15	1.9		0	
	17	0		0	
	19	0		0	
	22	799.7	+ (100)	3.3	
	24	11.9		17.5	+ (89)
	26	5.9		4.2	
	29	2.7		13.3	+ (88)
Previous high:		425	(1997)	496	(1997)
Notice level		16		10	
Hake larvae					
June	1	0.9			
	3	0			
	5	2.0	+ (95)		
	8	0			
	10	0.7			
	12	2.1	+ (95)		
	15	0			
	17	0			
	19	0			
	22	18.0	+ (100)		
	24	0			
	26	2.5	+ (97)		
	29	50.6	+ (100)		
Previous high:		5	(1981)		
Notice level:		1			

Table 3 (continued).

Labrid eggs				**Cunner larvae**		
June	1	195.7		June	118	
	3	165.5			3	0
	5	1774.7			5	2.0
	8	2181.9			8	27.0
	10	863.9			10	64.5
	12	7173.6			12	0
	15	551.6			15	0
	17	228.7			17	0
	19	36017.2	+ (100)		19	3.1
	22	10186.4			22	2215.6 + (100)
	24	792.2			24	178.2
	26	1184.5			26	34.5
	29	1860.3			29	239.9
Previous high:		37282	(1995)	Previous high:		1249 (1981)
Notice level:		21599		Notice level		265

Radiated shanny larvae			
June	1	7.1	
	3	12.4	
	5	52.8	+ (99)
	8	0	
	10	0	
	12	90.0	+ (99)
	15	13.3	
	17	0	
	19	8.5	
	22	0	
	24	0.8	
	26	25.2	+ (95)
	29	0	
Previous high:		262	(1996)
Notice level:		15	

APPENDIX A*. Densities of fish eggs and larvae per 100 m^3 of water recorded in the PNPS discharge canal by species, date, and replicate, January-June 1998.

*Available upon request.

APPENDIX B*. Geometric mean monthly densities and 95% confidence limits per 100 m^3 of water for the dominant species of fish eggs and larvae entrained at PNPS, January-June 1982-1998.

Note the following:

When extra sampling series were required under the contingency sampling regime, results were included in calculating monthly mean densities.

Shaded columns for certain months in 1984 and 1987 delineate periods when sampling was conducted with only salt service water pumps in operation. Densities recorded at those times were probably biased low due to low through-plant water flow (MRI 1994).

*Available upon request..

IMPINGEMENT OF ORGANISMS AT PILGRIM NUCLEAR POWER STATION

(January - June 1998)

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Boston Edison Company

October 1998

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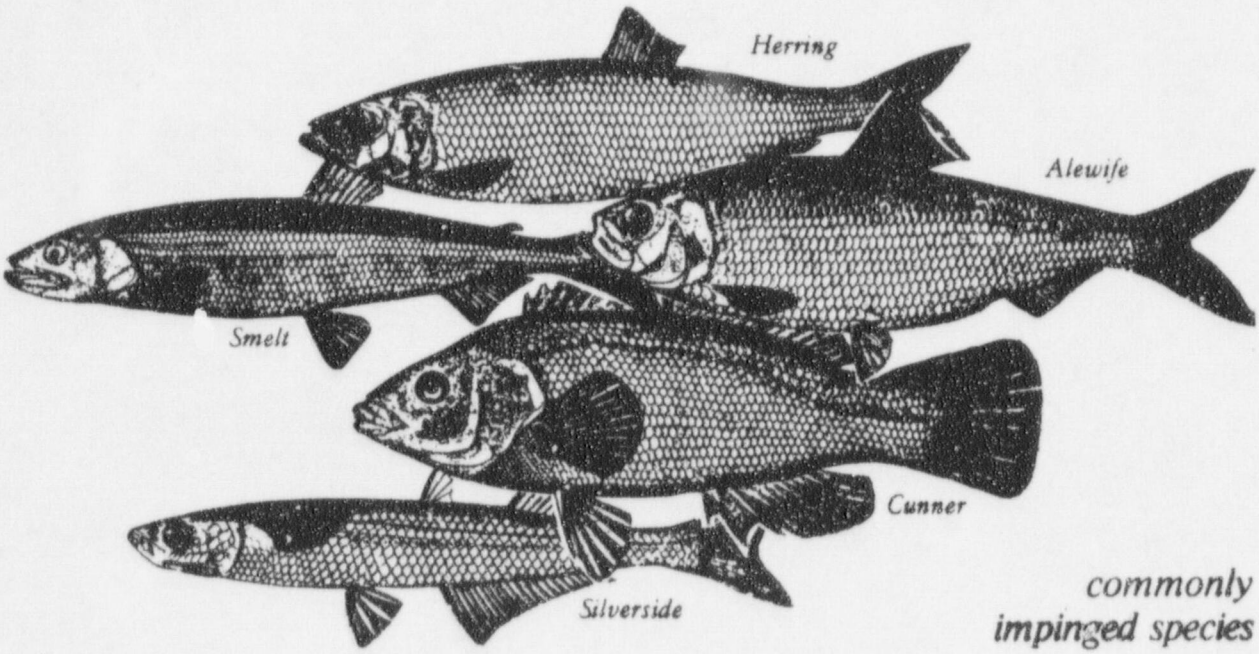

commonly impinged species

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SECTION I

SUMMARY

Fish impingement rate averaged 1.86 fish/hour during the period January-June 1998. Atlantic silverside (Menidia menidia), winter flounder (Pleuronectes americanus), and rainbow smelt (Osmerus mordax) accounted for 82% of the fishes collected. Initial impingement survival for all fishes from static screen wash collections was approximately 31% and from continuous screen washes 62%.

The collection rate (no./hr.) for all invertebrates captured from January-June 1998 was 1.54. Sevenspine bay shrimp (Crangon septemspinosa), green crabs (Carcinus maenus) and longfin squid (Loligo pealei) accounted for 95% of the invertebrates impinged. Mixed species of algae collected on intake screens amounted to 731 pounds.

The relatively high fish impingement rates from January-June 1993 (2.58), 1994 (3.34), 1995 (4.36), 1996 (3.32) and 1998 reflect circulating water pumps operating regularly during most of these periods, and high numbers of silversides impinged in early spring of each year. The invertebrate impingement was not as reflective of high intake flow.

The Pilgrim Nuclear Power Station capacity factor was ~ 97% from January-June 1998.

SECTION 2

INTRODUCTION

Pilgrim Nuclear Power Station (lat. 41°56' N, long. 70°34' W) is located on the northwestern shore of Cape Cod Bay (Figure 1) with a licensed capacity of 670 MWe. The unit has two circulating water pumps with a capacity of approximately 345 cfs each and five service water pumps with a combined capacity of 23 cfs. Water is drawn under a skimmer wall, through vertical bar racks spaced approximately 3 inches on center, and finally through vertical traveling water screens of 3/8 inch mesh (Figure 2). There are two traveling water screens for each circulating water pump.

This document is a report pursuant to operational environmental monitoring and reporting requirements of NPDES Permit No. 0003557 (USEPA) and No. 359 (Mass. DEP) for Pilgrim Nuclear Power Station, Unit I. The report describes impingement of organisms and survival of fishes carried onto the vertical traveling water screens at Unit I. It presents analysis of the relationships among impingement, environmental factors, and plant operational variables.

This report is based on data collected from screen wash samples during January-June 1998.

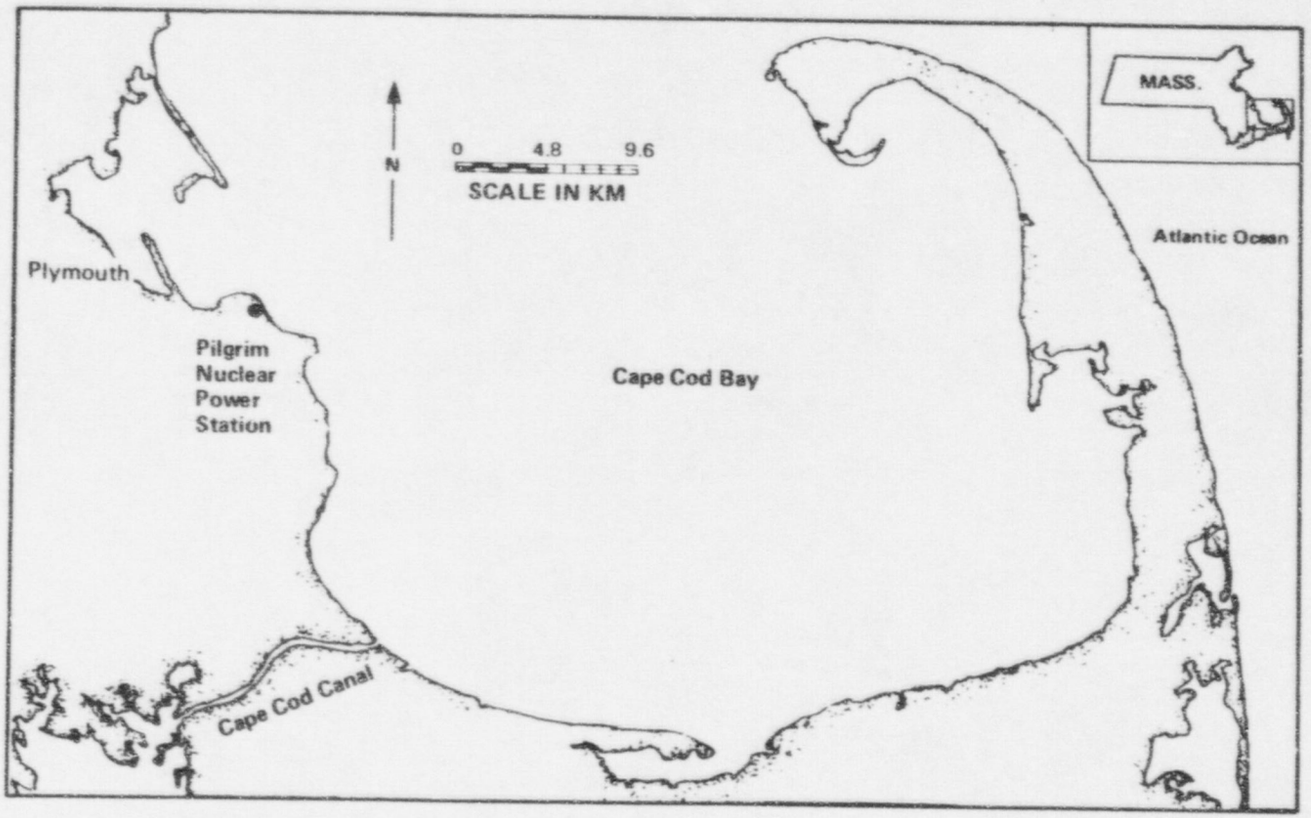

Figure 1. Location of Pilgrim Nuclear Power Station.

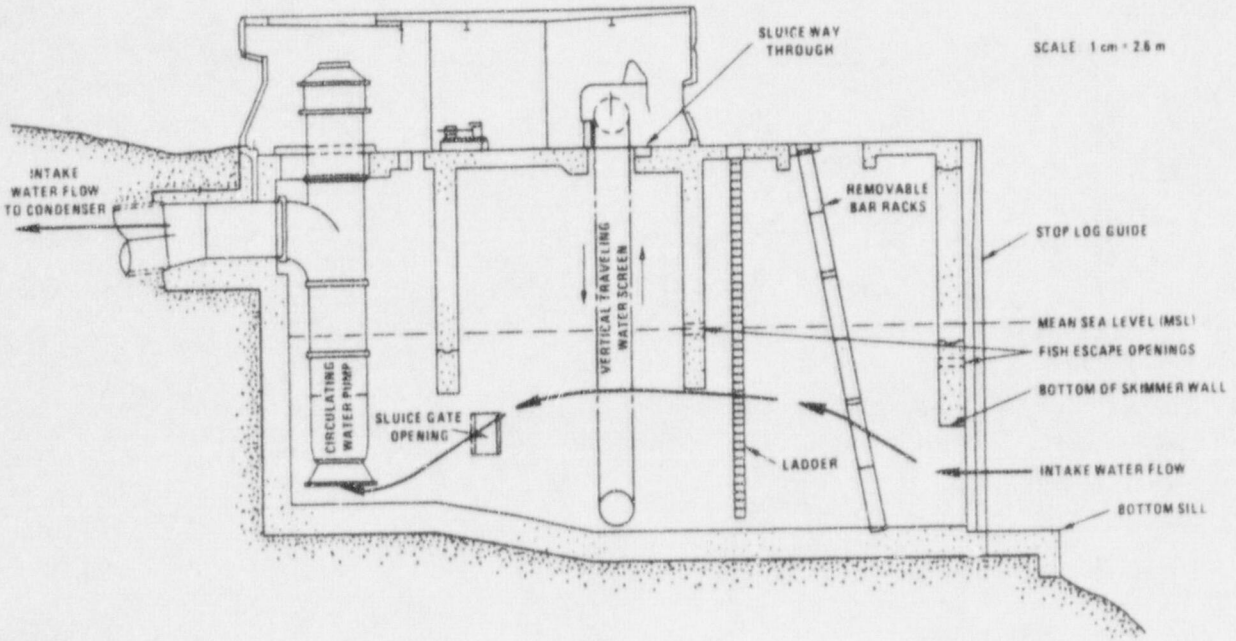

Figure 2: Cross-section of intake structure of Pilgr. Nuclear Power Station.

SECTION 3

METHODS AND MATERIALS

Three screen washings each week were performed from January-June 1998 to provide data for evaluating the magnitude of marine biota impingement. The total weekly collection time was 24 hours (three separate 8-hour periods: morning, afternoon and night). Two collections represented dark period sampling and one represented light period sampling. At the beginning of each collection period, all four traveling screens were washed. Eight hours later, the screens were again washed (approximately 30 minutes each) and all organisms collected. When screens were being washed continuously, one hour collections were made at the end of the regular sampling periods, and they represented two light periods and one dark period on a weekly basis.

Water nozzles directed at the screens washed impinged organisms and debris into a sluiceway that flowed into a trap. The trap was made of galvanized screen (3/8-inch mesh) attached to a removable steel frame and it collected impinged biota, in the screenhouse, shortly after being washed off the screens. Initial fish survival was determined for static (8-hour) and continuous screenwash cycles.

Variables recorded for organisms were total numbers, and individual total lengths (mm) and weights (gms) for up to 20 specimens of each species. A random sample of 20 fish or invertebrates was taken whenever the total number for a species exceeded 20; if the total collection for a species was less than 20, all were measured and weighed. Field work was conducted by Marine Research, Inc.

Intake seawater temperature, power level output, tidal stage, number of circulating water pumps in operation, time of day and date were recorded at the time of collections. The collection rate (#/hour) was calculated as number of organisms impinged per collecting period divided by the total number of hours in that collecting period. All common and scientific names in this report follow the American Fisheries Society (1988, 1989, 1991a and 1991b).

SECTION 4

RESULTS AND DISCUSSION

4.1 Fishes

In 327 collection hours, 608 fishes of twenty-five species (Table 1) were collected from Pilgrim Nuclear Power Station intake screens during January - June 1998. The collection rate was 1.86 fish/hour. Atlantic silverside (Menidia menidia) was the most abundant species accounting for 63.5% of all fishes collected (Table 2). Winter flounder (Pieuronectes americanus) and rainbow smelt (Osmerus mordax) accounted for 11.5 and 6.6% of the total number of fishes collected. Atlantic silverside were impinged in highest numbers during March/April. These were primarily adult fish that averaged 98 mm total length. Winter flounder and rainbow smelt were mostly impinged in April and February, respectively. The January-June 1998 fish impingement rate was within the range from the same period in 1989-1997, when rates varied from 0.52 (1990) to 4.36 (1995). Rates increased the past ten years compared to the 1988 rate (0.30), and this is possibly attributable to greater circulating water pump operating capacity from 1989-1998 and higher silverside impingement numbers, in general, in the springtime period.

4.2. Invertebrates

In 327 collection hours, 505 invertebrates of ten species (Table 3) were collected from Pilgrim Station intake screens between January-June 1998. The collection rate was 1.54 invertebrates/hour. Sevenspine bay shrimp (Crangon septemspinosa), green crabs (Carcinus maenus) and longfin squid (Loligo pealei) accounted for 90.9%, 2.4% and 1.8%, respectively, of the total number of invertebrates enumerated.

Table 1 - Monthly Impingement for All Fishes Collected from Pilgrim Station Intake Screens, January - June 1998

Species	Jan.	Feb.	March	April	May	June	Total
Atlantic silverside	33	7	145	200	1		386
Winter flounder	8	16	10	34	1	1	70
Rainbow smelt	9	29		2			40
Windowpane	3	3	1	15	2	1	25
Lumpfish			1		15		16
Grubby	4		4	5	1		14
Alewife				9			9
Blueback herring			3	4			7
Hake spp					2	4	6
Atlantic cod				2	3		5
Atlantic herring			1	2	2		5
Threespine stickleback	2		1	1			4
Radiated shanny	1		1	1			3
Tautog	2			1			3
Cunner	1				1		2
Little skate						2	2
Rock gunnel				1	1		2
Spotted hake				2			2
Fourbeard rockling				1			1
Fourspot flounder						1	1
Northern searobin						1	1
Red hake					1		1
Scup						1	1
Smallmouth flounder				1			1
Summer flounder					1		1
Totals	63	55	167	281	31	11	608
Collection Time (hrs.)	26	17	32	67	71	114	327
Collection Rate (#hr.)	2.42	3.24	5.22	4.19	0.44	0.10	1.86

Table 2 - Species, Number, Total Length (mm), Weight (gms) and Percentage For All Fishes Collected From Pilgrim Station Impingement Sampling, January -June 1998

Speicies	Number	Length Range	Mean Range	Weight Range	Mean Weight	Percent Of Total Fish
Atlantic silverside	386	70-135	98	2-9	4	63.5
Winter flounder	70	43-277	79	-	-	11.5
Rainbow smelt	40	82-157	112	3-21	8	6.6
Windowpane	25	47-291	87	-	-	4.1
Lumpfish	16	31-50	39	1-5	2	2.6
Grubby	14	50-74	59	2-5	3	2.3
Alewife	9	75-118	98	3-12	6	1.5
Blueback herring	7	71-96	84	2-5	4	1.2
Hake spp.	6	60-117	73	1-10	3	1.0
Atlantic cod	5	53-67	57	1-3	2	0.8
Atlantic herring	5	45-275	97	0.2-170	35	0.8
Threespine stickleback	4	36-62	50	1-5	2	0.7
Radiated shanny	3	78-130	97	4-18	9	0.5
Tautog	3	75-132	96	5-41	18	0.5
Cunner	2	46-108	77	1-16	9	0.3
Little skate	2	385-420	403	-	-	0.3
Rock gunnel	2	67-148	108	1-9	5	0.3
Spotted hake	2	76	76	3	3	0.3
Fourbeard rockling	1	74	74	2	2	0.2
Fourspot flounder	1	163	163	-	-	0.2
Northern searobin	1	170	170	37	37	0.2
Red hake	1	137	137	13	13	0.2
Scup	1	190	190	94	94	0.2
Smallmouth flounder	1	52	52	1	1	0.2
Summer flounder	1	365	365	-	-	0.2

Table 3 - Monthly Impingement for All Invertebrates Collected from Pilgrim Station Intake Screens, January - June 1998

Speicies	Jan.	Feb.	March	April	May	June	Total
Sevenspine bay shrimp	12	2	310	135			459
Green crab	1		1	2	4	4	12
Longfin squid				1	3	5	9
American lobster					6	2	8
Horseshoe crab					2	3	5
Common starfish				1	3		4
Nereis sp.	2	1					3
Rock crab				2	1		3
Isopod					1		1
Lady crab				1			1
Totals	15	3	311	142	20	14	505
Collection Time (hrs.)	26	17	32	67	71	114	327
Collection Rate (#hr.)	0.58	0.18	9.72	2.12	0.28	0.12	1.54

The collections of sevenspine bay shrimp occurred primarily during March, green crabs and longfin squid in May and June. In 1989 from January - June blue mussels and mussel predators dominated impingement, possibly due to the lack of effective macrofouling controls that year. Only eight specimens of the commercially important American lobster were captured which as in 1997 (10 lobsters) is much lower than in recent years, and even as far back as 1990 and 1991 when 16 and 21 were recorded, respectively, for the same time frame.

Approximately 731 pounds of mixed algae species were recorded during impingement sampling, or 2.2 pounds/hour. Like the January-June, 1989-1998 fish impingement rates, the algal impingement rates for these years were notably higher than recorded for the same period in 1988 when lower circulating water pump operation was evident.

4.3 Fish [illegible]

Fish survival data collected while impingement monitoring are shown in Table 4. Static screen wash collections provided high numbers of fishes and revealed good impingement survival rates for some species, including winter flounder. Continuous screen wash collections had relatively higher survival rates, although fewer fishes were sampled.

Table 4 - Survival Summary for the Fishes Collected During Pilgrim Station Impingement Sampling, January-June 1998. Iniital Survival Numbers are Shown Under Static (8-Hour) and Continuous Wash Cycles

	Number Collected		Number Surviving		Total Length (mm)	
Speicies	Static Washes	Cont. Washes	Static	Cont.	Mean	Range
Atlantic silverside	349	37	79	22	98	70-135
Winter flounder	34	36	25	35	79	45-277
Rainbow smelt	8	32	2	8	112	82-157
Windowpane	21	4	14	4	87	47-291
Lumpfish	16	0	10	-	39	31-50
Grubby	13	1	11	1	59	50-74
Alewife	8	1	0	1	98	75-118
Blueback herring	7	0	0	-	84	71-96
Hake spp.	4	2	0	0	73	60-117
Atlantic cod	2	3	0	1	57	53-67
Atlantic herring	4	1	0	0	97	45-275
Threespine stickleback	3	1	3	1	50	36-62
Radiated shanny	2	1	2	1	97	78-130
Tautog	2	1	2	1	96	75-132
Cunner	1	1	1	0	77	46-108
Little skate	2	0	0	-	403	385-420
Rock gunnel	2	0	1	-	108	67-148
Spotted hake	2	0	0	-	76	76
Fourbeard rockling	1	0	1	-	74	74
Fourspot flounder	1	0	1	-	163	163
Northern searobin	1	0	0	-	170	170
Red hake	1	0	0	-	137	137
Scup	1	0	0	-	190	190
Smallmouth flounder	1	0	0	-	52	52
Summer flounder	1	0	0	-	365	365
All Speicies	487	121	152	75		
Number (%Surviving)			(31.2)	(62.0)		

SECTION 5

CONCLUSIONS

1. The average Pilgrim impingement rate for the period January-June 1998 was 1.86 fish/hour. The collection rate was notably lower in 1988 than in 1989 - 1998, possibly due to more circulating water pump capacity during the latter years.

2. Twenty-five species of fish were recorded in 327 impingement collection hours.

3. The major species collected and their relative percentages of the total collections were Atlantic silverside, 63.5%; winter flounder, 11.5%; and rainbow smelt, 6.6%.

4. The hourly collection rate for invertebrates was 1.54 with sevenspine bay shrimp (90.9%), green crabs (2.4%) and longfin squid (1.8%) dominating the catch. Eight American lobsters were caught. Impingement rates for invertebrates were higher and algae lower for this period in 1988 (minimum circulating water pumps operating) than in 1989-1998.

5. Impinged fish survival was relatively low overall during static screen washes compared with continuous screen washes.

SECTION 6

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MEMORANDUM

To: Members of the Administrative-Technical Committee, Pilgrim Power Plant Investigations
From: John Boardman, Recording Secretary
Subject: Minutes from the 89th meeting of the A-T Committee
Date: June 17, 1998

The 89th meeting of the Pilgrim A-T Committee was called to order by Gerald Szal at 9:40 A.M., on June 17, 1998 at Blackstone.

I. Minutes of the 88th Meeting

Bob Lawton mentioned the importance of having someone record the minutes from these meetings. He also suggested having a recording secretary at the Brayton Point meetings.

Carolyn Griswold made a motion to accept the minutes from the 88th A-T Committee meeting; Jack Paar seconded. The minutes were accepted unanimously with no changes.

II. Pilgrim Station Operational Review

Bob Anderson (BECo) reported on the current operational status at Pilgrim Station. Bob reviewed Figure 1 in the Introduction section of the Semi-Annual Report (51). He explained that the plant operated at a lower capacity in 1997 as compared to the 1996 output. This was caused by a planned refueling outage and the replacement of the main transformer. The plant has operated at approximately 96% in 1998. Since 1973, the overall operating capacity of Pilgrim Station is now about 55%.

Bob commented on the dredging project in the intake. The dredging commenced in late June and was finished by the end of August. Jack Paar made a motion to have Bob Anderson send him any available information on the dredging project at the plant; Gerry Szal seconded. Bob agreed to send Jack the information he requested within the next few weeks.

Bob also talked about the possible sale of Pilgrim Station by the end of the year. He mentioned that if the sale occurs, the new owners may want to expand plant operational capacity, and the possibility of a fossil fuel unit in the future.

III. Impingement Monitoring

Bob Anderson presented the impingement data. The overall impingement rate for 1997 was about 1.4 fish per hour, which is the lowest rate since 1989. There were no significant individual impingement incidents in 1997. The Atlantic silverside was ranked first in fish impinged, comprising 47% of the collections followed by smelt at 13%. The overall survival rate was 28% for static wash cycles and 61% for continuous wash cycles. Jack Parr asked Bob if he could obtain a summary of static vs. continuous wash cycles at the plant for the past few years. Bob told Jack he would send him the information with the other materials requested. Bob reviewed pages 12 and 16 of the Impingement Section in Semi-Annual Report 51 and explained how the hourly impingement rate is expanded.

IV. Fisheries Monitoring

Bob Lawton (MDMF) presented the fisheries monitoring results. He summarized the smelt section of the 1997 report and commented on 1998 smelt work. He also explained how DMF, the Jones River Watershed Association and students at Silver Lake High School worked together to clear snags from the Jones River. John Boardman described the smelt run in the Jones River for 1998, noting that the run was evidently the largest of this decade. Egg sets of varying densities completely covered the spawning grounds. John also saw large numbers of smelt during the daytime in the river.

Bob mentioned the need for improving water quality and protecting habitat in and around the Jones River, as well as other riverine systems throughout the state. The committee discussed this topic at length.

Bob then presented findings from the winter flounder work. DMF tagged 7,500 flounder during the spring of 1998. Since 1994, about 22, 000 winter flounder have been tagged. All the tagging has been done within the study area as defined by Eric Adams' (M.I.T) modeling analysis. The recapture rate through 1997, including DMF returns, was 5.6%. One-hundred and twenty eight known recaptures came from the tagging area during the spawning period. This gives a fidelity estimate of 64% for this population.

Next, Bob discussed the cunner recruitment work. DMF continued Paul Nitschke's work begun in 1995. Bob reviewed pages 26 and 27 of the cunner section in the Report 51 with the committee. After analyzing the data, it appears that the plant had little or no impact on the cunner population in 1995 and 1997. In 1996, storms reduced cunner recruits to a low level, and the entrainment of their eggs and larvae may have had a consequential impact on the local cunner population.

V. Benthic Monitoring

Isabelle Williams (ENSR) and an associate presented results of the Benthic Monitoring Program. The SCUBA survey in September 1997 revealed that the impact zone had enlarged to about one acre. This was larger than any past areal measurements. Isabelle hypothesized that dredging in the intake may have contributed to this phenomenom. A video was presented of discharge mapping, which ENSR had done on June 11, 1998. Measurements indicated that the impact zone had contracted in size and was now more "normal" in size.

VI. Entrainment Monitoring

Mike Scherer (MRI) discussed the entrainment data. He explained that MRI was still using the protocol they adopted in April 1994. Samples were taken three times a week on Monday, Wednesday and Friday from March through September. Samples (3) are collected every other week from October to February. Collections are with a .333mm mesh plankton net. However, during the flounder spawning period, a .202mm mesh is used.

Mike talked about the record high number of winter flounder larvae entrained in 1997. He also presented larval entrainment numbers and adult equivalency estimates for cunner and Atlantic mackerel. He mentioned that there were no lobster larvae entrained in 1997. Jack motioned to have Mike assign adult equivalency dollar values to the commercially important species experiencing entrainment at the plant. The group unanimously supported this request. Jack then asked about the possibility of using this information for a multi-generational assessment.

VII. Marine Fisheries and Benthic Subcommittees

The Fisheries and Benthic Subcommittees agreed to meet on August 4 to formulate 1999 monitoring efforts. The meetings will be held in Narragansett RI, at the National Marine Fisheries Service headquarters.

The meeting adjourned at 2:40 P.M.

VII. Attendees at the 89th meeting of the A-T Committee:

CZM - Rick Zeroka

DEP - Gerry Szal
Bob Maietta

DMF - Leigh Bridges
Bob Lawton
John Boardman

EPA - Jack Paar

ENSR - Isabelle Williams
Erich Horgan

MRI - Michael Scnerer

NMFS - Carolyn Griswold

PNPS - Bob Anderson

PILGRIM NUCLEAR POWER PLANT

ADMINISTRATIVE-TECHNICAL COMMITTEE

September, 1998

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August 10, 1998

MEMORANDUM FOR: PNPS Technical Advisory Committee

FROM: Carolyn Griswold
Carolyn Griswold
Chair, Fisheries Subcommittee

SUBJECT: 1999 Pilgrim Station Fisheries Monitoring Program

Marine Fisheries Program

The Fisheries Subcommittee of the TAC met on 4 August 1998 at the NMFS Laboratory in Narragansett, RI. Voting members present were R. Anderson (BECo), C. Griswold (NOAA/NMFS), Bob Maietta (MASS DEP), and Jack Paar (USEPA). Gerry Szal (MASS DEP), Leigh Bridges and Robert Lawton (MASS DMF) also attended.

The past years' programs were discussed with an eye to what should be continued in the future. Several options were discussed:

a) do nothing,
b) continue the absolute abundance studies to provide information to compare adult equivalency models from entrainment figures,
c) continue mark-recapture studies,
d) continue work on the lobster report (in progress),
e) consider restoration possibilities (Pilot Program), and
f) continue rainbow smelt egg box maintenance.

Jack Paar motioned, and it was carried, that Bob Lawton should develop a list and set priorities about what studies should be continued, consider what formats reports should be in - report or for publication, consider the possibility of incorporating other local (i.e., MASS DMF) long term studies on abundance and distribution of key species into comprehensive fisheries manuscripts.

A discussion ensued about the possibility of recommending that, as the programs scale back monies be made available for local restoration projects. The Subcommittee thought that Pilgrim, with its long monitoring data base, might provide a perfect opportunity for a watershed restoration pilot study. This will be discussed further.

Impingement and Entrainment

The Impingement Program will remain the same as for 1997.
The Entrainment Program will remain the same as that for 1998, with the addition of three more equivalent adult analysis species, including associated monetary values and a RAMAS population modeling for winter flounder. Mike Scherer will be asked to develop a power cost analysis of how much more sampling effort would be needed to detect smaller differences from year to year in the Adult Equivalency Index.

Barrier Net

The Barrier Net was not discussed.

Other Recommendations

Unlike previous years, no recommendations regarding sole-source contractors were discussed.

Another meeting of the full TAC is tentatively scheduled for mid-September 1998.