SEABROOK ENVIRONMENTAL STUDIES, 1991
A CHARACTERIZATION OF ENVIRONMENTAL CONDITIONS IN THE HAMPTON-SEABROOK AREA DURING THE OPERATION OF SEABROOK STATION

TECHNICAL REPORT XXIII-I

Prepared for

NORTH ATLANTIC ENERGY SERVICE CORPORATION
P.O. Box 700
Seabrook Station
Seabrook, New Hampshire

Prepared by

NORMANDEAU ASSOCIATES INC.
25 Nashua Road
Bedford, New Hampshire 03110-5500

R-13145

November 1992

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES

LIST OF FIGURES
(Continued)

Page

LIST OF FIGURES
(Continued)

Page

LIST OF FIGURES
(Continued)

Page

LIST OF FIGURES
(Continued)

Page

LIST OF FIGURES
(Continued)

Page

LIST OF FIGURES
(Continued)

Page

LIST OF FIGURES
(Continued)

LIST OF TABLES

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

Page

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

Page

LIST OF TABLES
(Continued)

LIST OF TABLES
(Continued)

1.0 STUDY DESIGN/RATIONALE

1.1 APPROACH

The purpose of this report is to assess whether there have been changes in the "balanced, indigenous populations" in the nearfield coastal waters of New Hampshire as a result of the first 17 months of commercial operation of Seabrook Station. The ability to determine whether operation of the plant has affected the aquatic biota in the area is dependent upon a systematic approach to impact assessment, incorporating both temporal and spatial components (Figure 1.1-1). Potential operational effects could be ruled out if: (1) results from the operational period were similar to previous (preoperational) years; or, (2) differences within the operational period were observed in both nearfield and farfield areas. In addition, other potential sources of change were investigated before conclusions were drawn. This study design was modeled after objectives discussed by Green (1979) which have been described in more detail previously (NAI 1991b).

A basic assumption in the monitoring program was that there are two major sources of naturally-occurring variability: (1) that which occurs among different areas or stations, i.e., spatial, and (2) that which varies in time, from daily to weekly, monthly or annually. In the experimental design and analysis, the Seabrook Environmental Program focused on the major source of variability in each community type and then determined the magnitude of variability in each community. The frequency and spatial distribution of the sampling effort were determined based on the greatest sources of variability for each parameter (NAI 1991b). Biological variability was measured on two levels: species and community (Table 1.1-1). A species' abundance, recruitment, size and/or growth are important for understanding operational impact, if any. Thus, these parameters were monitored for selected species from each community type. These species were chosen for more intensive study based on their commercial or numerical importance, sensitivity to temperature, potential as a nuisance organism, or habitat preference. Overall community structure of the biota, e.g., the number and type of species, total abundance and/or the dominance structure, may also be affected by plant operation in a way not detected by monitoring individual species. Therefore, the natural variation in community structure was also monitored.

A previous Summary Report (NAI 1977e) concluded that the balanced indigenous community in the Seabrook study area should not be adversely influenced by loss of individuals due to entrapment in the circulating water system (CWS), exposure to the thermal plume or exposure to increased particulate material (dead organisms) settling from the discharge. This assessment focuses on the likely sources of potential influence from plant operation, and the sensitivity of a community or parameter to that influence within the framework of natural variability (Table 1.1-1). Naturally, a community or species within the study area might be affected by more than one aspect of the CWS. However, results from this monitoring program will be discussed in light of that as-

SEQUENCE OF EVENTS FOR DETERMINING IF THERE ARE ENVIRONMENTAL CHANGES DUE TO OPERATION OF SEABROOK STATION

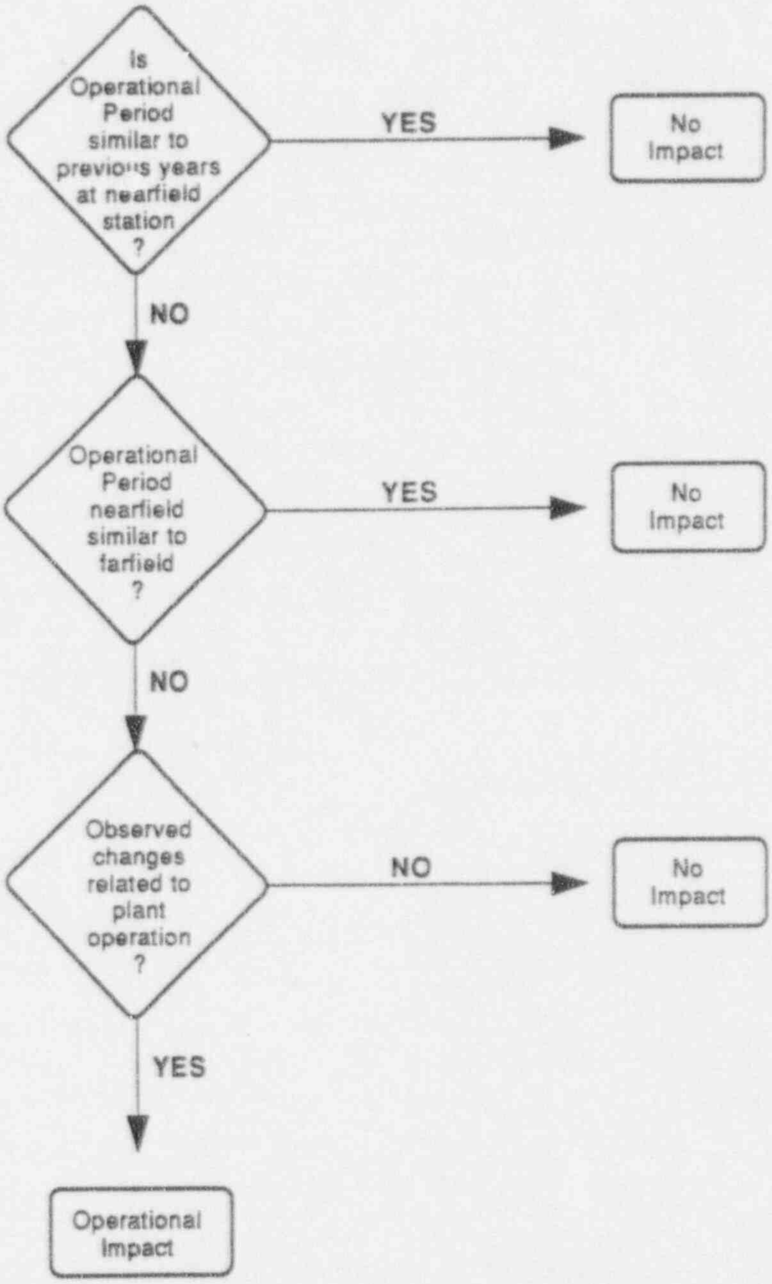


Figure 1.1-1. Sequence of events for determining if there are environmental changes due to the operation of Seabrook Station. Seabrook Operational Report, 1991.

TABLE 1.1-1. SUMMARY OF BIOLOGICAL COMMUNITIES AND TAXA MONITORED FOR EACH POTENTIAL IMPACT TYPE. SEABROOK OPERATIONAL REPORT, 1991.

MONITORING AREA	IMPACT TYPE	SAMPLE TYPE	LEVEL MONITORED: COMMUNITY	LEVEL MONITORED: SELECTED SPECIES/ PARAMETERS
Intake	Entrainment	Microzooplankton	x	x
		Macrozooplankton	x	x
		Fish eggs	x	
		Fish larvae	x	x
		Soft-shell clam larvae		x
		Cancer crab larvae		x
	Impingement	Juvenile/Adult fish	x	x
Discharge	Thermal Plume	Nearshore water quality		x
		Phytoplankton	x	x
		Lobster larvae		x
		Intertidal/shallow subtidal macroalgae and macrofauna	x	x
		Subsurface fouling community	x	x
	Detrital Rain	Mid-depth/deep macrofauna and macroalgae	x	x
		Bottom fouling community		x
		Demersal fish	x	x
		Lobster adults		x
		Cancer crab adults		x
Estuary	Cumulative Sources	Estuarine temperature		x
		Soft-shell clam spat and adults		x
		Estuarine fish	x	x

pect of the cooling water system that has the greatest potential for affecting that particular component of the biological community. This approach was explained in more detail in the first operational report (NAI 1991b).

Entrainment and impingement were addressed with in-plant monitoring of the organisms entrapped in the circulating water system (CWS). The effects on the balanced, indigenous population of aquatic biota in the waters in the vicinity of the CWS intake and discharge structures were evaluated through continued monitoring at the stations established during the preoperational period and statistical comparison of the results at both the community and the species levels.

The approach to this presentation will be in reverse of the "normal" scientific technical report in order to carry the reader from the general to the specific. Thus, the findings of the study to date are summarized first (Section 2.0) while the detailed results and methods are presented in succeeding sections (3.0 and 4.0). The null hypothesis in all tests is that there has been no change in community structure or selected species abundance or biomass. This in turn would indicate, based on the approach outlined in Figure 1.1-1, that the balanced indigenous populations have been maintained. As mentioned previously, the focus will be on the particular impact type that is most pertinent to the particular population.

1.2 STUDY PERIODS

Environmental studies for Seabrook Station began in 1969 and focused on plant design and siting questions. Once these questions were resolved, a monitoring program was designed to assess the temporal (seasonal and yearly) and spatial (nearfield and farfield) variability during the preoperational period as a baseline against which to evaluate conditions during plant operation. This report focuses on the preoperational data collected from 1976 through 1989 for fisheries studies and from 1978 through 1989 for most plankton and benthic studies; during these years sampling design has consistently focused on providing the background to address the question of operational effects.

August 1990 is considered the beginning of the operational period for the purposes of this environmental assessment. Commercial operation of Seabrook Station began intermittently in July and August 1990, and continued for periods of approximately three weeks in September and October. After operation at 100% for less than a week at the beginning and end of November, the plant operated nearly continuously from December 1990 through July 1991 when it was shut down for routine maintenance (Figure 1.2-1). The circulating water system was active throughout 1990 and 1991, although occasionally at reduced levels (Table 1.2-1).

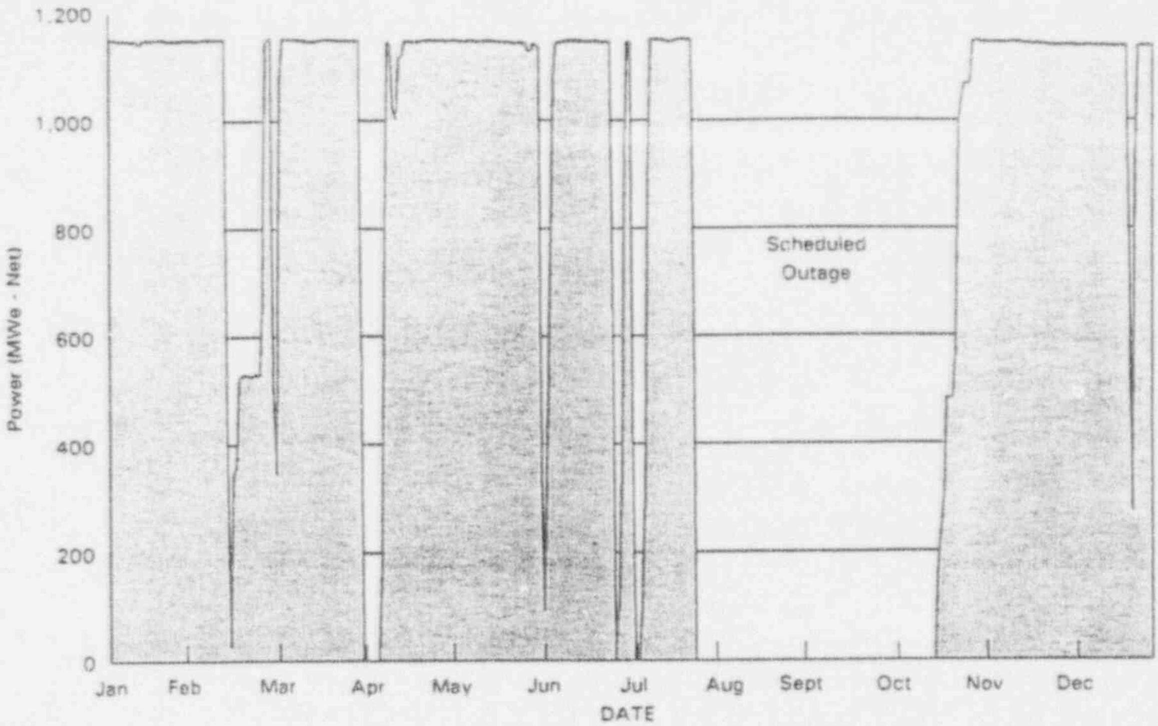


Figure 1.2-1. Average daily power level at Seabrook Station 1991. Seabrook Operational Report, 1991.

TABLE 1.2-1. MONTHLY CHARACTERISTICS OF SEABROOK STATION OPERATION IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

	DAYS OF CIRCULATING WATER SYSTEM OPERATION		AVERAGE DAILY FLOW (mgd)	
MONTH	1990	1991	1990	1991
Jan	31	31	324	584
Feb	28	28	564	580
Mar	31	31	563	580
Apr	30	30	563	581
May	31	31	562	581
June	30	30	563	578
Jul	31	31	582	535
Aug	31	21	588	253
Sep	30	26	588	257
Oct	31	31	590	552
Nov	30	30	590	590
Dec	31	31	589	591

2.0 SUMMARY OF FINDINGS

2.1 INTAKE AREA STUDIES

2.1.1 Entrainment

Background

The focus of monitoring plankton in the intake area (Figure 2.1-1) was to evaluate the effect of entrainment of organisms by the circulating water system (CWS) on community structure and population levels in the nearfield area (Table 2.1-1). Due to their limited control of horizontal movements and often broad vertical distribution in the water column, most types of planktonic organisms could be exposed to entrainment. Estimates of total monthly levels of entrainment are presented to quantify losses to bivalve larvae and fish eggs and larvae. Community structure and abundances of selected species in the nearfield area during commercial operation were compared to historical conditions and to farfield conditions. These comparisons address the question of whether the balanced, indigenous planktonic populations within the study area have been affected by the plant intake during commercial operations to date.

Entrainment Estimates

Although Seabrook Station has operated its circulating water system at varying levels since 1985, no power or heated discharge were produced until the summer of 1990. Entrainment of bivalve larvae and finfish eggs and larvae has been monitored since June 1990. These collections provide a measure of the actual number of organisms directly affected by plant entrainment.

It has been shown previously that community characteristics of entrained organisms were similar to the indigenous populations monitored offshore, adjacent to the intakes, at Station P2 (NAI 1991b). Eggs or larvae of some fish species were entrained less frequently than their natural occurrence would suggest because of their stratification within the water column. For example, cunner larvae concentrate in near-surface waters (NAI 1981b, 1981f). In-plant (entrainment) samples represent water primarily from the middle of the water column since the intakes draw primarily from that depth zone. In contrast, offshore collections at Station P2 are oblique tows encompassing the entire water column, thus capturing species that may be more concentrated near the surface or bottom.

The number of bivalve larvae entrained monthly was estimated from June through October 1990 and late April through early August 1991 (Figure 2.1-2); sampling was not conducted during a scheduled maintenance outage of the plant (August-September 1991). Three taxa, *Mytilus edulis* (blue mussel), *Heteranomia squamula* and *Hiatella* sp., comprised more than 85% of the bivalve larvae entrained during June and July of each year. *Modiolus modiolus* was intermittently entrained during this period. Monthly entrainment of the soft-shell clam *Mya arenaria* was reduced in 1991 in comparison to 1990, during comparable months. Reduced CWS flows during the outage in August and September, when larvae reached their peak abundance

TABLE 2.1-1. SUMMARY OF POTENTIAL EFFECTS (BASED ON NUMERICAL CLASSIFICATION AND MANOVA RESULTS) OF OPERATION OF SEABROOK STATION INTAKE ON INDIGENOUS ZOOPLANKTON AND ICHTHYOPLANKTON COMMUNITIES. SEABROOK OPERATIONAL REPORT, 1991.

PLANKTON COMMUNITY	OPERATIONAL PERIOD SIMILAR TO PREOPERATIONAL PERIOD? [a]	DIFFERENCES BETWEEN OPERATIONAL AND PREOPERATIONAL PERIODS CONSISTENT AMONG STATIONS? [a]
Microzooplankton:		
seasonal occurrence	yes	yes
abundances	yes	yes
Bivalve larvae:		
seasonal occurrence	yes	yes
abundances	no - most Op<Preop (except _M. edulis_)	yes
Macrozooplankton holo/meroplankton:		
seasonal occurrence	yes	yes
abundances	Op>Preop	yes
tychoplankton:		
seasonal occurrence	yes	yes
abundances	no-variable among species	yes
Fish eggs:		
seasonal occurrence	yes	yes
abundances	no-Op<Preop in several taxa	yes
Fish larvae:		
seasonal occurrence	yes	yes
abundances	no-variable among taxa	yes

[a]Based on results of numerical classification or MANOVA.

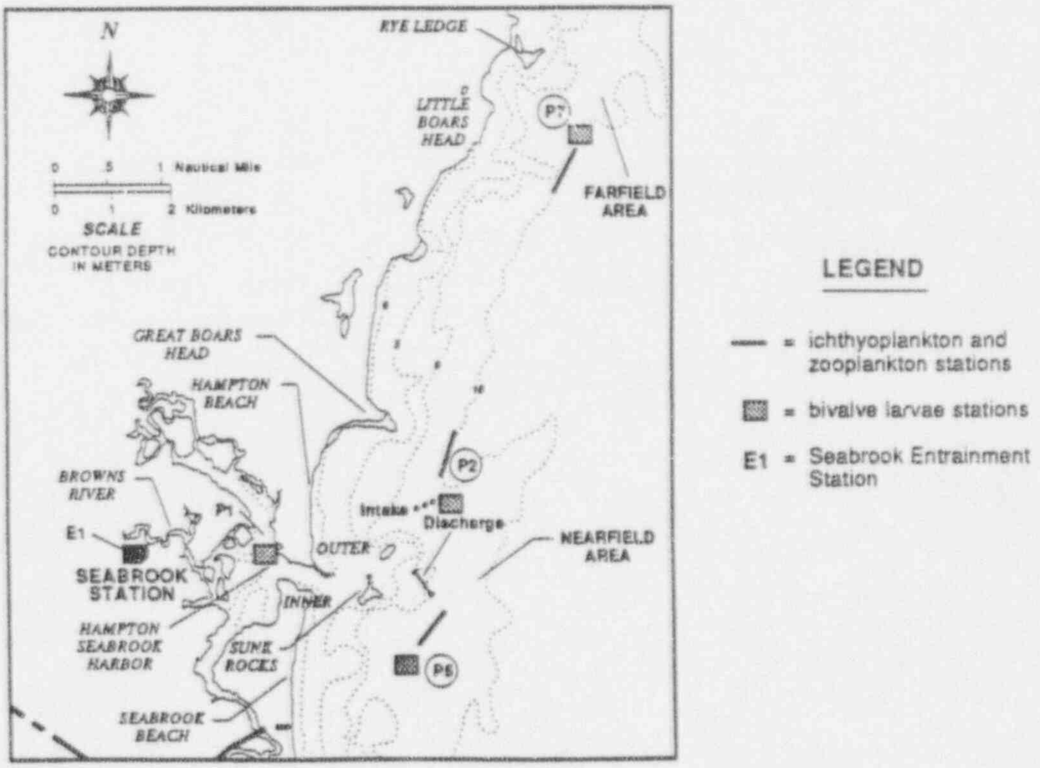


Figure 2.1-1. Plankton, water quality and entrainment sampling stations. Seabrook Operational Report, 1991.

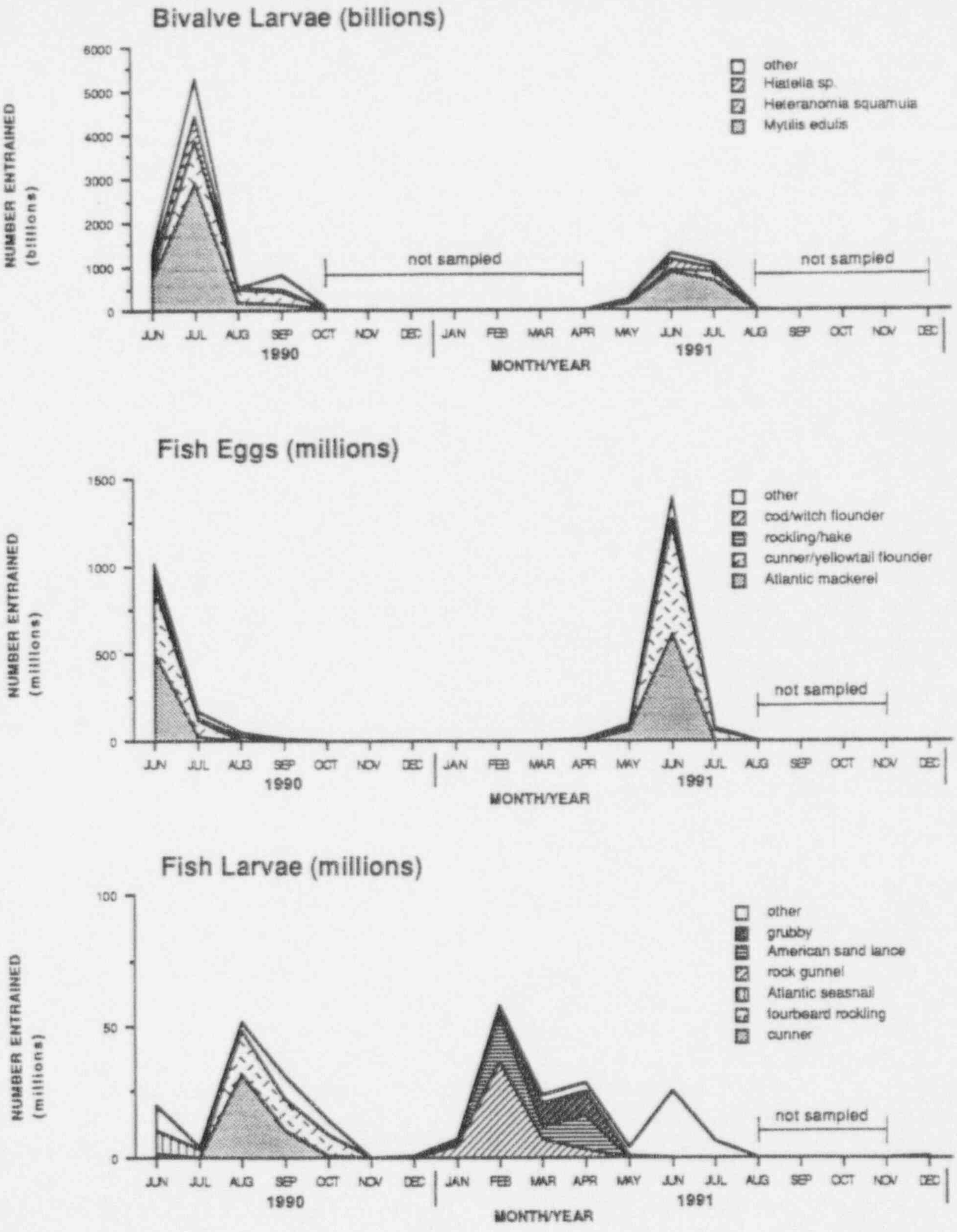


Figure 2.1-2. Number of bivalve larvae (billions), fish eggs (millions) and fish larvae (millions) entrained by Seabrook Station, 1990-1991. Seabrook Operational Report, 1991.

levels in local coastalwaters led to reduced entrainment. Peak total entrainment in both 1990 and 1991 occurred in mid-summer, coincident with peak abundances of *Mytilus edulis*. The lower abundances of *M. edulis* larvae observed in local coastal waters (P2, P5, P7) in 1991 compared to 1990 was reflected in lower entrainment levels.

During the periods sampled, entrainment of fish eggs reached peaks in June of both years. Levels of fish egg entrainment were an order of magnitude higher than for fish larvae (Figure 2.1-2). Approximately 95% of the ichthyoplankton entrained were fish eggs. Maximum fish larvae entrainment was recorded in the summer of 1990 and the winter of 1991, each peak involving different species. However, interannual differences in sampling periods make comparisons of total entrainment between 1990 and 1991 difficult. Cooling water flows were reduced during the scheduled outage from the second week in August through October 1991 (Figure 2.1-2); thus, entrainment samples were not collected. The seven months sampled in 1990 (June-December) did not include the late-winter peak in larvae abundance and the spring peak in egg abundance that were sampled in 1991. However, entrainment loss estimates in 1991 were of the same order of magnitude as 1990 even though nine months were sampled in 1991 and only seven months were sampled in 1990.

In 1991, Atlantic mackerel eggs (673.1 million) were the predominant eggs entrained, followed by cunner/yellowtail flounder (664.1 million) and Atlantic cod/witch flounder (69.4 million). Entrainment of each of these groups and entrainment of all species was greatest in June, consistent with offshore trends in abundance. The species composition of the entrainment community and the seasonal pattern of entrainment was similar in 1990 when Atlantic mackerel were most common (499.1 million) followed by cunner/yellowtail flounder (380.4 million and rockling/hake (86.1 million). Total entrainment in 1990 was also highest in June, among the months sampled, as was true in offshore collections.

In 1991, rock gunnel larvae were the predominant larvae entrained (51.1 million), followed by American sand lance (37.3 million) and grubby (22.4 million). Entrainment of rock gunnel and American sand lance larvae was greatest in February, while grubby larvae entrainment was greatest in April, paralleling peak offshore abundances. Total entrainment peaked in February. Species composition in 1990 was different from 1991, primarily due to the different months sampled. In 1990, cunner was the dominant fish larva entrained (42.7 million) followed by fourbeard rockling (37.9 million) and Atlantic seasnail (11.6 million). Peak entrainment of cunner and fourbeard rockling was in August and peak entrainment of Atlantic seasnail was in June, consistent with offshore trends. Among the months sampled, entrainment of all species was greatest in August.

Estimates of ichthyoplankton entrainment have little meaning by themselves. The potential effects of ichthyoplankton entrainment can only be determined by examining changes in ichthyoplankton and adult fish abundances in the study area. Potential changes in adult fish abundances due to ichthyoplankton entrainment would be demonstrable when the larval fish metamorphosed to juveniles and the juveniles are fully recruited to the population sampled by the gear utilized. The question of whether entrainment of ichthyoplankton and other planktonic organisms has affected the balanced indigenous population to date is addressed in the following sections on community structure and selected species.

Indigenous Plankton Communities

Background. The purpose of examining the community structure of entrainable plankton is to determine whether operation of Seabrook Station has had an effect on the balanced indigenous population of planktonic organisms inhabiting the waters in the vicinity of the intakes. Using the conservative assumption, it is assumed that all organisms entrained at Seabrook Station were lost to the study area, except as detritus. Changes in either the species composition or abundance of the natural population were examined for any potential effects resulting from entrainment. The community composition was considered unchanged if collections at the nearfield station in the operational period in a particular season were similar to the majority of samples from the same season from the preoperational years, causing the similarity analysis (numerical classification) to group them together. Potential operational effects were also ruled out statistically if community abundances in the August 1990 - December 1991 period were similar at the nearfield compared to previous years, or if differences in this period were consistent throughout the area, based on multivariate analysis of variance of the dominant taxa.

All of the planktonic communities discussed in this section had species assemblages that changed with season during the baseline period (NAI 1991b). These groups were differentiated primarily on the distribution and abundance of dominant species; however, the relative abundance or even absence of other species was also a factor. The species entrained depend on the seasonal assemblage present at the time.

Microzooplankton. Seasonal patterns of the natural assemblage of microzooplankton have historically been dominated by the population dynamics of the copepods *Oithona* sp. and *Pseudocalanus* sp. and the production of early lifestages (nauplius larvae) of other copepods that have been present year-round. Seasonally, other taxa such as polychaete larvae, bivalve larvae and tintinnids influenced community structure. Since Seabrook Station began commercial operation, species composition continued to resemble the historical patterns (Table 2.1-1). Similarity analysis of all microzooplankton collections indicated that 90% of the operational period collections were similar to preoperational collections. Late summer-early fall 1990 was unusual in having lower abundances of *Oithona* sp. and other dominant taxa than has been typically observed. However, no statistical differences in community structure were detected among stations in 1991. Therefore, entrainment by Seabrook Station has had no discernible impact on the balanced, indigenous microzooplankton population occurring within the nearfield study area through the 1990-1991 operational period.

Bivalve Larvae. Varying abundances of *Hiatella* sp., *Mytilus edulis* and *Heteranomia squamula* defined most seasonal groups identified by the similarity analysis. Community structure in 1991 differed significantly from recent preoperational years (1988 and 1989; Table 2.1-1) because high abundances of *Hiatella* sp. occurred earlier than usual and a number of summer collections contained relatively low abundances. However, the bivalve larvae community structure was statistically similar at nearfield and farfield stations both preoperationally and during the operational period. Entrainment of bivalve larvae in the circulating water system of Seabrook Station, therefore, has had no discernible effect to date on the bivalve larvae populations occurring within the nearfield study area.

Macrozooplankton. Species comprising the macrozooplankton community exhibit three basic life history patterns: holoplanktonic species remain planktonic throughout their life cycle; meroplanktonic species are planktonic during a specific lifestage; tychoplanktonic species are generally associated with the substrate but make regular excursions into the water column. Because the circulating water system could impact these organisms differentially, the tychoplankton assemblage was examined separately from the holo- and meroplankton assemblage.

Seasonal patterns in the holo- and meroplankton assemblage have been distinct and consistent, showing high predictability from year to year. Population dynamics of the dominant copepods (*Calanus finmarchicus*, *Temora longicornis* and *Centropages typicus*) have defined much of the annual cycle. Larvae of benthic species such as barnacles (Cirripedia) and crabs (*Cancer* sp.) have occurred in predictable patterns. This continued to be the case during the operational period; however, abundances in 1991 tended to be higher than in recent (1988-1989) preoperational years (Table 2.1-1). Therefore, this is attributable to broadscale events rather than the operation of Seabrook Station.

The annual cycle of the tychoplankton assemblage has been characterized by changes in relative abundances of four omnipresent (*Neomysis americana*, *Pontogeneia inermis*, *Diastylis* sp. and Oedicerotidae) and two intermittent (Harpacticoida and *Mysis mixta*) dominants. Seasonal groupings of the tychoplankters are less distinct and more variable than for the holo-/meroplankton assemblage for several reasons. Most taxa occur throughout the year and appear to fluctuate only moderately in abundance. In addition, the affinity of these taxa for the substrate may result in a sampling bias since abundances are estimated from oblique tows.

The tychoplankton assemblage varied significantly between 1991 and recent preoperational years (Table 2.1-1), with some species occurring in higher abundances and others in lower abundances in 1991. Differences among stations, however, have been well-documented for the tychoplankton assemblage (NAI 1991b) and are attributable to differences in substrate type and complexity as well as proximity to Hampton-Seabrook estuary. These station differences were consistent between preoperational and operational periods (Table 2.1-1), indicating that Seabrook Station has had no immediate effect on dynamics of this assemblage.

Ichthyoplankton. Changes in either the species assemblages or abundance of the nearfield station were examined for any potential effect on the ichthyoplankton community in the study area (Table 2.1-1). Similarity analysis (numerical classification) based on the abundance of 11 dominant taxa of fish eggs indicated that the time of year was the only factor related to the changes in fish egg species assemblages. Cunner/yellowtail flounder were the most abundant fish eggs found in the study area and they were predominant in the mid-spring through early summer. Hake/fourbeard rockling were the second most abundant fish eggs and they were dominant in late spring through early fall. The pattern of succession of the eight seasonal fish eggs groups was consistent between the preoperational and operational periods. There was also a high degree of similarity of the fish egg assemblages between the nearfield and farfield stations.

Similarity analysis also identified eight seasonal groups within the fish larvae community; there was no tendency for samples to group selectively according to plant operational status, year or station. Time of year was the primary factor in determining sample groups. American sand lance were the most abundant fish larvae followed by cunner and mackerel. American sand lance were most common in the winter through early spring while cunner and mackerel were most common in early summer.

Seasonal patterns of the ichthyoplankton assemblages were very consistent between the preoperational and operational periods (Table 2.1-1). Differences in the abundances of ichthyoplankton occurred between the preoperational and operational periods; however, these changes were consistent between the nearfield and farfield stations (Table 2.1-1). Changes occurring at both the nearfield and farfield stations do not appear to be attributable to the operation of Seabrook Station and are probably due to factors that operated on a larger geographic scale than the study area. Such factors may be broad scale environmental influences on the plankton or changes in the numbers or fecundity of spawning adults, both within and outside the study area.

Selected Species of Indigenous Plankton

Zooplankton. Ten indigenous zooplankton taxa and their major planktonic lifestages were monitored to evaluate effects of entrainment at Seabrook Station. Most lifestages of the selected taxa attained similar abundances in 1991 to those occurring in recent preoperational years (Table 2.1-2). Distribution of all taxa among the stations was homogeneous. Thus, no effects of the operation of Seabrook Station on these taxa were apparent in the nearfield study area.

Lifestages of several taxa (*Eurytemora* sp. copepodites, *Pseudocalanus/Calanus* nauplii, and *Neomysis americana*) occurred in greater abundance preoperationally than during 1991. Preoperational abundances of lifestages of three taxa (*Oithona* sp., *Mytilus edulis* larvae and *Cancer* sp. larvae) were lower than in 1991 (Table 2.1-2). In each case, changes in abundance were consistent at all stations, as they were in 1990. Thus, there is no evidence that the first 17 months of operation of Seabrook Station has significantly impacted populations of the zooplankton in the study area.

Ichthyoplankton. Nine species of fish were selected for detailed analyses of larval abundance patterns between the preoperational and operational periods and among stations (Table 2.1-2). For three of these species, American sand lance, cunner, and hake sp., there were no significant differences in the larval densities between the preoperational and operational periods or among stations. This indicates that the entrainment losses from Seabrook Station had no immediate impact on the level of larval densities of these species within the nearfield area.

Larval densities of two species, Atlantic cod and Atlantic mackerel, were greater during the operational period than the preoperational period and this increase was observed at all stations. The spawning stock biomass of Atlantic cod and the age 1 stock biomass of Atlantic mackerel have both increased since 1986 (NOAA 1991b). The increase in larval densities of these species in the study area may be due to an increase in the biomass of potential spawning adults.

The larval densities of three species, yellowtail flounder, Atlantic herring, and pollock were significantly lower during the operational period than the preoperational period. The decrease in larval densities in the operational period was observed at all stations indicating the cause of the decrease in density was not due to the operation of Seabrook Station. The National Marine Fisheries Service biomass indices for yellowtail flounder and pollock have decreased since the early 1980s. Thus, the decrease in larval densities in recent years may be a result of decreases in the abundance of spawning adults in the region.

Larval densities of winter flounder were also lower in the operational period. During both the operational and preoperational periods, the density of winter flounder larvae was lower at the farfield area than the nearfield area. The Preop-Op X Station interaction term for winter flounder larvae was not significant indicating that the decline in abundance between the operational and preoperational periods was proportional

TABLE 2.1-2. SUMMARY OF POTENTIAL EFFECTS (BASED ON ANOVA RESULTS) OF OPERATION OF SEABROOK STATION INTAKE ON ABUNDANCES OF SELECTED INDIGENOUS SPECIES. SEABROOK OPERATIONAL REPORT, 1991.

PLANKTON SELECTED SPECIES AND LIFESTAGES	OPERATIONAL PERIOD SIMILAR TO PREOPERATIONAL PERIOD?	DIFFERENCES BETWEEN OPERATIONAL AND PREOPERATIONAL PERIODS CONSISTENT AMONG STATIONS?
Eurytemora sp. copepodites	Op<Preop	yes
E. herdmani adults	yes	yes
Pseudocalanus/Calanus nauplii	Op<Preop	yes
Pseudocalanus sp. copepodites	yes	yes
adults	yes	yes
Oithona sp. nauplii	Op>Preop	yes
copepodites	Op>Preop	yes
adults	Op>Preop	yes
Calanus finmarchicus		
copepodites	yes	yes
adults	yes	yes
Mya arenaria larvae	yes	yes
Mytilus edulis larvae	Op>Preop	yes
Crangon septemspinosa larvae	yes	yes
Cancer crab larvae	Op>Preop	yes
Carcinus maenas larvae	yes	yes
Neomysis americana	Op<Preop	yes
American sand lance larvae	yes	yes
Winter flounder larvae	Op<Preop	yes
Atlantic cod larvae	Op>Preop	yes
Yellowtail flounder larvae	Op<Preop	yes
Atlantic mackerel larvae	Op>Preop	yes
Cunner larvae	yes	yes
Hake larvae	yes	yes
Atlantic herring larvae	Op<Preop	yes
Pollock larvae	Op<Preop	yes

between the nearfield and farfield areas. The National Marine Fisheries Service biomass index for winter flounder has been declining since its peak in 1983, suggesting a regional decline in spawning stock. Thus, there was no direct effect due to entrainment losses resulting from the operation of Seabrook Station.

2.1.2 Impingement

Background

Finfish have been monitored in the vicinity of Seabrook Station to assess the effects of impingement, as well as any other plant-related effects, on the balanced, indigenous population within the coastal waters of New Hampshire. Because of the mid-water location of the intake structure, it was assumed that pelagic species would be most likely to be impinged.

The number of fish impinged, rate of fish impingement, and species composition of the impingement community at Seabrook Station differed between 1990 and 1991 (Figure 2.1-3). Impingement increased from 499 fish in 1990 to 1,019 fish in 1991 (Table 2.1-3). Impingement rate also increased from 2.5 fish/10^9 gallons in 1990 to 5.5 fish/10^9 gallons in 1991. The increase in impingement and impingement rates between 1990 and 1991 is most likely due to a strong northeastern storm in October. This storm may have increased the vulnerability of some species, especially winter flounder, to impingement. Despite the increase in impingement in 1991, fewer fish were impinged in 1991 compared to a test period from June through December 1986, when 1,212 fish were impinged.

The composition of the impingement community differed between 1990 and 1991 (Figure 2.1-3). Windowpane flounder, pollock and winter flounder were most

TABLE 2.1-3. COMPARISON OF IMPINGEMENT AT NEW ENGLAND POWER PLANTS WITH MARINE INTAKES. SEABROOK OPERATIONAL REPORT 1991.

STATION	PERIOD	NUMBER OF FISH IMPINGED ANNUALLY	
Pilgrim Station[a]	1973-1990	1,143-87,752	mean = 17,043
Salem Harbor Electric Generating Station[b]	1989 1974	3,472[c] 39,578	
Millstone Station[d]	1976-1988	16,266-511,387	mean = 101,953
Seabrook Station	1990 1991	499 1,019	mean = 759

[a] Boston Edison (1991)
[b] Robert DeHart pers. comm., Massachusetts Division of Marine Fisheries (1975)
[c] 1989 is most recent data available.
[d] NUSCo (1987)

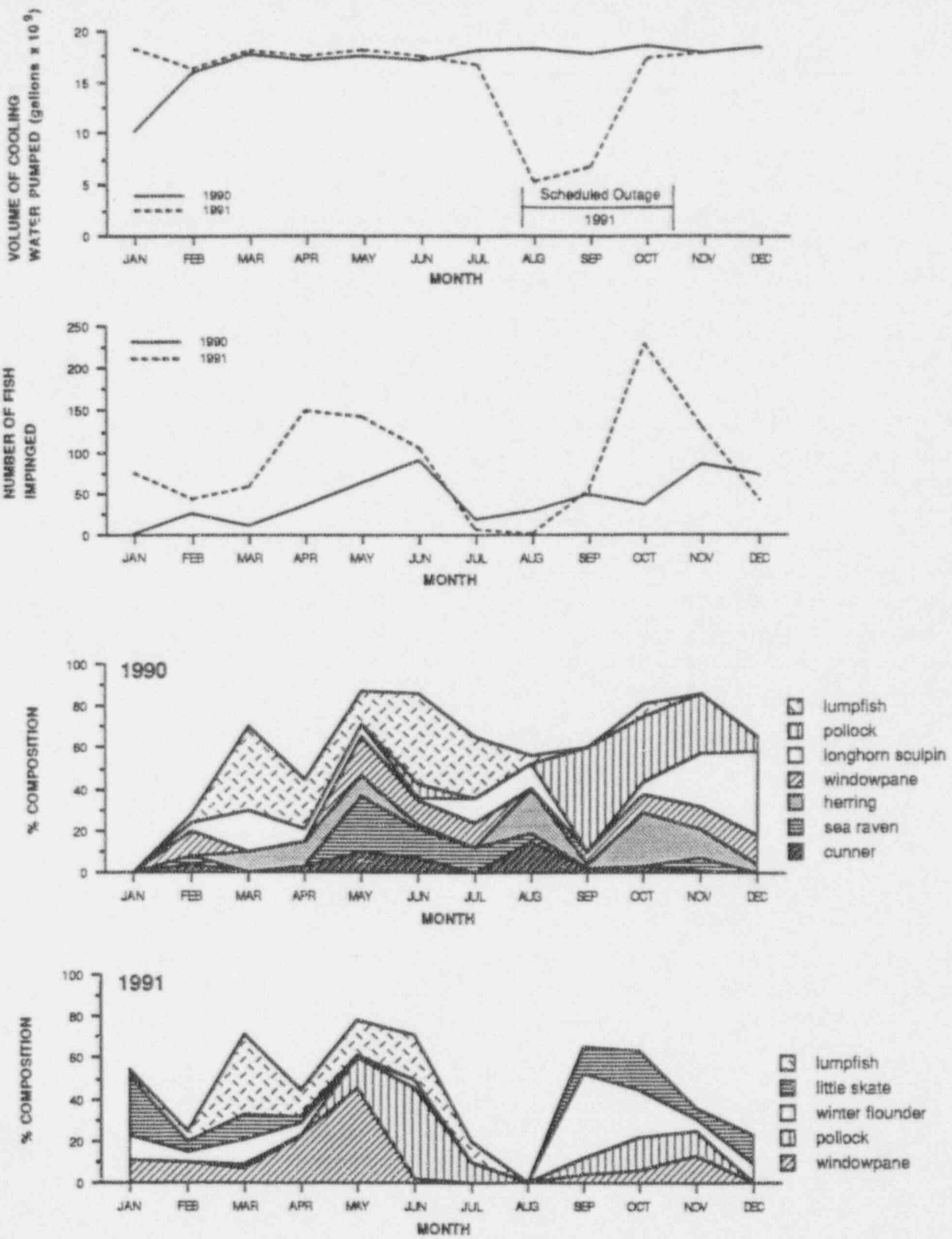


Figure 2.1-3. Volume of cooling water pumped and finfish impinged at Seabrook Station during 1990 and 1991. Seabrook Operational Report, 1991.

frequently impinged in 1991 compared to lumpfish, pollock and longhorn sculpin in 1990. As in previous years, few pelagic species were impinged in 1991. The species composition of fish impinged in 1990 and 1991 more closely resembled the species composition of the demersal fish community than the community described by mid-water gill net catches. The low abundance of pelagic species in impingement collections suggests that the intake caps are performing as designed to minimize entrapment. The increase in winter flounder impingement in 1991 was partially due to a storm event in late October that apparently increased the vulnerability of winter flounder to impingement. Storm events have resulted in increased impingement of winter flounder at other power plants (NUSCo 1987).

The number of fish impinged at Seabrook Station is smaller than the number impinged at other electrical generating stations in New England identified by the Utility Water Act Group (Tetra Tech 1978) as having marine intakes (Table 2.1-3). Moreover, the largest yearly number of fish impinged at Seabrook Station to date is less than the smallest yearly number of fish impinged at any other station.

To put impingement losses in perspective, the number of fish impinged at Seabrook Station was compared to the recreational catch of fish in the marine waters of New Hampshire. The National Marine Fisheries Service estimates that 1,584,000 marine fish were captured by recreational anglers in the marine waters of New Hampshire during 1989, the most recent year for which statistics are available (NOAA 1991a). Of these fish, approximately 27% were released alive, resulting in a harvest of 1,156,000 fish. Assuming that the recreational harvest of marine fishes was of the same order of magnitude in 1991 as 1989, fish losses due to impingement at Seabrook Station in 1991 were negligible when compared to the losses due to recreational harvest of marine fishes in New Hampshire.

Effects on Pelagic Fish Population in the Study Area

It was expected that any potential effects due to operation of Seabrook Station would be detectable in the pelagic fish community. The intake structure withdrew water from the water column, which is the habitat of pelagic fish. However, the species composition of fish impinged at Seabrook Station was more similar to the demersal fish community than the pelagic fish community. Plant operations have not resulted in the impingement of large numbers of pelagic fish. The effects of plant operation on the demersal fish community are discussed in Section 2.2.2.

Atlantic herring, Atlantic mackerel and pollock are the primary constituents of the pelagic fish community in the study area as identified through gill net collections (Figure 2.1-4). Trends in catch per unit effort in the study area (Table 2.1-4) and long term population trends as observed by the NMFS in the Gulf of Maine and Georges Bank do not agree closely. The disagreements may be due to differences in sampling gear. The NMFS survey uses a high-rise

TABLE 2.1-4. SUMMARY OF POTENTIAL EFFECTS OF OPERATION OF SEABROOK STATION INTAKE ON ABUNDANCES OF PELAGIC FINFISH. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER	OPERATIONAL PERIOD SIMILAR TO PREOPERATIONAL PERIOD? [a]	DIFFERENCES BETWEEN OPERATIONAL AND PREOPERATIONAL PERIODS CONSISTENT AMONG STATIONS? [a]
Community	Op<Preop	yes
Atlantic herring	Op<Preop	yes
Atlantic mackerel	yes	yes
Pollock	yes	yes
Spiny dogfish	Op>Preop	yes

[a]based on ANOVA results, except spiny dogfish

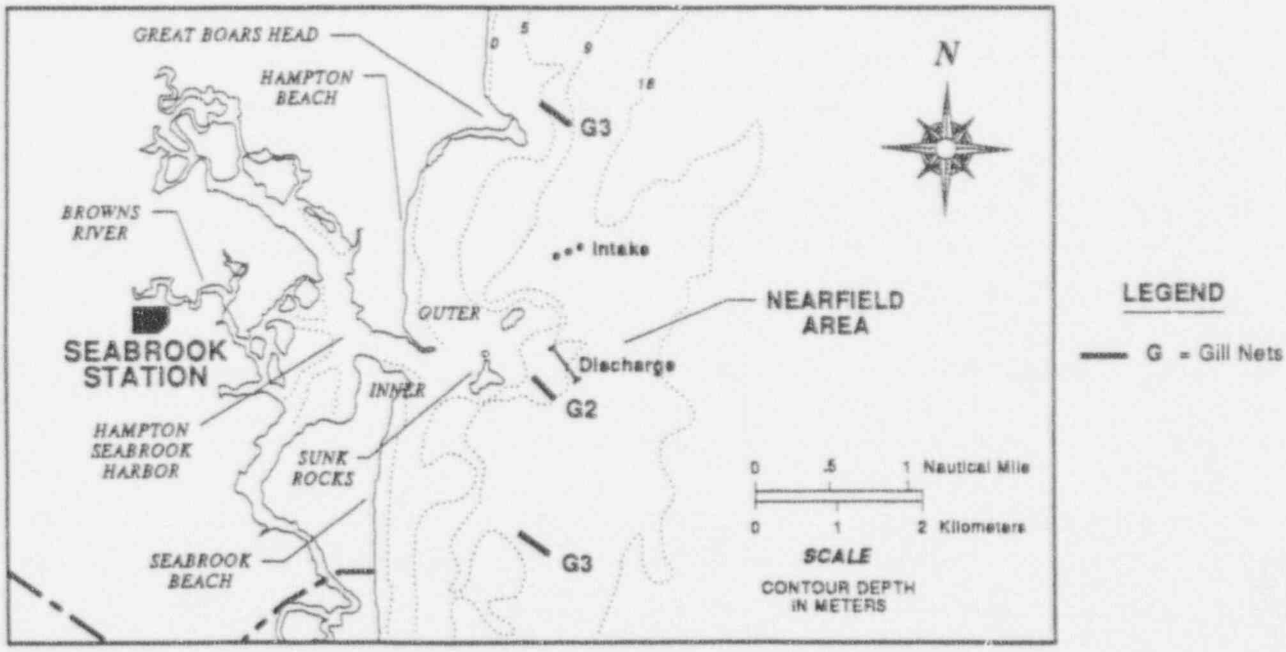


Figure 2.1-4. Pelagic finfish sampling stations. Seabrook Operational Report, 1991.

otter trawl to monitor pelagic fish abundance, while the monitoring in the study area is conducted with gill nets.

The NMFS Atlantic herring index of Age 2+ biomass, and the Atlantic mackerel index of Age 1+ biomass for the Gulf of Maine have increased dramatically since 1983. However, these dramatic increases have not been observed in the study area. CPUE of Atlantic herring in the study area has decreased steadily since 1980 (Table 2.1-4). CPUE of Atlantic mackerel has increased slightly in recent years with the 1990 CPUE being the greatest observed. CPUE of pollock has been relatively stable in the study area while the NMFS biomass index has decreased steadily since 1986.

The major change in the pelagic fish community in the study area has been an increase in the abundance of spiny dogfish (Table 2.1-4). Until the early 1980s, spiny dogfish CPUE in the gill nets was negligible. Since the early 1980s, spiny dogfish CPUE has increased so that it is generally one of the five most abundant fish each year. The NMFS biomass estimate for spiny dogfish in the Gulf of Maine-middle Atlantic region increased steadily since 1985 and was at a record level in 1990 (NOAA 1991b). Spiny dogfish comprised 41% of the species composition on Georges Bank in 1986 as opposed to 2% in 1963 (NOAA 1991b). This dramatic increase in spiny dogfish abundance in the study area cannot be attributed to the operation of Seabrook Station because it also occurred over a wide geographic area that extended throughout the Gulf of Maine, Georges Bank and middle Atlantic areas.

2.2 DISCHARGE AREA STUDIES

2.2.1 Plume Entrainment

Because the discharge plume's largest exposure will be to surface and near-surface waters, the primary focus in this section will be on parameters or organisms in this part of the water column, namely nearfield water quality parameters, phytoplankton and lobster larvae (Figure 2.2-1). Other organisms, such as zooplankton, pelagic fish and ichthyoplankton will, of course, have some exposure to the discharge plume, but it is assumed that entrainment and/or impingement are the more important issues for these organisms.

Water Quality

The first question to be answered is whether there have been changes in the physical/chemical characteristics of the water column in the study area which could have a bearing on the biotic communities. Further, if there have been changes do they appear to be plant-induced? In general, surface nutrient values were the same in 1990 and 1991 as in the preoperational period,while salinity, dissolved oxygen and water temperatures at the surface and bottom have shown differences between the preoperational and operational periods (Table 2.2-1). These differences are the focus of the following summary.

Temperature. Characteristics of the thermal plume resulting from cooling water discharge have been estimated from hydrothermal modeling studies (Teyssandier et al. 1974), and confirmed in recent field studies (Padmanabhan and Heckler 1991). The extent and temperature rise associated with the thermal plume will vary depending on ambient hydrographic conditions. Results from field studies generally confirmed initial model results, indicating that the discharge plume area was relatively small under the conditions tested. A surface temperature increase of 1.7°C (3°F) extended over an area less than 32 acres around the discharge area.

Continuous Temperature Data. Differences were noted in the monthly means of the continuously monitored temperature data supplied by YAEC for the period of plant operation. The difference in monthly mean temperature between the discharge station (DS, Figure 2.2-2) and farfield Station T7 gives an indication of the temperature increase from Seabrook Station. This difference varied seasonally; the greatest differences (1.0-1.8°C) occurred in the late fall and winter months (December 1990 - March 1991, November - December 1991; Figure 2.2-2). During summer months (July and August 1990 and 1991), mean surface water temperature at the discharge was actually cooler than at T7 (Δt = -0.1 to -0.4°). The well-developed thermocline in these months caused entrainment of cooler near-bottom water by the intakes and discharge diffusers. The differences in mean temperature during September and October in 1991 were smaller than those that occurred in 1990; due to the scheduled outage, heated water was not discharged. At Station ID, midway between DS and T7, mean monthly temperatures were always within 0.22°C of those

TABLE 2.2-1. SUMMARY OF POTENTIAL EFFECTS OF OPERATION OF SEABROOK STATION ON WATER QUALITY PARAMETERS. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER	OPERATIONAL PERIOD SIMILAR TO PREOPERATIONAL PERIOD? [b]	DIFFERENCES BETWEEN OPERATIONAL AND PREOPERATIONAL PERIODS CONSISTENT AMONG STATIONS? [b]
Temperature -		
Surface	Op>Preop	Yes
Bottom	Op>Preop	Yes
Salinity -		
Surface	Op<Preop	Yes
Bottom	Op<Preop	Yes
Dissolved Oxygen -		
Surface	Op<Preop	Yes
Bottom	Op<Preop	Yes
Orthophosphate - Surface	Yes	Yes
Total phosphorus - Surface	Yes	Yes
Nitrite - Surface	Yes	Yes
Nitrate - Surface	Yes	Yes
Ammonia - Surface	Yes[a]	Yes

[a]Analytical methods for ammonia changed in April 1988; preoperational data for ammonia therefore includes April 1988 through December 1989.
[b]Based on ANOVA results.

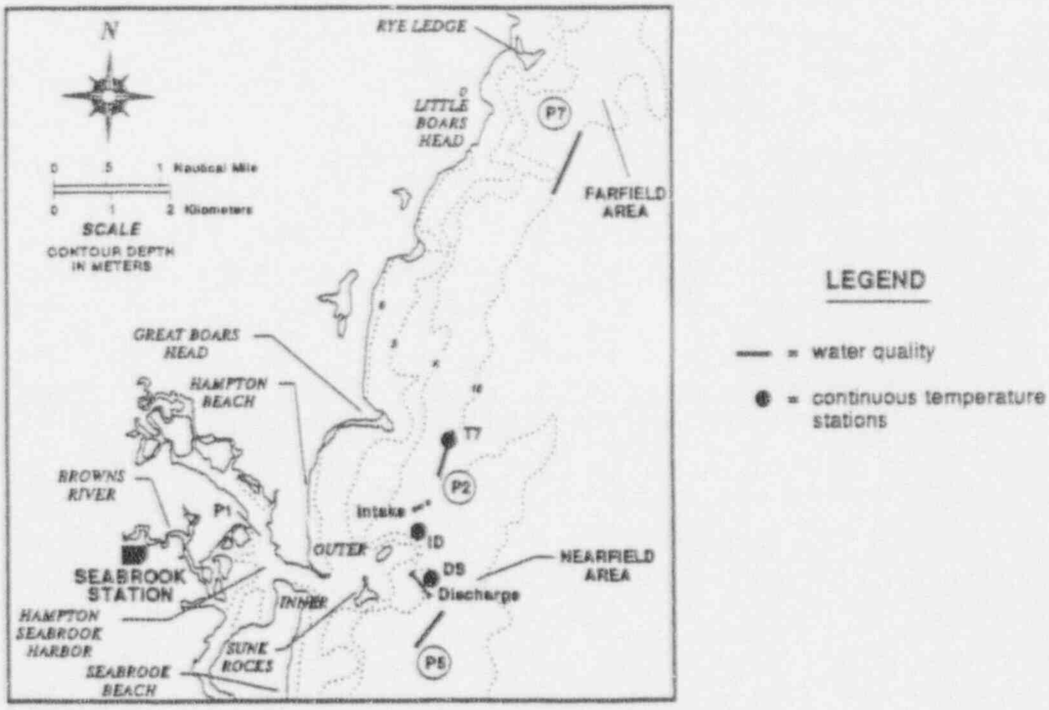
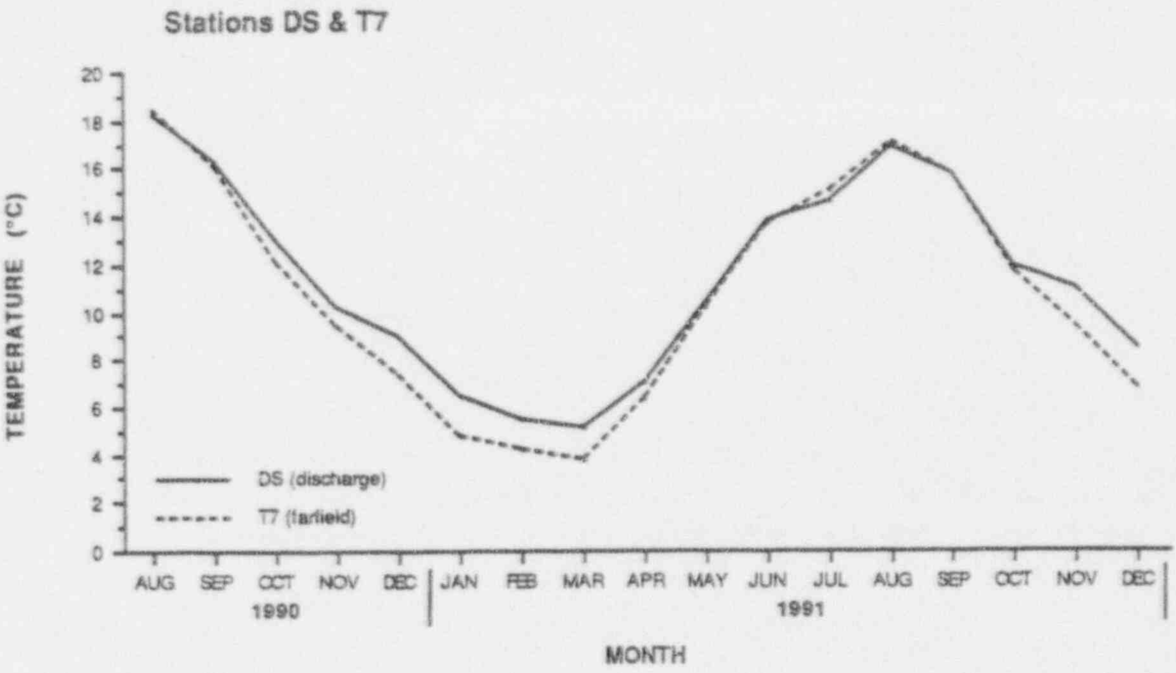


Figure 2.2-1. Water quality and continuous temperature monitoring sampling stations. Seabrook Operational Report, 1991.



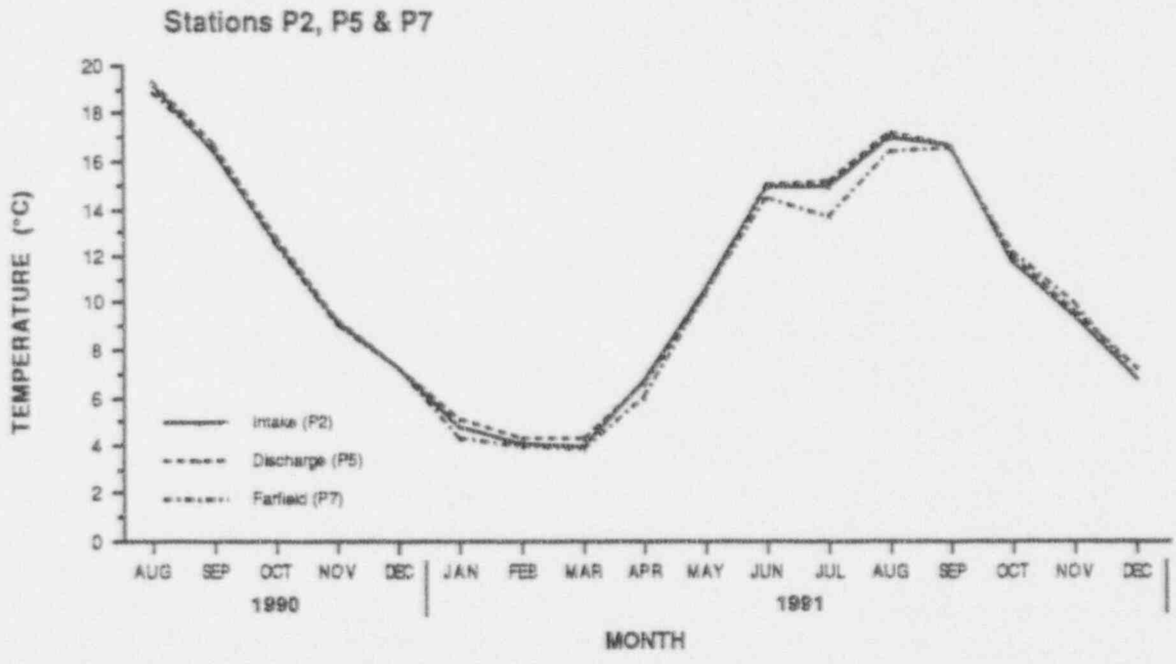


Figure 2.2-2. Comparison of monthly mean temperature (°C) between discharge Station DS and farfield Station T7 and among intake Station P2, discharge Station P5 and farfield Station P7. Seabrook Operational Report, 1991.

at T7, indicating that dissipation of the thermal plume was virtually complete when it reached ID, 900 meters from the discharge. Monthly mean mid-depth and bottom temperatures at Station ID were usually cooler than at farfield Station T7. No distinct seasonal pattern was apparent for mid-depth, possibly because of varying thermocline depths between 1990 and 1991. Differences in mean bottom temperature appeared to follow a strong seasonal pattern with temperature most similar at ID and T7 in August through October and most different in late fall through winter months.

Discrete Temperature Data. Water temperature was monitored over 21 sampling periods annually in the nearfield at Stations P2 (between T7 and the plant intake structure; Figure 2.2-1), P5 (south of DS) and at farfield station P7 (near Rye Ledge) over the preoperational and operational periods in conjunction with plankton sampling. The annual mean surface temperature at Station P2 was the highest observed during fourteen years of monitoring and statistically higher than the preoperational mean value. However, since continuous temperature data indicate that the thermal plume had dissipated before reaching Station ID, temperature increases related to plant operation would not be expected at stations farther away, such as Stations P2 or P5 (Figure 2.2-2). Although surface and bottom temperatures have varied significantly among stations (P5>P2>P7), these differences have been consistent regardless of the operational status of Seabrook Station. It is likely that temperatures at Stations P2 and P5 are influenced by the Hampton-Seabrook estuary, whose ebb tide plume extends to the intake and discharge areas. Therefore, it is unlikely that the higher surface temperature in 1991 can be related to operation of Seabrook Station. It appears that water temperature increases are most likely due to recent climatological changes which have increased local temperatures (Boston Globe 1992). Because of the higher air temperatures on a regional basis, and because the thermal plume is buoyant, it is unlikely that operation of Seabrook Station has influenced bottom temperatures at Stations P2, P5 or P7, even though they were significantly higher in 1991.

Dissolved Oxygen and Salinity. Reduced levels of dissolved oxygen in 1991 compared to 1987-1989 (Table 2.2-1) may be related to increased temperatures in both surface and bottom waters. Dissolved oxygen has shown a generally inverse relationship to temperature within each depth zone. In 1991, mean values in surface and bottom waters were about the same levels that occurred in 1982, coincident with the third highest annual surface temperatures (NAI 1991b). The trend towards reduced values was apparent beginning in April 1990, prior to power generation at Seabrook Station. This, coupled with the fact that dissolved oxygen concentrations exhibited similar patterns at Stations P2, P5 and P7, over the same time period indicates that operation of the plant was not a factor in reducing dissolved oxygen levels but that they were part of area-wide changes in 1991.

Both surface and bottom salinity were lower, on average, in 1991 than in 1987-1989 (Table 2.2-1), although the seasonal trends differed with depth. Surface salinities were depressed in May and September through December 1991, whereas bottom salinities, normally less variable, were depressed during the entire year. Both conditions were consistent at nearfield (P2 and P5) and farfield (P7) stations reflecting unusually high precipitation in May and in the fall of 1991 (Section 3.3.1). As no freshwater is discharged through the cooling water system at Seabrook Station, there is no implication of plant impacts on salinity.

Phytoplankton

Following an approved reduced program effort, monitoring of the phytoplankton community was resumed in 1990, prior to the commercial operation of Seabrook Station (Figure 2.2-3). Annually and seasonally, there has been high variability in phytoplankton species composition and abundance. However, the dominant taxa were usually diatoms, with seasonal contributions by yellow-green algae (some years) and dinoflagellates. Total abundances were similar in 1991 to preoperational years (Table 2.2-2); although species composition varied from earlier years. Diatoms continued to dominate the phytoplankton in 1991, with the dominant diatom, *Skeletonema costatum*, reaching higher abundances in 1991 than in previous years. However, as was also found for total phytoplankton, patterns were similar at nearfield and farfield stations in 1991. Therefore differences in species abundance and composition represented natural, not plant-induced, variability. During both operational years, abundances of ultraplankton (<10 μm in length) were similar in farfield and nearfield areas, and other Gulf of Maine researchers have observed ultraplankton abundances at levels similar to those in the Seabrook study area. There is substantial indication that improved microscopy, in fact, has allowed closer attention to and hence better quantification of ultraplankton in recent years (Hall and Vincent 1990, Stockner 1988). It is unlikely, then, that the apparent increase in ultraplankton reported in 1990 was induced by operation of Seabrook Station.

Chlorophyll *a* levels provide a measure of phytoplankton standing crop, tempered somewhat by varying amounts of pigment contained in different sizes and species of phytoplankton. A comparison of chlorophyll *a* in 1991 to 1987-1989 indicated that there were no changes in the nearfield (Table 2.2-2), indicating no plant effects.

In addition to the above, nuisance algae were monitored by tracking the occurrence of paralytic shellfish poisoning (PSP), caused by blooms of the dinoflagellate *Alexandrium tamarense* (formerly *Gonyaulax* sp.) in the Gulf of Maine. Although PSP was detected in 1991, it never reached the levels (80μg/100g mussel tissue) mandating closure of shellfish beds in New Hampshire waters. Because areas both north and south of New Hampshire experienced closures in 1991 due to PSP, New Hampshire shellfish beds were also closed in 1991 as a cautionary measure. Because

TABLE 2.2-2. SUMMARY OF EVALUATION OF DISCHARGE PLUME EFFECTS ON THE PHYTOPLANKTON AND LOBSTER LARVAE IN THE VICINITY OF SEABROOK STATION. SEABROOK OPERATIONAL REPORT, 1991.

COMMUNITY/ SPECIES	PARAMETER [a]	OPERATIONAL PERIOD SIMILAR TO PREVIOUS YEARS?	NEARFIELD-FARFIELD DIFFERENCES CONSISTENT WITH PREVIOUS YEARS?
Ultraplankton (<10μm)	Composition	Op>Preop	yes
Phytoplankton (≥10μm)	Abundance	yes	yes
	Composition	sometimes	some spatial differences
<u>Skeletonema costatum</u>	Abundance	yes	yes
Chlorophyll <u>a</u>	Concentration	yes	yes
Lobster larvae	Abundance	Op>Preop	yes

[a]Community evaluated qualitatively, remainder evaluated with ANOVA.

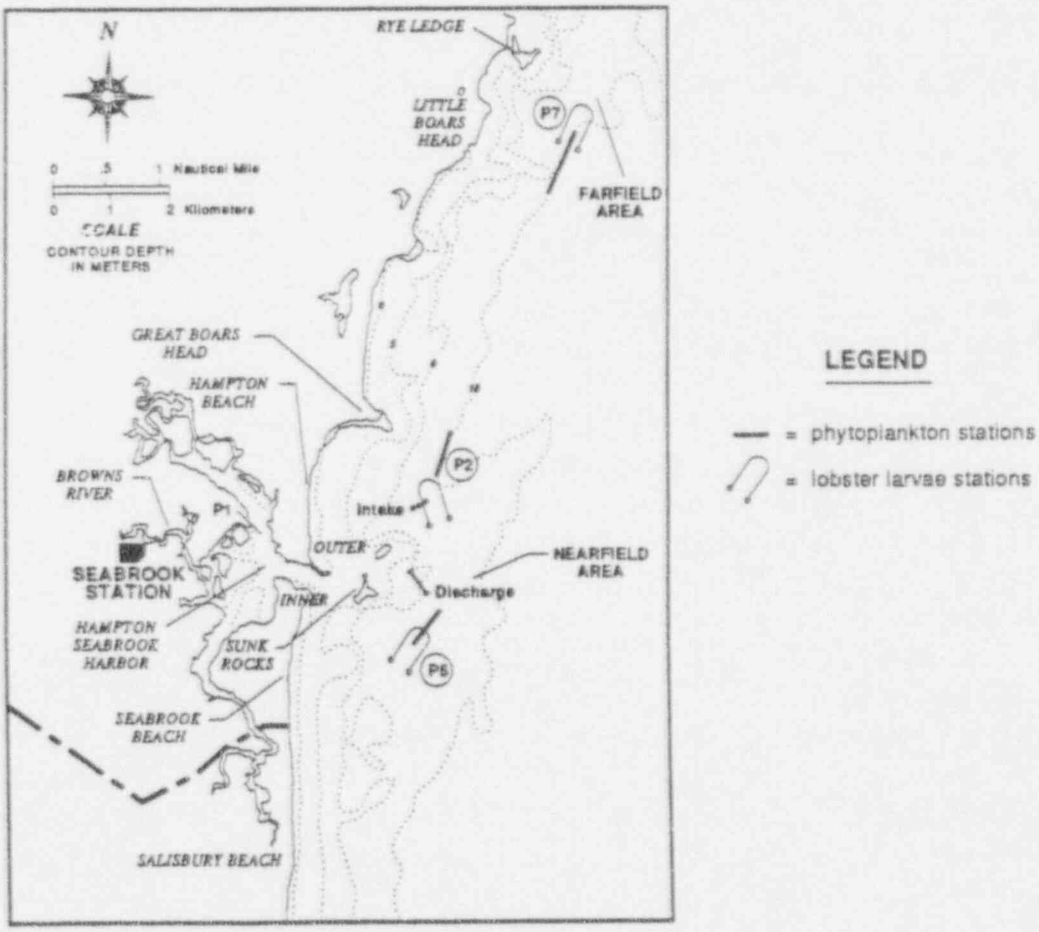


Figure 2.2-3. Phytoplankton and lobster larvae sampling stations. Seabrook Operational Report, 1991.

of PSP's historical presence, its concurrent presence in Maine and Massachusetts and the fact that the projected source of blooms is from outside the study area, it is very unlikely that episodes of elevated PSP are related to operation of Seabrook Station.

Lobster Larvae

Lobster larvae have traditionally been thought of as strictly neustonic, although current research suggests that they are distributed throughout waters above the thermocline (Harding et al. 1987, Boudreau 1991). Lobster larvae were the only shellfish larvae that were evaluated for discharge plume effects. The most important effect of the discharge plume entrainment would be in the survival, molting and successful bottom settlement of Stage IV lobster. Adult lobsters in the study area are recruited from Stage IV larvae (the stage prior to benthic settlement) originating from the Gulf of Maine and Georges Bank (Harding et al. 1983). Although the level of adult recruitment has been correlated with abundances of larvae (Harding et al. 1982, Harding et al. 1983), others have failed to confirm this relationship (Fogarty and Idoine 1986). Recent research indicates that successful benthic recruitment of larval lobsters is affected more by habitat availability for the early benthic phase than by larval abundance (Wahle and Steneck 1991). Lobster larvae have historically been relatively rare in the study area, averaging less than 1 per 1000 m^2. Densities in 1990 and 1991, particularly Stage IV larvae, however, were significantly higher than observed historically at all three stations (Table 2.2-2). Thus they are part of an area-wide increase rather than an effect of plant operation. Density increases appear to be unrelated to the increase in the legal size limits because Stage IV larvae, the predominant lifestage, do not originate in the study area.

Fouling Community

Subsurface (-3 m) "fouling" panels, placed in the projected inner (B19) and outer (B04) discharge plume areas and at farfield areas (Figure 2.2-4), were established to help monitor impacts to the types, timing and abundances of typically-benthic organisms that can settle on hard substrate. Short-term panels, exposed for one month, allow estimation of recruitment levels while monthly sequential panels, exposed for 1-12 months, show the development of the fouling community. Community parameters (total biomass, abundance of noncolonial fauna, and richness of faunal taxa) showed seasonal patterns in 1991 that were similar to previous years and between nearfield and farfield areas. Seasonal changes in the settling community composition in 1991 and in the operational period of 1990 were consistent with those observed historically. Nearfield-farfield differences in community structure occurred occasionally during the operational period, but no more frequently than observed historically. Other measures of the settling community structure in 1991 were either similar to previous years or differed in 1991 at both nearfield and farfield stations, indicating an area-wide change that was unrelated to plant operation

TABLE 2.2-3. SUMMARY OF EVALUATION OF DISCHARGE PLUME EFFECTS ON THE FOULING COMMUNITY IN THE VICINITY OF SEABROOK STATION. SEABROOK OPERATIONAL REPORT, 1991.

COMMUNITY	AREA/DEPTH ZONE	PARAMETER [a]	OPERATIONAL PERIOD SIMILAR TO PREVIOUS YEARS?	NEARFIELD-FARFIELD DIFFERENCES CONSISTENT WITH PREVIOUS YEARS?
Fouling community: Settlement[c]	Inner plume	Abundance	yes	yes
		No. of taxa	Op>Preop	yes
		Biomass	yes	yes
	Outer plume	Abundance	Op>Preop	yes
		No. of taxa	Op>Preop	yes
		Biomass	yes	yes
Fouling community: Development[c]	Inner plume	Abundance	yes	yes
		No. of taxa	Op>Preop	yes
		Biomass	no	NF:Op=Preop FF:Op<Preop
	Outer plume	Abundance	yes	yes
		No. of taxa	yes	yes
		Biomass	yes	yes
Fouling community Settlement	Inner plume	Mytilidae	no	NF:Op>Preop FF:Op=Preop
	Outer plume		Op>Preop	yes
	Inner plume	Jassa marmorata	yes	yes
	Outer plume		yes	yes
	Inner plume	Tubularia sp.	Op<Preop	yes
	Outer plume		yes	yes

[a]Abundance, no. of taxa, biomass, total density, evaluated using ANOVA; community structure evaluated using numerical classification
[b]NF = nearfield FF = farfield
[c]Settlement = short term panels; Development = MS panels

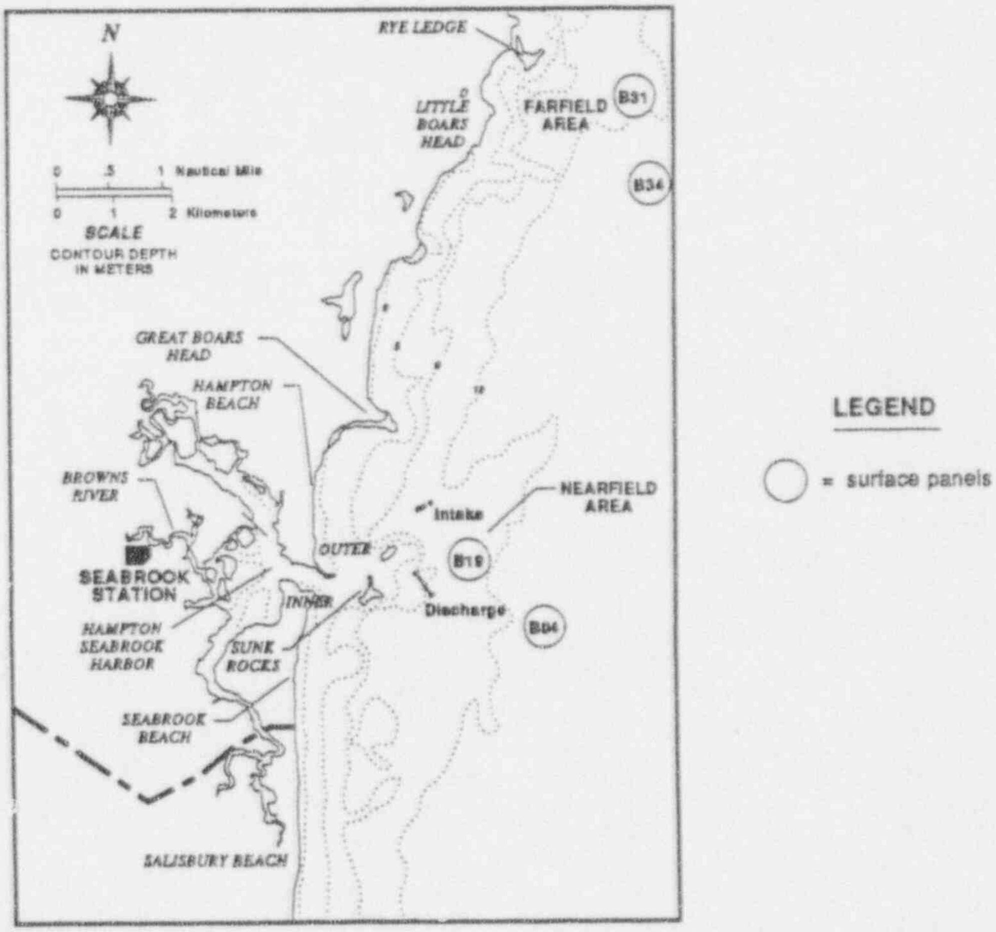


Figure 2.2-4. Surface panel sampling stations. Seabrook Operational Report, 1991.

(Table 2.2-3). Community development parameters showed no differences that were restricted to the nearfield stations.

Seasonal patterns of dominant species in the settling community in 1991 were similar to previous years, although some differences in abundance levels were noted. Mytilidae spat (mainly juvenile blue mussels), the dominant settling organism, showed significantly higher abundances at the nearfield inner plume Station B19 and at both nearfield and farfield Stations B04 and B34 (Table 2.2-3). Significantly higher-than-average abundances also occurred prior to plant start-up at both nearfield stations in 1990 as well as one of the farfield stations (NAI 1991b). 1990 and 1991 annual abundances of *Mytilus edulis* larvae were likewise higher than average. Increased mytilid abundances that occurred at the nearfield/farfield station pairs in 1991 can be regarded as unrelated to plant operation. The trends in mytilid abundances on panels at the discharge station represent a more-complex situation. Elevated densities that occurred only at the inner plume nearfield station may be indicative of higher-than-average densities in the study area, as occurred at the other stations further offshore. On the other hand, high densities of mytilids restricted to the nearfield inner plume station may be a result of environmental conditions that could include plant operation. Although mytilid abundances were elevated at the nearfield station in 1991, they are still lower than the exceptionally-high densities observed in 1990 and thus represent a return to near-average conditions.

<u>Intertidal/Shallow Subtidal Benthic Community</u>

<u>Background</u>. The Outer Sunk Rocks and nearby shallow subtidal (4.6 m depth) areas are monitored to ascertain potential nearfield effects of the discharge plume on the nearest land form (Figure 2.2-5). A recent study to validate model results for the discharge plume showed no measurable temperature increase at the Outer Sunk Rocks under the conditions tested (Padmanabhan and Hecker 1991). Furthermore, temperature increases at shallow subtidal depths (4.6 m in the area of the benthic stations) were less than 1°C. Thus there is no indication that the intertidal and shallow subtidal benthic communities are exposed to significant temperature increases resulting from plant operation, consistent with projections made for permitting the CWS.

The intertidal and shallow subtidal horizontal ledge benthic communities are characterized by a thick cover of red algae (mainly *Chondrus crispus*) and large numbers of juvenile mussels (mainly *Mytilus edulis*, the blue mussel). These two species provide cover and habitat for other algae, bivalves and crustaceans.

<u>Intertidal Benthic Community</u>. Most measures of community structure in the intertidal zone measured during 1990/1991 were similar to previous years (Table 2.2-4). No changes occurred in macroalgae and macrofauna community composition in 1990 and 1991, as indicated by numerical classification. The numbers of algae and fauna taxa were

TABLE 2.2-4. SUMMARY OF EVALUATION OF DISCHARGE PLUME EFFECTS ON THE BALANCED INDIGINOUS COMMUNITIES IN THE VICINITY OF SEABROOK STATION. SEABROOK OPERATIONAL REPORT, 1991.

COMMUNITY	AREA/DEPTH ZONE	PARAMETER [a]	OPERATIONAL PERIOD SIMILAR TO PREVIOUS YEARS?	NEARFIELD-FARFIELD DIFFERENCES CONSISTENT WITH PREVIOUS YEARS?
Macroalgae[c]	Intertidal	No. of Taxa	Op<Preop	yes
		Total biomass	no	NF:Op<Preop FF:Op=Preop
		Community structure	yes	yes
	Shallow subtidal	No. of taxa	yes	yes
		Total biomass	yes	yes
		Community structure	yes	yes
Macrofauna[c]	Intertidal	No. of Taxa	Op<Preop	yes
		Total abundance	no	NF:Op<Preop FF:Op=Preop
		Community structure	yes	yes
	Shallow subtidal	No. of taxa	yes	yes
		Total abundance	yes	yes
		Community structure	yes	yes

[a]Abundance, no. of taxa, biomass, total density, evaluated using ANOVA; community structure evaluated using numerical classification
[b]NF = nearfield FF = farfield
[c]1990 included in operational period

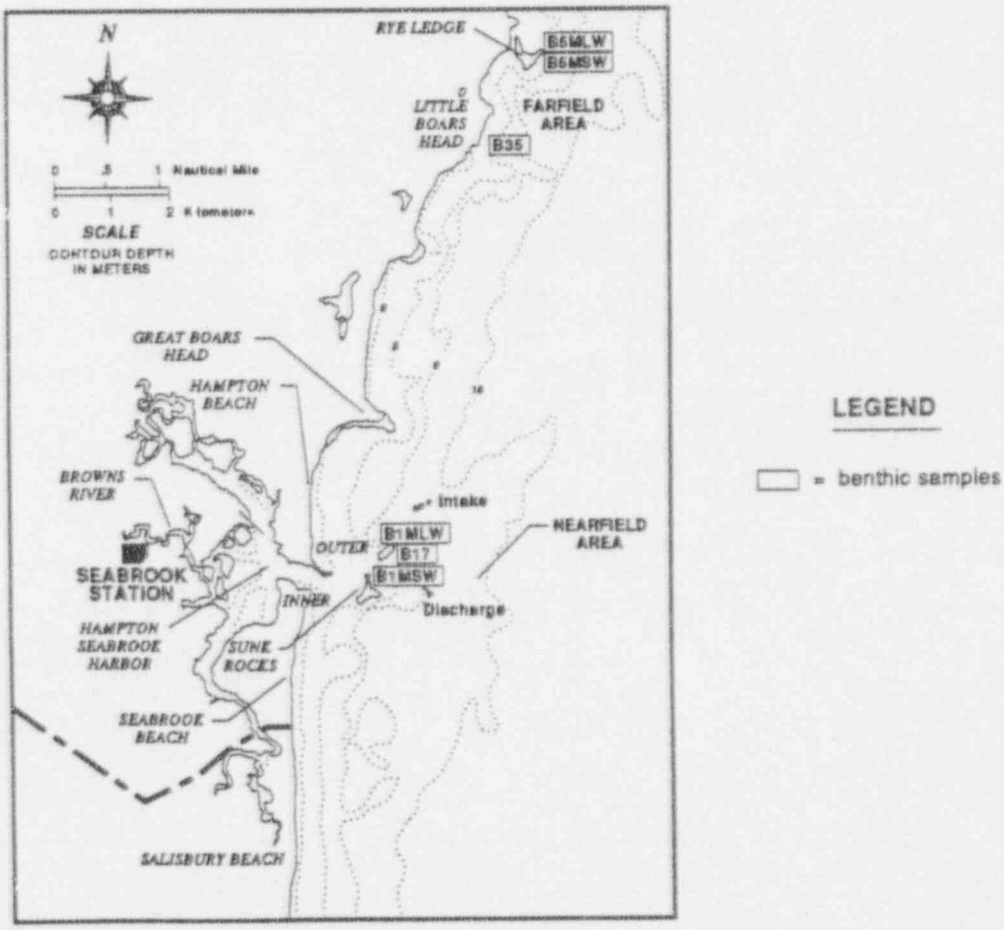


Figure 2.2-5. Intertidal and shallow subtidal benthic sampling stations. Seabrook Operational Report, 1991.

reduced during the operational period; however, as reductions occurred in both nearfield and farfield areas, they appear to be part of an area-wide trend.

Two community measures showed changes during the operational period at the nearfield intertidal station. Annual total algae biomass was significantly lower during the operational period at B1MLW (Table 2.2-4), mainly due to reduced levels of dominant *Chondrus crispus* in 1990. However, when triannual samples were considered, the reduced biomass of *C. crispus* was evident at both stations prior to plant operation, and continued through 1990. In 1991, *C. crispus* biomass levels recovered and showed no significant difference from historical levels (Table 2.2-5). Thus the reduced biomass appears to reflect natural year-to-year variability rather than plant operation.

Annual total macrofauna densities also showed changes during the operational period. Densities reached near-record levels in 1990 at both intertidal stations, then decreased to their lowest point in 1991. The trends were similar at both stations, although more pronounced at the nearfield station (Table 2.2-4). Increased densities were due mainly to fluctuations in Mytilidae. When triannual collections were considered, trends were more consistent between nearfield and farfield stations, resulting in no significant difference in Mytilidae density between stations during the operational period (Table 2.2-5).

TABLE 2.2-5. SUMMARY OF EVALUATION OF DISCHARGE PLUME EFFECTS ON REPRESENTATIVE IMPORTANT SPECIES IN VICINITY OF SEABROOK STATION.

COMMUNITY	AREA/DEPTH ZONE	SELECTED SPECIES	OPERATIONAL PERIOD SIMILAR TO PREVIOUS YEARS?[a]	NEARFIELD-FARFIELD DIFFERENCES CONSISTENT WITH PREVIOUS YEARS?[b]
Macroalgae	Intertidal	*Chondrus crispus*	yes	yes
	Subtidal		Op<Preop	yes
	Subtidal	*Laminaria digitata*	no	NF:Op<Preop FF:Op=Preop
	Subtidal	*Laminaria saccharina*	no	NF:Op<Preop FF:Op=Preop
Macrofauna	Intertidal	*Ampithoe rubricata*	Op<Preop	no
	Intertidal	*Nucella lapillus*	Op<Preop	yes
	Intertidal	Mytilidae	Op<Preop	yes
	Subtidal	*Jassa marmorata*	yes	yes
	Subtidal	Asteriidae	Op<Preop	yes
	Subtidal	Mytilidae	Op<Preop	yes

[a]Results of analysis of variance.
Operational period = 1991.
[b]NF = nearfield FF = farfield

Four benthic algae and fauna taxa are intensively studied as representative important species of the intertidal habitat (Table 2.2-5). They have been selected based on their importance as dominants, habitat-formers, and/or predators and represent a variety of tolerances and trophic levels. Only one taxon (alga *Chondrus crispus*) showed no change during the operational period. Two others (gastropod *Nucella lapillus* and bivalve Mytilidae) showed changes that occurred on an area-wide basis (Table 2.2-5). The amphipod *Ampithoe rubricata* was a dominant in the intertidal zone in the early years of the study, but had disappeared by 1986. These organisms returned to the farfield intertidal station in 1988, and showed increases in abundance through 1991, but remained absent from the nearfield station. As a result, *A. rubricata* densities were significantly higher at the farfield station in comparison to the nearfield station. As this situation developed prior to plant operation, it appears to be a result of natural spatial variability. Considering all aspects of the selected intertidal species, no changes occurred that could be directly related to operation of Seabrook Station.

Shallow Subtidal Benthic Community. The shallow subtidal benthic community showed no changes that could be related to plant operation. All measures of community structure for both macrofauna and macroalgae in 1990 and 1991 were similar to historical conditions (Table 2.2-4)

Most of the five benthic selected species in the shallow subtidal zone showed no significant changes in abundance or biomass in 1991 that were restricted to the nearfield station (Table 2.2-5). Abundances of amphipod *Jassa marmorata* during the operational period were similar to previous years. Alga *Chondrus crispus*, and macrofauna taxa Asteriidae and Mytilidae all showed areawide changes in abundance during the operational period. The two dominant kelp species, *Laminaria digitata* and *L. saccharina*, had significantly lower densities in 1991 in the nearfield area. Although densities were also reduced at the farfield area, this reduction was not statistically significant. Densities have been declining since 1988 (*L. digitata*) or 1989 (*L. saccharina*) at the nearfield station. Reductions during the operational period appear to be a continuation of this trend that was initiated prior to commercial operation of the plant.

2.2.2 Detrital Effects

Benthic Community

Background. Monitoring of the benthic organisms (macroinvertebrates, algae, demersal fish, and epibenthic crustaceans) was established to determine the extent of change (if any) to the community structure in the mid-depth (9-12 m) and deep (18-21 m) horizontal ledge communities (Figure 2.2-6) as a result of increased detritus from the discharge plume. Changes could be manifested by (1) the enhancement of detritivores and suspension feeders, (2) the increased attraction of benthic feeders caused by

TABLE 2.2-6. SUMMARY OF EVALUATION OF DETRITAL RAIN EFFECTS ON THE BALANCED INDIGINOUS COMMUNITIES IN THE VICINITY OF SEABROOK STATION. SEABROOK OPERATIONAL REPORT, 1991.

COMMUNITY	AREA/DEPTH ZONE	PARAMETER [a]	OPERATIONAL PERIOD SIMILAR TO PREVIOUS YEARS? [b]	NEARFIELD-FARFIELD DIFFERENCES CONSISTENT WITH PREVIOUS YEARS? [c]
Macroalgae	Mid-depth	No. of taxa	no	intake, FF: Op=Preop discharge: Op<Preop
		Total biomass	no	discharge, FF: Op=Preop intake: Op<Preop,
		Community structure	no	discharge, FF: Op=Preop intake: 1991 similar to 1984
	Deep	No. of taxa	yes	yes
		Biomass	no	intake Op>Preop discharge Op=Preop, far-field Op<Preop
		Community structure	yes	yes
Macrofauna	Mid-depth	No. of taxa	Op>Preop	yes
		Total density	no	intake: Op<Preop discharge, FF: Op=Preop
		Community Structure	yes	yes
	Deep	No. of taxa	Op>Preop	yes
		Total density	yes	yes
		Community structure	yes	intake similar to recent years

[a] Abundance, no. of taxa, biomass, total density, evaluated using ANOVA; community structure evaluated using numerical classification
[b] Operational period = August 1990, 1991
[c] NF = nearfield FF = farfield

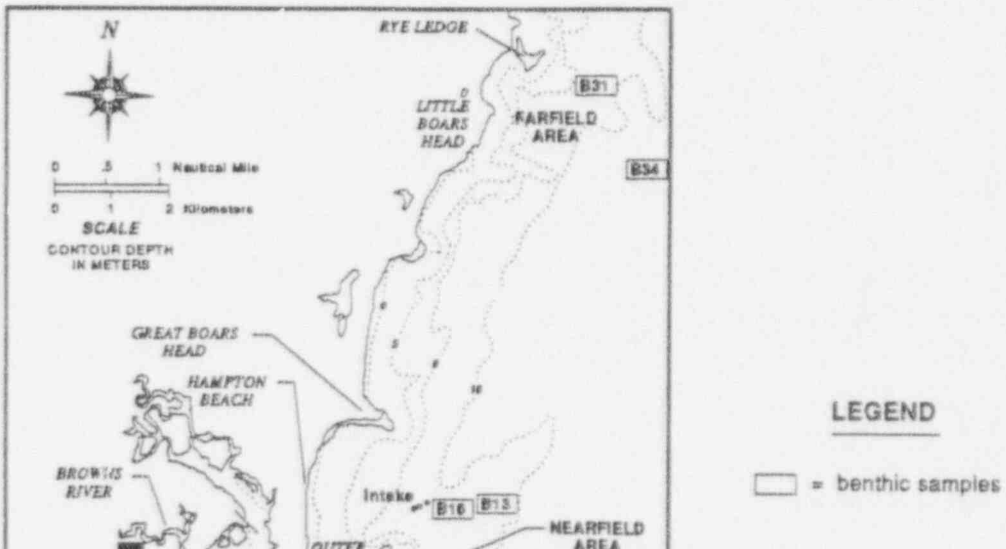


Figure 2.2-6. Mid-depth and deep benthic sampling stations. Seabrook Operational Report, 1991.

locally-increased food supply, and/or (3) impact on organisms sensitive to the increased detritus resulting from the decay of entrained organisms.

The benthic community was characterized by an overstory of kelps (mainly *Agarum cribrosum* and *Laminaria digitata*) and macroalgae (*Phyllophora* spp. and *Ptilota serrata*) along with bivalves (Mytilidae, *Hiatella* sp., *Anomia* sp.) and a variety of peracarid crustaceans. Community composition was relatively stable from year-to-year. Although abundance or biomass of individual species occasionally showed significant year-to-year changes, these differences were consistent between nearfield and farfield stations.

Mid-Depth Benthos. Macroalgae community composition at the discharge (B19) and farfield (B31) stations in 1990 and 1991, as revealed by numerical classification, numbers of taxa, and total biomass, was similar in most cases to previous years (Table 2.2-6). The number of taxa at the discharge site was reduced by 1-2 taxa (approximately 10% of the total) during the operational period; no change was noted at the farfield site. As this difference is small, it is likely due to natural variability. Additional years of sampling will allow verification of this conclusion.

Algae community composition at the intake site (B16) is generally unique, but in 1991 was different from most previous years (Table 2.2-6). In 1991, as in 1984, community composition at the intake was similar to that at the mid-depth discharge station, a result of reduced biomass of *Chondrus crispus* and *Ceramium rubrum*. The change at this station is also reflected in decreased total algal biomass, but not in numbers of taxa. Since similar results occurred in 1984, it does not appear to be related to plant operation.

The faunal community in the mid-depth zone during the operational period was generally similar to previous years. There was no change in community structure as shown by numerical classification (Table 2.2-6). Numbers of taxa in 1990/1991 were elevated compared to previous years at all three stations, suggesting an area-wide trend. Total macrofaunal density remained unchanged at the discharge and farfield stations. However, total macrofaunal density was reduced at the intake station in comparison to previous years. Reduced densities of the dominant bivalve Mytilidae in August led to the decrease in total abundance, paralleling the lower biomass of macroalgae.

Although benthic community composition in the mid-depth zone has been stable from year-to-year, annual variations in abundance or biomass of representative important species have typically occurred. Annual fluctuations again occurred in 1991 during plant operation, but spatial differences remained unchanged during the operational period, indicating the changes were part of an area-wide trend and unrelated to plant operation (Table 2.2-7). The green sea urchin is monitored as a juvenile and adult because of its potential for becoming a nuisance organism. Population eruptions have occurred at the nearby Isle of Shoals, where urchin grazing

TABLE 2.2-7. SUMMARY OF EVALUATION OF DETRITAL EFFECTS ON REPRESENTATIVE IMPORTANT SPECIES.

COMMUNITY	SPECIES	OPERATIONAL PERIOD SIMILAR TO PREVIOUS YEARS?[a]	NEARFIELD-FARFIELD DIFFERENCES CONSISTENT WITH PREVIOUS YEARS?[b]
Macroalgae	Laminaria digitata	Op<Preop	yes
	Laminaria saccharina	yes	yes
Macrofauna	Pontogeneia inermis	Op<Preop	yes
	Modiolus modiolus	Op<Preop	yes
	Mytilidae	Op<Preop	yes
	Strongylocentrotus droebachensis	yes	yes

[a]Conclusions derived from analysis of variance or nonparametric analyses.
Operational period = 1991.
[b]NF = nearfield FF = farfield

denuded the substrate of erect algae (Witman 1985). Juvenile and adult sea urchin abundances in 1991 were similar to previous years, indicating that the population is stable.

The mid-depth zone has shown some changes in the algae and fauna restricted to Station B16, near the intakes. Total algae biomass and macrofauna density at B16 were significantly lower in 1990 and 1991 in comparison to previous years. No changes occurred at discharge and farfield areas. Because of the distance from the discharge area, these changes are probably not plant-related. Other community parameters show no relationship to plant operation (Table 2.2-6).

Deep Benthic Community. The algae community in the deep zone (nearfield stations B04 and B13, farfield station B34) during the operational period was similar to previous years in terms of community structure and numbers of taxa (Table 2.2-6). Total biomass was elevated at the deep station B13 (near intakes), but was similar to previous years at the deep discharge station.

In 1990 and 1991, the faunal community at the discharge and farfield stations in the deep zone showed similar community composition to all previous years. At the intake station, community structure and total density showed no differences from the recent preoperational period. Numbers of taxa were elevated areawide in 1990 and 1991 in comparison to previous years.

Although some changes have occurred in the deep benthic community in 1990 and 1991, only one parameter, enhanced total algae biomass, was restricted to the nearfield (near the intakes) zone. No differences occurred at the discharge station, where impacts would be most likely.

Demersal Fish

Background. Demersal fish that inhabit or feed in the nearshore area are important not only because of their predominance in the food chain but also because of their commercial value. As would be expected with any bottom-oriented species, the nearshore population of demersal fish shows spatial differences associated with substrate and location relative to Hampton Harbor (Figure 2.2-7). There were significant differences in catch among stations for several demersal species, attributable to the differences in habitat, and consistent between the preoperational and operational periods. Impact assessment has therefore focused on changes in catches of demersal finfishes between the preoperational and operational periods.

Total Catch. There were significant differences in total catch per unit effort (CPUE) between the preoperational and operational periods that generally agreed with population trends observed by the National Marine Fisheries Service (NMFS) in the Gulf of Maine and Georges Bank (Table 2.2-8). The similarity in demersal finfish population trends between the study area and the Gulf of Maine-Georges Bank area suggests that mechanisms operating on a large geographic scale, such as overfishing of commercial fish stocks, had an influence on the population trends of demersal finfishes in the study area.

Dominants. The major change in the species composition of the demersal fish community in the study area has been an increase in the abundance of skate sp. (Table 2.2-8). Skate sp. CPUE began to increase dramatically in 1981 and by the end of the preoperational period, skates ranked among the five most abundant finfish species, coincident with declining abundances of most demersal fish. Skate sp. CPUE appeared to stabilize at high levels in the study area after 1987. Similar trends in abundance of skate sp. were observed in the Gulf of Maine and Georges Bank (NOAA 1991b). The increase in skate CPUE observed in the study area is not attributable to the operation of Seabrook Station because it took place over a wide geographic area and began before Seabrook Station became operational.

Abundance trends of Atlantic cod in the study area closely paralleled abundance trends in the Gulf of Maine and the Georges Bank area (Table 2.2-8). The presence of a strong 1987 year class of Atlantic cod was apparent in 1987 young-of-the-year CPUE data from the study area and from the NMFS index of spawning stock biomass. CPUE of Atlantic cod in the study area generally decreased after 1984, although CPUE was high in 1988 as the strong 1987 year class was fully recruited. The index of spawning stock biomass of Atlantic cod in the Gulf of Maine was at its highest recorded levels in 1989 and 1990 as the strong 1987 year class approached maturity (NOAA 1991b). The recent decrease in Atlantic cod CPUE in the study area after 1988, and the increase in the NMFS spawning stock index after 1988 is probably due to movement of the maturing

TABLE 2.2-8. SUMMARY OF POTENTIAL PLANT EFFECTS ON ABUNDANCE OF DEMERSAL FINFISHES. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER MEASURED	OPERATIONAL PERIOD SIMILAR TO PREOPERATIONAL PERIOD [a]	DIFFERENCES BETWEEN PREOPERATIONAL AND OPERATIONAL PERIODS CONSISTENT AMONG STATIONS [a]	LONG TERM ABUNDANCE TREND IN GULF OF MAINE [b]
Atlantic cod	Op<Preop	Yes	Increasing, strong 1987 year class, stocks still over- exploited
Hake	Op<Preop	Yes	Red hake: Increasing White hake: No trend
Rainbow smelt	Op<Preop	Yes	No information
Yellowtail flounder	Op<Preop	Yes	Decreasing, stocks over exploited
Winter flounder	Yes	Yes	Decreasing, stocks over exploited
Lobster: Total Catch	No	NF:OP=Preop FF:Op<Preop	Catches increasing
Lobster: Legal Catch	Op<Preop	Yes	Catches increasing
Rock crab	No	NF:Op=Preop FF:Op>Preop	--
Jonah crab	Op<Preop	Yes	--

[a]based on ANOVA results
[b]Source: NOAA 1991b

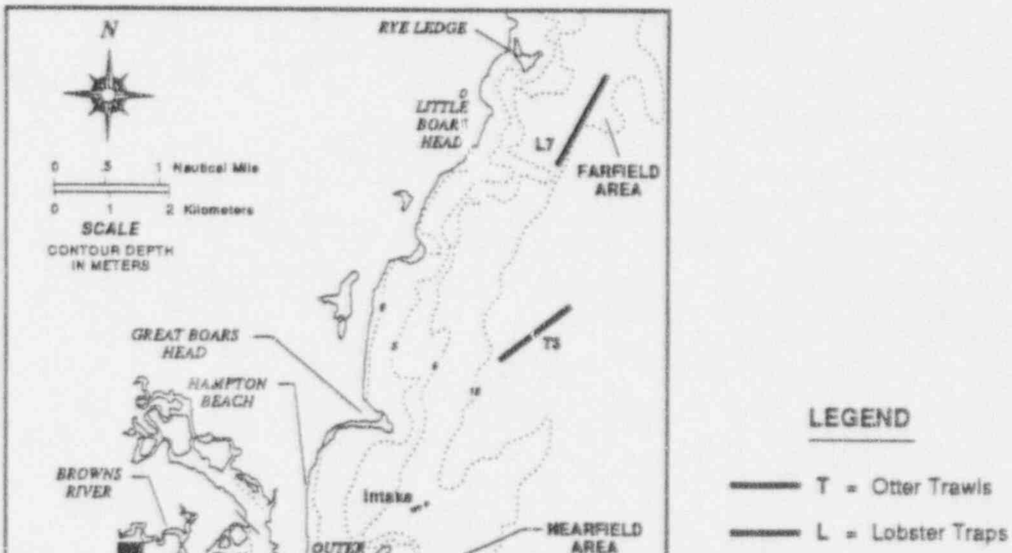


Figure 2.2-7. Demersal finfish and Epibenthic crustacea sampling stations. Seabrook Operational Report, 1991.

1987 year class out of the relatively shallow study area to deeper water offshore.

CPUE of hake sp. in the study area and the NMFS biomass indices do not show the same trends (Table 2.2-8). The term "hake sp." represents catches of red, white and spotted hake. CPUE of hake sp. in the study area decreased slowly until 1990 when the lowest CPUE was recorded. The NMFS biomass index for red hake in the Gulf of Maine has increased to the highest recorded levels in 1990, but the NMFS index for white hake has remained stable since 1981 with no discernible trends (NOAA 1991b). It is difficult to compare the indices for red and white hake with the CPUE of combined hake species from the study area. This lack of specificity may contribute to the apparent differing trends. Reductions however, occurred prior to plant operation and are therefore unrelated.

Yellowtail flounder CPUE in the study area has decreased steadily since 1980, paralleling the NMFS biomass index on Georges Bank, which has decreased steadily since its most recent peak in 1983. Yellowtail flounder stocks on Georges Bank are considered overexploited (NOAA 1991b). The decrease in yellowtail flounder CPUE in the study area cannot be attributed to the operation of Seabrook Station because it began before operation and occurred over a wide geographic area beyond the potential impact zone of Seabrook Station.

Winter flounder CPUE in the study area was greatest in 1980 and 1981 and has since declined, although there were no significant differences in CPUE between the operational and preoperational periods. The Massachusetts Division of Marine Fisheries (MDMF) spring winter flounder abundance index was greatest in 1981 and 1983 and has likewise declined to the lowest levels in the series in 1988-1990 (NOAA 1991b). Winter flounder stocks on Georges Bank and the Gulf of Maine are considered to be overexploited (Table 2.2-8; NOAA 1991b). Similar to yellowtail flounder, the decline in winter flounder abundance in the study area began before Seabrook station became operational and took place over a wide geographic area, and thus cannot be attributed to the operation of Seabrook Station.

Epibenthic Crustacea

Lobster (*Homarus americanus*). Because of its commercial importance, all life stages of the American lobster have been studied over the last 14-17 years. Benthic-oriented juvenile and adult lobsters would most likely be susceptible to the potential effects of plant operation by changes in their food sources resulting from the effects of increased detritus (Figure 2.2-7). Changes in temperature resulting from Seabrook Station are unlikely at the depths where lobsters are monitored for this study because of the buoyancy of the discharge plume. Temperature in general can affect lobster activity levels and the likelihood of capture (Dow 1969) as well as migratory behavior (Campbell 1986). Seasonal patterns of total lobster catches in 1991 were similar to previous years. The average annual catch at the discharge site in

1991, 76 per 15-trap effort, was not significantly different from previous years (Table 2.2-8). However, total catch at the farfield area was significantly reduced in 1991.

The adult lobster catches are influenced by a number of factors. Inshore lobster catches have been steadily increasing from 1975-1990 (NOAA 1991b). This increase may in part be the result of increasing water temperatures in general throughout the region, which have been correlated with lobster landings, both in the current year and after a six-year lag period (Fogarty 1988; Campbell et al. 1991). In addition, there is evidence suggesting that fishing intensity is also increasing in an effort to maintain landings after increases in the legal size-limit (NOAA 1991b). In Maine, newly recruited legal-sized lobsters are almost completely harvested in the same year (Fogarty 1988). Approximately 2.4 legal-sized lobsters (per 15 trap effort) were caught at the discharge site in 1991, similar to levels in 1990, when the last legal-size increase was enacted in New Hampshire. Historically, in this study, percentages of legal-sized lobsters have decreased with each increase in the legal-size limit, as would be expected. The trend of decreasing catches of legal-sized lobsters is similar between the nearfield and farfield stations, indicating that it is a result of changes in legal-size definition rather than an effect of plant operation. Proportions of female and egg-bearing lobsters were consistent with previous years. Thus plant operation has not affected the proportion of reproducing females.

Impingement of lobsters in the cooling water system was not expected because of the off-bottom intake location. However, in 1991, 29 sublegal-sized lobsters were impinged, most after a severe northeastern storm in October. Only four lobsters were impinged in 1990. This level of impingement does not pose a threat to the local lobster population.

Jonah and Rock Crabs. Jonah (*Cancer borealis*) and rock crabs (*C. irroratus*) are the two other important invertebrate predators in the study area and could be subject to the same potential for impact as lobsters. Jonah crabs have shown evidence of a multiple-year cycle in catch levels, resulting in a significant decrease during the operational period in comparison to previous years (Table 2.2-8). As a similar trend occurred at nearfield and farfield stations, the change is unrelated to plant operation.

Rock crabs are less prevalent than their congener in the study area, probably because of their preference for sandy substrate (Jefferies 1966). Catches of rock crabs also show multiple-year trends that differed between nearfield and farfield areas. No significant differences occurred between operational and preoperational catches at the nearfield station. However, at the farfield station, rock crab catches were significantly higher in 1991 than during the preoperational period (Table 2.2-8).

2.3 ESTUARINE ZONE

Background

Environmental studies in Hampton Harbor estuary include monitoring physical parameters (temperature and salinity), fish populations, benthic macrofauna, and juvenile and adult soft-shell clams (*Mya arenaria*) (Figure 2.3-1). The estuary has been monitored to determine the effects, if any, of the settling basin discharge since 1978. This included any possible effects of tunnel dewatering, which added large volumes of ocean water to Browns River through 1983. Current estuarine monitoring efforts are conducted to identify any potential effects from either settling basin discharge or Seabrook Station operation. One of the main environmental issues in the Hampton-Seabrook estuary related to plant operation was whether the offshore intake and discharge would impact the adult clam population in Hampton Harbor. The probability of impact from the most-likely source, entrainment of *Mya* larvae, is small (NAI 1977e), as discussed in Sections 2.1.1 and 3.3.7. Effects on juvenile and adult *Mya* were evaluated by comparing population estimates developed for 1991 with those from previous years.

Temperature and Salinity. Temperature and salinity, monitored in Hampton Harbor and Browns River since 1978, show predictable seasonal circles. Temperatures generally followed the same pattern in 1991 but were higher than average in September-October. In 1991, heavy rains in August (resulting from Hurricane Bob) and September led to lower-than-average salinities during these months. Hampton Harbor salinities showed higher salinity and lower year-to-year variability than Browns River because of the influx of a large volume of offshore waters.

Benthic Macrofauna

The benthic macrofaunal community in Mill Creek (Station 9), outside the influence of Seabrook Station's settling basin, and Browns River (Station 3) was typical of New England estuaries. Surface and subsurface deposit feeders predominated, including opportunistic polychaetes such as *Streblospio benedicti* and *Capitella capitata*, with suspension feeders and omnivores forming an important component. In Mill Creek and Browns River, the biological parameters measured were highly variable seasonally and annually, with total abundance, numbers of taxa, and abundances of most of the dominant species significantly different among years and between stations. In 1991, total density, numbers of taxa, and community dominants were similar to previous years (Table 2.3-1).

Fish

Important estuarine fish include both diadromous species as well as residents (Figure 2.3-1). The dominant resident fish species in the estuary for both the preoperational and operational periods was Atlantic silverside. Atlantic silverside made up approximately 66% of the total catch for the preoperational period and 51% of the catch in the operational period. The dominance of Atlan-

TABLE 2.3-1. SUMMARY OF EVALUATION OF EFFECTS OF OPERATION OF SEABROOK STATION IN HAMPTON ESTUARY. SEABROOK OPERATIONAL REPORT,1991.

COMMUNITY/ SPECIES	LIFESTAGES	OPERATIONAL PERIOD SIMILAR TO PREVIOUS YEARS? [a]	SPATIAL DIFFERENCES CONSISTENT WITH PREVIOUS YEARS? [a]
Benthic Macrofauna			
Number of taxa			
Total density	--	Yes	Yes
Streblospio	--	Yes	Yes
benedicti	--	Yes	Yes
Soft-shell clam	Young-of-year (1-5mm)	No (within harbor)	Flat 4 Op<Preop Flats 1, 2 Op=Preop
	Young-of-year (1-12mm)	Yes (area-wide)	Hampton=Ipswich
	Spat (6-25mm)	Op<Preop	Yes
	Juvenile (26-50mm)	Op<Preop	Yes
	Adult (>50mm)	No	Flat1 Op=Preop Flat4 Op>Preop Flat2 Op<Preop
Fish			
Winter flounder		Op<Preop	yes
Rainbow smelt		yes	yes
Atlantic silverside		yes	yes

[a]Operational period for soft-shell clam defined as 1990 and 1991, for estuarine benthos and fish defined as 1991. Results based on ANOVA.

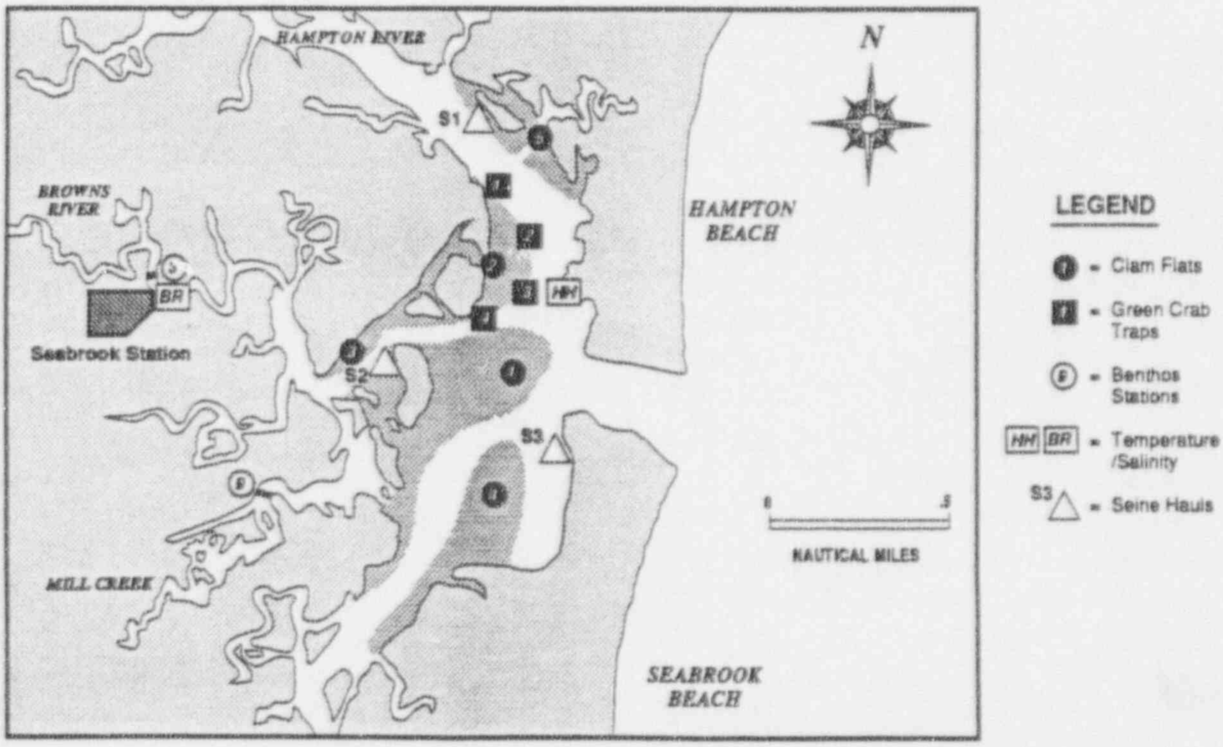


Figure 2.3-1. Hampton-Seabrook estuary temperature/salinity, soft-shell clam *Mya arenaria*, green crab *Carcinus maenas* and benthos sampling stations. Seabrook Operational Report, 1991.

tic silverside was reduced in 1990 due to high catches of rainbow smelt, although Atlantic silverside CPUE was within the range of previous years. In 1991 CPUE and percent composition of Atlantic silverside was comparable to the preoperational period (Table 2.3-1). The population historically has been composed primarily of yearling fish but the occurrence of young-of-the-year size classes in spring has indicated spawning and recruitment in the estuary (NAI 1985b). The year-to-year variation in silverside catch has been the main cause of the observed variation in the total annual catch in beach seines for all species combined. However, given the high annual variability in silverside catches, there were no significant differences in CPUE between the preoperational and operational periods.

Rainbow smelt were an important but highly variable (both seasonally and annually) constituent of the demersal fish community at the entrance to the estuary, generally present in spring and summer, when young-of-the-year and yearling smelt move into the estuary. CPUE of rainbow smelt in 1990 was the highest observed to date. Since increased abundances of smelt were for the most part due to higher catches prior to commercial operation, they are not related to plant operation. In 1991 CPUE of rainbow smelt was recorded at preoperational levels. There were no significant differences in CPUE between the preoperational and operational period (Table 2.3-1).

Winter flounder have composed only a small portion of the estuarine fish assemblage, averaging only 2% since 1976. This species undergoes onshore/offshore migration, depending on the time of the year (Bigelow and Schroeder 1953). Juveniles (ages one and two, based on length-frequency analysis) have been the main constituent in the estuary, primarily collected during the spring and summer (NAI 1985b). CPUE of winter flounder in the seines during the operational period was significantly lower than the preoperational period (Table 2.3-1). Similarly, densities of larval winter flounder were significantly lower during the operational period. However, there were no significant differences in CPUE of adult winter flounder in the trawls between the preoperational and operational periods. Winter flounder in the estuary are primarily juveniles and the decrease in CPUE observed in the estuary may be a result of decreased larval densities. The decrease in larval densities and the decrease in CPUE in the estuary observed during the operational period may appear in future years as a decrease in adult winter flounder in the trawls. Winter flounder abundance in the Gulf of Maine has decreased steadily since 1983 and the stock is presently overexploited (NOAA 1991b). The decrease in the young life stages of winter flounder (larvae and juveniles) is likely a result of a regional decrease in the abundance of adults.

Soft-Shell Clam

Since the Hampton-Seabrook estuary contains the majority of New Hampshire's stock of the recreationally-important species *Mya arenaria*, an extensive sampling program (initiated in 1969) has been undertaken in order to characterize the natural variability in the population for all lifestages.

Recruitment to and survival of the soft-shell clam population in Hampton Harbor is affected by a variety of factors, including predation and disease, that must be considered in impact assessment. Recruitment of larvae to young-of-the-year is not well understood. Apparently unrelated to the abundance levels of larval stages (NAI 1982b), it is instead a function of the presence of favorable conditions when veligers are able to settle. Successful young-of-the-year sets have occurred throughout the preoperational period. Young-of-the-year densities in 1991 were less than the higher-than-average levels in 1990, but, with the exception of Flat 4, similar to the 1974-1989 average. Considered together, 1990 and 1991 young-of-the-year densities were similar to the preoperational average at Flats 1 and 2, and lower than average at Flat 4 (Figure 2.3-1, Table 2.3-1). For Hampton Harbor as a whole, young-of-the-year densities in 1990 and 1991 were not different from those at nearby Plum Island Sound.

Survival of young-of-the-year to adult size depends on a number of factors including the level of disease and predation. The preoperational period includes the extremes of a "boom and bust" cycle of spat, juvenile and adult clams, in part dictated by a classic predator-prey relationship. Densities averaged over the 1974-1989 period are elevated by the "boom period" of the 1970's and early 1980's. As a result, densities of spat, juveniles and adults from 1990 and 1991, even though similar to recent years, are lower than the preoperational average (Table 2.3-1). The reasons for the recent mortality of young-of-the-year sets since 1984 are complex, but certainly include the increase of its major predator, green crab *Carcinus maenas*. Warm winter temperatures from 1984 through 1989 enhanced green crab survival, coinciding with decreased densities of spat and juvenile clams. Lower green crab catches in 1990 corresponded to increases in spat and juvenile clams on some flats (NAI 1991b). However, reduced green crab catches in 1991 did not result in an overall increase in spat and juveniles.

Another factor in evaluation of long-term trends is human predation by clam diggers, who harvest adult clams and disturb the flats, hampering survival of juveniles as well. Numbers of clam licenses sold dropped sharply beginning in 1981, followed by closure of the flats in 1989. Coincident with the decrease in clamming was an increase in the numbers of harvestable clams throughout Hampton Harbor that was sustained through the mid-1980's. After that time, low numbers of spat and juveniles limited recruitment to the adult size class.

Another factor affecting growth and survival of clams was the presence of sarcomatous neoplasia, a lethal form of cancer in the soft shell clam. The incidence of neoplasia in Hampton Harbor in 1986 and 1987 was restricted to Flats 1 and 2 (Hillman 1986, 1987). Significant increases in adult clam densities in 1990/1991 in comparison to previous years occurred only at Flat 4, where neoplasia has historically been absent.

The key to monitoring the soft-shell clam population is understanding its long-term cycle and all of the factors that affect it. Young of the year (1-12 mm) recruitment in 1990 and 1991 in Hampton Harbor was similar to that in a neighboring estuary, indicating that Seabrook Station was not affecting larval settlement (Table 2.3-1). Spat and juvenile densities in 1990 and 1991 at each flat were lower than the preoperational average. However, the preoperational average includes extremely successful periods of clam recruitment and survival, when densities of its major predator were low, as well as periods of very low density, leading to significant differences in density among years. Trends in the spat and juvenile soft-shell densities were similar to recent years, suggesting that there is no effect from operation of Seabrook Station. Densities of adults continue to be diminished at Flat 2, but were similar to the preoperational average at Flat 1. Flat 4 was the only area to show an increase in adult densities in 1990/1991. Flat 4 was also the only area where historically no evidence of the lethal disease neoplasia was detected.

3.0 RESULTS

3.1 WATER QUALITY AND PLANKTON

3.1.1 Water Quality

Three physical (temperature, salinity, and dissolved oxygen) and five chemical (orthophosphate, total phosphorus, nitrite-nitrogen, nitrate-nitrogen, and ammonia-nitrogen) parameters have been monitored over the last 14 years at three stations: P2 (discharge), P5 (intake), and P7 (farfield; added to program in 1982). The data from this effort describe the seasonal, temporal, and spatial characteristics of the water column in nearshore waters and off of Hampton Harbor. In general, the water quality data show definitive seasonal cycles with one or two annual peaks at all stations; that there are differences between the preoperational (1978-1989) and operational (1990-1991) periods at each station; and that there are few quantitative differences among the three stations. The methods used to draw these comparisons were an analysis of annual means and an analysis of variance (ANOVA) procedure. The ANOVAs were structured as followed:

a) Preop-Op tests differences in concentrations or temperatures between the preoperational and operational periods, regardless of station, and will detect whether operational period falls within historical variability;

b) Station tests differences in concentrations or temperatures among Stations P2, P5 and P7, regardless of sample date, and will detect whether there has been a consistent relationship in concentrations or temperatures spatially;

c) Year (Preop-Op) tests differences in concentrations or temperatures among years nested within preoperational and operational periods, regardless of station, and will detect whether any year or years are unique;

d) Month (Preop-Op) tests differences in concentrations or temperatures among months nested within preoperational and operational periods, regardless of station, and will detect whether there is a consistent seasonal pattern; and

e) Preop-Op X Station tests differences in concentrations or temperatures between the main effects of preoperational and operational periods and station and will detect whether the relationship in concentrations or temperatures among stations has been consistent between preoperational operational periods.

Water temperature was monitored in the nearfield both continuously and from discrete samples collected weekly, twice-weekly, or monthly during plankton cruises. Historically, monthly mean values derived from both sampling methods have been similar (NAI 1980d, 1981f, 1982a, 1985a). On a monthly basis, both surface and bottom temperatures recorded in 1991 at Station P2 were equal to or greater than the preoperational monthly means throughout the year (Figure 3.1.1-1). Temperatures followed similar sea-

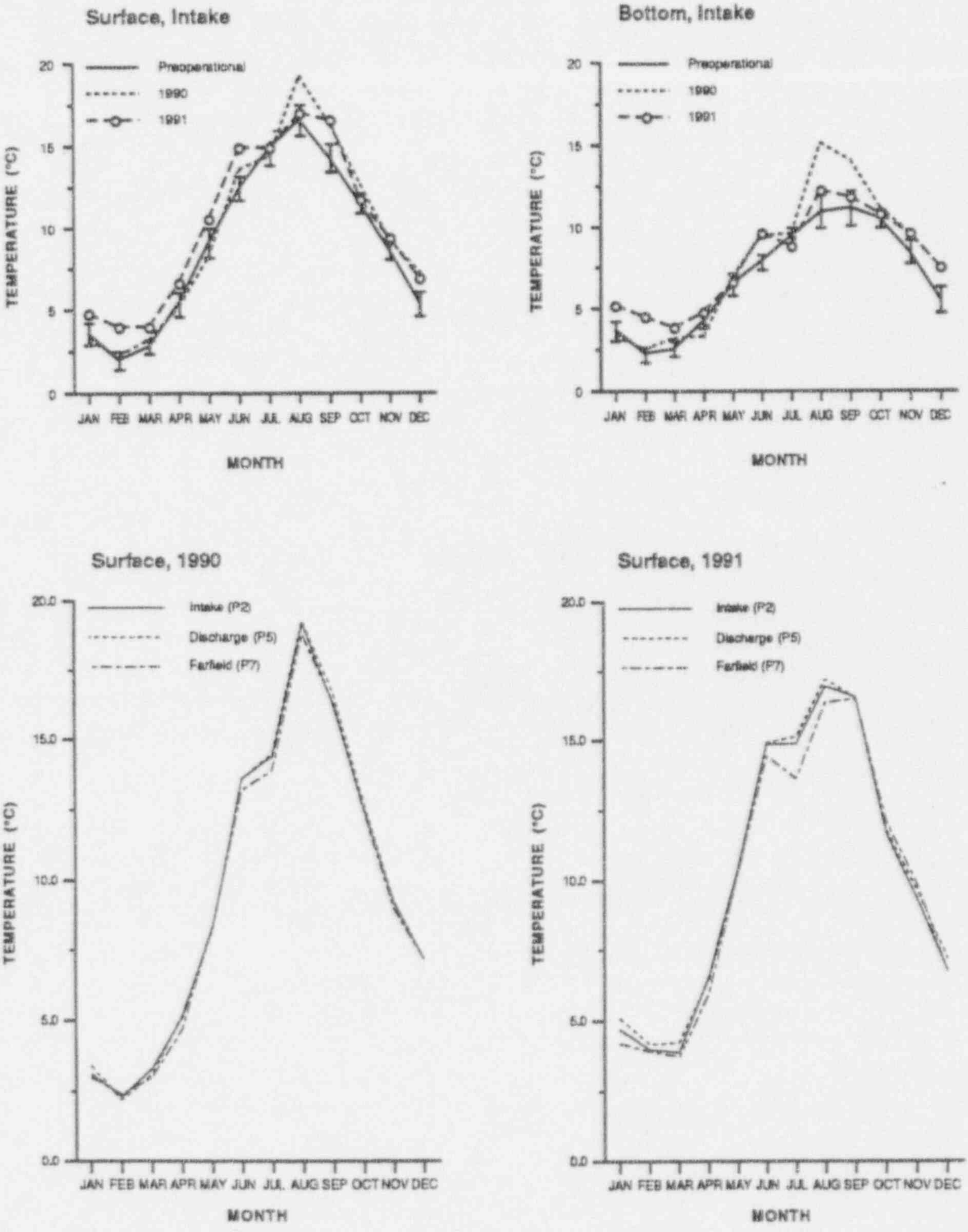


Figure 3.1.1-1. Surface and bottom temperature (°C) at nearfield Station P2, monthly means and 95% confidence intervals over all years from 1978-1989 and monthly means of surface temperature at Stations P2, P5, and P7 in 1990 and 1991. Seabrook Operational Report, 1991.

sonal patterns during both periods. The 1991 annual mean surface and bottom temperatures were significantly greater than the preoperational means (Tables 3.1.1-1 and 3.1.1-2). Since 1987, when P5 was first sampled, significant spatial differences have been apparent in surface and bottom temperatures among the three stations, with temperatures at P5 greater than at P2, and temperatures at P2 greater than at P7; this relationship between the three stations has been consistent over the recent (1987-1989) preoperational period and through 1991 (Table 3.1.1-2). As previous studies have indicated that Hampton-Seabrook estuarine circulation can extend to the intake/discharge areas, long-term spatial differences in temperature could be related to the estuary. The analysis of variance (ANOVA) results also indicate that, at all stations, surface and bottom temperatures differed among months (seasonally) and among individual years.

Temperature was monitored on a continuous basis at the discharge (DS) and in the farfield (T7) area beginning in August 1990, at the start of commercial operation. The continuously-recorded data revealed the same seasonal pattern of a summer maximum (August) and a late winter minimum (March) as noted in data collected during the plankton cruises (Figure 3.1.1-2). With the exception of July and August 1991, monthly mean temperatures at the discharge were consistently higher than at the farfield station (Table 3.1.1-3). The August, September and October 1990 temperatures at both locations were slightly higher than those observed in 1991, but temperatures overall are similar between the two years.

Differences between surface and bottom temperatures have followed a similar pattern during both the preoperational and operational periods, and among the three stations (Figure 3.1.1-3). The thermocline generally begins to build by late February, reaching its strongest point in July or August, and gradually erodes by November. With few exceptions (April and September at P2; April, May, June, and September at P7), the strength of the thermocline observed in 1991 was similar to that observed in the preoperational period. For each of the exceptions noted, the 1991 thermocline was stronger than observed during the preoperational period.

With the exception of 1990, surface salinities at Station P2 have historically reached an annual minimum during April or May, largely in response to the period of spring runoff (Figure 3.1.1-4). In 1991, a second low occurred in October, which corresponds to the occurrence of a northeast storm in the New England coastal area. Although there was a significant difference in surface salinities between the preoperational period and 1991, (1991 average value was lower), no differences among stations were apparent (Tables 3.1.1-1 and 3.1.1-2). Bottom salinities followed a similar but less pronounced seasonal pattern. Similar bottom salinity differences were noted between preoperational and operational periods, and differences among the three stations were also apparent (Tables 3.1.1-1 and 3.1.1-2). This difference occurred primarily between Stations P2 and P7 (Table 3.1.1-1), and was apparent in both the preoperational period and in 1991.

TABLE 3.1.1-1. GEOMETRIC MEANS AND 95% CONFIDENCE LIMITS FOR WATER QUALITY PARAMETERS MEASURED DURING PLANKTON CRUISES AT STATIONS P2, P5, AND P7 OVER PREOPERATIONAL YEARS AND GEOMETRIC MEANS IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER	PREOPERATIONAL YEARS[a] LCL	$\bar{x}$	UCL	$\bar{x}$ 1990	1991
Surface Temperature (°C)					
P2	8.60	9.12	9.63	9.55	10.02
P5	8.99	9.66	10.33	9.64	10.20
P7	8.28	8.82	9.37	9.37	9.77
Bottom Temperature (°C)					
P2	6.74	7.10	7.46	7.81	7.90
P5	6.80	7.24	7.68	7.91	8.01
P7	6.53	6.89	7.25	7.81	7.78
Surface Salinity (ppt)					
P2	31.50	31.62	31.74	31.30	31.22
P5	31.44	31.61	31.79	31.11	31.10
P7	31.40	31.56	31.72	31.12	31.10
Bottom Salinity (ppt)					
P2	32.11	32.19	32.26	31.95	31.57
P5	32.12	32.21	32.30	31.80	31.68
P7	32.17	32.25	32.32	31.74	31.86
Surface Dissolved Oxygen (mg/L)					
P2	9.59	9.72	9.84	9.67	9.50
P5	9.51	9.65	9.80	9.70	9.54
P7	9.53	9.66	9.79	9.60	9.46
Bottom Dissolved Oxygen (mg/L)					
P2	9.05	9.20	9.35	9.11	8.91
P5	8.91	9.10	9.29	9.16	9.04
P7	8.91	9.08	9.25	8.97	8.92
Orthophosphate (µg/L)					
P2	11.96	13.06	14.17	13.95	13.57
P5	10.78	12.33	13.88	13.90	14.67
P7	14.22	15.69	17.16	15.48	14.52
Total Phosphorus (µg/L)					
P2	24.00	25.74	27.48	28.10	28.57
P5	25.02	27.33	29.63	30.95	30.00
P7	26.68	28.86	31.04	31.43	29.52
Nitrite (µg/L)					
P2	1.84	2.07	2.31	2.76	1.95
P5	1.87	2.17	2.47	2.64	2.00
P7	1.64	1.94	2.24	3.10	2.19

(continued)

TABLE 3.1.1-1. (Continued)

PARAMETER	PREOPERATIONAL YEARS[a] LCL	$\overline{X}$	UCL	$\overline{X}$ 1990	1991
Nitrate (µg/L)					
P2	32.60	39.21	45.81	60.48	44.29
P5	30.73	38.61	46.50	60.00	45.71
P7	32.27	40.90	49.52	67.62	43.57
Ammonia (µg/L)					
P2	4.84	6.46	8.08	8.13	6.67
P5	4.70	6.25	7.80	7.50	5.42
P7	4.96	7.71	10.46	10.42	7.08

[a]Preoperational years: P2 = 1978-1984 and 1987-1989
P5 = 1986 - 1989
P7 = 1982-1984 and 1987-1989

[b]Because analytical methods for ammonia changed in April 1988, preoperational period for ammonia is April 1988 - December 1989.

TABLE 3.1.1-2. RESULTS OF ANALYSIS OF VARIANCE COMPARING WATER QUALITY CHARACTERISTICS AMONG STATIONS P2, P5, AND P7 DURING PREOPERATIONAL AND OPERATIONAL (1991) PERIODS.

PARAMETER	SOURCE OF VARIATION[a]	DF	SS	F	MULTIPLE COMPARISONS
Surface Temperature	PREOP-OP[b,c]	1	43.87	682.96***	OP>PREOP
	YEAR (PREOP)[d]	2	3.09	24.08***	
	MONTH (YEAR)[e]	44	3451.88	1221.31***	
	STATION[f]	2	2.28	17.74***	P5>P2>P7
	PREOP-OPxSTATION[g]	2	0.06	0.49 NS	
	ERROR	92	5.91		
Bottom Temperature	PREOP-OP	1	64.84	773.37***	OP>PREOP
	YEAR (PREOP)	2	1.29	7.69***	
	MONTH (YEAR)	44	1162.13	315.05***	
	STATION	2	0.83	4.96**	P5 P2 P7
	PREOP-OPxSTATION	2	<0.01	0.01 NS	
	ERROR	92	7.71		
Surface Salinity	PREOP-OP	1	2.25	24.74***	PREOP>OP
	YEAR (PREOP-OP)	2	15.96	87.62***	
	MONTH (YEAR)	44	227.66	56.81***	
	STATION	2	0.51	2.82 NS	
	PREOP-OPxSTATION	2	0.08	0.46 NS	
	ERROR	92	8.38		
Bottom Salinity	PREOP-OP	1	5.02	126.71***	PREOP>OP
	YEAR (PREOP)	2	6.21	78.42***	
	MONTH (YEAR)	44	46.92	26.92***	
	STATION	2	0.76	9.53***	P7>P5>P2
	PREOP-OPxSTATION	2	0.11	1.37 NS	
	ERROR	92	3.64		

(continued)

TABLE 3.1.1-2 (Continued)

PARAMETER	SOURCE OF VARIATION[a]	DF	SS	F	MULTIPLE COMPARISONS
Surface Dissolved Oxygen	PREOP-OP	1	2.09	103.37***	PREOP>OP
	YEAR (PREOP)	2	0.63	15.64***	
	MONTH (YEAR)	44	134.05	150.58***	
	STATION	2	0.06	1.46 NS	
	PREOP-OPxSTATION	2	0.01	0.32 NS	
	ERROR	92	1.86		
Bottom Dissolved Oxygen	PREOP-OP	1	2.54	111.20***	PREOP>OP
	YEAR (PREOP)	2	10.85	237.09***	
	MONTH (YEAR)	44	212.77	211.29***	
	STATION	2	0.20	4.27 NS	
	PREOP-OPxSTATION	2	0.13	2.77 NS	
	ERROR	92	2.11		
Orthophosphate	PREOP-OP	1	10.86	3.84 NS	
	YEAR (PREOP-OP)	2	234.38	41.48***	
	MONTH (YEAR)	44	9761.89	78.53***	
	STATION	2	11.36	2.01 NS	
	PREOP-OPxSTATION	2	8.56	1.52 NS	
	ERROR	92	259.91		
Total Phosphorus	PREOP-OP	1	7.82	0.26 NS	
	YEAR (PREOP-OP)	2	911.50	14.95***	
	MONTH (YEAR)	43	14944.65	11.40***	
	STATION	2	46.64	0.76 NS	
	PREOP-OPxSTATION	2	19.33	0.32 NS	
	ERROR	90	2743.61		
Nitrite	PREOP-OP	1	0.83	0.23 NS	
	YEAR (PREOP-OP)	2	6.09	8.54***	
	MONTH (YEAR)	44	305.18	19.47***	
	STATION	2	0.80	1.12 NS	
	PREOP-OPxSTATION	2	0.10	0.14 NS	
	ERROR	92			

(continued)

TABLE 3.1.1-2 (Continued)

PARAMETER	SOURCE OF VARIATION[a]	DF	SS	F	MULTIPLE COMPARISONS
Nitrate	PREOP-OP	1	1.17	0.04 NS	
	YEAR (PREOP-OP)	2	7521.18	113.07***	
	MONTH (YEAR)	44	478299.48	326.85***	
	STATION	2	15.19	0.23 NS	
	PREOP-OPxSTATION	2	180.30	2.71 NS	
	ERROR	92	3059.72		
Ammonia[h]	PREOP-OP	1	0.24	0.06 NS	
	YEAR (PREOP-OP)	1	33.86	9.20**	
	MONTH (YEAR)	30	521.30	4.72***	
	STATION	2	33.82	4.59*	
	PREOP-OPxSTATION	2	4.02	0.55 NS	
	ERROR	62	228.17		

[a]Based on averaged semi-monthly collections
[b]Preoperational years: 1987-1989 at each station
[c]Preoperational versus operational period, regardless of station
[d]Year nested within preoperational and operational periods, regardless of station
[e]Month nested within year nested within preoperational and operational periods, regardless of station
[f]Station P2 versus P5 versus P7, regardless of year
[g]Interaction between main effects
[h]Preoperational period for ammonia is April 1988 through December 1989

NS = not significant ($p \geq 0.05$)
* = significant ($0.05 \geq p > 0.01$)
** = highly significant ($0.01 \geq p > 0.001$)
*** = very highly significant ($0.001 \geq p$)

(continued)

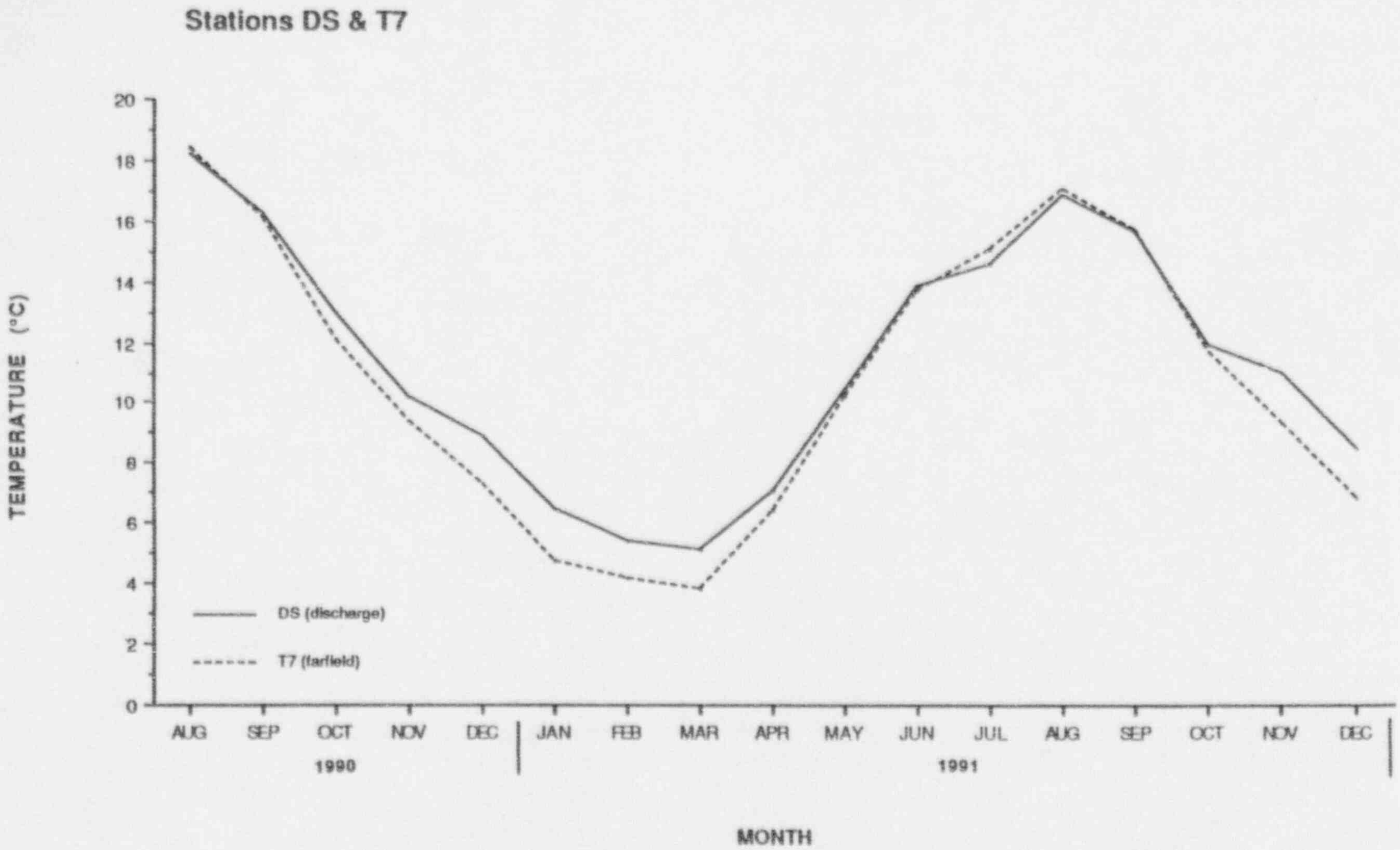


Figure 3.1.1-2. Comparison of monthly averaged **continuous temperature** (°C) data collected at discharge (DS) and farfield (T7) stations during commercial operation, August 1990-December 1991. Seabrook Operational Report, 1991.

TABLE 3.1.1-3. MONTHLY MEAN TEMPERATURES (°C) AND TEMPERATURE DIFFERENCES BETWEEN DISCHARGE (DS) AND FARFIELD (T7) AT THE SURFACE, AND NEARFIELD (ID) AND FARFIELD (T7) STATIONS AT SURFACE, MID-DEPTH (8.5 m) AND BOTTOM (16.2 m) DEPTHS COLLECTED FROM CONTINUOUSLY MONITORED TEMPERATURE SENSORS. SEABROOK OPERATIONAL REPORT, 1991.

		DS-T7 SURFACE			ID-T7 SURFACE			ID-T7 MID-DEPTH			ID-T7 BOTTOM		
YEAR	MONTH	DS	T7	DELTA T	ID	T7	DELTA T	ID	T7	DELTA T	ID	T7	DELTA T
1990	JUL	14.54	14.63	-0.08	14.69	14.63	0.07	11.76	11.50	0.26	9.08	9.62	-0.54
	AUG	18.16	18.36	-0.20	18.11	18.11	0.01	14.81	15.42	-0.61	13.26	13.14	0.12
	SEP	16.31	16.09	0.22	16.22	16.06	0.16	14.06	13.94	0.12	12.14	12.31	-0.17
	OCT	13.04	12.11	0.93	13.17	12.98	0.19	11.92	11.85	0.07	11.03	11.17	-0.14
	NOV	10.24	9.44	0.80	9.38	9.39	-0.02	9.42	9.53	-0.11	9.49	9.91	-0.42
	DEC	8.91	7.32	1.59	7.37	7.34	0.03	7.47	7.57	-0.11	7.43	7.96	-0.53
1991	JAN	6.47	4.71	1.76	4.63	4.72	-0.09	4.83	5.00	-0.17	5.14	5.74	-0.60
	FEB	5.38	4.17	1.21	4.24	4.14	0.10	4.19	4.31	-0.12	4.19	4.81	-0.62
	MAR	5.11	3.78	1.33	3.95	3.77	0.18	3.53	3.64	-0.11	3.39	3.87	-0.48
	APR	6.99	6.37	0.62	6.36	6.21	0.15	5.36	5.44	-0.08	4.83	5.13	-0.30
	MAY	10.43	10.21	0.22	10.29	10.21	0.08	8.11	8.39	-0.28	6.32	6.67	-0.35
	JUN	13.81	13.70	0.11	13.78	13.70	0.08	11.19	11.46	-0.27	9.15	9.46	-0.31
	JUL	14.58	15.02	-0.44	15.12	15.02	0.10	11.24	11.74	-0.50	9.01	9.34	-0.33
	AUG	16.86	17.06	-0.20	16.70	16.57	0.13	14.96	14.88	0.08	13.08	12.92	0.16
	SEP	15.66	15.69	-0.03	15.34	15.38	-0.04	13.74	13.87	-0.13	11.89	11.99	-0.10
	OCT	11.87	11.68	0.19	11.58	11.68	-0.10	10.94	11.14	-0.20	10.28	10.37	-0.09
	NOV	11.00	9.33	1.67	9.16	9.34	-0.18	9.41	9.58	-0.17	9.40	--	--
	DEC	8.45	6.81	1.64	6.59	6.81	-0.22	6.86	7.11	-0.25	6.93	--	--

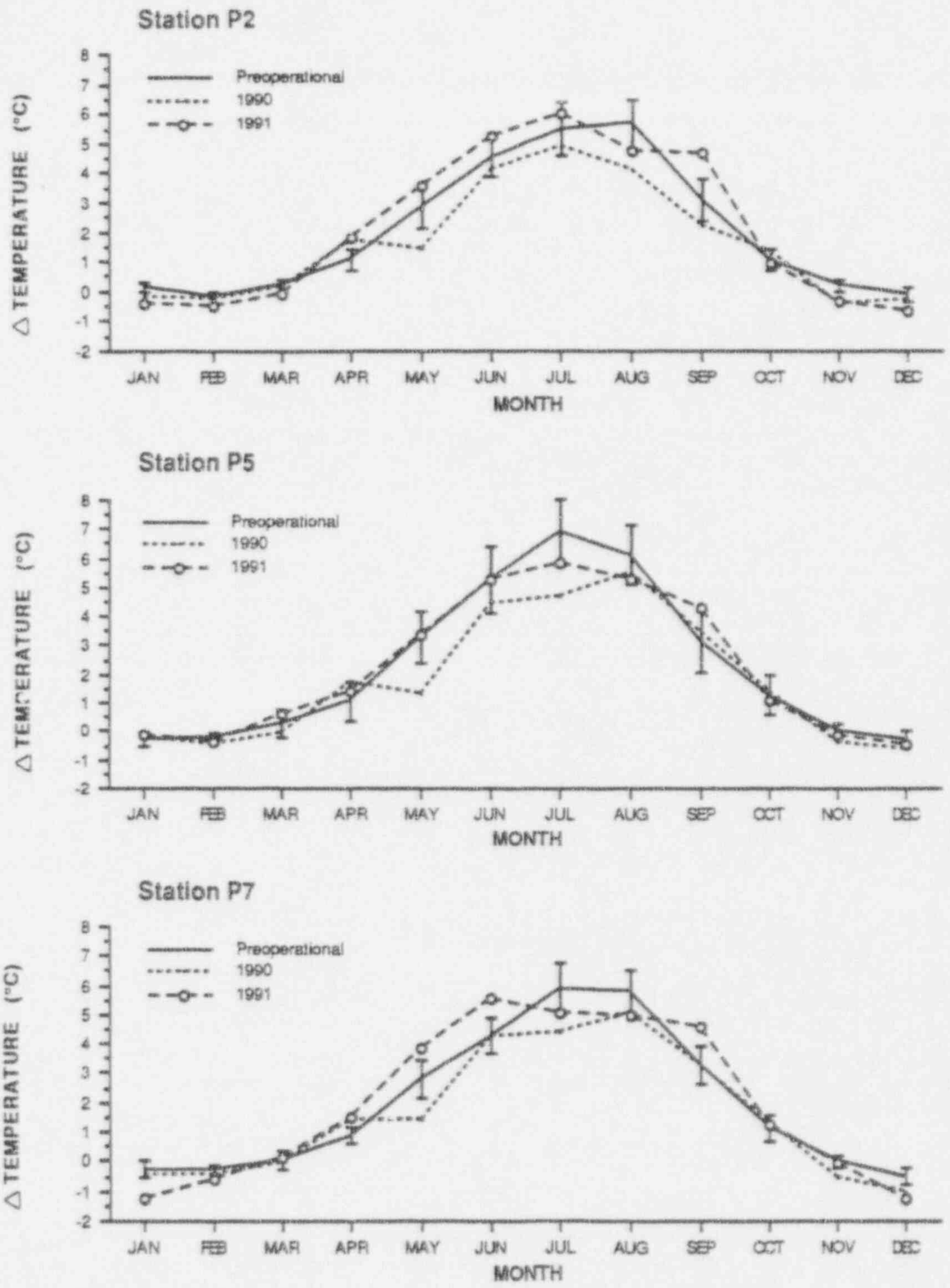


Figure 3.1.1-3. Monthly mean difference and 95% confidence limits between surface and bottom temperatures (°C) at Stations P2, P5, and P7 over all years from 1978-1989 and monthly means for 1990 and 1991. Seabrook Operational Report, 1991.

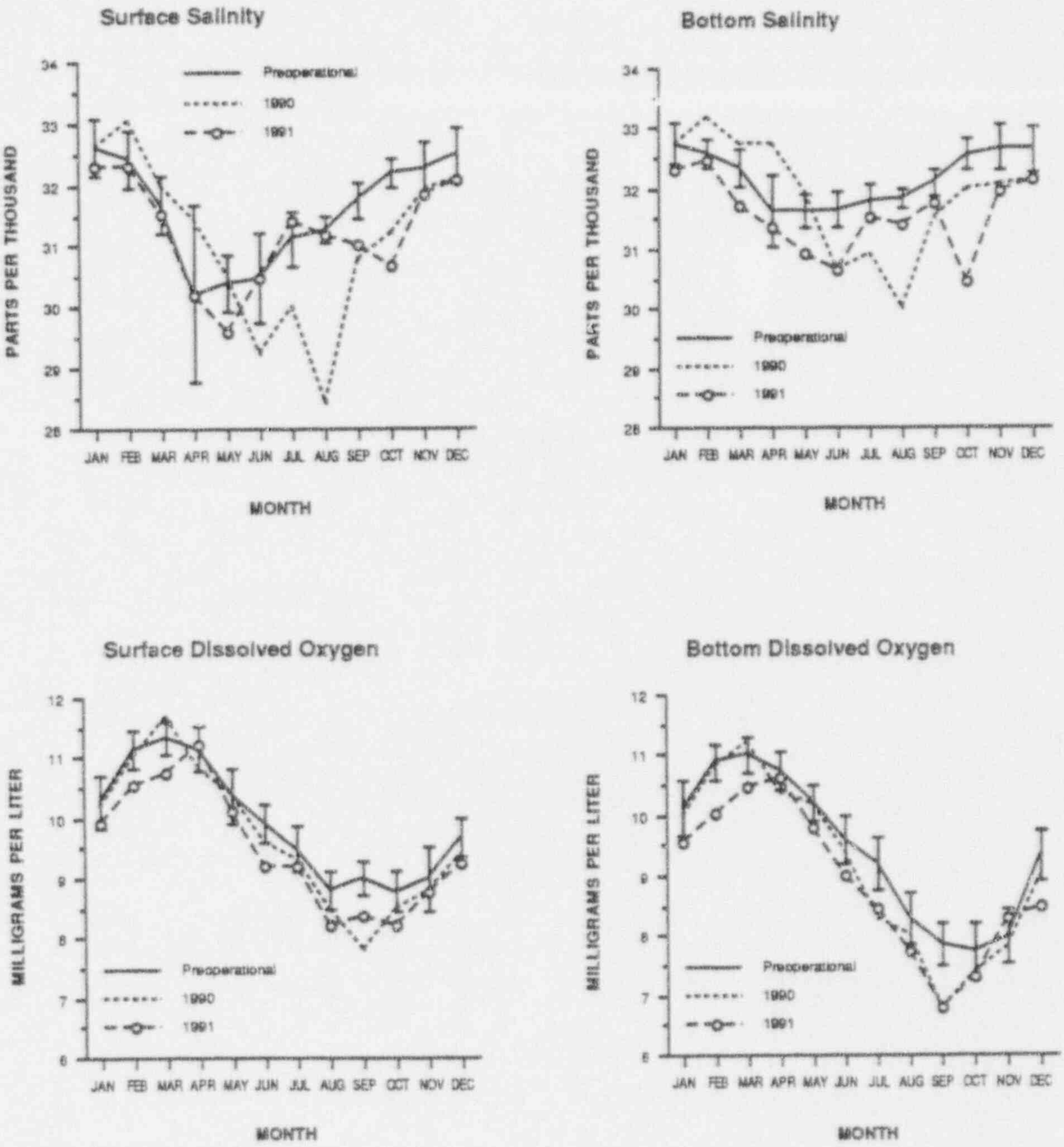


Figure 3.1.1-4. Surface and bottom **salinity** (ppt) and **dissolved oxygen** at nearfield Station P2, monthly means and 95% confidence intervals over all years from 1978-1989, and monthly means for 1990 and 1991. Seabrook Operational Report, 1991.

Surface and bottom dissolved oxygen concentrations at Station P2 followed similar seasonal patterns, in the preoperational period and in 1991 (Figure 3.1.1-4). As with temperature and salinity, dissolved oxygen data show significant differences between the preoperational period and 1991; no spatial differences were apparent (Table 3.1.1-2). With the exception of April surface concentrations and November bottom concentrations, preoperational dissolved oxygen levels were higher than those recorded in 1991. On the basis of annual means, dissolved oxygen exhibited a depth-dependent inverse relationship with temperature.

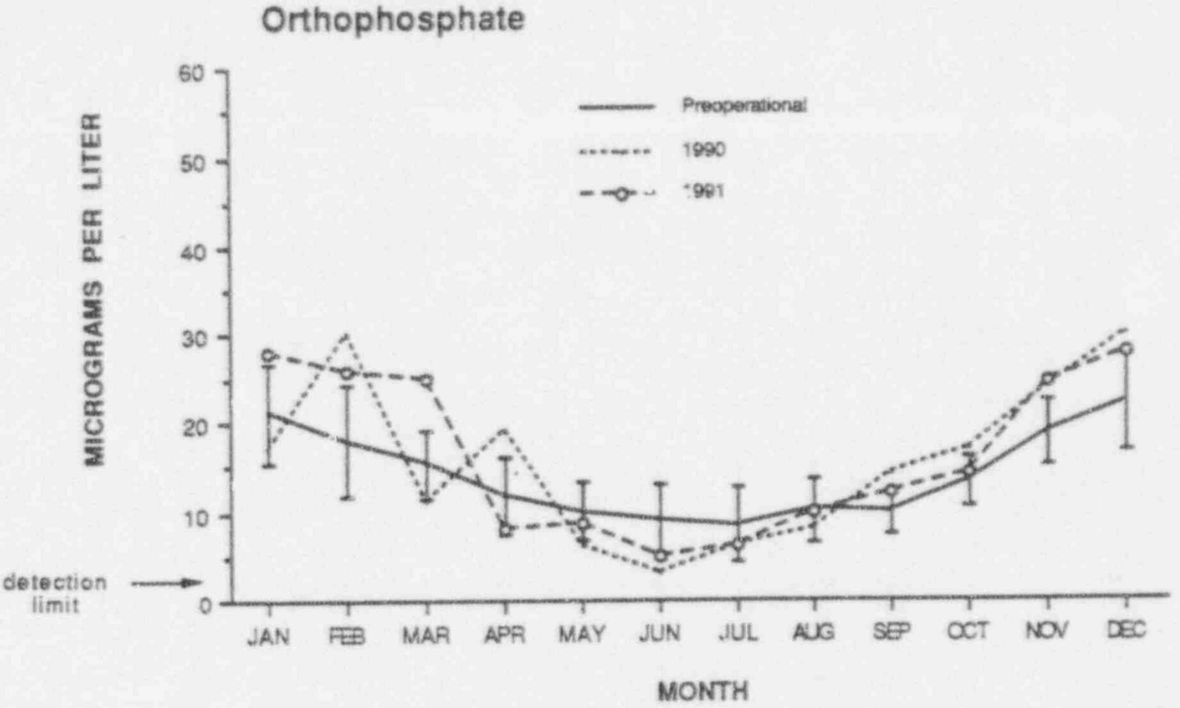
Orthophosphate concentrations have historically shown a week seasonal pattern of annual minima occurring in June or July; this pattern was evident, and slightly stronger, at Station P2 in 1991 (Figure 3.1.1-5). No significant differences were detected during the operational period and no spatial differences were apparent (Tables 3.1.1-1 and 3.1.1-2). In 1991, the January and March concentrations were the highest yet observed for those months. All other 1991 monthly means were within the range of previous observations.

Total phosphorus concentrations from Station P2 have historically followed a pattern similar to and slightly stronger than orthophosphate concentrations (Figure 3.1.1-5). The annual mean concentrations in 1991 were not significantly different from those from the preoperational period. As with orthophosphate, no spatial differences were apparent in either period (Tables 3.1.1-1 and 3.1.1-2). Monthly mean total phosphorus concentrations observed in February, June, and September of 1991 at Station P2 were the higher than historical confidence limits, while the April 1991 concentration was lower.

Nitrite concentrations followed a much less distinct pattern than nitrate concentrations, although annual lows also tended to occur during summer and highs during the winter (Figure 3.1.1-6). No significant differences between preoperational and 1991 concentrations were detected, nor were any detected between stations (Table 3.1.1-2). The January 1991 concentration at Station P2 was higher than the historical confidence limits.

In 1991 and the preoperational period, nitrate concentrations observed at Station P2 showed a strong seasonal pattern. The annual minimum (often less than the detection limit) occurred from early summer to early fall and the maximum occurred during the winter (Figure 3.1.1-6). Differences between the preoperational period and 1991 were not significant at all three stations; furthermore, no significant differences among stations were detected (Tables 3.1.1-1 and 3.1.1-2). The monthly mean nitrate concentration recorded in March of 1991 at Station P2 was higher than the historical confidence limits.

In 1991, ammonia concentrations at Station P2 were nearly always less than the detection limit (Figure 3.1.1-6). Because analytical methods for ammonia changed in 1988, preoperational-operational comparisons are based on the period after April 1988. No differences in ammonia concentrations between the



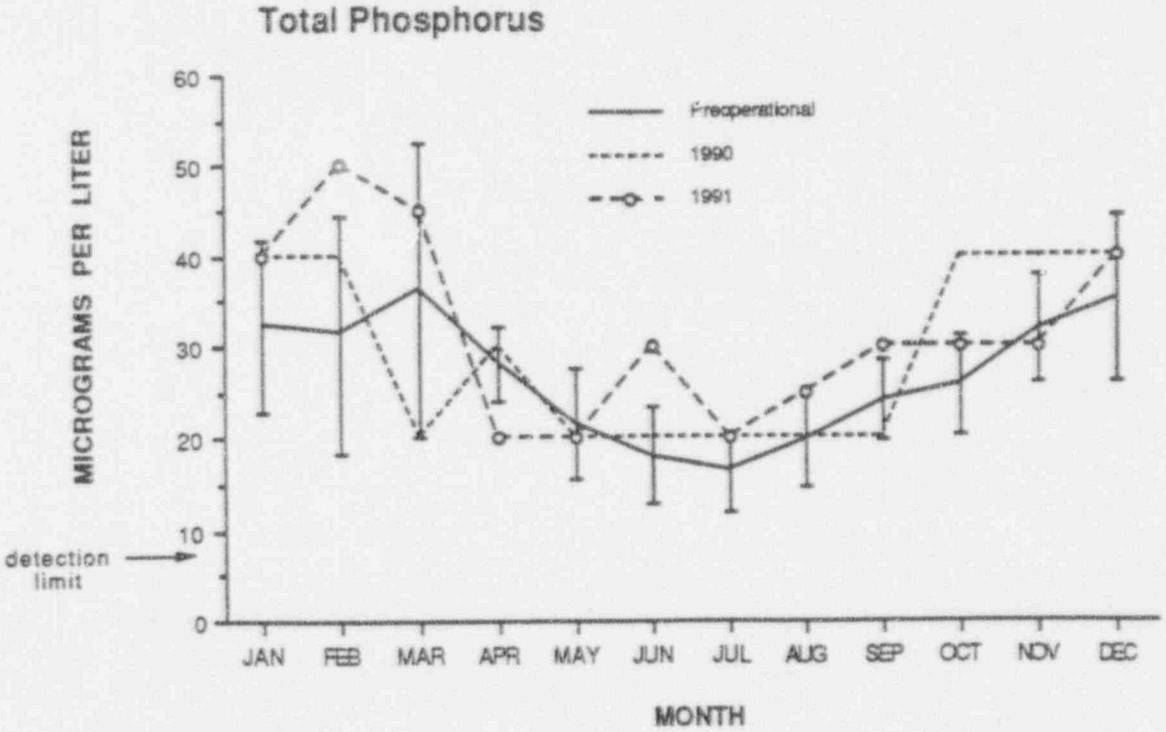
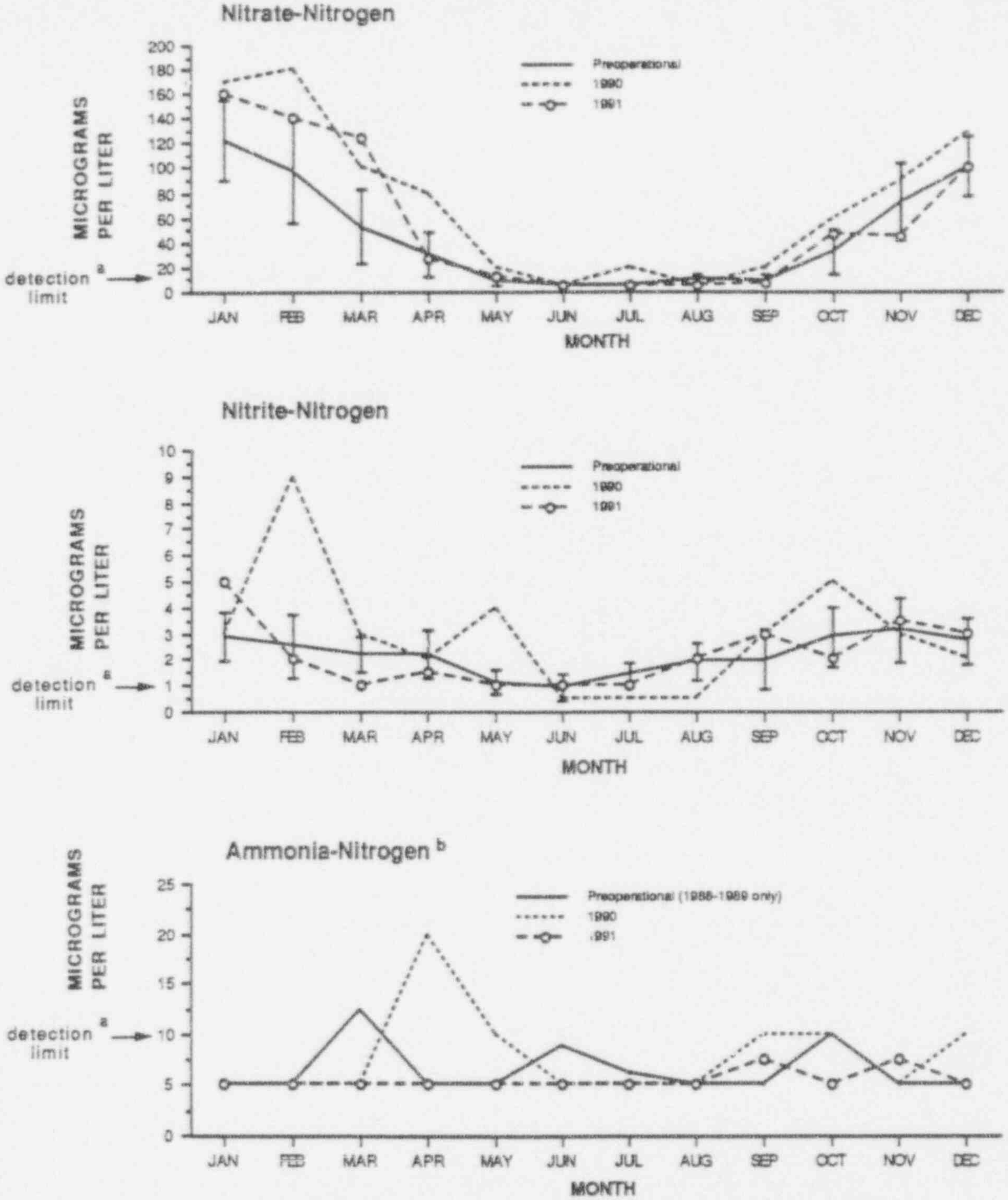


Figure 3.1.1-5. Surface **orthophosphate** and **total phosphorus** (µg P/L) at nearfield Station P2, monthly means and 95% confidence intervals over all years from 1978-1984 and 1986-1989, and monthly means for 1990 and 1991. Seabrook Operational Report, 1991.



[a] For the purpose of calculating monthly means, data points reported as "below detection limit" were given a value of one-half the detection limit.

[b] Preoperational period for ammonia is April 1988-December 1989.

Figure 3.1.1-6. Surface nitrite-nitrogen, nitrate-nitrogen and ammonia-nitrogen (µg N/L) at nearfield Station P2, monthly means and 95% confidence intervals over all years from 1978-1984 and 1986-1989, and monthly means for 1990 and 1991. Seabrook Operational Report, 1991.

preoperational period, as defined here, and the operational period were detected (Table 3.1.1-2). Differences between stations were significant (Table 3.1.1-2) although not highly so, with concentrations at P7 generally greater than at P2 and P5 (Table 3.1.1-1); this relationship was consistent in both the operational and preoperational periods.

The physical and chemical water quality data collected during the last 14 years show several consistent patterns, with few exceptions: differences between preoperational and 1991 data were significant for all physical parameters and ammonia, as were monthly (seasonal) and yearly differences. The remaining nutrients showed no significant differences during the operational period. With the exception of surface and bottom temperatures and bottom salinities, no significant differences were noted between stations. Seasonal patterns observed for all parameters were consistent between the preoperational period and 1991.

Effects of Plant Operation

These results indicate that operation of the Seabrook Station to date has not altered the water quality in the vicinity of Hampton Beach. Although there are preoperational-operational differences among hydrographic parameters, these differences are apparent among the preoperational years as well, suggesting the presence of long-term regional water quality trends. Furthermore, operational effects would likely be evident in spatial comparisons, as previous hydrographic studies have shown that the nearfield and farfield areas are exposed to the same water mass (NAI 1985b). The consistency of the relationship among the three stations over the preoperational and operational periods, and the lack of significant differences between the stations for most parameters, indicates that there are no such effects.

3.1.2 Phytoplankton

3.1.2.1 Total Community

For the purpose of this analysis, the phytoplankton community has been divided into two size fractions: ultraplankton (<10 μm) and phytoplankton (≥10 μm) as defined by Marshall and Cohen (1983). They described the ultraplankton group as primarily including several, difficult to identify taxa that appear to be cyanophyceae (cyanobacteria = blue-green algae) and/or chlorophyceae (green algae); these cells are typically round to ovoid and less than 10 μm (many between 2-3 μm) in diameter. The cyanophyceae group appears to be dominated by cells typically described as *Synechococcus* (single-celled) or *Nostoc* (small chain-forming cells). The ultraplankton group include picoplankton (0.2-2.0 μm) and the smaller nanoplankton (2.0-10 μm) (Sieburth et al., 1978). The ultraplankton was analyzed separately from the phytoplankton (≥10μm) because: 1) ultraplankton were not really dealt with quantitively in the scientific community at large prior to 1978-1980 (Johnson and Sieburth, 1979; Hall and Vincent, 1990); 2) the Seabrook program dealt with this group only partially (i.e., generally did not identify the picoplankton size fraction) during the 1981-1984 period;

it was during this period that the broad scale reporting of these taxa were being initiated (Stockner 1988); and 3) phase contrast microscopy, which allows for better recognition of these smaller taxa, was only used during the more recent (1984, 1990, 1991) monitoring periods. Thus, for the purposes of conducting a fair evaluation of phytoplankton species assemblages between the preoperation and operational period, the ultraplankton group was evaluated separate from the rest of the phytoplankton.

Phytoplankton - Temporal Characteristics

During 1991, seasonal trends and monthly mean abundances of phytoplankton (≥10 µm) were similar to the preoperational period, with peaks in spring (May) and fall (October) as depicted by nearfield (P2) collections (Figure 3.1.2-1). In the winter of 1991 (January, February), densities were among the highest values (but still within the upper confidence limits, UCL) when compared with preoperational monthly values; densities in July and September were low but again within the 95% confidence limits. Phytoplankton densities during all other months in 1991 were quite similar to preoperational values. These trends are different from those reported in 1990 because at that time the very small cells (i.e., ultraplankton) were included in the total density values (NAI 1991b).

Although there is seasonal succession in the phytoplankton community, the dominant species greater than 10 µm are almost always diatoms (Bacillariophyceae)(Figure 3.1.2-1). This was as true for 1991 as it was for the preoperational period; these taxa typically dominated the community for nine to ten months out of the year. The diatoms that typically dominated the nearfield (P2) population within any year included *Skeletonema costatum*, *Rhizosolenia delicatula*, *Leptocylindrus minimus*, *Cylindrotheca clostrium*, and *Thallassionema nitschioides* with various *Chaetoceros* and *Nitzschia* species (Table 3.1.2-1). Some of these diatoms were abundant in late winter/spring while others were most abundant during the summer and/or fall period. Other classes of algae typically contributed to a greater percentage of the population during the spring (April/May) and late summer/fall periods (Figure 3.1.2-1). Averaged over the seven year preoperational period at P2, the yellow-green algae (Xanthophyceae) were the only other group making up more than 10% of the population in a month mainly due to blooms of *Phaeocystis pouchetii* in certain years. This species was quite common from 1978 to 1980 and very abundant in 1981 and 1983; it was present in 1990 but not observed in 1982, 1984 or 1991 (Table 3.1.2-1). This is one of the species that appears to have a highly variable occurrence from year to year, thus making it difficult to characterize the "typical" seasonal phytoplankton community within the study area. Dinoflagellates (Dinophyceae) were the only other group contributing more than 1% to preoperational monthly values. Densities and species composition were similar to those reported elsewhere for the Gulf of Maine/northeastern continental shelf area (Marshall 1984; Marshall and Cohen 1983).

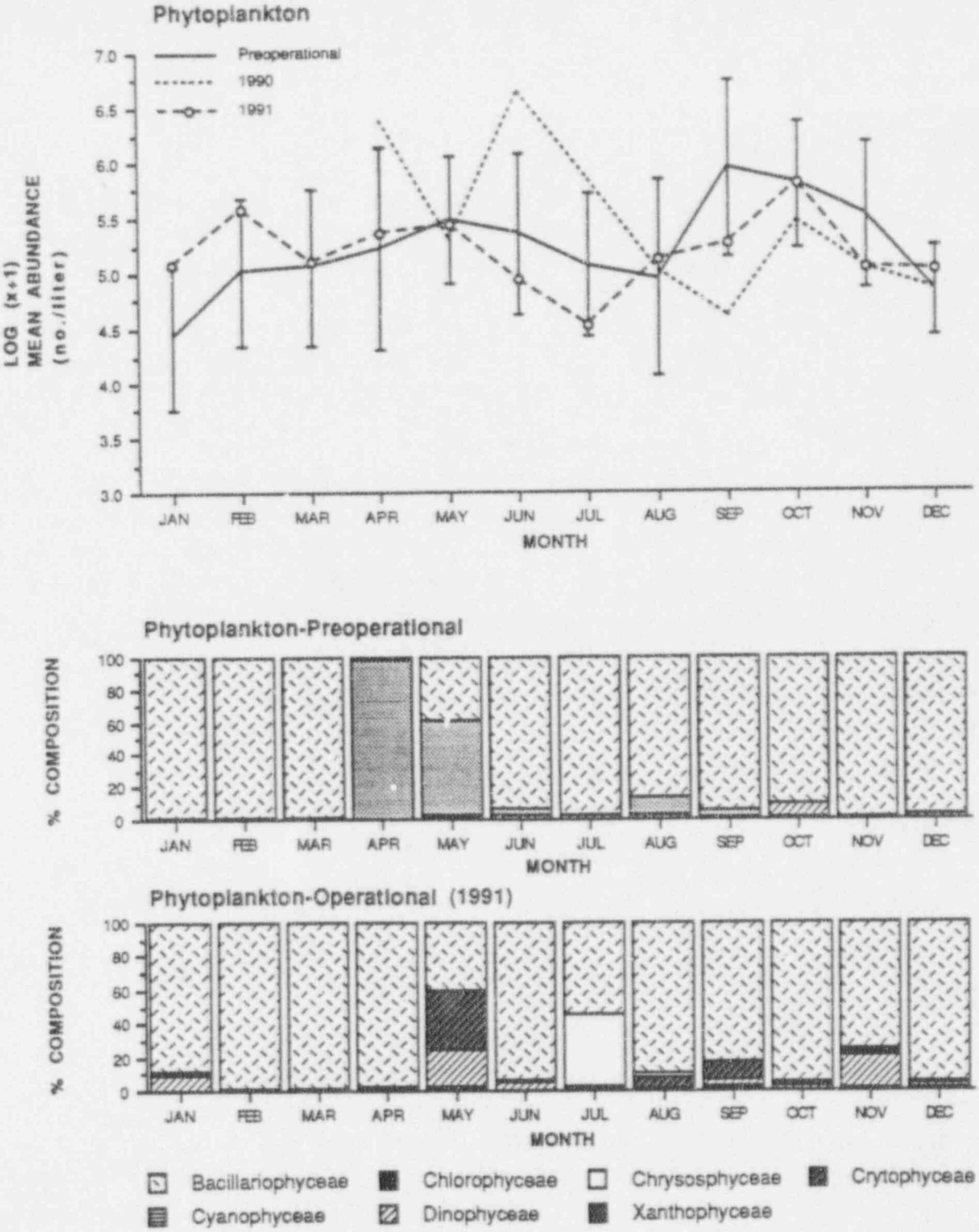


Figure 3.1.2-1. Log (x+1) total abundance (no./l) of **phytoplankton** (≥10 μm) at nearfield Station P2; monthly means and 95% confidence intervals and percent composition by major group over all preoperational y'ars (1978-1987) and monthly means for 1990 and 1991. Seabrook Ope'ational Report, 1991.

TABLE 3.1.2-1. PERCENT COMPOSITION[a] OF SPECIES BY YEAR FOR PHYTOPLANKTON AT STATION P2. SEABROOK OPERATIONAL REPORT, 1991.

STATION-P2

CLASS	TAXA	78	79	80	81	82	83	84	91
BACILLARIOPHYCEAE	SKELETONEMA COSTATUM	50.10	10.43	78.82	15.58	35.15	3.98	39.49	17.50
	RHIZOSOLENIA DELICATULA	16.49	60.40	6.15	5.94	0.42	4.65	1.10	10.17
	T. NITZSCHIOIDES	6.36	0.02	1.69	0.52	7.13	0.86	0.36	2.91
	CHAETOCEROS DEBILIS	6.10	0.23			20.24	0.23	0.03	1.13
	NITZSCHIA SP.	4.19	3.05	2.59	11.38	10.79	1.35	2.47	1.89
	BACILLARIOPHYCEAE	3.03	0.06	0.47	0.46	1.78	3.56	0.83	6.66
	THALASSIOSIRA SP.	1.39	0.13	3.44	1.29	7.70	0.95	1.61	8.01
	CHAETOCEROS SOCIALIS	0.36	0.27	0.09	0.00			39.71	4.25
	CHAETOCEROS LACINIOSUS	0.17	0.46			0.07	0.01	0.09	0.60
	CYLINDROTHECA CLOSTERIUM	0.13	0.03	0.02	0.05	0.04	0.25	0.15	3.75
	ASTERIONELLA GLACIALIS	0.12	0.02	0.11	0.00	0.00	0.57	0.00	
	CHAETOCEROS SP.	0.21	0.26	0.76	1.08	3.09	1.30	3.03	6.43
	CHAETOCEROS DECIPIENS	0.09	0.01	0.04	0.00	0.02	0.10		3.68
	CERATAULINA BERGONII	0.03	3.31	0.21	0.00		1.36	3.04	
	LEPTOCYLINDRUS DANICUS	0.00	0.13			0.05	0.15	2.32	1.04
	GYROSIGMA/PLEUROSIGMA SP.	0.00	1.49	0.03	0.02	0.04	0.01	0.01	0.02
	THALASSIONEMA SP.				1.65	0.03			
	LEPTOCYLINDRUS MINIMUS				1.52	8.95	0.48	2.45	13.49
	RHIZOSOLENIA SP.				0.02	1.12	0.01	0.00	
XANTHOPHYCEAE	PHAEOCYSTIS POUCHETII	10.75	10.66	4.57	55.25		75.95		
DINOPHYCEAE	PROROCENTRUM MICANS	0.03	6.46	0.11	0.38	0.25	0.00	0.08	2.02
	GYMNODINIUM/GYRODINIUM	0.01	1.09	0.01	0.99	0.09	0.20	0.00	1.58
	PERIDINIUM TROCHOIDEUM	0.00	0.01	0.01		0.47	0.01	0.15	1.17
	PERIDINIUM SP.	0.00	0.17	0.00	0.78	0.18	0.43	0.01	0.67
	HETEROCAPSA TRIQUETRA	0.00			0.48	0.00	0.01	0.04	
	DINOPHYCEAE				0.10	0.09	2.01	2.38	
CHLOROPHYCEAE	EUGLENALES	0.01	0.02	0.02	1.17	0.35	0.13	0.04	0.48
	ALGA; FILAMENTOUS					0.10		0.01	
CRYPTOPHYCEAE	CRYPTOMONAS SP.				0.00			0.00	6.88

[a] Includes taxa whose abundance constitutes >1% of total annual abundance; taxa shown as 0.00 are present but less than 0.01%.

During 1991, phytoplankton taxa of secondary dominance included dinoflagellates, cryptomonads (Cryptophyceae) and yellow-brown algae (Chrysophyceae), which contributed up to 42% of the population in a given month (Figure 3.1.2-1). These latter two groups included, respectively, taxa such as *Cryptomonas* sp., which was most abundant in spring (May), and *Dinobryon sertularia*, which was most abundant in July. The most abundant dinoflagellates had maximum levels in May (*Gymnodinium* and *Peridinium* species) or late fall/winter (*Prorocentrum micans*). Species composition for phytoplankton (>10 µm) in 1991 did not appear unusual compared with previous years, although there were some differences. However, cluster analysis conducted in 1984 indicated that it is difficult to characterize a truly "typical" year (NAI 1985b). As described previously, there can be large blooms of a particular species unique to a given year, which makes the combination of taxa which dominate the population somewhat different from year to year. The 1984 analysis showed some years to be similar but some to be quite unique. For this reason, phytoplankton studies have included an analysis of parameters that may be more predictable indicators of population status, such as the abundance of a selected species (*Skeletomena costatum*) or total biomass (chlorophyll *a*).

Phytoplankton - Spatial Patterns

Phytoplankton has been examined in the nearfield (Stations P2 and P5) and the farfield (Station P7) areas to determine whether their historical relationship has been maintained during operation of Seabrook Station. Spatial differences in phytoplankton in this study area can be caused by several factors. The patchy distribution of plankton in general can be a major contribution to nearfield-farfield differences. The direction and magnitude of the water currents and their relationship to the sampling sequence can also change the relationship of sample collection to a patch. These factors contribute more to nearfield-farfield variability than differences between the nearfield (P2, P5) stations. Nearfield variability may in part be a result of potential differences in ebb tide plumes from Hampton-Seabrook estuary and/or low speed (tidally driven) currents. Hydrographic studies done in 1977 indicate that the estuarine plume can extend offshore into the area of Station P5 but may not directly influence P2 (NAI 1978b). Thus, it is the value of multiple years of preoperational collections that characterize this spatial variability and provide a background for comparison.

An examination of mean annual densities at each station indicates that total abundances were spatially quite similar during the preoperational and operational periods (Table 3.1.2-2). During 1991, the nearfield Stations P2 and P5 were quite similar and generally similar to the farfield Station P7 based upon the percent composition of the 19 numerically dominant taxa (Table 3.1.2-3). The greatest spatial difference in relative abundance was the dominant taxa, *Skeletonema costatum*, (further discussed in Section 3.1.2-2), which composed twice as much of the population (36%) at P7 compared with its contribu-

TABLE 3.1.2-2. ANNUAL MEAN ABUNDANCE (log x +1) OF PHYTOPLANKTON (≥10μm) AT STATIONS P2, P5, AND P7 IN 1991 COMPARED WITH THE PREOPERATIONAL PERIOD. SEABROOK OPERATIONAL REPORT, 1991.

STATION	PREOPERATIONAL $\bar{x}$	PREOPERATIONAL LCL-UCL[b]	PREOPERATIONAL (YEARS)	OPERATIONAL (1991) $\bar{x}$
P2	5.22	5.04-5.40	(78-84)[a]	5.19
P5	5.23	4.97-5.49	(78-81)	5.30
P7	5.08	4.84-5.31	(82-84)	5.23

[a]( ) = preoperational years
[b]Lower 95% confidence limit-upper 95% confidence limit

TABLE 3.1.2-3. 1991 PHYTOPLANKTON PERCENT COMPOSITION BY STATION. SEABROOK OPERATIONAL REPORT, 1991.

CLASS	TAXA	P2 % COMP	P5 % COMP	P7 % COMP
DINOPHYCEAE	GYMNODINIUM/GYRODINIUM	1.58	0.62	0.24
	PERIDINIUM TROCHOIDEUM	1.17	0.32	0.64
	PROROCENTRUM MICANS	2.02	2.16	3.69
CRYPTOPHYCEAE	CRYPTOMONAS SP.	6.88	3.33	2.50
CYANOPHYCEAE	OSCILLATORIA SP.		4.37	5.22
BACILLARIOPHYCEAE	BACILLARIOPHYCEAE	6.66	4.55	5.54
	CHAETOCEROS DEBILIS	1.13	2.67	0.90
	CHAETOCEROS DECIPIENS	3.68	9.39	4.15
	CHAETOCEROS LACINIOSUS	0.60	4.26	0.84
	CHAETOCEROS SOCIALIS	4.25	8.21	8.39
	CHAETOCEROS SP.	6.43	5.80	3.31
	CYLINDROTHECA CLOSTERIUM	3.75	2.37	2.44
	LEPTOCYLINDRUS DANICUS	1.04	1.21	1.74
	LEPTOCYLINDRUS MINIMUS	13.49	8.80	5.99
	NITZSCHIA SP.	1.89	1.41	1.57
	RHIZOSOLENIA DELICATULA	10.17	5.10	0.98
	SKELETONEMA COSTATUM	17.50	19.03	35.51
	T. NITZSCHIOIDES	2.91	2.05	2.52
	THALASSIOSIRA SP.	8.01	7.21	7.63

tion at P2 (18%). The difference in the nearfield was made up mostly by other diatoms. Among non-diatom taxa, *Cryptomonas* sp. exhibited the most noticeable difference, composing 7% of the annual abundance at P2 versus 3% at P7. A multivariate analysis of variance (MANOVA), testing the abundances of the 19 numerically important taxa from all three stations in 1991, indicated that species abundances were not significantly different ($p \geq 0.05$) among Stations P2, P5 and P7.

Ultraplankton

Ultraplankton (<10μm) was responsible for the higher total phytoplankton abundances observed in 1990 (NAI 1991b), when compared with the 1978 to 1984 period. Because of this, the significance of the ultraplankton to the ecology of coastal waters of New Hampshire has been further evaluated in this report.

Densities for the ultraplankton group were substantially higher in 1991 compared with the operational period but were similar to levels observed in 1990 (Figure 3.1.2-2). Although annual means are of limited interpretive value, these data showed increasing counts each year, contributing to the apparent operational versus preoperational difference (Table 3.1.2-4). During the periods 1978-1980 and 1978-1983, small, unicellar flagellate algae, either of the class Chlorophyceae (unidentified taxa) or Crytophyceae (*Chroomonas* sp.) were reported as comprising the majority of the ultraplankton (Table 3.1.2-5). In 1981, unidentified blue-green algae (Cyanophyceae) were dominant. In 1984 and 1991, as well as 1990 (Figure 3.1.2-2), *Synecococcus*-type Cyanophyceae algae were recorded as very abundant and dominated the ultraplankton size class. Because these taxa are very small (<2 μm) the use of improved microscopy (i.e., phase contrast) since 1984 likely contributed to the more recent higher counts. Although the apparent annual increases may initially have causedconcern about operational influences, spatial comparisons of 1990 and 1991 abundances showed that all trends were area-wide, as observed by the similarities between nearfield (P2, P5) and farfield (P7) stations

TABLE 3.1.2-4. TOTAL LOG MEAN ULTRAPLANKTON ABUNDANCE BY YEAR AND 95% CONFIDENCE INTERVALS.

STATION	1978	1979	1980	1981	1982	1983	1984	1991
P2	1.78 (1.03)	2.71 (1.10)	2.18 (1.28)	4.10 (0.98)	4.14 (0.52)	4.56 (0.45)	4.99 (0.45)	6.60 (0.25)
P5								6.55 (0.29)
P7								6.53 (0.25)

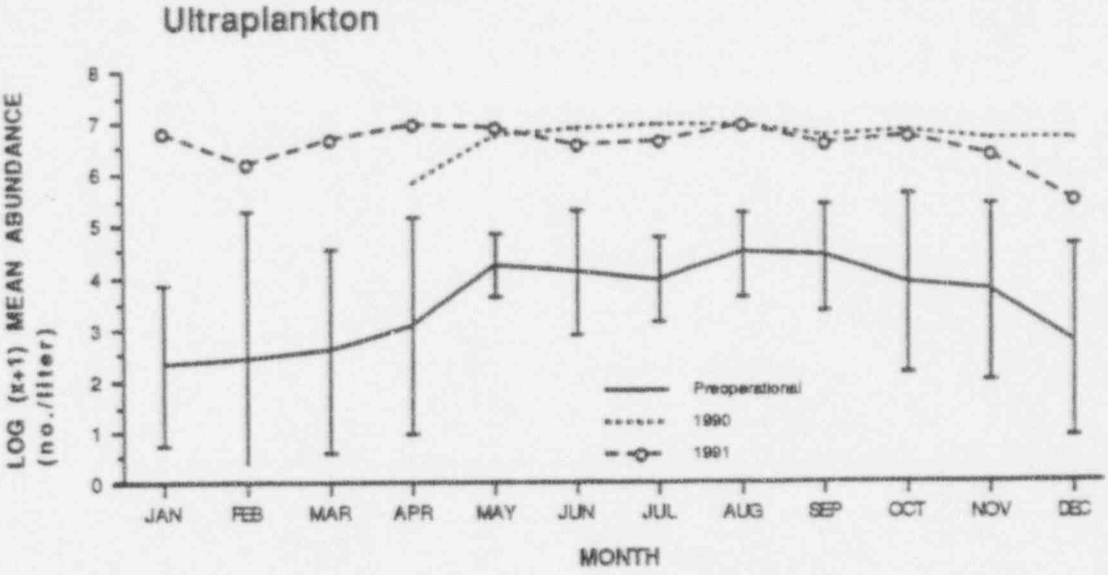


Figure 3.1.2-2. Log (x+1) monthly mean abundance and 95% confidence intervals of **ultraplankton** at Station P2 during the preoperational years (1978-1984) and monthly means during 1990 and 1991. Seabrook Operational Report, 1991.

TABLE 3.1.2-5. PERCENT COMPOSITION OF TAXA BY YEAR FOR ULTRAPLANKTON AT STATION P2. SEABROOK OPERATIONAL REPORT, 1991.

	PERCENT COMPOSITION BY YEAR [a]							
TAXON	78	79	80	81	82	83	84	91
Cyanophyceae; colonial				4.3			68.8	80.0
Alga; unicellular	47.1			5.2	0.1	2.1	0.2	9.7
Cyanophyceae; filamentous					3.8	<.1	0.1	4.0
Chroomonas sp.	52.0	91.5	22.0	2.4	21.6	1.4		2.9
Alga; flagellate		8.5	78.0	31.9	74.5	96.4	30.3	2.9
Ocytoxum sp.	0.9			0.1			0.4	0.5
Cyanophyceae				56.1		0.1	0.2	
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] 1990 not represented here because samples not collected for 12 months; see NAI 1991b for results

(Figure 3.1.2-2; Table 3.1.2-5). Not only were total densities quite similar among stations in 1991, but the percent composition of these most abundant taxa were also quite similar.

The abundances of ultraplankton in this study are consistent with findings from studies in the region. It has been reported that the general oceanic abundances of picoplankton (0.2-2.0μm) range from 10^5 to 10^8 cells/liter for the cyanobacteria forms and 10^5 to 10^7 cells/liter for eukaryotic (i.e., chlorophyceae, etc.) forms (Joint 1986). The ubiquitous nature of the picoplankton and the magnitude of their abundance has been reported elsewhere (Stockner 1988) as has the abundance of the dominant picoplanktonic species, *Synechococcus* (Karlson and Nilsson, 1991; Shapiro and Haugen 1988; Murphy and Haugen 1985; Glover et al. 1986). These studies corroborate the abundances of ultraplankton recorded in the 1991 Seabrook studies. For example, counts of cyanobacteria (*Synechococcus*) in Boothbay Harbor, Maine during 1984-85 sampling were reported to be in the range of 1 to 15 x 10^6 cells/liter (Shapiro and Haugen 1988), similar to levels that are now being reported in these studies. Recent studies in Massachusetts Bay have shown ultraplankton to have a similar species composition as in this study and total abundance in the same order of magnitude or higher (Haugen 1991). For example in August 1990, Haugen reported ultraplankton levels on the order of 95 x 10^6 cells/liter (August 14) while in these studies we recorded values of 9 x 10^6 cells/liter (August 9)(NAI 1991a).

Thus, it appears that improved methodologies in these studies have allowed a true recognition of the abundances of ultraplankton that exist in the study area. Currently, comparative abundances of ultraplankton with other studies in the region, combined with similar abundances of these taxa between the nearfield and farfield areas of this study would indicate that Seabrook operation has had no effect on this group of phytoplankton.

Chlorophyll *a* Concentrations

Chlorophyll *a* concentrations may, in general, be used as a measure of phytoplankton standing crop (biomass), although the issue is complicated by the varying amounts of chlorophyll *a* contained in the differing sizes and species of phytoplankton. During the preoperational period, chlorophyll *a* concentrations showed a bimodal pattern, with peaks in spring and fall (Figure 3.1.2-3). Concentrations followed a similar pattern in 1991, with the spring (May) sampling events occurred during a higher peak than the fall collections. The two highest concentrations at P2 in 1991 were observed in May and in November; smaller peaks were apparent in February and in September. Preoperational chlorophyll *a* peaks are less distinct because the 12-year average integrates year-to-year shifts in the timing of peak occurrences. Thus, although annually there are usually two noticeable seasonal peaks in chlorophyll *a*, the timing of each peak may vary over a several-month period from year-to-year. This factor also contributes to

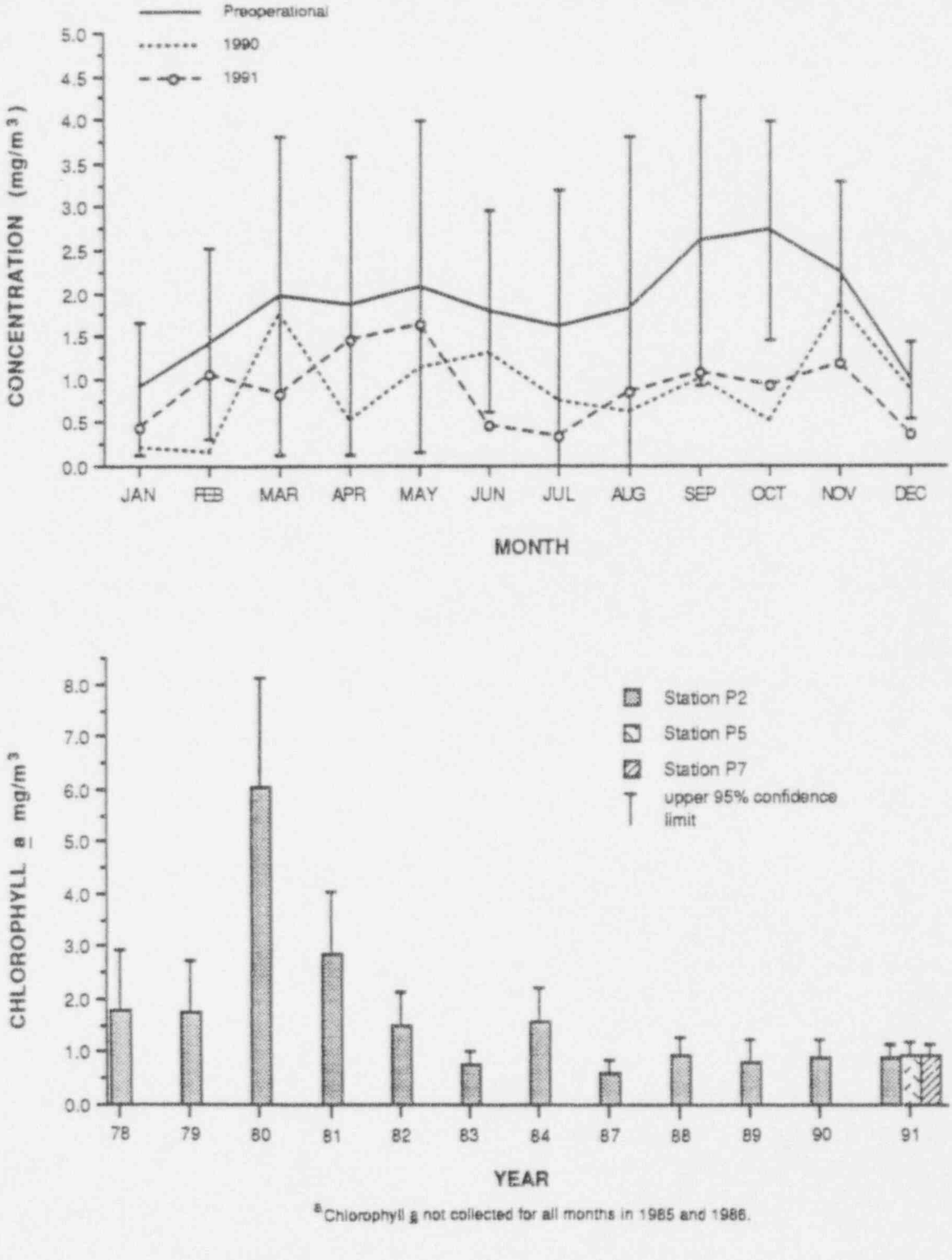


Figure 3.1.2-3. Mean monthly **chlorophyll a** concentrations and 95% confidence intervals at Station P2 over preoperational years, 1978-1989 , and monthly means in 1990 and 1991; and mean yearly chlorophyll a concentrations at Station P2 during 1978-1989 and Stations P2, P5 and P7 during 1991. Seabrook Operational Report, 1991.

the variability in the monthly confidence intervals.

The average monthly chlorophyll *a* concentrations at nearfield Station P2 in 1991 were lower than the mean but were within the broad confidence intervals of the preoperational period (Figure 3.1.2-3). The preoperational monthly means are high due to the occurrence of very high chlorophyll *a* levels in 1980 and 1981 (NAI 1982c) and to a lesser degree by the two to three year period of higher than average levels on either side of 1980 (Figure 3.2.1-3). Since 1981, a seasonal peak value greater than 4.0 mg/m^3 has been very rare, with most ranging between 1.0 and 4.0 mg/m^3. Chlorophyll *a* levels during the 1990 and 1991 periods of Seabrook operation have been generally consistent with levels recorded during the more recent preoperational period, i.e., 1983-1989 (Figure 3.1.2-3).

Some variability in the occurrence of seasonal peaks of chlorophyll *a* was also observed among stations. For example, in 1991 the highest spring values were recorded in March (1.18 mg/m^3) and April (1.17 mg/m^3) at the farfield station (P7), while in the nearfield the monthly average was highest in April (1.73 mg/m^3) at P5 but occurred in May at P2 (1.62 mg/m^3) (NAI 1992). The fall values were similar among stations in 1991, with the exception of quite divergent nearfield/farfield levels in December (i.e., 3-4 times higher at P7). Different trends in chlorophyll *a* values between nearfield and farfield areas was born out previously in the correlation analysis (NAI 1991b). In 1990, nearfield stations (P2, P5) were highly correlated; correlations with farfield values were still significant but correlation values were lower; all correlations were also significant in 1991. Observed differences may have been due to small-scale patchiness rather than significant differences in population biomass within the study area.

Temporal and spatial patterns in chlorophyll *a* concentrations were examined with ANOVA for the recent period (1987-1989 and 1991) when all three stations were sampled concurrently for 12 months (Table 3.1.2-6) Chlorophyll *a* levels were significantly higher in the first full operational year (1991) than in recent preoperational years. Although this could be primarily attributable to lower levels at Station P7 (NAI 1992), the lack of a significant interaction term (Preop-Op X Station) implies that differences between preoperational and operational periods were consistent among stations.

PSP Levels

PSP toxicity levels in *Mytilus edulis*, as provided by the State of New Hampshire, have shown a reasonably consistent seasonal pattern of highest values occurring during the late spring and early summer during the preoperational period (Figure 3.1.2-4). PSP concentrations also show a small peak in toxicity levels occurring in August.

In 1991, the State recorded only two occurrences of PSP levels above the method detection limit of 44 µg/100 gm mussel tissue and these measured only 45 mg/100 gm (May 2 and 9). Despite these

TABLE 3.1.2-6. RESULTS OF ANALYSIS OF VARIANCE COMPARING ABUNDANCES OF THE PHYTOPLANKTON SELECTED SPECIES/PARAMETERS AMONG STATIONS P2, P5 AND P7 DURING PREOPERATIONAL YEARS AND THE OPERATION (1991) PERIOD. SEABROOK OPERATIONAL REPORT, 1991.

SOURCE OF VARIATION	df	SS	F	MULTIPLE COMPARISONS
CHLOROPHYLL *a*: P2, P5, P7 (1987-1989; 1991)[a,b,c]				
Preop-Op[d]	1	0.3209	5.17 *	Op>Preop
Year (Preop-Op)[e]	2	1.6298	13.13 ***	
Month (Year)[f]	44	29.1518	10.68 ***	
Station	2	0.1517	1.22 NS	
Preop-Op x Station[g]	2	0.0545	0.44 NS	
Error	92	5.7082		
SKELETONEMA COSTATUM: P2 VS. P7 (1982-1984, 1991)[a,b]				
Preop-Op[d]	1	2.26	30.08 ***	Op>Preop
Year (Preop-Op)[e]	2	6.11	40.65 ***	
Month (Year)[f]	44	63.30	19.15 ***	
Station	1	0.02	0.28 NS	
Preop-Op x Station[g]	1	0.27	3.58 NS	
Error	46	3.46		
SKELETONEMA COSTATUM: P2 VS. P5 (1979-1981; 1991)[a,b,c]				
Preop-Op[d]	1	1.63	3.18 NS	
Year (Preop-Op)[e]	2	6.89	6.71 **	
Month (Year)[f]	43	167.20	7.57 ***	
Station	1	1.35	2.63 NS	
Preop-Op x Station[g]	1	1.77	3.44 NS	
Error	45	205.01		

[a]based on mean of twice-monthly collections Mar-Nov; monthly Dec-Mar
[b]years when these stations were collected concurrently
[c]only includes years when all 12 months were sampled
[d]preoperational versus operational period regardless of station
[e]year, regardless of preop-op
[f]month nested within year regardless of station
[g]interaction between main effects

NS = not significant ($p \geq 0.05$)
* = significant ($0.05 > p \geq 0.01$)
** = highly significant ($0.01 \geq p > 0.001$)
*** = very highly significant ($0.001 \geq p$)

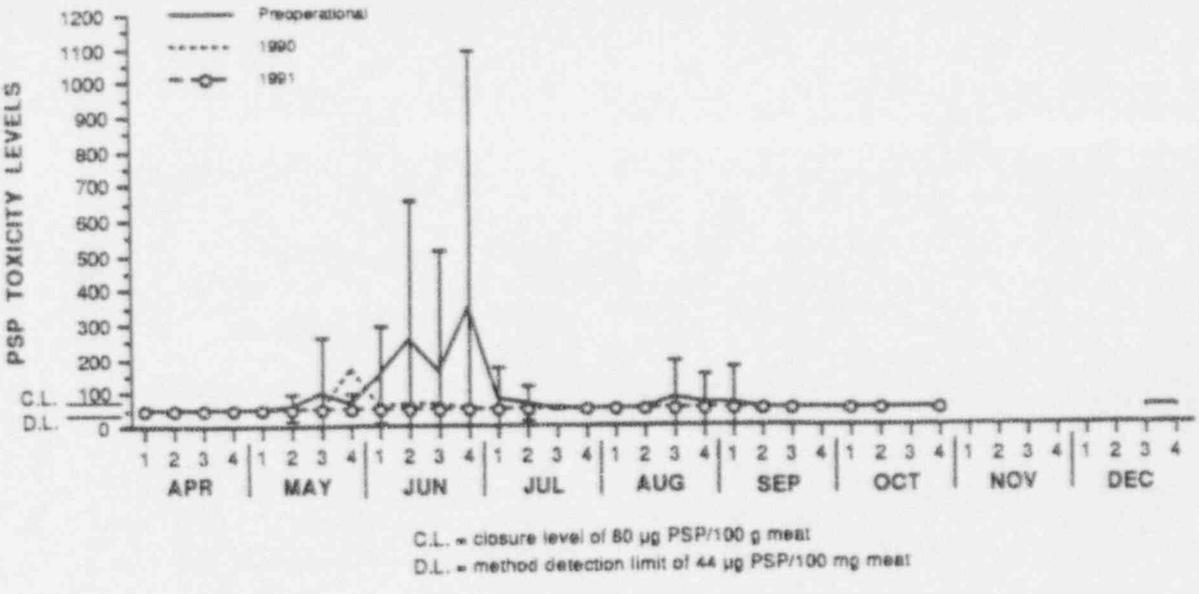


Figure 3.1.2-4. Mean and 95% confidence intervals of weekly paralytic shellfish poisoning (PSP) toxicity levels in *Mytilus edulis* in Hampton Harbor, as provided by the State of New Hampshire, over preoperational years, 1983-1989, and mean levels in 1990 and 1991. Seabrook Operational Report, 1991.

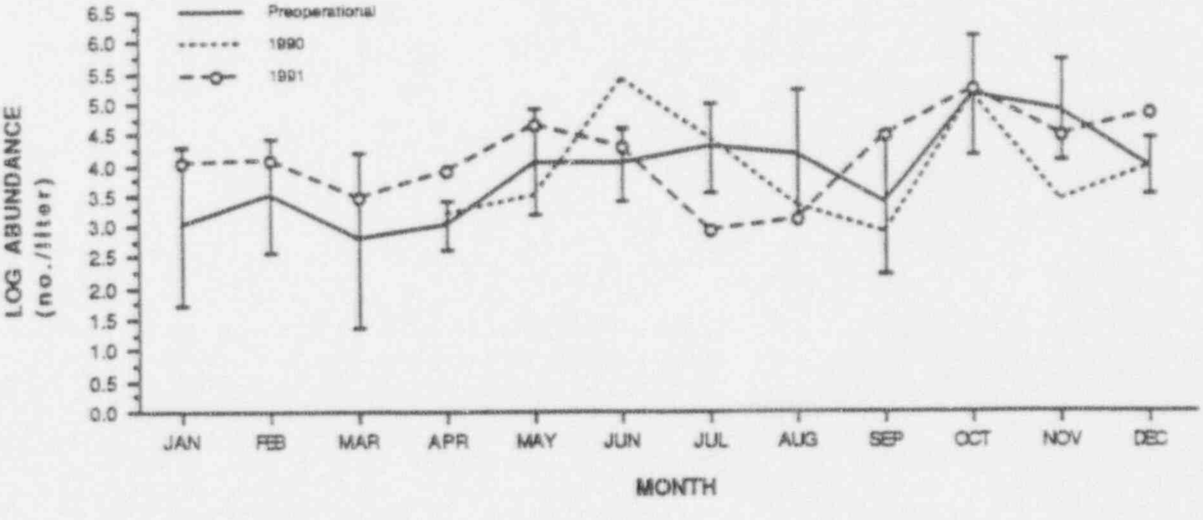


Figure 3.1.2-5. Log $(x+1)$ abundance (no./l) *Skeletonema costatum* at nearfield Station P2; monthly means and 95% confidence intervals over all preoperational years (1978-1984) and monthly means for 1990 and 1991. Seabrook Operational Report, 1991.

low levels. New Hampshire's coastal shellfish beds were closed on June 14 due to high PSP readings reported in shellfish from Maine and Massachusetts at that time. The coastal shellfish beds were reopened to recreational takings on September 9, 1991.

The occurrence of PSP toxicity in this portion of the Gulf of Maine was first documented in 1972 (NAI 1985b), possibly the result of the transport of the PSP-producing dinoflagellate *Alexandrium tamarense* (formerly called *Gonyaulax* sp.), from the Bay of Fundy following Hurricane Carrie. With few exceptions, PSP has been recorded seasonally in this region of the western Gulf of Maine ever since, although not always at toxic levels. It is currently thought that *A. tamarense* blooms are transported to this region on coastally-trapped buoyant plumes derived from the Androscoggin and/or Kennebec River (Maine) outflows (Franks and Anderson, 1992a). This theory is consistent with the generally observed north-to-south seasonal progression of occurrence of this dinoflagellate and the PSP levels (Franks and Anderson 1992b). Local sources of dinoflagellates may also contribute to the blooms as well. However, there have not been PSP "outbreaks" associated solely with this segment of the New Hampshire coast nor have closings in New Hampshire been conducted independent of larger regional (Southern Maine and Massachusetts) closings. Consistent, historical PSP occurrences since 1972, coupled with current theories of PSP bloom sources in the southwestern Gulf of Maine would indicate that the operation of Seabrook Station could have no effect on this problem. The low PSP levels in New Hampshire in 1992 would further corroborate this conclusion.

3.1.2.2 Selected Species

Skeletonema costatum was chosen as a selected species because of its historic omnipresence and overwhelming dominance during much of the year. During the preoperational period, abundances were slightly bimodal in nature, usually showing a smaller peak in the spring (varying from year-to-year from February to May) and a larger peak in the late summer or fall (varying from August to October). This pattern was somewhat different in 1990 and 1991 (Figure 3.1.2-5) when the spring peaks were larger and later than typical. The fall peaks were consistent with earlier observations. *Skeletonema costatum* abundances were tested with ANOVA to evaluate spatial and temporal trends.

During the period when nearfield Station P2 and farfield Station P7 were sampled for 12 months concurrently (1982-2984; 1991), significant differences in *Skeletonema costatum* abundances were shown to exist between the preoperational years and 1991 (Preop-Op), among years (Year), and among months (Month (Year)) (Table 3.1.2-6). These latter two variables are not particularly important in determining impact. No significant differences in abundances were found among stations and the relationship among stations in terms of abundance of *S. costatum* did not vary between preoperational years and 1991 (Table 3.1.2-6, Preop-Op X Station). Thus, although 1991 abundances of *S. costatum* were higher than the 1982-1984 period, these differences were consistent area wide. Similarly, nearfield Station (P2, P5) differences were also tested (in this case for the 1979-1981; 1991 period) (Table 3.1.2-6). *Skeletonema costatum* abundances within the nearfield zone have been statistically similar, both in 1991 and in the preoperational period sampled.

3.1.2.3 Effects of Plant Operation

The phytoplankton community has been studied to determine if the thermal plume has caused detectable changes in the community structure or abundance within the nearfield study area. Lack of detectable impacts form plant operation (primarily from the plume in the near-surface waters) is implied if operational collections are similar to preoperational collections or if not, nearfield/farfield collections are similar.

An examination of the phytoplankton ≥10μm did not indicate any deleterious plume effects when comparing preoperational periods (1978-1984) with the operational period (August 1990-December 191) in the nearfield; monthly mean abundances were similar. Spatial trends were examined for the top 19 species dominating the community structure in 1991 and no significant nearfield-farfield differences were found, further indicating no plant impacts to this group of phytoplankton. A statistical examination of total phytoplankton biomass (chlorophyll *a*) over the 1987-1991 period reinforced this lack of spatial differences. Although statistical tests showed chlorophyll *a* values in 1991 to be higher than the 1987-1989 preoperational period, this trend was consistent among stations. Chlorophyll *a* values in 1991 were within the range observed across the entire preoperational period at Station P2 (1978-1989).

Diatoms dominated the phytoplankton (≥10 μm) group both preoperationally and in 1991, indicating a generally unchanged community structure. The dominant diatom taxon, *Skeletonema costatum*, exhibited similar abundance patterns at nearfield Station P2 and farfield Station P7 when both were sampled (1982-1984, 1991). Thus, since abundances of *S. costatum* were statistically higher in the 1991 operation period compared with the 1982-1984 preoperational period at both nearfield and farfield stations, this difference appears to be due to natural year-to-year variability and not related to operation of the plant. Nuisance algae were also monitored by examining long-term trends in PSP values in mussels in Hampton Harbor. Due to the low occurrences of PSP in New Hampshire in 1990 and 1991, combined with the current theories on more northerly sources of toxic dinoflagellates to this portion of the Gulf of Maine, increases to these nuisance phytoplankton from plant-induced effects were clearly not implicated during this period.

This study has reported steady increases in total abundances of the ultraplankton group, from an annual average of 60 cells/liter in 1975 to about 4 x 10^6 cells/liter in 1991. Abundances in this study are similar to levels reported recently by other Gulf of Maine researchers. Furthermore, farfield ultraplankton abundances were similar to those in the nearfield, reinforcing the fact that these abundances are an area-wide occurrence. This regional distribution, coupled with the improved methodology, which enabled more-accurate enumeration of ultraplankton, suggests that there has been no plant-induced effect on the ultraplankton.

3.1.3 Microzooplankton

3.1.3.1 Total Community

Temporal Characteristics

Temporal variability in species abundances and taxonomic composition of the nearshore microzooplankton community (surface and bottom samples averaged) at Station P2 for all preoperational (1978-1984 and 1986) and operational (1990 and 1991) collections was examined using numerical classification. Collections were grouped into six major groups that corresponded with the annual seasonal cycle and two additional smaller groups (one collection date was ungrouped, Figure 3.1.3-1). The major seasonal patterns in the microzooplankton community structure were largely delineated by changes in both total abundance and the dominance structure of numerically important taxa. Lifestages of the copepods *Oithona* sp. and *Pseudocalanus* sp., and *Pseudocalanus/Calanus* nauplii were the most abundant organisms in virtually every seasonal group during both preoperational and operational periods (Table 3.1.3-1). Among-year differences in the dates assigned to cluster groups 3, 4 and 5 (late winter to early fall, Figure 3.1.3-1) were more apparent than for the other seasons because of the dominant taxa's highly variable densities. The dominant copepods continued to maintain moderate populations throughout the fall and into winter (Groups 5 and 6) while densities of most other taxa declined. The summer/fall 1990 and 1991 and small fall clusters (Groups 7 and 8) did not differ appreciably from the other collection dates with respect to those taxa that were numerically important.

Comparison of the specific dates included within the major cluster groups indicated that differences among years were generally moderate. The most pronounced variation occurred during late summer and fall of preoperational years where cluster groups included a number of "outlying collections" (i.e., a collection date separated by more than two weeks from the rest of the seasonal group) (Figure 3.1.3-1). Summer tended to be a period of high abundance and diversity partly due to recruitment of meroplankton into the zooplankton community. These factors contributed to variability within each season and among years. Collections from 1990 and 1991 generally clustered into groups containing corresponding dates from the preoperational period, although some collections from summer/fall 1990 with lower than typical abundances were identified as a separate group (Group 7). With the exception of one collection in 1991, this condition of reduced abundances did not recur. Preoperational and operational periods were similar in the rank order of numerically dominant taxa identified from each cluster group (Table 3.1.3-1). Differences among groups, in large measure, were attributed to seasonal variability in the

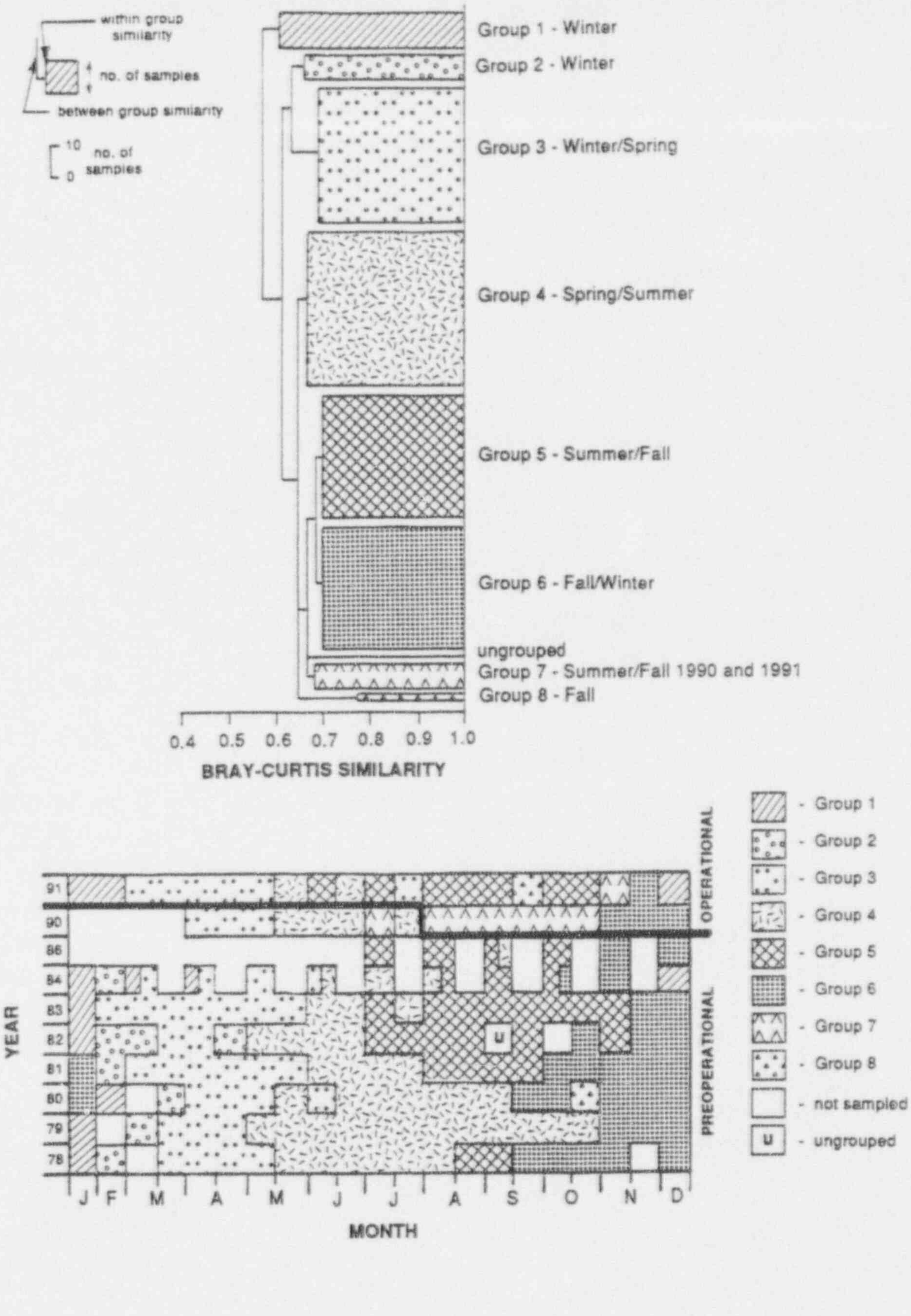


Figure 3.1.3-1. Dendrogram formed by numerical classification of log (x+1) transformed **microzooplankton** abundances (no./m) at nearfield Station P2, 1978-1984, July-December 1986, and April-December 1990 and 1991. Seabrook Operational Report, 1991.

TABLE 3.1.3-1. GEOMETRIC MEANS OF MICROZOOPLANKTON ABUNDANCE (NO./m^3), 95% CONFIDENCE LIMITS, AND NUMBER OF SAMPLES FOR DOMINANT TAXA OCCURRING IN SEASONAL CLUSTER GROUPS IDENTIFIED BY NUMERICAL CLASSIFICATION OF COLLECTIONS AT NEARFIELD STATION P2, 1978 - 1985, JULY - DECEMBER 1986, APRIL - DECEMBER 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

GROUP	DOMINANT[a] TAXA	PREOPERATIONAL PERIOD LCL	PREOPERATIONAL PERIOD MEAN	PREOPERATIONAL PERIOD UCL	N	OPERATIONAL PERIOD LCL	OPERATIONAL PERIOD MEAN	OPERATIONAL PERIOD UCL	N
1	Copepoda nauplii	110.2	286	738.2	9	167.3	436	1135.4	3
Winter	Foraminiferida	11.6	77	484.9		1.1	106	5497.3	
(0.61/0.57)[b]	*Oithona* sp.	121.9	326	870.3		1030.3	1418	1952.6	
	Pseudocalanus sp.	68.6	158	360.7		191.9	287	428.6	
	Pseudocalanus/Calanus nauplii	56.6	161	454.3		17.4	117	759.7	
	Tintinnidae	41.6	275	1784.6		1.1	39	738.0	
2	Cirripedia larvae	35.8	247	1675.7	8	not represented			
Winter	Copepoda nauplii	127.3	258	522.4					
(0.66/0.64)	*Microsetella norvegica*	45.6	139	417.8					
	Oithona sp.	334.5	842	2115.0					
	Polychaeta larvae	31.5	162	819.8					
	Pseudocalanus sp.	44.1	142	455.7					
	Pseudocalanus/Calanus nauplii	259.1	542	1130.7					
3	*Acartia* sp.	50.8	76	114.2	36	34.9	548	8397.1	6
Winter/Spring	Copepoda nauplii	700.2	988	1394.9		1047.4	2358	5309.1	
(0.69/0.64)	*Oithona* sp.	942.9	1342	1910.3		2036.2	3484	5959.8	
	Pseudocalanus sp.	220.1	329	490.8		127.0	293	674.2	
	Pseudocalanus/Calanus nauplii	520.2	791	1203.4		88.9	398	1775.2	
4	Bivalvia veliger larvae	1377.7	2473	4439.8	46	--	1505	--	2
Spring/Summer	Copepoda nauplii	4189.8	5795	8015.2		--	6171	--	
(0.66/0.65)	*Oithona* sp.	5299.2	6690	8445.3		--	7562	--	
	Pseudocalanus sp.	1218.5	1698	2366.1		--	1809	--	
	Pseudocalanus/Calanus nauplii	1963.7	2687	3677.3		--	1614	--	
	Temora longicornis	159.5	268	450.1		--	1969	--	
5	Bivalvia veliger larvae	548.0	902	1485.7	31	225.7	1197	6332.5	7
Summer/Fall	Copepoda nauplii	1457.2	2211	3354.8		1614.7	3613	8081.7	
(0.71/0.69)	*Oithona* sp.	3955.1	5178	6780.4		4269.3	8049	15175.4	
	Pseudocalanus sp.	817.6	1245	1896.2		509.1	805	1271.3	
	Pseudocalanus/Calanus nauplii	1365.4	2025	3002.3		264.4	418	660.7	

(continued)

TABLE 3.1.3-1. (Continued)

GROUP	DOMINANT[a] TAXA	PREOPERATIONAL PERIOD LCL	PREOPERATIONAL PERIOD MEAN	PREOPERATIONAL PERIOD UCL	N	OPERATIONAL PERIOD LCL	OPERATIONAL PERIOD MEAN	OPERATIONAL PERIOD UCL	N
6	Copepoda nauplii	663.9	991	1480.1	33	179.0	960	5135.5	4
Fall/winter	*Oithona* sp.	1320.0	1824	2519.7		494.6	1715	5942.2	
(0.71/0.69)	*Pseudocalanus* sp.	212.7	306	440.4		119.4	255	544.6	
	Pseudocalanus/Calanus nauplii	454.7	633	880.3		41.1	295	2071.7	
	Tintinnidae	47.8	125	325.6		39.7	2686	177442.0	
7	*Acartia* sp.	--	4989	--	1	31.2	126	502.8	7
Summer/Fall	Bivalvia veliger larvae	--	3283	--		139.7	455	1477.2	
1990	Copepoda nauplii	--	3963	--		577.0	1344	3130.4	
(0.68/0.66)	*Oithona* sp.	--	5937	--		1235.8	2754	6137.4	
	Pseudocalanus sp.	--	736	--		105.3	341	1099.8	
	Temora longicornis	--	2833	--		69.9	468	3104.9	
8	Bivalvia veliger larvae	--	208	--	1	--	108	--	1
Fall	Copepoda nauplii	--	382	--		--	795	--	
(0.77/0.66)	*Oithona* sp.	--	432	--		--	4959	--	
	Polychaeta	--	86	--		--	21	--	
	Pseudocalanus sp.	--	86	--		--	314	--	
	Pseudocalanus/Calanus nauplii	--	272	--		--	44	--	

[a] taxa comprising ≥ 5% of total group abundance
[b] within group similarity/between group similarity

abundances of these dominant taxa. Seasonal groups identified by numerical classification generally encompassed collection periods with similar temperature regimes, particularly with respect to the depth and intensity of the thermocline (NAI 1985b; NAI 1991b; Figure 3.1.1-3).

Spatial Patterns of Microzooplankton Abundances

Spatial variation (i.e., among-stations differences) in the microzooplankton community structure was examined separately for both the preoperational and operational periods, with abundances averaged over depth. Comparison of total microzooplankton densities from 1982 to 1984 using Wilcoxon's two-sample test (Sokal and Rohlf 1969) revealed no significant differences between Stations P2 and P7 (NAI 1985b). Although some numerically important taxa exhibited large differences in rank order or percent composition between stations, their individual abundances were also not significantly different (NAI 1985b).

A multivariate analysis of variance (MANOVA) was performed using the April-December 1991 abundances of 35 numerically important taxa from Station P2, P5, and P7. Species composition and abundances were not significantly different among these stations (p=0.24), as was found in 1990 (NAI 1991b).

3.1.3.2 Selected Species

The copepods *Pseudocalanus* sp. and *Oithona* sp. were selected for in-depth analysis in the microzooplankton program because of their dominant roles in the community. Their abundance and low trophic level make them important members of the marine food web. *Eurytemora herdmani* has been reported to be an abundant coastal copepod in the northern region of the western Atlantic (Katona 1971) and as such, may be particularly sensitive to perturbations in the local temperature regime. Lifestages of these taxa were identified whenever possible to develop an understanding of the dynamics of population recruitment cycles. In some cases, however, the likely presence of congeneric species made it impossible to routinely identify all lifestages to species level.

Eurytemora sp.

Earlier studies indicated that *Eurytemora* sp. copepodite and *E. herdmani* adult populations in Hampton Harbor and the nearfield Station P2, underwent similar seasonal cycles, but during the spring the estuarine population was much larger (NAI 1978b, 1979b). These observations suggest that recruitment to the coastal population may be supplemented by the estuarine population. Other sources of recruitment in the spring might be maturation of, and subsequent reproduction of, overwintering copepodites or hatching of diapause (overwintering) eggs.

In 1990, *Eurytemora* sp. copepodite d ies did not exhibit the historic e . mid-summer peak and were well below the preoperational average from May through August (Figure 3.1.3-2). However, a late fall peak was evident

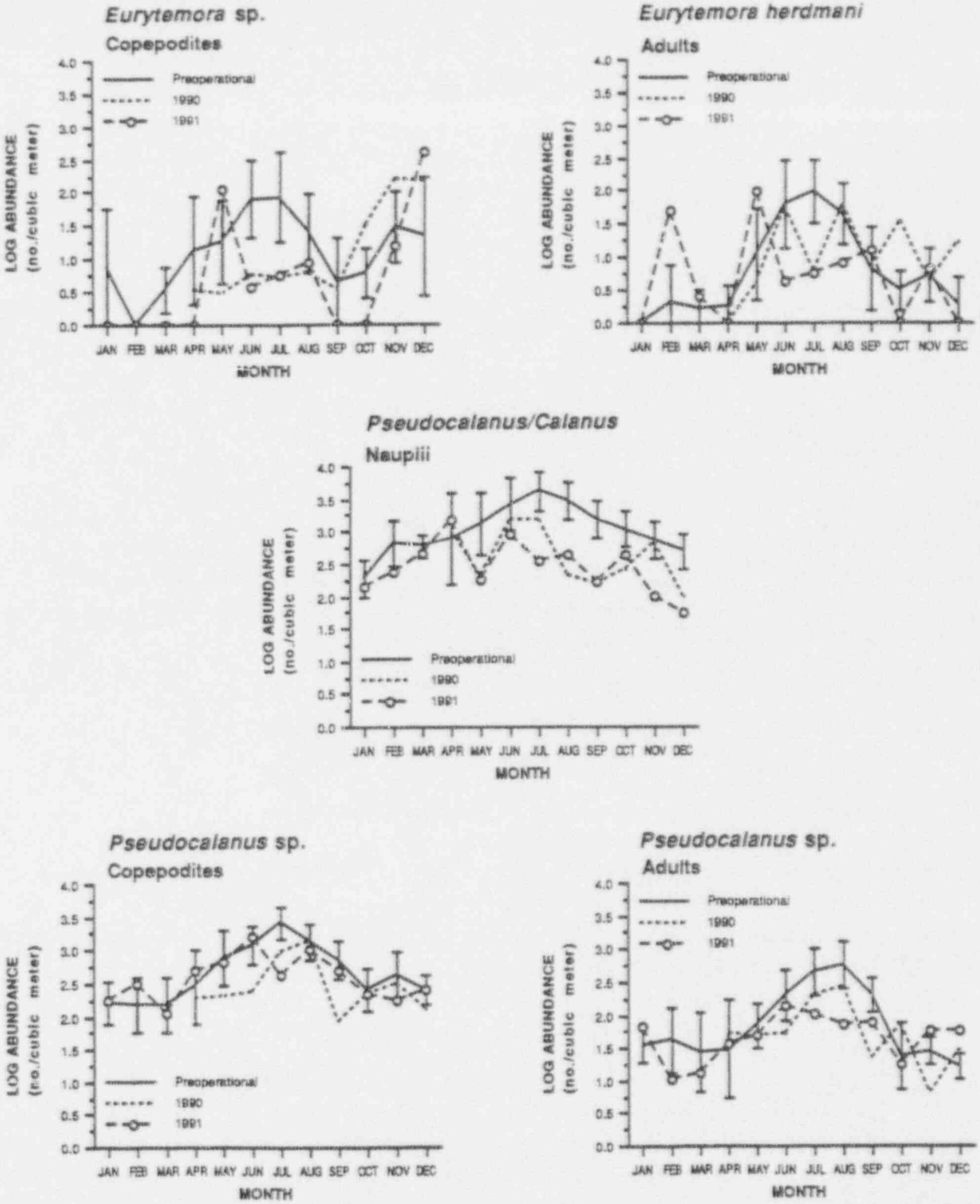


Figure 3.1.3-2. Log (x+1) abundance (no./m³) of *Eurytemora* sp. copepodites and *Eurytemora herdmani* adults, *Pseudocalanus/Calanus* sp. nauplii, and *Pseudocalanus* sp. copepodites and adults; monthly means and 95% confidence intervals over all preoperational years (1978-1984 and 1986) and monthly means for 1990 and 1991 at nearfield Station P2. Seabrook Operational Report, 1991.

which was slightly higher than the mean for the preoperational years. *Eurytemora* sp. copepodite densities in 1991 displayed both late spring and fall peaks that were comparable in magnitude to preoperational years. The 1991 geometric annual mean for copepodites at Station P2 was well below the overall mean for the preoperational years (Table 3.1.3-2), but was within the range of mean values for individual years (NAI 1991b). Results of the two-way ANOVA on *Eurytemora* sp. copepodites indicated that abundances during the operational period were significantly lower than preoperational densities. However, this was an area-wide pattern, as indicated by the lack of significance in the Area (i.e., nearfield versus farfield) and interaction (Preop-Op) terms (Table 3.1.3-3).

Temporal changes in the abundance of *E. herdmani* adults followed the same general seasonal trend in 1990 and 1991 as during preoperational years, but continued to exhibit the high variability observed in the preoperational period (Figure 3.1.3-2). Annual mean abundances of *E. herdmani* adults in 1991 at Stations P5 and P7 were comparable in magnitude to mean densities at Station P2 (Table 3.1.3-2). Densities of *E. herdmani* adults were not significantly different between preoperational years and operational years, nor were differences detected between nearfield and farfield areas (Table 3.1.3-3), indicating that there was no relationship with the operating status of Seabrook Station.

Pseudocalanus sp.

Historically, *Pseudocalanus/Calanus* sp. nauplii were present year-round at Station P2 (Figure 3.1.3-2), and were among the numerically dominant taxa comprising the microzooplankton community in most seasons (Table 3.1.3-1). Seasonal peak abundance was attained during mid-summer during both preoperational years and 1990, while the highest densities in 1991 were observed in the spring. Annual mean densities for the operational period were significantly lower than the overall preoperational mean (Table 3.1.3-3). These differences were apparent in both nearfield and farfield areas as indicated by lack of significance in the Preop x Area interaction term, and, therefore were not related to operation of Seabrook Station.

Pseudocalanus sp. copepodites and adults were also present throughout the year during the preoperational period with peak abundances occurring in either spring or mid-summer (Figure 3.1.3-2). The annual mean densities of both copepodites and adults during the operational period were significantly lower than the overall preoperational mean (Table 3.1.3-3). As with *Pseudocalanus/Calanus* sp. nauplii, however, these differences in abundance were reflected in both nearfield and farfield areas.

Oithona sp.

All *Oithona* sp. lifestages were present year-round and comprised one of the most abundant microzooplankton taxa

TABLE 3.1.3-2. GEOMETRIC MEANS (NO/m^3) AND 95% CONFIDENCE LIMITS FOR PREOPERATIONAL YEARS AND MEANS FOR OPERATIONAL YEARS OF SELECTED MICROZOOPLANKTON SPECIES AT STATIONS P2, P5, AND P7 (APRIL-DECEMBER). SEABROOK OPERATIONAL REPORT, 1991.

		PREOPERATIONAL YEARS[a]			OPERATIONAL YEARS[b]
SPECIES/LIFESTAGE	STATION	LCL	MEAN	UCL	1991
Eurytemora sp. copepodites	P2	5.6	12	25.9	4
	P5	--	--	--	3
	P7	<0.1	10	145.0	5
Eurytemora herdmani adults	P2	2.4	5	10.4	4
	P5	--	--	--	2
	P7	<0.1	7	62.6	6
Pseudocalanus/Calanus sp. nauplii	P2	759.0	1013	1352.9	271
	P5	--	--	--	214
	P7	291.5	792	2150.0	239
Pseudocalanus sp. copepodites	P2	310.3	452	659.2	368
	P5	--	--	--	319
	P7	111.7	392	1371.5	403
Pseudocalanus sp. adults	P2	42.5	67	104.3	45
	P5	--	--	--	39
	P7	16.9	68	263	72
Oithona sp. nauplii	P2	534.6	930	1559.2	1410
	P5	--	--	--	1455
	P7	117.7	666	3749.4	1565
Oithona sp. copepodites	P2	450.3	785	1368.8	1379
	P5	--	--	--	1532
	P7	39.3	496	6125.3	1302
Oithona sp. adults	P2	121.7	194	308.0	277
	P5	--	--	--	222
	P7	15.3	173	1862.4	253

[a]Preoperational years: P2 = 1978-1984, P5 = not sampled, P7 = 1982-1984
[b]1990 not sampled during January through March; annual $\bar{x}$ not calculated

TABLE 3.1.3-3. RESULTS OF THE TWO-WAY ANALYSIS OF VARIANCE OF LOG (X+1) TRANSFORMED DENSITY (NO/m^3) OF SELECTED MICROZOOPLANKTON SPECIES AMONG PREOPERATIONAL YEARS (1982-1984) AND OPERATIONAL YEARS (1991) AND AREA (NEARFIELD VS. FARFIELD). SEABROOK OPERATIONAL REPORT, 1991.

SPECIES/ LIFESTAGE	SOURCE OF VARIATION[a]	df	SS	F	MULTIPLE COMPARISONS
Eurytemora sp. copepodite	Preop-Op	1	2.63	5.95*	Preop>Op
	Year (Preop-Op)	2	13.73	15.54***	
	Month (Year)	44	83.64	4.30***	
	Area	1	0.48	1.09 NS	
	Preop-Op X Area	1	<0.01	0.02 NS	
	Error	139	61.39		
Eurytemora herdmani adult	Preop-Op	1	0.98	2.44 NS	
	Year (Preop-Op)	2	10.37	12.87***	
	Month (Year)	44	83.51	4.71***	
	Area	1	1.46	3.62 NS	
	Preop-Op X Area	1	0.18	0.44 NS	
	Error	139	55.99		
Pseudocalanus/Calanus sp. nauplii	Preop-Op	1	10.15	57.45***	Preop>Op
	Year (Preop-Op)	2	2.59	7.34***	
	Month (Year)	44	37.48	4.82***	
	Area	1	<0.01	0.00 NS	
	Preop-Op X Area	1	0.03	0.18 NS	
	Error	139	24.56		
Pseudocalanus sp. copepodite	Preop-Op	1	<0.01	0.06 NS	
	Year (Preop-Op)	2	3.56	12.99***	
	Month (Year)	44	43.83	7.28***	
	Area	1	0.12	0.87 NS	
	Preop-Op X Area	1	0.07	0.48 NS	
	Error	139	19.02		
Pseudocalanus sp. adult	Preop-Op	1	0.15	0.80 NS	
	Year (Preop-Op)	2	6.05	16.70***	
	Month (Year)	44	59.66	7.48***	
	Area	1	0.71	3.92 NS	
	Preop-Op X Area	1	0.31	1.70 NS	
	Error	139	25.19		

(continued)

TABLE 3.1.3-3. (Continued)

SPECIES/ LIFESTAGE	SOURCE OF VARIATION[a]	df	SS	F	MULTIPLE COMPARISONS
Oithona sp. nauplii	Preop-Op	1	3.43	32.41***	Op>Preop
	Year (Preop-Op)	2	6.60	31.13***	
	Month (Year)	44	37.02	7.94***	
	Area	1	0.03	0.24 NS	
	Preop-Op X Area	1	0.17	1.57 NS	
	Error	139	14.73		
Oithona sp. copepodite	Preop-Op	1	5.87	54.05***	Op>Preop
	Year (Preop-Op)	2	10.68	49.12***	
	Month (Year)	44	47.94	10.03***	
	Area	1	0.14	1.33 NS	
	Preop-Op X Area	1	0.02	0.14 NS	
	Error	139	15.11		
Oithona sp. adult	Preop-Op	1	0.77	5.91*	Op>Preop
	Year (Preop-Op)	2	10.98	42.05***	
	Month (Year)	44	34.21	5.95***	
	Area	1	<0.01	0.02 NS	
	Preop-Op X Area	1	0.04	0.28 NS	
	Error	139	18.15		

NS = Not Significant (P> 0.05)
* = Significant (0.05 ≥ P >0.01)
** = Highly Significant (0.01 ≥ P > 0.001)
*** = Very Highly Significant (P ≤ 0.001)

[a]Preop-Op = pre-operational period vs. operational period, regardless of area
Year (Preop-Op) = year nested within pre-operational and operational periods, regardless of area
Month (Year) = month nested within year
Area = nearfield vs. farfield stations
Preop-Op X Area = interaction of main effects

throughout the preoperational period (Tables 3.1.3-1 and 3.1.3-2). Nauplii and copepodites occurred at similar levels of abundance, while adults were slightly less abundant (Figure 3.1.3-3).

In 1990 and 1991, *Oithona* sp. nauplii at Station P2 generally exhibited the same seasonal pattern of abundance as during the pre-operational period (Figure 3.1.3-3). The annual geometric mean for nauplii in 1991 at Station P2 was slightly lower than the overall preoperational mean but was within the range of individual mean values recorded during those years (NAI 1991b; Table 3.1.3-2). *Oithona* sp. copepodites also followed the same general pattern of seasonal abundances in 1990 and 1991 that was evident during the preoperational period (Figure 3.1.3-3). The geometric mean for copepodites at Station P2 in operational years was somewhat larger than the overall mean for the preoperational period and five of the seven preoperational years (NAI 1991b; Table 3.1.3-2). Seasonal abundance of *Oithona* sp. adults in 1990 was highly variable, monthly means exhibiting particularly low values in August through October (Figure 3.1.3-3). Densities in 1991 were more similar to those observed during the preoperational period. Geometric mean abundance for adults at Station P2 in 1991 was higher than the mean for all preoperational years (Table 3.1.3-2) but was within the range of individual mean values for those years (NAI 1991b). Operational densities of *Oithona* sp. nauplii, copepodites, and adults were all significantly greater than those observed during the preoperational period (Table 3.1.3-3). However, the lack of significance in the spatial (Area) and interaction terms (Preop-Op x Area) indicated that this was an area-wide pattern and could not be related to plant operation.

3.1.3.3 Effects of Plant Operation

Trends in both the densities and pattern of temporal variation recorded during operational years (1990 and 1991) for selected microzooplankton species were generally similar to overall mean densities and temporal variation from the preoperational period at nearfield Station P2 (Figures 3.1.3-2 and 3.1.3-3; Table 3.1.3-2). Although ANOVAs detected statistically significantly lower operational versus preoperational mean densities for *Eurytemora* sp. copepodites and *Pseudocalanus* sp. lifestages and significantly higher abundances of *Oithona* sp. lifestages during operation (Table 3.1.3-3, Preop-Op), the lack of significance in the spatial (Area) and interaction terms (Preop-Op X Area) indicated that the temporal differences observed throughout the study area (i.e., at both nearfield and farfield stations) and therefore could not be attributed to operation of Seabrook Station. In summary, plant operation did not appear to have had a negative impact on the microzooplankton community.

3.1.4 Bivalve Larvae

3.1.4.1 Community Structure

Patterns of abundance of the bivalve larvae assemblage were examined using numerical classification to address the

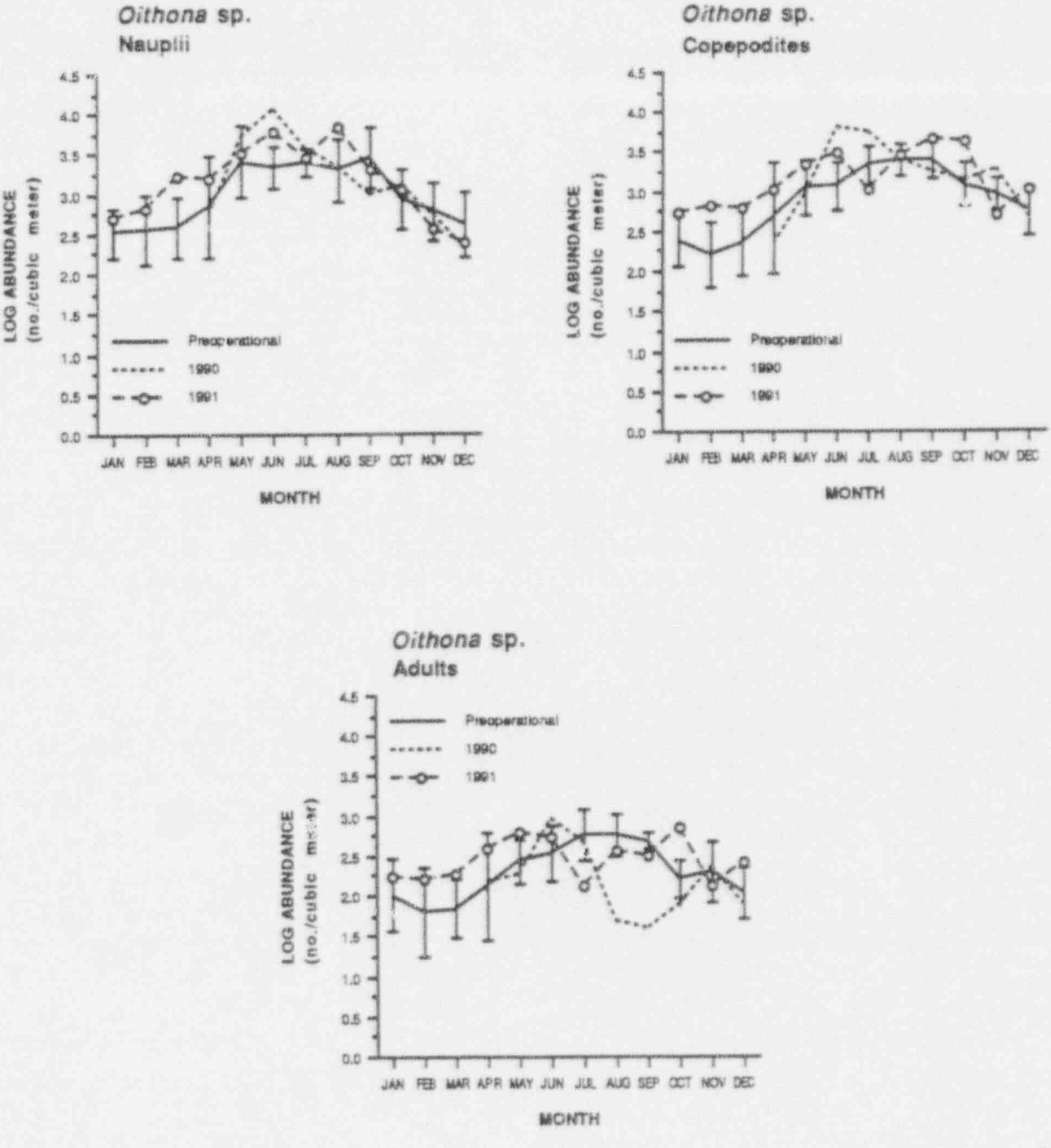


Figure 3.1.3-3. Log (x+1) abundance (no./m³) of *Oithona* sp. nauplii, copepodites and adults; monthly means and 95% confidence intervals over all preoperational years (1978-1984 and 1986) and monthly means for 1990 and 1991 at nearfield Station P2. Seabrook Operational Report, 1991.

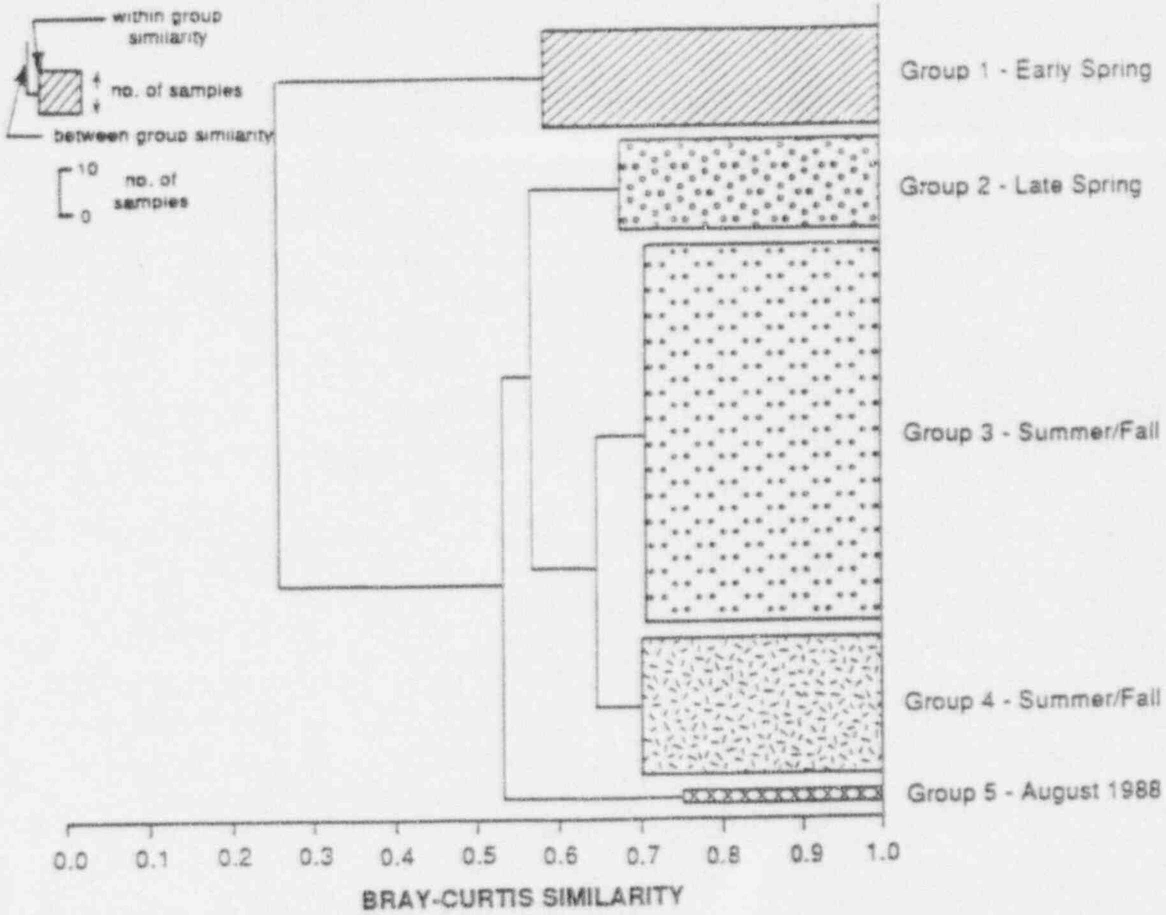
questions of whether there were differences among stations or between the preoperational and operational periods. This aggregation of meroplanktonic species exhibited strong seasonal patterns that were generally consistent among years and stations (Figure 3.1.4-1). Mean abundances (averaged on a twice-monthly basis) were grouped seasonally, mostly falling into one of four distinct groups. The seasonal structure of the community reflected recruitment of different taxa as dominants (Table 3.1.4-1). The patterns observed in 1991 were similar to those previously described (NAI 1991b).

Spatial Patterns

Distribution of meroplankton in marine waters can be largely related to several factors - distribution of spawning adults, length of larval existence and local hydrographic conditions. The dominant bivalve larvae collected in coastal waters of New Hampshire are species whose adults are widely distributed along the New England coastline. Duration of larvae stage is dependent on temperature, but is typically up to six weeks. The local hydrography is dominated by tidal and longshore currents (NAI 1980d). Stations P2, P5 and P7 are located in waters of similar depth (Figure 2.1-1) with no physical barriers between them. These conditions tend to homogenize the bivalve larvae spatially. It is not unexpected, then, that there were few occasions when species composition at the three stations differed sufficiently to classify any station differently than the others (Figure 3.1.4-1). During 87% of half month periods, all three stations were grouped together; P2 and P5 clustered together 90% of the time. Multivariate analysis of variance indicated there were no significant differences in the bivalve larvae assemblage in the operational period ($F=1.10$, $p=0.35$) or over the years 1988, 1989 and 1991 ($F=0.75$, $p=0.78$).

Temporal Patterns

No unusual assemblages of bivalve larvae have occurred during the operation of Seabrook Station, as evidenced by the classification of all the operational period abundances into groups that occurred preoperationally (Figure 3.1.4-1 and Table 3.1.4-1). Seasonal abundances of dominant taxa during operation were generally within the 95% confidence limits of the abundances observed preoperationally (Table 3.1.4-1). Most (84.2%) half-month periods during the operational period were grouped in the same seasonal group as preoperational (1988 through mid-1990) collections from the same time period (Figure 3.1.4-1). The exceptions were early May 1991, late July 1991 and early August 1990 and 1991. In 1991, abundances of *Hiatella* sp. were an order of magnitude higher in early May than previously reported, causing this period to be classified in Group 2. The higher-than-normal regional temperatures in winter and early spring 1991 (Figure 3.1.1-1) may have induced earlier spawning than normal. The July and August collections were classified in Group 4, characterized by reduced abundances of the typical summer assemblage. These reduced abundances were observed prior



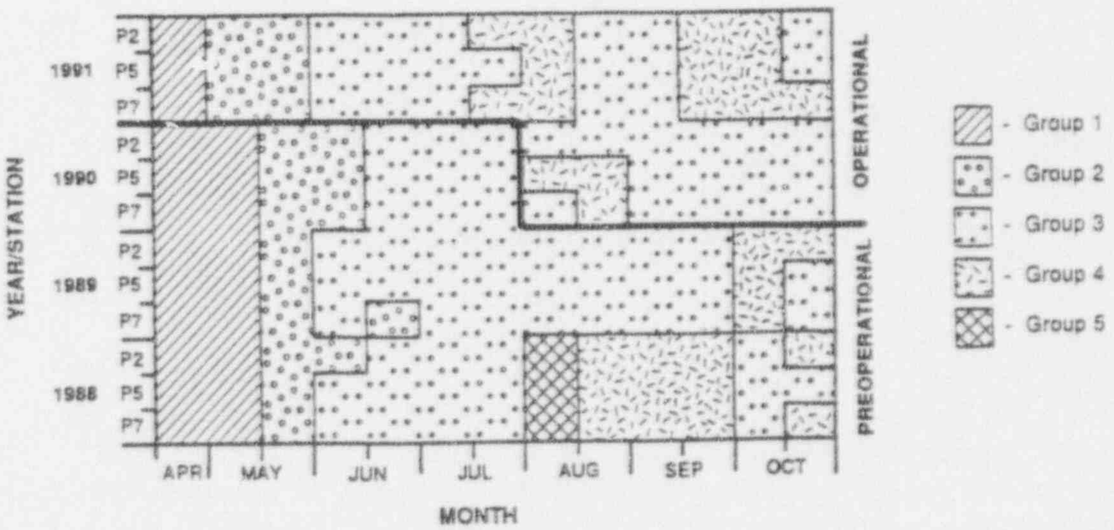


Figure 3.1.4-1. Dendrogram and seasonal groups formed by numerical classification of **bivalve larvae** log (x+1) transformed abundances (half monthly means; no./m³) at Seabrook intake (P2), discharge (P5) and farfield (P7) stations, April-October, 1988-1991. Seabrook Operational Report, 1991.

TABLE 3.1.4-1. GEOMETRIC MEAN ABUNDANCE (No./m^3), 95% CONFIDENCE LIMITS OF DOMINANT TAXA AND NUMBER OF SAMPLES OCCURRING IN SEASONAL GROUPS FORMED BY NUMERICAL CLASSIFICATION OF BIVALVE LARVAE COLLECTIONS AT INTAKE (P2), DISCHARGE (P5) AND FARFIELD (P7) STATIONS, 1988-1991. SEABROOK OPERATIONAL REPORT, 1991.

GROUP	DOMINANT TAXA[a]	PREOPERATIONAL YEARS				OPERATIONAL YEARS[b]			
		n	LCL	$\overline{x}$	UCL	n	LCL	$\overline{x}$	UCL
1	*Hiatella* sp.	18	38.5	59	89.6	3	16.1	78	359.9
Early spring	*Mytilus edulis*		.1	1	1.3		0.1	12	145.0
(0.59/0.26)[c]									
2	*Hiatella* sp.	14	1402.4	2174	3371.3	6	1124.2	1532	2088.8
Late spring	*Mytilus edulis*		322.3	630	1232.2		7.0	120	1825.5
(0.67/0.57)	*Mya truncata*		175.2	308	541.7		39.7	54	74.2
3	*Mytilus edulis*	49	2499.4	4064	6606.5	33	824.2	1274	1967.6
Summer/Fall	*Heteranomia squamula*		1410.2	2211	3464.7		640.8	1018	1602.1
(0.71/0.65)	*Modiolus modiolus*		734.3	1011	1392.0		155.0	277	492.8
4	*Heteranomia squamula*	15	127.4	222	386.9	15	140.4	226	362.0
Summer/Fall	*Modiolus modiolus*		22.3	49	104.8		3.7	7	11.6
(0.70/0.65	*Mytilus edulis*		28.6	48	79.9		104.0	193	358.3
	Mya arenaria		16.4	30	52.8		4.3	11	25.2
5	*Modiolus modiolus*	3	12.3	157	1872.9			not	
August 1988	*Heteranomia squamula*		3.0	146	5492.2			represented	
(0.75/0.54)	*Mytilus edulis*		5.8	24	88.5				

[a]those taxa contributing ≥5% of total group abundance in either preoperational or operational period collections
[b]August 1990 - October 1991
[c](within-group similarity/between-group similarity)

to 1988 in this July-August period (NAI 1991b) and so are unlikely to be related to operation of Seabrook Station. Results of a two-way MANOVA comparing station and operational condition (1988, 1989 and 1991) indicated that, although 1991 differed from 1988 and 1989 ($F=45.8$, $p=0.0001$), differences were consistent among stations (Station X Preop-Op: $F=1.19$, $p=0.26$).

3.1.4.2 Selected Species

Mya arenaria was identified as a selected species because of the interest in recreational (locally) and commercial (regionally) harvesting of adults and the concern that impacts to the larval population could manifest themselves in standing stock of harvestable clams. *Mytilus edulis* has been the most abundant species encountered in bivalve larvae investigations. Temporal and spatial patterns of both species were examined to evaluate whether there was evidence of impacts induced by operation of Seabrook Station.

Mya arenaria

This species is discussed in detail in Section 3.3.7.

Mytilus edulis

As in previous years, *Mytilus edulis* larvae reached peak abundances in summer of 1991 and continued to be relatively abundant through October when sampling ceased (Figure 3.1.4-2). *M. edulis* abundances were significantly higher in 1991 than in the preoperational years of 1988 and 1989 (Table 3.1.4-2). This may be related to increased settlement of mytilids observed in 1990 (NAI 1991b). Peak larval abundances were reached earlier than previously observed (Figure 3.1.4-2). The warming trend observed both locally and regionally (Section 3.1.1) may have been a factor in stimulating spawning. Because higher abundances occurred at all stations (Table 3.1.4-3), the ANOVA found no significant differences in the Station x Preop-Op interaction (Table 3.1.4-2), implying that this change in abundance was not restricted to the nearfield area.

3.1.4.3 Effects of Plant Operation

The effects of operation of Seabrook Station on bivalve larvae are monitored through entrainment sampling and comparisons of both community and population characteristics over time and space. The estimated total number of larvae entrained in the cooling water system in 1991 is presented on Table 3.1.4-4. As in 1990, *Mytilus edulis* was the most frequently entrained species, reflecting its dominance in the nearshore bivalve larvae assemblage (Table 3.1.4-1). *Hiatella* sp. and *Heteranomia squamula* were both relatively abundant in the entrainment collections, as they were in 1990.

Entrainment was highest in June, reflecting the natural peak in bivalve larval abundance observed nearshore. Entrainment appeared to be substantially lower in July 1991 than 1990 (NAI 1991b), primarily due to lower entrain-

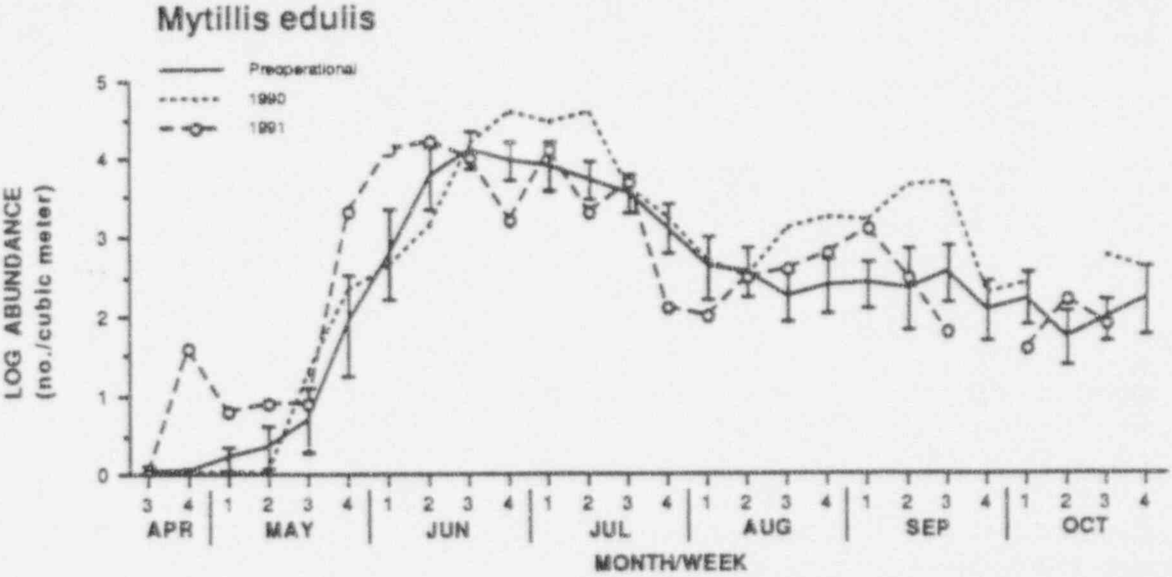


Figure 3.1.4-2. Weekly mean log (x+1) abundance (no./m^3) of *Mytilus edulis* larvae during preoperational years (1978-1989, including 95% confidence intervals), and weekly means in 1990 and 1991 at nearfield Station P2. Seabrook Operational Report, 1991.

TABLE 3.1.4-2. RESULTS OF ANALYSIS OF VARIANCE COMPARING INTAKE (P2), DISCHARGE (P5) AND FARFIELD (P7) WEEKLY ABUNDANCES OF *MYTILUS EDULIS* DURING PREOPERATIONAL (1988-1989) AND OPERATIONAL (1991) PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SOURCE OF VARIATION	df	SS	F	MULTIPLE COMPARISONS
Preop-Op	1	2.60	23.49***	Op > Preop
Station	2	0.05	0.23 NS	
Year (Preop-Op)	1	22.80	206.20***	
Week (Year)	72	349.39	43.89***	
Station x Preop-Op	2	0.24	1.09 NS	
Error	146	16.14		

TABLE 3.1.4-3. ANNUALIZED GEOMETRIC MEAN ABUNDANCE (No./m^3) AND UPPER AND LOWER 95% CONFIDENCE LIMITS OF *MYTILUS EDULIS* LARVAE AT STATIONS P2, P5 AND P7 DURING PREOPERATIONAL YEARS AND GEOMETRIC MEAN ABUNDANCE IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

		PREOPERATIONAL YEARS			OPERATIONAL YEARS	
STATION	YEARS	LCL	$\bar{x}$	UCL	1990	1991
P2	1982-1989	153.6	224	327.8	442	274
P5	1988-1989	79.6	169	358.7	365	296
P7	1982-1984 1986-1989	147.6	242	396.6	317	260

TABLE 3.1.4-4. ESTIMATED NUMBER OF BIVALVE LARVAE (billions/month) ENTRAINED BY THE COOLING WATER SYSTEM AT SEABROOK STATION DURING APRIL THROUGH AUGUST 1991. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES	APR[a]	MAY	JUN	JUL	AUG[b]
Mytilus edulis	<0.1	153.3	858.9	661.9	13.3
Modiolus modiolus	<0.1	0.3	110.3	49.1	0.4
Placopecten magellanicus	0	0.2	0.5	0	0
Heteranomia squamula	0	2.8	55.0	182.2	10.8
Spisula solidissima	0	0	2.9	1.4	<0.1
Mya arenaria	0	0	0.5	0.1	0
Mya truncata	0	1.2	5.1	0.2	0
Hiatella sp.	<0.1	93.9	243.7	113.1	0.5
Macoma balthica	<0.1	0	1.1	0	0
Bivalvia	<0.1	2.2	18.9	15.5	0.3
Teredo navalis	0	2.8	11.6	1.2	0.3
Solenidae					
TOTAL	<0.1	256.7	1308.5	1024.7	25.6

[a]represents lask week of April only
[b]represents first week of August only. Plant shut down for maintenance through September 1991. Entrainment sampling not resumed.

ment of *Mytilus edulis*, *Hiatella* sp. and *Heteranomia squamula*.

Entrainment of bivalve larvae in Seabrook Station has not caused discernible changes in the nearshore assemblage (Section 3.1.4.1). Although community structure differed between 1991 and the two most recent preoperational years (1988, 1989), differences were apparent in all stations, including farfield Station P7. When compared to the entire preoperational period (1982-1989) at Station P2 (NAI 1991b), seasonal pattern of community structure in 1991 fell within the range of previous observations.

Abundances and seasonality of *Mytilus edulis* larvae were similar in nearfield and farfield areas in 1991. Increased abundances in 1991 may be related to elevated early spring temperatures, and the increased settlement of Mytilids observed in 1990 (NAI 1991b). However, the warming of nearshore waters is a widespread regional phenomenon (Section 3.1.1) and is not attributable to the operation of Seabrook Station.

3.1.5 Macrozooplankton

3.1.5.1 Community Structure

The macrozooplankton community is comprised of numerous species that exhibit three basic life history strategies. The holoplankton species, e.g. copepods, are planktonic essentially throughout their entire life cycle. Meroplankton includes species that spend a distinct portion of their life cycle in the plankton, e.g. larvae of benthic invertebrates. Species that alternate between association with the substrate and rising into the water column on a regular basis are called tychoplankton, e.g. mysids.

Historical analysis (1978-1984 and 1986-1989) of the macrozooplankton assemblage at the nearfield Station P2 showed seasonal changes that were greatly influenced by the population dynamics of the dominant copepods *Centropages typicus* and *Calanus finmarchicus* (NAI 1990b). Other taxa, particularly meroplanktonic species, exerted short-term influences, especially during the spring and summer (NAI 1985b). Because of their lower abundances, seasonal patterns of tychoplanktonic species, e.g., mysids, amphipods and cumaceans, were not well documented by numerical classification of the entire macrozooplankton assemblage. To identify seasonal patterns more clearly, the tychoplankton assemblage was analyzed separately from the mero- and holoplankton.

Spatial and Temporal Patterns of the Holo- and Meroplankton Assemblage

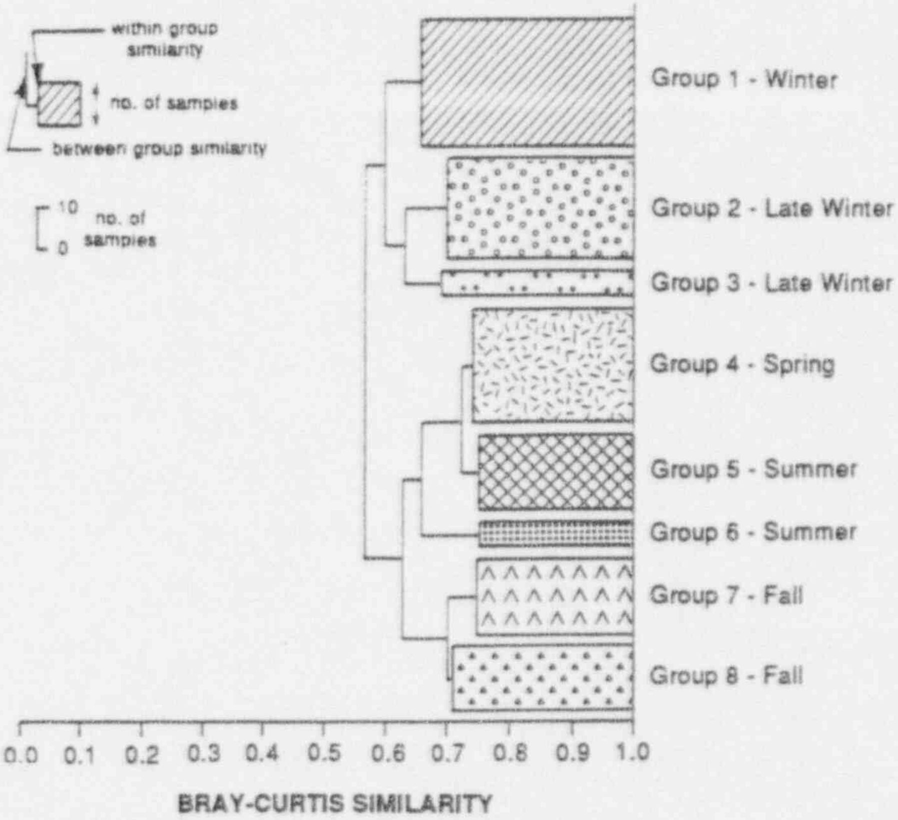
In previous years, spatial and temporal trends were evaluated separately. Because it has been well documented that patterns of abundance and dominance in the holo- and meroplankton assemblage were predominantly seasonally-influenced, the two questions were addressed simultaneously. Monthly mean abundances of holo- and meroplankton at Stations P2, P5 and P7 were examined from 1988 through 1991 using numerical classification and multivariate analysis of variance techniques to evaluate whether there were differences among stations or between the preoperational and operational periods.

The strong seasonality previously observed was again evident when 1991 data were included (Figure 3.1.5-1). Winter Group 1 was dominated by copepods and oceanic species such as *Sagitta elegans* and *Oikopleura* sp. (Table 3.1.5-1). Barnacle (Cirripedia) larvae were abundant in late winter (Groups 2 and 3). Generally spring (Group 4) and summer (Group 5) were characterized by relatively high abundances of numerous taxa, particularly copepods and decapod larvae. Summer Group 6, however, included only six preoperational collections with few abundant taxa. During this transitional period, abundances of decapod larvae declined while *Centropages typicus* reached its annual peak. Copepods of the genus *Centropages* dominated fall collections (Groups 7 and 8). The seasonal shifts in dominance observed among the copepods *Calanus finmarchicus*, *Centropages typicus* and, to a lesser degree, *Pseudocalanus* sp. were consistent with observations for the Gulf of Maine in general (Sherman et al. 1988).

Previous analyses have suggested that there are no spatial differences in holo- and meroplanktonic assemblages in the study area (NAI 1991b). The geography of coastal New England helps to create the hydrographic conditions of the Gulf of Maine. There are no major land barriers between the Bay of Fundy and Cape Cod that would divert coastal currents offshore, although several embayments can affect local conditions. This condition promotes a circulation pattern that allows widespread dispersal of planktonic organisms, particularly holoplankton and those meroplanktonic species with extended larval existence. The distances among Stations P2, P5 and P7 are small relative to the area from which holo- and meroplanktonic organisms could be recruited (via current transport) to coastal New Hampshire.

Numerical classification of holo- and meroplanktonic abundances in 1988-1991 revealed no spatial differences among Stations P2, P5 and P7 (Figure 3.1.5-1). Collections from all stations were grouped together within each month. This conclusion was further supported by MANOVA comparing species abundances at these stations (p=0.42).

Species composition of holo- and meroplanktonic components of the macrozooplankton assemblage was similar during the operation of Seabrook Station to the preoperational period examined. Collections from each month in the operational period (August 1990 through December 1991) were grouped with collections from the same month in the preoperational period (Figure 3.1.5-1). Geometric mean abundances of dominant taxa were generally higher in the operational year of 1991 than in the preoperational years period of 1988-1989 (MANOVA testing operational status; p=0.0001; note, 1990 excluded from testing due to mid-year startup of plant). Of the 14 taxa and lifestages that dominanted the holo-meroplankton during various parts of the annual cycle, nine (*Temora longicornis*, *Centropages typicus*, *Oikopleura* sp., Cirripedia, *Calanus finmarchicus*, *Cancer* sp., *Meganyctiphanes norvegica*, *Podon* sp. and *Centropages* sp. copepodites)



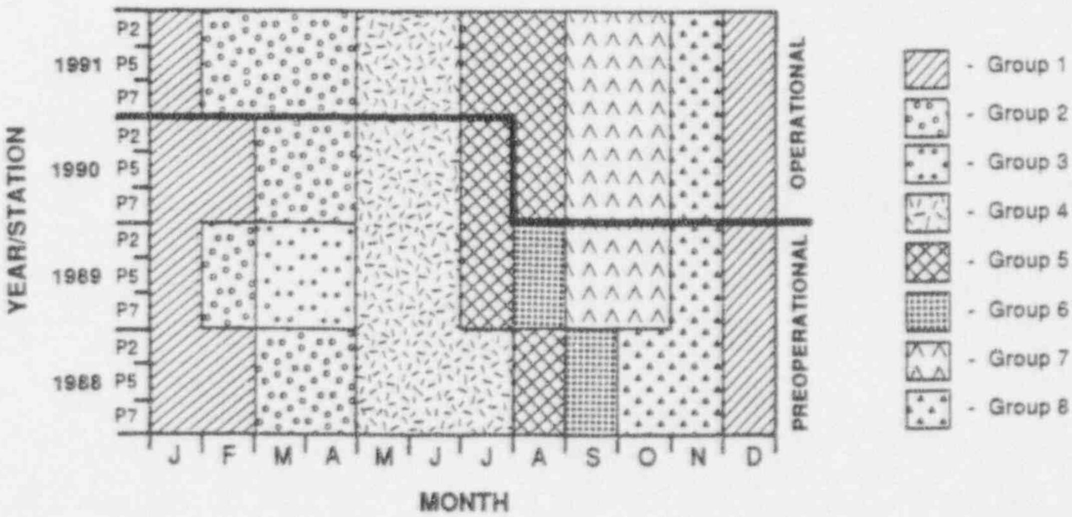


Figure 3.1.5-1. Dendrogram and seasonal groups formed by numerical classification of monthly mean log (x+1) transformed abundances (no./1000 m³) of **holo- and meroplanktonic species** of macrozooplankton at intake Station P2, discharge Station P5 and farfield Station P7, 1988-1991. Seabrook Operational Report, 1991.

TABLE 3.1.5-1. GEOMETRIC MEAN ABUNDANCE (No./1000m^3) AND 95% CONFIDENCE LIMITS OF DOMINANT HOLO- AND MEROPLANKTONIC TAXA OCCURRING IN SEASONAL GROUPS FORMED BY NUMERICAL CLASSIFICATION OF MACROZOOPLANKTON COLLECTIONS (MONTHLY MEANS) AT INTAKE STATION P2, DISCHARGE STATION P5 AND FARFIELD STATION P7, 1988-1991. SEABROOK OPERATIONAL REPORT, 1991.

GROUP	DOMINANT SPECIES[a]	PREOPERATIONAL YEARS[b]				OPERATIONAL YEARS[b]			
		n	LCL	$\overline{x}$	UCL	n	LCL	$\overline{x}$	UCL
1 Winter (0.66/0.60)[c]	*Temora longicornis*	21	4399.2	7240	11914.8	9	326.1	737	1666.2
	Sagitta elegans		1229.3	2290	4266.7		471.1	892	1686.8
	Centropages typicus		602.5	1782	5263.8		1511.4	4861	15630.7
	Pseudocalanus sp.		892.9	1582	2803.1		47.2	109	250.6
	Oikopleura sp.		432.0	1055	2576.2		172.7	529	1617.8
	Centropages hamatus		348.4	891	2278.2		6.9	34	152.0
2 Late Winter (0.70/0.63)	Cirripedia	15	16349.2	54156	179381.1		36251.5	143206	565705.5
	Calanus finmarchicus		3479.8	7681	16953.0		408.8	4169	42431.4
	Oikopleura sp.		701.3	3342	15906.2		17085.4	33929	67375.2
	Evadne sp.		906.4	2881	9155.7		3408.5	11169	36594.6
3 Late Winter (0.69/0.63)	*Calanus finmarchicus*	6	5132.3	11713	26729.6		not represented		
	Cirripedia		2218.0	10596	50604.4				
4 Spring (0.74/0.72)	*Calanus finmarchicus*	21	47593.3	74413	116345.2	6	62282.3	89177	127686.1
	Temora longicornis		10656.0	17203	2770.6		5509.6	17421	55079.5
	Evadne sp.		6536.6	14291	31244.5		2505.8	14688	86067.1
	Eualus pusiolus		6405.1	10474	17126.0		2750.4	5028	9192.3
	Cancer sp.		3620.5	6260	10824.6		11178.5	24559	53953.3
	Meganyctiphanes norvegica		502.1	2540	12836.2		6699.3	21873	71406.6
	Centropages typicus		21.1	114	595.3		3910.2	18741	89805.2
	Podon sp.		2717.5	5435	10870.9		5997.2	15412	39606.4

(continued)

TABLE 3.1.5-1. (Continued)

GROUP	DOMINANT SPECIES[a]	PREOPERATIONAL YEARS[b]				OPERATIONAL YEARS[b]			
		n	LCL	$\overline{x}$	UCL	n	LCL	$\overline{x}$	UCL
5 Summer (0.75/0.72)	*Calanus finmarchicus*	9	97154.0	199016	407673.3	9	23987.9	64093	171245.9
	Cancer sp.		39549.3	111324	313354.6		41703.6	71704	123286.4
	Eualus pusiolus		10358.8	35392	120913.3		3978.4	13091	43070.7
	Meganyctiphanes norvegica		8686.9	29895	102876.8		2038.3	5891	17024.4
	Centropages typicus		4565.5	17550	67454.0		80466.3	124219	191761.3
	Temora longicornis		3232.7	9815	29793.2		11322.0	18185	29206.2
6 Summer (0.75/0.66)	*Centropages typicus*	6	71764.4	269122	1009219.9		not represented		
	Calanus finmarchicus		11930.3	34422	99313.5				
7 Fall (0.74/0.70)	*Centropages typicus*	6	46345.2	88739	169909.5	12	152363.6	344797	780270.6
	Centropages sp.		3986.1	7877	15565.8		1956.1	7247	26839.1
	Podon sp.		1382.9	4153	12465.3		16735.7	30342	55010.0
8 Fall (0.71/0.70)	*Centropages typicus*	9	22645.6	75753	253396.9	6	8252.0	75150	684322.7
	Centropages hamatus		4144.0	10822	28260.1		351.7	792	1783.9
	Centropages sp.		2483.7	8460	28814.2		640.4	5568	48344.0

[a]those taxa contributing ≥5% of total group abundance in either preoperational or operational periods
[b]Preoperational period = Jan 1988-Jul 1990; Operational period = Aug 1990-Dec 1991
[c](within-group similarity/between-group similarity)

reached higher abundances in 1991 than in the recent preoperational period. *Calanus finmarchicus* was reported to have increased in the Northwest Atlantic in 1990 (Sherman 1991). Only *Centropages hamatus* declined in abundance. *Sagitta elegans*, *Pseudocalanus* sp., *Evadne* sp. and *Eualus pusiolus* were similar in abundance between the two time periods. Differences in abundances between preoperational (1988-1989) and operational (1991) periods were consistent among stations (p=0.36), however, indicating that broadscale events beyond the influence of Seabrook Station's intake and discharge structures have occurred.

Spatial and Temporal Pat˙ ˙rns of the Tychoplankton Assemblage

Abundances of tychoplanktonic species tended to vary over only one-two orders of magnitude; four taxa (amphipods *Pontogeneia inermis* and *Oedicerotidae*; cumacean *Diastylis* sp.; mysid *Neomysis americana*) were usually among the dominants (Table 3.1.5-2). Seasonality of tychoplankton species assemblage is less clearly defined by numerical classification than are seasonal patterns of the holo- and meroplankton assemblage. In general, within-group similarities are lower and between-group differences are smaller for tychoplankton groups (Figure 3.1.5.2; Table 3.1.5-2) than for holo- and meroplankton groups, as noted in NAI (1991b). Apparent seasonal patterns likely reflect a combination of factors: intermittent swimming activity, recruitment of new individuals and sampling bias introduced by use of oblique tows that integrated collections over the entire water column. Some general observations can be made, however.

The annual cycle of the tychoplankton assemblage was characterized by changes in relative abundance of the four omnipresent taxa as well as two intermittent dominants (Harpacticoida and *Mysis mixta*). Abundances were lowest in winter (primarily February; Groups 1, 2 and 8) although the six dominants were all present. In the spring, the assemblage was overwhelmingly dominated by *Mysis mixta*, whose abundance was an order of magnitude higher than other species during its offshore migration. Summer collections (Groups 4,5 and 9) were characterized by varying abundances of codominant amphipods *Pontogeneia inermis* and Oedicerotidae. Peak abundances of *Neomysis americana* typified fall and early winter (Group 6) collections. Collections from 1991 followed the same basic pattern observed in recent preoperational years (Figure 3.1.5-2; Table 3.1.5-2).

Differences between the nearfield and farfield areas in tychoplankton assemblages from 1988 through 1991 were apparent from numerical classification (Figure 3.1.5-2). Stations P2 and P5 were usually (85% of collections) grouped together. Station P7 exhibited generally similar seasonal patterns to Stations P2 and P5, but lower abundances of dominant taxa (Table 3.1.5-2) resulted in most collections from P7 (60%) being classified in separate groups (Groups 7-10). Results of numerical classification were substantiated by MANOVA which indicated that there were significant differences among stations in species composition (p=0.0001).

TABLE 3.1.5-2. GEOMETRIC MEAN ABUNDANCE (No./1000m^3) AND 95% CONFIDENCE LIMITS OF DOMINANT TYCHOPLANKTONIC TAXA OCCURRING IN SEASONAL GROUPS FORMED BY NUMERICAL CLASSIFICATION OF MACROZOOPLANKTON COLLECTIONS (MONTHLY MEANS) AT INTAKE STATION P2, DISCHARGE STATION P5 AND FARFIELD STATION P7, 1988-1991. SEABROOK OPERATIONAL REPORT, 1991.

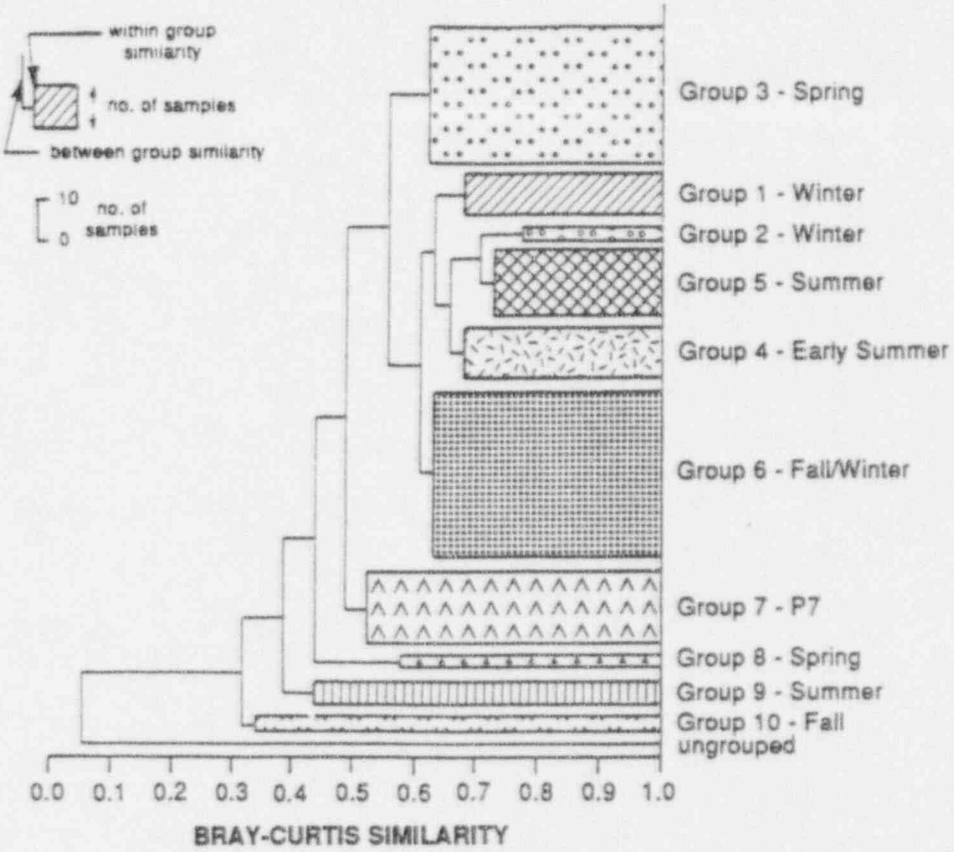
GROUP	DOMINANT SPECIES[a]	PREOPERATIONAL YEARS[b]				OPERATIONAL YEARS[b]			
		n	LCL	$\overline{x}$	UCL	n	LCL	$\overline{x}$	UCL
1 Winter (0.68/0.63)[c]	Harpacticoida	7	30.7	70	157.7	3	4.6	11	26.7
	Pontogeneia inermis		16.2	50	149.7		2.3	27	239.5
	Oedicerotidae		16.7	34	69.7		14.1	37	95.0
	Neomysis americana		13.6	33	80.2		<0.1	32	1285.1
	Diastylis sp.		7.3	17	39.9		<0.1	26	700.9
	Pseudoleptocuma minor		6.1	13	24.9		0.7	37	863.1
	Mysis mixta		0.1	2	7.0		<0.1	40	147245.1
2 Winter (0.77/0.71)	*Pontogeneia inermis*	3	22.0	121	651.1	not represented			
	Neomysis americana		64.5	120	222.0				
	Diastylis sp.		3.6	117	3025.6				
	Oedicerotidae		10.8	115	1135.3				
	Harpacticoida		16.7	72	300.0				
	Pseudoleptocuma minor		3.4	71	1180.9				
3 Spring (0.62/0.56)	*Mysis mixta*	25	760.3	2326	7111.0	8	210.5	1614	12328.0
	Pontogeneia inermis		26.6	46	79.2		37.6	151	601.3
4 Early Summer (0.68/0.66)	*Pontogeneia inermis*	10	395.8	663	1109.5	2	-	233	-
	Oedicerotidae		53.4	409	3080.6		-	464	-
	Neomysis americana		49.3	218	951.5		-	166	-
5 Summer (0.73/0.71)	Oedicerotidae	7	134.9	474	1659.5	9	39.0	317	2520.6
	Pontogeneia inermis		149.9	202	273.2		113.3	182	292.6
	Harpacticoida		40.6	107	281.5		146.7	265	477.3
	Diastylis sp.		41.4	79	151.2		14.7	49	158.8
	Neomysis americana		12.3	66	340.5		47.5	111	256.1
6 Fall/Winter (0.63/0.61)	*Neomysis americana*	20	1262.9	2386	4507.3	19	283.3	525	970.5
	Diastylis sp.		28.8	58	115.4		26.8	49	87.2
	Pontogeneia inermis		35.2	56	88.6		32.4	61	114.6

(continued)

TABLE 3.1.5-2. (Continued)

GROUP	DOMINANT SPECIES[a]	PREOPERATIONAL YEARS[b]				OPERATIONAL YEARS[b]			
		n	LCL	$\overline{x}$	UCL	n	LCL	$\overline{x}$	UCL
7 P7 (0.53/0.49)	*Neomysis americana*	13	184.3	336	612.3	4	263.6	528	1056.0
8 Spring, P7 (0.58/0.44)	*Pontogeneia inermis*	2	-	38	-	1	-	18	-
	Mysis mixta		-	9	-		-	21	-
	Diastylis sp.		-	6	-		-	4	-
	Harpacticoida		-	6	-		-	5	-
	Ischyrocerus anguipes		-	3	-		-	0	-
	Pseudoleptocuma minor		-	1	-		-	16	-
	Neomysis americana		-	1	-		-	10	-
9 Summer, P7 (0.44/0.38)	Harpacticoida	4	4.0	31	205.5	2	-	9	-
	Oedicerotidae		<0.1	6	61.8		-	76	-
	Pontogeneia inermis		<0.1	4	28.3		-	7	-
	Calliopius laeviusculus		<0.1	3	14.0		-	2	-
	Neomysis americana		<0.1	2	13.8		-	6	-
10 Fall, P7 (0.34/0.32)	*Neomysis americana*	1	-	11	-	3	<0.1	9	1161.5
	Gammarus lawrencianus		-	10	-		<0.1	1	54.5
	Oedicerotidae		-	1	-		<0.1	1	9.4
	Diastylis sp.		-	0	-		<0.1	4	36.3
	Hyperiidae		-	1	-		0.1	4	18.1
	Erythrops erythropthalma		-	0	-		<0.1	2	25.6
Ungrouped (P7) (-/0.05)	*Calliopius laeviusculus*	1	-	10	-	not represented			
	Mancocuma stellifera		-	1	-				

[a]taxa contributing ≥5% of total group abundance in either preoperational or operational period
[b]Preoperational period = Jan 1988-Jul 1990; Operational period = Aug 1990-Dec 1991
[c](within-group similarity/between-group similarity)



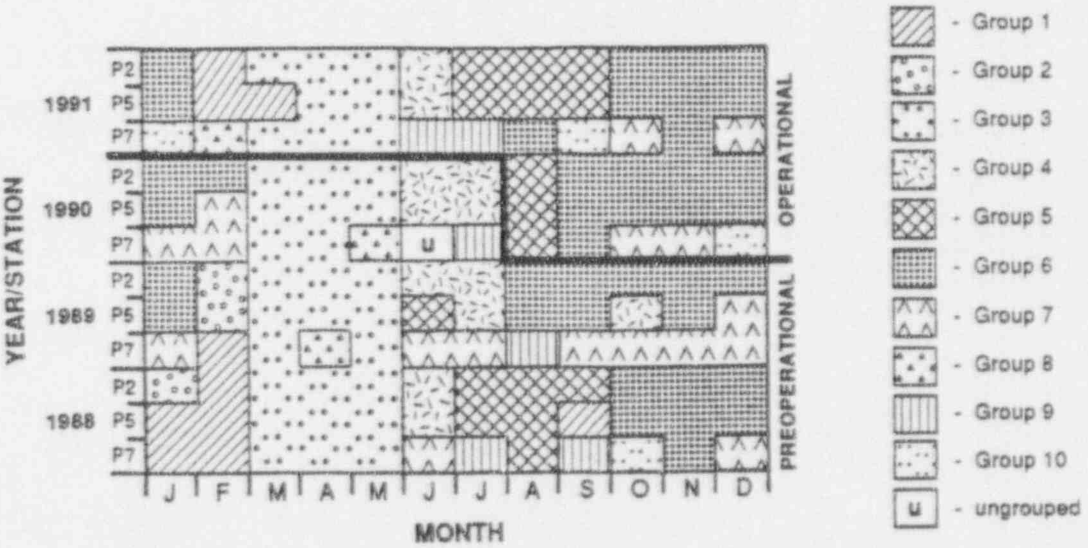


Figure 3.1.5-2. Dendrogram and seasonal groups formed by numerical classification of monthly mean log (x+1) transformed abundances (no./1000 m³) of **tychoplanktonic species** of macrozooplankton at intake Station P2, discharge Station P5 and farfield Station P7, 1988-1991. Seabrook Operational Report, 1991.

Seventeen of twenty-two species exhibited spatial differences, most having lower abundances at Station P7 than P2 or P5. Of the 13 taxa dominating seasonal groups (Table 3.1.5-2), the amphipods *Pontogeneia inermis*, Oedicerotidae, *Ischyroceros anguipes* and *Gammarus lawrencianus*; the cumaceans *Diastylis* sp. and *Pseudoleptocuma minor*; the mysids *Neomysis americana* and *Mysis mixta*; and harpacticoid copepods occurred in significantly lower abundances at Station P7 than both Stations P2 and P5.

Differences among stations have been documented previously (NAI 1991b). Tychoplanktonic species are often strongly associated with specific substrate conditions. Substrate type and complexity, as well as proximity to Hampton-Seabrook estuary, may account for some of the observed differences. Historically, *Neomysis americana*, *Pontogeneia inermis*, *Diastylis* sp. and Oedicerotid amphipods have had higher abundances at Station P2, where substrate is sand and cobble, than at P7, where the substrate is mainly sand (NAI 1985b, 1988b, 1989b and 1990b). In addition, Hampton-Seabrook estuary may provide a source of *N. americana* to Stations P2 and P5. At Station P5, where substrate is largely ledge outcrop and cobble, densities of *Diastylis* sp. have been lower than at P2 (NAI 1988b, 1989b).

Seasonal groups of the tychoplankton assemblage were similar between Stations P2 and P5 during preoperational and operational periods at Stations P2 and P5 (Figure 3.1.5-2), but exhibited less seasonal variability (fewer groups within a given month) in the operational period than preoperationally. There was little consistency at Station P7, partially an artifact of the relatively low abundances at this station. Although MANOVA results indicated that differences between preoperational (1988-1989) and operational (1991) years existed ($p=0.0001$), they were consistent at the three stations (Station X Preop-Op, $p=0.75$). These results suggest that differences are due to influences other than the operation of Seabrook Station.

3.1.5.2 Selected Species

Calanus finmarchicus

Calanus finmarchicus, particularly the copepodite lifestage, has historically been a dominant macrozooplankton species, as observed in the community assessment (Table 3.1.5-1). Both lifestages are usually present (Figure 3.1.5-3). In 1991, copepodite abundances followed the historical (preoperational) pattern almost exactly, showing peak abundances from April through October; annual mean abundance (Table 3.1.5-3) was also similar to recent (1987-1989) preoperational years (Table 3.1.5-4). The April and October abundances in 1991 were slightly higher than the upper 95% confidence levels for historical data, and September and October abundances were slightly lower than the historical confidence limits. Adult abundances in 1991 were generally similar to the historical pattern; abundances in February, September, November and December were, however, lower than the historical confidence limits, and the April abundance was higher. Annual mean abundance of adults in 1991 did not

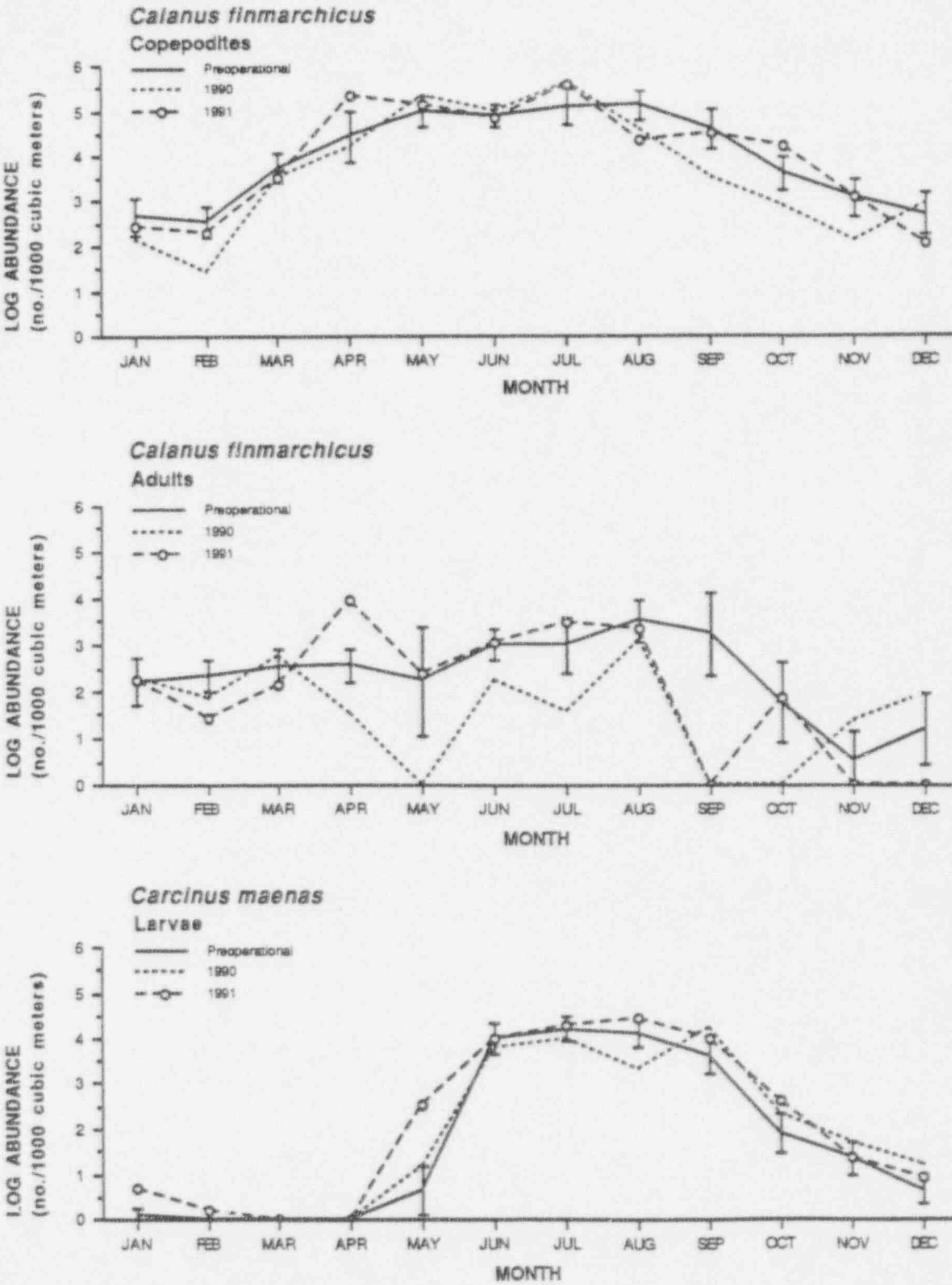


Figure 3.1.5-3. Log (x+1) abundance (no./1000 m^3) of *Calanus finmarchicus* copepodites and adults and *Carcinus maenas* larvae; monthly means and 95% confidence intervals over all preoperational years (1978-1984, 1986-1989) and monthly means for 1990 and 1991 at intake Station P2. Seabrook Operational Report, 1991.

TABLE 3.1.5-3. ANNUAL GEOMETRIC MEAN ABUNDANCE (No./1000 m^3) AND UPPER AND LOWER 95% CONFIDENCE LIMITS OF SELECTED MACROZOOPLANKTON SPECIES AT STATIONS P2, P5, AND P7 DURING PREOPERATIONAL YEARS (1978-1984 AND 1987-1989) AND GEOMETRIC MEAN ABUNDANCES IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES/LIFESTAGE	STATION[a]	PREOPERATIONAL			1990	1991
		LCL	$\bar{x}$	UCL	$\bar{x}$	$\bar{x}$
Calanus finmarchicus	P2	6,343	8,687	11,897	3,996	8,480
copepodites	P5	7,012	9,546	12,994	3,742	8,276
(January-December)	P7	4,255	6,684	10,498	2,862	4,817
Calanus finmarchicus	P2	115	213	392	35	97
adults	P5	37	86	201	56	101
(January-December)	P7	45	171	636	13	54
Carcinus maenas	P2	5,586	8,451	12,785	7,074	15,472
larvae	P5	2,076	5,392	14,336	2,245	18,014
(June-September)	P7	4,625	8,001	13,842	2,667	12,707
Crangon septemspinosa	P2	243	329	444	198	394
zoeae and postlarvae	P5	144	229	363	152	353
(January-December)	P7	156	264	446	101	314
Neomysis americana	P2	160	333	692	973	282
all lifestages	P5	22	78	268	117	58
(January-December)	P7	48	116	281	39	43

[a]Years sampled: P2 = 1978-1984, 1987-1991
P5 = 1987-1991
P7 = 1982-1984, 1987-1991

TABLE 3.1.3-4. RESULTS OF ANALYSIS OF VARIANCE COMPARING ABUNDANCES OF SELECTED MACROZOOPLANKTON SPECIES FROM STATIONS P2, P5, AND P7 DURING PRE-OPERATIONAL (1987-1989) AND OPERATIONAL (1991) PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES[a]	SOURCE[b]	d.f.	SS	F		MULTIPLE COMPARISONS
Calanus finmarchicus copepodites (January-December)	Preop-Op[c]	1	0.54	1.24	NS	
	Year (Preop-Op)[d]	2	4.07	4.71	**	
	Month (Year)[e]	44	390.58	20.54	***	
	Station[f]	2	2.15	2.49	NS	
	Preop-Op x Station[g]	2	0.28	0.33	NS	
	Error	236	101.98			
Calanus finmarchicus adults (January-December)	Preop-Op	1	0.06	0.06	NS	
	Year (Preop-Op)	2	16.07	7.64	***	
	Month (Year)	44	347.23	7.50	***	
	Station	2	4.18	1.98	NS	
	Preop x Station	2	0.55	0.26	NS	
	Error	236	248.40			
Carcinus maenas larvae (June-September)	Preop-Op	1	1.20	2.39	NS	
	Year (Preop-Op)	2	<0.01	0.00	NS	
	Month (Year)	12	19.63	3.26	***	
	Station	2	0.28	0.28	NS	
	Preop x Station	2	0.24	0.24	NS	
	Error	76	38.13			
Crangon septemspinosa zoeae and post larvae (January-December)	Preop-Op	1	<0.01	0.00	NS	
	Year (Preop-Op)	2	2.30	3.99	*	
	Month (Year)	44	356.01	28.11	***	
	Station	2	2.96	5.13	**	P2=P5>P7
	Preop x Station	2	0.03	0.05	NS	
	Error	236	67.93			
Neomysis americana all lifestages (January-December)	Preop-Op	1	5.06	8.41	**	
	Year (Preop-Op)	2	29.00	24.09	***	PREOP>OP
	Month (Year)	44	116.00	4.38	***	
	Station	2	28.78	23.90	***	P2>P5>P7
	Preop x Station	2	0.18	0.15	NS	
	Error	236	142.05			

[a]Based on twice monthly sampling periods
[b]Commercial operation began in August 1990; 1990 data left out of analysis to keep a balanced design in the ANOVA procedure.
[c]Preoperational (1987-1989) versus operational (1991) periods, regardless of station; 1987-1989 reflects the period of time that all three stations were sampled coincidentally.
[d]Year nested within preoperational and operational periods, regardless of station.
[e]Month nested within year, regardless of station.
[f]Station P2 vs. station P5 vs. station P7, regardless of year.
[g]Interaction between main effects.

NS = Not significant ($p > 0.05$)
* = Significant ($0.05 \geq p > 0.01$)
** = Highly significant ($0.01 \geq p > 0.001$)
*** = Very highly significant ($0.001 \geq p$)

differ significantly from recent (1987-1989) preoperational years (Table 3.1.5-4).

Copepodite abundances were slightly higher at Station P2 than at P5 and P7 in 1991 (Table 3.1.5-3), although historically abundances were highest at P5. However, differences among the three stations were not significant (Table 3.1.5-4). Differences in adult abundances between the three stations were also insignificant. The similarity of abundances of both *Calanus finmarchicus* copepodites and adults at the nearfield stations in 1991 to preoperational abundances and to farfield abundances indicates that operation of Seabrook Station has had no identifiable effect on this species.

Carcinus maenas

Larvae of the green crab *Carcinus maenas* exhibited the same seasonal pattern of abundance at Station P2 in 1991 as they have historically (Figure 3.1.5-3). Abundances were lowest during the late fall through early spring (particularly January through April), and peaked in June through September. Monthly larval abundances during this "peak" period in 1991 were similar to historical data. The May 1991 abundance however, was substantially higher than the preoperational value. Higher winter temperatures in 1991 (Figure 3.1.1-1) may have induced earlier spawning. Because the occurrence of *C. maenas* larvae is largely limited to late spring and summer, the analysis of variance (ANOVA) procedure and annual geometric mean computations were structured to represent only this peak period.

The ANOVA results, based on recent preoperational and 1991 operational abundances, indicate that *C. maenas* abundance has not varied significantly among years, between preoperational and operational periods or among stations (Table 3.1.5-4). Annual geometric mean abundances (based on all preoperational data) for the three stations (Table 3.1.5-3) support the lack of spatial differences indicated in the ANOVA results. However, when each station is examined individually (Table 3.1.5-3), 1991 annual mean abundances were two to three times higher than the preoperational mean. Overall, spatial and temporal (preoperational versus 1991) differences in the abundances of *C. maenas* larvae were not significant, suggesting that operation of Seabrook Station has had no effect on *C. maenas* larvae.

Crangon septemspinosa

Larvae and post-larvae *Crangon septemspinosa* are typically most abundant at Station P2 between June and September; this was true in 1991 as well, although abundances in February through May were higher than preoperational confidence limits (Figure 3.1.5-4). In November and December, abundances were lower than preoperational confidence limits. Mean annual abundances in 1991 at each station were generally similar to preoperational annual abundances (Table 3.1.5-3). Although no differences were apparent in abundances between 1991 and the preoperational period, there were significant differences among years (Table

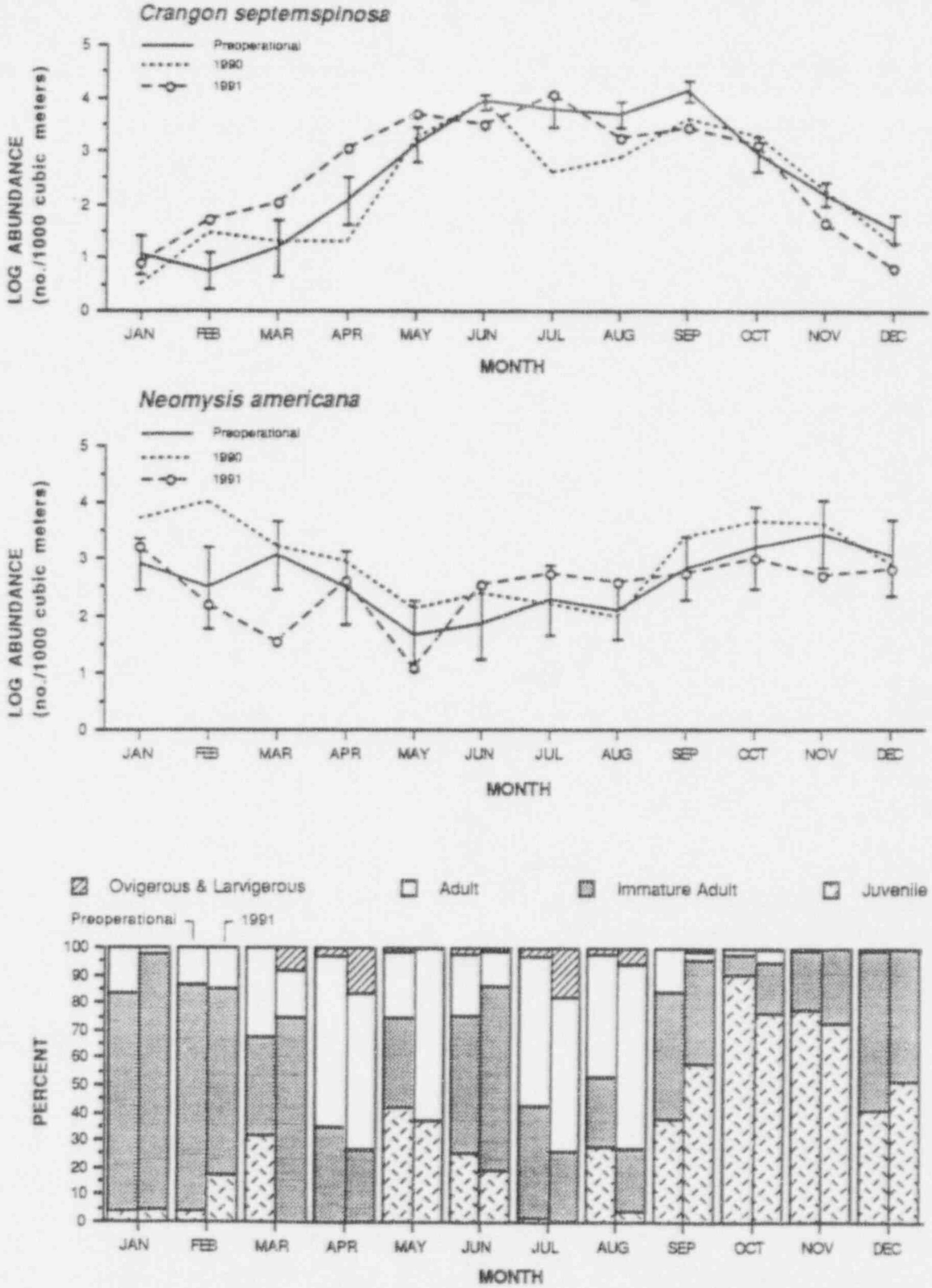


Figure 3.1.5-4. Log (x+1) abundance (no./1000 m³) of *Crangon septemspinosa* (zoea and post larvae) and *Neomysis americana* (all lifestages); monthly means and 95% confidence intervals over all preoperational years (1978-1984, 1986-1989) and monthly means for 1990 and 1991; and mean percent composition of *Neomysis americana* lifestages over all preoperational years (1978-1984, 1986-1989) and for 1991 at intake Station P2. Seabrook Operational Report, 1991.

3.1.5-4). Seasonal differences were also significant, as were differences between stations. There was not, however, a significant change in the relationship of the abundances at each station between the years 1987-1989 and 1991 (Table 3.1.5-4, Preop-Op X Station term), indicating the operation of Seabrook Station has not affected *C. septemspinosa* abundances.

Neomysis americana

The weak bimodal pattern (based on long-term average conditions) in the abundances of *Neomysis americana* (all lifestages) was even less distinct in 1991 (Figure 3.1.5-4) from June through December. Annual mean abundances based on all preoperational data at Stations P2 and P5 were similar in 1991 compared to the preoperational period, while abundances at P7 were lower in 1991 compared to the preoperational period (Table 3.1.5-3). Over all three stations, the annual mean abundance in 1991 was significantly different from that based on the period 1987-1989 (Table 3.1.5-4), although differences among individual years were also significant. Spatial differences were apparent in 1991, and have historically been attributed to substrate differences and the distances of the stations from Hampton Harbor.

The seasonal occurrences of individual *N. americana* life stages in 1991 were generally similar to preoperational patterns (Figure 3.1.5-4). Juveniles have typically been the most abundant lifestage in late spring and throughout the fall; this was true as well in 1991. Immature adults have typically been present throughout the year, but most abundant in the late fall through the winter, with a secondary peak in June and July; this was also observed in 1991. Ovigerous and larvigerous females make up the smallest proportion of the *N. americana* population, and are typically present only from April through August. These females comprised a relatively large proportion of the population during the spring and summer in 1991. Adults have typically been present from January until October, and have been the most common lifestage in April and in July and August. Adults comprised a comparatively large proportion of the population in May of 1991, and a lesser proportion in January, March, June and September. In general, monthly percent composition of each life stage was similar in 1991 to preoperational patterns.

3.1.5.3 Effects of Plant Operation

Evaluation of the nearshore populations of macrozooplankton provides a measure of the effect of plant operation. The holo- and meroplankton community exhibited similar patterns in 1991 compared to recent preoperational years (1988-1989), although abundances tended to be higher in 1991. Community characteristics did not vary among stations in either time frame, suggesting any temporal differences were regional and outside the influence of Seabrook Station.

The tychoplankton community exhibited consistent differences among stations regardless of operational status of the plant. Spatial differences are likely due to substrate differences and proximity to the Hampton-Seabrook estuary. There was no indication that operation of Seabrook Station has affected the tychoplankton assemblage.

Overall, selected species abundances in 1991 were similar to historical data. No operational effects are apparent in either the full-preoperational period (1978-1989 at nearfield Station P2) vs. 1991 comparisons or the 1987-1989 preoperational period comparisons at all three stations.

3.2 FINFISH

Common names recognized by the American Fisheries Society (Robins et al. 1991) are used for fish taxa. The common and scientific names for every taxon collected from 1975 through 1990 in the Seabrook ichthyoplankton and adult finfish programs are listed with their relative abundances by gear type in NAI (1991b). No species new to the Seabrook program were encountered during the 1991 surveys.

3.2.1 Ichthyoplankton

3.2.1.1 Community

Many of the dominant ichthyoplankton eggs collected in this program are difficult to identify to the species level. All larval taxa, however, are identified to species level. Most of the dominant pelagic and demersal adult finfish are collected as larvae in the study area, although few are identified in the egg stage from ichthyoplankton collections.

The nearfield ichthyoplankton community has been examined in annual baseline reports using numerical classification (NAI 1982c, 1983b, 1984b, 1985b) and discriminant analysis (NAI 1987b, 1988b, 1989b, 1990b). Species composition of both eggs and larvae exhibited distinct seasonal changes, which were consistent among years. In the first operational report (NAI 1991b), numerical classification (cluster analysis) demonstrated that the 1990 community followed the same seasonal patterns observed in previous years. This year the community analysis of fish eggs and larvae again uses numerical classification, but its focus has been expanded to include a comparison of intake, discharge, and farfield stations.

Eggs

Numerical classification of 195 monthly ichthyoplankton samples from three stations based on abundances of 11 dominant taxa of fish eggs resulted in eight sample groups (Figure 3.2.1-1). Each group was characterized by its distinct species composition and abundances (Table 3.2.1-1). The distribution of samples among the groups indicates the extent to which any factor in the sampling design corresponds to changes in the composition of the fish eggs community (Figure 3.2.1-1). The time of year was clearly the only factor that was related to the changes in species assemblages among the groups. Each month's samples occurred in no more than three of the nine groups. Conversely, each sample group consisted only of samples from a brief season (one to four months). The other factors investigated (plant operational status, year, and station) were unrelated to group assignment. No sample group had a disproportionately high number of samples from the preoperational period, the operational period, any single year, or any single station.

Samples from different stations collected in the same month tended to occur in the same sample group, indicating a high degree of similarity of fish eggs assemblages among the three stations. In 88% of the months in the analysis, collections from all three stations were

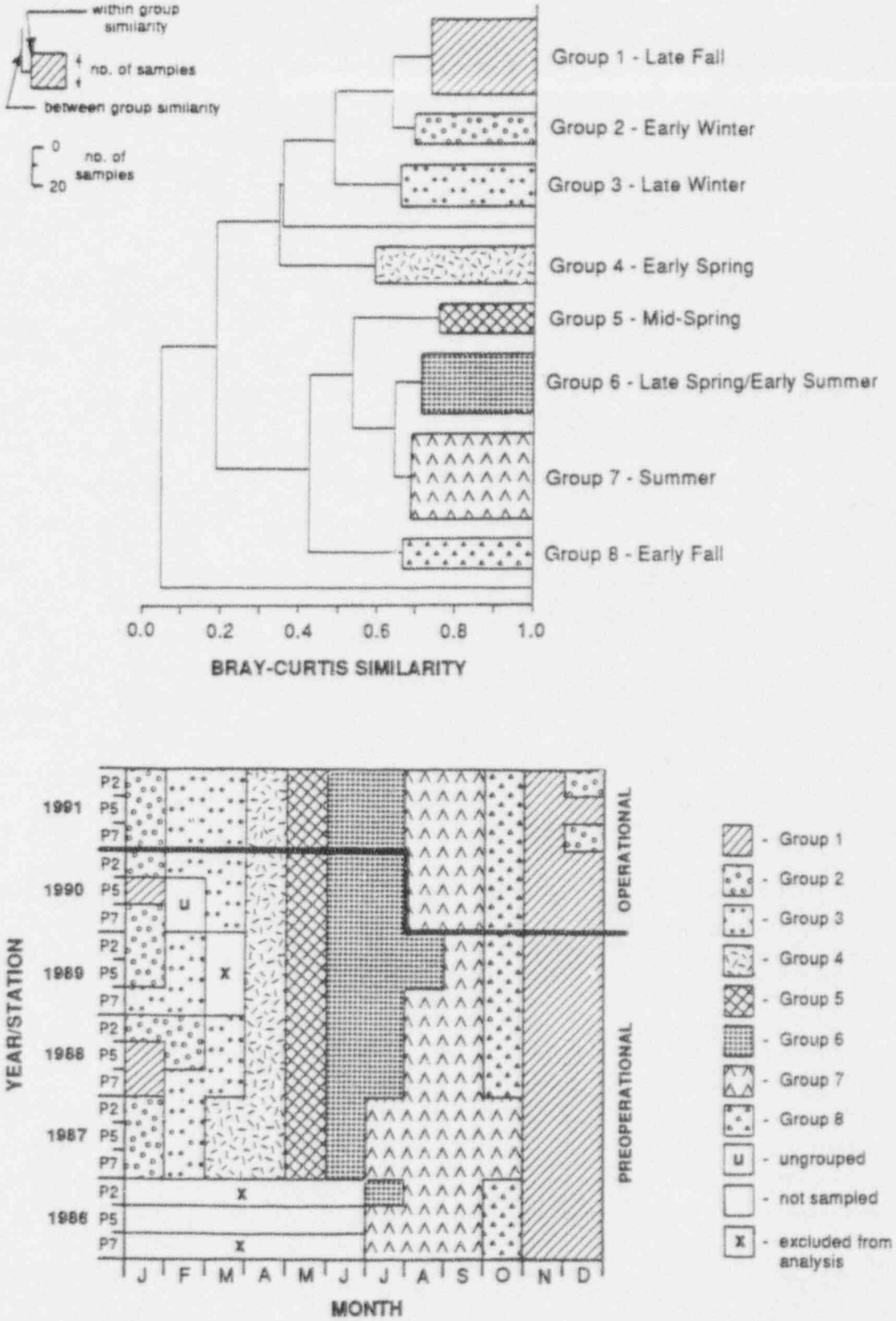


Figure 3.2.1-1. Dendrogram and temporal/spatial occurrence pattern of fish egg assemblages formed by numerical classification of ichthyoplankton samples (monthly means of log (x+1) transformed number per 1000 m³) at Seabrook intake (P2), discharge (P5), and farfield (P7) stations, July 1986-December 1991. Seabrook Operational Report, 1991.

TABLE 3.2.1-1. FAUNAL CHARACTERIZATION OF GROUPS FORMED BY NUMERICAL CLASSIFICATION OF SAMPLES OF FISH EGGS COLLECTED AT SEABROOK INTAKE (P2), DISCHARGE (P5), AND FARFIELD (P7) STATIONS DURING JULY 1986 THROUGH DECEMBER 1991.[a] SEABROOK OPERATIONAL REPORT, 1991.

		NUMBER OF SAMPLES AND DENSITY (EGGS/1000 m^3)[d]							
		PREOPERATIONAL PERIOD[e]				OPERATIONAL PERIOD[e]			
GROUP	DOMINANT TAXA[c]	N	LCL	MEAN	UCL	N	LCL	MEAN	UCL
1 Late Fall (0.73/0.63)[b]	Atlantic cod/haddock	27	68	90	119	10	36	62	106
2 Early Winter (0.69/0.63)	Atlantic cod/haddock	10	6	8	12	5	5	8	13
	pollock		1	3	5		<1	2	6
3 Late Winter (0.66/0.48)	Atlantic cod/haddock	15	4	6	8	6	2	6	12
	American plaice		1	1	2		1	2	6
4 Early Spring (0.59/0.35)	American plaice	15	22	38	64	3	41	54	72
	Atlantic cod/haddock		7	15	30		11	33	93
	fourbeard rockling		4	8	16		0	<1	2
5 Mid-Spring (0.76/0.53)	cunner/yellowtail flounder	12	175	293	488	3	576	1,160	2,340
	fourbeard rockling		77	235	715		17	96	525
	American plaice		54	73	97		95	111	130
	Atlantic mackerel		18	37	77		30	401	5,220
6 Late Spring/ Early Summer (0.71/0.64)	cunner/yellowtail flounder	24	6,190	10,200	16,900	6	7,890	17,500	38,900
	hake/fourbeard rockling		189	460	1,110		134	292	634
7 Summer (0.68/0.64)	hake	30	163	243	361	12	153	354	815
	hake/fourbeard rockling		123	205	344		121	226	422
	cunner/yellowtail flounder		41	129	401		18	85	389
	windowpane		43	77	134		101	158	248
8 Early Fall (0.67/0.42)	Atlantic cod/haddock	9	10	20	39	6	1	6	23
	hake/fourbeard rockling		4	10	25		2	7	25
	hake		6	10	17		2	4	10
	Atlantic whiting		5	8	12		4	10	21
	fourbeard rockling		1	4	10		<1	1	1

[a] Each "sample" consisted of the average of tows within date and dates within month.
[b] (Within group/between group similarity)
[c] Those whose preoperational geometric mean densities together accounted for ≥90% of the sum of the preoperational geometric mean densities of all taxa within the group.
[d] Geometric mean and lower (LCL) and upper (UCL) 95% confidence limits.
[e] Preoperational = July 1986 - July 1990; Operational = August 1990 - December 1991.

classified in the same group (Figure 3.2.1-1). Furthermore, in 35% of the months, high similarity levels in the collections from the three stations caused them to group more closely with each other than with any of the other samples in the same group. The high level of similarity among stations is consistent with the observation in previous years that samples collected on the same date at different stations resembled each other much more than samples collected at the same station one week apart (NAI 1983b, 1984b).

Similarity of the fish eggs community among stations can be explained by the passive drifting of planktonic organisms and the dynamic nature of the water masses in the study area. For example, during February through April 1978 when American sand lance larvae were most abundant, tidal current and longshore currents in the sampling area were typically 0.2 to 0.6 knots about 75% of the time (NAI 1980d). Currents of this magnitude could transport a water mass about two nautical miles in a single tidal excursion, or about 5-15 miles in 24 hours during periods dominated by longshore flow. The distance from Station P2 to P5 (1-2 miles) or from P2 to P7 (3-4 miles) is short enough that plankton communities are transported from one station to another in a matter of hours. Thus on the time scale of this study, in which samples are collected and compared over weeks, months, and years, the intake (P2), discharge (P5), and farfield (P7) stations are not, in reality, isolated from each other.

The pattern of seasonal succession of the eight fish egg assemblages identified by this analysis remained consistent from year to year, and the period following the initiation of commercial operation in August 1990 agreed very well with the pattern in previous years (Figure 3.2.1-1). The December 1991 samples indicated a slightly earlier transition from the Group 1 late fall cod eggs assemblage to the Group 2 early winter cod/pollock assemblage than in the previous five years, but transitions from one assemblage to another have varied by one month in several preoperational occasions as well (Figure 3.2.1-1). Overall, the species composition and abundance of fish eggs have been very consistent between the preoperational and operational periods. This conclusion is substantiated by the results of a multivariate analysis of variance (MANOVA), which showed that although there was a detectable change in the egg community between preoperational and operational periods ($p<0.001$), the difference was consistent at nearfield and farfield stations ($p=0.97$). This result implies that there were some among-year differences in the fish egg community as a whole, but because they were not limited to nearfield stations, there is no evidence that they are related to plant operation. The most notable differences between preoperational and operational periods were decreased densities of fourbeard rockling and pollock eggs in the operational periods.

Larvae

Eight sample groups were identified from numerical classification of 198 monthly ichthyoplankton samples from three stations on the basis of abundances of 22 dominant taxa of fish larvae (Figure 3.2.1-2). Each sample group was characterized by a unique set of dominant species and their abundances (Table 3.2.1-2). The limited number of months represented in each sample group (no more than three) shows that the groups reflect highly consistent seasonal assemblages (Figure 3.2.1-2). In contrast, there was no tendency for samples to group selectively according to plant operational status, year, or station. Each sample group contained a representative selection of samples from both preoperational and operational periods, samples from several different years, and samples from all three stations.

In 97.0% of the months analyzed, all three stations were classified into the same sample group (Figure 3.2.1-2). In 42.4% of the months, the three stations not only fell in the same group, but they were more closely similar to each other than to any other samples of their group. The extremely high similarity of the larval fish community among stations is due to the same circumstances discussed for fish eggs: the high degree of overlap among the three stations caused by plankton transport over time.

Larval fish assemblages in the operational period (August 1990 and later) followed the same seasonal progression as in preoperational years (Figure 3.2.1-2). Slight variations in the timing of the appearance of the various seasonal assemblages occurred among years within the preoperational period, but the seasonal pattern in the operational period did not vary at all from the usual preoperational pattern. The species composition in the operational period was similar to that in the preoperational period, although average densities were not always similar between preoperational and operational periods. For example, Atlantic herring densities in the late fall (Group 1) decreased between the preoperational and operational periods, whereas Atlantic mackerel densities in early summer (Group 6) increased between preoperational and operational periods. Shifts in the larvae community composition such as this are reflected in a significant operational status effect ($p<0.001$) in a MANOVA for this same data set. When the operational status vs. station interaction (Preop-Op X Station) is examined, however, it is clear that any changes during the operational period were not limited to the nearfield stations ($p>0.99$). This is an indication that changes in larval abundances in the operational period were not related to plant operation, and it is likely that the significant difference between preoperational and operational fish larvae communities is due to among-year variation.

3.2.1.2 Selected Species

Nine species of fish were selected for detailed analyses of within-year and among-year patterns of larval abundance because of their numerical dominance or importance as either a recreational or commercial species. Although larval

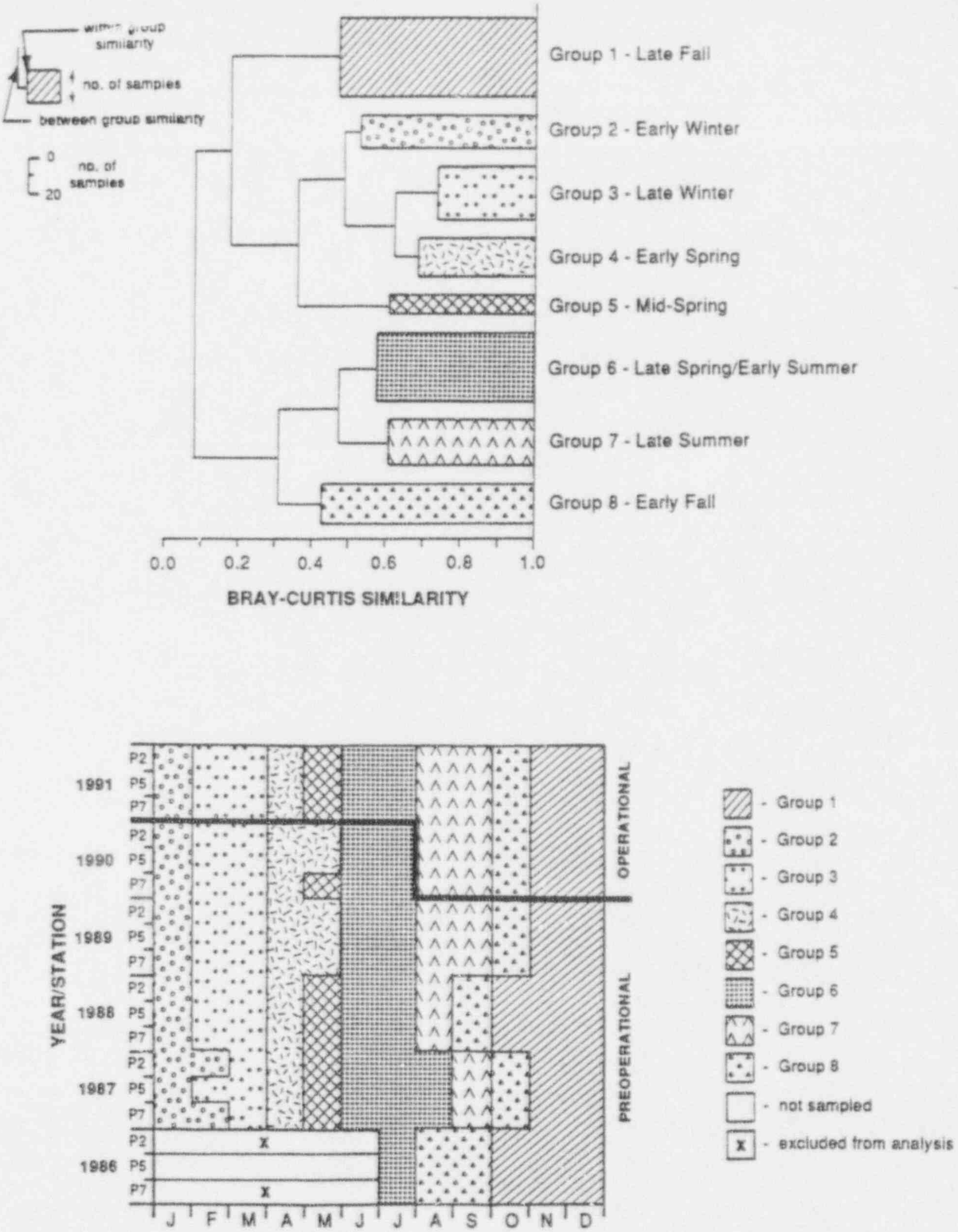


Figure 3.2.1-2. Dendrogram and temporal/spatial occurrence pattern of fish larvae assemblages formed by numerical classification of ichthyoplankton samples (monthly means of log (x+1) transformed number per 1000 m³) at Seabrook intake (P2), discharge (P5), and farfield (P7) stations, July 1986-December 1991. Seabrook Operational Report, 1991.

TABLE 3.2.1-2. FAUNAL CHARACTERIZATION OF GROUPS FORMED BY NUMERICAL CLASSIFICATION OF SAMPLES OF FISH LARVAE COLLECTED AT SEABROOK INTAKE (P2), DISCHARGE (P5), AND FARFIELD (P7) STATIONS DURING JULY 1986 THROUGH DECEMBER 1991.[a] SEABROOK OPERATIONAL REPORT, 1991.

		NUMBER OF SAMPLES AND DENSITY (LARVAE/1000 m^3)[d]							
		PREOPERATIONAL PERIOD				OPERATIONAL PERIOD			
GROUP	DOMINANT TAXA[c]	N	LCL	MEAN	UCL	N	LCL	MEAN	UCL
1 Late Fall (0.47/0.18)[b]	Atlantic herring	30	29	50	84	12	7	15	34
2 Early Winter (0.53/0/48)	American sand lance	14	12	24	48	3	<1	17	235
	Atlantic herring		2	4	8		0	1	8
	gulf snailfish		2	4	6		1	4	8
	pollock		1	3	8		<1	3	11
3 Late Winter (0.74/0.62)	American sand lance	22	226	324	463	6	105	192	350
	rock gunnel		23	37	58		7	25	80
4 Early Spring (0.68/0.62)	American sand lance	17	51	80	125	3	39	75	146
	Atlantic seasnail		13	23	40		2	4	7
	gulf snailfish		7	11	18		2	5	12
	grubby		6	11	19		2	6	19
	rock gunnel		6	10	17		1	3	7
5 Mid-Spring (0.60/0.36)	Atlantic seasnail	7	31	87	240	3	3	30	227
	winter flounder		6	18	51		1	8	55
	radiated shanny		11	17	26		2	17	106
	American sand lance		6	10	17		0	8	150
	American plaice		4	7	13		3	10	32
6 Late Spring/ Early Summer (0.57/0.47)	cunner	30	52	116	254	6	2	43	645
	fourbeard rockling		32	55	93		30	59	117
	radiated shanny		19	29	42		28	43	66
	Atlantic mackerel		10	19	36		33	286	2,420
	winter flounder		6	11	20		2	6	13
7 Late Summer (0.61/0.47)	cunner	12	69	146	306	12	140	467	1,550
	fourbeard rockling		19	51	132		25	38	59
	hake		5	8	14		13	42	130
	witch flounder		3	7	14		1	2	4

(continued)

TABLE 3.2.1-2. (CONTINUED)

GROUP	DOMINANT TAXA[b]	NUMBER OF SAMPLES AND DENSITY (LARVAE/1000 m^3)[d]							
		PREOPERATIONAL PERIOD				OPERATIONAL PERIOD			
		N	LCL	MEAN	UCL	N	LCL	MEAN	UCL
8 Early Fall (0.43/0.31)	fourbeard rockling	15	1	3	5	6	3	8	19
	cunner		1	3	6		0	1	1
	windowpane		1	1	2		<1	1	2
	Atlantic herring		<1	1	2		<1	1	3
	hake		1	1	2		1	2	3
	Atlantic whiting		<1	1	2		0	1	3
	witch flounder		<1	1	1		<1	<1	1

[a]Each "sample" consisted of the average of tows within date and dates within month.
[b](Within group/between group similarity).
[c]Those whose preoperational geometric mean densities together accounted for ≥90% of the sum of the preoperational geometric mean densities of all taxa within the group.
[d]Geometric mean and lower (LCL) and upper (UCL) 95% confidence limits.
[e]Preoperational = July 1986 - July 1990; Operational = August 1990 - December 1991.

fish were present in every month, each species exhibited a period of peak abundance of three or four months and was usually absent for part of the year. These seasonal fluctuations were the primary reason for the high within-year variability (NAI 1983b).

Two-way analyses of variance (ANOVAs) were used to test the statistical significance of temporal (preoperational vs. operational) and spatial (intake, discharge, and farfield stations) differences in log (x + 1) transformed densities. Only collections after the initiation of sampling at all three stations (July 1986) were included in the ANOVAs. The ANOVAs focussed on the periods of peak abundance for each species as identified in the historical data.

American Sand Lance

Historically, American sand lance were usually present in collections from December through July, with peak abundances occurring from January through April (Figure 3.2.1-3). The relatively long period of occurrence is due primarily to an extended hatching period (Richards 1982) and a long planktonic period for the larval stage (Bigelow and Schroeder 1953). The periods of occurrence and peak abundances during the operational years (1990 and 1991) were very similar to the preoperational periods, but abundance in 1990 was generally greater than during the preoperational period, whereas 1991 abundance was generally lower than during the preoperational period (Figure 3.2.1-3). American sand lance was the most abundant species during the preoperational period at all stations (Table 3.2.1-3). Analysis of variance indicated that there was no significant relationship between the abundance of larval sand lance and sampling location (Table 3.2.1-4; Station) or operational status (Table 3.2.1-4; Preop-Op). The main effect interaction term (Preop-Op X Station) was also not significant, indicating that there is not direct effect due to operation of Seabrook Station.

Winter Flounder

Winter flounder larvae, which were the fourth-most abundant of the selected species during the preoperational period, were usually present from April through July, with the greatest abundance occurring in May and June (Figure 3.2.1-3). Very few specimens were caught between August and March. The period of occurrence during the operational years (1990 and 1991) was similar to the preoperational period, although the peak in abundance in 1991 was broader than usual, lasting from May through July (Figure 3.2.1-3). Abundance of larval winter flounder during the operational period has been lower than during the preoperational period at all stations (Table 3.2.1-3). Densities of winter flounder larvae have been highly variable from year to year, so the lower values during the operational years are not necessarily indicative of negative effects due to Seabrook Station. The ANOVA results indicated that not only was preoperational abundance greater than operational, but abundance at the nearfield station (P2) exceeded abundance at the farfield station (Table

Figure 3.2.1-3. Mean monthly log (x+1) abundance (no./1000 m^3) in preoperational years (1975-1989, with 95% confidence limits), 1990 and 1991 for larvae of American sand lance, winter flounder, Atlantic cod, and yellowtail flounder at nearfield Stations P2 and P3. Seabrook Operational Report, 1991.

TABLE 3.2.1-3. GEOMETRIC MEAN ABUNDANCE (No./1000 m^3) AND 95% CONFIDENCE LIMITS OF SELECTED SPECIES OF FISH LARVAE AT STATIONS P2, P5, AND P7 OVER PREOPERATIONAL YEARS AND GEOMETRIC MEAN ABUNDANCE IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES (peak period)	STATION	PREOPERATIONAL YEARS[a] LCL	MEAN	UCL	OPERATIONAL YEARS 1990	1991
American sand lance	P2	106.5	147.9	205.3	163.9	65.7
(Jan-Apr)	P5	111.4	178.6	286.2	260.6	125.9
	P7	68.1	108.9	173.8	76.1	71.7
Winter flounder	P2	9.7	14.0	19.9	5.6	5.5
(Apr-Jul)	P5	6.7	11.2	18.4	5.5	4.8
	P7	6.1	9.8	15.3	1.5	1.6
Atlantic cod	P2	1.4	2.0	2.8	0.7	1.8
(Apr-Jul)	P5	0.9	1.6	2.6	0.8	1.7
	P7	0.6	1.1	1.7	0.2	0.8
Yellowtail flounder	P2	2.2	3.1	4.3	0.7	1.1
(May-Aug)	P5	2.1	3.6	5.9	1.6	1.0
	P7	1.9	3.1	4.8	0.6	0.8
Atlantic mackerel	P2	4.6	7.3	11.3	5.9	31.7
(May-Aug)	P5	2.5	5.4	10.5	7.5	18.5
	P7	3.1	5.9	10.5	5.8	29.2
Cunner	P2	32.3	49.6	75.8	274.0	105.9
(Jun-Sep)	P5	40.1	74.5	137.5	191.7	81.4
	P7	34.2	61.1	108.6	228.3	140.1
Hake	P2	2.5	4.1	6.3	60.9	2.1
(Jul-Sep)	P5	1.9	3.4	5.4	33.9	4.9
	P7	2.0	3.9	7.1	33.6	11.8
Atlantic herring	P2	18.1	26.9	39.6	2.1	19.3
(Oct-Dec)	P5	20.0	33.6	56.1	4.7	19.1
	P7	18.6	32.5	56.3	3.2	18.6
Pollock	P2	3.9	5.4	7.5	1.0	b
(Nov-Feb)	P5	3.2	4.9	7.2	2.0	b
	P7	1.6	2.5	3.7	1.0	b

[a]Preoperational years:

P2 = 1975-1989
P5 = 1975-1981 and 1986-1989
P7 = 1982-1989

(Years in which one or more months of the peak period were not sampled at a station were not included in the mean)

[b]Yearly mean not computed for pollock in 1991 because January and February 1992 data were not available.

TABLE 3.2.1-4. RESULTS OF ANALYSIS OF VARIANCE[a] OF LOG (x+1) TRANSFORMED ABUNDANCES (No./1000 m^3) OF SELECTED SPECIES OF FISH LARvAE AMONG STATIONS P2, P5, AND P7 DURING PREOPERATIONAL AND OPERATIONAL[b] PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES (peak period)	SOURCE OF VARIATION	df	SS	F	MULTIPLE COMPARISONS
American sand lance (Jan-Apr)	Preop-Op[c]	1	0.58	1.18 NS	
	Year (Preop-Op)[d]	3	2.65	1.79 NS	
	Month (Year)[e]	15	61.18	8.27***	
	Station	2	2.57	2.61 NS	
	Preop x Station[f]	2	0.77	0.78 NS	
	Error	172	97.67		
Winter flounder (Apr-Jun)	Preop-Op	1	2.96	7.97**	Preop>Op
	Year (Preop-Op)	3	4.94	4.44**	
	Month (Year)	15	73.57	13.22***	
	Station	2	2.85	3.84*	P2 P5 P7
	Preop x Station	2	0.34	0.45 NS	
	Error	172	75.65		
Atlantic cod (Apr-Jul)	Preop-Op	1	1.75	14.89***	Op>Preop
	Year (Preop-Op)	3	1.15	3.27*	
	Month (Year)	15	8.89	5.05***	
	Station	2	0.46	1.95 NS	
	Preop x Station	2	0.11	0.46 NS	
	Error	161	23.97		
Yellowtail founder (May-Aug)	Preop-Op	1	1.62	5.18*	Preop>Op
	Year (Preop-Op)	2	3.30	5.27**	
	Month (Year)	12	21.35	5.68***	
	Station	2	0.05	0.09 NS	
	Preop x Station	2	0.26	0.42 NS	
	Error	172	53.87		
Atlantic mackerel (May-Aug)	Preop-Op	1	17.34	21.64***	Op>Preop
	Year (Preop-Op)	2	5.13	3.20*	
	Month (Year)	12	136.84	14.23***	
	Station	2	0.35	0.22 NS	
	Preop x Station	2	0.38	0.24 NS	
	Error	172	137.84		

(continued)

TABLE 3.2.1-4. (Continued)

SPECIES (peak period)	SOURCE OF VARIATION	df	SS	F	MULTIPLE COMPARISONS
Cunner (Jun-Sep)	Preop-Op	1	0.00	0.00 NS	
	Year (Preop-Op)	2	8.64	5.85**	
	Month (Year)	12	121.06	13.66***	
	Station	2	0.69	0.47 NS	
	Preop x Station	2	0.18	0.12 NS	
	Error	172	127.03		
Hake (Jul-Sep)	Preop-Op	1	1.52	3.03 NS	
	Year (Preop-Op)	3	5.98	3.97**	
	Month (Year)	10	27.87	5.56***	
	Station	2	2.44	2.43 NS	
	Preop x Station	2	1.58	1.57 NS	
	Error	161	80.77		
Atlantic herring (Oct-Dec)	Preop-Op	1	17.96	43.83***	Preop>Op
	Year (Preop-Op)	4	25.43	15.52***	
	Month (Year)	12	53.25	10.83***	
	Station	2	0.58	0.70 NS	
	Preop x Station	2	0.02	0.02 NS	
	Error	188	77.01		
Pollock (Nov-Feb)	Preop-Op	1	1.37	7.79**	Preop>Op
	Year (Preop-Op)	3	12.83	24.30***	
	Month (Year)	15	16.10	6.10***	
	Station	2	0.56	1.58 NS	
	Preop x Station	2	0.03	0.09 NS	
	Error	210	36.95		

[a] based on each species' peak period as defined in Table 3.2.1-3
[b] Preoperational = July 1986 - July 1990; Operational = August 1990 - December 1991; 1990 data were not included in the analysis for species where the period of peak abundance includes both July and August (e.g., yellowtail flounder)
[c] preoperational versus operational period regardless of station
[d] year nested within preoperational and operational periods, regardless of station
[e] month nested within year nested within preoperational and operational periods, regardless of station
[f] interaction between main effects (status and station)

NS = not significant (p>0.05)
* = significant (0.05≥p>0.01)
** = highly significant (0.01≥p>0.001)
*** = very highly significant (p≤0.001)

3.2.1-4). The Preop-Op X Station interaction was not significant, however, indicating that differences among stations were consistent regardless of plant operational status and there was no direct effect on this species due to Seabrook Station (Table 3.2.1-4; Preop-Op X Station).

Atlantic Cod

Atlantic cod larvae typically exhibited a bimodal period of occurrence with one peak lasting from November through January and a second, usually larger peak, lasting from April through July (Figure 3.2.1-3). Monthly abundance of larval Atlantic cod in 1990 was generally lower than the preoperational average. Monthly abundance in 1991 was lower than the preoperational period during much of the year, but was similar or slightly higher than the preoperational average during May, June, and November. Analysis of variance indicated that mean abundance was higher during operational years but this pattern was consistent at all three stations (Table 3.2.1-4; Preop-Op; Station; Preop-Op X Station).

Yellowtail Flounder

Yellowtail flounder larvae were normally collected from May through September, with peak abundance occurring in June and July (Figure 3.2.1-3). Monthly abundance of yellowtail flounder larvae during the operational period has generally been lower than during the preoperational period, particularly in May and June. Geometric mean abundance during the periods of peak occurrence was similar among stations, but was higher during the preoperational period (Table 3.2.1-3). Analysis of variance results supported this finding (Table 3.2.1-4; Preop-Op and Station). The interaction term between Preop-Op and Station was not significant (Table 3.2.1-4; Preop-Op X Station), indicating a broadscale trend not directly related to operation of Seabrook Station.

Atlantic Mackerel

Atlantic mackerel larvae have historically exhibited a period of occurrence lasting from May through September with greatest densities occurring in July (Figure 3.2.1-4). The period of occurrence has remained similar during the operational period, although peak densities in 1991 were substantially higher than during 1990 or the preoperational mean. The geometric mean abundance of larval Atlantic mackerel was also substantially higher during 1991 than during 1990 or preoperational years (Table 3.2.1-3). Analysis of variance indicated that mean abundance was greater during operational years than during preoperational years (Table 3.2.1-4; Preop-Op). There was no significant difference in abundance among the three stations (Table 3.2.1-4; Station) and the interaction between Preop-Op and Station was also not significant (Table 3.2.1-4; Preop-Op X Station) indicating a widespread increase in abundance in 1991, unlikely to be related to operation of Seabrook Station.

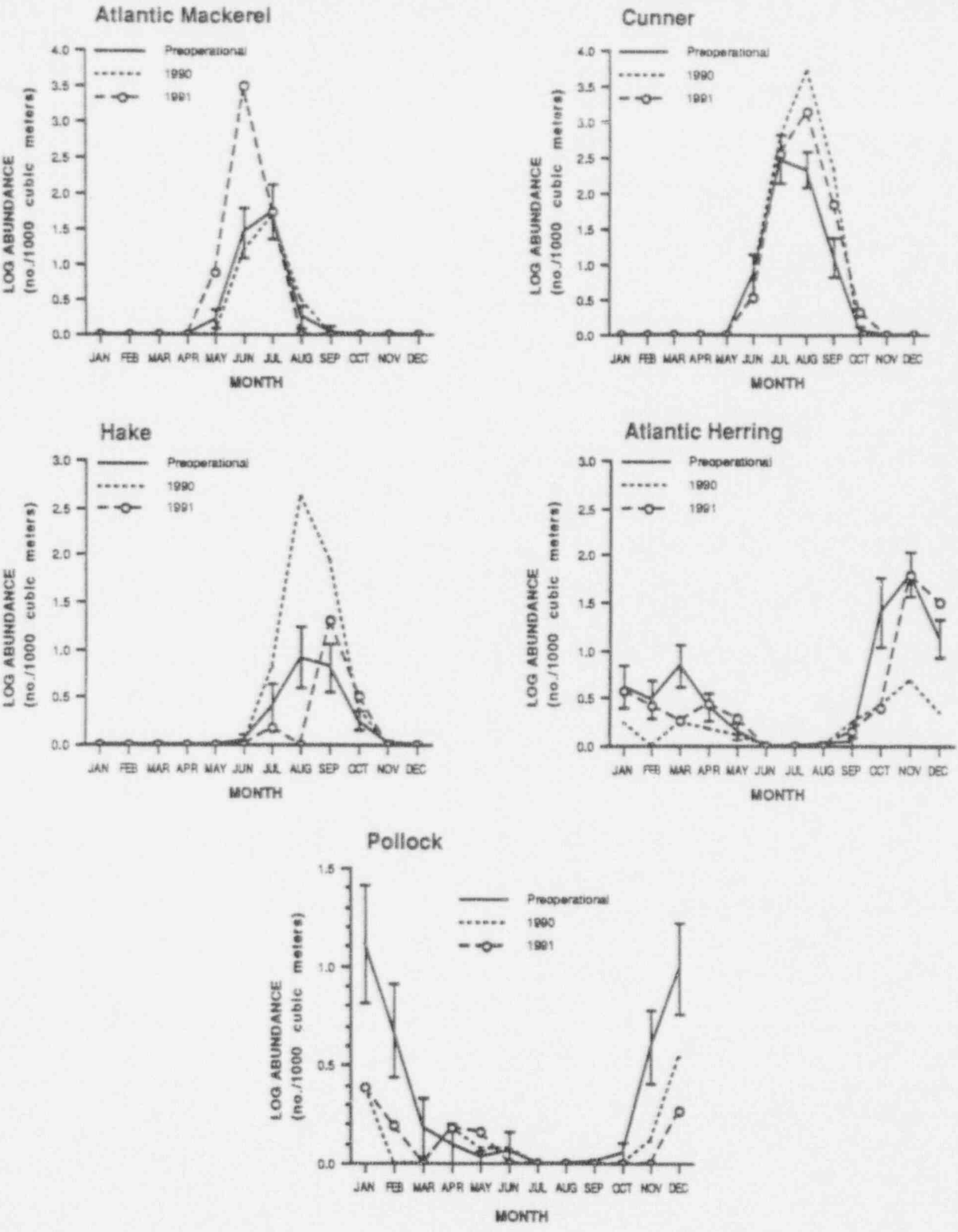


Figure 3.2.1-4. Mean monthly log (x+1) abundance (no./1000 m³) in preoperational years (1975-1989, with 95% confidence limits), 1990 and 1991 for larvae of **Atlantic mackerel**, **cunner**, **hake**, **Atlantic herring**, and **pollock** at nearfield Stations P2 and P3. Seabrook Operational Report, 1991.

Cunner

Cunner larvae have historically been collected from June through October, with peak abundance during July and August (Figure 3.2.1-4). Data from the operational period generally followed this same pattern, although the time of peak occurrence appears to have shifted to July, August, and September. Although mean abundance at all stations has been higher during the operational period than during the preoperational period (Table 3.2.1-3), ANOVA results indicated this difference was not significant (Table 3.2.1-4; Preop-Op). There were no significant differences among stations (Table 3.2.1-4; Station) and the interaction term between Preop-Op and Station was not significant (Table 3.2.1-4; Preop-Op X Station).

Hake

Historically, hake larvae were confined to a relatively brief period of occurrence, beginning in June or July, peaking in August and September, then declining to near zero by November (Figure 3.2.1-4). Although generally similar to the historical pattern, the operational period of occurrence has been rather variable over the two years studied. The timing of the 1990 period of occurrence was very similar to the historical pattern but abundance was far greater in 1990 than in previous years. The 1991 period of peak occurrence was later than normal (September) and abundance was lower than normal in some months yet higher in others. The 1990 abundances for hake were excluded from the ANOVA because the peak period in 1990 included both preoperational and operational months. This explains the non-significance of the Preop-Op factor (Table 3.2.1-4) despite the extremely high hake densities in the summer of 1990 (Table 3.2.1-3). Neither the Station term nor the Preop-Op X Station interaction term was statistically significant (Table 3.2.1-4).

Atlantic Herring

Atlantic herring larvae typically occurred from October through May and were rare for the remainder of the year (Figure 3.2.1-4). Peak abundance usually occurred from October through December but a second, smaller peak was commonly observed in March. A similar pattern was also observed during the operational period, although the timing of the secondary peak appears to be variable. Geometric mean abundance was generally similar to the preoperational period (Table 3.2.1-3). There was a dramatic difference between mean abundance in 1990 and the mean of the preoperational period, but 1991 values were closer to the preoperational average (Table 3.2.1-3). Preoperational abundances were significantly greater than operational abundances at all stations (Table 3.2.1-4; Preop-Op X Station).

Pollock

Pollock larvae also exhibited a fall-winter pattern of occurrence, but it was generally briefer than that of herring larvae. Relatively large densities of pollock larvae were collected from November though February and few to none were caught from March through October (Figure 3.2.1-4). However, monthly pollock catches during the preoperational period were highly variable from year to year, as evidenced by the broad confidence limits (Figure 3.2.1-4). Catches of larval pollock were also somewhat irregular during the operational years, with higher than usual catches during April and May but lower than usual catches in November, December, and January. Geometric mean abundance in 1990 was lower than the preoperational mean, but this pattern was consistent among all stations (Table 3.2.1-3). The 1991 mean abundances are not yet available because the period of peak abundance extends through the change of year. Analysis of variance indicated that the 1990 (operational) abundance was lower than abundance during the preoperational period (Table 3.2.1-4; Preop-Op). However, there were no significant differences in abundance among stations (Table 3.2.1-4; Station) or among stations due to operational status (Table 3.2.1-4; Preop-Op X Station), so there is no evidence that operation of Seabrook Station is affecting abundance of larval pollock.

3.2.1.3 Effects of Plant Operation

The greatest potential effect of the operation of Seabrook Station on ichthyoplankton is expected to be mortality of fish eggs and larvae entrained by the cooling water system. Seabrook's circulating water system was in operation 351 days during 1991. The average flow rate ranged from 253 million gallons per day (MGD) in August to 591 MGD in December. Entrainment samples were collected on 30 dates in 1991, primarily during January-July and during December.

Fifteen taxa of fish eggs and 22 taxa of fish larvae were recorded from entrainment samples in 1991. Total entrainment was estimated for both eggs and larvae for January-July and for December on the basis of observed densities in entrainment samples and the total cooling water flow (Table 3.2.1-5). Atlantic mackerel and cunner/yellowtail flounder were the egg taxa entrained in the greatest numbers during those months, and the greatest numbers of larvae entrained were rock gunnel, American sand lance, and grubby. These estimates of numbers entrained can be considered to represent total losses due to entrainment (assuming the worst case of 100% mortality of entrained ichthyoplankton).

The effect of plant operation (entrainment losses plus thermal plume effects) on coastal ichthyoplankton populations was evaluated by comparing preoperational and operational abundances in the vicinity of the plant (stations P2 and P5) to abundances at farfield Station P7. Only if the relationship among stations differed between preoperational and operational periods would it be possible to implicate plant operation in the change. For the fish eggs community and the fish larvae community the seasonal assemblages were highly consistent between preoperational and operational periods, and the three stations were very similar in their species composition (Section 3.2.1.1). Both the eggs community and the larvae community exhibited preoperational vs. operational differences in abundances,

TABLE 3.2.1-5. MONTHLY ESTIMATED NUMBERS OF FISH EGGS AND LARVAE (IN MILLIONS) ENTRAINED BY THE COOLING WATER SYSTEM DURING JANUARY THROUGH JULY AND DECEMBER 1991. SEABROOK OPERATIONAL REPORT, 1991.

TAXON	JAN	FEB	MAR	APR	MAY	JUN	JUL	DEC
EGGS								
Atlantic mackerel				1.9	55.0	611.0	5.2	
Cunner/yellowtail flounder				0.1	1.3	612.5	50.2	
Cod/witch flounder				2.0	20.6	40.5	6.3	
Cunner				<0.1	0.1	51.6	0.5	
Hake/fourbeard rockling				0.3	6.0	27.8	1.0	
American plaice			0.2	4.9	7.9	7.7	0.3	
Windowpane				0.1	1.0	14.7	4.1	
Atlantic cod	0.1	0.3		0.1	0.8	3.1	0.3	0.2
Fourbeard rockling				<0.1	1.7	2.5	0.1	
Hake						2.4	0.2	
Unidentified			0.7	<0.1	0.2	1.1		
Pollock	0.7	0.1						0.2
Atlantic menhaden						0.5		
Cusk						0.5		
Atlantic cod/haddock			0.2					
Tautog						0.1	0.1	
LARVAE								
Rock gunnel	4.5	36.6	7.1	2.8	0.1			
American sand lance	1.8	17.1	5.1	13.0	0.1	0.1		0.1
Grubby	0.2	2.9	8.7	9.7	0.9			
Atlantic seasnail			0.3	2.2	1.6	11.0	0.9	
Winter flounder					0.2	5.2	3.6	
Atlantic mackerel					0.2	4.3	0.2	
Radiated shanny				0.2	0.1	1.8	1.0	
Gulf snailfish	0.5	0.8	1.0	0.3	0.1			0.1
Unidentified			0.7	0.4	0.2	0.7	0.1	
Atlantic cod						1.2	0.3	
American plaice				0.2	0.1	0.7		
Longhorn sculpin		0.5	0.1	<0.1				
Atlantic herring	0.2		0.1					0.2
Fourbeard rockling							0.5	
Snailfish			0.2		0.1			
Yellowtail flounder					0.1	0.2		
Shorthorn sculpin	<0.1	0.1	0.1					
Wrymouth	<0.1	0.1						
Moustache sculpin				<0.1	0.1			
Alligatorfish			0.1					
Lumpfish					0.1			
Windowpane						<0.1		
Cunner							<0.1	

but these changes were the same at nearfield and farfield stations, thus there is no evidence of any impact from plant operation.

Although there were significant differences between preoperational and operational abundance for six of the nine selected species, the interaction effect (Preop-Op X Station) was nonsignificant in all cases (Section 3.2.1.2). Therefore, the differences in abundance corresponding to operational status were consistent among all stations. Given that the farfield station is presumed to be beyond the zone of influence, these results would not be expected if operation of Seabrook Station were affecting larval abundance.

Winter flounder was the only species that exhibited variable abundance among stations, with density at the nearfield station (P2) greater than at the farfield station (P7). The demersal nature of the eggs and relatively remote location of Station P7 could explain the observed spatial variation. However, the significance level of the F-test was not extreme. Also, due to the transient nature of ichthyoplankton, the three stations are not isolated from each other when viewed on a time scale exceeding a few hours or days.

Eight of the nine selected species showed significant year to year variability and this undoubtedly contributed to the significance of the operational status factor in the ANOVA models. As the size of the operational data set increases, it is probable that fewer of the Preop-Op comparisons will be statistically significant.

3.2.2 Adult Finfish

3.2.2.1 Community

Inter-Annual Patterns in the Pelagic Fish Community

Catch per unit effort (CPUE) for gill nets (all stations pooled) was 4 fish per net in 1991 (Figure 3.2.2-1). CPUE in 1991 was similar to CPUE for the period 1981 through 1990. CPUE in 1991 was well below the highest CPUE of 29 fish per 24-hour set in 1980. The low CPUE in 1990 and 1991 reflects a continuation of the low and generally decreasing trend in CPUE that started in 1981.

Changes in the annual composition of the pelagic fish community were examined by comparing CPUE of the dominant species among years. CPUE was used to evaluate the species composition because it provides a measure of the contribution of a species to the entire catch that is independent of contributions by other species. Five taxa accounted for approximately 90% of the average preoperational gill net catch (Table 3.2.2-1). During the preoperational period, CPUE of Atlantic herring was greatest followed by blueback herring, Atlantic whiting, pollock and Atlantic mackerel. During the operational period, Atlantic mackerel was dominant followed by Atlantic herring, pollock and spiny dogfish.

Multivariate analysis of variance was used to examine changes in community composition, as measured by mean yearly CPUE of species, between the preoperational and operational periods. The species composition of the pelagic community during the preoperational period

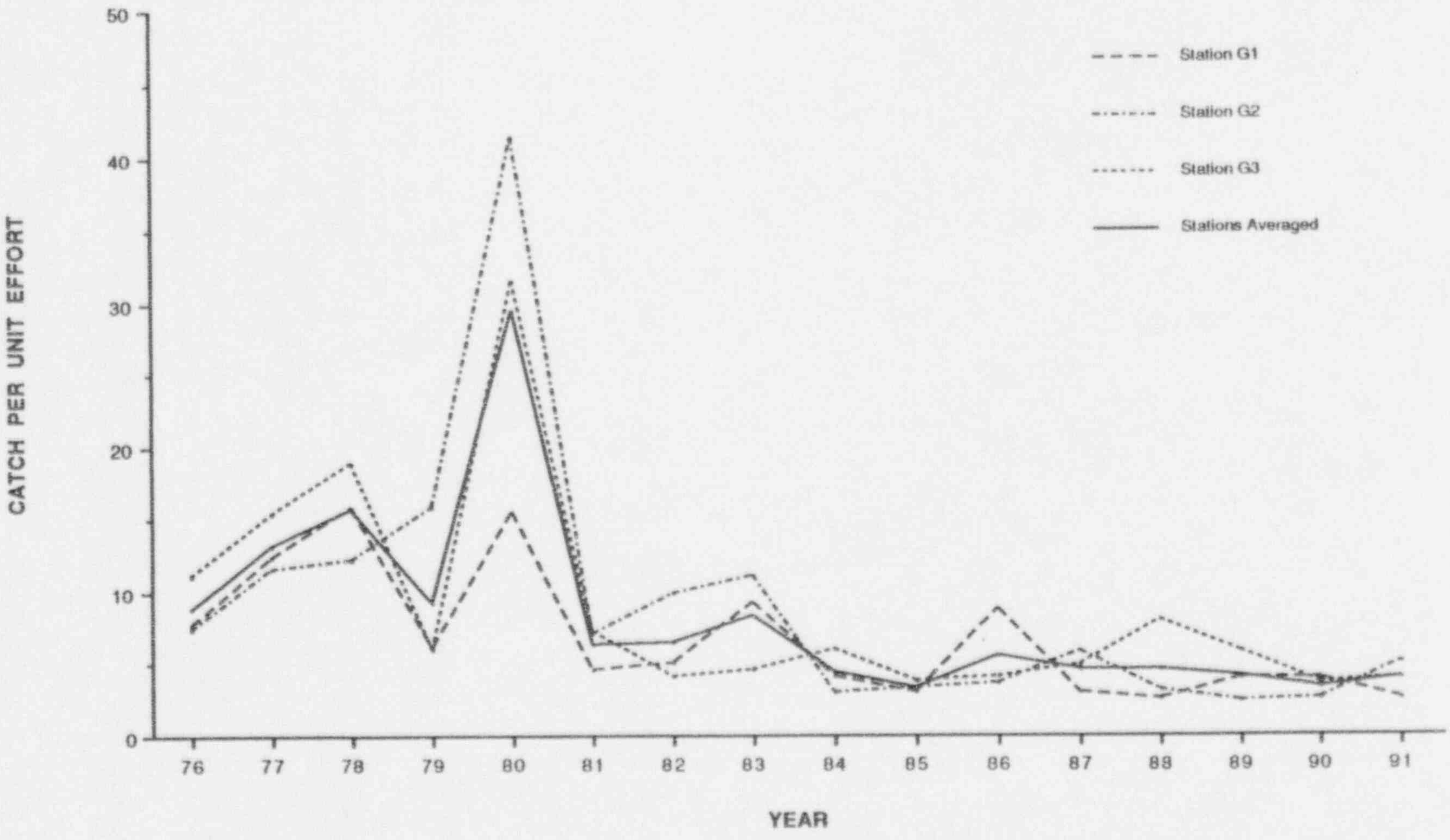


Figure 3.2.2-1. Annual total catch per unit effort (number per 24-hour set of one net, surface or bottom) in **gill nets** by station and mean of stations, 1976-1991. Seabrook Operational Report, 1991.

TABLE 3.2.2-1. CATCH PER UNIT EFFORT (NUMBER PER 24-HOUR SET, SURFACE AND BOTTOM) BY YEAR, AND ALL PREOPERATIONAL YEARS COMBINED FOR ABUNDANT SPECIES IN GILL NET SAMPLES FROM 1976 THROUGH 1991 AT STATIONS G1, G2, AND G3 COMBINED. SEABROOK OPERATIONAL REPORT, 1991.

	YEAR														PREOP		
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	$\bar{x}$	1990	1991
Atlantic herring	4.67	6.33	11.66	7.39	24.03	2.81	4.02	4.02	1.13	0.86	1.89	2.35	1.51	2.44	6.06	0.08	1.30
Atlantic whiting	1.47	2.72	0.37	0.40	1.79	0.34	0.44	0.08	0.23	0.04	0.07	0.21	0.04	0.02	0.80	0.15	0.04
Blueback herring	0.47	1.48	2.24	0.16	0.49	0.12	0.61	0.89	0.38	0.33	0.87	0.72	0.48	0.26	0.81	0.17	0.40
Pollock	0.51	0.46	0.18	0.20	1.52	1.13	0.22	1.11	0.44	0.74	1.01	0.26	0.60	0.40	0.57	0.76	0.42
Atlantic mackerel	1.05	0.88	0.29	0.14	0.59	0.88	0.32	0.45	0.26	0.33	0.18	0.33	1.01	0.24	0.52	1.22	0.42
Alewife	0.11	0.21	0.29	0.04	0.14	0.10	0.12	0.39	0.21	0.19	0.19	0.11	0.27	0.04	0.20	0.04	0.18
Atlantic menhaden	0.04	0.34	0.06	0.22	0.24	0.04	0.09	0.48	0.22	0.14	0.24	0.07	0.03	0.09	0.18	0.06	0.04
Hake species[a]	0.15	0.25	0.11	0.10	0.12	0.28	0.07	0.10	0.31	0.06	0.10	0.01	0.21	0.01	0.14	0.03	0.00
Rainbow smelt	0.10	0.14	0.15	0.12	0.11	<0.01	<0.01	0.11	0.26	0.08	0.20	0.15	0.04	0.02	0.11	0.02	0.03
Atlantic cod	0.11	0.11	0.06	0.09	0.11	0.04	0.11	0.14	0.13	0.02	0.12	0.08	0.09	0.04	0.10	0.01	0.00
Spiny dogfish	<0.01	0.03	0.03	<0.01	0.00	<0.01	0.03	0.08	0.12	0.17	0.37	0.01	0.03	0.15	0.06	0.39	0.45
Other species	0.08	0.21	0.24	0.40	0.33	0.55	0.33	0.47	0.66	0.38	0.24	0.24	0.20	0.28	0.32	0.35	0.59
All species	8.76	13.16	15.68	9.26	29.47	6.30	6.36	8.32	4.35	3.34	5.48	4.54	4.51	3.99	9.87	3.28	3.87

[a]includes red, white and spotted hake

was significantly different ($p<0.0001$) from the pelagic community during the operational period. With the possible exception of Atlantic herring, the yearly changes in the composition of the pelagic fish community in the study area were similar to the changes in the composition of the pelagic fish community in the Gulf of Maine (NOAA 1991a,b). The primary differences in the community composition in the study area between the preoperational and operational periods were a decrease in abundance of Atlantic herring and Atlantic whiting and an increase in abundance of Atlantic mackerel and spiny dogfish (Table 3.2.2-1). Atlantic herring CPUE in the study area was greatest in 1979-1980 and has subsequently decreased. In contrast, the National Marine Fisheries Service (NMFS) Atlantic herring abundance index in the Gulf of Maine has risen steadily since 1984 and is presently near its highest recorded value (NOAA 1991b). CPUE of Atlantic whiting in the study area began to decrease in the early 1980s. Atlantic whiting stocks have fluctuated in the Gulf of Maine greatly in the 1980's and presently the stock is considered fully exploited (NOAA 1991b). Atlantic mackerel began to increase in CPUE in the study area beginning in 1987. Atlantic mackerel stocks have been increasing since 1981 in the Gulf of Maine (NOAA 1991b). Spiny dogfish CPUE began to increase in the study area beginning in 1983. Spiny dogfish abundance in the Gulf of Maine and Mid-Atlantic has increased steadily over at least the last ten years (NOAA 1991b).

Spatial Patterns in the Pelagic Fish Community

CPUE at gill net Stations G1, G2, and G3 showed similar fluctuations among years (Figure 3.2.2-1). CPUE was greatest in 1980 for all stations combined primarily due to large catches of Atlantic herring. Since 1980, annual CPUE at each gill net station has fluctuated within a narrow range. Species composition was similar among stations within the preoperational and operational periods (Table 3.2.2-2).

Atlantic herring dominated the catch during the preoperational period at Station G1, located approximately 2 km south of the discharge (Table 3.2.2-2). During 1990, the first operational year, Atlantic herring declined in CPUE and Atlantic mackerel was the dominant species followed by pollock. Species composition in 1991 was similar to the preoperational years, with Atlantic herring the dominant species; however, CPUE of Atlantic herring was smaller in 1991 than the preoperational years. During 1990, CPUE of spiny dogfish was greater than the preoperational period; although spiny dogfish CPUE returned to preoperational levels in 1991.

Station G2, located approximately 250 m from the discharge, showed a similar pattern in species composition to Station G1. Atlantic herring was the dominant species during the preoperational period. In 1990, Atlantic mackerel and pollock were the dominant species as Atlantic herring catches declined. In 1991 Atlantic herring was the dominant species again, followed by blueback herring and pollock. However, the rela-

TABLE 3.2.2-2. CATCH PER UNIT EFFORT (NUMBER-PER-24-HOUR SET, SURFACE AND BOTTOM) BY STATION FOR ABUNDANT SPECIES IN GILL NETS, ALL PREOPERATIONAL YEARS (1976-1989), 1990 AND 1991, DEPTHS COMBINED. SEABROOK OPERATIONAL REPORT, 1991.

	STATION								
	G1			G2			G3		
SPECIES	PREOP. YEARS	1990	1991	PREOP. YEARS	1990	1991	PREOP. YEARS	1990	1991
Atlantic herring	25.11	0.33	3.75	37.67	0.17	6.83	30.34	0.50	5.00
Atlantic whiting	3.42	0.50	0.08	3.77	0.92	0.00	5.19	0.42	0.42
Blueback herring	2.74	0.50	1.42	4.16	0.58	3.17	5.49	0.92	0.17
Atlantic mackerel	2.38	6.42	1.17	2.64	4.50	0.17	2.98	3.75	3.67
Pollock	2.46	0.92	0.92	3.07	2.00	2.92	3.25	6.25	1.25
Hake species[a]	0.99	0.17	0.00	0.75	0.25	0.00	0.47	0.00	0.00
Atlantic menhaden	1.00	0.67	0.00	0.64	0.08	0.17	1.10	0.00	0.33
Alewife	0.92	0.25	0.92	1.13	0.17	0.50	1.02	0.08	0.75
Rainbow smelt	0.52	0.00	0.25	0.51	0.25	0.00	0.69	0.00	0.08
Longhorn sculpin	0.43	0.08	0.17	0.44	0.00	0.08	0.18	0.17	0.00
Atlantic cod	0.47	0.08	0.00	0.39	0.08	0.00	0.62	0.00	0.00
Bluefish	0.35	0.08	0.50	0.35	0.00	2.33	0.20	0.50	0.83
Spiny dogfish	0.30	3.83	0.08	0.07	0.08	2.42	0.49	0.75	2.92
All other species	0.75	1.67	0.92	0.99	0.92	1.75	1.28	0.83	0.50

[a]includes red, white, and spotted hakes

tive abundance of Atlantic herring was less than during the preoperational period. CPUE of spiny dogfish increased steadily from the preoperational period to 1990 and 1991. Spiny dogfish and bluefish CPUE was greater in 1991 than the preoperational period.

Station G3, located approximately 2.5 km north of the discharge area, showed similar patterns in species composition as Stations G1 and G2. Atlantic herring was the dominant species during the preoperational period and CPUE of Atlantic herring declined greatly during 1990 when Atlantic mackerel and pollock were dominant. Atlantic herring were dominant again in 1991 followed by Atlantic mackerel and spiny dogfish.

Since 1980, mid-water gill nets have been set in addition to the surface and off-bottom nets during February, June and October to characterize the fish community that may be exposed to impingement (Table 3.2.2-3). In the preoperational period, Atlantic herring, Atlantic mackerel and Atlantic menhaden were dominant. In the operational period Atlantic mackerel and Atlantic whiting were dominant along with Atlantic menhaden in 1990 and Atlantic herring in 1991.

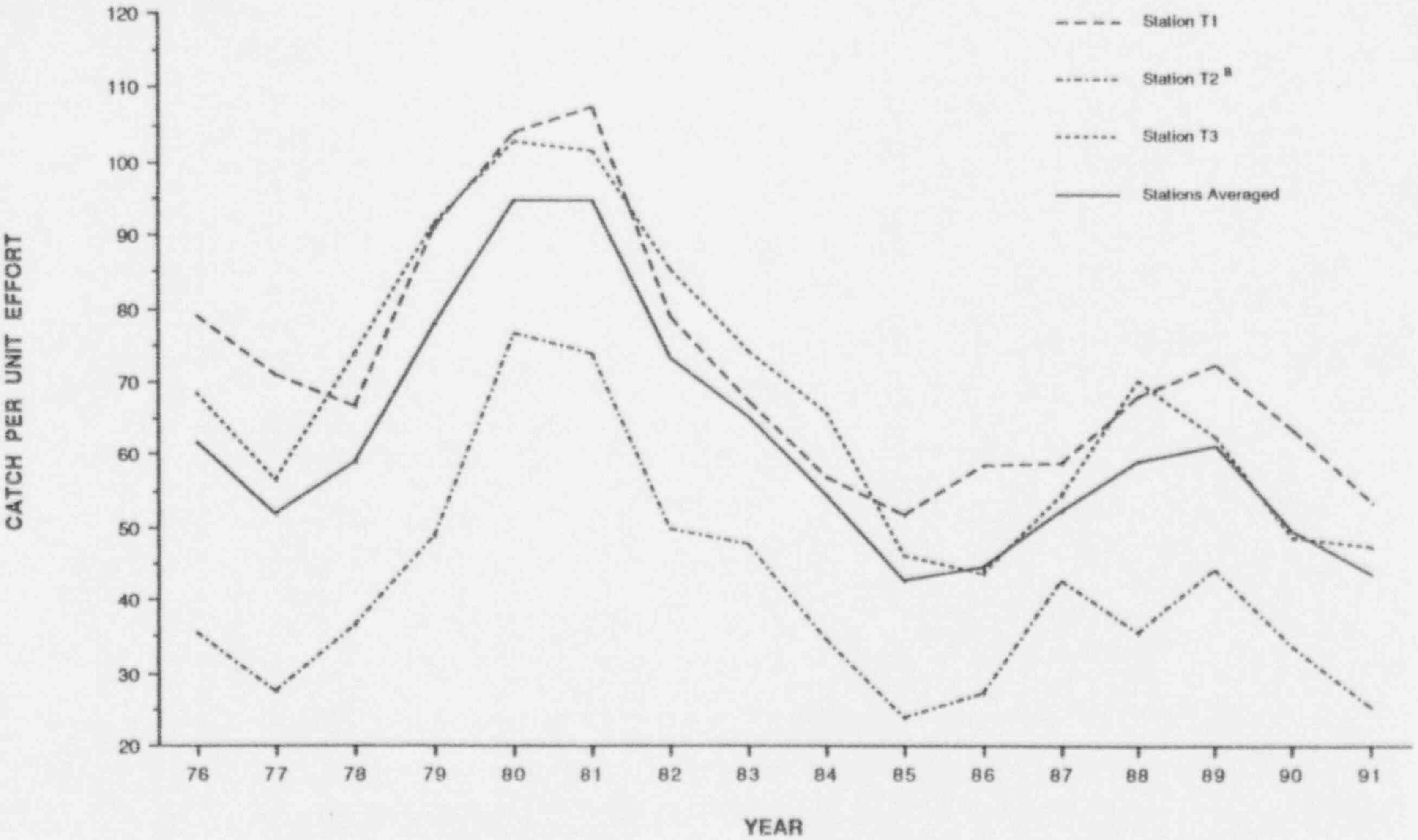
Inter-Annual Patterns in the Demersal Fish Community

Otter trawl CPUE (fish per ten minute tow) for all stations and species combined during the preoperational period peaked in 1981 at 95 fish/tow (Figure 3.2.2-2). CPUE increased to a second peak of 61 fish/tow in 1989, but has declined steadily since then. CPUE in 1991, the first full operational year, was significantly below the preoperational mean CPUE ($p<0.0001$). The de-

TABLE 3.2.2-3. CATCH PER UNIT EFFORT[a] FOR THE DOMINANT SPECIES CAPTURED IN MID-DEPTH GILL NETS OVER ALL STATIONS AND DATES, PREOPERATIONAL YEARS (1980 THROUGH 1989), 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES	PREOPERATIONAL YEARS	1990	1991
Atlantic herring	2.9	0.1	1.2
Atlantic whiting	0.5	0.4	0.3
Atlantic mackerel	0.9	2.2	1.4
Pollock	0.2	0.0	0.0
Alewife	0.1	0.2	0.0
Blueback herring	0.3	0.2	0.1
Atlantic menhaden	0.7	0.6	0.0
Rainbow smelt	<0.1	0.0	0.0

[a]number per one 24-hour set of one net (surface, mid-depth, or bottom)



[a] In most years sampling was curtailed at station T2 during September and October due to presence of lobster gear.

Figure 3.2.2-2. Annual total catch per unit effort (mean number per 10 minute tow) in otter trawls by station and mean of stations, 1976-1991. Seabrook Operational Report, 1991.

crease in CPUE in otter trawls corresponds with an overall decrease in demersal fish abundance observed in Georges Bank and the Gulf of Maine (NOAA 1991b). Otter trawl catches are primarily composed of demersal fish such as flounders and members of the cod family. The National Marine Fisheries Service (NMFS) index of abundance for these species (1963-1991) peaked in 1978 and subsequently declined to the lowest recorded values in 1987 and 1988 (NOAA 1991b). The index increased slightly since 1988 but still remains below historical levels. The decrease in CPUE observed in the demersal fish community in the study area is likely a reflection of a widespread decrease in abundance of demersal fish in the Gulf of Maine and Georges Bank.

Changes in the annual species composition of the demersal fish community were examined through multivariate analysis of variance of mean yearly CPUE of dominant trawl species. Species composition was significantly different between the preoperational and operational periods ($p<0.0001$). During all preoperational years combined, CPUE of yellowtail flounder was greatest followed by longhorn sculpin, hake sp., winter flounder and rainbow smelt (Table 3.2.2-4). Species composition appeared to change in 1986 and 1987 when CPUE of skate sp. and rainbow smelt increased. Prior to these years, the three most-abundant fish were either yellowtail flounder, hake sp., longhorn sculpin, Atlantic cod or winter flounder. Beginning in 1986, skate sp. were among the five most-abundant species every year. Similarly, from 1987 through 1990 rainbow smelt were among the three most-abundant species each year.

The change in species composition that occurred in the mid- 1980s and continues to the present appeared to be a reflection of a larger change in species composition in the Gulf of Maine and not due to operation of the Seabrook Station. According to NMFS "...catches of both skates and dogfish since 1986 have been the highest observed in the time series..." that began in 1968 (NOAA 1991b).

Spatial Patterns in the Demersal Fish Community

Mean annual CPUE was similar at the offshore stations (T1 and T3), while CPUE at the shallower nearshore station (T2) was much lower (Figure 3.2.2-2). Trawls are generally not fished at Station T2 during September and October due to high density of lobster gear in the Station area. Furthermore, the habitat at Station T2 is different from the other trawl stations. Station T2 is in shallower water with a bottom covered by large quantities of drift algae (NAI 1989b). In 1991 trawls were not fished at Station T2 during August through October. These months are typically a period of high abundance for demersal species and the lack of sampling could bias the results, causing a lower mean CPUE at Station T2.

Species composition, as measured by CPUE, was different among stations (Table 3.2.2-5). During both the preoperational and operational periods, yellow

TABLE 3.2.2-4. CATCH PER UNIT EFFORT (FISH PER TEN MINUTE TOW) BY YEAR, AND ALL PREOPERATIONAL YEARS COMBINED, FOR ABUNDANT SPECIES IN OTTER TRAWLS 1976 THROUGH 1991 AT STATIONS T1, T2[a] AND T3 COMBINED. SEABROOK OPERATIONAL REPORT, 1991.

	YEAR																
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	PREOP $\bar{x}$	1990	1991
Yellowtail flounder	21.99	14.94	13.46	26.16	30.90	26.71	15.94	12.63	9.73	11.60	8.70	9.76	11.59	18.37	16.90	13.10	6.59
Longhorn sculpin	3.06	3.95	5.31	9.90	13.89	15.64	11.83	15.96	14.67	9.37	4.11	4.90	6.20	6.39	8.98	7.53	5.86
Hake species[b]	11.21	15.40	11.33	6.69	7.50	12.84	14.14	6.19	7.04	6.23	6.10	5.15	5.01	4.79	8.67	2.43	4.81
Winter flounder	3.21	4.01	5.43	5.75	11.65	13.87	6.84	5.13	3.94	3.77	4.64	5.60	5.38	6.56	6.19	5.37	7.00
Rainbow smelt	8.16	1.70	5.85	5.29	3.62	5.51	3.77	5.60	3.50	0.57	1.46	7.78	10.78	11.44	5.43	5.46	3.00
Atlantic cod	2.46	1.35	8.38	10.62	8.05	5.79	5.05	5.39	2.92	1.08	1.45	2.90	5.04	0.85	4.50	0.39	0.77
Skate species[c]	1.60	2.37	1.32	1.35	1.44	1.93	2.51	4.45	4.10	4.59	6.41	5.52	5.56	5.21	3.34	5.36	5.46
Atlantic whiting	3.57	1.58	2.16	2.05	1.33	2.41	3.16	0.56	0.40	0.32	3.68	0.76	0.55	0.67	1.64	0.34	1.17
Ocean pout	1.37	2.09	2.01	1.67	1.22	2.06	1.82	2.19	2.78	1.16	1.24	1.53	1.05	0.93	1.66	1.40	0.64
Pollock	0.45	0.51	0.47	3.23	6.27	2.09	1.04	0.98	0.22	0.31	1.09	1.41	0.64	0.39	1.40	2.04	2.51
Windowpane	0.97	1.12	0.77	0.71	2.45	2.03	1.73	2.94	3.51	2.09	2.91	3.93	4.59	3.05	2.30	3.51	2.48
Haddock	1.77	1.25	0.01	2.57	3.96	0.28	1.72	0.49	0.11	0.02	0.15	0.03	0.02	0.00	0.92	0.00	0.00
Other species	1.71	1.65	2.28	1.81	2.32	3.56	3.55	2.67	1.19	1.41	2.51	2.96	2.60	2.33	2.32	2.45	3.27
All species	61.53	51.92	58.78	77.8	94.60	94.74	73.1	65.18	54.11	42.52	44.45	52.23	59.01	60.98	64.25	49.38	43.56

[a] In most years sampling was curtailed at Station T2 during September and October due to presence of lobster gear.
[b] includes red, white, and spotted hakes
[c] includes big, little, and thorny skates

TABLE 3.2.2-5. CATCH PER UNIT EFFORT BY STATION OF ABUNDANT SPECIES COLLECTED IN OTTER TRAWLS, ALL PREOPERATIONAL YEARS COMBINED (1976-1989), 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

	STATION								
	T1			T2[a]			T3		
SPECIES	PREOP. YEARS	1990	1991	PREOP. YEARS	1990	1991	PREOP. YEARS	1990	1991
Yellowtail flounder	27.92	21.81	11.73	6.32	4.84	1.31	14.67	10.92	5.42
Hake species[b]	11.01	4.48	5.83	4.10	1.26	2.69	10.12	1.29	5.38
Longhorn sculpin	8.33	6.71	5.54	2.07	1.82	0.89	15.36	12.88	9.90
Atlantic cod	3.74	0.35	0.46	2.11	0.26	0.19	7.25	0.52	1.50
Rainbow smelt	4.34	4.17	1.88	8.29	7.13	5.03	4.13	5.42	2.60
Winter flounder	4.64	4.92	8.60	11.30	8.00	6.00	3.50	3.75	6.15
Atlantic whiting	2.36	0.33	0.96	0.40	0.05	0.17	1.96	0.58	2.15
Windowpane	3.22	6.73	4.27	1.71	1.71	1.36	1.88	1.73	1.52
Skate species[c]	2.86	7.44	7.19	0.88	1.34	0.33	5.87	6.46	7.58
Pollock	1.03	3.04	3.27	2.88	2.87	3.72	0.53	0.40	0.83
Ocean pout	1.04	0.31	0.33	1.35	1.74	0.89	2.55	2.21	0.75
Haddock	0.75	0.00	0.00	0.10	0.00	0.00	1.79	0.00	0.00
Other species	2.54	2.79	3.27	2.42	2.42	2.81	2.01	2.10	3.54

[a] In most years sampling was curtailed at Station T2 during September and October due to presence of lobster gear.

[b] includes red, white, and spotted hakes

[c] includes big, little, and thorny skates

tail flounder was the dominant species at Station T1, winter flounder was dominant at Station T2 and longhorn sculpin was dominant at Station T3. These species and skate sp. were important members of the demersal fish communities at each station. Abundance of skate sp. was greater in 1990 and 1991 at all stations compared to the preoperational period.

Species composition during the preoperational period at Station T1, located approximately 4 km south of the discharge area, was dominated by yellowtail flounder, hake sp., and longhorn sculpin. Yellowtail flounder remained the dominant species during 1990 and 1991, although CPUE declined. In 1990, skate sp. ranked second in CPUE followed by windowpane. Species composition at Station T1 in 1991 was similar to 1990 except winter flounder ranked second in abundance followed by skate sp.

Winter flounder, followed by rainbow smelt and yellowtail flounder were the dominant species during the preoperational period and during 1990 at Station T2, located approximately 1 km south of the discharge. In 1991 winter flounder and rainbow smelt were again the dominant species, but skate sp. ranked third in abundance.

Longhorn sculpin was the dominant species during both the preoperational and operational periods at Station T3 located approximately 4 km north of the discharge area. During the operational period, CPUE of hake sp., yellowtail flounder and Atlantic cod declined while the importance of skate sp. increased.

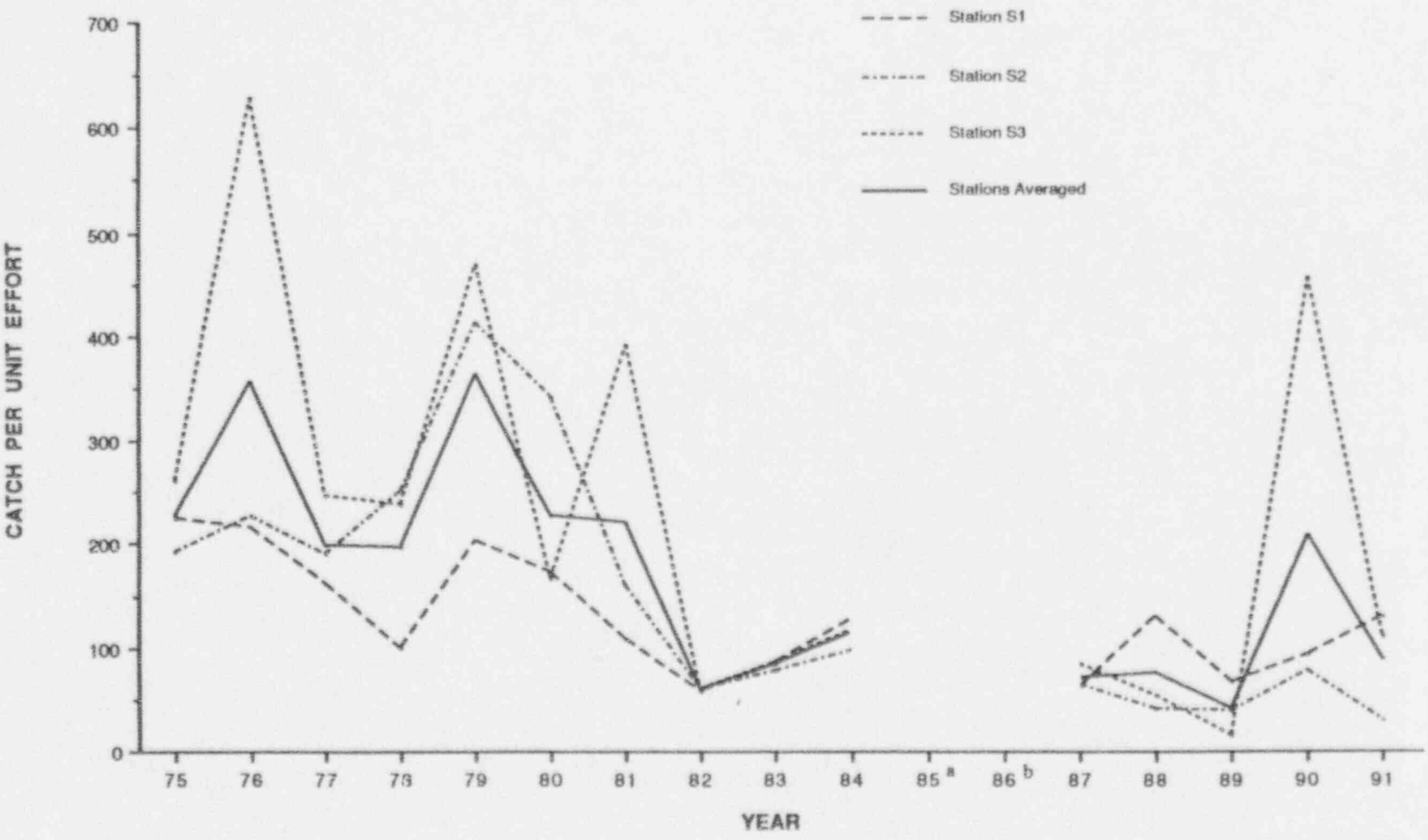
Inter-annual Patterns in the Estuarine Fish Community

Average CPUE for all seine stations combined within the Hampton/Seabrook estuary ranged from 41 to 362 fish/haul (Figure 3.2.2-3). Changes in the annual species composition of the estuarine fish community were examined through multivariate analysis of mean yearly CPUE of dominant estuarine species. Species composition was significantly different between the preoperational and operational periods ($p<0.002$).

The three most abundant species each year were either Atlantic silverside, *Fundulus* sp., American sand lance, or rainbow smelt. Variations in species composition between the preoperational and operational periods were a result of changes in CPUE of Atlantic silverside and rainbow smelt. Seine CPUE was generally lower for the period 1982 through 1991 (41 to 114 fish/haul) than 1975 through 1981 (200 to 362 fish/haul), primarily due to substantial decreases in Atlantic silverside abundance beginning in 1982 (Table 3.2.2-6). Rainbow smelt CPUE also strongly influenced yearly total CPUE. During peak years of CPUE, such as 1976, 1979 and 1990, rainbow smelt CPUE was above average.

Spatial Patterns in the Estuarine Fish Community

Mean annual CPUE during the preoperational period was either highest at Station S3 (near the mouth of the estuary) or there were no large differences among stations (Figure 3.2.2-3). In 1990, CPUE was highest at Station S3 due



[a] No seine samples collected in 1985.

[b] Seine samples not collected in April through June.

Figure 3.2.2-3. Annual total catch per unit effort (mean number per 10 minute tow) in **beach seines** by station and mean of stations, 1976-1991. Seabrook Operational Report, 1991.

TABLE 3.2.2-6. CATCH PER UNIT EFFORT (NUMBER PER HAUL) BY YEAR AND ALL PREOPERATIONAL YEARS COMBINED FOR THE TEN MOST ABUNDANT SPECIES COLLECTED IN BEACH SEINES FROM 1976 THROUGH 1991 (EXCLUDING 1985 AND 1986) AT STATIONS S1, S2 AND S3 COMBINED. SEABROOK OPERATIONAL REPORT, 1991.

	YEAR														
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1987	1988	1989	PREOP $\bar{x}$	1990	1991
Atlantic silverside	261.35	108.95	146.84	218.00	153.22	193.82	34.49	39.44	54.42	39.48	39.19	22.35	76.63	86.40	66.25
Fundulus species[a]	55.04	45.58	9.48	9.62	8.55	3.74	6.07	6.46	7.99	2.35	2.73	9.85	9.44	19.77	11.10
Pollock	3.06	0.02	2.28	28.31	46.85	0.10	3.96	4.16	1.51	1.08	0.04	0.00	5.05	0.06	0.31
Alewife	0.17	2.60	0.06	65.33	0.05	0.07	0.88	0.01	0.69	0.15	0.00	0. 00	3.89	0.00	0.04
Rainbow smelt	14.71	9.40	0.11	16.71	0.06	4.67	2.78	3.40	9.77	5.48	0.15	0.67	3.66	73.40	0.94
American sand lance	8.85	17.03	14.77	1.64	0.02	0.98	4.56	1.83	0.21	0.00	1.67	0.19	2.85	8.13	2.90
Atlantic herring	0.09	0.43	10.65	3.32	10.08	9.66	0.07	5.69	9.68	1.27	0.06	0.63	2.84	0.17	1.17
Ninespine stickleback	5.34	7.64	2.12	0.30	0.29	1.41	1.31	5.78	18.52	15.50	27.73	1.56	4.32	16.98	1.19
Winter flounder	2.09	3.89	3.35	5.86	6.21	3.23	3.77	2.47	3.91	1.44	1.04	1.85	2.19	1.12	1.46
Blueback herring	0.18	1.43	1.65	4.13	0.18	1.08	0.06	11.48	0.19	0.00	0.38	0.00	2.15	0.46	2.63
Other species	6.01	2.80	4.75	8.77	1.35	0.85	2.03	3.32	7.19	3.96	1.79	3.48	2.46	1.75	1.65

[a]includes mummichogs and striped killifish

to high catches of rainbow smelt. In 1991, CPUE was similar between Stations S3 and S1, and lowest at Station S2.

During both the preoperational and operational periods, Atlantic silverside was the dominant fish at Station S1 followed by either *Fundulus* sp. or American sand lance (Table 3.2.2-7). This pattern of species composition was generally followed at Station S2, with the exception of 1990 when *Fundulus* sp. was dominant. Station S3, located in more saline waters, had a slightly different species composition. During the preoperational period, Atlantic silverside, rainbow smelt and ninespine stickleback were the dominant species. In 1990, rainbow smelt were dominant followed by Atlantic silverside and ninespine stickleback. The year 1991 was more similar to the preoperational period at Station S3. Atlantic silverside were again dominant followed by Atlantic herring and winter flounder.

3.2.2.2 Selected Species

General

Seasonal, inter-annual, and spatial variations in abundance were analyzed for nine selected species. Selection of species was based on two criteria: (1) high abundance in at least one life stage and gear type; (2) importance in local commercial or sport fisheries. The nine selected species and their primary collection methods were:

Species	Gear Type
Atlantic herring	gill nets
Atlantic mackerel	gill nets
Pollock	gill nets
Atlantic cod	otter trawl
Hakes (red, white, spotted)	otter trawl
Yellowtail flounder	otter trawl
Winter flounder	otter trawl and beach seine
Rainbow smelt	otter trawl and beach seine
Atlantic silverside	beach seine

Geometric mean CPUE for the preoperational period with 95% confidence limits and geometric mean CPUE for 1990 and 1991 are presented in Table 3.2.2-8 for each selected species.

Analysis of variance (ANOVA) was used to statistically test for temporal and spatial differences in CPUE for the selected species. Periods with historically high coefficients of variation and periods when the selected species were historically not captured were excluded from the analysis. This method increased the power of the model to detect significant differences among years by mirimizing within-year variation. The year 1990 was classified as either preoperational, operational or was excluded from the analysis depending on the selection of months for analysis.

TABLE 3.2.2-7. MEAN CATCH PER UNIT EFFORT (NUMBER PER HAUL) BY STATION OF ABUNDANT SPECIES COLLECTED IN BEACH SEINES, ALL PREOPERATIONAL YEARS COMBINED (1976-1984, 1987-1989), 1990 AND 1991, APRIL THROUGH NOVEMBER. SEABROOK OPERATIONAL REPORT, 1991.

	STATION								
	S1			S2			S3		
SPECIES	PREOP. YEARS	1990	1991	PREOP. YEARS	1990	1991	PREOP. YEARS	1990	1991
Atlantic silverside	86.80	61.50	72.88	97.61	20.69	27.06	177.38	177.00	98.81
Fundulus species[a]	18.09	4.62	33.31	26.42	54.50	0.00	0.07	0.19	0.00
American sand lance	4.37	22.94	8.62	4.80	0.12	0.00	4.27	1.31	0.06
Blueback herring	7.86	1.06	7.75	0.51	0.06	0.00	1.78	0.25	0.13
Ninespine stickleback	6.66	1.50	3.38	3.98	0.62	0.06	9.75	48.81	0.13
Atlantic herring	2.01	0.19	0.38	9.20	0.00	0.19	2.18	0.31	2.94
Winter flounder	1.95	0.31	1.25	2.18	1.31	0.25	6.23	1.75	2.88
Pollock	1.57	0.00	0.19	10.93	0.00	0.06	11.33	0.19	0.69
Alewife	0.82	0.00	0.12	17.07	0.00	0.00	0.49	0.00	0.00
Rainbow smelt	0.87	0.38	0.19	2.26	0.19	1.31	14.15	219.63	1.31
All other species	2.80	0.69	0.50	3.09	1.19	0.69	5.72	3.38	3.75

[a]includes mummichog and striped killifish

TABLE 3.2.2-8. GEOMETRIC MEAN CATCH PER UNIT EFFORT[a] FOR SELECTED FINFISH SPECIES FOR THE PREOPERATIONAL PERIOD (1976-1989), THEIR CONFIDENCE LIMITS, AND 1990 AND 1991 MEAN CATCHES. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES	STATION	LOWER 95% CL	PREOPERATIONAL PERIOD $\bar{x}$	UPPER 95% CL	1990 $\bar{x}$	1991 $\bar{x}$
Atlantic herring	G1-G3	0.96	1.03	1.11	0.05	0.39
Pollock	G1-G3	0.19	0.21	0.23	0.17	0.20
Atlantic mackerel	G1-G3	0.19	0.21	0.23	0.47	0.12
Atlantic cod	T1	1.80	2.00	2.23	0.20	0.26
	T2	0.61	0.72	0.84	0.17	0.14
	T3	2.87	3.21	3.59	0.33	0.76
	T1-T3	1.74	1.87	2.01	0.23	0.39
Hake species	T1	3.66	4.18	4.76	2.29	2.91
	T2	1.41	1.63	1.88	0.78	1.07
	T3	3.14	3.60	4.11	0.73	2.36
	T1-T3	2.83	3.07	3.32	1.20	2.11
Yellowtail flounder	T1	18.82	20.15	21.56	16.42	7.51
	T2	2.63	2.97	3.35	2.50	0.71
	T3	9.73	10.43	11.17	7.81	3.56
	T1-T3	8.90	9.42	9.97	7.66	3.38
Winter flounder	T1	2.87	3.12	3.39	3.47	4.75
	T2	5.69	6.29	6.95	4.54	3.36
	T3	2.01	2.21	2.41	2.26	3.29
	T1-T3	3.27	3.46	3.65	3.24	3.79
Rainbow smelt	T1	0.87	1.05	1.25	1.09	0.55
	T2	1.67	1.99	2.34	2.40	1.56
	T3	0.62	0.76	0.91	0.87	0.87
	T1-T3	1.05	1.17	1.29	1.31	0.90
Atlantic silverside	S1-S3	7.07	8.28	9.67	5.33	5.57

[a]OTTER TRAWL (T) mean catch per two 10-minute tows at each station and mean of all stations
GILL NET (G) mean catch per 24 hour set of either level (surface or bottom), a mean for all stations
SEINES (S) mean catch per haul, a mean for all stations

Pelagic Species

Atlantic Herring

Atlantic herring monthly mean CPUE during the preoperational period was highest during the spring and fall (Figure 3.2.2-4). In 1990, catches were much lower than the preoperational mean for all months except July. Catches of Atlantic herring in 1991 were greater than 1990, but lower than the preoperational period, except for the months of March, May and June.

CPUE in the selected months of the preoperational period was significantly greater than the operational period and there were no significant differences among stations (Table 3.2.2-9). The significant difference between the preoperational and operational periods is primarily due to the large catches of Atlantic herring in 1978 through 1980. The Preop-Op X Station interaction term was not significant. The significant differences in CPUE observed between the preoperational and operational periods occurred at both nearfield and farfield stations.

Pollock

Monthly mean CPUE of pollock in gill nets was typically highest during the late spring and late fall, and lowest during the winter (Figure 3.2.2-4). The high catches during the spring and late fall were a result of annual onshore and offshore movements. In 1990, pollock CPUE was greater than the preoperational mean for the months June through August. Similarly, pollock CPUE in 1991 was greater than the preoperational mean for the months of June through September.

There were no significant differences in CPUE during the selected months between the preoperational and operational periods and no significant differences among stations (Table 3.2.2-9).

Atlantic Mackerel

Atlantic mackerel monthly mean CPUE in gill nets was historically greatest in June through November (Figure 3.2.2-4). In 1990, CPUE was greater than the preoperational mean in May through July, and September and October. Atlantic mackerel CPUE in 1991 was lower than the preoperational mean for every month except October.

There were no significant differences in CPUE during the selected months between the preoperational and operational periods (Table 3.2.2-9). However, there were significant differences in CPUE among stations. Significantly more Atlantic mackerel were captured at Station G3 located north of the intake than at Station G1 located south of the intake. The Preop-Op X Station interaction term was not significant, indicating a consistent relationship among stations regardless of operational status.

Demersal Species

Atlantic Cod

Monthly mean Atlantic cod CPUE was typically highest in the spring and

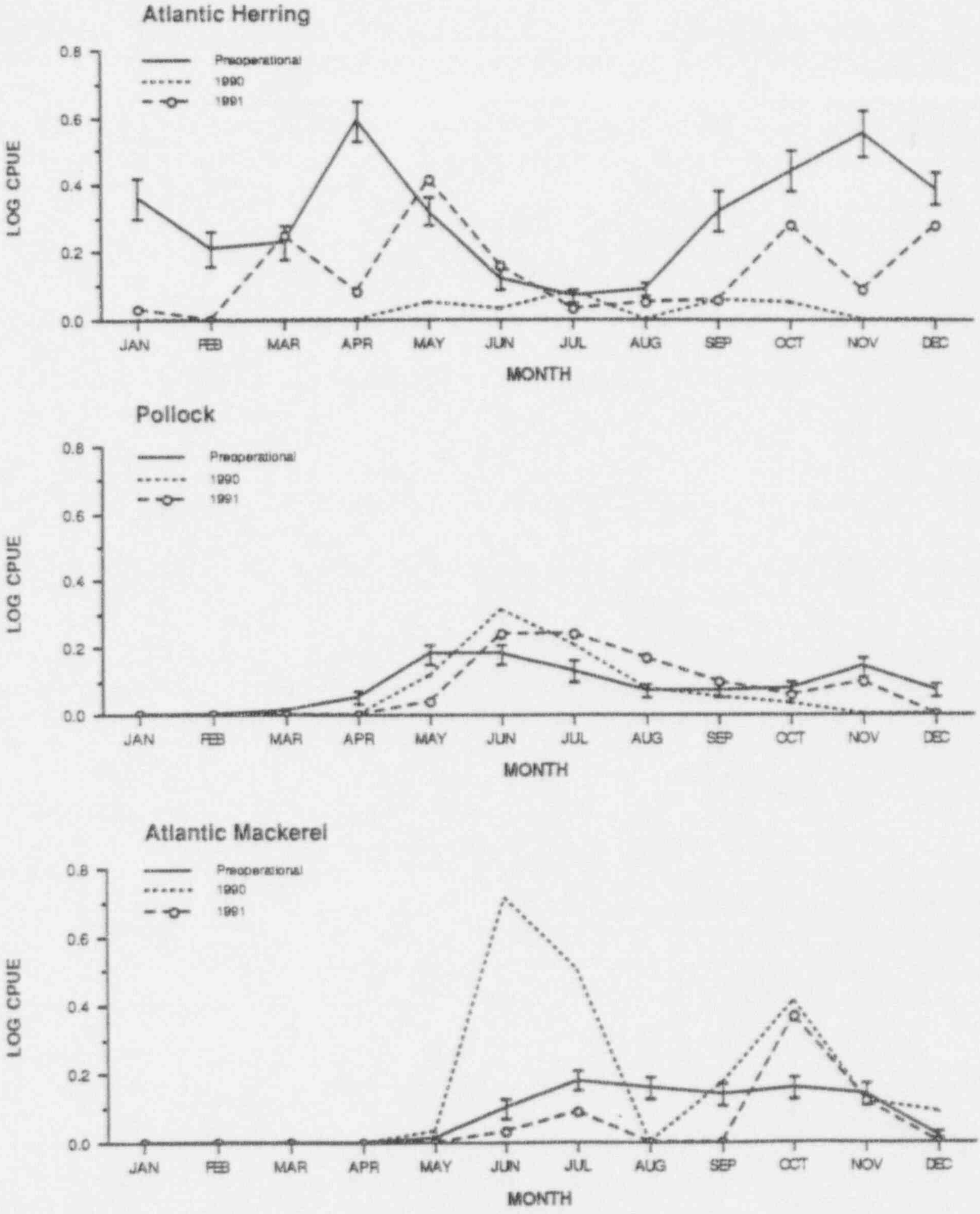


Figure 3.2.2-4. Log (x+1) catch per unit effort (one 24-hr. set) for **Atlantic herring, pollock** and **Atlantic mackerel**; monthly means and 95% confidence intervals over all preoperational years (1976-1989) and monthly means for 1990 and 1991 averaged over gill net Stations G1, G2 and G3. Seabrook Operational Report, 1991.

TABLE 3.2.2-9. RESULTS OF ANALYSIS OF VARIANCE COMPARING ABUNDANCES OF SELECTED SPECIES OF PELAGIC FINFISH AT ALL GILL NET STATIONS DURING PREOPERATIONAL AND OPERATIONAL PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES (MONTHS USED)	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Atlantic herring[c] (Jan-May & Aug-Dec)	Preop-Op	1	1.05	10.34**	Preop>Op
	Year (Preop-Op)	13	27.53	20.84***	
	Month (Year)	134	77.97	5.73***	
	Station	2	0.03	0.13 NS	
	Preop-Op x Station	2	0.02	0.09 NS	
	Error	501	50.91		
Pollock[d] (May-Jul)	Preop-Op	1	<0.01	0.04 NS	
	Year (Preop-Op)	14	2.76	3.76***	
	Month (Year)	32	1.85	1.10 NS	
	Station	2	0.25	2.38 NS	
	Preop-Op x Station	2	0.08	0.75 NS	
	Error	155	8.11		
Atlantic mackerel[c] (Jul-Nov)	Preop-Op	1	0.03	0.89 NS	
	Year (Preop-Op)	13	2.32	4.86***	
	Month (Year)	60	7.70	3.50***	
	Station	2	0.27	3.64*	G3 G2 G1
	Preop-Op x Station	2	0.18	2.45 NS	
	Error	251	9.20		

[a]Preop-Op = Preoperational period vs. operational period
Year (Preop-Op) = Year nested within preoperational and operational peroiods
Month (Year) = Month nested within year

[b]NS = not significant (p>0.05)
* = significant (0.05≥p>0.001)
** = highly significant (0.01≥p>0.001)
*** = very highly significant (p≤0.001)

[c]1990 data deleted

[d]1990 classified preoperational

fall, and lowest during the summer (Figure 3.2.2-5). Atlantic cod migrate offshore in the summer as water temperatures increase (Bigelow and Schroeder 1953). Monthly mean CPUE in 1990 and 1991 was generally lower than monthly mean CPUE mean for the preoperational period at all stations.

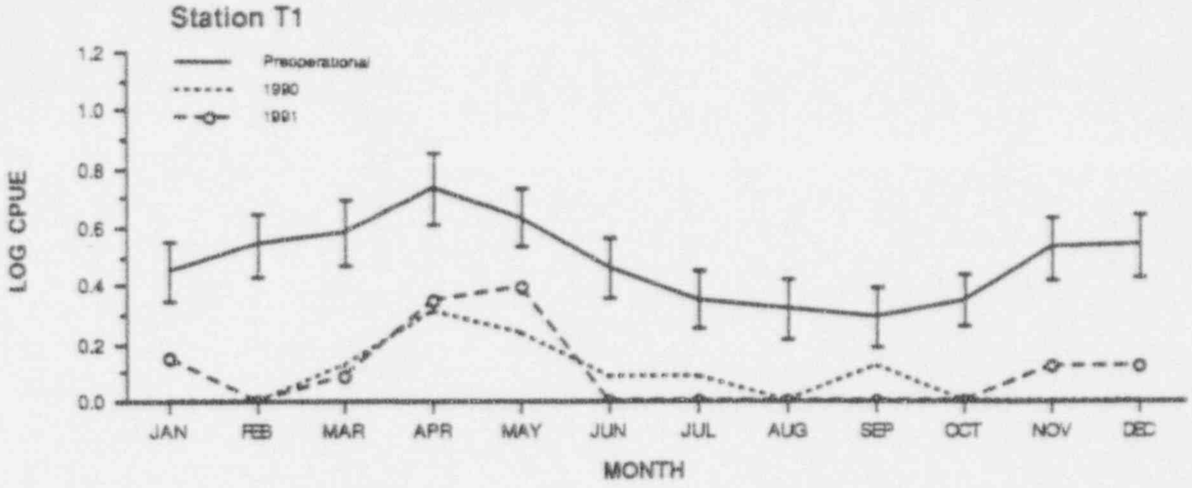
CPUE was significantly greater during the selected months in the preoperational period primarily due to catches in 1978 that were greater than all other years (Table 3.2.2-10). CPUE was lowest in the operational years of 1990 and 1991. There were also significant differences among stations, with the largest catches occurring at Station T3. The Preop-Op X Station term was not significant, which indicates that the differences among stations were consistent between the preoperational and operational periods. These differences were probably due to differences in habitat among the stations that occurred during both the preoperational and operational periods. The cause of the significant differences between the preoperational and operational periods operated on a larger geographic scale than the study area because all stations were affected similarly. The differences between the preoperational and operational periods may be due to the overexploitation of commercial stocks in the Gulf of Maine and Georges Bank. Although the spawning stock biomass and commercial landing have risen since 1987, the Gulf of Maine and Georges Bank Atlantic cod stocks are considered overexploited (NOAA 1991b).

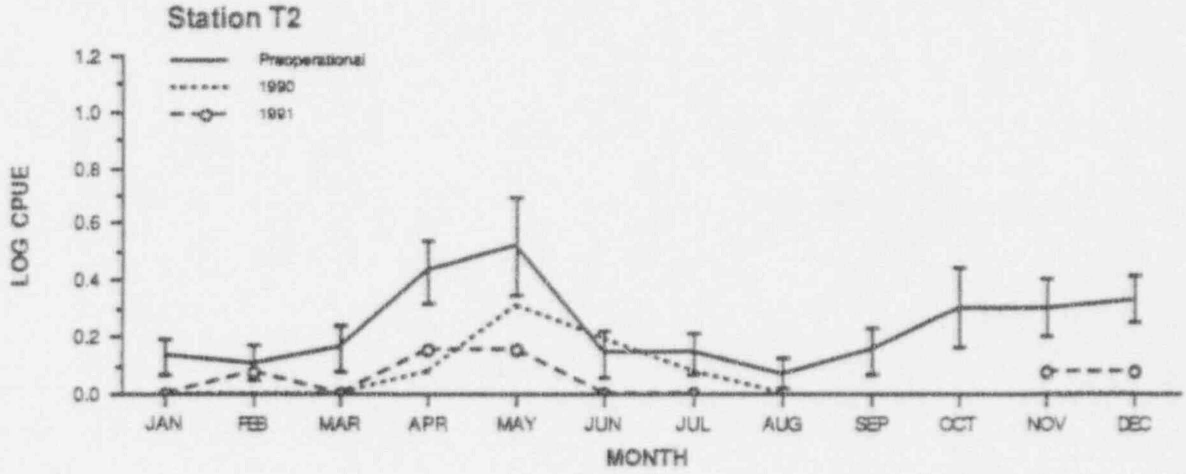
CPUE of young-of-the-year (YOY) Atlantic cod was significantly higher in the preoperational period (Table 3.2.2-11). The 1987 year class of Atlantic cod appeared to be exceptionally strong as CPUE of YOY Atlantic cod in 1987 was significantly greater than all other years. The observations of YOY Atlantic cod abundance in the study area agree with the findings from the Gulf of Maine. The 1986 and 1987 year classes were exceptionally strong, comprising about 80% of the 1990 population by number and 70% by weight (NOAA 1991b). The Preop-Op X Station interaction term was not significant, which indicates that the significant differences among station occurred during both the preoperational and operational periods.

Hakes

Monthly mean CPUE of hakes was typically greatest in May through November (Figure 3.2.2-6). Hake CPUE in 1990 and 1991 was generally lower than the preoperational period, with the exception of January through April CPUE in 1991.

There were significant differences in CPUE during the selected months between the preoperational and operational periods (Table 3.2.2-10). The highest hake CPUE occurred in the preoperational period during the years 1976, 1977 and 1982. The lowest hake CPUE was in 1991, the only year in the operational period. With a few exceptions, hake CPUE prior to 1986 was greater than hake CPUE after 1986. The index of red hake abundance calculated by NMFS for the Gulf of Maine and northern Georges Bank has increased steadily since 1986. Red hake stocks in these areas are considered under-exploited (NOAA 1991b). The white hake





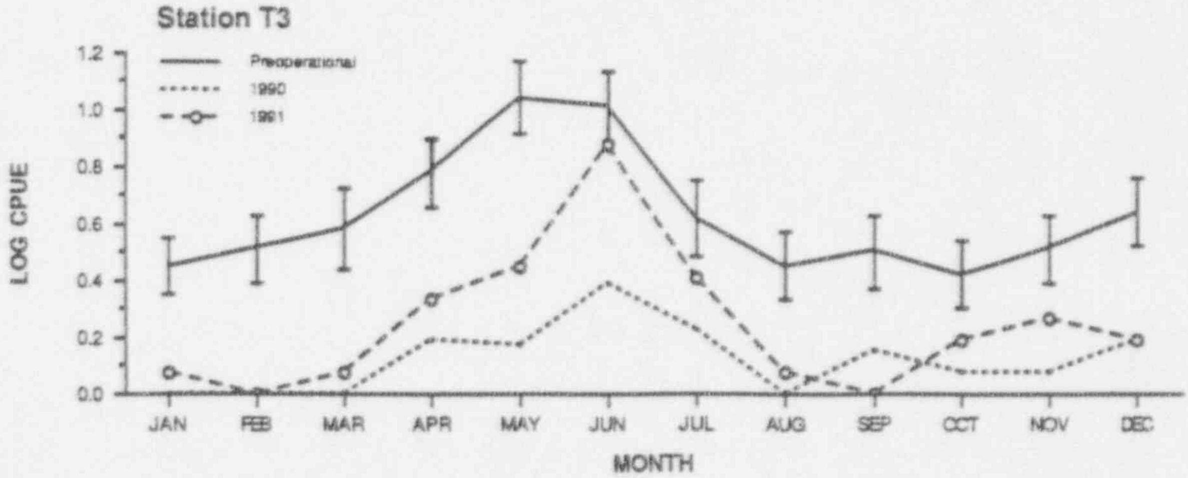


Figure 3.2.2-5. Log (x+1) catch per unit effort (one 24-hr. set) for **Atlantic cod**; monthly means and 95% confidence intervals over all preoperational years (1976-1989) and monthly means for 1990 and 1991 at otter trawl Stations T1, T2 and T3. Seabrook Operational Report, 1991.

TABLE 3.2.2-10. RESULTS OF ANALYSIS OF VARIANCE COMPARING ABUNDANCES OF SELECTED SPECIES OF DEMERSAL FINFISH AT ALL TRAWL STATIONS DURING PREOPERATIONAL AND OPERATIONAL PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES (MONTHS USED)	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Atlantic cod[c] (Oct-Dec)	Preop-Op	1	2.92	66.38***	Preop>Op
	Year (Preop-Op)	14	8.85	14.35***	
	Month (Year)	32	3.69	2.62***	
	Station	2	0.61	6.95*	T3>T1>T2
	Preop-Op x Station	2	0.11	1.30 NS	
	Error	130	5.73		
Hakes[d] (Jun-Oct)	Preop-Op	1	1.64	19.31***	Preop>Op
	Year (Preop-Op)	13	7.91	7.18***	
	Month (Year)	60	7.21	1.42*	
	Station	2	0.91	5.38**	T1>T3>T2
	Preop-Op x Station	2	0.17	1.03 NS	
	Error	193	16.36		
Yellowtail flounder[c] (Sep-Nov)	Preop-Op	1	0.24	4.36*	Preop>Op
	Year (Preop-Op)	14	5.11	6.73***	
	Month (Year)	32	2.03	1.17 NS	
	Station	2	3.43	31.60***	T1>T3>T2
	Preop-Op x Station	2	0.11	1.04 NS	
	Error	118	6.40		
Winter flounder[e] (Aug-Nov)	Preop-Op	1	0.18	3.42 NS	
	Year (Preop-Op)	14	3.46	4.78***	
	Month (Year)	48	5.88	2.37***	
	Station	2	0.42	4.09*	T2 T1 T3
	Preop-Op x Station	2	0.04	0.41 NS	
	Error	163	8.41		

(continued)

TABLE 3.2.2-10. (Continued)

SPECIES (MONTHS USED)	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Rainbow smelt[e] (Jan-Feb)	Preop-Op	1	0.83	5.44*	Preop>Op
	Year (Preop-Op)	14	10.72	5.02***	
	Month (Year)	16	1.26	0.52 NS	
	Station	2	0.03	0.11 NS	
	Preop-Op x Station	2	0.12	0.39 NS	
	Error	90	13.74		

[a]Station: T1 vs. T2 vs. T3 regardless of year or month; Preop-Op = Preoperational period vs. operational period; Year (Preop-Op) = Year nested within preoperational and operational periods, regardless of area; Month (Year) = Month nested within year, regardless of station; Preop-Op x Station = interaction of main effects

[b] NS = not significant ($p>0.05$)
 * = significant ($0.05\geq p>0.001$)
 ** = highly significant ($0.01\geq p>0.001$)
 *** = very highly significant ($p\leq 0.001$)

[c]1990 classified operational

[d]1990 data deleted

[e]1990 classified preoperational

TABLE 3.2.2-11. RESULTS OF ANALYSIS OF VARIANCE COMPARING ABUNDANCES OF SELECTED YOUNG-OF-THE-YEAR SPECIES OF DEMERSAL FINFISH AT ALL TRAWL STATIONS DURING PREOPERATIONAL AND OPERATIONAL PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES (MONTHS USED)	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Atlantic cod[c]	Preop-Op	1	0.15	10.17**	Preop>Op
(Aug-Dec)	Year (Preop-Op)	15	2.70	12.05***	
	Month (Year)	68	2.14	2.11***	
	Station	2	0.02	0.81 NS	
	Preop-Op x Station	2	<0.01	0.11 NS	
	Error	223	3.33		
Hake[d]	Preop-Op	1	0.36	5.93*	Op>Preop
(Apr-Jul)	Year (Preop-Op)	15	8.57	9.54***	
	Month (Year)	48	11.95	4.16***	
	Station	2	0.95	7.92**	T2 T1 T3
	Preop-Op x Station	2	0.08	0.66 NS	
	Error	189	11.32		
Rainbow smelt[d]	Preop-Op	1	0.05	0.35 NS	
(Jan-Apr)	Year (Preop-Op)	14	18.38	10.06***	
	Month (Year)	48	25.78	4.12***	
	Station	2	0.44	1.67 NS	
	Preop-Op x Station	2	0.08	0.29 NS	
	Error	181	23.62		
Yellowtail flounder[d]	Preop-Op	1	5.46	58.15***	Preop>Op
(Jan-Jul)	Year (Preop-Op)	15	12.12	8.60***	
	Month (Year)	96	14.22	1.58**	
	Station	2	6.45	34.37***	T1>T3>T2
	Preop-Op x Station	2	0.03	0.17 NS	
	Error	327	30.70		

(continued)

TABLE 3.2.2-11. (Continued)

SPECIES (MONTHS USED)	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Winter flounder[d] (Jan-Apr)	Preop-Op	1	0.04	0.56 NS	
	Year (Preop-Op)	14	5.10	5.10***	
	Month (Year)	48	4.69	1.37 NS	
	Station	2	3.18	22.26***	T2>T1>T3
	Preop-Op x Station	2	0.05	0.36 NS	
	Error	181	12.94		

[a]Station: T1 vs. T2 vs. T3 regardless of year or month; Preop-Op = Preoperational period vs. operational period; Year (Preop-Op) = Year nested within preoperational and operational periods, regardless of area; Month (Year) = Month nested within year, regardless of station; Preop-Op x Station = Interaction of main effects

[b] NS = not significant ($p>0.05$)
* = significant ($0.05\geq p>0.001$)
** = highly significant ($0.01\geq p>0.001$)
*** = very highly significant ($p\leq 0.001$)

[c]1990 classified operational

[d]1990 classified preoperational

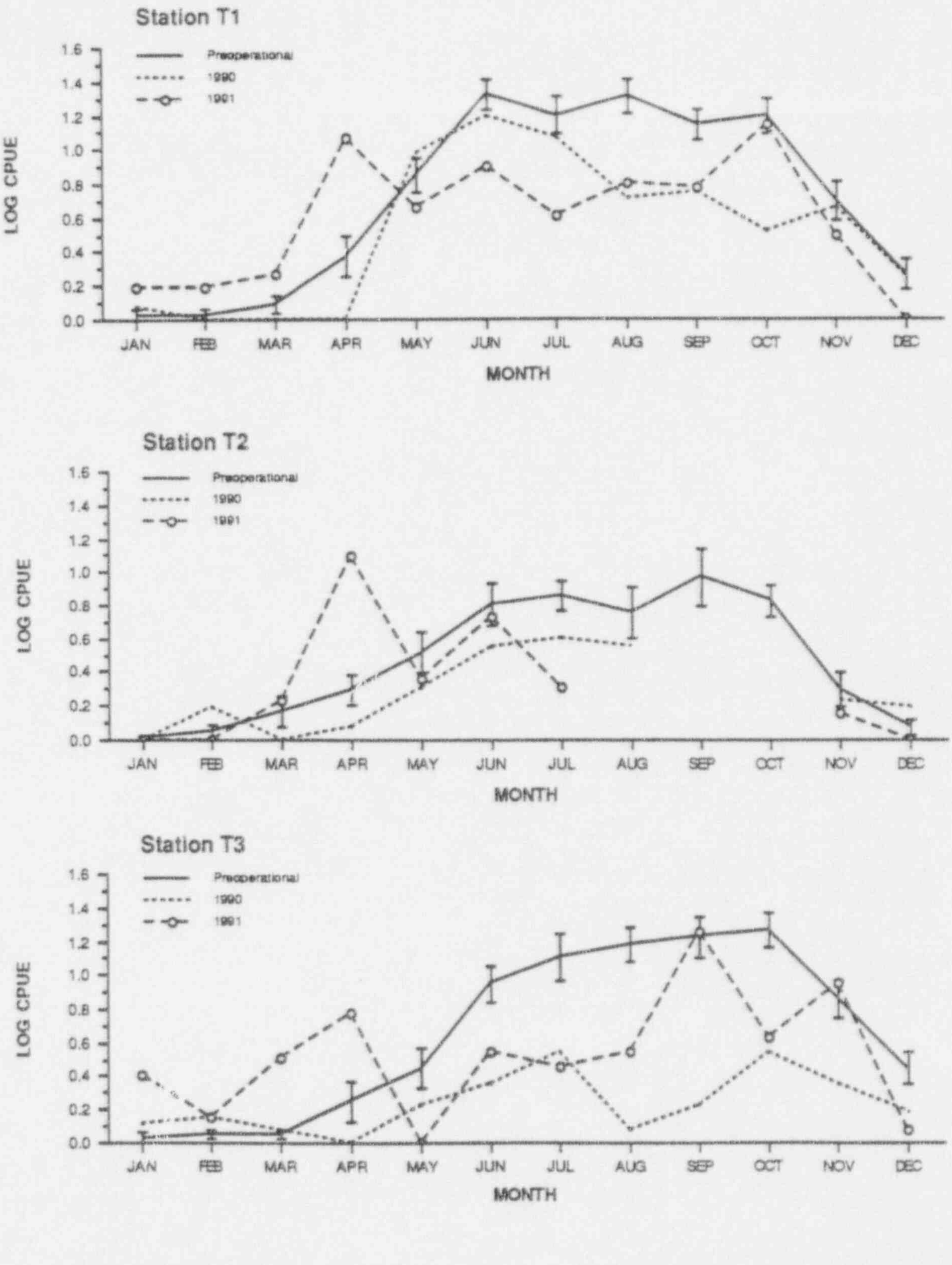


Figure 3.2.2-6. Log (x+1) catch per unit effort (one 24-hr. set) for hakes; monthly means and 95% confidence intervals over all preoperational years (1976-1989) and monthly means for 1990 and 1991 at otter trawl Stations T1, T2 and T3. Seabrook Operational Report, 1991.

abundance index has fluctuated without any consistent long-term trends since the early 1970s. White hake stocks in the Gulf of Maine and Georges Bank are considered fully exploited (NOAA 1991b). The study area and the Gulf of Maine-Georges Bank areas apparently exhibited differing trends in the long term abundance of hakes.

There were also significant differences in hake CPUE among stations (Table 3.2.2-10). CPUE at Station T1 was significantly greater than CPUE at the other stations, probably due to differences in habitat. The Preop-Op X Station interaction term was not significant. Although CPUE was significantly different among stations, the difference was consistent between the preoperational and operational periods and is likely attributable to differences in habitat.

In contrast to the analysis of total hake CPUE, young-of-the-year (YOY) hake CPUE was significantly greater during the operational period. Spatial differences were also evident. CPUE of YOY hake was significantly lower at Station T3 (Table 3.2.2-11). However, the Preop-Op X Station interaction term was not significant, indicating spatial relationships were consistent between the preoperational and operational periods.

Yellowtail Flounder

Monthly mean CPUE of yellowtail flounder was generally greater during the preoperational period than 1990 and 1991, with the major exception of Station T1, where CPUE during May through October of 1990 was greater (Figure 3.2.2-7). CPUE at Station T2 was generally lower than other stations during both the preoperational and operational periods.

CPUE of yellowtail flounder during the selected months was significantly greater during the preoperational period (Table 3.2.2-10). CPUE was highest in 1980 and 1976 in the preoperational period. CPUE in 1991 was the lowest recorded during the study. There were also significant differences in CPUE among stations. CPUE at Station T1 was significantly greater than CPUE at Station T3, which was significantly greater than CPUE at Station T2. The Preop-Op X Station interaction term was not significant, indicating that the reduced CPUE in the operational period occurred at all stations, and that spatial differences were maintained during both the preoperational and operational periods. The yellowtail flounder autumn survey index for Georges Bank is in agreement with CPUE data from the study area. The index was high in 1980 and has declined steadily since then (NOAA 1991b). The decrease in CPUE in the study area appears to be a component of a larger regional decline in yellowtail flounder abundance.

CPUE of YOY yellowtail flounder followed the same pattern as total yellowtail flounder CPUE (Table 3.2.2 11). CPUE of YOY yellowtail flounder during the preoperational period was significantly greater than the operational period, and CPUE at Station T1 was significantly greater than the other sta-

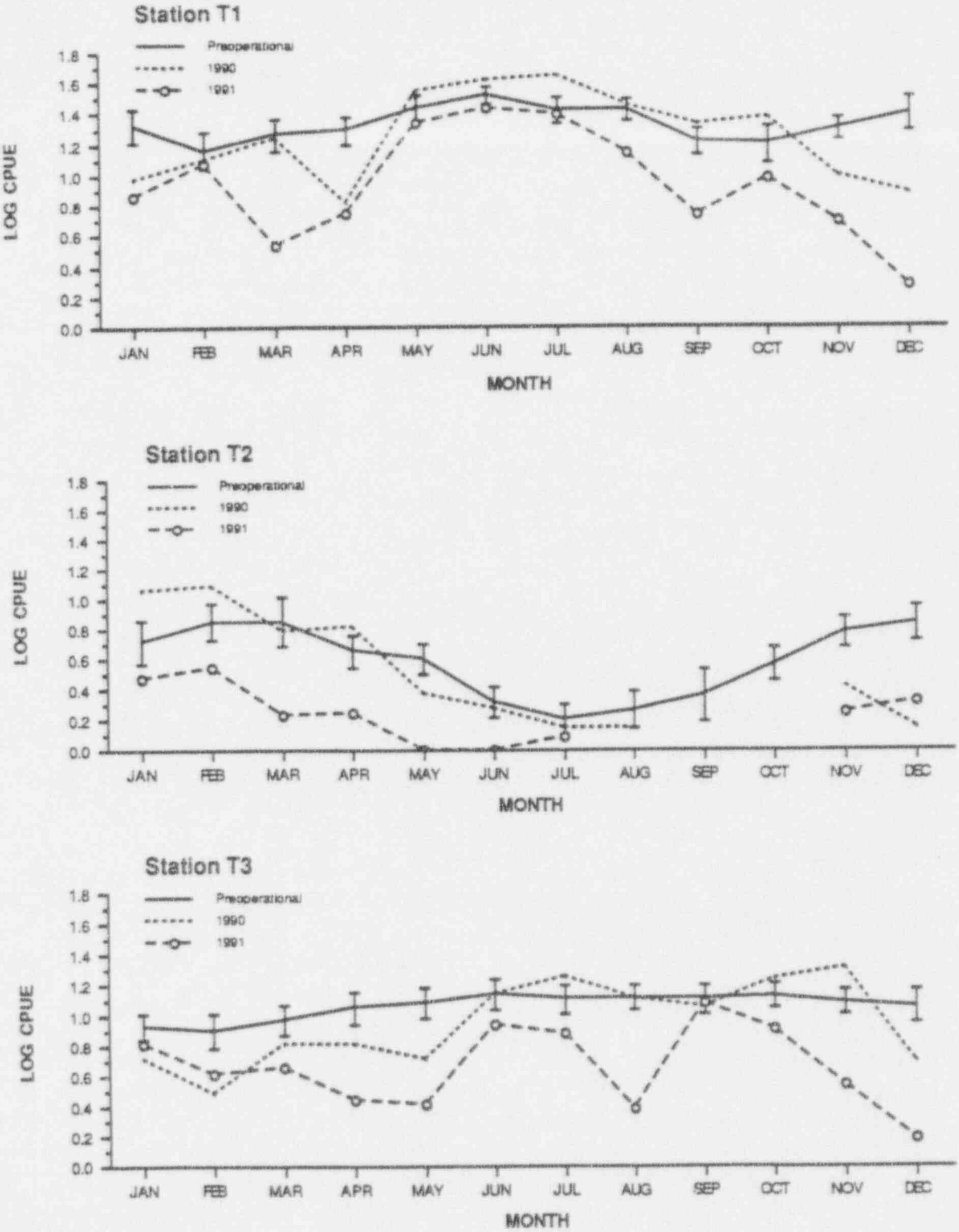


Figure 3.2.2-7. Log (x+1) catch per unit effort (one 24-hr. set) for **yellowtail flounder**; monthly means and 95% confidence intervals over all preoperational years (1976-1989) and monthly means for 1990 and 1991 at otter trawl Stations T1, T2 and T3. Seabrook Operational Report, 1991.

tions. The Preop-Op X Station interaction term was not significant.

Demersal and Estuarine Species

Winter Flounder

Winter flounder monthly mean CPUE in the otter trawl was relatively constant each month during the preoperational period (Figure 3.2.2-8). CPUE in 1991 was higher than the preoperational mean at Station T2 during May through October.

There were no significant differences in winter flounder otter trawl CPUE during the selected months between the preoperational and operational periods (Table 3.2.2-10). However, there were significant differences among stations. CPUE at Station T2 was greater than CPUE at Stations T1 and T3. The Preop-Op X Station interaction term was not significant, meaning that the significant differences among stations occurred equally during the preoperational and operational periods.

CPUE of YOY winter flounder in otter trawls exhibited the same pattern as total CPUE (Table 3.2.2-11). There were no significant differences in CPUE between the preoperational and operational periods, and CPUE at Station T2 was significantly greater than the other stations. The Preop-Op X Station term was not significant, indicating that the station differences were consistent between the preoperational and operational periods.

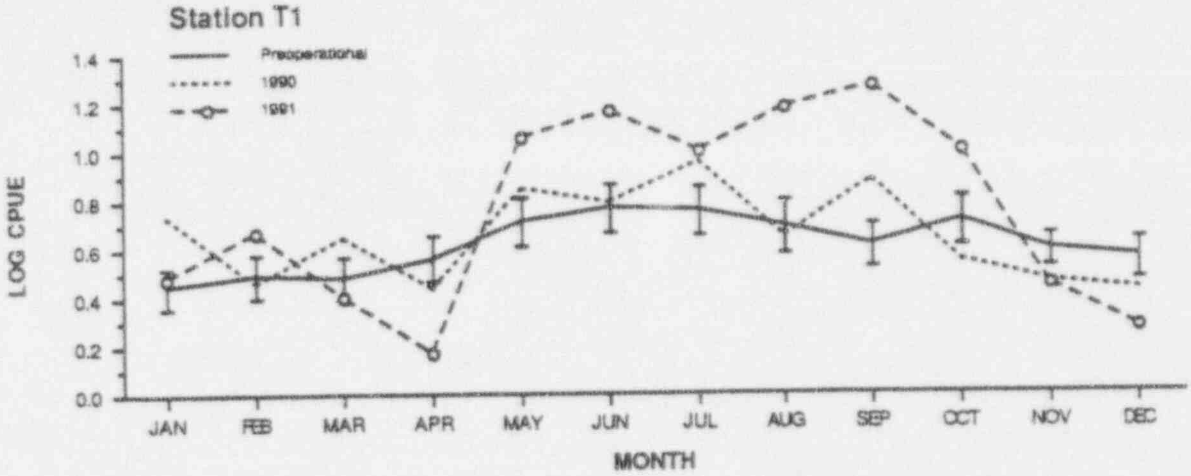
Mean monthly CPUE of winter flounder in estuarine seine catches was greatest in June through September (Figure 3.2.2-9). Seine CPUE for winter flounder was generally lower in 1990 and 1991 than the preoperational period, with the exception of July 1991.

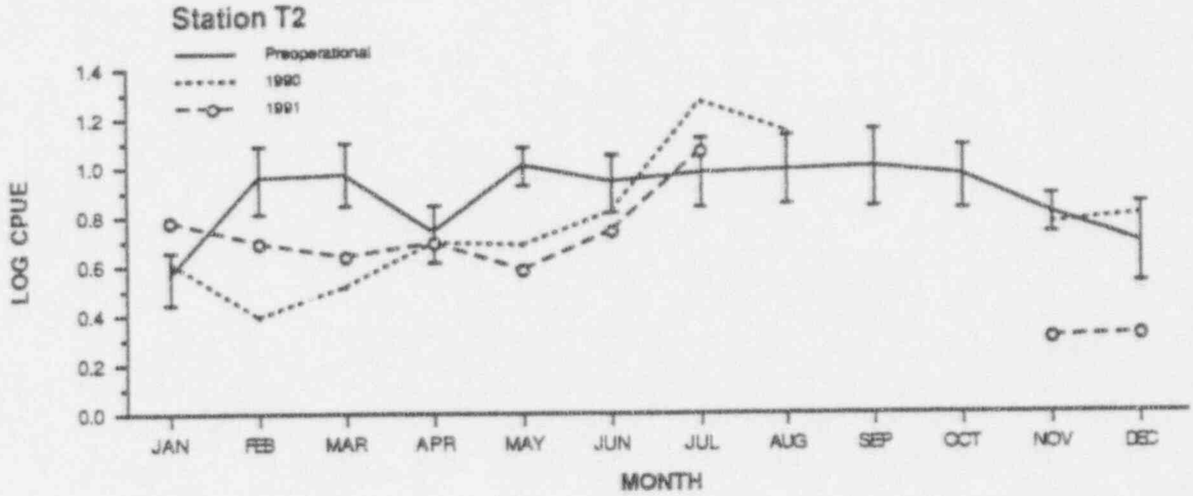
There were significant differences in winter flounder CPUE in seines between the preoperational and operational periods and among stations (Table 3.2.2-12). CPUE was great during the preoperational period primarily due to high annual mean CPUE during 1979 and 1980. Mean CPUE at Station S3 was significantly greater than other stations, possibly due to the higher salinity at this station. The Preop-Op X Station interaction term was not significant.

Rainbow Smelt

Rainbow smelt monthly mean CPUE in the otter trawl was greatest in December, and January through March during both the preoperational and operational periods (Figure 3.2.2-10). During these months, mean CPUE in 1990 was generally equal to or greater than the preoperational mean. Mean monthly CPUE in 1991 was generally less than the preoperational mean.

Rainbow smelt CPUE in otter trawls during the selected months was significantly greater during the preoperational period than the operational period (Table 3.2.2-10). Annual mean CPUE in 1989 was the highest observed. The Preop-Op X Station interaction term was not significant, which indicates that the significant differences between the preop





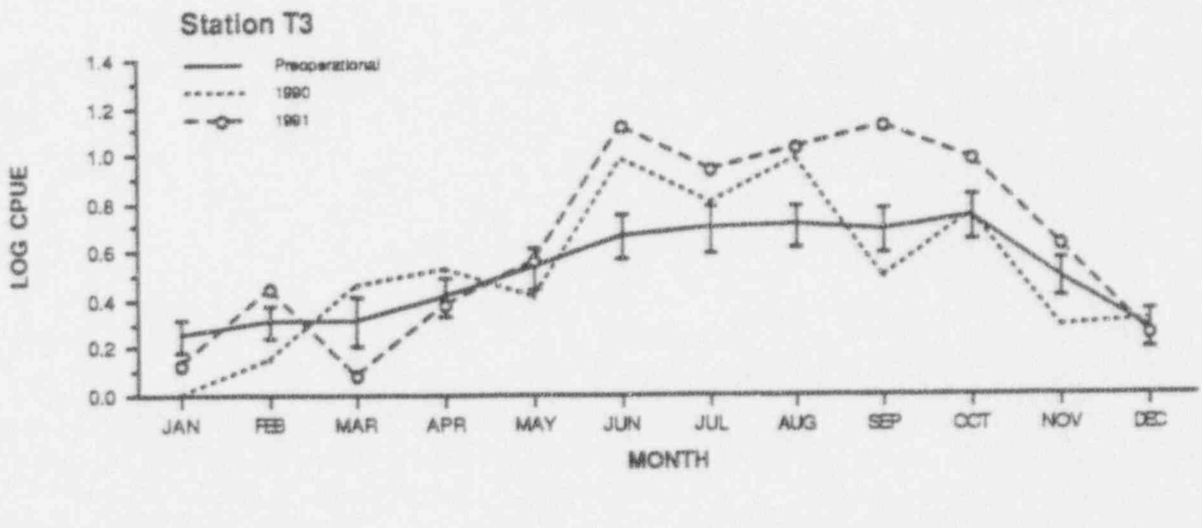


Figure 3.2.2-8. Log (x+1) catch per unit effort (one 24-hr. set) for **winter flounder**; monthly means and 95% confidence intervals over all preoperational years (1976-1989) and monthly means for 1990 and 1991 at otter trawl Stations T1, T2 and T3. Seabrook Operational Report, 1991.

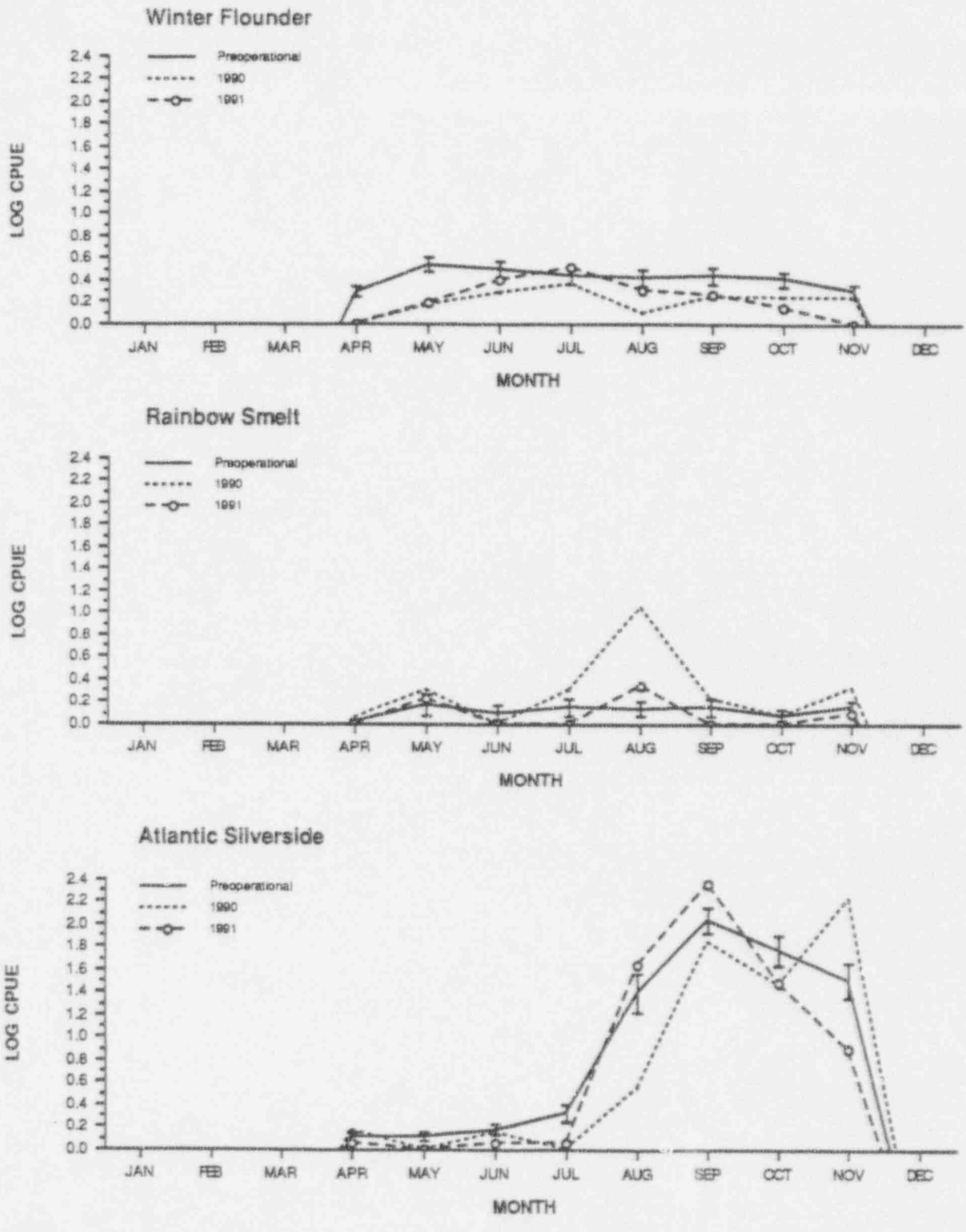


Figure 3.2.2-9. Log (x+1) catch per unit effort (one 24-hr. set) for **winter flounder, rainbow smelt** and **Atlantic silverside**; monthly means and 95% confidence intervals over all preoperational years (1976-1989) and monthly means for 1990 and 1991 averaged over beach seine Stations S1, S2 and S3. Seabrook Operational Report, 1991.

TABLE 3.2.2-12. RESULTS OF ANALYSIS OF VARIANCE COMPARING ABUNDANCES OF SELECTED SPECIES OF ESTUARINE FINFISH AT ALL BEACH SEINE STATIONS DURING PREOPERATIONAL AND OPERATIONAL PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES (MONTHS USED)	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Winter flounder	Preop-Op	1	0.67	7.22**	Preop>Op
(Apr-Nov)	Year (Preop-Op)	11	6.03	5.92***	
	Month (Year)	91	17.23	2.05***	
	Station	2	1.84	9.96***	S3 S1 S2
	Preop-Op x Station	2	0.30	1.62 NS	
	Error	387	35.80		
Rainbow smelt	Preop-Op	1	0.01	0.06 NS	
(Apr-Nov)	Year (Preop-Op)	11	3.31	2.03*	
	Month (Year)	91	22.48	1.67**	
	Station	2	0.62	2.11 NS	
	Preop-Op x Station	2	0.17	0.59 NS	
	Error	387	57.32		
Atlantic silverside	Preop-Op	1	0.12	0.37 NS	
(Sep-Nov)	Year (Preop-Op)	12	17.92	4.66***	
	Month (Year)	28	25.41	2.83***	
	Station	2	3.43	5.36**	S3 S1 S2
	Preop-Op x Station	2	1.12	1.74 NS	
	Error	152	48.71		

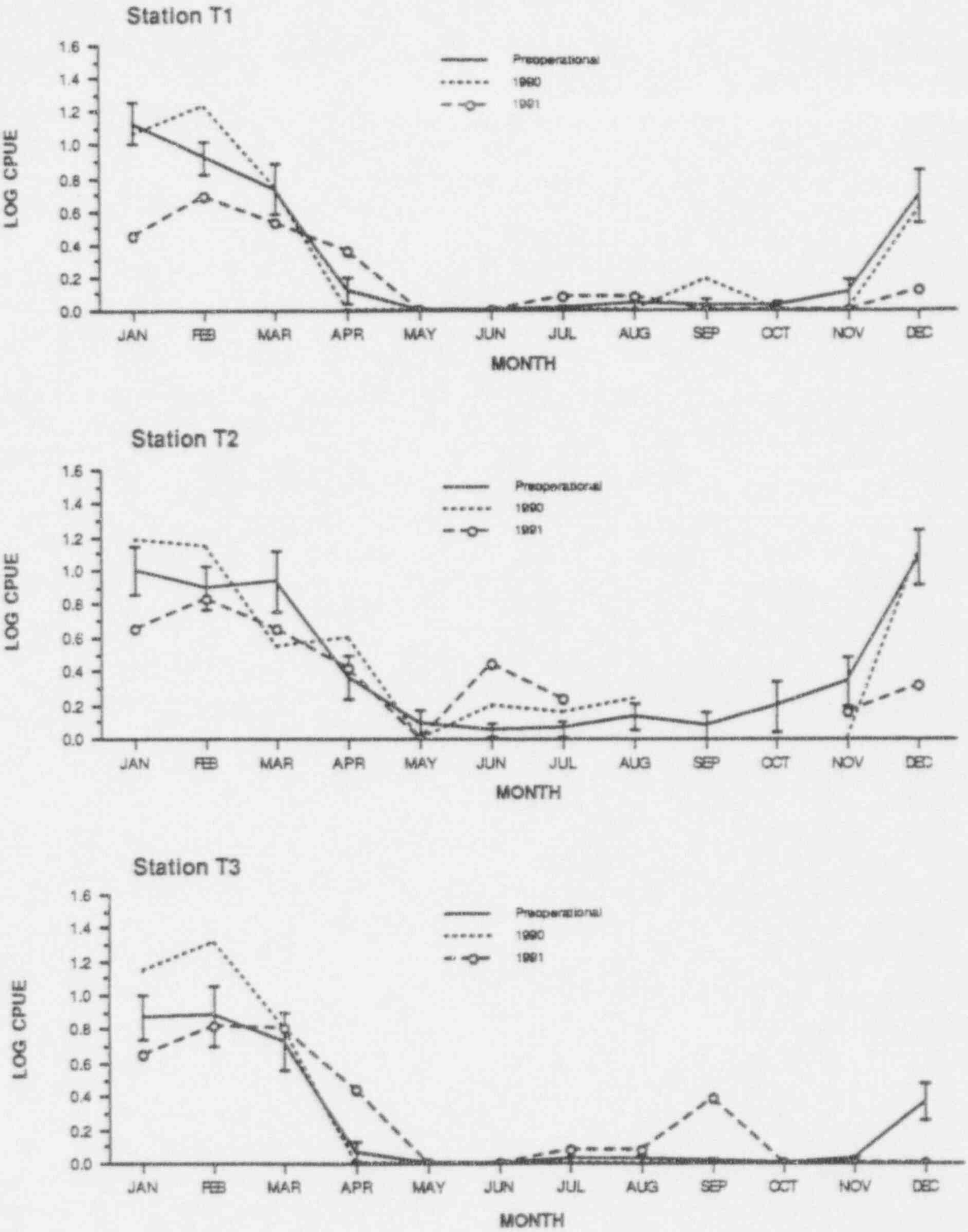


Figure 3.2.2-10. Log (x+1) catch per unit effort (one 24-hr. set) for rainbow smelt; monthly means and 95% confidence intervals over all preoperational years (1976-1989) and monthly means for 1990 and 1991 at otter trawl Stations T1, T2 and T3. Seabrook Operational Report, 1991.

erational and operational periods occurred at all stations.

There were no significant differences in CPUE of YOY rainbow smelt between the preoperational and operational periods, or between stations (Table 3.2.2-11). The Preop-Op X Station interaction term was not significant.

Rainbow smelt monthly mean CPUE in seines was greater in 1990 than the preoperational period, with the exception of June (Figure 3.2.2-9). In 1991, rainbow smelt monthly mean CPUE exceeded the preoperational mean only in May and August. Although rainbow smelt were captured almost every month during both the preoperational and operational periods, catches were extremely variable. There were no periods of consistently low coefficients of variation for monthly mean CPUE. Therefore, all months were used in the analysis of variance. The year 1990 was deleted from the analysis because it could not be classified as entirely preoperational or operational. There were no significant differences in rainbow smelt CPUE in the seines between the preoperational and operational pe. ods, and among stations (Table 3.2.2-12).

Atlantic Silverside

Atlantic silverside monthly mean CPUE in the seines was greatest in August through November for both the preoperational and operational periods (Figure 3.2.2-9). Monthly mean CPUE in 1991 was greater than the preoperational mean in August and September while monthly mean CPUE in 1991 was lower than the preoperational mean for every month except April and December.

There were no significant differences in Atlantic silverside CPUE during the selected months between the preoperational and operational periods (Table 3.2.2-12). CPUE at Station S3 was significantly greater than Station S2, although neither station was significantly different from Station S1. The Preop-Op X Station interaction term was not significant, which indicated that the differences among stations occurred equally during the preoperational and operational periods and are probably due to differences in habitat.

3.2.2.3 Effects of Plant Operation

Impingement

A total of 1,019 fish were impinged at Seabrook Station in 1991 (Table 3.2.2-13). The greatest number of fish impinged was in April through June and October through November. The impingement rate (fish/10^6 gallons of cooling water pumped) was greatest in October. The predominant species impinged were windowpane, pollock, winter flounder, little skate, lumpfish, longhorn sculpin and shorthorn sculpin, each of which comprised 5% or more of the total number of fish impinged. With the exception of pollock these are demersal species. During April through June, windowpane, pollock and lumpfish were the predominant species impinged. Pollock and winter flounder were the predominant species impinged in October and November.

TABLE 3.2.2-13. NUMBER OF ORGANISMS IMPINGED AT SEABROOK STATION BY MONTH AND SPECIES DURING 1991.[a] SEABROOK OPERATIONAL REPORT 1991.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	PERCENT
Windowpane	8	4	4	34	65	2			2	14	17		150	14.72
Pollock			1		20	45	2		4	37	15		124	12.17
Winter flounder	9	2	7	9		4			21	52	8	4	116	11.38
Little skate	21	2	7	5	1				7	40	7	6	96	9.42
Lumpfish	2	2	21	20	24	22	2						93	9.13
Longhorn sculpin	2	1	1	13	5	4			2	9	11	6	54	5.30
Shorthorn sculpin	4	7	4	3	8	13				1	4	3	47	4.61
Sea raven		1	5	13	2	1			2	5	4	9	42	4.12
Hake sp.	2			8					4	13	6		33	3.24
American lobster						2			1	4	19	3	29	2.85
Atlantic cod	1				4	3				9	3	8	28	2.75
Grubby	10	3	3	2						5	3		26	2.55
Silver hake									2	11	9		22	2.16
Wrymouth	2		1						2	8	1	1	15	1.47
Atlantic mackerel										5	8		13	1.28
Searobin spp.				4					3	5			12	1.18
Rainbow smelt	2	4		3					1	1	1		12	1.18
Yellowtail flounder	4	6	1										11	1.08
Rock gunnel	1	1		5		1				2	1		11	1.08
Clearnose skate	1			8									9	0.88
Atlantic silverside	2	1								2	3		8	0.79
Tautog					5	2						1	8	0.79
Herring spp.				3							4	1	8	0.79
Flounder spp.	1	3		3									7	0.69

(continued)

TABLE 3.2.2-13. (Continued)

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	PERCENT
Northern pipefish	1	2		3									6	0.59
Lamprey eel				5									5	0.49
Unknown					4								4	0.39
Threespine stickleback				3									3	0.29
Summer flounder				3									3	0.29
Seasnail										2	1		3	0.29
Saurel		2	1										3	0.29
Cunner					2								2	0.20
Ocean pout						2							2	0.20
Spiny dogfish							1		1				2	0.20
Fourspot flounder				1	1								2	0.20
Radiated shanny											1		1	0.10
Tautog											1		1	0.10
Cusk	1												1	0.10
Conger eel				1									1	0.10
Northern kingfish										1			1	0.10
Scup											1		1	0.10
Black sea bass												1	1	0.10
Atlantic wolffish													1	0.10
American eel						1							1	0.10
Alewife						1				1			1	0.10
	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	74	41	56	149	141	103	5	0	52	227	128	43	1019	100
Rate (No. of fish/10^6 gallons pumped)	0.004	0.002	0.003	0.009	0.008	0.006	0.000	0.000	0.007	0.014	0.007	0.002	0.005	

[a]Data provided by Yankee Atomic Electric Corporation.

Windowpane, pollock and winter flounder were the three most-abundant species impinged in 1991 and the majority of these fishes were less than 30 cm in length (Figure 3.2.2-11). Windowpane, winter flounder and pollock less than 30 cm are generally less than three years old (Bigelow and Schroeder 1953). Larger fish (30-45 cm) were more predominant among little skate, lumpfish, longhorn sculpin, shorthorn sculpin and sea raven. Approximately half of the hake sp. impinged were less than 15 cm. All length groups of Atlantic cod were impinged; the predominant fish were between 45 and 60 cm.

The species composition of fish impinged in 1991 differed from the species composition impinged in 1990. In 1991, windowpane and pollock were the two most-abundant species impinged as opposed to lumpfish and pollock in 1990. Winter flounder was the third most abundant species in 1991, but only ranked eighth in 1990. Similarly, little skate and lumpfish, which ranked fourth and fifth in impingement in 1991, ranked fifteenth and first respectively in 1990. Herring sp., which were the fifth most abundant species impinged in 1990, ranked twenty-third in 1991.

The species composition of the impingement community more closely resembled the species composition of the demersal fish community than either the pelagic or estuarine communities. The impingement community was markedly different in species composition from the community captured in mid-depth gill nets. Atlantic herring, Atlantic mackerel, Atlantic menhaden and Atlantic whiting were the dominant fish in mid-depth gill nets. These four species combined comprised less than 3% of the impingement community. The four most-abundant fishes impinged at Seabrook Station, windowpane, pollock and winter flounder and skate sp. were also dominant members of the demersal fish community (Table 3.2.2-4). Of the fish commonly impinged, only pollock and winter flounder were abundant in the pelagic and estuarine fish communities. Lumpfish, which were the fifth most-common fish impinged, were not common in either the demersal, pelagic or estuarine fish communities. Lumpfish were impinged primarily in the spring when the adults move inshore to spawn (Bigelow and Schroeder 1953). Lumpfish are structure-oriented fish and the structure provided by the intake may result in local concentrations of lumpfish.

The number of fish impinged in 1991 (1,019) was greater than the number impinged in 1990 (499). The species composition and number of fish impinged is influenced by the operational characteristics of the plant such as intake type and location, the volume of cooling water pumped, the abundance of the fish community exposed to impingement and environmental variables such as water temperatures and storm events that affect the vulnerability of the fish community to impingement (Grimes 1975; Landry and Strawn 1974). The operational characteristics of the plant did not change between 1990 and 1991. The volume of cooling water pumped in 1991 (approximately 186.8 x 10^9 gallons) was less than the volume pumped in 1990 (approximately 202.7 x 10^9 gallons). The abundance of the fish community exposed to impingement was slightly

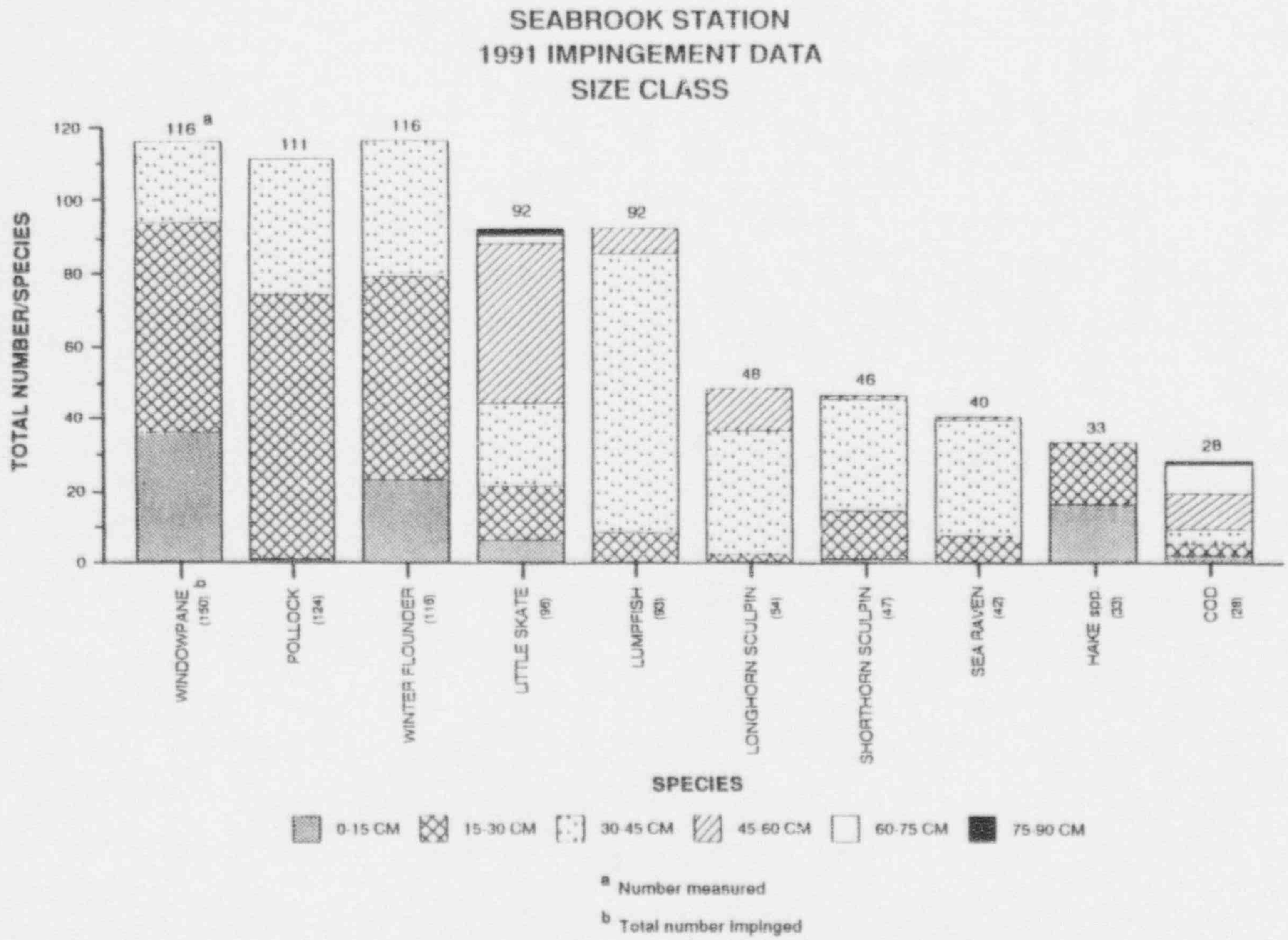


Figure 3.2.2-11. Number of **fish impinged** at Seabrook Station during 1991 for various size classes of most abundant species. Seabrook Operational Report, 1991.

lower in 1991 compared to 1990 (Figure 3.2.2-2), assuming that CPUE is a valid measure of abundance and the demersal fish community is the community most likely to be impinged. The increase in fish impingement observed in 1991 may be partially due to an increase in the vulnerability of the fish population exposed to impingement. An extremely strong northeast storm occurred off the coast of New England on 29 October 1991. This storm may have increased the vulnerability of some species, especially winter flounder, to impingement. Approximately 45% of all the winter flounder impinged during 1991 were impinged in October, and the majority of these were collected during and immediately after the storm (Ken Dow, YAEC, pers. comm.). No winter flounder were impinged in October of 1990. Storm events have been associated with increased impingement in freshwater (Lifton and Storr 1977; Thomas and Miller 1976). Winter flounder impingement was associated with storm events and sudden decreases in water temperature at the Millstone Nuclear Generating Station (NUSCo 1987). The mechanism for the increased impingement during storm events is unknown, but it is possible that increased wave activity and turbidity disorients fish increasing their off-bottom activity and making them more vulnerable to impingement.

Finfish Populations

Significant differences in CPUE were detected between the preoperational and operational periods for most of the selected species. In addition, significant differences among stations were also detected for several of the selected species. However, none of these significant differences appeared attributable to the operation of Seabrook Station because the Preop-Op X Station interaction term was not significant for any species. The significant differences between the preoperational and operational periods occurred at all stations, indicating that a mechanism that operated on a wide geographic scale was responsible for the changes in CPUE. Similarly, significant differences among stations occurred during both the preoperational and operational periods indicating that differences in habitat were responsible for the differences in CPUE.

CPUE was significantly different between the preoperational and operational periods for Atlantic herring captured in gill nets and winter flounder captured in otter trawls. There were no significant differences among stations. It is unlikely that the significant differences between the preoperational and operational periods were due to the operation of Seabrook Station because it was expected that any impact caused by plant operation would occur only at the nearfield station, which would result in a significant Preop-Op X Station interaction term. The cause of the significant differences between the preoperational and operational periods probably functioned on a larger geographic scale than the study area. Recent over-exploitation of commercial fish stocks in the Gulf of Maine and Georges bank may be cause of the differences in CPUE observed between the preoperational and operational periods in the study area.

Similarly, for Atlantic mackerel captured in gill nets, rainbow smelt captured in otter trawls, and Atlantic silverside captured in seines, CPUE was significantly different only among stations. However, the magnitude of the significant differences among stations was constant between the preoperational and operational periods, and therefore apparently not due to the operation of Seabrook Station. Differences in habitat among stations that did not change between the preoperational and operational periods would account for significant differences in CPUE among stations.

For a larger group of species including Atlantic cod, hake sp. and yellowtail flounder captured in otter trawls, and winter flounder captured in seines, there were significant differences in CPUE between the preoperational and operational period, and among stations. However, the significant differences could not be attributed to the operation of Seabrook Station. Significant differences in CPUE occurred when there were temporal changes in the abundance of a species that operated on a larger geographic scale than the study area, and there were differences in the habitat among stations that occurred during both the preoperational and operational periods.

3.3 BENTHOS

3.3.1 Estuarine Benthos

3.3.1.1 Physical Environment

Salinity and Temperature

The outfall from the Seabrook Station settling basin runs into Browns River, and usually contains the fresh water discharge from the station's sewage treatment plant and runoff from rainfall. During the period of intake and discharge tunnel construction from November 1979 through November 1983, the outfall became saline (approximately 25 ppt) and volume of the discharge increased (NAI 1991b). Once tunnel construction was completed in 1983, the discharge from the settling basin diminished to relatively low levels with no saline component. In 1991, the total annual volume of discharge (110×10^6 gallons) was lower than the discharge in the preceding year (150×10^6 gallons).

Weekly measurements of surface water salinity and temperature at high and low slack tides in Browns River and Hampton Harbor and daily rainfall data from Logan Airport, Boston, MA (National Climatic Data Center 1991) were used to investigate annual and monthly patterns. The nearfield water quality station is located in Browns River just downstream from the benthic transect, and about 0.5 km downstream from the settling basin outfall; the Hampton Harbor station is a farfield station away from the influence of that outfall. The most extreme water temperature and salinity occur at low tide, when the water is less influenced by the tidal influx of sea water. Water conditions at low tide are more likely to influence the structure of the estuarine benthic communities, and are the focus of this section.

Precipitation (rain and melted snow and ice) has a relatively high annual variation (Figure 3.3.1-1). Annual precipitation in 1991 was close to the fourteen-year average, although monthly precipitation was low in February, May and July, and high in August, following Hurricane Bob on August 19, and also in September.

The overall mean monthly salinity and 95% confidence interval from 1979-1991 at low tide in Browns River ranged from 17.0 ± 3.1 ppt in April to 24.6 ± 1.6 ppt in August (Table 3.3.1-1, Figure 3.3.1-1). In 1991, monthly salinities were below the 95% confidence limits of the mean in four months (Figure 3.3.1-1). The annual salinity in 1991 was slightly below the lower confidence interval for the twelve-year study period (Table 3.3.1-2).

At the Hampton Harbor station, the mean monthly low tide salinity and 95% confidence interval during the study period ranged from 24.7 ± 2.5 ppt in April to 29.4 ± 0.8 ppt in September (Table 3.3.1-1). The salinity in Hampton Harbor was always higher and less variable than in Browns River due to the moderating influence of sea water from the inlet. The low tide twelve-year average and 95% confidence interval was 27.7 ± 0.4 ppt, and 1991 was an average year (Table 3.3.1-2).

The overall mean monthly temperature and 95% confidence interval at low tide

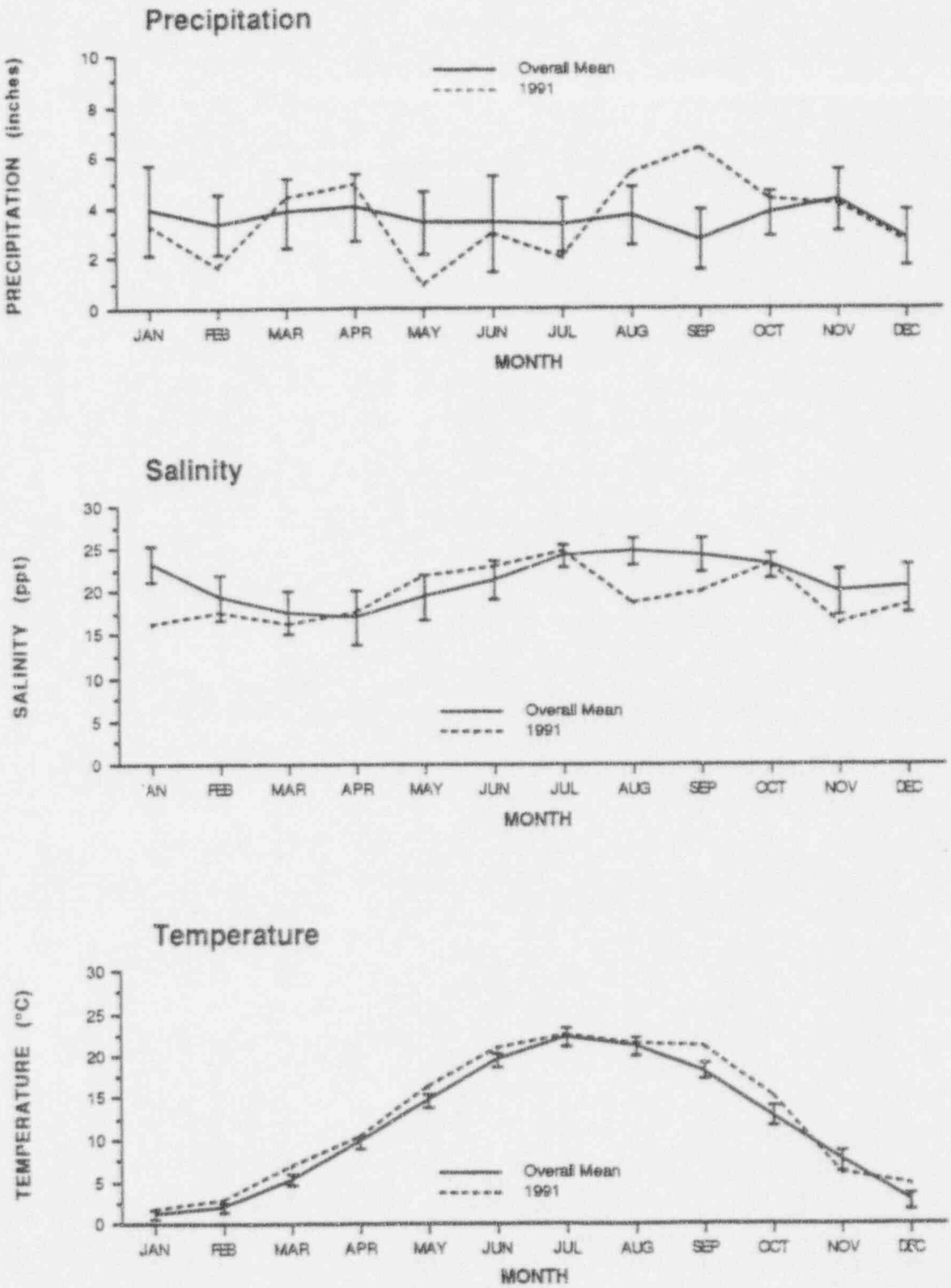


Figure 3.3.1-1. Monthly means and 95% confidence limits for precipitation measured in Boston, MA, from 1978-1991 and surface salinity and temperature taken at low tide in Browns River from May 1979-December 1991. Seabrook Operational Report, 1991.

TABLE 3.3.1-1. MEAN MONTHLY SEAWATER SURFACE TEMPERATURE (°C) AND SALINITY (ppt) TAKEN IN BROWNS RIVER AND HAMPTON HARBOR AT HIGH AND LOW TIDE. MAY 1979 - DECEMBER 1991. SEABROOK BASELINE REPORT, 1991.

TEMPERATURE	BROWNS RIVER				HAMPTON HARBOR			
	HIGH TIDE		LOW TIDE		HIGH TIDE		LOW TIDE	
	MEAN	CL	MEAN	CL	MEAN	CL	MEAN	CL
JAN	1.7	0.9	1.1	0.5	2.7	0.7	1.1	0.5
FEB	1.8	0.8	1.9	0.6	2.6	0.7	2.0	0.7
MAR	4.3	0.8	5.3	0.6	3.7	0.4	4.4	0.6
APR	7.1	0.7	9.6	0.6	6.3	0.6	8.3	0.5
MAY	12.9	1.4	14.6	0.8	10.1	0.6	12.6	0.7
JUN	16.3	0.9	19.4	0.8	13.5	0.5	16.4	0.7
JUL	18.4	0.8	22.1	1.0	15.8	0.5	18.5	0.7
AUG	19.1	0.8	21.2	1.0	17.0	0.7	18.8	0.7
SEP	16.3	0.8	18.2	0.9	14.8	0.7	16.4	0.6
OCT	12.0	0.8	12.7	1.2	12.0	0.6	12.0	0.7
NOV	8.3	0.7	7.5	1.2	9.0	0.5	8.3	0.8
DEC	4.8	1.1	2.6	1.0	5.3	0.7	3.5	0.8

SALINITY	BROWNS RIVER				HAMPTON HARBOR			
	HIGH TIDE		LOW TIDE		HIGH TIDE		LOW TIDE	
	MEAN	CL	MEAN	CL	MEAN	CL	MEAN	CL
JAN	31.5	0.6	23.1	2.1	32.1	0.4	28.6	1.3
FEB	29.6	1.7	19.3	2.5	31.8	0.5	27.4	1.8
MAR	29.1	1.3	17.6	2.4	31.2	0.7	26.1	2.0
APR	27.3	2.1	17.0	3.1	30.1	1.1	24.7	2.5
MAY	28.9	1.5	19.3	2.5	30.0	0.7	26.4	1.4
JUN	29.0	1.3	21.2	2.2	30.4	0.7	27.7	1.6
JUL	30.1	0.8	24.0	1.3	31.0	0.4	28.9	0.6
AUG	29.8	0.9	24.6	1.6	31.3	0.3	29.2	0.8
SEP	30.6	0.8	24.1	1.9	31.5	0.2	29.4	0.8
OCT	30.3	0.8	22.8	1.5	31.6	0.2	29.0	0.7
NOV	29.7	1.2	19.8	2.6	31.7	0.3	27.9	1.1
DEC	30.5	1.3	20.3	2.8	31.8	0.5	27.7	1.7

TABLE 3.3.1-2. ANNUAL MEAN[a] WITH 95% CONFIDENCE LIMITS[b] FOR TEMPERATURE (°C) AND SALINITY (PPT) TAKEN AT BOTH HIGH AND LOW SLACK TIDE FROM BROWNS RIVER AND HAMPTON HARBOR FROM 1980-1991. SEABROOK OPERATIONAL REPORT, 1991.

	BROWNS RIVER							
	LOW TIDE				HIGH TIDE			
	TEMPERATURE	CL	SALINITY	CL	TEMPERATURE	CL	SALINITY	CL
1980	10.9	5.2	25.1	1.9	9.6	4.4	31.0	1.6
1981	10.6	4.4	25.5	1.6	10.3	4.6	30.0	1.7
1982	10.7	4.5	22.8	1.8	9.9	4.1	30.0	1.2
1983	11.9	5.0	19.4	3.6	11.0	4.2	28.0	1.9
1984	11.9	5.1	18.1	3.3	10.6	3.9	28.4	1.8
1985	11.3	5.0	21.7	2.1	10.1	4.4	30.6	0.7
1986	10.3	4.8	20.4	3.1	9.6	4.0	30.2	0.9
1987[a]	11.5	5.1	20.6	2.6	9.6	4.1	28.9	1.8
1988	10.6	5.1	20.5	2.2	10.3	4.0	29.8	0.7
1989	11.5	5.4	20.2	2.5	10.1	3.9	30.0	0.7
1990[a]	12.6	5.3	19.5	2.7	10.9	4.5	29.6	1.4
1991	12.4	5.0	19.4	1.9	11.7	4.1	29.6	1.3
OVERALL[c]	11.3	1.3	21.1	0.7	10.3	1.0	29.7	0.4

	HAMPTON HARBOR							
	LOW TIDE				HIGH TIDE			
	TEMPERATURE	CL	SALINITY	CL	TEMPERATURE	CL	SALINITY	CL
1980	9.6	4.4	29.9	1.4	9.1	3.6	32.0	0.5
1981	10.1	4.4	28.9	1.1	9.3	3.8	31.5	0.4
1982	10.2	4.1	27.3	1.5	9.2	3.5	31.2	0.6
1983	10.4	4.3	25.5	2.4	9.9	3.4	30.1	0.9
1984	10.4	4.1	25.8	2.3	9.4	3.1	30.2	0.9
1985	10.6	4.2	29.1	1.0	10.1	3.3	32.2	0.3
1986	10.0	3.9	27.7	1.3	9.4	3.0	31.5	0.4
1987	10.0	4.3	27.5	2.2	8.9	3.5	30.7	0.9
1988	9.7	3.9	27.8	1.0	9.2	3.3	31.3	0.4
1989	10.2	4.4	28.0	1.2	9.2	3.3	31.4	0.7
1990	10.3	4.3	27.2	1.2	9.7	3.6	31.3	0.6
1991	11.1	4.0	28.0	0.9	9.8	3.1	30.9	0.4
OVERALL[c]	10.2	1.0	27.7	0.4	9.4	0.8	31.2	0.2

a - Annual mean=mean of 12 monthly means, except for Browns River in 1987 and 1990 when January and February monthly means were estimated by using the overall years monthly mean from 1980-1990.

b - Confidence limits expressed as half the confidence interval.

c - Overall mean=mean of monthly means.

in Browns River ranged from 1.1 ± 0.5°C in January to 22.1 ± 1.0°C in July during the study period (Figure 3.3.1-1). In 1991, monthly temperatures were slightly above the overall years' average for eleven months and below average only in November (Figure 3.3.1-1). The annual mean temperature in 1991 was the second warmest of the twelve-year study period following 1990 (Table 3.3.1-2).

In Hampton Harbor, the overall average monthly temperatures and 95% confidence intervals at low tide ranged from 1.1 ± 0.5°C in January to 18.8 ± 0.7°C in August during the study period (Table 3.3.1-1). Due to its proximity to the inlet, the temperature range in Hampton Harbor was not as great as Browns River. The low-tide twelve-year average temperature and 95% confidence interval from 1980 to 1991 was 10.2 ± 1.0°C (Table 3.3.1-2). Low-tide mean temperature in 1991 was the warmest during the twelve-year study period.

3.3.1.2 Macrofauna

Subtidal and intertidal estuarine benthic species composition at nearfield stations (3 and 3MLW) in Browns River and farfield stations (9 and 9MLW) in Mill Creek were typical for quiet, tidal creeks with fine-grained sediments on the East Coast (Watling 1975, McCall 1977, Whitlatch 1977, Santos and Simon 1980). Sediment at subtidal stations was generally fine sand with organic carbon ranging from 1.0 to 2.7%. At intertidal stations the sediment usually varied between fine sand and silt with organic carbon ranging from 1.6 to 5.9% (NAI 1985b). Spatial distribution of organisms was very patchy, and large population fluctuations occurred among sampling periods as is typical in estuarine habitats. The most numerous species inhabiting estuaries are those that are resistant and resilient to natural changes in the physical environment, such as fluctuating salinity, sediment grain size and temperature. The polychaete *Streblospio benedicti* was the most abundant species in the estuary, and comprised 7 to 9% of the total density at both intertidal stations, and 14 to 22% of the total density at both subtidal stations over all years (Table 3.3.1-3). Oligochaeta and *Capitella capitata* were also present in very high numbers. The clam worm *Hediste diversicolor* was very abundant intertidally in Browns River. The soft-shelled clam, *Mya arenaria*, was also present in substantial numbers at both sampling locations, especially Mill Creek (Table 3.3.1-3).

Total density (number of individuals/m^2) of all macrofaunal organisms showed year-to-year variations during the fourteen-year study period. These variations appear to be related to area-wide environmental trends, since major changes often occurred simultaneously in both Browns River and Mill Creek (Table 3.3.1-3). Annual variations in total density were significant at all four stations (Table 3.3.1-4) with one-way ANOVAs. In 1991, total density was well within the range of natural variability at each station.

The mean number of taxa collected annually at each of the four stations ranged from 16 to 47 during the fourteen-year study period (Table 3.3.1-3).

TABLE 3.3.1-3. MEAN NUMBER OF TAXA AND THE GEOMETRIC MEAN DENSITY (No./m^2) FOR EACH YEAR AND OVERALL YEARS WITH 95% CONFIDENCE LIMITS FROM ESTUARINE STATIONS AT BROWNS RIVER (3) AND MILL CREEK (9) SAMPLED FROM 1978 THROUGH 1991 (EXCLUDING 1985). SEABROOK OPERATIONAL REPORT, 1991.

															ALL YEARS[c]		
	STATION	1978	1979	1980	1981	1982	1983	1984	1986	1987	1988	1989	1990	1991	MEAN	UPPER	LOWER
Mean No. of Taxa[a]	3	35	41	38	42	47	32	27	38	33	38	38	35	32	37	39	34
	9	26	34	47	44	34	36	21	36	21	27	25	31	30	32	35	29
	3MLW	28	37	31	38	35	28	18	32	23	31	31	28	25	30	32	27
	9MLW	28	35	35	41	36	33	21	36	16	29	29	36	25	31	33	28
	MEAN	29	37	38	41	38	32	22	35	23	31	31	32	28	32	33	31
Total Density[b]	3	3170	4616	4978	5360	9331	2635	1244	1182	1198	3472	2583	1707	1889	2739	3538	2121
	9	3619	2209	14,767	11,277	4335	4533	620	2819	726	4764	1878	2488	5373	3219	4664	2221
	3MLW	4260	6136	5695	6833	8022	2723	2187	5632	1727	3936	6940	1778	6834	4270	5393	3381
	9MLW	3120	4512	6947	12,189	11,383	11,151	5131	4203	653	6115	7525	3845	3572	5038	7033	3609
	MEAN	3514	4099	7344	8424	7796	4364	1715	2980	995	4467	3990	2321	3967	3711	4318	3189
Streblospio benedicti	3	367	123	193	525	1064	552	239	99	66	550	181	56	462	244	367	162
	9	106	26	2396	525	81	538	16	161	49	744	167	400	1612	211	426	105
	3MLW	439	505	1010	928	3584	525	535	1421	316	1306	3227	259	3301	920	1381	613
	9MLW	566	434	466	2700	2354	3215	1560	1299	11	744	399	1023	604	702	1244	395
	MEAN	314	163	684	912	925	842	242	415	58	794	445	278	1105	427	565	324
Oligochaeta	3	242	270	204	651	2189	556	225	95	133	768	301	156	233	311	458	211
	9	16	100	2910	969	1058	1603	162	528	131	272	233	260	525	339	575	200
	3MLW	87	186	318	320	350	292	382	968	215	322	409	48	197	253	384	166
	9MLW	574	810	1067	861	565	2877	572	742	161	351	2888	362	610	705	1126	441
	MEAN	119	253	671	646	823	931	298	437	157	392	537	163	348	370	465	295
Capitella capitata	3	11	63	123	473	889	216	66	73	57	105	72	16	33	84	144	48
	9	238	29	2453	277	291	376	28	808	113	1530	262	259	479	281	471	168
	3MLW	17	29	138	244	540	208	124	197	26	46	27	24	10	66	105	41
	9MLW	279	45	125	320	276	800	303	234	19	1068	173	466	143	214	346	132
	MEAN	60	40	269	318	443	341	91	228	42	299	98	84	71	135	175	104

(continued)

TABLE 3.3.1-3. (Continued)

	STATION	1978	1979	1980	1981	1982	1983	1984	1986	1987	1988	1989	1990	1991	ALL YEARS[c]		
															MEAN	UPPER	LOWER
Caulleriella	3	330	221	835	1	2	3	12	9	1	101	7	6	24	18	40	8
sp. B	9	10	40	46	292	136	35	7	10	3	16	4	4	75	21	44	10
	3MLW	106	174	607	3	23	52	44	255	87	244	80	28	4	60	110	32
	9MLW	8	298	48	43	1634	278	325	307	1	21	3	8	8	44	102	19
	MEAN	42	147	183	17	64	37	34	53	5	54	10	9	16	32	46	22
Hediste	3	83	172	158	352	452	45	50	52	43	128	52	38	64	91	130	64
diversicolor	9	21	29	41	205	41	7	7	43	2	33	29	8	45	23	37	14
	3MLW	800	1343	1169	1613	975	220	296	987	150	523	1235	199	1906	662	1005	437
	9MLW	170	164	101	241	135	57	513	184	6	29	93	18	30	79	129	49
	MEAN	125	183	167	410	223	45	89	143	18	90	115	33	115	103	137	78
Mya arenaria	3	69	158	92	181	132	75	31	21	30	12	35	64	7	48	73	32
	9	265	427	299	246	148	168	157	34	53	83	69	208	48	131	192	90
	3MLW	106	224	26	179	117	103	22	13	27	12	73	25	22	47	75	29
	9MLW	100	328	62	400	141	70	86	13	73	39	425	266	102	109	167	72
	MEAN	118	265	82	237	134	98	55	19	42	26	93	98	30	76	94	61
Spio setosa	3	38	39	65	155	159	120	113	151	171	244	447	334	376	144	203	102
	9	50	59	287	346	170	16	3	75	6	315	236	110	158	74	141	38
	3MLW	7	9	8	6	4	8	2	46	25	46	24	26	8	12	20	7
	9MLW	54	59	43	78	48	30	8	65	2	32	41	117	46	36	61	21
	MEAN	30	33	51	72	51	26	10	76	16	104	102	103	70	47	62	35

[a] Yearly mean number of taxa = mean of three seasonal totals (where seasonal total = total number in all five 1/16 m^2 replicates combined)
[b] Yearly mean density = mean of three seasonal means (where seasonal mean = mean of five replicates)
[c] All years mean = mean of 39 seasonal means (3 seasons x 13 years)

TABLE 3.3.1-4. RESULTS OF ONE-WAY ANALYSIS OF VARIANCE AMONG YEARS FOR THE MEAN NUMBER OF TAXA (per 5/16 m^2) AND LOG (x+1) TRANSFORMED DENSITY (No./m^2) OF THE MOST ABUNDANT ESTUARINE SPECIES AND THE TOTAL DENSITY OF MACROFAUNA COLLECTED AT ESTUARINE STATIONS FROM 1978 THROUGH 1991 (EXCLUDING 1985). SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER[a]	STATION	F[b]	MULTIPLE COMPARISONS[c] - SUBTIDAL STATIONS	STATION	F[b]	MULTIPLE COMPARISONS[c] - INTERTIDAL STATIONS
Number of Taxa	3	2.30*	82 81 79 80 88 89 86 90 78 87 91 83 84	SMLW	[illegible].97**	81 79 82 86 89 80 88 78 83 90 91 87 84
	9	5.53***	80 81 83 86 79 82 90 91 88 78 89 87 84	9MLW	3.05**	81 90 82 86 80 79 83 88 89 78 91 84 87
Total Density	3	3.83**	82 81 80 79 88 78 83 89 91 90 84 87 86	SMLW	2.64*	82 89 91 81 79 80 86 78 88 83 84 90 87
	9	3.26**	80 81 91 88 83 82 78 86 90 79 89 87 84	9MLW	2.38*	81 82 83 89 80 88 84 79 86 90 91 78 87
Streblospio benedicti	3	2.12*	82 83 88 81 91 78 84 80 89 79 86 87 90	SMLW	2.05 NS	82 91 89 86 88 80 81 84 83 79 78 87 90
	9	1.95 NS	80 91 88 83 81 90 89 86 78 82 87 79 84	9MLW	3.51**	83 81 82 84 86 90 88 91 78 80 79 89 87
Oligochaeta	3	1.94 NS	82 88 81 83 89 79 78 91 84 80 90 87 86	SMLW	0.97 NS	86 89 84 82 88 81 80 83 87 91 79 78 90
	9	4.18***	80 83 82 81 86 91 88 90 89 84 87 79 78	9MLW	0.85 NS	89 83 80 81 79 86 78 84 91 82 90 88 87
Capitella capitata	3	2.05 NS	82 81 83 80 88 86 89 84 79 87 91 90 78	SMLW	4.33**	82 81 83 86 80 84 88 79 89 87 90 78 91
	9	3.74**	80 88 86 91 83 82 81 89 90 78 87 7? 84	9MLW	2.15*	88 83 90 81 84 78 82 86 89 91 80 79 87

(continued)

TABLE 3.3.1-4. (Continued)

PARAMETER[a]	STATION	F[b]	MULTIPLE COMPARISONS[c] - SUBTIDAL STATIONS	STATION	F[b]	MULTIPLE COMPARISONS[c] - INTERTIDAL STATIONS
Hediste diversicolor	3	2.44*	82 81 79 80 88 78 91 86 89 84 83 87 90	3MLW	1.64 NS	91 81 79 89 80 86 82 78 88 84 83 90 87
	9	2.43*	81 91 86 82 80 88 79 89 78 90 84 83 87	9MLW	3.36**	84 81 86 78 79 82 80 89 83 91 88 90 87
Mya arenaria	3	2.70*	81 79 82 80 83 78 90 89 84 87 86 88 91	3MLW	1.80 NS	79 81 82 78 83 89 87 80 90 84 91 86 88
	9	1.63 NS	79 80 78 81 90 83 84 82 88 89 87 91 86	9MLW	2.54*	89 81 79 90 82 91 78 84 87 83 80 88 86
Caulleriella sp. B	3	6.80***	80 78 79 88 91 84 86 89 90 83 82 81 87	3MLW	3.36*	80 86 88 79 78 87 89 83 84 90 82 91 81
	9	1.28 NS	81 82 91 80 79 83 88 86 78 84 89 90 87	9MLW	3.88**	82 84 86 79 83 80 81 88 90 78 91 89 87
Spio setosa	3	2.36*	89 91 90 88 87 82 81 86 83 84 80 79 78	3MLW	0.92 NS	86 88 90 87 89 79 80 83 91 78 81 82 84
	9	2.37*	81 88 80 89 82 91 90 86 79 78 83 87 84	9MLW	1.11 NS	90 81 86 79 78 82 91 80 69 88 83 84 87

[a]Degrees of freedom for the model (years) = 12
Degrees of freedom for the error = 26

[b] NS = not significant (p>0.05)
* = significant (0.05≥p>0.01)
** = highly significant (0.01≥p>0.001)
*** = very highly significant (p≤0.001)

[c]Multiple comparison test is Waller-Duncan K-ratio T test;
Horizontal lines connect statistically similar years.
[d]Since the F value is NS, years are reported in order of decreasing abundance

Annual variations in the number of taxa were significant at each station (Table 3.3.1-4). Number of taxa in 1991 was below the fourteen-year average at each station, ranking in the lowest group with the Waller comparison test (Table 3.3.1-4). However, 1991 was within the fourteen-year range for each station (Table 3.3.1-3). Annual changes in the number of taxa were generally similar at all four stations for most of the study period, particularly for years of extremes in salinity or precipitation.

Streblospio benedicti is a cosmopolitan, opportunistic polychaete (Grassle and Grassle 1974), and one of the first to colonize after a perturbation of the environment (Rhoads et al. 1978). It is the most abundant species in the estuary, and extremely high densities occurred during any season at both intertidal and subtidal stations. Such high densities were rarely sustained into the next sampling period, causing tremendous population fluctuations (NAI 1987b). With such high seasonal variation, no significant differences among years were found at two out of four stations. Population decreases in some years coincided with low salinities, which may have impeded recruitment. In 1991, densities increased greatly over 1990 lows at Browns River, and were well above average at three out of four stations (Table 3.3.1-3). Intertidal densities were at least 3 times higher than subtidal densities when averaged over all years (Table 3.3.1-3).

The class Oligochaeta is a species complex that is abundant in the estuary, with no evidence of annual trends. The seasonal cycle of oligochaetes indicated that peak densities occurred during any season (NAI 1987b), but were not sustained. No consistent differences in densities were found between Browns River and Mill Creek stations (Table 3.3.1-3). Likewise, no significant differences occurred among years, except at Station 9 (Table 3.3.1-4). When examining the yearly densities, population fluctuations were not consistent, probably because they were represented by more than one species. Oligochaete densities in 1991 were within the 95% confidence limits of the overall mean.

The opportunistic polychaete *Capitella capitata* was common at both intertidal and subtidal stations and typically showed large annual population fluctuations. Browns River densities were usually lower than densities at Mill Creek (Table 3.3.1-3). Significant differences were found among years at all stations except the subtidal station in Browns River (Table 3.3.1-4). In 1990 and 1991, densities in Browns River were very low, and a new all-time low was set at the intertidal station in 1991. In Mill Creek, the 1990 and 1991 densities were within the range of the study period (Tables 3.3.1-3,4).

Caulleriella sp. B is a polychaete that was occasionally abundant in the estuary. It rarely sustained densities of over 100/m² for more than three consecutive years. Significant differences among years occurred at all stations except the subtidal station in Mill Creek (Table 3.3.1-4). In 1991, densities at both subtidal stations increased markedly, while intertidal densities remained low (Table 3.3.1-3).

The clam worm, *Hediste diversicolor*, is a euryhaline species that is most common intertidally where there is a mixture of fresh and salt water (Pettibone 1963). It is an omnivore, frequently abundant in nutrient rich areas, and has been considered an opportunist and an indicator of pollution (Hull 1987). Both intertidal and subtidal stations at Browns River had substantially higher densities than stations of comparable depth at Mill Creek (Table 3.3.1-3). Intertidal stations had higher densities than subtidal stations (Table 3.3.1-3), particularly Station 3MLW in Browns River. Highly significant differences among years occurred at all stations except Station 3MLW, where *H. diversicolor* was most abundant (Table 3.3.1-4). Densities at Station 3MLW reached an all-time high in 1991, while remaining at or below average at the other three stations.

Mya arenaria, the soft-shelled clam, had important recreational value until 1989, when Hampton Harbor flats were closed due to coliform contamination (Section 3.3.7). *Mya* spat (<5 mm) and a few yearling clams (≤12 mm) are the predominant life stages in estuarine samples. Densities of *Mya* spat were statistically similar among years at Stations 3MLW and 9 (Table 3.3.1-4). Densities were usually higher in Mill Creek than in Browns River (Table 3.3.1-3). *Mya* densities in 1991 were well below average at three out of four stations, but within the range of previous years, with the exception of Station 3.

Substantial variability has occurred throughout the estuary in total density, number of taxa, and density of the dominant species. As these changes were not site-specific, and tended to occur simultaneously at Browns River and Mill Creek (except in 1983), they can be related to area-wide environmental variables such as precipitation and corresponding salinity changes, temperature, and abundance of predators and competitors. The largest abundances for most of the estuarine polychaetes, and highest total density, and number of taxa in both Browns River and Mill Creek occurred during the period of low precipitation and highest salinity (1980-1983). By 1986, physical and biological parameters had returned to the pre-1980 conditions. In 1984 and 1987 the most pronounced drops in density and number of taxa which occurred during the study period seemed to be related to high precipitation and low salinity. These biological parameters recovered, and approached the average range within one or two years (NAI 1991b). In 1991, a year of slightly below-average salinity and near-average precipitation, densities were typically within normal range, except at Station 3MLW in Browns River where *Hediste diversicolor* reached an all-time high, and *Capitella capitata* reached an all time low. *Mya arenaria* was at an all-time low at Station 3. The number of taxa in 1991 was below average at all four stations.

3.3.1.3 Effects of Plant Operation

Salinity and temperature monitored in Browns River and Hampton Harbor showed similar seasonal trends in 1991 to previous years. Annual mean temperatures in 1991 at low tide were well above the overall average in Browns River and

Hampton Harbor, paralleling trends in offshore temperatures (Section 3.1.1) and air temperatures (Boston Globe 1992). Salinity was affected by heavy rains in August of 1991, following Hurricane Bob, and again in September, leading to lower-than-average salinities during these months (Figure 3.3.1-1).

In Mill Creek and Browns River, the biological parameters measured were highly variable seasonally and annually, with number of taxa, total density, and density of most of the dominant species significantly different among years and between stations. Results in 1991 in Browns River were within the variability observed in previous years, and similar to Mill Creek. This indicates that effects from the limited plant discharge into the Browns River are not negatively impacting the indigenous benthic population.

3.3.2 Marine Macroalgae

3.3.2.1 Macroalgal Community

Number of Taxa

The number of taxa is an important measure of community diversity. Macroalgae taxa richness is measured two ways. Although a qualitative measure, the number of taxa from "general collections" represents the maximum number occurring at a station during a given season, depending on the visibility and other factors affecting collection efficiency. The number of taxa collected from destructive samples represents a quantitative measure in a 1/16 m^2 area, nd thus can be statistically tested.

Number of Taxa: General Collections

A total of 128 taxa has been collected during the preoperational study from 1978 through 1989 in general collections (NAI 1990b). No new taxa were collected in 1990 or 1991. This number includes plants not identifiable to the species level that were placed in genera or higher classifications. Historically, (through 1989) over half (51%) of these taxa were red algae (Rhodophyta), with the remainder divided almost evenly between brown algae (Phaeophyta, 27%) and green algae (Chlorophyta, 22%)(NAI 1990b). This proportion is typical for the New Hampshire coast (Mathieson and Hehre 1986). In 1991, the proportions were similar. More than half of the species were red algae (55%), more than one quarter brown algae (26%), and the remainder (19%) were green algae (NAI 1992).

In 1991, numbers of taxa from general collections were below the median value for the preoperational period at almost all of the stations, although most were within the range of previous years. Numbers of taxa in 1991 were the lowest ever recorded at the nearfield intertidal Station B1MLW and mid-depth Station B16. However, numbers of taxa in 1991 increased over the low values in 1990 at eight of the twelve stations. A decrease in the annual number of taxa was first noted in 1989, when the number of taxa at half of the stations was lower than the lowest recorded annual value (NAI 1990b). This trend continued in 1990, when the numbers of taxa were the lowest ever recorded at half of the stations (Figure 3.3.2-1).

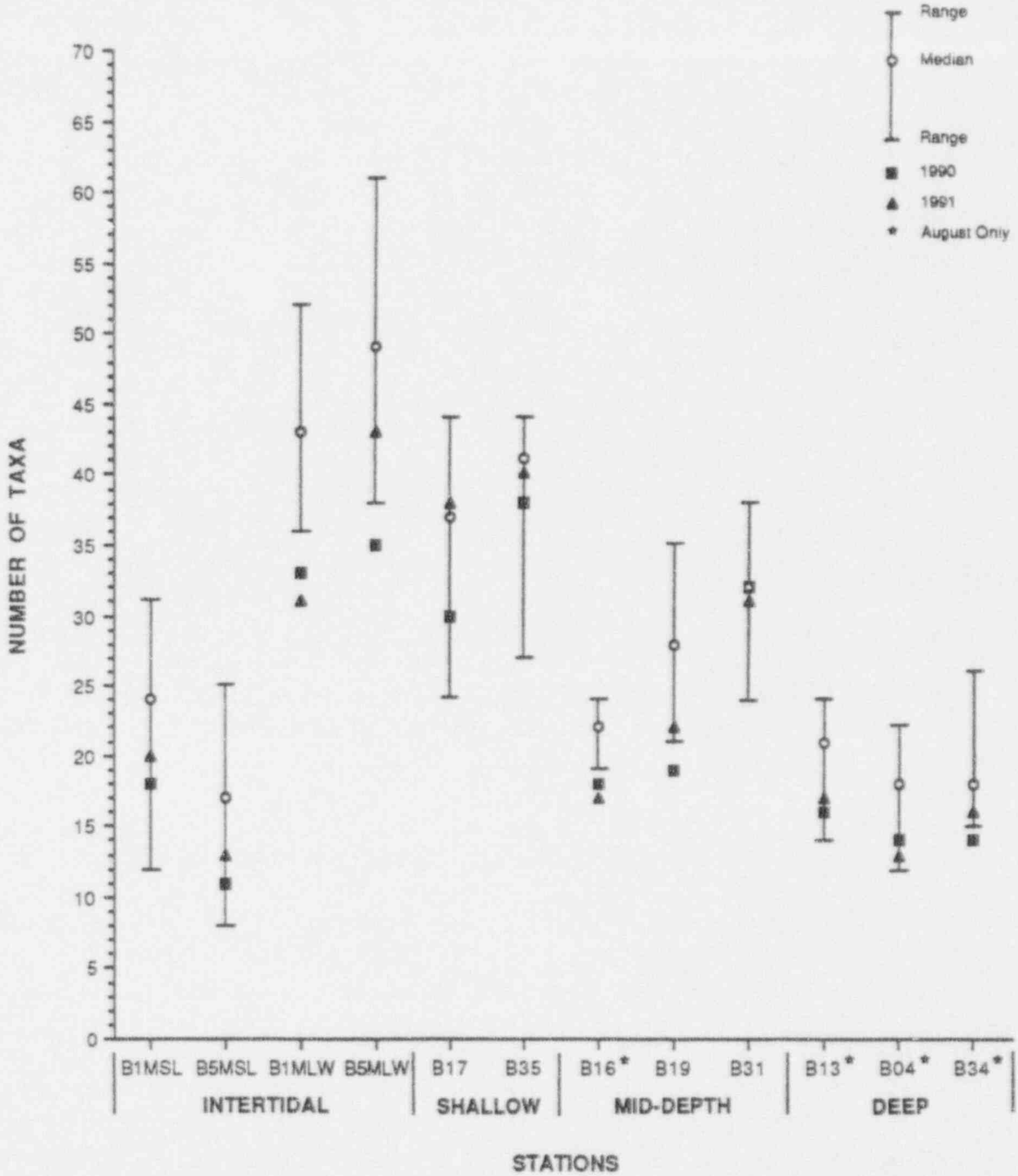


Figure 3.3.2-1. Preoperational (through 1989) median and range and 1990 and 1991 values of number of taxa collected in triannual general collections at Stations B1MSL, B1MLW, B17, B19, B31 (1978-1991), B5MSL, B5MLW, B35 (1982-1991), and annual collections at B16 (1980-1984; 1986-1991), B13, B04 (1978-1984; 1986-1991) and B34 (1979-1984; 1986-1991). Seabrook Operational Report, 1991.

In 1991, numbers of taxa were highest at the farfield intertidal (MLW) and both shallow subtidal stations. Lowest numbers of taxa were found at the deep stations and high intertidal (MSL) stations. During the preoperational period, numbers of taxa were highest in the intertidal MLW zone, and generally decreased with increasing depth (Figure 3.3.2-1). This pattern was consistent with other New Hampshire studies (Mathieson *et al.* 1981). Declining numbers of taxa has made spatial differences less clear-cut.

Nearfield/farfield differences in numbers of taxa from general collections in 1991 followed previously-observed trends. The numbers of taxa collected at corresponding nearfield and farfield shallow subtidal and deep stations were closely related, during both the preoperational period and in 1990 and 1991. In the intertidal zone, the nearfield station (B1MLW) had fewer taxa at the approximate mean low water mark and a greater number of taxa at mean sea level than its farfield counterpart at Rye Ledge (B5MLW), a trend that continued in 1990 and 1991 (Figure 3.3.2-1). In the mid-depth zone, fewer taxa have been recorded throughout the study at the station near the intake (Station B16) than at the discharge and farfield stations (B19 and B31). This may be due in part to fewer annual collections at B16 (once per year) than at B19 and B31 (three times per year). In 1990 and 1991, the number of taxa at the nearfield mid-depth station (B19) was close to that at B16 and lower than at the farfield (B31) station.

Number of Taxa: Quantitative Samples

Numbers of taxa from August quantitative samples collected at shallow subtidal and deep stations during the operational period were not significantly different from the preoperational period (Tables 3.3.2-1,2), paralleling trends in the general algae collections (Figure 3.3.2-1). Collections at both intertidal (MLW) stations had significantly lower numbers of taxa during the operational period when compared to previous years (Tables 3.3.2-1,2), as was first noted in 1990. At mid-depth Stations B31 and B16, numbers of taxa during the operational period were not statistically different from the preoperational period. However, at the nearfield Station B19, numbers of taxa were significantly reduced during the operational period.

Total Biomass

The effect of light on the quantity of macroalgae was evident from the inverse relationship between total biomass and depth. During the operational period (1990 and 1991), August total biomass values have been highest in the intertidal and shallow subtidal areas, and lowest at deep stations, consistent with previous years (Table 3.3.2-1). However, in the intertidal zone, total biomass was significantly lower during the operational period at the nearfield station, whereas biomass at the farfield station during the operational period (1990 and 1991) was not significantly different from previous years (Table 3.3.2-2). Total biomass in 1991 increased over the low values noted in

TABLE 3.3.2-1. PREOPERATIONAL MEAN AND 95% CONFIDENCE LIMITS AND 1990 AND 1991 MEAN NUMBER OF TAXA, TOTAL BIOMASS, AND *CHONDRUS CRISPUS* BIOMASS COLLECTED AT INTERTIDAL, SHALLOW SUBTIDAL, MID-DEPTH, AND DEEP BENTHIC STATIONS. SEABROOK OPERATIONAL REPORT, 1991.

			PREOPERATIONAL[c]			OPERATIONAL	
PARAMETER/TAXON	DEPTH ZONE	STATIONS	LCL	$\bar{x}$	UCL	1990 $\bar{x}$	1991 $\bar{x}$
Number of taxa[a] (no. per 1/16 m^2)	Intertidal	B1MLW	9.8	10.9	12.0	10.6	8.4
		B5MLW	16.4	17.9	19.4	13.4	14.0
	Shallow subtidal	B17	10.7	11.3	11.9	10.2	11.2
		B35	14.2	15.2	16.2	14.2	13.2
	Mid-depth	B19	9.7	10.1	10.6	8.2	9.2
		B31	10.6	11.0	11.4	10.2	12.2
		B16	8.6	9.0	9.4	9.8	8.0
	Deep	B04	7.3	7.6	7.9	7.8	6.6
		B13	7.6	7.9	8.2	8.4	6.6
		B34	7.3	7.7	8.0	7.6	7.8
Total biomass[a] (g/m^2)	Intertidal	B1MLW	1166.0	1296.3	1426.6	729.5	979.5
		B5MLW	1080.7	1208.3	1336.0	900.8	1110.1
	Shallow subtidal	B17	1129.2	1200.9	1272.6	1176.6	1417.1
		B35	1043.3	1168.6	1293.9	1215.3	1181.9
	Mid-depth	B19	277.2	311.3	345.3	418.9	460.0
		B31	415.7	471.9	528.2	286.3	384.3
		B16	688.3	779.8	871.3	665.6	525.0
	Deep	B04	89.3	99.7	110.0	69.8	87.8
		B13	80.6	96.0	111.5	142.7	122.9
		B34	55.6	71.4	87.1	42.1	24.5
Chondrus crispus[b] (g/m^2)	Intertidal	B1MLW	787.5	908.7	1029.8	363.0	884.1
		B5MLW	644.9	787.8	930.8	404.7	688.9
	Shallow subtidal	B17	553.4	644.1	734.8	528.9	575.2
		B35	413.6	477.3	541.1	573.1	338.0
	Mid-depth	B19	0.3	1.4	2.5	1.1	1.1
		B31	77.9	99.9	121.9	31.9	33.6

[a] August only
[b] Triannual samples, intertidal, shallow and mid-depth subtidal only. Rarely collected at deep stations.
[c] Preoperational, 1978-1989 period (Stations B1MLW, B17, B19, B31: 1978-1989; Stations B5MLW, B35: 1982-1989; Station B16: 1980-1984, 1986-1989; Stations B13, B04: 1978-1984, 1986-1989; B34: 1979-1984, 1986-1989)

TABLE 3.3.2-2. RESULTS OF ANALYSIS OF VARIANCE OF NUMBER OF TAXA (per 1/16 m^2) AND TOTAL BIOMASS (g per m^2) OF MACROALGAE COLLECTED IN AUGUST AT INTERTIDAL, SHALLOW SUBTIDAL, AND DEEP STATION PAIRS, 1978-1991. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER	DEPTH ZONE (STATION)	SOURCE OF VARIATION	df	SS	F[e]	MULTIPLE COMPARISONS (Ranked in decreasing order)
Number of Taxa	Intertidal	Preop-Op[a]	1	86.4	12.01***	Preop>Op
	(B1MLW, B5MLW)	Station[b]	1	390.8	54.31***	B1MLW>B5MLW
		Year (Preop-Op)[c]	12	1075.9	12.46***	
		Station X Preop-Op[d]	1	9.3	1.30 NS	
		Error	100	719.6		
	Shallow	Preop-Op	1	11.6	2.60 NS	
	Subtidal	Station	1	156.6	34.93***	B35>B17
	(B17, B35)	Year (Preop-Op)	12	270.4	5.03***	
		Station X Preop-Op	1	0.3	0.79 NS	
		Error	100	448.3		
	Mid-depth	Preop-Op	1	5.4	2.79 NS	
	(B16, B19, B31)	Station	2	89.9	23.36***	B31 Op B31 Pre B19 Pre B16 Pre B16 Op B19 Op
		Year (Preop-Op)	12	135.4	5.86***	
		Station X Preop-Op	2	13.2	3.42*	
		Error	172	331.1		
	Deep	Preop-Op	1	1.6	1.45 NS	
	(B04, B34, B13)	Station	2	1.8	0.82 NS	
		Year (Preop-Op)	11	54.0	4.44***	
		Station X Preop-Op	2	1.6	0.48 NS	
		Error	173	191.2		

TABLE 3.3.2-2. (Continued)

PARAMETER	DEPTH ZONE (STATION)	SOURCE OF VARIATION	df	SS	F[e]	MULTIPLE COMPARISONS
Total Biomass	Intertidal	Preop	1	751,180.2	9.34**	
	(B1MLW, B5MLW)	Station	1	90,185.6	1.12 NS	B1 Pre B5 Op B5 Pre B1 Op
		Year (Preop)	11	12,948,741.7	13.41***	
		Station X Preop	1	811,697.6	10.09**	
		Error	100	8,043,731.6		
	Shallow	Preop	1	44,040.7	0.54 NS	
	Subtidal	Station	1	55,065.8	0.67 NS	
	(B17, B35)	Year (Preop)	11	2,434,838.5	2.48**	
		Station X Preop	1	24,431.1	0.30 NS	
		Error	100	8,174,732.8		
	Mid-depth	Preop	1	98,890.7	2.51 NS	
	(B16, B19, B31)	Station	2	1,966,745.5	24.96***	B16 Pre B16 Op B31 Pre B19 Op B31 Op B19 Pre
		Year (Preop)	12	1,647,976.7	3.49***	
		Station X Preop	2	478,333.3	6.07**	
		Error	172	6,776,120.7		
	Deep	Preop	1	1,205.4	0.54 NS	
	(B04, B34, B13)	Station	2	66,827.9	14.88***	B13 Op B04 Pre B13 Pre B04 Op B34 Pre B34 Op
		Year (Preop)	11	59,659.4	2.41**	
		Station X Preop	2	25,067.3	5.58**	
		Error	173	388,550.0		

[a]Preop-Op = 1990 and 1991 vs. preoperational (1978-1989) period (Stations B1MLW, B17, B19, B31: 1978-1989; Stations B5MLW, B35: 1982-1989; Station B16: 1980-1984, 1986-1989; Stations B13, B04: 1978-1984, 1986-1989; B34: 1979-1984, 1986-1989)
[b]Stations within depth zone
[c]Year nested within preoperational and operational periods regardless of area
[d]interaction between main effects
[e]NS = Not significant (p>0.05)
* = Significant (0.05≥p>0.01)
** = Highly significant (0.01≥p>.001)
*** = Very highly significant (p≤.001)

1990, and although less than the preoperational average, was within the range of previous years (Table 3.3.2-1, NAI 1991b). Total biomass at the shallow subtidal stations showed no significant changes in 1990 and 1991 when compared to previous years. Changes in total biomass in the mid-depth zone were not consistent among stations (Tables 3.3.2-1,2). Total biomass was significantly lower during the operational period than during the preoperational period at Station B16, although still higher than the lowest value of 368 g/m^2 reported in 1984 (NAI 1985a). However, at B19 and B31, total biomass during the operational period was not statistically different from previous years. At the deep stations, total biomass was significantly higher during the operational period at B13 than during the preoperational period. At B34, however, biomass was significantly lower during the operational period than during the preoperational period. At nearfield station B04 there was no significant difference between operational and preoperational biomass levels.

Community Analysis

The focus of the multivariate community analysis was to determine if plant operation had caused changes in the species assemblages typically found in each depth zone. The algae community during the operational period (1990 and 1991) was judged to be similar to previous years if 1990 and 1991 collections at a given station were placed with the majority of collections from the preoperational period. This was true in almost all cases.

The intertidal algae community has been stable at both nearfield and farfield areas (B1MLW and B5MLW) since the study's beginning (Figure 3.3.2-2, Table 3.3.2-3). *Chondrus crispus* was the overwhelming dominant, and *Mastocarpus stellatus* a secondary dominant in 1990 and 1991, similar to the preoperational period. *C. crispus* group 1 biomass was lower during the operational period in comparison to the preoperational mean (Table 3.3.2-3), but includes the exceptionally low values recorded in 1990 (NAI 1991b).

At the shallow subtidal stations (B17 and B35), community composition during the operational period, as well as during the preoperational period. *Chondrus crispus* was also the dominant species at this depth, with *Phyllophora* spp. the second most abundant species, both during preoperational and operational periods. *C. crispus* biomass in August 1991 has apparently recovered from lower-than-average values noted in 1990 (NAI 1991b), resulting in a group 2 operational mean that is similar to that of the preoperational period.

The mid-depth area has been characterized by a predominance of *Phyllophora* spp., and decreased amounts of *Chondrus crispus* in comparison to shallower communities. Secondary dominants differentiate the three mid-depth stations. The intake station (B16) in most years has been characterized by *Phyllophora* spp., along with *Phycodrys rubens* as a secondary dominant (Table 3.3.2-3). Moderate amounts of three traditionally shallow-subtidal species (*Cystoclonium purpureum*, *Ceramium rubrum* and *Chondrus crispus*) differentiate this station from

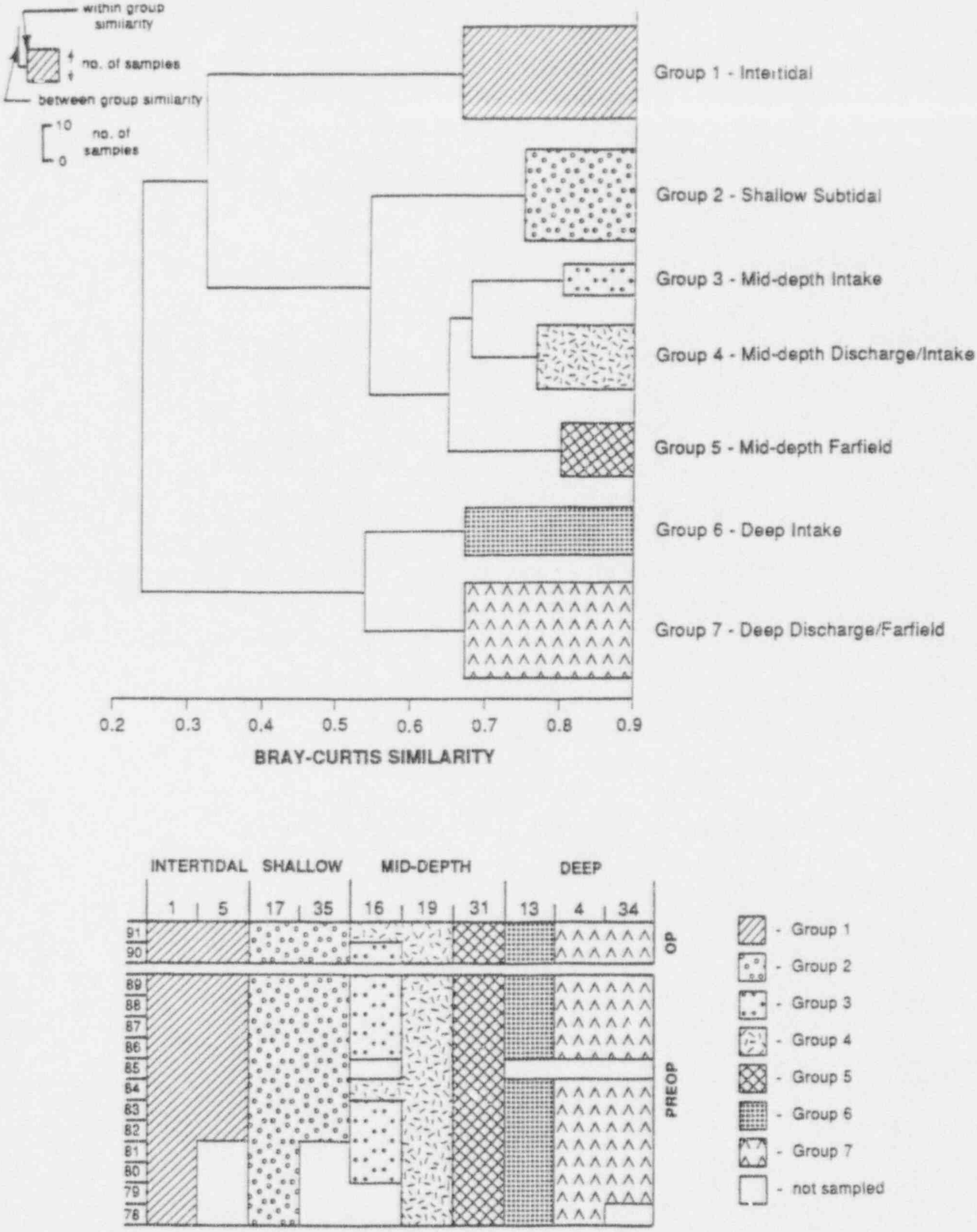


Figure 3.3.2-2. Dendrogram and spatial groups by year formed by numerical classification of August collections of marine benthic algae, 1978-1991. Seabrook Operational Report, 1991.

TABLE 3.3.2-3. SUMMARY OF SPATIAL ASSOCIATIONS IDENTIFIED FROM NUMERICAL CLASSIFICATION (1978-1991) OF BENTHIC MACROALGAE SAMPLES COLLECTED IN AUGUST. SEABROOK OPERATIONAL REPORT, 1991.

DEPTH ZONE (GROUP)	STATIONS	MEAN DEPTH (m)	YEARS INCLUDED	WITHIN/ BETWEEN GROUP SIMILARITY	DOMINANT TAXA	GROUP BIOMASS (g/m^2) PREOP[a] MEAN[b]	PREOP[a] CI[b]	OP[c] MEAN
Intertidal (1)	B1MLW	MLW	1978-1991	[illegible]/.32	*Chondrus crispus*	[illegible]	[illegible]	[illegible]
	B5MLW	MLW	1982-1991		*Mastocarpus stellatus*	[illegible]	[illegible]	[illegible]
					Corallina officinalis	51.25	31.30	17.75
Shallow Subtidal (2)	B17	4.6	1978-1991	.75/.55	*Chondrus crispus*	774.22	111.65	660.72
	B35		1982-1991		*Phyllophora* spp.	204.73	61.90	348.71
					Ceramium rubrum	69.29	20.72	51.75
					Cystoclonium purpureum	56.59	41.12	91.78
					Corallina officinalis	51.58	23.24	37.25
Mid-depth Intake (3)	B16	9.4	1980-1983; 1986-1990	.80/.68	*Phyllophora* spp.	429.87	93.92	369.02
					Phycodrys rubens	203.80	72.19	215.46
					Chondrus crispus	61.16	33.55	17.60
					Cystoclonium purpureum	49.39	27.86	28.90
					Ceramium rubrum	37.08	23.41	2.21
					Callophyllis cristata	32.73	10.02	19.30

(continued)

TABLE 3.3.2-3. (Continued)

DEPTH ZONE (GROUP)	STATIONS	MEAN DEPTH (m)	YEARS INCLUDED	WITHIN/ BETWEEN GROUP SIMILARITY	DOMINANT TAXA	GROUP BIOMASS (g/m^2) PREOP[a] MEAN[b]	CI[b]	OP[c] MEAN
Mid-depth Discharge/ Intake (4)	B19	9.4-12.2	1978-1991	.77/.68	*Phyllophora* spp.	201.79	34.84	279.86
					Chondrus crispus	3.29	3.96	0.19
					Phycodrys rubens	51.64	17.87	122.38
	B16		1984,1991		*Corallina officinalis*	14.52	4.26	5.17
					Callophyllis cristata	13.89	6.00	14.27
					Ptilota serrata	15.58	5.84	8.96
					Cystoclonium purpureum	5.93	4.03	29.30
Mid-depth Farfield (5)	B31	9.4	1978-1991	.81/.65	*Phyllophora* spp.	213.17	64.66	190.54
					Corallina officinalis	97.77	26.70	84.90
					Chondrus crispus	114.80	42.26	29.71
					Phycodrys rubens	22.93	5.49	15.52
Deep Intake (6)	B13	18.3	1978-1984; 1986-1991	.67/.54	*Phyllophora* spp.	68.85	23.77	109.71
					Ptilota serrata	11.54	3.96	11.63
					Phycodrys rubens	5.82	2.95	7.60
Deep Discharge/ Farfield (7)	B04	18.9-21.0	1978-1984; 1986-1991	.67/.54	*Ptilota serrata*	64.00	18.27	38.69
					Phyllophora spp.	10.97	5.04	10.65
	B34		1979-1984; 1986-1991		*Corallina officinalis*	6.86	3.59	1.10

[a]Preop - preoperational, 1978-1989 period (Stations B1MLW, B17, B19, B31: 1978-1989; Stations B5MLW, B35: 1982-1989; Station B16: 1980-1984, 1986-1989; Stations B13, B04: 1978-1984, 1986-1989; B34: 1979-1984, 1986-1989)
[b]Mean and 95% confidence interval
[c]Op- 1990 and 1991

B19 and B31. However, in 1991, as in 1984, the community composition at B16 was more similar to the mid-depth discharge station (B19). In both years, this was due to lower-than average levels of *C. crispus* and *C. rubrum* (Table 3.3.2-3; NAI 1985a, 1992). Higher-than-average levels of mid-depth species *P. rubens* and *Phyllophora* spp. also contributed to the difference in 1991 (NAI 1992).

Phyllophora spp. also predominated at the discharge station B19, along with *P. rubens*. Community composition during the operational period was similar to previous years. Community composition at the farfield mid-depth station, while similar to other mid-depth stations, was distinct. *Phyllophora* spp. was the most abundant taxon, as at the other mid-depth stations. Moderate amounts of *Corallina officinalis* and *C. crispus*, and low amounts of *P. rubens* distinguished this area from its nearfield counterpart. Although this farfield station cannot strictly be considered as a "control" station because of its differences from the nearfield station, it is useful for monitoring area-wide trends. Community composition at B31 during 1990 and 1991 was similar to all previous years, indicating that the species assemblage here shows little year-to-year variability.

Community composition at nearfield and farfield deep stations (B04 and B34) in 1990 and 1991 was similar to previous years. *Ptilota serrata*, the dominant species during the preoperational period, continued to predominate in 1991. Average *P. serrata* biomass for the group during the operational period was approximately 60% of the preoperational average. However, reductions in *P. serrata* biomass occurred only at the farfield station; nearfield biomass values were similar to previous years (NAI 1991a, 1992).

Despite its 18-m depth, the algae assemblage at the deep intake Station B13 was composed mainly of the mid-depth species *Phyllophora* sp. The presence of moderate amounts of typically-deep species *Ptilota serrata* suggests it is a transition zone between mid-depth and deep areas. No change in community composition was noted during the operational period.

In order to monitor the algal community for new or infrequently occurring species that might bloom to "nuisance" levels, the occurrence of rare taxa was also examined. Twenty-four species out of a total of 128 occurred sparsely (less than 1.7% frequency) in the biomass collections from 1978 to 1989 (Table 3.3.2-4). Two taxa appeared more frequently in 1990 and 1991 than in previous years. *Bonnemaisonia hamifera*, a relatively uncommon taxon that was new to quantitative collections in 1986, occurred in small amounts eight times in 1990 at three farfield stations (B5MLW, B35, B31) and twice in 1991 in the shallow subtidal (B17, B35). This species, typical of southern Massachusetts and Long Island (Taylor 1952), has been recorded in coastal New Hampshire and Great Bay (Mathieson and Hehre 1986). Its occurrence at offshore sites in this study may have been related to the naturally-increased water temperatures in the nearshore area (NAI 1991b). As *B. hamifera*, which is not considered a

TABLE 3.3.2-4. A COMPARISON OF SPARSELY OCCURRING MACROALGAE TAXA IN AUGUST BENTHIC DESTRUCTIVE SAMPLES DURING THE PRE-OPERATIONAL PERIOD (1978-1989) AND THE OPERATIONAL PERIOD (1990 AND 1991). SEABROOK OPERATIONAL REPORT, 1991.

SPARSELY OCCURRING TAXA 1978-1989[a]	SPARSELY OCCURRING TAXA[b] 1990-1991
Monostroma grevillei	x
Monostroma oxyspermum	x
Enteromorpha intestinalis	x
Enteromorpha linza	x
Enteromorpha prolifera	x
Ectocarpus siliculosus	x
Giffordia granulosa	x
Sphacelaria cirrosa	x
Desmarestia viridis	x
Petalonia fascia	
Scytosiphon lomentaria	x
Dumontia contorta	x
Ceramium deslongchampii	x
Pilayella littoralis	x
Plumaria elegans	x
Polysiphonia denudata	x
Polysiphonia harveyi	x
Porphyra miniata	x
Entocladia viridis	x
Spongonema tomentosum	x
Cladophora sericea	x
Spongomorpha spinescens	x
Bonnemaisonia hamifera	
Palmaria palmata	x

[a]less than 9 occurrences out of 512 samples (1.8%)
[b]occurred twice or less during operational period (2%)

nuisance organism, has occurred only at low levels, it does not pose a threat to the established algae community. *Petalonia fascia*, also not considered a nuisance species, occurred three times in 1990 and 1991 and twice during the preoperational period. Since it composed less than 1% of the total biomass during the operational period (NAI 1991a, 1992), there is no evidence that it is becoming a nuisance species.

Kelps and Understory Species

To monitor larger macroinvertebrates and macroalgae that are not adequately represented in destructive samples, transect surveys were performed at shallow and mid-depth stations. Invertebrate results are discussed in Sections 3.3.5.7 and 3.3.5.8. Kelps are important habitat formers that are not collected in destructive samples. Spatial differences in species abundances of adult kelp appear primarily attributable to depth differences.

Some of the 1991 observations of kelps in the shallow subtidal zone were significantly different from the preoperational years (Table 3.3.2-5). At the shallow subtidal Station B17, the two *Laminaria* species, *L. saccharina* and *L. digitata*, demonstrated statistically significant reductions in abundance in 1991 when compared to previous years. The decline began in 1989 for *L. saccharina* (NAI 1991b) and in 1988 for *L. digitata* (NAI 1989b, 1990b, 1991b). Although abundances of both kelp species were reduced at the farfield station B35 in 1991, the differences were not significantly different. Substantially-higher abundance of *Lacuna vincta*, a molluscan predator on kelps, coincided with reduced kelp density in August 1990 and 1991 (Section 3.3.3; NAI 1991a, 1992). *L. digitata* continued to be less abundant than *L. saccharina* at both shallow subtidal stations.

Kelps in the mid-depth zone also showed differences in 1991 abundances. Mean abundances of *Alaria esculenta* and *Laminaria saccharina* at the mid-depth stations, B19 and B31, in 1991 were not significantly different from previous years (Table 3.3.2-5). Although the 1991 mean abundances for *Agarum cribrosum* were somewhat reduced at both stations when compared to both the 1990 and preoperational means, the reductions were not statistically significant. However, the abundances recorded at both stations for the month of October were substantially reduced when compared to the same month in 1990 and bear close observation in the future (NAI 1992). The 1991 *L. digitata* abundances were significantly reduced at both mid-depth stations in comparison to the preoperational period. The continuing decline at Station B19 is part of an overall trend which began in 1988 (NAI 1989b), and the reduction at Station B31 became evident in the spring of 1990 before plant operation began (NAI 1991b).

Kelps are sensitive to storm events (Witman 1985). Three of the kelps species, (*Laminaria digitata* at B19, *L. saccharina* at B17 and B35, *Agarum cribrosum* at B19 and B31) showed substantial reductions in October, after Hurricane Bob (NAI 1992). Strong bottom currents may have dislodged the kelps. Newly-established kelp beds have been

TABLE 3.3.2-5. PREOPERATIONAL MEAN AND UPPER AND LOWER 95% CONFIDENCE LIMITS AND RESULTS OF NONPARAMETRIC ONE-WAY ANOVA COMPARING NUMBERS OF FOUR KELP SPECIES AND PERCENT FREQUENCIES OF THREE UNDERSTORY ALGAE TAXA IN 1991 TO VALUES FROM 1981-1989. SEABROOK OPERATIONAL REPORT, 1991.

		PREOPERATIONAL						
TAXON	STATION	LCL	$\bar{x}$	UCL	1990 $\bar{x}$	1991 $\bar{x}$	df	Z[a]
Laminaria digitata	17	169.9	213.9	257.9	77.7	32.5	1	-2.81**
	35	117.2	148.9	180.6	125.3	94.4	1	-1.53 NS
	19	105.9	139.9	173.9	202.3	19.8	1	-2.56*
	31	433.6	500.2	566.8	265.0	225.3	1	-2.71**
Laminaria saccharina	17	326.1	415.1	504.1	152.3	97.6	1	-2.46*
	35	231.2	316.4	401.6	197.5	207.9	1	-0.88 NS
	19	10.7	59.1	107.5	11.1	13.5	1	-1.16 NS
	31	72.3	95.5	118.7	42.0	57.9	1	-0.61 NS
Alaria esculenta	19	0.0	2.4	6.8	0.0	8.7	1	1.65 NS
	31	32.7	75.2	117.7	46.8	24.6	1	-1.66 NS
Agarum cribrosum	19	676.3	786.6	896.9	944.1	696.9	1	-0.61 NS
	31	309.2	366.4	423.6	405.4	269.3	1	-0.87 NS
Chondrus crispus	17	68.1	71.8	75.4	72.5	78.3	1	0.70 NS
	35	50.0	54.6	59.3	63.6	70.3	1	1.36 NS
	19	1.9	4.2	6.4	5.6	11.7	1	1.41 NS
	31	16.9	21.0	25.1	14.7	23.3	1	1.40 NS
Phyllophora sp.	17	16.5	20.3	24.1	15.6	17.5	1	-0.70 NS
	35	14.1	19.2	24.2	11.9	13.1	1	-0.58 NS
	19	30.5	34.0	37.6	35.6	35.8	1	-1.40 NS
	31	27.7	31.8	35.8	33.3	30.8	1	0.0
Ptilota serrata	17	0.2	0.8	1.4	0.6	2.8	1	1.49 NS
	35	0.1	0.6	1.0	0.3	0.8	1	0.0
	19	31.3	35.6	39.8	28.1	28.1	1	-0.70 NS
	31	10.2	13.1	15.9	8.9	8.3	1	-1.05 NS

[a]NS = not significant ($p>0.05$)
* = significant ($0.05 \geq p > 0.01$)
** = highly significant ($0.01 \geq p > .001$)

observed adjacent to the transect areas, suggesting that the kelps may have relocated.

Measurements of percent frequency of occurrence of the three understory algae that were dominant at transect sites during the preoperational period (Table 3.3.2-5), showed differences among depths that were similar to those observed from biomass collections (NAI 1991b). The understory community in the shallow zone historically has been dominated by *Chondrus crispus* with *Phyllophora* spp. a secondary dominant, while the mid-depth community was dominated by *Phyllophora* spp. A similar pattern occurred during the operational period. Algal frequencies during 1991 at all four stations were not significantly different from those observed historically (Table 3.3.2-5).

Intertidal Communities (Nondestructive Monitoring Program)

In situ counts of macroalgae in fixed quadrats at the intertidal stations (B1 and B5) were conducted at locations representing three tidal elevations between approximate MHW and MLW. The three quadrats were situated (from highest to lowest elevation) on bare ledge, fucoid-covered ledge, and *Chondrus*-covered ledge. These quadrats monitor fixed locations, thus eliminating small-scale spatial variability and focusing on temporal variation. During 1991, with few exceptions, there was little or no change in algal percent frequency of occurrence compared to 1990 or the preoperational period (1982-1989). Table 3.3.2-6 shows the occurrence of the more common species.

The Bare Ledge Site, at the upper edge of the mid-tidal zone was characteristic of ledge not continuously covered by macroalgae. Although seasonally high in variability, barnacles have been common in this quadrat (see Section 3.3.3 for faunal coverage). In 1991, as in previous years, during the spring, the annual greens, *Urospora penicilliformis* and *Ulothrix flacca* (at both stations), and the red alga, *Bangia fuscopurpurea* (Station B5), were the most frequently-occurring species (Table 3.3.2-6). In 1991, *B. fuscopurpurea* occurred in low frequencies at Station B5 for the first time since 1986. The annual red alga, *Porphyra* spp. continued to be unique to Station B1 during all seasons in frequencies similar to previous years, while *U. penicilliformis* and *U. flacca* occurred at both stations in somewhat reduced frequencies but within the preoperationally established ranges. Small, immature perennial *Fucus* spp. plants were found at the farfield station in 1991 in all seasons, as has been true since 1986 (NAI 1991b). Although they occurred frequently (at least 87%), their percent cover was low (25% or less). In summer *Fucus* spp. percent cover at Station B5 was noticeably reduced from 1990, but was well within the preoperational ranges established for each season.

The Fucoid Ledge Site, in the mid-tide zone, is situated in the area of maximum fucoid algae cover. In 1991, the perennial *Fucus* spp. was the dominant taxon within the quadrats, as has been true in

TABLE 3.3.2-6. MEDIAN AND RANGE OF PERCENT COVER AND PERCENT FREQUENCY OF PERENNIAL AND ANNUAL MACROALGAE SPECIES PER 0.25 m² AT FIXED INTERTIDAL NON-DESTRUCTIVE SITES DURING THE PREOPERATIONAL PERIOD (1982-1989), IN 1990, AND IN 1991. SEABROOK OPERATIONAL REPORT, 1991.

	STATION			PERENNIAL ALGAE								
				BARE LEDGE[b]			FUCOID LEDGE[b]			CHONDRUS ZONE[b]		
				APR	JUL	DEC	APR	JUL	DEC	APR	JUL	DEC
Percent Cover[a,e]												
Fucus spp.[c]	B1	1982-89	median (range)	1 (0-8)	<1 (0-10)	<1 (0-40)	93 (25-98)	93 (60-100)	68 (25-95)	25 (4-38)	18 (13-69)	18 (0-38)
		1990		0	4	2	92	95	25	0	0	0
		1991		1	0	1	95	80	78	10	18	3
	B5	1982-89	median (range)	6 (0-50)	11 (<1-75)	23 (0-80)	94 (60-98)	94 (65-100)	93 (2-98)	0 (0)	0 (0)	0 (0)
		1990		18	77	25	60	65	50	0	0	0
		1991		25	17	12	71	87	85	0	0	0
Percent frequency[a,f]												
Fucus spp.[c]	B1	1982-89	median (range)	6 (0-81)	19 (0-94)	6 (0-94)	94 (69-100)	88 (75-100)	88 (69-94)	13 (0-44)	13 (2-75)	16 (0-60)
		1990		0	0	0	94	100	94	0	6	0
		1991		0	0	12	87	100	81	0	19	0
	B5	1982-89	median (range)	82 (0-100)	97 (12-100)	100 (0-100)	85 (62-100)	85 (69-100)	91 (31-100)	0 (0)	0 (0)	0 (0)
		1990		100	100	100	88	87	88	0	0	0
		1991		94	100	87	87	100	81	0	0	0
Chondrus[d] crispus	B1	1982-89	median (range)	0 (0)	0 (0)	0 (0)	2 (0-8)	1 (0-13)	2 (0-7)	45 (20-53)	34 (20-38)	45 (28-53)
		1990		0	0	0	15	2	3	41	23	53
		1991		0	0	0	4	0	7	57	26	38
	B5	1982-89	median (range)	0 (0)	0 (0)	0 (0)	<1 (0-5)	<1 (0-8)	0 (0-2)	45 (0-72)	48 (41-55)	41 (39-48)
		1990		0	0	0	0	0	5	50	39	61
		1991		0	0	0	3	<1	1	58	61	53
Mastocarpus[d] stellatus	B1	1982-89	median (range)	0 (0)	0 (0)	0 (0)	9 (0-29)	7 (0-19)	13 (0-32)	47 (21-69)	66 (65-71)	48 (32-67)
		1990		0	0	0	37	19	22	61	59	49
		1991		0	0	0	35	24	27	47	69	31
	B5	1982-89	median (range)	0 (0)	0 (0)	0 (0)	6 (0-15)	5 (0-13)	10 (0-19)	47 (0-53)	51 (41-63)	44 (43-56)
		1990		0	0	0	10	10	13	26	63	44
		1991		0	0	0	18	26	17	43	63	39

(continued)

TABLE 3.3.2-6. (Continued)

	STATION			BARE LEDGE[b] APR	BARE LEDGE[b] JUL	BARE LEDGE[b] DEC	ANNUAL ALGAE FUCOID LEDGE[b] APR	ANNUAL ALGAE FUCOID LEDGE[b] JUL	ANNUAL ALGAE FUCOID LEDGE[b] DEC	CHONDRUS ZONE[b] APR	CHONDRUS ZONE[b] JUL	CHONDRUS ZONE[b] DEC
Corallina officinalis	B1	1982-89	median	0	0	0	0	0	0	0	0	0
			(range)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		1990		0	0	0	0	0	0	0	0	0
		1991		0	0	0	0	0	0	0	0	0
	B5	1982-89	median	0	0	0	0	0	0	30	52	52
			(range)	(0)	(0)	(0)	(0)	(0)	(0)	(15-57)	(33-61)	(31-65)
		1990		0	0	0	0	0	0	63	40	51
		1991		0	0	0	0	0	0	66	68	45
Percent Frequency[a,f]												
Porphyra sp.	B1	1982-89	median	<1	5	<1	2	7	<1	0	0	0
			(range)	(0-15)	(0-78)	(0-21)	(0-9)	(0-17)	(0-5)	(0)	(0-9)	(0)
		1990		1	3	2	0	5	0	0	36	0
		1991		<1	17	3	0	9	0	0	0	0
	B5	1982-89	median	0	0	0	0	0	0	0	0	0
			(range)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		1990		0	0	0	0	0	0	0	0	0
		1991		0	0	<1	0	0	0	0	0	0
Urospora penicilliformis/ Ulothrix flacca	B1	1982-89	median	45	0	0	0	0	0	0	0	0
			(range)	(0-99)	(0)	(0)	(0-P[e])	(0)	(0)	(0)	(0)	(0)
		1990		79	0	0	0	0	0	0	0	0
		1991		32	0	0	0	0	0	0	0	0
	B5	1982-89	median	73	0	0	0	0	0	0	0	0
			(range)	(0-100)	(0)	(0)	(0-5)	(0)	(0)	(0)	(0)	(0)
		1990		0	0	0	0	0	0	0	0	0
		1991		31	0	0	0	0	0	0	0	0
Bangia fuscopurpurea	B1	1982-89	median	0	0	0	0	0	0	0	0	0
			(range)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		1990		0	0	0	0	0	0	0	0	0
		1991		0	0	0	0	0	0	0	0	0
	B5	1982-89	median	25	0	0	0	0	0	0	0	0
			(range)	(0-100)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
		1990		0	0	0	0	0	0	0	0	0
		1991		1	0	0	0	0	0	0	0	0

[a]Based on fixed quardrats
[b]Bare ledge station is at upper edge of MSL zone, at approximate mean high water. Fucoid station is at approximate mean sea level mark. *Chondrus* zone station, first sampled in 1985, is at approximate mean low water mark.
[c]Percent frequency of fucoid algae is based on presence of holdfasts only.
[d]% frequency recorded using different method in 1982.
[e]Present; % frequency not recorded.
[f]Based on point contact line sampling.
[g]Percent cover of fucoid algae is based on whole plant.

previous years (Table 3.3.2-6). These fucoids were quite persistent and occurred frequently, although relatively low (<40%) coverages have been occasionally recorded in previous years. The perennial red algae *Chondrus crispus* and *Mastocarpus stellatus* occurred in the understory at both stations in low amounts in 1991, as was true in previous years; the latter species was more persistent and abundant. At both stations, *M. stellatus* occurrences were greater than the preoperationally-established range during April and July and at the upper end of the range in December. This is a continuation of an increase that began in 1990 prior to the operational period. Of the other algae occurring in these quadrats, only *Porphyra* sp. was common (at Station B1 only) in 1991, consistent with previous years.

As part of the nondestructive program, fixed line transects have been surveyed in the fucoid zone since 1983 to quantify the areal coverage of the fucoid algae. In 1991, unlike previous years, *Ascophyllum nodosum* occurred somewhat less frequently at Station B5 than at B1. In 1991, the percent frequency of occurrence at B1 was higher than in 1990 and during the preoperational period. At B5, occurrence was similar to 1990 and within the confidence limits established for the preoperational period. No significant difference was detected between 1990 and 1991 and previous years (Table 3.3.2-7). In 1990 and 1991, *Fucus vesiculosus* was more frequent at farfield Station B5 than at nearfield Station B1; the reverse has been true historically. The 1991 frequencies for *Fucus vesiculosus* were lower than the 95% confidence limits established for the preoperational period at both stations for the third consecutive year (Table 3.3.2-7, NAI 1990b). Frequencies recorded since 1989 (NAI 1990b, Table 3.2.2-6) for *F. vesiculosus* show a continuous, marked decline at Station B1. *F. distichus* ssp. *edentatus*, historically less frequent than the two other *Fucus* species, was only recorded at Station B1 in 1991. Coincident with the decline of *F. d.* spp. *edentatus*, *F. d.* spp. *distichus* was recorded at both stations for the first time in 1991. These trends suggest that *F. d.* spp. *distichus* may be replacing *F. vesiculosus* within the sample quadrats and is part of an area-wide trend.

The *Chondrus* zone quadrat in the MLW (mean low water) zone is situated in the area of maximum red algae cover. In 1991, as has been true historically, *Chondrus crispus* and *Mastocarpus stellatus* dominated this zone. Median percent frequencies exceeded 30% with no differences noted between the two stations, as in previous years (Table 3.3.3-6). Understory taxa *Fucus* sp. and *Corallina officinalis* were also important in this zone. In 1991, *Fucus* spp. was present throughout the year at Station B1 only (Table 3.3.2-6). Frequencies and percent cover estimates were within the range of previous years. *C. officinalis* occurred only at B5 in 1991, consistent with previous years. This species occurred in moderate frequencies in all seasons; 1991 frequencies were similar to previous years.

TABLE 3.3.2-7. MEAN PERCENT FREQUENCY AND UPPER AND LOWER 95% CONFIDENCE LIMITS OF FUCOID ALGAE AT TWO FIXED TRANSECT SITES IN THE MEAN SEA LEVEL ZONE FOR THE PREOPERATIONAL PERIOD (1983-1989) AND THE MEAN PERCENT FREQUENCY FOR 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

TAXA	STATION	PREOPERATIONAL LCI	PREOPERATIONAL $\bar{x}$	PREOPERATIONAL UCI	1990 $\bar{x}$	1991 $\bar{x}$	df	Z[a]
Ascophyllum nodosum	B1	28.42	32.0	35.58	31.7	39.3	1	1.75 NS
	B5	34.73	41.2	47.74	38.3	33.3	1	-1.32 NS
Fucus vesiculosis	B1	35.68	47.4	59.08	3.7	2.0	1	-2.49*
	B5	20.92	27.0	32.98	15.7	20.0	1	-1.27 NS
Fucus distichus	B1	8.51	16.2	23.87	50.0	14.3	1	0.04 NS
spp. *edentatus*	B5	0.00	3.6	7.84	10.3	0.0	1	-0.61 NS
Fucus distichus	B1	--	0.0	--	0.0	18.3	1	3.73***
spp. *distichus*	B5	--	0.0	--	0.0	3.7	1	3.73***
Fucus sp.	B1	1.30	7.6	13.94	20.7	32.3	1	2.17*
	B5	0.00	0.6	1.40	7.3	9.7	1	3.10**

[a]NS = not significant ($p>0.05$)
* = significant ($0.01<p\leq0.05$)
** = highly significant ($0.001<p\leq.01$)
*** = very highly significant ($p\leq0.001$)

3.3.2.2 Selected Species

Chondrus crispus

Chondrus crispus (Irish moss), a red algae, is common to intertidal and shallow subtidal habitats from Nova Scotia to New Jersey (Taylor 1952). It was the dominant understory algal species in the lower intertidal zone and, to a lesser extent, in the shallow subtidal zones near the Sunk Rocks (see Community Analysis section).

In the intertidal zone, *Chondrus crispus* biomass at both stations in 1991 was not statistically different from values collected during the preoperational period (Table 3.3.2-8). The trend of decreased biomass in 1990 at both stations, which began prior to plant operation in August, was apparently reversed in 1991, when biomass at both stations increased (Table 3.3.2-1, NAI 1991b). In the shallow subtidal zone, *C. crispus* biomass levels in 1991 were significantly lower than collections from the preoperational period (Table 3.3.2-8). As the decrease occurred at both nearfield and farfield stations (Table 3.3.2-1), it appears to be part of an area-wide trend. It must be noted that *C. crispus* biomass at intertidal and shallow subtidal stations was substantially reduced in November 1991 following a severe northeastern storm (NAI 1992).

3.3.2.3 Effects of Plant Operation

Community structure in the intertidal zone was similar to previous years. However, other community parameters, including number of taxa and total biomass showed some differences in comparison to previous years. The number of taxa collected from general collections in the intertidal mean low water zone has been depressed since 1989 (NAI 1990b). In 1990 and 1991, numbers of taxa (general collections) were lower than the median value, although some recovery was evident at the farfield station in 1991. Numbers of taxa from quantitative samples were significantly lower during the operational period at both nearfield and farfield intertidal stations. Thus, the diminished number of taxa in the intertidal zone (general and quantitative collections) appears to be part of an area-wide trend that began prior to plant operation.

Total August biomass at the nearfield intertidal station was significantly lower during the operational period when compared to the preoperational period. This resulted from reduced biomass of the dominant *Chondrus crispus* in August collections. *C. crispus* first showed reduced biomass levels in the intertidal area in 1989, and this continued through 1990 (NAI 1991b). However, triannual collections of *C. crispus* in 1991 in the intertidal zone were not statistically different from previous years. Since the reduction of biomass of intertidal dominant *C. crispus*, while reduced in August, was not significantly different when the entire year was considered, it appears to be unaffected by plant operation. All aspects of community structure in the shallow subtidal (number of taxa, total biomass, and community composition) have shown no changes during plant operation.

TABLE 3.3.2-8. RESULTS OF ANALYSIS OF VARIANCE OF *CHONDRUS CRISPUS* BIOMASS (g/m^2) COMPARING COLLECTIONS DURING THE OPERATIONAL PERIOD (1990 and 1991) AT INTERTIDAL AND SHALLOW SUBTIDAL STATION PAIRS WITH BIOMASS FROM 1978-89. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER	DEPTH ZONE	SOURCE OF VARIATION	df	SS	F[e]	MULTIPLE COMPARISONS
Chondrus crispus	Intertidal	Preop-Op[a]	1	3,631.35	0.03 NS	B1MLW>B5MLW
		Year (Preop-Op)[c]	11	12,860,806.54	11.22***	
		Month (Year)	26	13,848,744.13	5.11***	
		Station[b]	1	1,542,424.35	14.80***	
		Station X Preop-Op[d]	1	59,894.83	0.57 NS	
		Error	249	25,941,559.34		
	Shallow subtidal	Preop-Op	1	188.24	5.01*	Op<Preop B17>B35
		Year (Preop-Op)	11	674.20	1.63 NS	
		Month (Year)	26	4,759.25	4.87***	
		Station	1	496.93	13.22***	
		Station X Preop-Op	1	2.52	0.07 NS	
		Error	249	9,356.80		

[a]Preop-Op = 1990 and 1991 vs. all previous years, regardless of station
[b]Station pairs within a depth zone: intertidal = B1MLW, BMLW; shallow subtidal = B17, B35, regardless of year or period
[c]Year nested within preoperational and operational periods regardless of area
[d]Interaction of main effects
[e]NS = Not significant (p>0.05)
 * = Significant (0.05≥p>0.01)
 ** = Highly significant (0.01≥p>0.001)
 *** = Very highly significant (p≤.001)

Nearfield stations in the mid-depth zone also showed differences in community structure that did not occur in the farfield area. At the discharge station B19, community structure has been stable since 1978. However, the number of taxa in 1991 was lower than during the pre-operational period. No changes were observed at farfield station B31. The number of taxa during the operational period was reduced by 1-2 taxa when compared to the preoperational mean (Table 3.3.2-1). While statistically significant, the reduction is small and is based on only 2 sampling efforts (August 1990 and 1991). The situation does not appear to be related to plant operation.

The macroalgae community at the intake Station B16 in 1991 was more similar to the discharge Station B19 than to pre-operational collections at B16. This situation is reflected in a significantly lower total biomass, caused by reduced amounts of *Chondrus crispus*. As this situation also occurred in 1984, it does not suggest a plant-related effect.

Community composition at the deep stations in 1990 and 1991 was similar to previous years. However, some differences in total biomass were noted in 1990 and 1991. At the deep intake station, total biomass was significantly higher in 1990/1991 than previous years, while at the deep farfield station, biomass was significantly lower than previous years. No differences in total biomass or number of species were noted at the deep discharge station.

3.3.3 Marine Macrofauna

Studies since 1978 of the macrofaunal invertebrates off Hampton Beach, New Hampshire have focused on quantitative samples from the horizontal algae-covered rock/ledge habitat at paired near- and farfield stations in four depth zones. Macrofaunal studies include a community analysis of intertidal and subtidal habitats, as well as an examination of populations of selected species (Section 3.3.5). Additional data were collected during three seasons each year (excluding winter) at fixed sites at the rocky intertidal station pair, and from panels set at the bottom at the mid-depth station pair to examine the bottom fouling community.

3.3.3.1 Horizontal Ledge Communities (Destructive Monitoring Program)

Numbers of Taxa and Total Density

Numbers of taxa and total density (number of noncolonial macrofauna/m^2) have been used to monitor spatial and annual trends in the macrofaunal community. These parameters have been measured in August since 1978, and have shown broadscale changes in relation to depth. The number of taxa generally increased from intertidal through mid-depth stations, and declined slightly at the deep stations. Total density showed a general decrease with increasing depth, mainly due to decreases in juvenile Mytilidae (NAI 1991b).

In the intertidal area, the habitat at nearfield Station B1MLW was mostly algae-covered ledge (predominantly *Chondrus crispus*) and 10% mussel (mytilid) beds. The farfield Station (B5MLW) was similar, except for the presence of boulders, and its more-protected condition. Although the number of taxa in the operational period (1990 and 1991) was significantly below the preoperational average, this reduction was consistent at nearfield and farfield areas, resulting in a nonsignificant interaction term (Tables 3.3.3-1,2). Although the mean numbers of taxa during the operational period at both stations were significantly lower than the preoperational means, they were within the range of the preoperational period (NAI 1991b). The operational total density was significantly different from the preoperational at the nearfield station, as indicated by significant Station X Preop interaction (Table 3.3.3-2). The 1991 densities at B1MLW reached an all-time low, although the 1990 densities were near the record high (Table 3.3.3-1). Since the large decrease in 1991 occurred at both near- and farfield stations, it is not likely to be due to plar' operation.

In the shallow subtidal area (5 m) the nearfield station had a significantly higher number of taxa than the farfield station (Table 3.3.3-2), and the relationship, evident in 1990, continued into 1991 (Table 3.3.3-1). The habitat at both near- and farfield stations (B17, B35) was predominantly algae-covered ledge, and a small portion of crustose aigae-covered ledge. Boulders were present at the farfield station, while *Laminaria saccharina* and *L. digitata*, canopy-forming kelps, occurred at both stations (Section 3.3.2.2). The mean number of taxa at each station during the operational period was not significantly different than the preoperational mean, and the interaction between the near- and farfield stations was not significant (Table 3.3.3-2). The mean density at each station during the operational period was slightly higher, but within the 95% confidence limits of the preoperational mean, and there was no significant interaction between the near- and farfield stations (Tables 3.3.3-1,2).

In the mid-depth area (9-12 m), the habitat at nearfield Station B19 (discharge) included algae-covered ledge and boulders (60%) and horse mussel beds (40%). Its farfield counterpart, B31, had 60% horse mussel beds, algae-covered rocks (30%) and about 10% cobble. Substrate at the nearfield Station B16 (intake) was more similar to the nearfield shallow subtidal station, primarily algae-covered ledge (75%) with mussel beds (25%), without boulders or cobble. The algae at all three mid-depth stations was more diverse than the shallower stations, but *Phyllophora* spp. generally predominated. The significant increase in the number of axa in the operational period was consistent at all three stations (Tables 3.3.3-1,2). The numbers of taxa at all three mid-depth stations in 1991 were within the 95% C.I. of the preoperational means; however, in 1990, the means were very high at B19 and B31 (Table 3.3.3-1).

The operational density was not significantly different than the preoperational average at Station B19 (discharge station) or Stations B31. However, the operational density was signifi-

TABLE 3.3.3-1. PREOPERATIONAL MEAN AND 95% CONFIDENCE LIMITS AND 1990 AND 1991 MEAN NUMBER OF TAXA (per 1/16m^2) AND GEOMETRIC MEAN DENSITY (No./m^2) FOR TOTAL DENSITY (NON-COLONIAL MACROFAUNA) SAMPLED IN AUGUST AT INTERTIDAL, SHALLOW SUBTIDAL, MID-DEPTH AND DEEP STATIONS. SEABROOK OPERATIONAL REPORT, 1991.

		PREOPERATIONAL[a]			OPERATIONAL[b]	1990	1991
DEPTH ZONE	STATION	LCL	MEAN	UCL	MEAN	MEAN	MEAN
MEAN NO. OF TAXA (No. per 1/16 m^2)							
Intertidal	B1	43	49	55	35	39	31
	B5	42	48	55	41	46	36
Shallow subtidal	B17	54	58	62	65	67	62
	B35	51	55	59	54	56	52
Mid-depth	B16	63	70	76	71	68	74
	B19	60	68	76	75	86	64
	B31	45	51	56	58	71	46
Deep	B04	57	63	69	71	70	73
	B13	49	54	59	67	62	72
	B34	54	64	74	64	64	64
TOTAL DENSITY (No./m^2)							
Intertidal	B1	99,871	123,740	153,313	84,675	204,332	35,089
	B5	54,446	68,141	85,281	87,247	157,695	48,270
Shallow subtidal	B17	20,128	23,857	28,277	24,279	32,102	18,362
	B35	23,105	29,012	36,430	34,645	37,942	31,635
Mid-depth	B16	24,656	31,590	40,473	13,604	16,501	11,217
	B19	10,539	12,830	15,619	21,788	33,800	14,044
	B31	11,039	14,782	19,795	14,928	10,679	20,868
Deep	B04	4,246	4,936	5,737	3,878	3,216	4,676
	B13	4,535	6,073	8,132	7,991	11,575	5,517
	B34	4,244	5,523	7,187	5,898	8,630	4,031

[a]Preoperational period extends through 1989 (Stations B1MLW, B17, B19, B31: 1978-1989; Statons B5MLW, B35: 1982-1989; Station B16: 1980-1984, 1986-1989; Stations B13, B04: 1978-1984, 1986-1989; Station B34: 1979-1984, 1986-1989)
[b]Operational period - 1990 and 1991

TABLE 3.3.3-2. RESULTS OF ANALYSIS OF VARIANCE OF NUMBER OF TAXA (per 1/16 m^2) AND TOTAL DENSITY (per m^2) OF MACROFAUNA COLLECTED IN AUGUST AT INTERTIDAL, SHALLOW SUBTIDAL, AND DEEP STATION GROUPS, 1978-1991. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER	STATION GROUPS	CLASS VARIABLE	df	SS	F[a]	MULTIPLE COMPARISONS[e]
Number of Taxa	B1I, B5I	Preop-Op[b]	1	1,449.13	18.86***	Preop>Op
		Station[c]	1	47.91	0.62 NS	
		Year (Preop-Op)	12	6,785.21	7.36***	
		Station X Preop-Op[d]	1	274.07	3.57 NS	
		Error	100	7,682.41		
	B17, B35	Preop-Op[b]	1	112.85	1.29 NS	
		Station[c]	1	695.21	7.96**	B17>B35
		Year (Preop-Op)	12	2,537.98	2.42**	
		Station X Preop-Op[d]	1	262.75	3.01 NS	
		Error	100	8,737.75		
	B19, B31, B16	Preop-Op[b]	1	724.95	5.39*	Op>Preop
		Station[c]	2	5,940.81	22.07***	B16 B19 B31
		Year (Preop-Op)	12	10,276.55	6.36***	
		Station X Preop-Op[d]	2	242.38	0.90 NS	
		Error	172	23,146.67		
	B04, B34, B13	Preop-Op[b]	1	1,313.16	9.55**	Op>Preop
		Station[c]	2	767.40	2.79 NS	
		Year (Preop-Op)	11	10,827.61	7.16***	
		Station X Preop-Op[d]	2	609.86	2.22 NS	
		Error	173	23,797.78		

(Continued)

TABLE 3.3.3-2. (Continued)

PARAMETER	STATION GROUPS	CLASS VARIABLE	df	SS	F[a]	MULTIPLE COMPARISONS[e]
Total Density	B1MLW, B5MLW	Preop-Op[b]	1	0.02	0.29 NS	
		Station[c]	1	0.22	3.34 NS	
		Year (Preop-Op)	12	6.76	8.74***	
		Station X Preop-Op[d]	1	0.27	4.13*	B1 Pre B5 Op B1 Op B5 Pre
		Error	100	6.44		
	B17, B35	Preop-Op[b]	1	0.03	0.64 NS	
		Station[c]	1	0.25	4.79 NS	
		Year (Preop-Op)	12	3.26	5.30***	
		Station X Preop-Op[d]	1	0.01	0.28 NS	
		Error	100	5.12		
	B19, B31, B16	Preop-Op[b]	1	0.08	0.70 NS	
		Station[c]	2	0.31	1.39 NS	
		Year (Preop-Op)	12	9.36	7.09***	B16 Pre B19 Op B31 Pre B31 Op B16 Op B19 Pre
		Station X Preop-Op[d]	2	1.39	6.33**	
		Error	172	18.94		
	B04, B34, B13	Preop-Op[b]	1	0.01	0.11 NS	
		Station[c]	2	0.69	3.71*	B13 B34 B04
		Year (Preop-Op)	11	8.88	8.68***	
		Station X Preop-Op[d]	2	0.22	1.19 NS	
		Error	173	16.10		

[a] NS = Not significant (p>0.05)
* = Significant (0.05≥p>0.01)
** = Highly significant (0.01≥p>.001)
*** = Very highly significant (p≤.001)

[b] preoperational (through 1989) versus operational (1990 and 1991) period, regardless of station

[c] nearfield = Stations B1MLW, B17, B19, B16, B04, B13; farfield = Stations B5MLW, B35, B31, B34, regardless of year/period

[d] interaction between main effects

[e] underlining signifies no significant differences (α = 0.05) among least squares means with a paired T-test

cantly lower at B16 (intake), as indicated by the significant interaction term (Tables 3.3.3-1,2). In 1991, total density was at an all-time low at B16, reflecting a decreasing trend that began in 1989. Large fluctuation in mytilids, a dominant organism, contributed to the large variations in total density during the preoperational period. Yet, the operational mean density at each of the three stations was within the range observed during the preoperational period (NAI 1991b).

In the deepest area (18-21 m), horse mussel beds comprised over 50% of the substrate at all three stations; algae-covered ledge was generally the next most frequent substrate. Boulders mixed with algae- covered ledge were present at B34 (farfield) and B13 and cobble (5%) was present at B13 (intake). Neither boulders nor cobble was present at the discharge Station (B04). Algae at Station B13 were predominantly *Phyllophora* spp. (like the mid-depth stations), but at B04 and B34 *Ptilota serrata* was the numerical dominant. The number of macrofaunal taxa at the deep stations was significantly higher during the operational period. The trend was consistent at all three stations, as indicated by the lack of significance of the interaction term. The operational means were within the range of the preoperational period at all stations (NAI 1991b). The total density showed no significant difference between the operational and preoperational periods, and the Station X Preop-Op interaction was not significant (Table 3.3.3-2). The 1991 means for total density were close to the preoperational averages at all three stations (Table 3.3.3-1).

Community Structure

The noncolonial, macrofaunal, hard-bottom community structure at all near- and farfield stations has historically shown changes related to depth (NAI 1991b). Intertidal (B1MLW, B5MLW), shallow subtidal (B17, B35), mid-depth (B16, B19, B31), and deep (B04, B13, B34) areas were distinct in both species distributions and abundances. In most cases, based on the similarity in species composition, the 1991 collections were placed in the group with the majority of preoperational collections from the same station (Table 3.3.3-3, Figure 3.3.3-1). The intertidal, shallow subtidal, and mid-depth assemblages showed little year-to-year variation in their community structure. Benthic assemblages were less stable at deep stations, as evidenced by shifts in group assignment by the cluster analysis.

Spatial differences in community structure among depths were indicated by differences in densities of dominant taxa as well as species composition. Mytilidae was one of the dominant taxa in all depth zones. Less-abundant species, such as peracarids *Calliopius laeviusculus*, *Jassa marmorata*, *Jaera marina*, and gastropod *Lacuna vincta*, accounted for the majority of the among-station variability.

The intertidal habitat (Group 1) was the most distinct (between-group similarity of only 0.436) of all areas because of the overwhelming predominance of Mytilidae spat (69,205/m² preoperationally) and the presence of species such as *Nucella lapillus*, *Turtonia minuta*, *Jaera marina*, and *Hyale nilssoni*

TABLE 3.3.3-3. STATION GROUPS FORMED BY CLUSTER ANALYSIS[a] WITH PREOPERATIONAL AND OPERATIONAL (1990-1991) GEOMETRIC MEAN DENSITY ± 95% CONFIDENCE LIMITS FOR ABUNDANT MACROFAUNAL TAXA (NON-COLONIAL) COLLECTED ANNUALLY IN AUGUST FROM 1978 THROUGH 1991. SEABROOK OPERATIONAL REPORT, 1991.

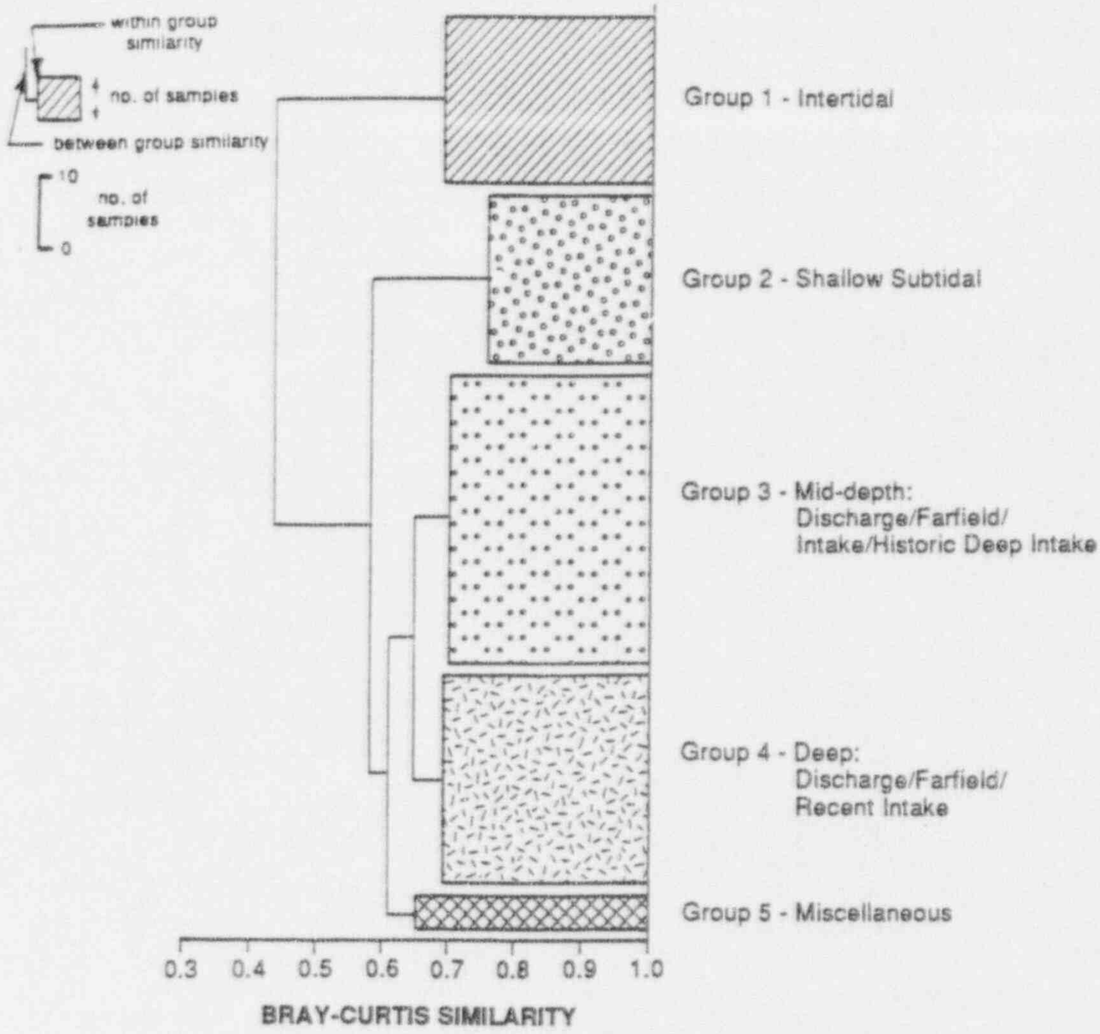
GROUP NO./ NAME SIMILARITY[b]	STATIONS (YEARS)	DOMINANT TAXA	PREOPERATIONAL LOWER	PREOPERATIONAL MEAN	PREOPERATIONAL UPPER	PREOPERATIONAL N	OPERATIONAL MEAN	OPERATIONAL N
1 Intertidal .686/.436	B1MLW (1978-91) B5MLW (1982-91)	Mytilidae	47977	69205	99824	20	65896	4
		Jaera marina	2116	3626	6216		993	
		Lacuna vincta	2035	3209	5060		3267	
		Oligochaeta	1203	2030	3423		1457	
		Turtonia minuta	1367	2707	5360		2065	
		Hiatella sp.	1464	2604	4631		865	
		Nucella lapillus	925	1501	2432		2663	
		Gammarellus angulosus	181	572	1803		82	
		Gammarus oceanicus	241	564	1318		132	
		Anomia sp.	373	493	650		550	
2 Shallow subtidal .759/.582	B17 (1978-91) B35 (1982-91)	Mytilidae	2905	4758	7793	20	5558	4
		Lacuna vincta	3761	5379	7694		11004	
		Idotea phosphorea	1695	2166	2768		2090	
		Pontogeneia inermis	1248	1773	2518		838	
		Jassa marmorata	1097	1572	2254		859	
		Caprella septentrionalis	479	701	1027		501	
		Idotea balthica	508	890	1559		1106	
		Asteriidae	385	602	940		2048	
		Hiatella sp.	129	186	270		93	

(continued)

TABLE 3.3.3-3. (Continued)

GROUP NO./ NAME SIMILARITY[b]	STATIONS (YEARS)	DOMINANT TAXA	PREOPERATIONAL LOWER	PREOPERATIONAL MEAN	PREOPERATIONAL UPPER	PREOPERATIONAL N	OPERATIONAL MEAN	OPERATIONAL N
3 Mid-Depth: Discharge/ Farfield/ Intake/ Recent Deep Intake .652/.704	B19 (1979-91)	Mytilidae	3582	5791	9363	34	5321	8
	B31 (1979-91)	*Pontogeneia inermis*	994	1527	2346		760	
	B16 (1980-84, 86-91)	*Caprella septentrionalis*	642	974	1476		568	
	B13 (1986-87, 89-91)	*Anomia* sp.	576	798	1105		919	
		Hiatella sp.	520	759	1105		535	
		Lacuna vincta	276	406	597		327	
		Balanus crenatus	30	88	251		369	
4 Deep: Discharge/ Farfield/ Intake .668/.652	B04 (1979-84, 86-91)	*Pontogeneia inermis*	211	297	420	27	100	4
	B13 (1978-84, 88)	Asteriidae	185	249	334		277	
	B34 (1979, 81-84, 86-91)	*Anomia* sp.	158	247	388		614	
		Tonicella rubra	132	157	187		67	
		Caprella septentrionalis	99	154	238		88	
		Mytilidae	107	184	316		142	
		Balanus crenatus	6	27	111		67	
		Thelepus cincinnatus	8	19	44		169	
5 Misc. .647/.609	B19 (1978)	*Pontogeneia inermis*	83	817	7986	4	-	0
	B31 (1978)	Mytilidae	3	148	5052		-	
	B34 (1980)	*Caprella septentrionalis*	149	235	369		-	
	B04 (1978)	*Hiatella* sp.	19	166	1365		-	
		Lacuna vincta	36	158	670		-	
		Anomia sp.	84	211	528		-	
		Asteriidae	96	221	507		-	

[a]Bray Curtis similarity coefficient (Clifford and Stephenson 1975) with group average agglomeration for the clustering method (Sneath and Sokal 1973)
[b]within/between group similarity



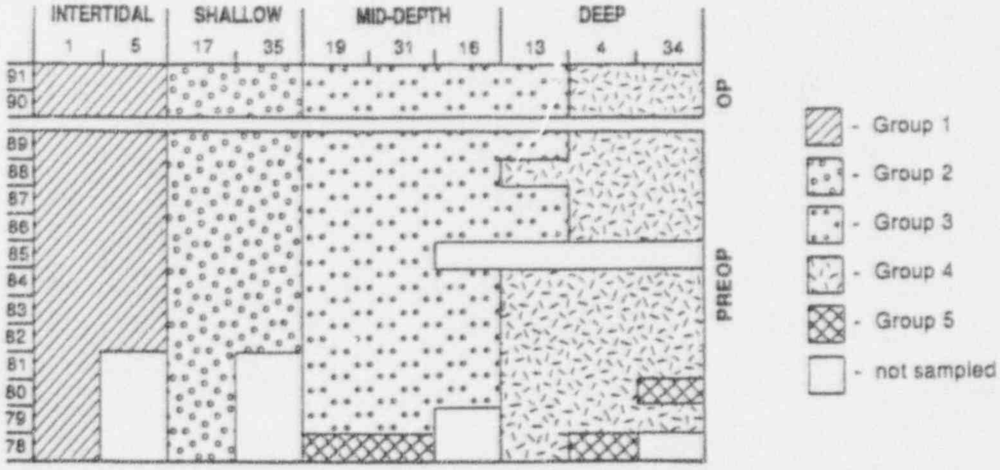


Figure 3.3.3-1. Dendrogram and spatial groups by year formed by numerical classification of August collections of marine macrofauna, 1978-1991. Seabrook Operational Report, 1991.

(less common) that are restricted to or most abundant in the intertidal zone (Table 3.3.3-3). Other dominants included the molluscs *Hiatella* sp. spat and *Lacuna vincta*, and the amphipod *Gammarellus angulosus*. Every intertidal collection taken, including the 1991 collections, was placed in Group 1 based on similar species composition and abundance. During the operational period (1990 and 1991) densities of *Jaera marina*, *Hiatella* sp., *Gammarellus angulosus*, *Gammarus oceanicus* and Oligochaeta decreased, whereas *Nucella lapillus* increased. Densities of mytilids and the three other most common species essentially showed no change (Table 3.3.3-3).

The shallow subtidal habitat (Group 2) includes Stations B17 and B35 and had the highest within-group similarity (Table 3.3.3-3). Mytilidae was still the predominant taxon, although an order-of-magnitude less abundant than in the intertidal area. Aside from the herbivorous gastropod, *Lacuna vincta*, and juvenile Asteriidae, dominants were peracarid crustaceans such as *Pontogeneia inermis*, *Caprella septentrionalis*, *Idotea phosphorea*, *I. balthica*, and *Jassa marmorata* (Table 3.3.3-3). Relatively high densities of the latter three species, along with the presence of *Calliopius laeviusculus* distinguished the shallow subtidal area from other areas. Stations B17 and B35 were placed in this group every year. During the operational period, juvenile Asteriidae showed the largest increase in abundance (due to a good set in 1990 at B35)(NAI 1991b). All other species were within the 95% confidence limits of the preoperational mean except *J. marmorata*, *P. inermis* and *Hiatella* sp., which were below it (Table 3.3.3-3).

Group 3 (primarily mid-depth stations and the deep intake station (B13) for most years since 1986) had the lowest within-group similarity of the four major groups. It was usually characterized by a predominance of Mytilidae and the amphipods *Pontogeneia inermis* and *Caprella septentrionalis* (Table 3.3.3-3). Stations B31 (farfield), B19 (discharge) and B16 (mid-depth intake) were characterized by this assemblage every year except 1978. Since 1986, Station B13 (deep intake) had joined this assemblage, except for 1988. The 1991 collections at all four stations were similar to previous years, and thus placed in the same group. During the operational period, numbers of amphipods decreased, and numbers of the barnacle *Balanus crenatus* increased.

Collections at deep Stations B04, B34, and B13 in some years (1978-84, 1988) comprised Group 4. The stations in Group 4 typically have low total density of macrofauna when compared to shallower stations. Total density of Group 4 was low due to low numbers of bivalve molluscs, particularly Mytilidae and *Anomia* sp. Crustaceans such as *Pontogeneia inermis*, and *Caprella septentrionalis* and juvenile starfish, Asteriidae, took on greater importance in this depth zone. Species with low abundance at shallower stations such as the northern red chiton, *Tonicella rubra*, and the tube-building fan worm, *Thelepus cincinnatus*, ranked among the most abundant at deep stations.

Group 5 consisted of only four samples, three of which were taken in 1978 at Stations B19, B31, and B04. The group was characterized by relatively low abundances of the molluscs Mytilidae, *Hiatella* sp., *Lacuna vincta* and *Anomia* sp., and high densities of *Pontogeneia inermis*. No collections have been similar to Group 5 since 1980.

3.3.3.2 Intertidal Communities (Non-destructive Monitoring Program)

Dominant intertidal species from the bare rock habitat (mean high water zone), the *Fucus* spp. habitat (mean sea level zone) and the *Chondrus crispus* habitat (mean low water zone) were monitored non-destructively at fixed stations on nearfield Outer Sunk Rocks (Station B1) and farfield Rye Ledge (Station B5) three times per year. The bare rock areas near mean high water supported low percentages of algae such as *Porphyra* spp. at intertidal Station B1 and *Fucus* spp. at farfield Station B5 (Section 3.3.2). The predominant macrofaunal resident was *Balanus* spp., which was most abundant in the bare rock habitat. *Balanus* spp. frequencies at both stations were slightly higher in April following the spring recruitment period than in July and December (Table 3.3.3-4). Preoperationally and in 1991, the nearfield station almost always had a lower frequency of *Balanus* spp. than the farfield station. Herbivorous gastropods, *Littorina littorea* and *Littorina saxatilis*, were also important constituents of the bare rock community, showing lower frequencies in April than in July or December during the preoperational period. Their densities during the operational period were within the preoperational range, except for *L. littorea*, which reached an all-time high in December 1991 at Station B1. Mytilid spat were least abundant in the bare rock zone, except for a large set which occurred at B5 in 1990. It did not reoccur in 1991, when mytilid densities were within the preoperational range.

Fucoid-covered ledge areas at approximately mean sea level were characterized by a heavy cover (over 80%) of the perennial algae *Fucus* spp. (mainly *F. vesiculosus*), with an understory of perennial red algae (*Mastocarpus stellatus* and, less frequently, *Chondrus crispus*)(Section 3.3.2). During both the preoperational and operational periods, Mytilidae was the most common taxon at nearfield Station B1, with high frequencies during all three sample periods (Table 3.3.3-4). Mytilidae usually did not show high frequencies at Station B5, where *Balanus* spp. were more common. Likewise, *Nucella lapillus*, an important mytilid predator in the fucoid zone, was more frequent at B1. It was most commonly encountered in July, during both preoperational and operational periods. Other common gastropods were *Acmaea testudinalis*, *Littorina obtusata* and *Littorina littorea* (almost exclusively occurring at Station B5). Frequencies in 1991 were within the baseline range except for *Acmaea testudinalis* whose occurrence in April at B5 exceeded the preoperational range (Table 3.3.3-4).

The *Chondrus* zone, at approximately mean low water, was characterized by rock ledge with a thick cover of red algae, mainly *Chondrus crispus* and

TABLE 3.3.3-4. MEDIAN AND RANGE OF PERCENT FREQUENCIES[a] OF THE DOMINANT FAUNA AT BARE ROCK, FUCOID LEDGE, AND CHONDRUS ZONE INTERTIDAL SITES AT STATIONS B1 (OUTER SUNK ROCKS) AND B5 (RYE LEDGE) MONITORED NONDESTRUCTIVELY DURING PREOPERATIONAL PERIOD (1982-1989) AND IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

				BARE ROCK[c]			FUCOID LEDGE[c]			CHONDRUS ZONE[c]		
	PERIOD[b]			APR	JUL	DEC	APR	JUL	DEC	APR	JUL	DEC
Acmaea testudinalis	PREOP	B1	median	0	0	0	0	6	13	13	13	13
			(range)	(0)	(0)	(0)	(0-25)	(0-38)	(6-69)	(6-38)	(0-25)	(6-81)
	1990		% freq.	0	0	0	12	12	12	6	19	31
	1991		% freq.	0	0	0	6	25	0	19	12	12
	PREOP	B5	median	0	0	0	6	6	10	0	0	0
			(range)	(0)	(0)	(0)	(0-19)	(0-38)	(0-38)	(0-44)	(0-13)	(0-25)
	1990		% freq.	0	0	0	12	38	25	12	0	0
	1991		% freq.	0	0	0	25	31	12	12	6	6
Balanus spp.	PREOP	B1	median	61	51	9	10	8	1	0	0	0
			(range)	(<1-100)	(9-88)	(0-88)	(0-100)	(1-38)	(0-63)	(0-47)	(0-4)	(0)
	1990		% freq.	35	35	27	19	11	1	7	7	0
	1991		% freq.	41	46	48	10	3	0	0	0	<1
	PREOP	B5	median	89	85	72	31	23	5	0	0	0
			(range)	(58-100)	(24-100)	(5-100)	(6-100)	(12-100)	([illegible]-88)	(0)	(0)	(0-3)
	1990		% freq.	96	88	59	31	21	9	0	0	0
	1991		% freq.	95	67	11	35	26	9	0	0	0
Littorina littorea	PREOP	B1	median	0	0	0	0	0	0	0	0	0
			(range)	(0)	(0-13)	(0-13)	(0)	(0-6)	(0-6)	(0)	(0-13)	(0-6)
	1990		% freq.	0	0	6	0	0	0	19	25	19
	1991		% freq.	0	0	75	0	0	6	19	6	12
	PREOP	B5	median	0	13	82	10	53	9	81	100	88
			(range)	(0-6)	(0-56)	(13-100)	(0-38)	(13-75)	(0-31)	(75-100)	(94-100)	(44-94)
	1990		% freq.	0	25	88	25	38	25	94	100	75
	1991		% freq.	62	44	25	19	44	0	81	100	9
Littorina obtusata	PREOP	B1	median	0	0	0	3	10	6	0	0	0
			(range)	(0)	(0-19)	(0)	(0-6)	(0-25)	(6-19)	(0-13)	(0-44)	(0-13)
	1990		% freq.	0	0	0	25	0	25	0	0	6
	1991		% freq.	12	0	0	6	19	12	0	0	6
	PREOP	B5	median	0	6	0	3	16	7	0	0	0
			(range)	(0-6)	(0-19)	(0-13)	(0-25)	(0-44)	(0-44)	(0-13)	(0)	(0)
	1990		% freq.	0	12	6	0	12	25	12	0	0
	1991		% freq.	6	19	0	12	31	37	0	0	0
	1991		% freq.									
Littorina saxatilis	PREOP	B1	median	7	57	16	0	0	0	0	0	0
			(range)	(0-44)	(0-88)	(0-88)	(0)	(0)	(0-6)	(0)	(0)	(0)
	1990		% freq.	0	0	12	0	0	0	0	0	0
	1991		% freq.	37	81	0	0	0	0	0	0	0
	PREOP	B5	median	50	66	75	0	0	0	0	0	0
			(range)	(0-100)	(38-94)	(6-100)	(0-6)	(0)	(0-6)	(0)	(0)	(0)
	1990		% freq.	100	100	88	0	0	0	0	0	0
	1991		% freq.	81	50	50	0	0	0	0	0	0	25

(continued)

TABLE 3.3.3-4. (Continued)

	PERIOD[b]			BARE ROCK[c] APR	BARE ROCK[c] JUL	BARE ROCK[c] DEC	FUCOID LEDGE[c] APR	FUCOID LEDGE[c] JUL	FUCOID LEDGE[c] DEC	CHONDRUS ZONE[c] APR	CHONDRUS ZONE[c] JUL	CHONDRUS ZONE[c] DEC
Mytilidae	PREOP	B1	median	0	8	3	82	76	78	90	89	65
			(range)	(0-20)	(0-40)	(0-75)	(37-100)	(27-100)	(43-100)	(54-95)	(71-95)	(15-85)
	1990		% freq.	0	11	18	73	82	69	55	84	63
	1991		% freq.	11	26	30	[illegible]	93	95	95	95	63
	PREOP	B5	median	0	15	33	8	1	5	49	63	26
			(range)	(0-38)	(0-38)	(1-75)	(2-100)	(0-100)	(0-100)	(10-72)	(23-80)	(0-49)
	1990		% freq.	30	47	26	9	16	8	46	69	15
	1991		% freq.	10	6	4	5	0	11	0	27	8
<u>Nucella lapillus</u>	PREOP	B1	median	0	0	0	6	100	25	75	100	56
			(range)	(0)	(0)	(0-6)	(0-25)	(25-100)	(6-50)	(13-100)	(100)	(31-88)
	1990		% freq.	0	0	0	6	100	12	12	100	19
	1991		% freq.	6	0	6	12	100	6	81	100	19
	PREOP	B5	median	0	0	0	0	28	0	94	38	69
			(range)	(0-94)	(0-44)	(0-56)	(0)	(6-81)	(0-6)	(75-100)	(13-56)	(56-81)
	1990		% freq.	0	6	0	0	19	0	100	75	75
	1991		% freq,	0	12	0	0	44	0	100	37	19

[a]Method of computing percent frequency varies among species (point-contact method for Mytilidae and <u>Balanus</u> since July 1983, percent frequency of occurrence for all other instances).
[b]PREOP period is 1982-1989, except for <u>Chondrus</u> zone, where sampling began in April, 1985.
[c]Bare ledge station is at upper edge of MSL zone, at approximate mean high water. Fucoid station is at approximate mean sea level mark. <u>Chondrus</u> zone station, first sampled in 1985, is at approximate mean low water mark.

Mastocarpus stellatus. At Station B1, *Fucus* spp. were also frequently encountered (Section 3.3.2). Of the macrofaunal species monitored, *Nucella lapillus* and Mytilidae spat were the most frequently encountered at both stations (Table 3.3.3-4). During the preoperational period, Mytilidae had medium-to-high frequencies in April and July with generally lower percentages in December. At Station B1, *Nucella* was more abundant in July than in April or December. In 1991, both *Nucella* and mytilid spat were within the preoperational range and showed similar seasonal patterns, except at Station B5, where mytilids were absent in April. No relationship between abundance levels of either Mytilidae or *Nucella* at mean low water or within the fucoid habitat at mean sea level has been noted (NAI 1987b). The gastropod, *Littorina littorea*, occurred in high frequencies at only Station B5 throughout the year, and was most numerous in the *Chondrus* zone. In 1990 and 1991, it occurred with moderate frequencies at B1 also. *Acmaea testudinalis* was enumerated in low-to-moderate frequencies in the *Chondrus* zone at Station B1 in all years and occasionally at Station B5; frequencies followed the same pattern in 1991.

3.3.3.3 Subtidal Fouling Community (Bottom Panel Monitoring Program)

Panels set at mid-depth stations (B19, B31) near the bottom were sampled triannually in April, August, and December to provide information on recruitment of four sessile macrofaunal species. *Balanus* spp. (mainly *Balanus crenatus*, with some *Balanus balanus*) typically settled by April. Recruitment continued in some years after the April sampling period and densities were higher in the August samples, while in other years April sampling occurred near the settlement peak (Table 3.3.3-5). By December, densities were consistently low, as *Balanus* populations disappeared due to mortality. In 1991, the *Balanus* set at both stations was later than average, as densities were low (below the baseline average) in April, but above the baseline average in August.

Anomia sp. was unique among the sessile taxa that were examined, showing a pattern of late summer-fall recruitment. Although low densities of *Anomia* sometimes occurred on panels by August, numbers were typically highest in December when abundances of all other sessile taxa were low (Table 3.3.3-5). In 1991, *Anomia* densities were very close to the baseline average in December at both stations while in April and August, the densities were well above the preoperational averages.

Hiatella sp. is a sessile bivalve that showed highest densities in August collections and had low abundances in April and December samples during the baseline period. Densities in 1991 were near average at the nearfield station, and very high at the farfield station in August. The 1991 seasonal pattern at both stations was similar to the preoperational trend (Table 3.3.3-5).

During the preoperational period, Mytilidae spat had generally settled on bottom panels by August, with numbers greatly reduced by December (Table

TABLE 3.3.3-5. ESTIMATED DENSITY (per 1/4 m^2) AFTER FOUR MONTHS' EXPOSURE OF SELECTED SESSILE TAXA ON HARD-SUBSTRATE BOTTOM PANELS AT STATIONS B19 AND B31 SAMPLED TRIANUALLY (APRIL, AUGUST, DECEMBER) FROM 1981-1991. SEABROOK OPERATIONAL REPORT, 1991.

		PREOP (1981[a]-1984, 1986[b], 1987-1989)						1990			1991		
		APR		AUG		DEC		APR	AUG	DEC	APR	AUG	DEC
		MEAN	SD	MEAN	SD	MEAN	SD						
Balanus spp.	Sta. B19	17053	13793	6403	4973	9	13	46366	3350	0	6017	11883	0
	Sta. B31	40962	22611	7917	6166	14	17	53333	700	0	14833	8617	0
Anomia sp.	Sta. B19	<1	<1	31	68	1232	1136	6	125	3100	193	154	1232
	Sta. B31	0	0	36	42	993	1246	6	345	1766	4	338	645
Ntatella sp.	Sta. B19	1	2	3966	2595	27	31	0	6117	36	3	3450	2
	Sta. B31	<1	<1	11659	10594	16	21	12	16304	49	2	23947	31
Mytilidae	Sta. B19	2	3	367	247	58	57	0	1083	44	55	537	56
	Sta. B31	8	11	5035	10054	36	36	20	4786	104	19	7351	112

[a]In 1981 only *Balanus* spp. and *Anomia* sp. were counted at Sta. B19. In 1982 only *Balanus* spp. and *Anomia* sp. were counted at both stations. In 1983 counts of all four taxa at both stations began. No samples were taken in 1985.
[b]Only December collections were made in 1986.

3.3.3-5). The density in August 1991 was within one standard deviation of the preoperational average at both stations. The December densities in 1990 and 1991 were near the baseline average at B19, and above the average at B31.

3.3.3.4 Effects of Plant Operation

Impact on the macrofaunal benthic community was judged by comparing preoperational and operational means for number of taxa and total density, as well as comparing the community using cluster analysis. If the preoperational and operational means at the nearfield and farfield stations showed the same trend, the trend was areawide, and thus, not related to plant operation. If the trends were different, as evidenced by a significant interaction term, significant changes must have occurred during the operational period at a nearfield station in order to show an impact. All three methods had similar outcomes. The only parameter to change significantly between preoperational and operational periods was total density of individuals at B16, the mid-depth intake station, which decreased during the operational period. However, there was no change in number of taxa or community structure.

The frequencies of the dominant species in fixed quadrats in the intertidal zone during the operational period were generally within range of the preoperational frequencies, and the seasonal patterns remained the same. Occasional all-time highs or lows appeared during one season, but seldom persisted to the following season. The dominant fauna of the intertidal community appeared very stable, with no major population changes between the operational and preoperational periods for any species.

In 1991, the densities or frequencies of the four dominant sessile species on bottom fouling panels were close to the preoperational averages, and the seasonal patterns remained the same. In 1991, the density of *Hiatella* sp. in August was well above average at the farfield station, while the nearfield station was close to the preoperational average. By December 1991, the *Hiatella* sp. densities were within one standard deviation of the preoperational average. The dominant sessile species are very stable, and no major population changes between operational or preoperational periods have been observed.

3.3.4 Surface Fouling Panels

The surface fouling panels program was designed to study both settlement patterns and community development in the discharge plume area and in corresponding farfield areas. Short-term panels submerged for one month, provided information on the temporal sequence of settlement activity, while monthly sequential panels, exposed from one to twelve months, provided information on growth and successional patterns of community structure.

3.3.4.1 Seasonal Settlement Patterns (Short-term Panels)

Faunal Richness and Abundance

Development of a typical fouling community begins with bacterial invasion, followed by colonization by diatoms and other microorganisms that are apparently prerequisites to recruitment of larvae and spores (Wahl 1989). The intensity of recruitment on short-term panels, measured by the richness and abundance of noncolonial organisms, gives an indication of the potential for fouling community development.

Seasonal cycles in faunal richness in 1991 were similar to historical trends with one exception. Number of taxa sharply increased in April (B04) or May (B19), earlier than usual, and remained high through September (B04) or October (B19, Figure 3.3.4-1). Number of taxa was higher than average during the peak period in 1991, a trend that occurred in 1990 both before and during plant operation (Figure 3.3.4-1). Average numbers of taxa in 1991 were significantly higher than during the preoperational period at both nearfield and farfield stations (Tables 3.3.4-1,2). Since the increase occurred at both nearfield and farfield stations, it is indicative of an area-wide trend and not related to operation of Seabrook Station.

The seasonal patterns of faunal abundance were similar to those of faunal richness. In 1991, as in previous years, abundances remained low from January through April, increased in May and remained high through September (B04) or October (B19, Figure 3.3.4-1). Annual mean abundances in 1991 were similar to previous years at the discharge station (B19) and its farfield counterpart (B31, Table 3.3.4-1), a pattern supported by analysis of variance (ANOVA) results (Table 3.3.4-2). Abundances in 1991 at nearfield Station B04, more distant from the discharge than B19, were higher than average in July and August, repeating the pattern noted in 1990 (Figure 3.3.4-1). ANOVA results indicate 1991 abundances at B04 and B34 were significantly higher than preoperational abundances (Table 3.3.4-2). Since the difference occurred at both nearfield and farfield stations, it is unrelated to operation of Seabrook Station.

Biomass

Seasonal settling patterns for the entire fouling community (motile fauna, colonial organisms, macroalgae) are best demonstrated by changes in biomass. The dry-weight biomass (g/panel) for short-term panels paralleled the pattern observed for the seasonal distribution of faunal abundance and richness, although it was compressed into a shorter period. The seasonal trend in total biomass at nearfield Station B19 in 1991 was similar to historical observations. The highest biomass at B19 occurred in September (Figure 3.3.4-1) coincident with highest numbers of bivalves such as Mytilidae, *Hiatella* sp. and *Anomia* sp., and frequencies of the hydroid *Tubularia* sp. (Figure 3.3.4-2). Peak biomass was higher than that observed during the preoperational period, although lower than the levels in 1990 (Figure 3.3.4-1). At B04, the seasonal trend approxi-

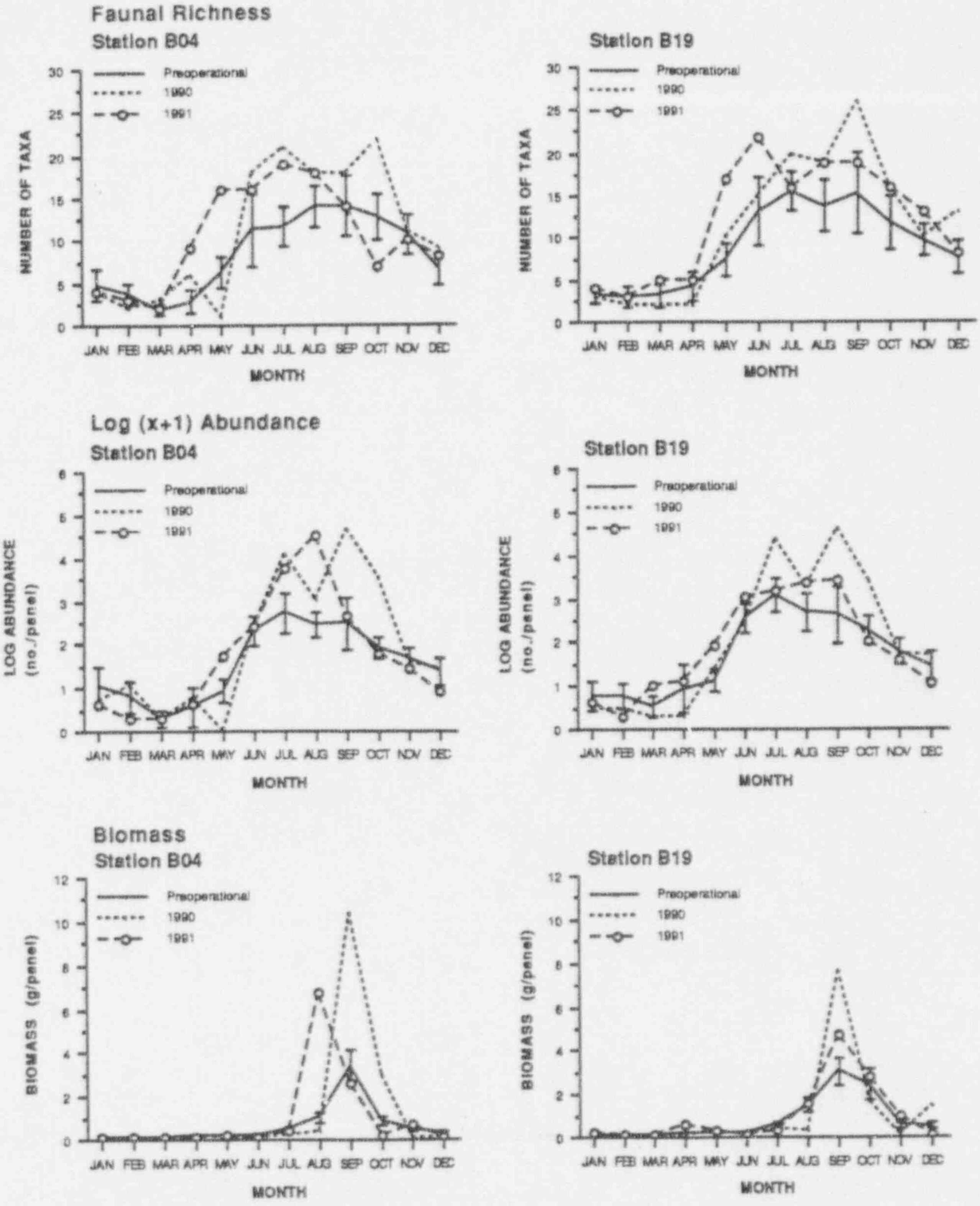


Figure 3.3.4-1. Monthly faunal richness (number of faunal taxa on two replicate panels) abundance, and biomass in 1990 and 1991 compared to means and 95% confidence limits on **short-term panels** at nearfield Stations B04 and B19 during preoperational period (1978-1984 and July 1986-December1989). Seabrook Operational Report, 1991.

TABLE 3.3.4-1. MEANS (PER/PANEL) AND 95% CONFIDENCE LIMITS OF SELECTED PARAMETERS AND SPECIES ABUNDANCES AT STATIONS B19, B31, B04, AND B34 OVER THE PREOPERATIONAL YEARS AND MEANS IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER/ TAXON	PANEL[a] TYPE	STATION	PREOPERATIONAL YEARS[b]			1990	1991
			LCL	$\bar{x}$[c]	UCL	$\bar{x}$[c]	$\bar{x}$[c]
No. of faunal taxa	ST	B19	8.2	9.2	10.3	11.4	12.3
		B31	7.7	8.7	9.7	11.7	9.8
		B04	7.6	8.5	9.5	11.0	10.4
		B34	7.6	8.8	10.1	10.4	11.7
Total noncolonial abundance	ST	B19	36.9	56.2	85.4	99.5	74.6
		B31	46.6	72.7	112.9	129.7	52.6
		B04	24.7	36.8	54.6	89.1	52.1
		B34	23.0	37.1	59.5	53.1	81.7
Total biomass (g)	ST	B19	0.5	0.8	1.1	1.0	1.0
		B31	0.4	0.6	0.9	1.5	0.2
		B04	0.4	0.6	0.9	1.2	0.9
		B34	0.5	1.0	1.5	0.6	0.8
Mytilidae	ST	B19	20.2	32.2	50.9	61.3	44.4
		B31	24.8	40.5	65.9	77.6	25.0
		B04	13.1	20.2	30.9	53.0	30.4
		B34	11.6	19.9	33.5	27.6	32.7
Jassa marmorata	ST	B19	2.4	3.3	4.6	1.3	2.4
		B31	2.9	4.2	5.9	4.2	3.2
		B04	1.9	2.7	3.7	1.8	2.9
		B34	1.6	2.4	3.6	3.6	3.8
Tubularia spp.	ST	B19	1.2	1.9	2.9	15.8	1.6
		B31	0.7	1.2	1.9	12.2	0.1
		B04	1.0	1.6	2.5	16.7	2.7
		B34	1.3	2.5	4.3	16.7	2.1
Biomass (g)	MS	B19	97.0	143.9	190.8	72.1	262.8
		B31	121.2	175.2	229.3	53.6	168.5
		B04	84.8	131.0	177.1	34.7	176.0
		B34	102.7	175.7	249.1	22.5	270.1

[a] ST = short term MS = monthly sequential
[b] Preoperational = 1978-1984; Jul 1986-Dec 1989 except B34, which was first sampled in 1982
[c] Geometric mean for total abundance, and Mytilidae and *J. marmorata* abundance
Percent frequency of occurrence for *Tubularia* sp.

TABLE 3.3.4-2. RESULTS OF ANALYSIS OF VARIANCE COMPARING MONTHLY NUMBER OF FAUNAL TAXA, ABUNDANCE, TOTAL BIOMASS, AND SELECTED SPECIES ABUNDANCE OR PERCENT FREQUENCY ON SHORT TERM PANELS AT MID-DEPTH (B19, B31) AND DEEP (B04, B34) STATION PAIRS DURING PREOPERATIONAL (1978-1989) AND OPERATIONAL (1991) PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

PARAMETER	STATIONS	SOURCE OF VARIATION	df	SS	F[f]	MULTIPLE COMPARISONS
Number of faunal taxa	B19, B31	Preop-Op[a]	1	85.06	14.93***	Op>Preop
		Year (Preop-Op)[b]	10	832.75	14.[illegible]***	
		Month (Year)[c]	125	7,276.79	10.22***	
		Station[d]	1	50.41	8.85**	
		Preop-Op X Station[e]	1	21.07	3.70 NS	
		Error	133	757.79		
	B04, B34	Preop-Op	1	146.57	29.35***	Op>Preop
		Year (Preop-Op)	10	711.04	14.24***	
		Month (Year)	125	5,771.03	9.25***	
		Station	1	1.62	0.32 NS	
		Preop-Op X Station	1	19.62	3.93 NS	
		Error	88			
Noncolonial faunal abundance	B19, B31	Preop-Op	1	<0.01	0.06 NS	
		Year (Preop-Op)	10	20.38	19.95***	
		Month (Year)	125	255.23	19.99***	
		Station	1	0.01	0.07 NS	
		Preop-Op X Station	1	0.38	3.70 NS	
		Error	133	13.58		
	B04, B34	Preop-Op	1	1.08	13.28***	Op>Preop
		Year (Preop-Op)	10	12.84	15.76***	
		Month (Year)	125	190.93	18.75***	
		Station	1	0.17	2.08 NS	
		Preop-Op X Station	1	0.22	2.65 NS	
		Error	88	7.17		

(continued)

TABLE 3.3.4-2. (Continued)

PARAMETER	STATIONS	SOURCE OF VARIATION	df	SS	F[f]	MULTIPLE COMPARISONS
Biomass	B19, B31	Preop-Op	1	0.41	0.39 NS	B19>B313
		Year (Preop-Op)	8	18.00	2.18*	
		Month (Year)	103	292.16	2.75***	
		Station	1	4.99	4.85*	
		Preop-Op X Station	1	1.82	1.77 NS	
		Error	111	114.36		
	B04, B34	Preop-Op	1	0.01	0.01 NS	
		Year (Preop-Op)	8	18.91	2.85**	
		Month (Year)	103	493.32	5.77***	
		Station	1	0.34	0.40 NS	
		Preop-Op X Station	1	1.49	1.80 NS	
		Error	88	73.10		
Mytilidae	B19, B31	Preop-Op	1	0.05	0.44 NS	Op Pre Op Pre B19 B31 B31 B19
		Year (Preop-Op)	10	20.80	17.52***	
		Month (Year)	125	308.96	20.82***	
		Station	1	0.11	0.90 NS	
		Preop-Op X Station	1	0.64	5.39*	
		Error	133	15.79		
	B04, B34	Preop-Op	1	0.53	5.41*	Op>Preop
		Year (Preop-Op)	10	12.74	13.03***	
		Month (Year)	125	220.23	18.02***	
		Station	1	<0.01	0.05 NS	
		Preop-Op X Station	1	0.00	0.05 NS	
		Error	88	8.60		

(continued)

TABLE 3.3.4-2. (Continued)

PARAMETER	STATIONS	SOURCE OF VARIATION	df	SS	F^f	MULTIPLE COMPARISONS
Jassa marmorata	B19, B31	Preop-Op	1	0.22	2.21 NS	
		Year (Preop-Op)	10	6.45	6.37***	
		Month (Year)	125	93.01	7.35***	
		Station	1	0.17	1.72 NS	
		Preop-Op X Station	1	0.00	0.01 NS	
		Error	133	13.47		
	B04, B34	Preop-Op	1	0.29	2.27 NS	
		Year (Preop-Op)	10	5.43	4.28***	
		Month (Year)	125	62.99	3.98***	
		Station	1	0.00	0.00 NS	
		Preop-Op X Station	1	0.16	1.28 NS	
		Error	88	11.15		
Balanus sp.	B19, B31	Preop-Op	1	0.02	0.89 NS	
		Year (Preop-Op)	10	3.46	15.49***	
		Month (Year)	125	36.69	13.14***	
		Station	1	0.04	1.77 NS	
		Preop-Op X Station	1	0.01	0.51 NS	
		Error	133	2.97		
	B04, B34	Preop-Op	1	0.01	0.88 NS	
		Year (Preop-Op)	10	0.95	8.01***	
		Month (Year)	125	13.76	9.26***	
		Station	1	0.03	2.15 NS	
		Preop-Op X Station	1	0.02	1.62 NS	
		Error	88	1.05		

(continued)

TABLE 3.3.4-2. (Continued)

PARAMETER	STATIONS	SOURCE OF VARIATION	df	SS	F[f]	MULTIPLE COMPARISONS
Tubularia sp.	B19, B31	Preop-Op	1	0.72	4.46*	Preop>Op
		Year (Preop-Op)	10	9.74	6.00***	
		Month (Year)	125	87.81	4.33***	
		Station	1	1.45	8.92**	
		Preop-Op X Station	1	0.38	2.35 NS	
		Error	133	21.59		
	B04, B34	Preop-Op	1	0.20	2.14 NS	
		Year (Preop-Op)	10	9.74	10.33***	
		Month (Year)	125	97.57	8.28***	
		Station	1	0.02	0.20 NS	
		Preop-Op X Station	1	0.04	0.39 NS	
		Error	88	8.30		

[a] Preop-Op = 1991 v. previous years (1978-84; July 1986-December 1989 except B34, which began in 1982) regardless of station
[b] Year nested within preoperational and operational periods regardless of station
[c] Month nested within year regardless of station
[d] Station regardless of year or period
[e] Interaction between main effects
[f] NS = Not significant (p≥0.05)
  * = Significant (0.05≥p>0.01)
 ** = Highly significant (.01≥p>0.001)
*** = Very Highly Significant (0.001≥p)

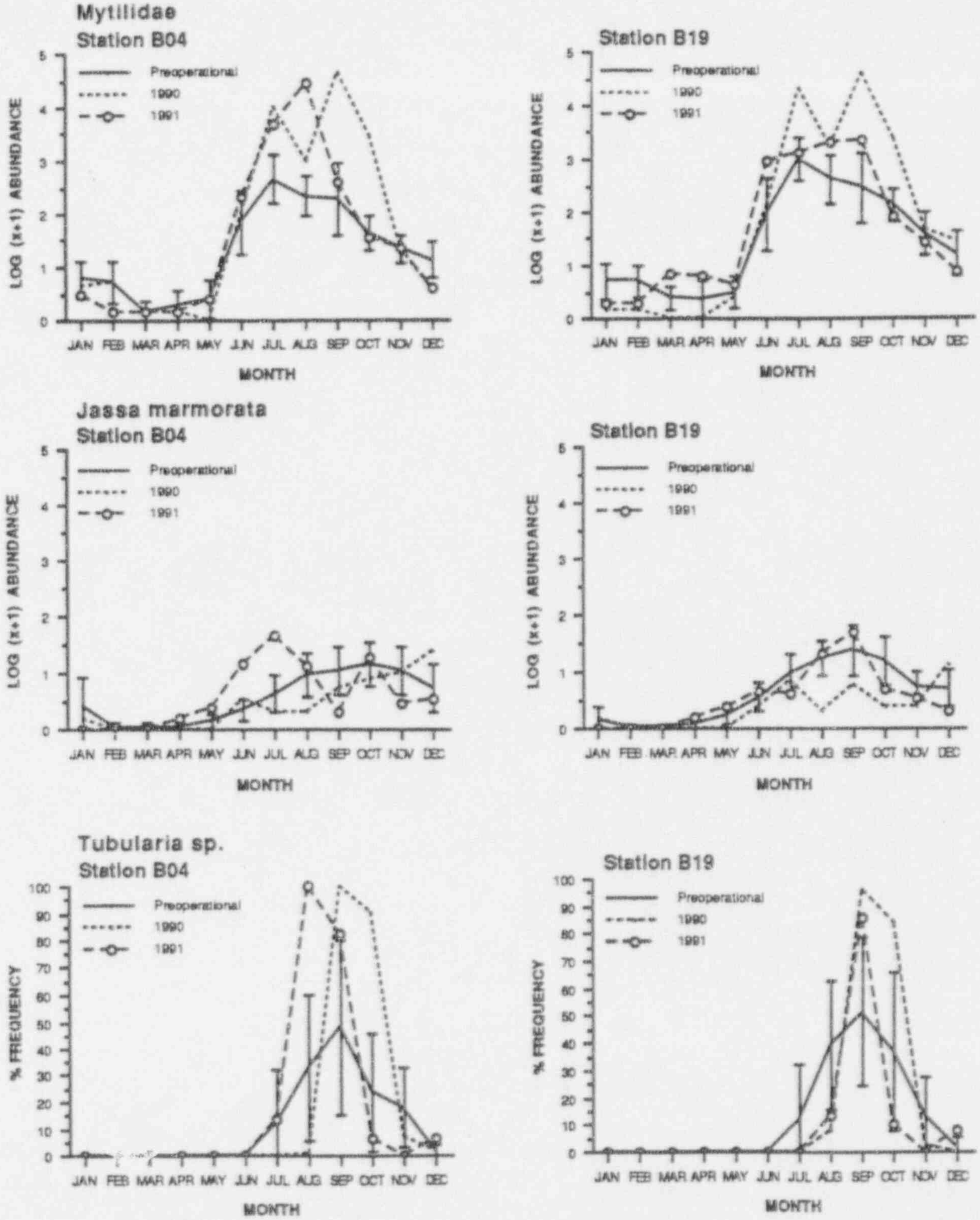


Figure 3.3.4-2. Log abundance (no. per panel) or monthly mean percent frequency of **Mytilidae**, *Jassa marmorata*, and *Tubularia* sp. on short-term surface panels at Stations B04 and B19 in 1990 and 1991 compared to mean abundance or percent frequency and 95% confidence limits during the preoperational period (1982-1984 and July 1986-December 1989). Seabrook Operational Report, 1991.

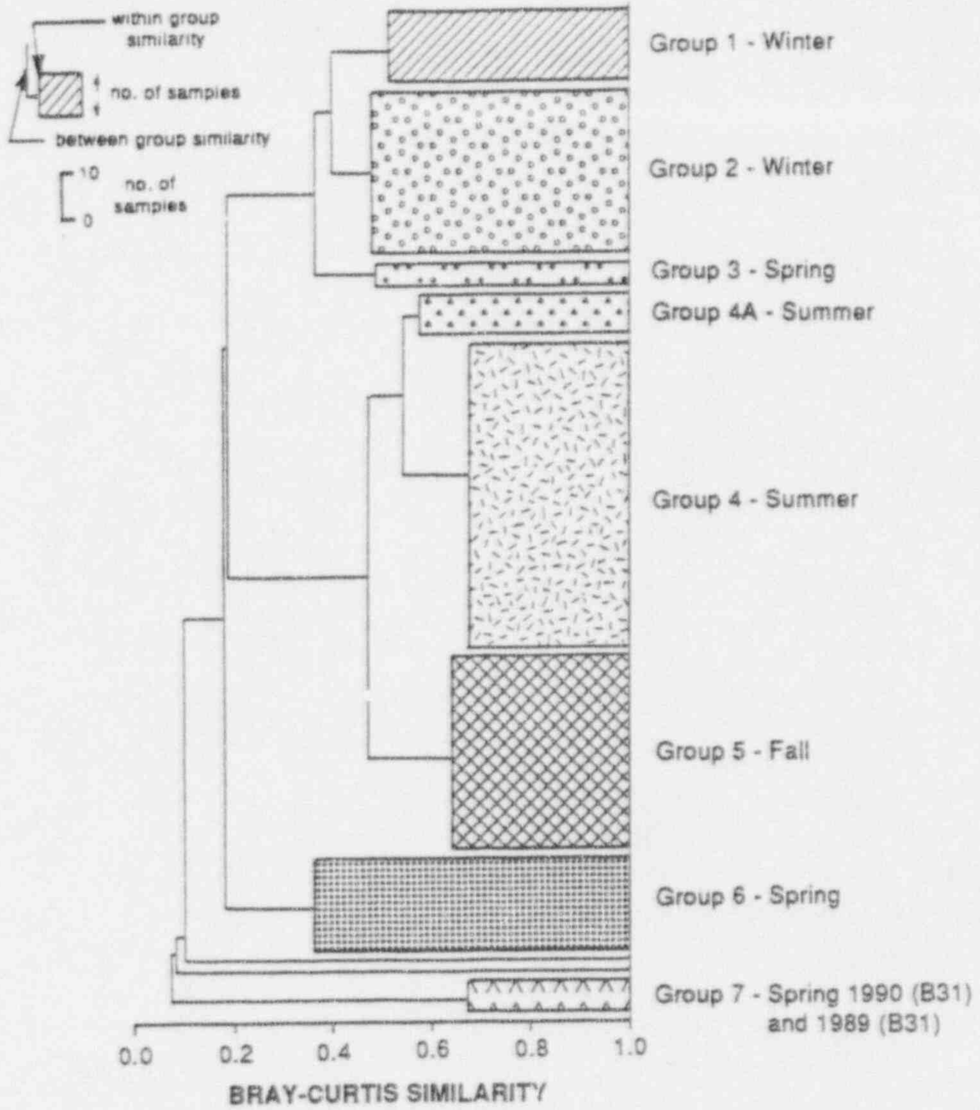
mated that of earlier years, although the peak biomass occurred earlier than previous years. As at B19, the seasonal maximum coincided with highest numbers of bivalves and greatest *Tubularia* sp. cover. Biomass at both nearfield and farfield stations in 1991 was not statistically different from biomass levels during the preoperational period (Table 3.3.4-2).

Community Composition

Potential changes in the fouling community during plant operation were further examined through the use of numerical classification. The focus of this assessment was to determine if the seasonal species assemblages observed after August 1990 at the discharge station (B19) were similar to previous years. Farfield Station B31 was included as a reference for comparison. The similarity levels of the various seasonal groups are displayed in a dendrogram, along with the months in each year that compose the seasonal groups (Figure 3.3.4-3). Abundances of the dominant taxa in each seasonal group are shown in Table 3.3.4-3.

Community composition of noncolonial organisms in 1991 was similar to previous years (Figure 3.3.4-3). Settlement activity was low from January through March and only a few bivalves were collected (Groups 1 and 2), as has occurred historically. In the spring (April and May), *Balanus* spp. colonized panels (Group 6), at both nearfield and farfield stations, a pattern consistent with several previous years. Peak settling activity occurred during the summer months (June through September, Group 4). The fouling community during this time period was composed mainly of juvenile blue mussels and other bivalves (*Anomia* sp., *Hiatella* sp.). The timing of the summer settling community and the density levels in 1991 were similar to those observed during the preoperational period. Settling activity diminished in the fall and winter (October and November), as was typical of previous years. This community (Group 5) was characterized by moderate densities of Mytilidae and low numbers of amphipod *Jassa marmorata*. Few organisms occurred on panels in December at the nearfield station (Group 2), similar to trends in 1988. As seasonal groups during the operational period were similar to previous years, there is no indication of an impact from operation of Seabrook Station.

Another measure of potential plant effects is a comparison of community composition between nearfield and farfield areas. If community composition was similar between the two stations, monthly collections were placed in the same seasonal group. During the preoperational period, nearfield-farfield station pairs occurred in the same seasonal group in 19 out of 31 sample collections (61%, Figure 3.3.4-3). During the operational period, community composition was similar in 13 of the 17 monthly collections (76%). Similarities in community composition at the two stations have not dramatically altered during the operational period.



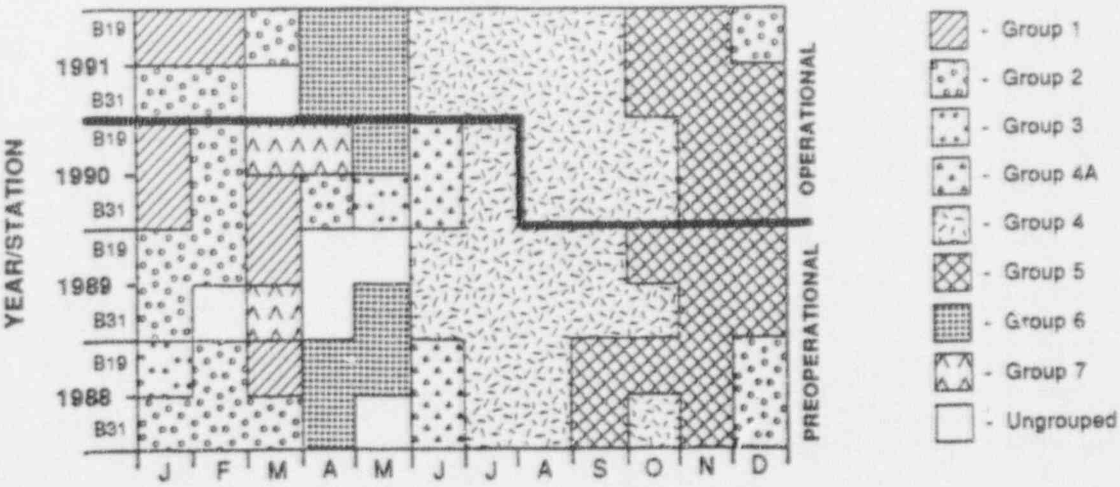


Figure 3.3.4-3. Dendrogram and seasonal groups formed by numerical classification of log (x+1) noncolonial abundances from short-term surface panels from Stations B19 and B31 collected from 1988-1991. Seabrook Operational Report, 1991.

TABLE 3.3.4-3. GEOMETRIC MEAN ABUNDANCE (NO./PANEL) AND 95% CONFIDENCE LIMITS OF DOMINANT NONCOLONIAL TAXA OCCURRING IN SEASONAL GROUPS FORMED BY NUMERICAL CLASSIFICATION OF SHORT-TERM SURFACE PANELS SET AT DISCHARGE STATION B19 AND FARFIELD STATION B31 FROM 1988-1991. SEABROOK OPERATIONAL REPORT, 1991.

GROUP NUMBER	SEASON	NUMBER OF SAMPLES PREOP[a]	OP[a]	WITHIN/BETWEEN GROUP SIMILARITY	DOMINANT TAXA	PREOPERATIONAL[a] L[b]	$\bar{x}$[b]	U[b]	OP[a] $\bar{x}$
1	Winter	5	2	0.51/.40	Mytilidae	0.4	0.6	0.9	1.0
					Hiatella sp.	0.0	0.2	0.6	0.4
2	Winter	12	4	0.47/.40	Mytilidae	1.8	3.0	4.5	3.7
					Anomia sp.	0.0	0.4	0.7	1.2
3	Spring	2	0	0.48/.37	Mytilidae	0.0	0.9	48.7	--
					Pontogeneia inermis	0.5	0.5	0.5	--
4a	Early Summer	4	0	0.57/.54	Mytilidae	46.0	210.8	953.3	--
					Hiatella sp.	4.0	32.4	174.7	--
4	Summer	16	14	0.67/.54	Mytilidae	762.4	1767.0	4094.0	2029.3
					Hiatella sp.	18.5	46.3	113.8	66.2
					Nudibranchia	3.6	7.7	15.7	8.7
					Anomia sp.	2.4	7.2	18.9	33.6
5	Fall	10	9	0.64/.47	Mytilidae	34.9	60.2	103.2	34.6
					Jassa marmorata	2.0	5.3	12.1	4.4
6	Spring	5	4	0.18/.36	*Balanus* sp.	1.1	1.5	2.0	7.3
					Mytilidae	0.0	0.3	1.2	2.2
7	Late Spring	3	0	0.07/.67	*Anomia* sp.	0.5	0.5	0.5	--

[a]Preop = January 1988 - July 1990
Op = August 1990 - December 1991
[b]L = lower confidence limit
U = upper confidence limit

Dominant Taxa

Several dominant taxa on short-term panels were monitored to determine their long-term recruitment patterns. Mytilidae spat (mainly *Mytilus edulis*) was the most abundant noncolonial taxon. In 1991, as in previous years, settlement took place throughout the year, but activity was most intense from June through September (Figure 3.3.4-2), coincident with larval availability (Figure 3.1.4-2). The peak abundance of mytilids at both nearfield stations was higher than average, a trend that also occurred in 1990 (Figure 3.3.4-2) and 1989 (NAI 1991b). Annual abundances were significantly higher in 1991 at nearfield Stations B19 and B04 and at farfield Station B34, but were lower than average at B31 (Table 3.3.4-2). Although significant differences occurred only at the nearfield Station B19, there is a trend of increased abundances at the nearfield and farfield stations further offshore (B04 and B34). Furthermore, mytilid abundances were elevated at nearfield and farfield areas during the two previous years. Thus, it is possible but unlikely that operation of Seabrook Station is related to elevated mytilid abundances.

The amphipod *Jassa marmorata* (formerly known as *J. falcata*) is a common fouling organism (Nair and Anger 1980). This species lacks a larval stage, so recruitment occurs through dispersal of juveniles or adults through the water column (Bousfield 1973). In 1991, *J. marmorata* appeared throughout the year but abundances were more common in the latter half of the year, a pattern consistent with previous years (Figure 3.3.4-2). In 1991, abundances were not statistically different from those from the preoperational period (Tables 3.3.4-1,2).

The hydroid *Tubularia* sp. is a dense summer colonizer. It is important because of its voluminous growth habits, which can provide a substrate (Field 1982) and food source (Clark 1975) for epifaunal taxa. In 1991, the *Tubularia* spp. cover reached highest frequencies in August at Station B04 and in September at B19 (Figure 3.3.4-2). In previous years, *Tubularia* sp. reached peak cover between July and September (NAI 1989b). The duration of heavy *Tubularia* cover was shorter than average in 1991 at B19 (Figure 3.3.4-2). At the farfield station, *Tubularia* sp. never occurred in high frequencies (NAI 1992), resulting in lower-than-averge annual mean (Table 3.3.4-1). This phenomenon also occurred in 1982 (NAI 1983a), 1983 (NAI 1984a), and 1988 (NAI 1989a). As a result, *Tubularia* sp. cover was significantly lower in 1991 than during the preoperational period at discharge Station B19 and its farfield counterpart, a difference that was part of an area-wide trend and unrelated to plant operation. There were no significant differences in *Tubularia* cover in 1991 at Stations B04 and B34.

3.3.4.2 Patterns of Community Development (Monthly Sequential Panels)

Biomass

Monthly sequential panels provide information on growth and successional patterns of community development. One method to assess seasonal patterns of community development is to examine the monthly biomass levels. In 1991, seasonal patterns of biomass were similar to those observed during the preoperational period at both nearfield stations (Figure 3.3.4-4). Biomass remained low through May, then increased steadily through October. Decreases in biomass in November occurred at both stations and may have been related to a severe northeaster storm that occurred at the end of October. Biomass rebounded in December at both stations.

The 1991 monthly mean biomass levels were above the preoperational average from October to December at Station B04 and from August to December at Station B19 (Figure 3.3.4-4). This is in sharp contrast to biomass values observed in 1990, which were well below average. Analysis of variance results suggest that biomass in 1991 was not significantly different from to previous years at both nearfield stations (Table 3.3.4-4). However, biomass at B31 was significantly lower than during the preoperational period.

Annual Community Development

Community development was also assessed by examining biomass, species richness and abundance on surface panels exposed for one year (Table 3.3.4-5). Year-end biomass values in 1991 were not significantly different from the preoperational averages, and were an order-of-magnitude higher than the 1990 values.

The numb of non-colonial taxa collected in '91 was higher than the preoperational average at all four stations (Table 3.3.4-5). This difference was statistically significant at B19 and B31. The number of taxa was also significantly higher in 1990 at B19 when compared to previous years. Non-colonial abundances in 1991 were not significantly different from those collected during the preoperational period at all four stations, although farfield abundances were substantially higher than the preoperational average.

No *Laminaria* sp. occurred on the one-year panels at the nearfield stations in 1991, consistent with the reduced numbers in 1990 and the variability during the preoperational period. No significant differences were noted between the operational and preoperational periods (Table 3.3.4-5).

As all parameters from one-year panels were similar to previous years, or if different, different at both nearfield and farfield stations, there was no indication of a plant-related effect.

Dominant Taxa

Seasonal patterns of community dominants in 1991 were similar to those observed during the preoperational period in most cases. Mytilidae spat settled heavily on panels in June at both nearfield stations (Figure 3.3.3-4). Frequency of occurrence remained near 100% and was higher than average for the remainder of the year. This pattern also occurred in previous years (e.g., 1986, 1988; NAI 1988b). Mytilidae spat

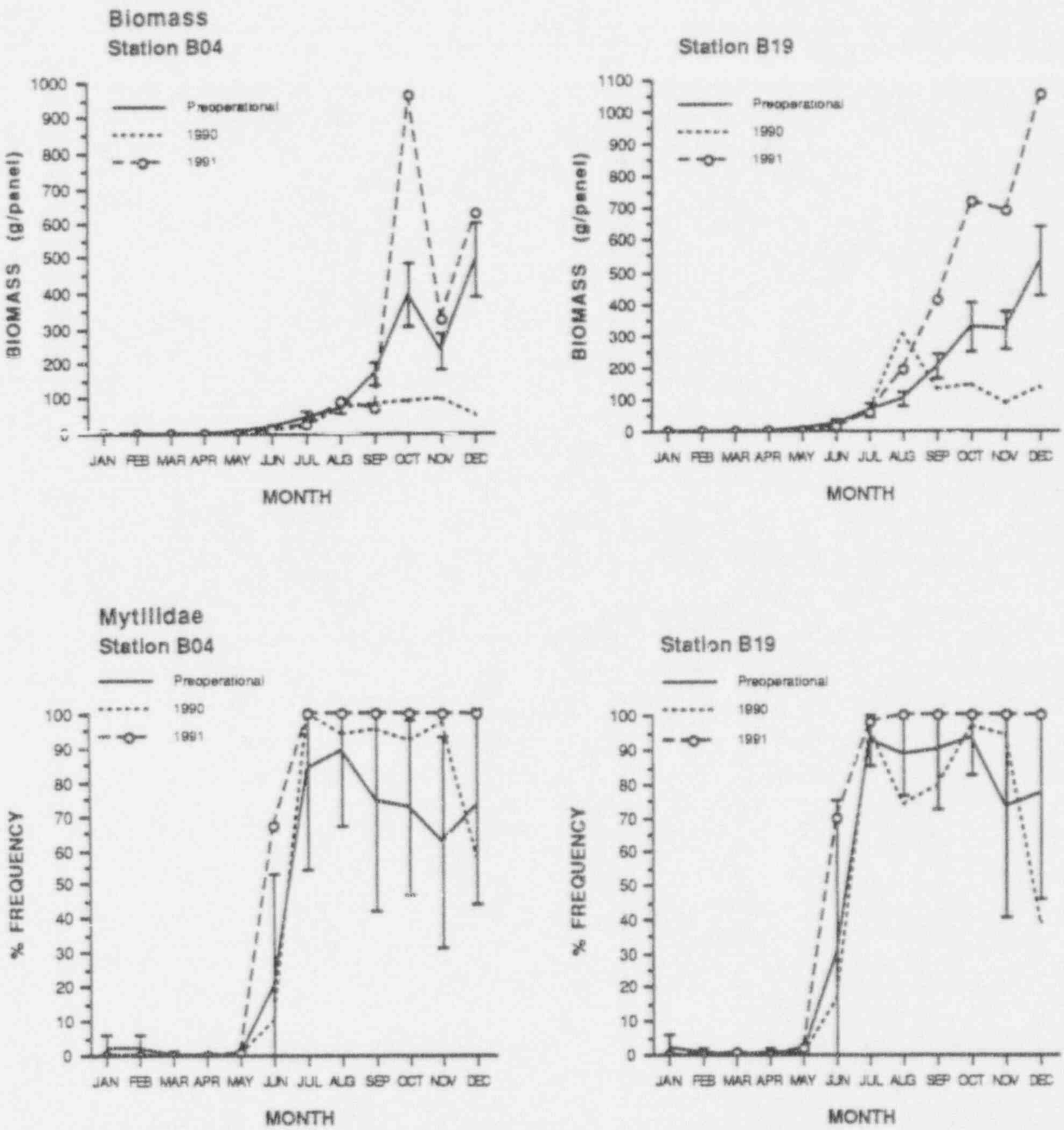


Figure 3.3.4-4. Mean **biomass** (g/panel) and **Mytilidae** (percent frequency of occurrence) in 1990 and 1991 compared to mean and 95% confidence limits during the preoperational period (Stations B04 and B19 from 1978-1984 and July-December 1986-1989) on monthly sequential panels. Seabrook Operational Report, 1991.

TABLE 3.3.4-4. ANOVA RESULTS COMPARING MONTHLY SEQUENTIAL BIOMASS AT MID-DEPTH (B19, B31) AND DEEP (B04, B34) STATION PAIRS FROM 1978-1991. SEABROOK OPERATIONAL REPORT, 1991.

STATIONS	SOURCE OF VARIATION	df	SS	F[f]	MULTIPLE COMPARISONS
					Op B19 Pre B31 Pre B19 Op B31
Mid-depth	Preop-Op[a]	1	6,870.3	0.61 NS	
B19, B31	Year (Preop-Op)[b]	10	3,229,896.2	28.72***	
	Station[c]	1	21,545.3	1.92 NS	
	Month (Year)[d]	113	124,358.4	11.06***	
	Preop-Op X Station[e]	1	85,597.7	7.61**	
	Error	123	1,383,414.9		
Deep	Preop-Op	1	19,300.5	1.69 NS	
B04, B34	Year (Preop-Op)	10	2,953,711.2	25.91***	
	Station	1	86,500.6	7.59**	
	Month (Year)	113	13,929,948.5	10.81***	
	Preop-Op X Station	1	18,259.6	1.60 NS	
	Error	88	18,148,577.6		

[a]Preop-Op = 1991 v. previous years (1978-84; July 1986-December 1989 except B34, which began in 1982)
[b]Year nested within preoperational and operational periods regardless of station
[c]Station regardless of year or period
[d]Month nested within year regardless of station
[e]Interaction between main effects
[f]NS = Not significant (.05>p)
* = Significant (.01<p≤.05)
** = Highly significant (.001<p≤.01)
*** = Very Highly Significant (p≤.001)

TABLE 3.3.4-5. DRY WEIGHT BIOMASS, NONCOLONIAL NUMBER OF TAXA, ABUNDANCE, AND *LAMINARIA* SP. COUNTS ON SURFACE FOULING PANELS SUBMERGED FOR ONE YEAR AT STATIONS B19, B31, B04, AND B34 DURING THE PREOPERATIONAL PERIOD (1982-1984 AND 1986-1989), IN 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

	STATION	PREOPERATIONAL MEAN	S.D.	OPERATIONAL 1990	1991
BIOMASS (g/panel)	B19	661.5	476.88	132.8 NS	1056.2 NS
	B31	708.9	523.86	52.1 NS	725.4 NS
	B04	600.9	474.66	51.1 NS	627.5 NS
	B34	823.2	570.39	60.5 NS	1136.6 NS
NUMBER OF NON-COLONIAL TAXA (No./panel)	B19	21.3	4.42	34*	33*
	B31	25.9	4.60	24.0 NS	42*
	B04	23.6	4.16	24.0 NS	33 NS
	B34	22.9	5.05	27.0 NS	36 NS
NONCOLONIAL ABUNDANCE (No./panel)	B19	13,905.1	7,046.48	27,625.0 NS	14,132 NS
	B31	21,967.6	18,398.27	23,265.0 NS	62,614 NS
	B04	19,386.0	15,063.89	27,024.0 NS	27,440 NS
	B34	19,221.7	19,986.38	5,693.0 NS	35,432 NS
LAMINARIA SP. (No./panel)	B19	24.3	36.91	0 NS	0 NS
	B31	39.3	29.24	4 NS	8 NS
	B04	14.1	34.40	2 NS	0 NS
	B34	15.9	26.83	0 NS	0 NS

*.01<p≤.05 when preoperational and 1990, 1991 means tested with a single sample t-test (Sokol and Rolf 1969)

measurements from monthly sequential panels were compared to determine if mean lengths differed between nearfield and farfield stations in 1991. Mytilids averaged approximately 7 mm in length in 1991 at all four stations (Table 3.3.4-6). Annual averages of Mytilidae spat lengths were similar between nearfield and farfield Stations B19 and B31 (t = 0.19, $t_{\alpha=.0,\ n=22}$ = 2.82) and B04 and B34 (t = -0.10, $t_{\alpha=.01,\ n=22}$ = 2.82).

In 1991, *Jassa marmorata* appeared in moderate percent frequencies only in September at B19 (Figure 3.3.4-5). In general, frequencies were lower than the preoperational average throughout the year, but higher than in 1990, when *J. marmorata* appeared in substantial frequencies only in November. *J. marmorata* occurred from June through December at B04 in 1991. Frequencies were higher than average in most of the summer and fall months.

TABLE 3.3.4-6. NEARFIELD/FARFIELD COMPARISON OF ANNUAL MEAN LENGTH (mm), AND STANDARD DEVIATION OF *JASSA MARMORATA* AND MYTILIDAE SPAT COLLECTED IN 1991 ON MONTHLY SEQUENTIAL PANELS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES	1991	B19	B31	B04	B34
Mytilidae spat	Mean	7.4	6.8	7.1	7.5
	SD	7.95	7.07	9.06	7.51
Jassa marmorata	Mean	4.6	4.7	4.9	4.4
	SD	1.39	1.27	1.87	0.70

Average lengths of *Jassa marmorata* colonizing monthly sequential panels measured approximately 4-5 mm in 1991 (Table 3.3.4-6). No significant differences were found between lengths at B19 and B31 (t = -0.15, $t_{\alpha=.01,\ n=18}$ = 2.88) and B04 and B34 (t=0.75, $t_{\alpha=.01,\ n=17}$ = 2.90).

In 1991, *Balanus* sp. appeared at nearfield stations in April (B04) or May (B19), similar to previous years (Figure 3.3.4-5). Percent frequencies of occur rence were higher than average for most of the remainder of 1991. Frequencies decreased markedly in September and again in November, following severe storms.

In 1991, *Tubularia* sp. appeared in July at both nearfield stations, consistent with the preoperational years (Figure 3.3.4-5). The amount of *Tubularia* cover at Station B19 was average from July through September and below average for the rest of the year. At Station

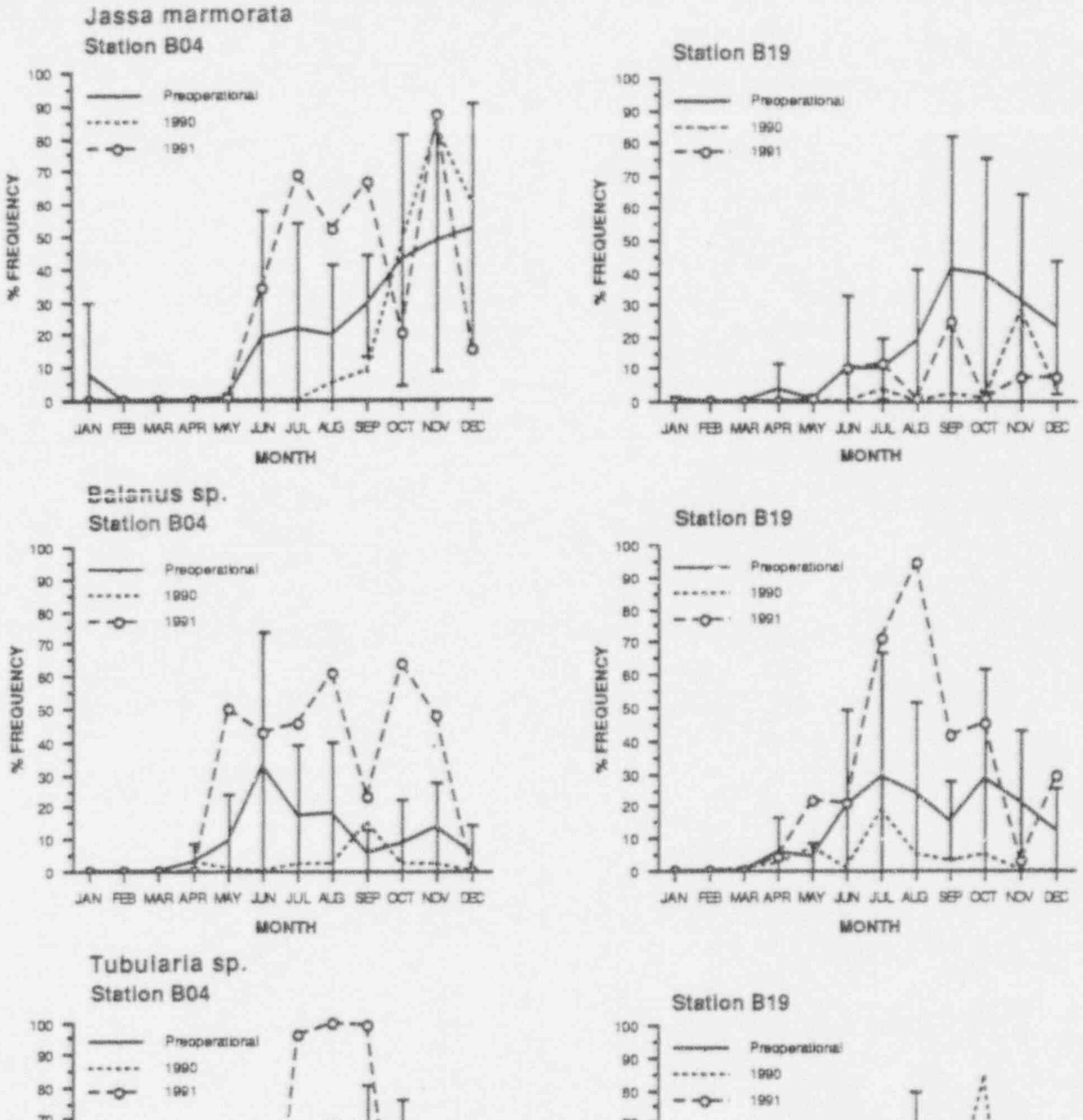


Figure 3.3.4-5. Monthly mean percent frequency of occurrence on **monthly sequential surface panels** for *Jassa marmorata*, *Balanus* sp., and *Tubularia* sp. at Stations B04 and B19 in 1990 and 1991, compared to mean and 95% confidence limits during the preoperational period (1982-1984 and July 1986-December 1989). Seabrook Operational Report, 1991.

B04, *Tubularia* cover was higher than average from July through September; and again in November and December.

3.3.4.3 Effects of Plant Operation

The fouling community showed no evidence of operational impact. Most parameters measured in 1991 were within the 95% confidence limits established during the preoperational period. Differences noted in 1991 occurred at both nearfield and farfield stations, indicating that differences were part of a regional trend. In one case, biomass on monthly sequential panels, a difference occurred in 1991 at the farfield station but not at the nearfield station. Mytilid abundances on short-term panels were elevated in 1991 at nearfield Stations B19 and B04, and farfield Station B34, but not at farfield Station B31. This repeats an area-wide trend of increased mytilid abundances in 1990 and 1989. Although possibly related to operation of Seabrook Station, it is unlikely, given these trends.

3.3.5 Selected Benthic Species

Eight macrofaunal taxa from the area of the discharge (nearfield) and from a control area off Rye Ledge (farfield) were selected for intensive monitoring from intertidal Stations B1MLW and B5MLW, shallow subtidal stations B17 and B35 and mid-depth Stations B19 and B31. Selection of taxa was based on abundance, and/or trophic level. Sampling generally took place in three seasons: May, August and November. For triannual sampling regimes, 1990 could not be included in tests of significance between preoperational and operational periods, since plant operation started in August 1990. Densities of large *Strongylocentrotus droebachiensis* and *Modiolus modiolus* counted by SCUBA divers on subtidal transects were estimated triannually.

3.3.5.1 Mytilidae

Mytilidae, composed primarily of juvenile (<25 mm) *Mytilus edulis*, was the most abundant taxon at all three nearfield/farfield station pairs. *Mytilus edulis*, the blue mussel, can reach 100 mm in length (Gosner 1978), and is an important prey species for fish, sea stars, lobsters, and gastropods. It clings to hard substrate with strong byssal threads, is an important fouling organism, and forms a habitat for many other species. The geometric mean density for the 1978-1989 preoperational period was over an order of magnitude higher at intertidal stations than subtidal depths (Table 3.3.5-1).

At the intertidal (B1MLW,B5MLW) and shallow subtidal (B17,B35) depths, the 1991 (operational) densities were significantly below the preoperational densities at both the near- and farfield stations (Tables 3.3.5-1,2). The interaction between station and operational status was not significant. At the mid-depth stations (B19,B31), the trend was the reverse of the shallow stations, and densities were significantly higher in 1991 than during the preoperational period. The density increase occurred consistently at both near- and farfield stations, as indicated by the lack of

TABLE 3.3.5-1. GEOMETRIC MEAN DESITY (NO./SQ. METER) OF SELECTED BENTHIC SPECIES SAMPLED TRIANNUALLY IN MAY, AUGUST, AND NOVEMBER FROM 1978 THROUGH 1991. SEABROOK OPERATIONAL REPORT, 1991.

TAXA	STATION	PREOP[a] LCL	PREOP[a] MEAN	PREOP[a] UCL	1990 MEAN	1991 MEAN
MYTILIDAE	B1MLW	105260	123874	145780	151386	34352
	B5MLW	60128	72491	87397	126900	24679
	B17	2090	2731	3570	6774	632
	B35	3514	4667	6198	5583	2023
	B19	1322	1816	2495	6568	4401
	B31	4513	5878	7657	1555	11221
NUCELLA LAPILLUS	B1MLW	1647	1928	2256	3361	826
	B5MLW	711	855	1029	1411	488
ASTERIIDAE	B17	551	631	723	1238	871
	B35	148	195	256	1680	504
	B19	97	121	152	235	178
	B31	47	60	76	45	4
PONTOGENEIA INERMIS	B17	1687	1955	2266	1300	1271
	B35	1674	2129	2708	1144	1170
	B19	509	623	762	643	388
	B31	326	399	487	281	127
JASSA MARMORATA	B17	818	1034	1307	502	1251
	B35	1187	1673	2358	1196	3226
AMPITHOE RUBRICATA	B1MLW	13	22	36	0	0
	B5MLW	2	3	6	25	206
STRONGYLOCEN-TROTUS DROE-BACHIENSIS	B17	31	39	50	24	16
	B35	31	45	63	12	19
	B19	51	71	97	9	33
	B31	22	30	40	20	22
MODIOLUS MODIOLUS[b]	B19	95	101	106	103	88
	B31	83	89	94	78	80

[a]Preoperational period extends through 1989. Sampling began in 1978 at Stations B1MLW, B17, B19, and B31, and in 1982 at Stations B5MLW and B35. Commercial operation began in August, 1990.
[b]Sampling for _Modiolus modiolus_ began in 1980.

TABLE 3.3.5-2. RESULTS OF TWO-WAY ANALYSES OF VARIANCE COMPARING LOG-TRANSFORMED DENSITIES OF SELECTED BENTHIC SPECIES AT NEAR- AND FARFIELD STATION PAIRS (1MLW/5MLW, B17/B35, B19/B31) DURING PREOPERATIONAL (THROUGH 1989) AND OPERATIONAL (1991) PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES[a]	STATION PAIRS	SOURCE OF VARIATION	SAMPLED IN MAY, AUGUST, NOVEMBER			MULTIPLE COMPARISONS[f]
			df	SS	F[b]	
Mytilidae (<25 mm)	B1MLW B5MLW	Preop-Op[c]	1	6.73	54.27***	Preop>Op
		Year (Preop-Op)	11	4.66	3.42***	
		Month (Year)	26	23.72	7.36***	
		Station[d]	1	0.95	7.65**	B1MLW>B5MLW
		Preop-Op X Station[e]	1	0.06	0.47 NS	
		Error	249	30.86		
	B17 B35	Preop-Op	1	5.99	23.58***	Preop>Op
		Year (Preop-Op)	11	21.01	7.52***	
		Month (Year)	26	41.89	6.34***	
		Station	1	3.50	13.79***	B35>B17
		Preop-Op X Station	1	0.49	1.93 NS	
		Error	241	61.22		
	B19 B31	Preop-Op	1	2.98	8.36**	Op>Preop
		Year (Preop-Op)	11	64.73	16.50***	
		Month (Year)	26	34.44	3.71***	
		Station	1	6.23	17.47***	B31>B19
		Preop-Op X Station	1	0.14	0.39 NS	
		Error	294	104.83		

(continued)

TABLE 3.3.5-2. (Continued)

SPECIES[a]	STATION PAIRS	SOURCE OF VARIATION	SAMPLED IN MAY, AUGUST, NOVEMBER df	SS	F[b]	MULTIPLE COMPARISONS[f]
Modiolus modiolus (adults)	B19 B31	Preop-Op	1	62474.44	4.49*	Preop>Op
		Year (Preop-Op)	9	1054127.19	8.42***	
		Month (Year)	22	591539.03	1.93**	
		Station	1	512.94	0.04 NS	
		Preop-Op X Station	1	103.70	0.01 NS	
		Error	750	10427369.62		
Nucella lapillus	B1MLW B5MLW	Preop-Op	1	3.10	24.29***	Preop>Op
		Year (Preop-Op)	11	6.46	4.60***	
		Month (Year)	26	17.22	5.18***	
		Station	1	1.78	13.95***	B1MLW>B5MLW
		Preop-Op X Station	1	0.03	0.23 NS	
		Error	249	31.83		
Asteriidae	B17 B35	Preop-Op	1	1.87	20.86***	Op>Preop
		Year (Preop-Op)	11	16.56	16.79***	
		Month (Year)	26	17.87	7.71***	
		Station	1	2.95	32.91***	B17>B35
		Preop-Op X Station	1	0.26	2.92 NS	
		Error	241	21.60		
Pontogeneia inermis	B19 B31	Preop-Op	1	3.09	14.60***	Preop>Op
		Year (Preop-Op)	11	6.74	2.90**	
		Month (Year)	26	27.10	4.93***	
		Station	1	2.94	13.88***	B19>B31
		Preop-Op X Station	1	0.66	3.11 NS	
		Error	294	62.19		

(continued)

TABLE 3.3.5-2. (Continued)

SPECIES[a]	STATION PAIRS	SOURCE OF VARIATION	SAMPLED IN MAY, AUGUST, NOVEMBER df	SS	F[b]	MULTIPLE COMPARISONS[f]
Jassa marmorata	B17	Preop-Op	1	0.53	1.56 NS	
	B35	Year (Preop-Op)	11	16.01	4.27***	
		Month (Year)	26	21.98	2.48***	
		Station	1	2.91	8.52**	B35>B17
		Preop-Op X Station	1	0.15	0.45 NS	
		Error	241	82.23		
Ampithoe rubricata	B1MLW	Preop-Op	1	0.30	0.77 NS	
	B5MLW	Year (Preop-Op)	11	236.02	55.35***	
		Month (Year)	26	31.22	3.10***	
		Station	1	33.85	87.32***	B5MLW>B1MLW
		Preop-Op X Station	1	31.22	80.54***	B5Op B5Pre B1Pre B1Op
		Error	249	96.52		
Strongylocentrotus droebachiensis	B19	Preop-Op	1	1.49	3.01 NS	
	B31	Year (Preop-Op)	11	39.67	7.27***	
		Month (Year)	26	38.96	3.02***	
		Station	1	2.12	4.27*	B19>B31
		Preop-Op X Station	1	0.32	0.64 NS	
		Error	294	145.78		

[a] Log (x+1) density, except for *M. modiolus* adults, were sampled semi-quantitatively and were compared with rank densities.
[b] NS = not significant (p>0.05)
 * = significant (0.05≥p>0.01)
 ** = highly significant (0.01≥p>0.001)
 *** = very highly significant (p≤0.001)
[c] preoperational (through 1989) versus operational (1991) period, regardless of station
[d] nearfield = Stations 1MLW, B17, and B19; farfield = Stations B5MLW, B35, B31, regardless of year/period
[e] interaction between main effects
[f] Underlining signifies no significant differences (alpha = 0.05) among least squares means with a paired T-test.

significance in the interaction term. The pattern of decreased mytilid density at intertidal and shallow subtidal stations, and increased density at mid-depth stations, also occurred between 1984 and 1985 (NAI 1991b). Since all changes in mytilid density occurred at both near- and farfield stations, and reflected patterns observed in some preoperational years, it is unlikely that plant operation was a primary factor in these changes.

The Mytilidae collected usually ranged from less than 1 mm to 25 mm in length, and averaged between 2 and 3 mm. Many of the smallest mytilids had settled on macroalgae rather than on the bottom or hard substrate, a pattern also observed by other investigators (Bayne 1965; Suchanek 1978). The preoperational mean length of intertidal mytilids was slightly larger than subtidal mytilids (Table 3.3.5-3), while intertidal population densities were much higher than subtidal densities (Table 3.3.5-1). Densities and lengths in 1991 and 1990 followed the same trend. Historically, mean mytilid lengths within each of the station pairs exhibited no significant variability among years (NAI 1987b). In 1991, the lengths at all three station pairs were within the range of previous years (NAI 1991b).

3.3.5.2 *Nucella lapillus*

Reaching up to 51 mm in length (Abbott 1974), *Nucella lapillus* is an abundant intertidal gastropod drill and an important predator, particularly on mytilid spat and barnacles (Gosner 1978). In 1991, densities were significantly lower than preoperational densities (Tables 3.3.5-1,2), as this trend occurred at both stations, the interaction (Preop-op X Station) was not significant. At the nearfield station (B1MLW), the 1991 densities were within the range of previous years (NAI 1991b), while the farfield density (B5MLW) was at an all-time low. The area-wide below-average densities in 1991 follow area-wide above-average densities in 1990 (NAI 1991b), coinciding with a similar trend in mytilids, one of its major prey species.

During preoperational years, *Nucella* averaged 6.0 mm in length in nearfield stations and 6.9 mm in farfield stations. In 1990 and 1991, the mean lengths were well below average. In 1991 (a low-density year), about 66% of the *Nucella* were juveniles measuring 5 mm or less (NAI 1992). In 1990 (a high-density year), the proportion of juveniles was slightly higher, and reached 78% at the nearfield station, indicating recruitment was high (NAI 1991a). Previous studies have shown juveniles (2-5 mm) are more evenly dispersed throughout the year, and adult snails are active only from May through October, retreating into crevices in the winter (Menge 1978).

3.3.5.3 Asteriidae

The Asteriidae collected are juveniles, too small to be assigned to genus. Two species of both *Asterias* and *Leptasterias* can occur within the study area (Gosner 1978). Asteriidae are important predators on bivalves, particularly on the recently-settled stages, as well as other mollusks and barnacles

TABLE 3.3.5-3. ANNUAL MEAN LENGTH (MM) AND 95% CONFIDENCE INTERVAL FOR SELECTED BENTHIC SPECIES SAMPLED TRIANNUALLY IN MAY, AUGUST, AND NOVEMBER AT SELECTED BENTHIC STATIONS FROM 1982 THROUGH 1991. SEABROOK OPERATIONAL REPORT, 1991.

TAXA	STATION	PREOP (1982-89)			1990	1991
		LCL	MEAN[a]	UCL	MEAN[a]	MEAN[a]
MYTILIDAE[b]	1MLW	3.1	3.1	3.2	3.1	3.1
	5MLW	3.2	3.3	3.3	3.5	2.7
	17	2.3	2.3	2.4	2.2	2.6
	35	2.4	2.5	2.5	2.5	2.2
	19	2.3	2.4	2.4	3.0	2.0
	31	2.7	2.8	2.9	2.7	2.5
NUCELLA	1MLW	6.7	6.9	7.0	5.4	5.4
LAPILLUS	5MLW	5.8	6.0	6.2	5.9	5.4
ASTERIIDAE	17	4.8	5.0	5.1	3.3	5.2
	35	6.4	6.7	7.1	3.0	5.6
PONTOGENEIA	19	5.0	5.1	5.3	5.2	5.4
INERMIS	31	5.2	5.3	5.4	6.0	5.9
JASSA	17	4.1	4.2	4.2	3.9	4.5
MARMORATA	35	3.9	3.9	4.0	4.0	4.4
AMPITHOE	1MLW	6.7	7.0	7.3	-[c]	9.9
RUBRICATA	5MLW	7.4	7.8	8.2	6.1	7.6
STRONGYLOCEN-	19	1.8	1.9	2.0	2.0	1.5
TROTUS DROE-	31	1.8	1.9	2.0	2.3	2.0
BACHIENSIS						

[a]Mean = sum of the lengths of all individuals measured in May, August, and November/total number of individuals measured in that year
[b]Mytilidae ≥25 mm were considered outliers, and not used in calculations of the mean
[c]- = none collected

(Gosner 1978). Abundances of asteriidae were highest at the shallow subtidal station pair (B17,B35).

Asteriidae densities were significantly higher in 1991 than their baseline densities; because abundance increased at both nearfield and farfield stations. There was no significant interaction (Table 3.3.5-1,2). As in previous years, differences between stations and among years, were significant, with more sea stars usually occurring at the nearfield station. 1991 was the second consecutive year of well above average densities, coinciding with lower-than-average mytilid density, one of its major prey items at the shallow subtidal pair.

In 1991, the annual average length was well within the range of annual means taken during the preoperational period (Table 3.3.5-3). Over 50% of the specimens collected in 1991 were 1 mm or less at both stations, and most of these were collected in August (NAI 1992).

3.3.5.4 *Pontogeneia inermis*

Pontogeneia inermis (maximum length, 11 mm) is a pelagic, cold water amphipod (Bousfield 1973), and a dominant species in both benthic and macrozooplankton collections (Section 3.1.5). It clings to submerged algae from the lower intertidal to depths greater than 10 m (Bousfield 1973). In 1991, densities at both near- and farfield mid-depth stations were similar to 1990 and significantly below the preoperational average. The interaction term (Preop-Op X Station) was not significant (Tables 3.3.5-1,2). Since the decline began prior to plant operation and occurred at both stations, it was related to area-wide occurrences, not a local effect of plant operation. Differences between stations were significant with the nearfield (B19) having a higher density than the farfield (B31) in most years (Tables 3.3.5-1,2).

During the preoperational period, ovigerous and brooding females have been collected in low numbers from January through September (NAI 1985b). Historically, recruitment, as indicated by a sharp increase in density and increased numbers in the 1 to 3 mm size class, has taken place between May and July. In fall and winter, abundance decreased, but average size increased as the population grew (NAI 1985b). The 1991 mean lengths were above the preoperational average at both stations, while population densities were below the preoperational average (Table 3.3.5-3).

3.3.5.5 *Jassa marmorata*

Jassa marmorata is a tube-building amphipod, and a dominant fouling organism on hard substrates in areas with strong tidal and wave currents (Bousfield 1973). It is a suspension feeder, and also preys on small crustaceans. The 1991 annual densities of *Jassa* at both stations were slightly higher than the preoperational means, although the difference was not significant (Tables 3.3.5-1,2). Likewise, no significant interaction occurred between 1991 and preoperational averages at the nearfield farfield station pair (Table 3.3.5-2), indicating stable populations at both stations.

Most lifestages of *Jassa* were collected at Stations B17 and B35, ranging from gravid females to newly-hatched young (NAI 1985b). The average length (all lifestages combined) during the preoperational period was 4.2 mm at Station B17 and 3.9 mm at Station B35. In 1991, the mean length at both stations was above the preoperational average (Table 3.3.5-3), but within the range of annual mean lengths in previous years (NAI 1991b).

3.3.5.6 *Ampithoe rubricata*

Ampithoe rubricata (maximum length, 14-20 mm) is an amphi-Atlantic amphipod that ranges south to Long Island Sound. It constructs a nest of tubes among fucoid algae and in mussel beds (Bousfield 1973). It is found primarily in intertidal areas, but is occasionally common at shallow subtidal stations. Yearly densities have fluctuated significantly during the study period, and steadily declined from about 500/m^2 in 1979 to 1986 when none were collected (NAI 1991b). In 1988, populations at the farfield station showed a slight increase in abundance that has continued through 1991. No *Ampithoe* were collected at Station B1MLW in 1990 and 1991, but densities were higher than average at B5MLW, as reflected in the significant Preop-op X Station interaction (Table 3.3.5-2).

Ovigerous and brooding females were rare, but during the preoperational period were occasionally collected from April through September (NAI 1985b). The largest numbers of small (1-3 mm) individuals were collected from April through September, suggesting recruitment occurred during this time period. In 1983 and 1984, recruitment appeared depressed, accounting for both lower overall densities and larger mean size (NAI 1985b), and the trend continued through 1990 (NAI 1991b). In 1991, the average length measured 7.6 mm at B5MLW, and 9.9 at the nearfield station, where only two specimens were collected. The relatively large mean length is due to the lack of small (1-3 mm) individuals in the population measured three times annually. In 1991, small *Ampithoe* comprised 10% of the population at the farfield station, and none occurred at the nearfield station (NAI 1992).

3.3.5.7 *Strongylocentrotus droebachiensis*

Strongylocentrotus droebachiensis, the green sea urchin, reaches 75 mm in diameter, and is an important prey species for lobsters, cod and other demersal fish, and sea stars (Gosner 1978). It is an omnivore, but prefers grazing on *Laminaria saccharina* over other common algal species (Larson *et al.* 1980; Mann *et al.* 1984). When the macroalgae supply is depleted, it will prey on *Mytilus edulis* (Briscoe and Sebens 1988). It is subject to population "explosions" that can denude large areas of macroalgae, leaving barren rock (Breen and Mann 1976). Density in 1991 was slightly lower at both stations, but the difference was not significant. Likewise, the interaction was not significant (Table 3.3.5-1,2).

Most of the individuals collected subtidally were juvenile, measuring less than 3 mm in diameter. Recruitment of newly-settled young through 1984 has historically occurred in August and September (NAI 1985b). Average lengths in 1991 were 1.5-2.0 mm (Table 3.3.5-3), and were within the range of the study period.

In order to account for adult individuals that were too large to be collected in the benthic sampling program, sea urchins were enumerated by SCUBA divers in the subtidal transect program. No more than a total of 13 large (>10 mm) sea urchins per year were counted ($0.02/m^2$) in the first three years of sampling (NAI 1986a, 1987a, 1988a). From 1988-1990 a gradual increase occurred to a maximum of 70 urchins ($0.14/m^2$) in 1990 (NAI 1988a, 1989a, 1990a). By 1991, numbers had dropped to pre-1988 levels, with a grand total of 7 urchins ($0.01/m^2$) from all four transects sampled during three seasons (NAI 1992). The extremely low densities of adult urchins in comparison to juveniles indicate that natural forces are keeping this potential nuisance species under control.

3.3.5.8 *Modiolus modiolus*

Modiolus modiolus, the northern horse mussel, is a boreal species that reaches a length of 15 cm (Gosner 1978) and forms beds subtidally, which can survive for several decades (Witman 1985). *Modiolus* populations, like large sea urchins and macroalgae, were enumerated triannually by divers along randomly pre-selected, radiating transects. They were most abundant at mid-depth Station B19 (near the discharge) and its farfield counterpart, B31. Although *Modiolus* densities were significantly below the preoperational averages in 1991, the decline occurred at both near- and farfield stations, resulting in no significant differences in the interac‿on term (Tables 3.3.5-1,2). Since the decreases were within the range of annual variation, and occurred at both near- and farfield stations, it is not likely to be an effect of plant operation.

3.3.5.9 Effects of Plant Operation

In conclusion, patterns in abundance and size distribution in selected benthic species were only slightly less-predictable than community characteristics presented in Section 3.3.3. During the preoperational period, abundances have varied among years and between near- and farfield stations (NAI 1991b). In 1991 (operational period), the abundance of mytilids (B19,B31 only) and asteriids (B17,B35) was significantly higher than the preoperational average. Likewise, the operational (1991) abundances of mytilids (B17,B35; B1MLW,B5MLW), *Modiolus* (B19,B31), *Pontogeneia* (B19,B31), and *Nucella* (B1MLW,B5MLW) were significantly lower than the preoperational averages. In each case, both near- and farfield stations followed a similar trend. Since operational increases or decreases occurred at both near- and farfield stations, there is not evidence of plant impact, only area-wide annual variations.

The only species to show a significantly different trend between the near- and farfield stations in 1991 was *Ampithoe rubricata*, which had the lowest preoperational mean densities. In 1991, densities were well below the preoperational average at the nearfield station (B1MLW) and well above the average at the farfield station (B5MLW). Following the virtual disappearance of the populations of both stations in 1984, *A. rubricata* reappeared in the farfield only in May 1990 and continues to increase through 1991. Since the decrease occurred at both stations and the increase began before the plant started commercial operation, differences may be attributed to natural temporal and spatial variations, rather than an impact of plant operation.

Length measurements have historically been a stable indicator of population recruitment and growth, showing low variability among years. In 1991, the average lengths of all species were within range of previous years (NAI 1990b). Average *Ampithoe* lengths were above average at both stations because only two adults were collected at the nearfield station, and only a few young measuring <5 mm were collected at the farfield station.

3.3.6 Epibenthic Crustacea

3.3.6.1 American Lobsters (*Homarus americanus*)

Lobster Larvae

Lobster larvae densities in 1991 were significantly higher than during the preoperational period at all three stations, continuing a trend first observed in 1990 (Tables 3.3.6-1,2; NAI 1991b). There were no differences among the three stations during the study period. Peak numbers of lobster larvae at the discharge station occurred in June, July, and August, and were rare in May, September and October, similar to previous years (Figure 3.3.6-1). The occurrence of peak abundances of lobster larvae in the study area is consistent with other studies in New England, summarized by Fogarty and Lawton (1983) as occurring from June through August. Other studies relate first appearance with a surface temperature of 12.5°C (Harding et al. 1983), which typically occurs in June or July in the study area (Figure 3.1.1-1). Increased density in 1991 was due mainly to increases in Stage IV larvae, the most numerous of the four lifestages (Figure 3.3.6-1). Stage I larvae were the second-most abundant lifestage both in 1991 and during the preoperational period. Stage II and Stage III larvae were the least abundant lifestages. Stage I lobster predominated in the majority of studies, mainly from southern New England, reviewed by Fogarty and Lawton (1983), although Stage IV lobsters were most numerous in some years in Cape Cod and Buzzards Bays, and Long Island Sound. A preponderance of Stage IV larvae typified the coast of southwestern Nova Scotia south to New Hampshire, supplied by lobster stock in the warm southwestern waters of the Gulf of Maine and Georges Bank (Harding et al. 1983, Harding and Trites 1988).

TABLE 3.3.6-1. ANNUAL MEAN ABUNDANCE (no./1000m^2) OR CATCH PER UNIT EFFORT (no./15 traps) AND 95% CONFIDENCE LIMITS OF LOBSTER LARVAE AND ADULTS, *CANCER* SPP. LARVAE, AND ADULT AND FEMALE JONAH AND ROCK CRABS AT NEARFIELD (P2, P5 FOR LARVAE, L1 FOR ADULTS) AND FARFIELD (P7,L7) STATIONS DURING PREOPERATIONAL YEARS, 1990 AND 1991. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES (period sampled)	STATION	PREOPERATIONAL YEARS[a] LCL	$\bar{x}$[b]	UCL	1990	1991
Lobster larvae (May-Oct)	P2	0.4	0.5	0.5	1.0	0.9
	P5	0.0	0.5	1.3	0.9	0.9
	P7	0.5	0.6	0.7	1.1	1.1
Lobsters, total (Jun-Nov)	L1	62.1	64.1	66.1	88.1	76.3
	L7	82.2	86.9	91.6	103.5	65.6
Lobsters, legal-sized (Jun-Nov)	L1	6.9	7.2	7.5	2.6	2.4
	L7	5.6	6.0	6.4	2.7	1.6
Lobsters, female (Jun-Nov)	L1	37.1	39.0	40.9	47.7	42.9
	L7	44.6	47.1	49.6	55.4	36.5
Lobsters, ovigerous (Jun-Nov)	L1	0.5	0.6	0.6	0.5	0.4
	L7	0.4	0.6	0.7	0.5	0.7
Cancer sp. larvae (May-Sep)	P2	17480.5	25250.1	36472.8	9249.2	52165.3
	P5	4610.3	9531.0	19702.6	8880.8	24769.3
	P7	11585.0	24121.3	50222.4	15764.4	40766.3
Jonah crabs, total (Jun-Nov)	L1	11.3	12.6	13.8	14.8	11.0
	L7	8.7	9.5	10.3	5.9	5.2
Jonah crab, females (Jun-Nov)	L1	8.7	9.7	10.7	10.2	7.9
	L7	6.1	6.8	7.4	3.6	3.0
Rock crab, total (Jun-Nov)	L1	2.1	2.5	2.9	4.4	1.9
	L7	1.2	1.6	1.9	4.5	3.5
Rock crab, female (Jun-Nov)	L1	0.3	0.5	0.7	1.2	0.5
	L7	0.2	0.3	0.4	0.6	1.5

[a]Preoperational P2, P7, L1, L7: 1982-1989. P5: 1988-1989
[b]Geometric mean for lobster larvae and *Cancer* spp. larvae

TABLE 3.3.6-2. RESULTS OF ANALYSIS OF VARIANCE COMPARING DENSITIES OF LOBSTER AND *CANCER* SP. LARVAE COLLECTED AT INTAKE, DISCHARGE, AND FARFIELD STATIONS, AND CATCHES OF TOTAL AND LEGAL-SIZED LOBSTERS, JONAH CRAB, AND ROCK CRAB AT THE DISCHARGE STATION AND RYE LEDGE. SEABROOK OPERATIONAL REPORT, 1991.

SPECIES	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Lobster larvae (May-Oct)	Preop-Op	1	0.76	20.13***	Op>Preop
	Station	2	0.08	1.09 NS	
	Year (Preop-Op)	7	0.59	2.22*	
	Week (Year)	168	36.50	5.73***	
	Preop-Op X Station	2	0.01	0.13 NS	
	Error	382			
Lobster (total catch) (Jun-Nov)	Preop-Op	1	5997.41	6.24*	L7 Pre L1 Op L1 Pre L7 Op
	Station	1	2909.80	3.03 NS	
	Year (Preop-Op)	7	145343.87	21.59***	
	Month (Year)	45	1365568.08	31.55***	
	Preop-Op X Station	1	10266.12	10.67**	
	Error	1098	2665339.88		
Lobster (legal size) (Jun-Nov)	Preop-Op	1	1221.31	102.66***	Preop>Op
	Station	1	1.75	0.15 NS	L1 = L7
	Year (Preop-Op)	7	3647.79	43.80***	
	Month (Year)	45	6941.21	12.97***	
	Preop-Op X Station	1	3.71	0.31 NS	
	Error	1098			
Cancer sp. larvae (May-Sep)	Preop-Op	1	4.98	6.55*	Op>Preop
	Station	2	1.69	1.11 NS	
	Year (Preop-Op)	2	0.62	0.41 NS	
	Month	16	95.77	7.88***	
	Preop-Op X Station	2	0.16	0.10 NS	
	Error	96			

(continued)

TABLE 3.3.6-2. (Continued)

SPECIES	SOURCE OF VARIATION[a]	df	SS	F[b]	MULTIPLE COMPARISONS
Jonah crab (Jun-Nov)	Preop-Op	1	462.95	5.63*	Preop>Op
	Station	1	1404.62	17.09***	L1>L7
	Year (Preop-Op)	7	15301.34	26.59***	
	Month (Year)	45	58583.24	15.84***	
	Preop-Op X Station	1	63.74	0.78 NS	
	Error	1076	88445.99		
Rock crab (Jun-Nov)	Preop-Op	1	47.94	3.36 NS	L7 Op L1 Pre L1 Op L7 Pre
	Station	1	55.53	3.89*	
	Year (Preop-Op)	7	3169.06	31.70***	
	Month (Year)	45	4626.71	7.20***	
	Preop-Op X Station	1	270.37	18.93***	
	Error	1076	15367.52		

[a]Preop-Op = Preoperational period (Lobster, *Cancer* larvae, all stations: 1988, 1989; Adult lobster and crabs: 1982-1989) vs. 1991 regardless of Station or month.
Station = Station differences (Lobster and *Cancer* Larvae: P2, P5, P7; Adult lobster: Discharge (L1) and Rye Ledge (L7)) regardless of year, month or period.
Preop-Op X Station = Interaction of main effects.
Year (Preop-Op) = Year nested within preoperational and operational periods regardless of year, month or Station.
Month (Year) or Week (Year) = Month or week nested within Year, regardless of Station.
[b]NS = Not significant ($p>0.05$)
* = Significant ($0.05\geq p>0.01$)
** = Highly significant ($0.01\geq p>0.001$)
*** = Very Highly Significant ($0.001\geq p$)

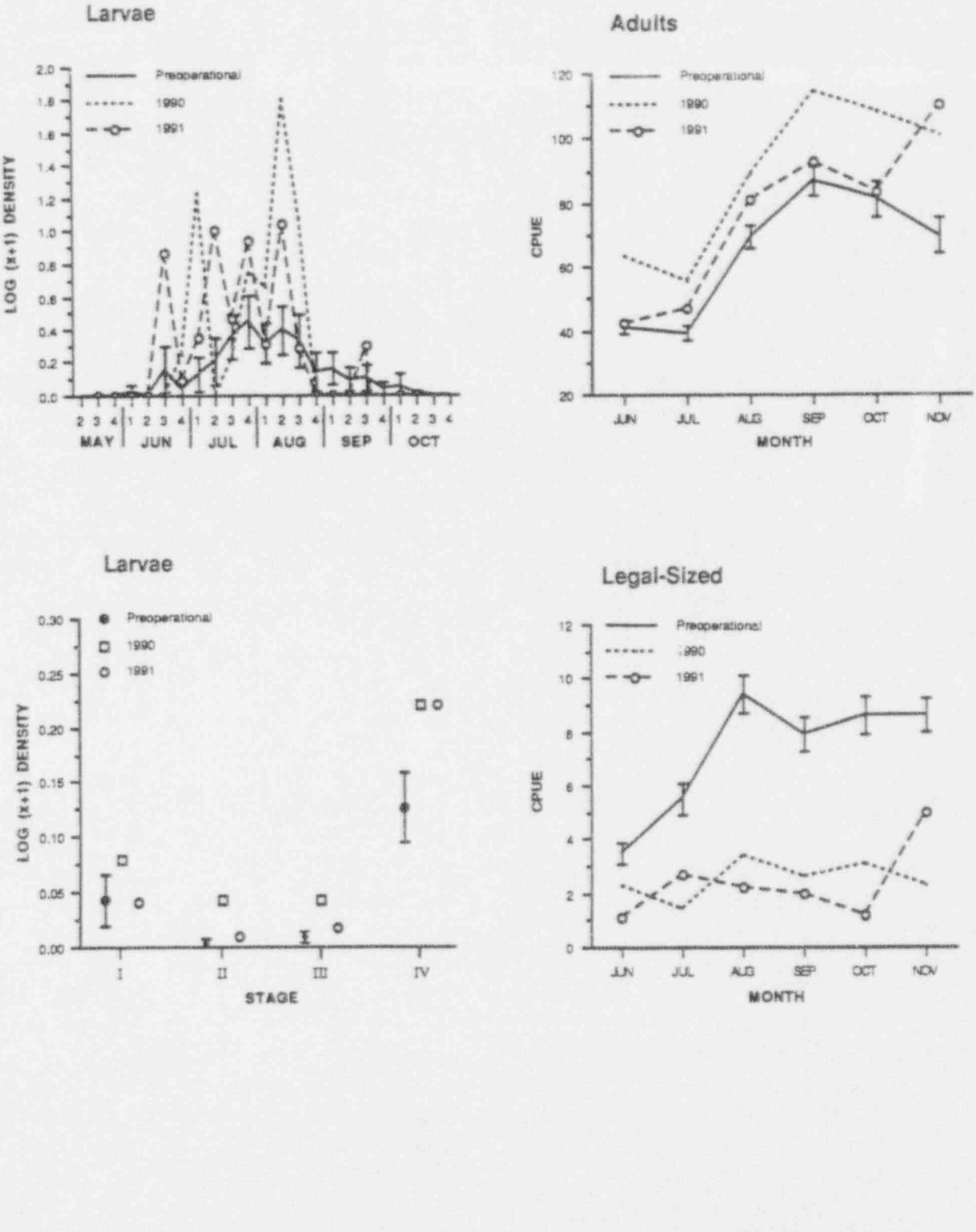


Figure 3.3.6-1. Weekly mean log (x+1) density of lobster larvae (no./1000 m^2) at Station P2, log (x+1) density of stage I, II, III and IV lobster larvae at Station P2 and monthly catch per unit effort (15 traps) of adult and legal-sized lobster at discharge Station L1 and 95% confidence intervals during the preoperational period (1978-1989: larvae, 1975-1989: adults), and monthly means in 1990 and 1991. Seabrook Operational Report, 1991.

Adults

Adult lobster catch in 1991 (collected from June through November only) averaged 76.3 per 15-trap effort at the discharge Station L1. The average catch was higher than the preoperational average, although lower than the annual catch in 1990 (Table 3.3.6-1). Adult catches at the farfield Station L7 were consistently higher than those at L1 through 1990, but were lower than those at L1 in 1991. Analysis of variance results indicate annual adult catch at the discharge site in 1991 was not significantly different from catches during the preoperational period, unlike 1991 catch at the farfield site, which was significantly lower than during the preoperational period (Table 3.3.6-2).

Seasonal patterns in 1991 were similar to previous years with one exception. Adult catch at the discharge station increased from July through September, decreased in October, then increased in November (Figure 3.3.6-1). Catches during the peak periods (August, September, November) were higher than the preoperational average. The seasonal pattern of lobster catches in 1991 was typical of the New England lobster fishery (New England Fishery Management Council 1983). New Hampshire Fish and Game (1992) also reported 1991 lobster catches from traps set in coastal New Hampshire were highest in August but were substantially lower in September and October. Seasonal variations in lobster catch are probably in part due to regional temperature changes, which act to increase the activity level, in turn enhancing the likelihood of being caught (McLeese and Wilder 1958, Dow 1969). In addition, temperature may affect seasonal lobster migrations (Campbell 1986). In New Hampshire, adult lobsters are thought to move inshore in spring and summer and offshore in fall and winter (NHFG 1992).

Year-to-year fluctuations in lobster catches are thought to be influenced by a number of factors It has been suspected that lobster densities are correlated with numbers of larvae (Harding et al. 1982), but others reject this idea (Fogarty and Idoine 1986). The availability of cobble substrate for recruitment of early benthic phase lobsters may also limit lobster populations (Wahle and Steneck 1991). Temperature is known to affect lobster catches. Total lobster catch in Maine (assumed to be legal-sized only) has been correlated with surface water temperature, both in the current year and six years prior (Fogerty 1988; Campbell et al. 1991). Higher temperatures also increase the likelihood of the molting of sublegal-sized lobsters into a harvestable size (Fogarty 1988). Inshore lobster catches in the northeastern United States have steadily increased from 1975-1990, reflecting both an increasing population as well as increasing effort by fishermen, who may be trying to offset new size limits (NOAA 1991b). Evidence suggests that in Maine, newly-recruited legal lobsters are almost completely harvested in the same year (Fogarty 1988). Thus, although regional temperatures were higher than average in 1990 and 1991 (Table 3.1.1-1), they may have had no effect on this highly-exploited resource.

Legal-sized Lobsters

Catches of legal-sized lobsters are affected by the same environmental conditions that affect total catch as well as changes in the regulations governing the fishery. The legal-size limit for lobsters has been increased in 1984, 1989, and in 1990, and is currently defined as a carapace length of 83 mm (3 1/4"). Each increase in the legal size reduced the proportional catch of legal sized lobsters (NAI 1991b, Figure 3.3.6-2). In 1991, the annual catch of 2.4 lobsters per 15-trap effort at the discharge station was similar to that in 1990 and significantly lower than the preoperational average of 7.2 (Tables 3.3.6-1,2). There was no difference between the nearfield and farfield stations.

The seasonal pattern of legal-sized lobster catches in 1991 appeared to be unrelated to seasonal patterns of adult lobsters, with the exception of November (Figure 3.3.6-1). Catches remained low from June through October, then increased dramatically in November as did total catch. In 1990, legal-sized lobsters showed no seasonal trend, unlike the preoperational average, which mirrored total catches.

Size Class Distribution

The majority of lobsters collected in 1991 were in the 67-79 mm (2 5/8"-3 1/8") size class, as was true in 1990 and in previous years. Lobsters measuring 54-67 mm (2 1/8-2 5/8") ranked second in abundance in 1991 (Figure 3.3.6-2). Catches in the 79-92 mm size class, which includes both legal-sized and sublegal-sized lobsters, were lower than in 1990, but higher than in 1989, when the last increase in the legal-size limit was made. In a 1991 study of New Hampshire coastal areas, the majority of lobsters measured between 77 and 80 mm, with an average length of 78 mm (NHFG 1992).

Female lobster catch averaged 42.9 CPUE at the discharge station in 1991, slightly more than half of the total lobster population (Table 3.3.6-1). This was similar to the 1984-1989 period, which ranged from 54-56% (NAI 1991b). The proportion was similar at Rye Ledge, both in 1991 and during the preoperational period. NHFG studies found that females constituted 52% of the total legal-sized population (Grout et al. 1989).

Egg-bearing female lobsters represented a small component of the lobster population for 1991; berried females averaged 0.4 CPUE, composing 0.5% of the total catch at the discharge station. Catches of ovigerous females at Rye Ledge were slightly higher, averaging 0.8 per effort or 1% of the total catch (Table 3.3.6-1). The percent of egg-bearing female lobsters has been variable, but generally less than 1% during the preoperational period (NAI 1991b; Table 3.3.6-1). Changes in legal-size limits for fishing do not appear to have affected the proportion of egg-bearing females. NHFG studies (Grout et al. 1989) found that 0.4% of the total lobsters examined during lobster surveys from 1983-1985 were berried.

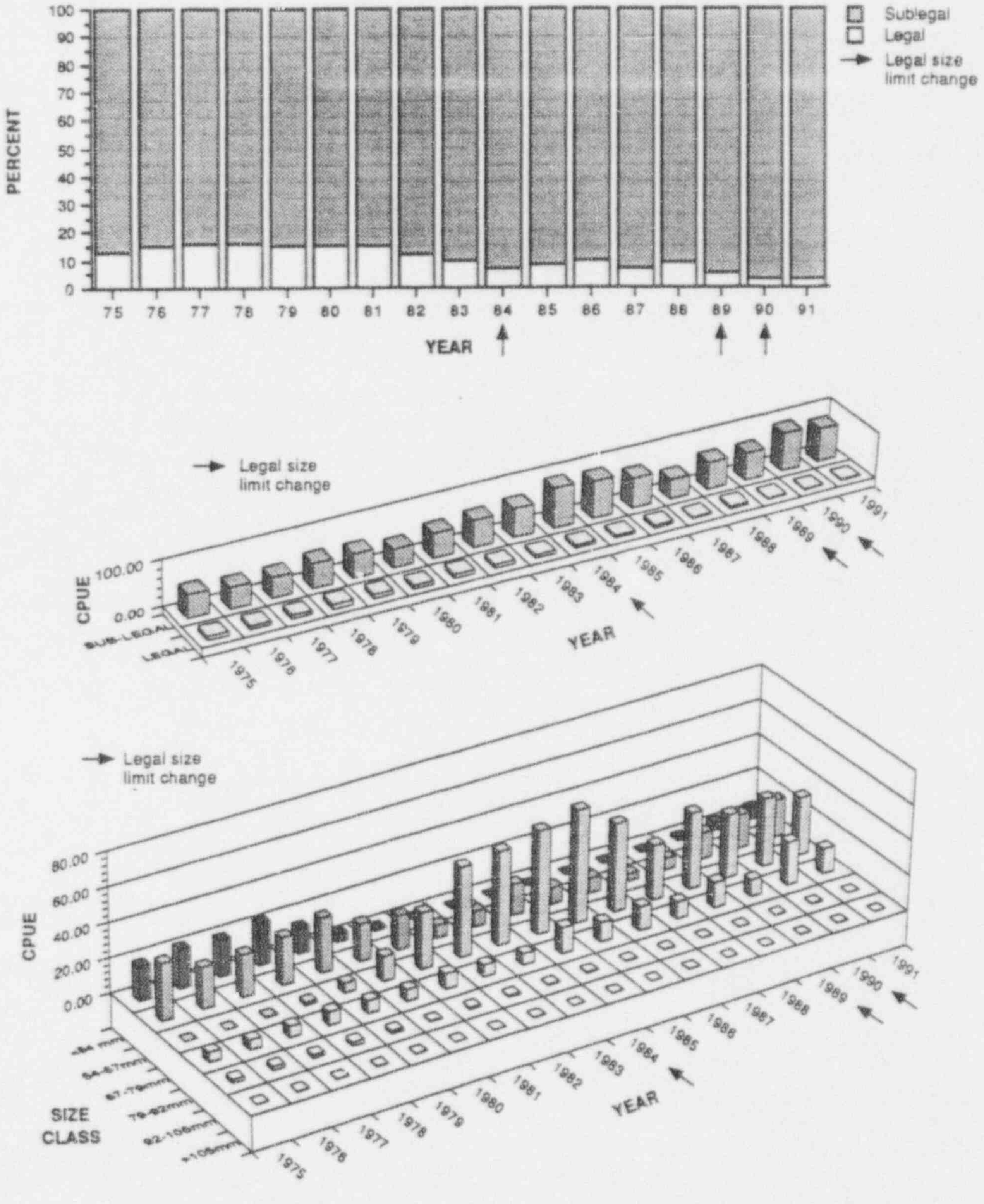


Figure 3.3.6-2. Percentage and catch (per 15 traps) of legal-sized and sublegal-sized lobsters and size-class distribution at the discharge site L1 from 1975-1991. Seabrook Operational Report, 1991.

In 1991, 29 lobsters were impinged in the plant's cooling water system. Nineteen of these (66%) were impinged in November, following the severe Northeastern storm. Four lobsters were impinged in 1990. This level of impingement does not represent a threat to the local lobster population.

3.3.6.2 Jonah Crab (*Cancer borealis*) and Rock Crab (*Cancer irroratus*)

Larvae

Cancer spp. (*Cancer borealis* and *Cancer irroratus*) larvae had significantly higher peak abundances in 1991 in comparison to the preoperational period at all three stations (Tables 3.3.6-1,2). Average densities were at least double those of the preoperational period. The seasonal trend of occurrence at P2 was similar to previous years. Densities were low from January through April, peaked from May through September, then decreased from October through December (Figure 3.3.6-3).

Adults

Annual Jonah crab (*Cancer borealis*) catches in 1991 averaged 11.0 CPUE at the discharge station and 5.2 at Rye Ledge, significantly lower than the preoperational average at both stations. However, 1991 catch levels at the discharge site were not unusual, but were similar to catches in 1987, and higher than the low catches observed from 1982-1984 (NAI 1991b). Catches at Rye Ledge were lower than those at the discharge station in 1991, consistent with previous years (Tables 3.2.6-1,2). Female crab catches were also lower than average in 1991, but composed approximately three-quarters of the total catch at the discharge station, similar to the average proportion during the preoperational period. Highest catches in 1991 at the discharge station occurred from July through September, but lacked the typical August peak evident in the preoperational average (Figure 3.3.6-3).

Rock crabs (*Cancer irroratus*) were less abundant than Jonah crabs in the study area, a result of intra-specific competition (Richards et al. 1983) and their preference for sandy habitat rather than the cobble-rock that predominates in the area (Jefferies 1966, Bigford 1979). Rock crab catches in 1991 averaged 1.9 CPUE at the discharge site and were not significantly different from the preoperational period. However, Rye ledge catches averaged 3.5 in 1991 and were significantly higher than the preoperational average (Table 3.3.6-1,2). In 1991, catches at the discharge site were highest in July, but decreased in August and remained below average for the remainder of the year (Figure 3.3.6-3). Female crabs composed approximately one-quarter of the total catch at the discharge site in 1991, consistent with previous years (Table 3.3.6-1). However, female crabs at Rye Ledge were much more numerous in 1991 in comparison to previous years.

3.3.6.3 Effects of Plant Operation

Differences occurred in 1991 in larval and adult stages of the predominant

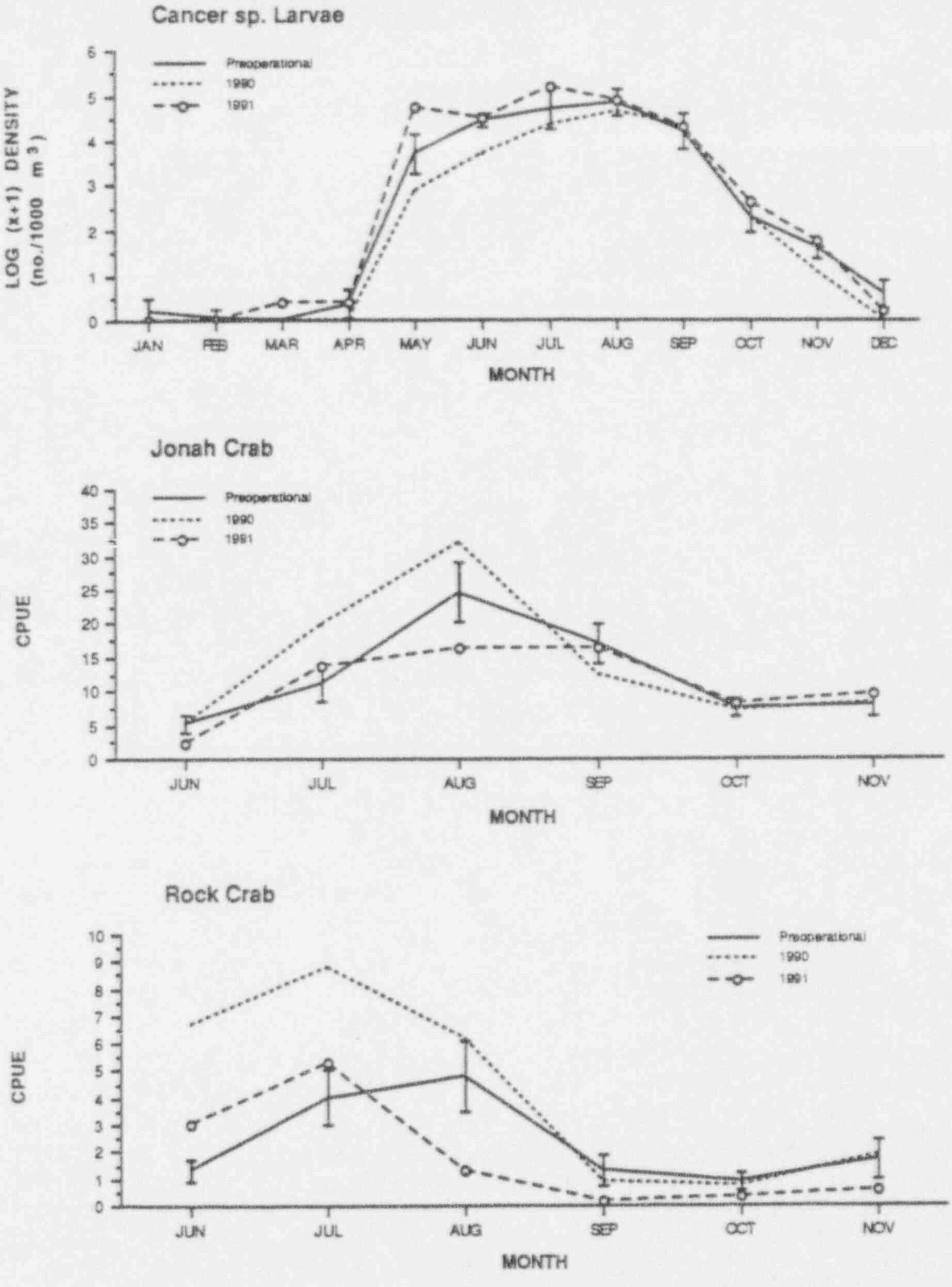


Figure 3.3.6-3. Monthly means and 95% confidence intervals of log (x+1) densit· (no./1000 m^3) of *Cancer* spp. larvae at Station P2, and catch per unit effort (15 ·raps) of Jonah and Rock crabs at Station L1 during the preoperational period (1978-1989: larvae, 1975-1989: adults) and monthly means in 1990 and 1991. Seabrook Operational Report, 1991.

epibenthic crustaceans. Both *Cancer* spp. and lobster larvae were more abundant in 1991 than during the preoperational period. Jonah crab catches were reduced from the preoperational average. As these changes occurred at both nearfield and farfield stations, they appear unrelated to operation of Seabrook Station. Adult lobster and rock crab catches at the discharge station in 1991 were not significantly different from catches during the preoperational period. However, significant differences occurred at the farfield station, which is remote from plant influence.

Legal-sized lobster catch has been substantially reduced, at least in part due to changes in the definition of legal size. Since the trend has been the same at nearfield and farfield stations, there is no indication of a plant-related effect.

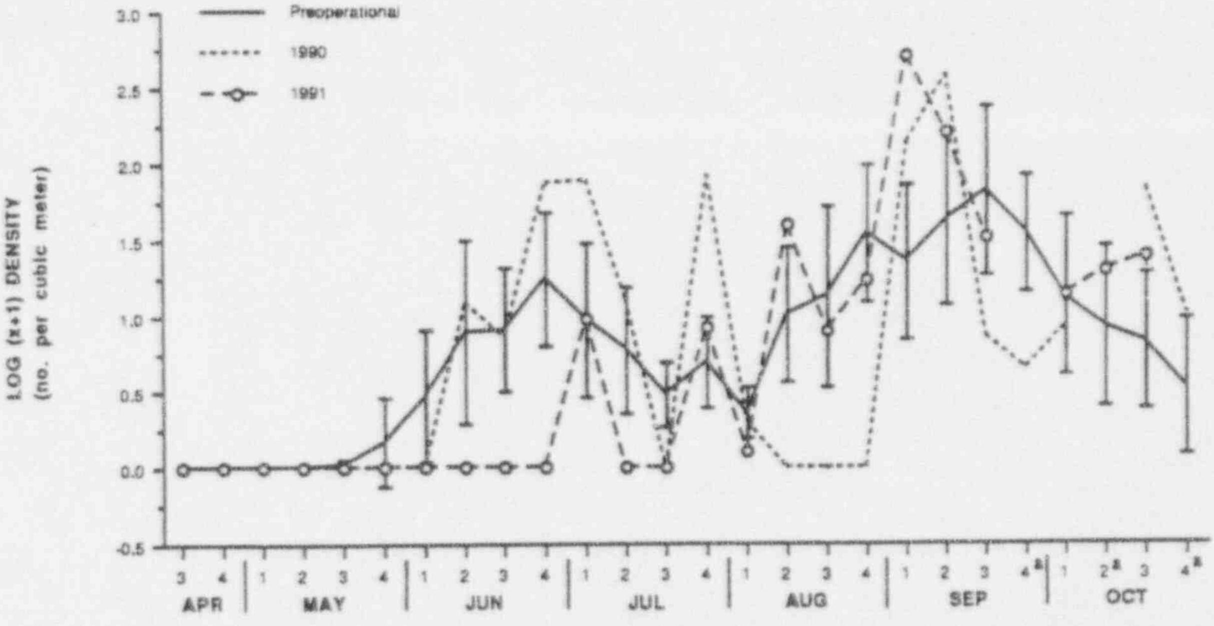
3.3.7 *Mya arenaria* (Soft-shell Clam)

3.3.7.1 Larvae

Mya arenaria larvae occurred most weeks from May through October in preoperational years at nearfield Station P2. Maximum densities were typically recorded in late summer or early fall, although a secondary peak usually occurred in early summer (Figure 3.3.7-1). Peak abundances in 1991 were observed in early September with lesser peaks in August and October (Figure 3.3.7-1). A two-way ANOVA comparing 1991 (operational) larval abundances with previous years (preoperational) at Nearfield (P2, P5) and Farfield (P7) stations found no significant spatial or temporal differences, except among weeks (Tables 3.3.7-1,2).

Factors influencing the timing and magnitude of the observed pattern of larval abundance are complex, including: adult condition at the time of spawning, temperature at spawning sites, location of spawning sites relative to prevailing coastal currents, water column stratification and larval behavior. *M. arenaria* is known to spawn in the spring at temperatures greater than 4-6°C with a summer spawning at 15-18°C (Brosseau 1978). Length of larval life is approximately 12 days at 20°C, but lasts up to 21 days under cooler conditions (Turner 1949). For most of their planktonic period, the larvae are in the umboned stage, which has been the focus of this larval study (NAI 1981c). Maximum larval abundances in August and September coincided with water temperatures in Hampton Harbor that regularly exceeded 15-18°C (Section 3.3.1). However, these temperatures also occurred frequently in June and July, which were characterized by much lower larval abundances, suggesting that temperature is a minimum requirement for spawning.

Recruitment of larvae of non-local origin is likely due to currents in the Gulf of Maine, which may move water masses and their entrained larvae significant distances before larval settlement (NAI 1979f). The late-summer peaks have been observed to be coincident with northward-flowing currents. Further evidence is provided by gonadal studies, which demonstrated that the onset of spawning in Hampton Harbor and Plum



ª No data collected in the 2nd week of Oct., 1990 and the 4th week of Sept. and Oct., 1991.

Figure 3.3.7-1. Weekly mean and 95% confidence interval for log (x+1) density (no. per cubic meter) of *Mya arenaria* larvae at Station P2, during the preoperational years 1978-1989 and weekly mean in 1990 and 1991. Seabrook Operational Report, 1991.

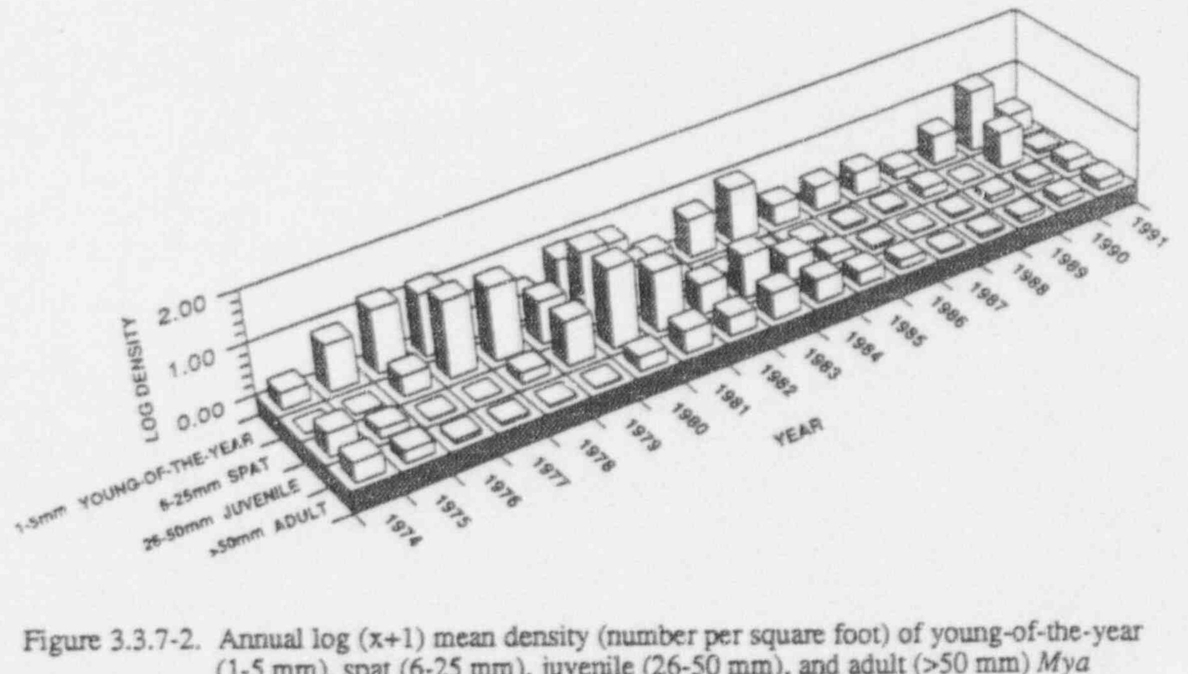


Figure 3.3.7-2. Annual log (x+1) mean density (number per square foot) of young-of-the-year (1-5 mm), spat (6-25 mm), juvenile (26-50 mm), and adult (>50 mm) *Mya arenaria* at Hampton-Seabrook Harbor Flat 1 from 1974-1991. Seabrook Operational Report, 1991.

TABLE 3.3.7-1. GEOMETRIC MEAN DENSITY (NUMBER PER CUBIC METER, LARVAE; NUMBER PER SQUARE FOOT JUVENILE/ADULTS) AND LOWER AND UPPER CONFIDENCE LIMITS (LCL,UCL) OF *MYA ARENARIA* COLLECTED DURING PREOPERATIONAL AND OPERATIONAL (1990 AND 1991) YEARS. SEABROOK OPERATIONAL REPORT, 1991.

		PREOPERATIONAL[b]			OPERATIONAL		
LIFESTAGE	AREA[a]	LCL	MEAN	UCL	1990	1991	MEAN
Larvae	P2	5.1	6.3	7.9	5.8	4.4	5.1
	P5	4.0	6.0	9.1	6.2	7.4	6.8
	P7	4.9	6.4	8.5	4.6	4.4	4.5
1-5 mm young-of-the-year	HH-1	2.0	3.5	6.0	12.8	1.5	4.9
	HH-2	3.7	8.6	18.0	13.4	3.2	6.7
	HH-4	5.5	10.5	19.0	12.4	1.4	4.7
6-25 mm spat	HH-1	0.4	1.7	4.3	4.0	0.2	1.4
	HH-2	0.1	0.7	1.7	0.6	<0.01	0.3
	HH-4	1.2	3.4	8.0	4.6	0.2	1.6
26-50 mm juveniles	HH-1	0.5	1.6	3.5	0.3	0.7	0.5
	HH-2	0.1	0.4	0.7	0.1	0.1	0.1
	HH-4	0.6	1.7	3.7	1.5	0.9	1.2
>50 mm adults	HH-1	0.3	0.6	1.0	0.4	0.6	0.5
	HH-2	0.2	0.4	0.7	0.1	0.1	0.1
	HH-4	0.3	0.5	0.8	1.9	1.4	1.6
1-12 mm spat	Nearfield	0.0	5.7	9.1	7.8	3.3	5.2
	Farfield	7.6	17.1	36.9	34.7	7.7	16.6
	Near/HH-2	2.7	7.3	17.4	13.1	12.7	12.9
	Near/HH-4	1.7	4.4	9.9	4.4	0.4	1.7

[a]Hampton Harbor (HH) surveys compared samples taken from 1974-1991 at Flats 1, 2, and 4 in Hampton Harbor. Number of samples varied annually, depending on abundance. Nearfield/Farfield surveys compared samples taken from 1987-1991 at Nearfield (Hampton Harbor, Flats 2 and 4) and Farfield (Plum Island Sound, Ipswich, MA; Lufkins Flat and Middle Ground). Five samples were taken per flat per year in the fall. Larvae samples from weekly bivalve larvae tows; P2 and P5 - nearfield, P7 - farfield.

[b]Hampton Harbor PREOP = 1974-1989.
Nearfield/Farfield PREOP = 1987-1989.
Larvae PREOP: P2 = 1978-1989; P5 = 1988-1989; P7 = 1982-1989.

TABLE 3.3.7-2. RESULTS OF ANALYSIS OF VARIANCE COMPARING *MYA ARENARIA* LARVAL, SPAT, JUVENILE AND ADULT DENSITIES DURING PREOPERATIONAL AND OPERATIONAL PERIODS. SEABROOK OPERATIONAL REPORT, 1991.

LIFESTAGE	STATION/FLAT	SOURCE OF VARIATION	F	df	SS	MULTIPLE COMPARISONS[i]
Mya arenaria larvae[a]	Nearfield (P2, P5) Farfield (P7)	Preop-Op[c,d]	1	0.27	1.47 NS	
		Year (Preop-Op)[e]	6	1.75	1.62 NS	
		Week (Preop-Op X Year)[f]	191	255.59	7.43***	
		Station[g]	1	0.12	0.69 NS	
		Preop-Op X Station	1	0.37	2.06 NS	
		Error	287	51.71		
	<u>HAMPTON HARBOR</u>					
1-5 mm[b] young-of-the-year	1, 2, 4	Preop-Op	1	1.92	4.25*	
		Year (Preop-Op)	2	9.60	10.62***	
		Area	16	185.41	25.64***	
		Preop-Op X Area	2	4.98	5.50**	4 Pre 2 Pre 2 Op 1 Op 4 Op 1 Pre
		Error	1377	622.40		
6-25 mm[b] spat	1, 2, 4	Preop-Op	1	2.76	11.38***	Preop>Op
		Year (Preop-Op)	2	9.68	19.93***	
		Area	16	196.96	50.67***	4>1>2
		Preop-Op X Area	2	1.40	2.88 NS	
		Error	1377	334.55		
26 -50 mm[b] juvenile	1, 2, 4	Preop-Op	1	5.09	30.39***	Preop>Op
		Year (Preop-Op)	2	13.19	39.40***	
		Area	16	190.95	71.28***	4>1>2
		Preop-Op X Area	2	0.76	2.28 NS	
		Error	2429	406.66		

(continued)

TABLE 3.3.7-2. (Continued)

LIFESTAGE	STATION/FLAT	SOURCE OF VARIATION	F	df	SS	MULTIPLE COMPARISONS[i]
>50 mm adult, legal	1, 2, 4	Preop-Op	1	0.29	5.34*	
		Year (Preop-Op)	2	6.42	58.40***	
		Area	16	34.94	39.75***	
		Preop-Op X Area	2	4.48	40.78***	4 Op 1 Pre 4 Pre 1 Op 2 Pre 2 Op
		Error	2429	133.44		
	NEARFIELD/FARFIELD					
1-12 mm[b]	Hampton Harbor	Preop-Op	1	0.01	0.02 NS	Farfield> Nearfield
	Plum Island Sound	Year (Preop-Op)	3	2.70	1.63 NS	
		Area	1	4.74	8.59**	
		Preop-Op X Area	1	0.004	0.01 NS	
		Error	93	51.31		

[a]Larval comparisons based on weekly sampling periods, mid-April through October
[b]Size classes from 1 through >50 mm were sampled annually in the Fall. Hampton Harbor Survey analyzed data from 1974-1991. The Nearfield/Farfield Survey analyzed data from 1987-1991.
[c]Commercial operation began in August 1990, therefore the operational period includes 1990 for spat, juveniles, and adults, but not for larvae.
[d]Operational versus preoperational period regardless of area. Larval preoperational period
[e]Year nested within preoperational and operational periods, regardless of area
[f]Week nested within year regardless of area
[g]Station or flat, regardless of year or period
[h]Interaction of main effects
[i]Underlining signifies no significant differences at alpha = 0.05

NS = Not significant ($p>0.05$)
* = Significant ($0.05 \geq p > 0.01$)
** = Highly significant ($0.01 \geq p > 0.001$)
*** = Very highly significant ($0.001 \geq p$)

Island Sound usually followed the appearance of larvae in offshore tows. Thus, the spring and early summer larvae population may originate further south (NAI 1985b). This implies that these offshore larval peaks may in part have a more southern origin.

3.3.7.2 Hampton Harbor Population Studies

Interannual Patterns

The soft-shell clam population has been studied through intensive surveys of clams at three flats in Hampton Harbor. Stations are randomly selected, and the number of samples per year varies and is dependent on population size.

Young-of-the-year (1-5 mm). In 1991, the spatfall (indicated by 1-5 mm clams) was well below the preoperational average at all three flats (Table 3.3.7-1), in contrast to 1990, which was very high. ANOVA results indicate there were significant differences among years, area (flats) and period (operational vs. preoperational). The interaction was significant for young-of-the-year because abundances were lower during the operational period at Flat 4, but stayed the same at Flats 1 and 2 (Tables 3.3.7.1,2).

Spat (6-25 mm) and Juveniles (26-50 mm). Trends in the 6-25 mm size class indicate the survival success of young-of-the-year. In 1991, densities of 6-25 mm clams were significantly lower than preoperational averages at all three flats (Tables 3.3.7-1, 2), indicating the relatively-large 1990 set had poor survival. Although differences between periods (operational and preoperational) and among years and among flats were significant, the interaction term was not implying that the spatial distribution of 6-25 mm spat was similar to preoperational and operational conditions. Flat 4 generally had the most 6-25 mm clams, while Flat 2 had the least, which contributed to the difference among areas. During the operational period, recruitment into the 6-25 mm size class was very low in 1991, but high in 1990, except at Flat 2.

Juveniles (26-50 mm), two to four years old, had 1991 densities that were significantly lower than the preoperational average at all flats (Tables 3.3.7-1, 2). Densities on Flat 4 were highest, followed by Flats 1 and 2. On Flat 1, 26-50 mm clams were more abundant than they have been since 1985, although density was well below the preoperational average (Figure 3.3.7-2). Relative distribution of juvenile clams on Flats 1, 2 and 4 were similar during the preoperational and operational periods, resulting in no significant differences in the interaction term (Table 3.3.7-2).

Adults (>50 mm). Clams measuring more than 50 mm are at least 4 years of age (Ayer 1968). The differences among areas, years, and the interaction were highly significant (Table 3.3.7-2). Historically, Flats 1 and 4 have had higher densities than Flat 2, and the trend continued into 1991. Annual densities at Flat 4 reached an all time high in 1990 and very high densities continued into 1991. The interaction between the Preop-Op time period and area was highly significant, since clams at Flat 4 reached their highest densities during the Operational period, while Flat 2 experienced the reverse trend. At Flat 1, the operational and preoperational densities were not significantly different. The increased density of adults more than 50 mm in length at Flat 4 can be traced back to high numbers of 6-25 mm clams in 1989, and 26-50 mm clams in 1990, relative to the other two flats (NAI 1990b, 1991b).

Spatial Patterns

Annual fall surveys of 1-12 mm clams from 10 nearfield stations (Hampton Harbor) and 10 farfield stations (Plum Island Sound, Ipswich, MA) have been analyzed since 1987. A comparison of mean densities at nearfield and farfield stations indicates *Mya* is significantly more abundant at farfield stations (Tables 3.3.7-1,2). No statistical difference between preoperational (1987-89) and operational (1990-91) time periods were found. Likewise, no difference among years was found (Tables 3.3.7-1,2).

3.3.7.3 Effects of Predation, Perturbation and Disease on Harvestable Clam Resources

Clams in Hampton Harbor are subject to predation pressure from two major sources: green crab (*Carcinus maenas*) which consume spat (1-25 mm) and juvenile (26-50 mm) *Mya*, and humans who dig adult *Mya* (>50 mm) and also cause mortality to smaller clams by disturbing the flat (perturbation). Sea gulls may also be major predators, as they are commonly observed picking over clam digger excavations for edible invertebrates. Clams are a major source of food for green crab, particularly in the fall months (Ropes 1969). Maximum green crab abundance usually occurred in the fall (Figure 3.3.7-3a), with the highest number recorded in 1984 (Figure 3.3.7-3b). Mean densities during the 1990 and 1991 operational period were lower than preoperational densities in eight out of ten months (Figure 3.3.7-3a).

Welch (1969) and Dow (1972) have shown that green crab abundance increased markedly following relatively warm winters, and data from Hampton Harbor from the past 18 years corroborate their findings (Figure 3.3.7-3b). During the winters when the minimum temperature was relatively high (1983-1989), green crab abundance in the following fall was also high (Figure 3.3.7-3b). In 1990 and 1991, when the minimum winter temperature was relatively low, green crab abundance was also low, similar to abundances in 1982.

Recreational clam digging on the Hampton Harbor flats had been a significant source of mortality for legal sized clams (>50 mm) through 1988. The perturbance it caused was probably a source of mortality to smaller clams as well. Hampton Harbor flats were closed for clam digging from April 1989 through December 1991 by the New Hampshire Department of Health and Human Services due to coliform contamination. With the Hampton Harbor flats closed, the few li-

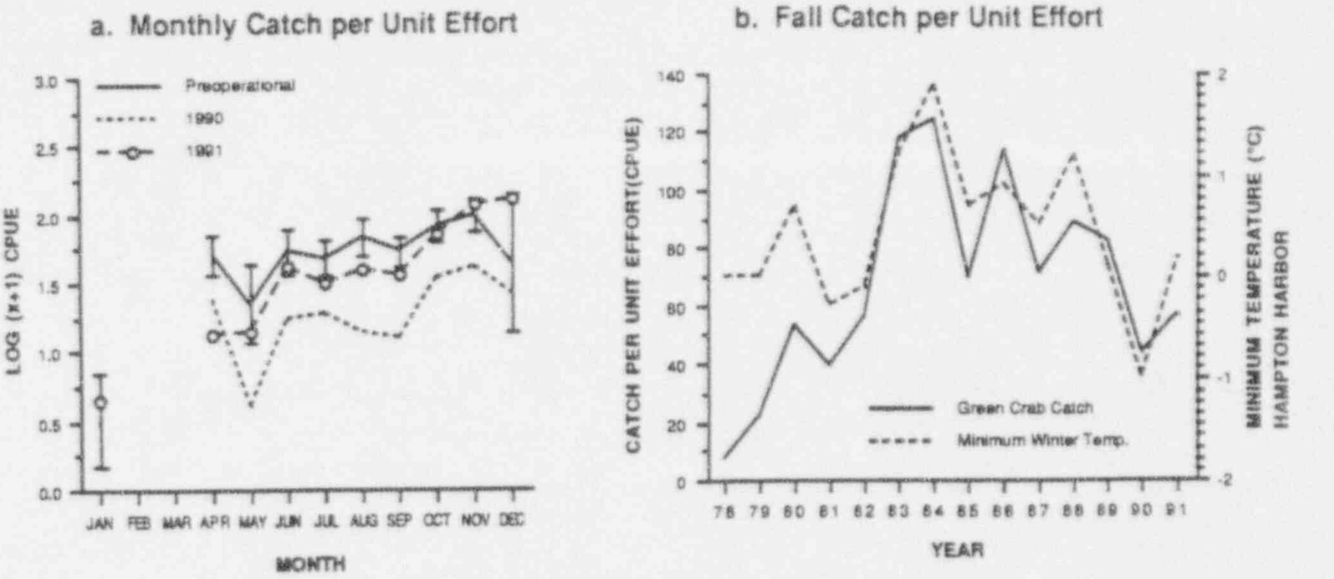


Figure 3.3.7-3. **a.** Mean monthly catch per unit effort [log (x+1)] and 95% confidence intervals for green crabs (*Carcinus maenas*) collected at estuarine stations from preoperational years (1983-1989) and operational years (1990 and 1991) and **b.** Mean fall (October-December) catch per unit effort for **green crab** in Hampton-Seabrook Harbor and its relationship to minimum winter temperature, 1978-1991. Seabrook Operational Report, 1991.

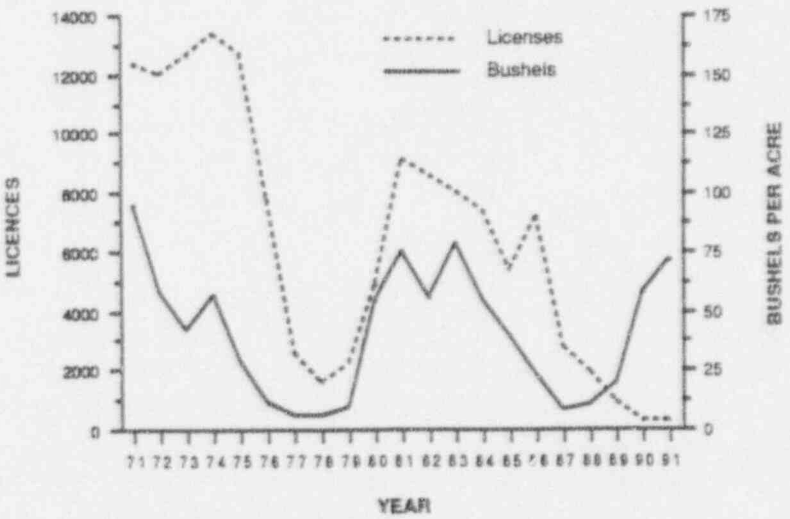


Figure 3.3.7-4. Number of clam licenses issued and the estimated bushels per acre of adult (>50 mm) clams in Hampton-Seabrook Harbor, 1971-1991. Seabrook Operational Report, 1991.

cense holders in 1990 and 1991 were restricted to digging in New Hampshire flats associated with Great Bay and the Piscataqua River Estuary. As the pressure on the adult clam population was lifted, the estimated number of bushels per acre increased dramatically (Figure 3.3.7-4). A more detailed discussion of the estimated bushels per acre and standing crop of harvestable clams (>50 mm) can be found in NAI (1991b).

Another anthropogenic effect on the Hampton Harbor clam population is caused by clam seeding. In 1987 and 1988, attempts by the New Hampshire Fish and Game Department to augment natural recruitment by seeding juvenile clams at Flat 5 were not successful (Morris 1989). In fall, 1988, the local 4-H organization planted 30,000 seed (approximately 12 mm) clams on Flat 4 (47.9 acres), which can be converted to roughly 0.01 clams/sq.ft. In late November, 1989, the 4-H planted 100,000 seed clams on Flat 4, or roughtly 0.05/sq.ft. (R.Wojtusik, 4-H; UNH Cooperative Extension, Durham, NH; pers. comm. June 1992). From 1988-1990, juvenile (6-25 mm) densities increased slightly at Flats 1 and 4 (but not at Flat 2). At Flat 4, the geometric mean density went from 1.41 sq.ft. in 1988 to 4.6/sq.ft. in 1990. Since the seed were stocked in low densities, it is unlikely that they made a measurable contribution to the population of Flat 4.

Effect of Disease on Harvestable Clam Resources

Sarcomatous neoplasia, a lethal form of cancer in *Mya arenaria*, has been observed in Hampton Harbor *Mya* populations (Hillman 1986, 1987). A virus similar to the B-type retroviruses is known to initiate the disease in *Mya* (Oprandy et al. 1981). Although the infection has been observed in regions of relatively-pristine waters, the rate of infection may also be enhanced by pollution-mediated deterioration of the environment (Reinisch et al. 1984). The infection rate in some *Mya* populations may reach 100 percent with 100 percent mortality of infected clams (Farley et al. 1986). The incidence of sarcomatous neoplasms in Hampton Harbor *Mya* populations was observed in October 1986 and February 1987 (Hillman 1986, 1987). Neoplastic infections were more prevalent in February, reaching 6% at Flat 1 and 27% at Flat 2. Infections were absent from Flat 4. Assuming 100 percent mortality of infected clams (Farley et al. 1986), Flats 1 and 2 may have suffered substantial disease-related reductions in clam production. In 1987, clam flat surveys did indicate, however, that juvenile and adult densities fell by over 50% at Flat 1 and Flat 2 while Flat 4 remained unchanged. In November 1989, fifteen large (>40 mm) clams were taken from Flat 2, and 80% had at least a few neoplastic cells (verified by D.J. Brousseau, Ph.D.; Fairfield University; Fairfield, CT). Clams from 6 to >50 mm have had a smaller decrease in abundance at Flat 4 during the 1990-1991 operational period, and adults >50 mm have nearly tripled their preoperational abundance in comparison to other flats (Table 3.3.7-1). Neoplasia may be the cause of these spatial differences.

3.3.7.4. Effects of Plant Operation

The Hampton-Seabrook estuary contains the majority of New Hampshire's stock of the recreationally-important species, *Mya arenaria*, and an extensive sampling program has been undertaken in order to characterize the natural variability in the population for all lifestages. Entrainment of *Mya* larvae has had no measureable effect on population levels as 1991 densities similar to previous years. Settlement densities of young-of-the-year (1-5 mm) appear to bear no relationship to the abundance or periodicity of *Mya* larvae in the nearshore waters (NAI 1982b). It would appear that *Mya* veliger behavior (i.e., their "readiness" or competency to settle) combined with the timing of favorable currents may be more important to settlement success than sheer numbers of larvae in the water column. Relative to preoperational means, densities of young-of-the-year were higher at all three flats in 1990, and lower in 1991, a reflection of the large annual variation of this size class.

Once settled, survival of young-of-the-year (1-5 mm) *Mya* depends on the level of predation from its two main predators, the green crab and human clam diggers, and the absence of diseases such as neoplasia. In 1990, dramatically decreased green crab catches may have enhanced the survival of smaller size classes (1-25 mm), in part contributing to increased densities at Flat 1 and Flat 4. In 1991, however, densities of both green crab and 1-25 mm clams were low, suggesting that some other mechanism was at work.

Increases in young-of-the-year recruitment in Hampton Harbor in 1990, along with continued survival of that year class in 1991, suggest that there are no adverse effects from plant operation, including settling pond discharge and offshore entrainment. Trends at farfield flats in 1990 and 1991 followed those at nearfield stations in Hampton Harbor for spat 1-12 mm in length. Operational densities were similar to preoperational densities (1987-1989), and no plant impact was detected.

4.0 METHODS

4.1 GENERAL

This study evaluates the balanced, indigenous population of shellfish, fish, and wildlife in the waters in and around Seabrook Station's intake and discharge. Previous reports have documented the natural temporal and spatial variability of communities and selected species. Data collected in 1990 during the months when Seabrook Station was operational (August-December) and 1991 (all months) were compared to the historical data base. Differences observed during the operational period were further investigated to determine if they were restricted to nearfield areas. A change was potentially attributed to operation of Seabrook Station only if these criteria were met and then only if other causes were eliminated.

Prior to 1975, the Seabrook Environmental Program involved studies of specific sites (e.g., the estuary, the discharge area, the intake area) or specific species (e.g., *Mya arenaria*) in order to (1) characterize their physical and/or biological environment and (2) assess impact of proposed plant design. The results of these studies were reviewed and discussed during the Environmental Protection Agency's hearings on Seabrook Station's open cycle cooling-water system (NAI 1977e; EPA 1977).

From July 1975 through 1989, the focus of the program has been to provide preoperational characterization of the environment in potentially affected areas. Field and laboratory methods that were used for data collected during 1980 through 1990 were thoroughly described in the data reports for those years (NAI 1981c, 1981f, 1982a, 1982b, 1983a, 1984a, 1985a, 1986, 1987a, 1988a, 1989a, 1990a, 1991a). Data collected in 1992 are summarized in this report. Data listings are unpublished, but available from Yankee Atomic Electric Company. Methods used prior to 1980 were summarized and explained in detail in previous annual reports for Seabrook Environmental Studies (NAI 1976a, 1976b, 1977a, 1977b, 1977c, 1977d, 1978a, 1978b, 1979a, 1979b, 1979c, 1979d, 1979e, 1979f, 1979g, 1980a, 1980b, 1980c, 1980d, 1981a, 1981b, 1981c, 1981d, 1981e).

In-depth reports describing baseline conditions were written for data collected through 1981 (NAI 1982c), 1982 (NAI 1983b) and 1983 (NAI 1984b). A complete assessment of preoperational conditions was made in the 1984 Seabrook Baseline Report (NAI 1985b). Subsequent baseline reports (NAI 1987b, 1988b, 1989b, 1990b) have built on conclusions made in that report, updating results with additional data for those programs that had been maintained without interruption. Operational effects of Seabrook Station for the first five months of operation (August-December 1990) were evaluated in NAI (1991b).

All studies performed during the 1990 program were continued unchanged in the 1991 program. Phytoplankton and microzooplankton sampling programs were reinstated in 1990, along with ichthyoplankton and bivalve larvae entrainment collections. Methods for the 1990 program, which are similar to the 1991 program, are presented in NAI (1991a).

Over the several years of this study there were instances in which some sample types were collected for only part of a year, or discontinued for a whole year or years, due to program modifications (particularly in 1985 and 1986). This report does not include data from partial sampling years if they erroneously influence sample statistics. For example, annual means of macrozooplankton selected species have not been calculated for 1986 because samples were not collected from January through June (a period of peak abundance) in that year. However, these data could be used in numerical classification and analysis of variance since samples are partitioned seasonally. When data were not presented in a table or figure, it was because they were either not collected or were incomplete for that period.

As in previous reports, conditions in the Hampton-Seabrook area were examined in this report at the community and species levels, both useful indicators of environmental change. Community structure and its variation in time and space were investigated using numerical classification or multivariate analysis of variance. Abundance of various key species (of numerical or commercial importance) previously identified as "selected species" were compared temporally or spatially using analysis of variance (ANOVA) or non-parametric techniques. In several cases, the size or growth of a selected species was examined in addition to abundance or biomass in order to provide a basis for detecting potential sublethal effects. These methods are effective in describing general patterns and magnitudes of variability that have occurred. Analyses have focused on a single species or several species grouped together in a higher taxonomic category. Components of and rationale for species "complexes" were discussed in the 1984 Data Report (NAI 1985a).

4.2 COMMUNITY STRUCTURE

Community analyses included numerical classification (Table 4.2-1) and multivariate analysis of variance (Table 4.2-2). Other community parameters such as total catch, abundance or biomass, and number of species were also assessed for some communities.

4.2.1 Numerical Classification

Numerical classification (Boesch 1977) was used to examine community structure either spatially (using data collected from different areas), or temporally (using data collected over time); comparisons were made based on species composition. Plankton (bivalve larvae, microzooplankton, macrozooplankton, ichthyoplankton eggs and larvae, and benthos (macroalgae, macrofauna, surface fouling panels) species assemblages were analyzed in this way (Table 4.2-1).

The "normal" classification forms groups of stations and/or sampling periods based on similarity levels calculated for all possible combinations of stations/sampling periods and the species that occur there. Normal classifications were performed using the Bray-Curtis similarity index (Clifford and Stephenson, 1975; Boesch, 1977). Values of the indices vary from 0 for absolute

TABLE 4.2-1. SUMMARY OF COMMUNITIES AND METHODS USED IN NUMERICAL CLASSIFICATION. SEABROOK OPERATIONAL REPORT, 1991.

COMMUNITY	STATIONS	DATES	DATA CHARACTERISTICS[a]
Macrozooplankton (505 micron net)	P2,P5,P7	1/88-12/91	Monthly $\bar{x}$; separated tychoplankton and holo/-meroplankton. Tychoplankton: used all taxa except Mysidacea and Amphipoda (22 taxa). Holo/mero: deleted taxa occurring in ≤5% of samples and general taxa. 50 taxa used in analysis.
Microzooplankton	P2	1978-1984, 7/86-12/86 4/90-12/91	$\bar{x}$, surface and bottom tows. Taxa excluded with frequency of occurrence <20% and total abundance <0.1%. 35 taxa used in analysis.
Bivalve larvae	P2,P5,P7	Apr-Oct, 1988-1991	Half-monthly $\bar{x}$. Deleted 1 general taxon (Bivalvia).
Fish eggs (505 micron net)	P2, P5, P7	7/86-12/91	Mean of 2 tows; dates averaged within month; excluded taxa with total percent composition <0.1% or percent frequency <5%; excluded 1 month with <20 eggs per station. 11 taxa used in analysis

(continued)

TABLE 4.2-1. (Continued)

COMMUNITY	STATIONS	DATES	DATA CHARACTERISTICS[a]
Fish larvae (505 micron net)	P2, P5, P7	7/86-12/9	Data treated as for eggs; excluded species with total percent composition <0.1% or frequency of occurrence <5%. 22 taxa used in analysis
Benthic macroalgae and macrofauna	B17,B19,B31, B1MLW	Aug 1978-1991	Algae: Mean of replicates; excluded taxa with <12.0% frequency of occurrence. 34 taxa used in analysis. Square root transformation. Macrofauna: Mean of replicates; excluded noncolonial species with 50 or less occurrences based on 1978-91 data (8.0%), and all colonials. 82 taxa used in analysis.
	B34	Aug 1980-1984; 1986-1991	
	B04,B13	Aug 1978-1984; 1986-1991	
	B35,B5MLW	Aug 1982-1991	
	B16	Aug 1979-1984; 1986-1991	
Short-term surface panels	B19,B31	1988-1991	Monthly mean abundance of noncolonials. Excluded taxa with <8 occurrences (5%). 20 taxa used in analysis.

[a]All data log (x+1) transformed unless otherwise noted.

TABLE 4.2-2. SUMMARY OF COMMUNITIES AND METHODS USED IN MULTIVARIATE ANALYSIS OF VARIANCE. SEABROOK OPERATIONAL REPORT, 1991.

COMMUNITY	STATIONS	DATES	DATA CHARACTERISTICS[a]
Phytoplankton (≥10 μm)	P2,P5,P7	1991	Mean of replicates. Taxa deleted if % comp. <1%. 19 taxa included in analysis.
Macrozooplankton (505 micron net)	P2, P5, P7	1988,1989, 1991	Mean of 3 replicate tows; excluded taxa with $\bar{x}$ annual abundance for all 3 stations <20 plus 4 general taxa. All months used in analysis.
Bivalve larvae	P2, P5, P7	1988,1989, 1991	Mean of duplicate tows. All taxa included except unidentified Bivalvia.
Microzooplankton	P2, P5, P7	1991	$\bar{x}$, surface and bottom tows. Deleted taxa <25% frequency of occurrence (all stations combined).
Fish eggs, Fish larvae (505 micron net)	P2, P5, P7	Jul 1986-Dec 1991	Mean of two tows per date. Taxa deleted if % comp. <0.1% or percent frequency of occurrence <5%.
Pelagic fish	G1, G2, G3	1976-1991 all months	Mean monthly CPUE for 13 dominant fish species and all other species combined.
Demersal fish	T1, T2, T3	1976-1991 all months	Mean monthly CPUE for 13 dominant fish species and all other species combined.
Estuarine fish	S1, S2, S3	1976-1984, 1987-1991, Apr-Nov	Mean monthly CPUE for 10 dominant fish species and all other species combined.

[a]All data log (x+1) transformed unless otherwise noted.

dissimilarity to 1 for complete similarity. Samples that contained very few organisms were excluded from the analysis because they usually contribute little to the community description. Rare species, which generally have no consistent pattern of occurrence and contribute little information to the overall analysis, were excluded from the classification based on their low frequency of occurrence or low total abundance over the period of study (Table 4.2-1). In all cases, abundance data were log- or square-root transformed to reduce differences between large and small values and thus avoid overemphasizing the abundant species. The classification groups were formed from arithmetic averages by the unweighted pair -group method (UPGMA: Sneath and Sokal, 1973). Results were simplified by combining the entities based on their similarity levels, determined by both the within-group and between-group similarity values. Results were presented graphically by dendrograms, which show the within-group similarity, and the similarity levels at which they link to the other groups. The groups were characterized by the mean abundance of dominant taxa and total abundance (sum of all taxa) during the preoperational and operational periods. Communities during the operational period (August 1990-December 1991) were judged to be similar to previous years if collections were placed in the group with the majority of seasonal (plankton, surface panels) or station (macrofauna, macroalgae) collections from previous years. A potential impact was suggested if community differences occurred solely during the operational period and were restricted to the nearfield area. This situation would trigger additional investigations. If community differences occurred at both nearfield and farfield stations, they were assumed to be part of an area-wide trend, and unrelated to plant operation.

4.2.2 Multivariate Analysis of Variance

Multivariate analysis of variance (MANOVA, Harris 1985) was used to assess simultaneously the similarity in abundances of dominant taxa among nearfield and farfield stations and between the preoperational and operational periods. Historically, there have been few differences in planktonic species assemblages among nearfield intake, discharge, and farfield stations. Continuation of the the trend during plant operation would suggest that there were no effects of plant operation on these communities. MANOVA was used for nearfield and farfield comparisons of the phytoplankton, macrozooplankton, bivalve larvae, microzooplankton and fish larvae communities during the preoperational and operational periods. MANOVA was also used for comparisons between preoperational and operational periods for the pelagic, demersal, and estuarine fish communities (Table 4.2-2). Probabilities associated with the Wilks' lambda test statistic were reported (SAS 1985a).

4.2.3 Other Community Methods

Other parameters associated with the entire community were evaluated. Parameters that reflect the total number of organisms in a collection, such as total catch for finfish, and total abundance or biomass in the phytoplankton, benthic, and surface panels communities were evaluated qualitatively or using analysis of variance (see section 4.3). The diversity of organisms, as indicated by the number of species, was evaluated in the benthic and surface panels programs. As in other measures of the community, potential effects of plant operation were indicated if a significant change occurred during the operational period that was restricted to the nearfield station.

Demersal, pelagic, and estuarine fish communities are composed almost exclusively of a few dominant species, many of which are designated as selected species. Previous use of multivariate analyses such as numerical classification indicated that there were basically two major seasonal assemblages (summer and winter), which changed based on seasonal movements of the most abundant taxa (NAI 1982c, 1983b). In previous reports since that time, seasonal, annual and spatial changes in the fish community have been monitored using relative abundance (percent composition) of dominant taxa. However, use of relative abundance masks the substantial changes in catch per unit effort (CPUE) that many dominants have experienced in the last 10 years. In this report, CPUE for dominant demersal, pelagic, and estuarine fish species is presented as a way to evaluate the entire community. For demersal and estuarine fish, spatial differences have been evaluated by comparing CPUE among stations (both qualitatively and through ANOVA for the selected species) during the preoperational and operational periods. Historically, pelagic fish have not shown area-wide differences due to their mobility. Although differences among stations for the pelagic fish were evaluated, data from individual stations were not used in impact assessment. Instead, catches during the operational period for all dominant species of fish were compared to previous years. Differences during the operational period that were outside the range of previous years warranted further scrutiny, using analyses outlined for selected species (Section 4.3).

Seasonal aspects of the phytoplankton community have been monitored using total abundance and relative abundance of dominant species and classes. To decrease the variability inherent in the phytoplankton community, taxa were divided into two groups: phytoplankton (≥10μm) and ultraplankton (<10μm), as defined by Marshall and Cohen (1983). Ultraplankton include several classes that are difficult to identify and enumerate, including Cyanophyceae (also called cyanobacteria or blue green algae). In general, this group has not been dealt with quantitatively before 1980 (Johnson and Sieburth 1979, Hall and Vincent 1990), and was not enumerated as part of this program until 1984. Separation of this group from the larger phytoplankton improves our ability to monitor both components of the community.

4.3 SELECTED SPECIES/PARAMETERS

Temporal and spatial differences for the selected species and water quality parameters were quantitatively evaluated for the preoperational and operational periods. Many of the selected species and physical/chemical parameters monitored in the Hampton-Seabrook area have shown year-to-year differences that are part of natural environmental variability. Given this framework, values from the operational period (1991 and in some cases 1990) were compared to previous years using analysis of variance or non-parametric techniques. In order to facilitate interpretation of ANOVA results, the preoperational mean and 95% confidence limits, as well as the 1990 and 1991 annual means are presented for each selected species by station. Most of the organisms and physical/chemical parameters show seasonal patterns as well. These within-year patterns are shown graphically in plots of the mean and 95% confidence limits over all preoperational years for each month. Monthly mean values from 1990 and 1991 were plotted on the same graph to provide a visual comparison of their magnitude and seasonality.

Many of the tables comparing organism abundances among years or months show geometric means and confidence limits. These are calculated by: (1) log (x+1) transforming the data, (2) calculating the mean and confidence limits of the transformed data and (3) back-transforming to the original units. Geometric means are generally somewhat lower than arithmetic means (averages of untransformed data), and the difference between the two means is greater in data sets exhibiting a high degree of variability. An outlier in a data set, such as an unusually high abundance in a single sample, will have less influence on a geometric mean than on an arithmetic mean. Thus a geometric mean is, in effect, a weighted mean, in which extreme values are given less weight than are typical values. For data sets that require logarithmic transformation to meet the assumptions of a normal distribution for statistical analysis, the geometric means faithfully portray the relationships within the data (among years, for example), whereas arithmetic means would sometimes show a different pattern than that detected by the analysis.

Differences in substrate, water mass movement, temperature, light penetration, depth, food availability, reproductive success or any combination of these factors can cause variation in species abundance and growth among stations or areas. As part of the experimental design, farfield stations beyond the influence of potential impact were established as reference or "control" stations in areas as similar as possible to the nearfield areas. Any change observed during the operational phase at nearfield stations can be compared with these farfield areas to ascertain whether the change is occurring throughout the coastal area or just within the nearfield area. Spatial differences in the selected species were evaluated as part of the ANOVA design, by utilizing a paired t-test (nearfield vs. farfield stations), or the non-parametric Wilcoxon's summed ranks (or "two-sample") test.

4.3.1 Analysis of Variance (ANOVA)

Analysis of variance was used to evaluate spatial or temporal variability in abundance of selected species and values of water quality parameters. Analysis of variance is a statistical technique that subdivides the total variability into portions attributable to different sources (Lentner 1972). In this study, the major sources of variability have been (1) spatial, among stations or areas within stations, (2) temporal, among years, seasons, or sampling dates, and (3) residual, any variability not explainable by the first two sources.

The initiation of plant operation introduced a new source of potential variation. All ANOVAs sought to test the null hypothesis that values collected during the operational period were statistically similar to previous years. An ANOVA design was developed with the assistance of Dr. Roger Green (University of Western Ontario), using the following variables:

- Preop-Op: Partitions data into the operational period (1991 and in some cases 1990) and all previous years, regardless of st..'on, testing whether the operational observations fall within the historical variability.
- Year (Preop-Op): Partitions data into years nested within operational and preoperational periods, regardless of station or sampling period, testing the variability among years.
- Sampling period (Year): For data that show seasonal trends, a variable was included, such as months, weeks, or sampling period nested within years, testing whether there are significant differences seasonally.
- Station or Area: Partitions data into stations or areas representing nearfield and farfield areas, where applicable, regardless of year or sampling period, testing whether there has been a consistent relationship spatially.

All appropriate class variables were used in the ANOVAs along with the pertinent interactions.

This ANOVA design specifically tests for potential impacts of plant operation. Differences occurring at one of the paired stations would be reflected in a significant result for the Preop-Op Station interaction term (Preop-Op X Station). Significant Preop-Op X Station results were further investigated to determine if the change occurred at the nearfield station (rather than the farfield station). If these conditions were met, a potential impact was suggested, triggering further investigation.

The operational period was defined on a species-specific basis. In cases where the peak period of abundance fell totally within the August to December time frame, the operational period was defined as August 1990-December 1991. If there was no distinct period of maximum abundance, or if the period of maximum abundance began before the August start-up date, data collected in 1990 were eliminated from the analysis, and the operational period was defined as 1991. This definition avoids mixing preoperational and operational data within the class variables. Annual and seasonal means for the preoperational period, 1990, and 1991 are presented in tables and figures for comparative purposes.

The variables for each selected species or parameters are listed in Table 4.3-1, along with the dates and stations used in the analyses, and the data manipulations that preceded the analysis.

In some cases, differences in 1991 were evaluated by a one-way analysis of variance among years at a nearfield station or station group or a single sample t-Test (Sokal and Rolf 1969). In some data sets that have been shown in previous baseline reports to exhibit no differences among stations (e.g., pelagic fish), or if stations are of essentially equal distance from the intake and discharge locations (e.g., estuarine fishes), data from all stations were combined.

Some types of data exhibit a high degree of within-year variability because of seasonal fluctuations. A variety of methods were used to minimize this variability. For fish larvae, as specimens are found only during certain seasons, a subset of the data was chosen to represent the peak period, and samples from that period in each of the years were used in the analysis. Adult fish data showed high variability because of seasonal movements. To decrease variability, data were subset based on the coefficient of variation of monthly mean CPUE. Monthly coefficients of variation were examined to determine periods of large variation in CPUE. Periods with historically high coefficients of variation and periods when the selected species were historically not captured were excluded from the analysis. This method increased the power of the model to detect significant differences among years by minimizing within-year variation.

ANOVA was also used to test for differences in catches for young-of-the-year (YOY) of the selected demersal fish species. Operation of Seabrook Station could cause significant differences in the catches of YOY fishes through changes in the mortality of YOY fishes between the preoperational and operational periods, or differential movements of YOY fishes between the preoperational and operational periods. Differential mortality or movement of YOY fishes in the study area might be detected as reduced CPUE of all age classes, but any reduction of the CPUE of YOY fishes would probably be masked for several years by the CPUE of older age classes. Therefore, analysis of CPUE of YOY fishes focuses impact assessment on this age class.

Monthly length frequency diagrams were constructed for each of the selected demersal fish species using data pooled over all years. Gill net data were no used because of the size selectivity inherent in gill net catches. Modal groups of YOY fish were identified through analysis of length frequencies. Only those months where YOY fish could be clearly identified as modal groups

TABLE 4.3-1. SELECTED TAXA AND PARAMETERS USED IN ANALYSIS OF VARIANCE OR NONPARAMETRIC ANALOGUE. SEABROOK OPERATIONAL REPORT, 1990.

COMMUNITY	PARAMETER/TAXON	LIFESTAGE[a]	STATIONS	DATES USED IN ANALYSIS	DATA CHARACTERISTICS[b]	SOURCE OF VARIATION[c]
Water quality	Surface/bottom temp.	--	P2, P5, P7	1988-1989, 1991	Monthly mean, no transformation	Preop-Op, Station, Year, Month
	Surface/bottom salinity	--				
	Surface/bottom DO	--				
	Orthophosphorus	--				
	Total phosphorus	--				
	Nitrate-nitrogen	--				
	Nitrite-nitrogen	--				
	Ammonia-nitrogen	--				
Phytoplankton	*Skeletonema costatum*	—	P2, P7	1982-84; 1991	Monthly $\bar{x}$ abundance	Preop-Op, Station, Month Year, Station
			P2, P5	1979-1981; 1991	As above	As above
Bivalve larvae	*Mytilus edulis*	L	P2, P5, P7	1988, 1989, 1991	Weekly $\bar{x}$,	Preop-Op, Station, Year, Week
Microzooplankton	*Eurytemora* sp.	C	P2, P7 P5	1982-1984, 1991	Mean, surface and bottom tows	Preop-Op, Year, Station, Month
	Eurytemora herdmani	A				
	Pseudocalanus/Calanus	N				
	Pseudocalanus sp.	C,A				
	Oithona sp.	N,C,A				
Macrozooplankton	*Calanus finmarchicus*	C,A	P2, P7 P5	1987-91	Mean abundances per sample period.	Preop-Op, Station, Year, Month
	Cancer sp.	L				
	Carcinus maenas	L				
	Crangon septemspinosa	L				
	Neomysis americana	All				

(continued)

TABLE 4.3-1. (Continued)

COMMUNITY	PARAMETER/TAXON	LIFESTAGE[a]	STATIONS	DATES USED IN ANALYSIS	DATA CHARACTERISTICS[b]	SOURCE OF VARIATION[c]
Ichthyoplankton	Winter flounder Yellowtail flounder American sand lance Atlantic cod Atlantic mackerel Hake Atlantic herring Pollock Cunner	L L L L L L L L L	P2, P5, P7	7/86-12/91, selected months	Mean abundance per sample period for months which together composed over 90% of the total annual abundance, excluding years when peak period was only partially sampled or it included both Preop and Op months.	Preop-Op, Year, Station, Month
Demersal fish (Otter trawl)	Winter flounder Yellowtail flounder Atlantic cod Hakes Rainbow smelt	J/A, YOY J/A, YOY J/A, YOY J/A, YOY J/A, YOY	T1, T2, T3	1/76-12/91 selected months	$\bar{x}$ CPUE (no. per haul) per date, restricted to periods with smallest variation in catch	Preop-Op, Station, Month, Year
Pelagic fish (Gill net)	Atlantic herring Pollock Atlantic mackerel	J/A J/A J/A	G1, G2, G3	1/76-12/91 selected months	$\bar{x}$ CPUE (no. per 24-hr set) per date, surface bottom nets averaged, restricted to periods with smallest variation in catch	Preop-Op, Station, Month, Year
Estuarine fish (Beach seine)	Winter flounder Rainbow smelt Atlantic silverside	J/A J/A J/A	S1, S2, S3	1/76-12/84, 1/87-12/91, selected months	$\bar{x}$ CPUE (no. per seine haul), restricted to periods with smallest variation in catch	Preop-Op, Station, Year, Month

(continued)

TABLE 4.3-1. (Continued)

COMMUNITY	PARAMETER/TAXON	LIFESTAGE[a]	STATIONS	DATES USED IN ANALYSIS	DATA CHARACTERISTICS[b]	SOURCE OF VARIATION[c]
Estuarine benthos	*Streblospio benedicti*	J/A	3, 9; 3MLW, 9MLW;	1978-1991 (except 1985)	Mean per sample period; all months used in analysis	Year
	Capitella capitata	J/A				
	Oligochaeta	J/A				
	Mya arenaria	J/A				
	Nediste diversicolor	J/A				
	Caulleriella sp. B	J/A				
	Total density	--				
	Number of taxa	--				
Benthic macroalgae	*Laminaria saccharina*	--	B17	1979-1991	Mean number per sample period and station, no transformation. Wilcoxon's summed ranks by station	Preop-Op
	Laminaria digitata	--	B35;	1982-1991		
	Alaria esculenta	--	B19, B31	1978-1991		
	Agarum cribosum	--	B19, B31	(except 1990)		
	Chondrus crispus	--	B17, B19, B31	1981-1991	Mean % frequency per year. No transformation. Wilcoxon's summed ranks test.	Preop-Op
	Phyllophora spp.	--	B35	1982-1991 (except 1990)		
	Ptilota serrata	--				
		--				
	Chondrus crispus	--	B17, B1MLW B5MLW, B35	1978-1991 1982-1991 (except 1990)	Mean biomass per sample period. Square root transformation, shallow subtidal; no transformation, intertidal	Preop-Op, Station, Year, Month
	Number of taxa	--	B1MLW, B17	August, 1978-1991	Mean per station and year; no transformation	Preop-Op, Station Year
	Total biomass	--	B19, B31			
			B5MLW, B35	1982-1991		
			B13, B04	1978-1984, 1986-1991		
			B34	1979-1984, 1986-1991		

(continued)

TABLE 4.3-1. (Continued)

COMMUNITY	PARAMETER/TAXON	LIFESTAGE[a]	STATIONS	DATES USED IN ANALYSIS	DATA CHARACTERISTICS[b]	SOURCE OF VARIATION[c]
Marine benthos, selected species	*Ampithoe rubricata*,	J/A	B1MLW,	1978-89, 1991	Abundance averaged over replicates; 3 dates per year	Preop-Op, Station, Year, Month
	Nucella lapillus,	J/A	B5MLW	1982-89, 1991		
	Mytilidae spat	J/A				
	Jassa marmorata,	J/A	B17,	1978-89, 1991		
	Mytilidae spat,	J/A	B35	1982-89, 1991		
	Asteriidae	J/A	B17,	1981-89, 1991		
			B35	1982-89, 1991		
	Pontogeneia inermis,	J/A	B19, B31	1978-89, 1991		
	Mytilidae spat,	J/A				
	Strongylocentrotus droebachiensis	J/A				
	Total density	--	B1MLW, B5MLW; B17, B35; B19, B31, B16; B04, B34, B13	August, 1978-1991 (see algae for years)	$\bar{x}$ per year and station	
	Number of taxa	--	Same as above	Same as above	$\bar{x}$ per year and station; no transformation	
	Modiolus modiolus	J/A	B19, B31	1980-1989, 1991	Mean per sample period, Wilcoxon's summed ranks test, No transformation	Preop-Op
Surface panels, short-term	Number of taxa	--	Station pairs: B19, B31; B04, B34	1978-1984 1986-1989; 1991 (B34 initiated in 1982).	$\bar{x}$ per station and sampling period. All months used in analysis. No transformation for No. of taxa, Biomass, *Balanus*, *Tubularia*	Preop-Op, Year, Month, Station
	Noncolonial abundance	--				
	Biomass	--				
	Mytilidae abundance	J/A				
	Jassa marmorata abundance	J/A				
	Balanus sp. % frequency	J/A				
	Tubularia sp. % frequency	J/A				

(continued)

TABLE 4.3-1. (Continued)

COMMUNITY	PARAMETER/TAXON	LIFESTAGE[a]	STATIONS	DATES USED IN ANALYSIS	DATA CHARACTERISTICS[b]	SOURCE OF VARIATION[c]
Surface panels, monthly sequential	Biomass (monthly)	--	B19, B31; B04, B34	1978-1984 1986-1989, 1991	$\bar{x}$ per station and sampling period. No transformation. All months used in analysis	Preop-Op, Year, Month, Station
	Biomass, No. of taxa, Noncolonial abundance *Laminaria* sp. counts (12-month panel)	-- -- -- J/A	B19, B31, B04, B34	1982-1984, 1986-1991 Dec. only	$\bar{x}$ per station and year. No transformation t-test by station	Preop-Op
Epibenthic crustaceans	*Homarus americanus*	L	P2, P5, P7	1988-1989; 1991	Weekly mean	Preop-Op, Year, Week, Station
	Cancer spp.	L	P2, P5, P7	1988-1989; 1991	Monthly mean	Preop-Op, Year, Month, Station
	Homarus americanus *Cancer borealis* *Cancer irroratus*	LE, A A A	L1, L7	1982-1989, 1991 Jun-Nov	Mean CPUE (per 15 traps) per month, no transformation.	Preop-Op, Station, Year, Month
Estuarine	*Mya arenaria*	J/A	Hampton, Flats 2 & 4; Plum Is. Sound	1987-1991 Oct only	Mean per year and station.	Preop-Op, Station, Year
		Y, S, J, A	Hampton Flats 1, 2, 4	1974-1991 Oct only	Mean per year and station.	Preop-Op, Station, Year
		L	P2, P5, P7	1982-1989 1991	Mean per week and station	Preop-Op, Station, Year, Week

[a]Life Stages: N = nauplii, C = copepodite, L = larvae, A = adult, All = all, J/A = juveniles and adults, YOY or Y = young-of-the-year, LE = legal-sized, S = spat, J = juvenile.
[b]$\log_{10}(x+1)$ transformation unless otherwise stated.
[c]Preop-Op: Operational period (1991 and August-December, 1990, if appropriate) vs. previous years.

were included in the analysis. Data were log (x+1) transformed prior to analysis.

Analysis of variance and related parametric techniques make the following assumptions: (1) all samples are randomly collected, (2) samples come from a normally-distributed population, (3) error terms are normally and independently distributed, and (4) variances of samples are equal or homogeneous (Sokal and Rohlf 1969). Random and independent collection of samples is a function of experimental design. Normality of data was tested using the Kolomogorov-Smirnov test when sample size was greater than 50 and the Shapiro-Wilk statistic when sample size was 50 or less (SAS 1985b). Homogeneity of variances was tested using the F-max test (Sokal and Rohlf 1969). If one or both of these two assumptions was not met, the data were transformed and re-evaluated. In most cases, transformation of the data improved the distribution sufficiently to allow the use of analysis of variance. Logarithmic transformations were performed by adding 1 to the data used in the analysis and taking the base-10 logarithm. Where sample sizes were unequal, a general linear model was used for the ANOVA (SAS 1985a).

4.3.2 Multiple Comparisons

If a significant difference among means was discovered using analysis of variance, the Waller-Duncan k-ratio t-test was used to test which means or groups of means were significantly different from each other. This test is less conservative than several other commonly used multiple comparisons tests (i.e., more likely to find significant differences between means). It was selected because more conservative tests failed in several cases to detect any significant differences among means even when the overall F-test of the ANOVA was highly significant. Significant Preop-Op X Station interaction terms were evaluated using least square means estimates and the associated probability of equivalence (SAS 1985a).

Several types of non-parametric tests of significance were also used. Differences in ranks were assessed by using the Wilcoxon two-sample test (Sokal and Rohlf 1969; equivalent to Wilcoxon's sum of rank test, SAS 1985a) or the Kruskal-Wallis test (Sokal and Rohlf 1969). Wilcoxon's two-sample test is a ranking procedure by which two samples of unequal size can be compared. All data are ranked, then ranks are summed within samples. The differences between the summed ranks are compared using the Z statistic. The Kruskal-Wallis test was used as a non-parametric alternative to one-way ANOVA to test among-year differences or among-station differences. This procedure ranks all pooled data, then sums ranks within a group and compares differences using an H-statistic, distributed approximately as chi square (Sokal and Rohlf 1969).

5.0 LITERATURE CITED

Abbott, R.T. 1974. American seashells. 2nd ed. New York: Van Nostrand Reinhold.

Ayer, W.C. 1968. Soft-shell clam population study in Hampton-Seabrook Harbor, New Hampshire. New Hampshire Fish and Game Dept. 39pp.

Bayne, B.L. 1964. Primary and secondary settlement in *Mytilus edulis* (Mollusca). J. Animal Ecol. 33:513-523.

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish. Bull. 53(74):1-577.

Bigford, T.E. 1979. Synopsis of biological data on the rock crab, *Cancer irroratus* Say. NOAA Tech. Rep. NMFS Circ. 426. May, 1979.

Boesch, D.F. 1977. Application of numerical classification in ecological investigations of water pollution. U.S. Environmental Protection Agency, Ecological Research Report Agency, Ecological Research Report, 114 pp.

Boston Globe. 1992. Boston's daily temperature - a month-by-month report, 1991. January 19, 1992.

Boudreau, B. Y. Simard and E. Bourget. 1991. Behavioral responses of the planktonic stages of the American lobster *Homarus americanus* to the thermal gradients, and ecological implications. Mar. Ecol. Prog. Ser. 76:13-23.

Bousfield, E.L. 1973. Shallow water gammaridean Amphipoda of New England. Comstock Publishing, Ithaca, NY 312 pp.

Breen, P.A., and K.H. Mann. 1976. Changing lobster abundance and destruction of kelp beds by sea urchins. Mar. Biol. 34:137-142.

Briscoe, C.S., and K.P. Sebens. 1988. Omnivory in *Strongylocentrotus droebachiensis* (Müller) (Echinodermata:Echinoidea): predation on subtidal mussels. J. Exp. Mar. Biol. Ecol. 115:1-24.

Brousseau, D.J. 1978. Population dynamics of the soft-shell clam *Mya arenaria*. Mar. Biol. 50:63-71.

Campbell, A. 1986. Migratory movements of ovigerous lobsters, *Homarus americanus*, tagged off Grand Manan, eastern Canada. Can. J. Fish. Aquat. Sci. 43:2197-2205.

Campbell, A., D.J. Noakes and R.W. Elmer. 1991. Temperature and Lobster, *Homarus americanus*, yield relationships. Can. J. Fish. Aquat. Sci. 48:2073-2082.

Clark, K.B. 1975. Nudibranch life cycles in the northwest Atlantic and their relationship to the ecology of fouling communities. Helgo. Wiss. Meeresonters. 27-28-69.

Clifford, H.T., and W. Stephenson. 1975. An introduction to numerical classification. Academic Press, New York. 229 pp.

Dow, R. 1969. Cyclic and geographic trends in seawater temperature and abundance of American lobster. Science 164:1060-1063.

__________. 1972. Fluctuations in Gulf of Maine sea temperature and specific molluscan abundance. J. Cons. Int. Explor. Mer 34(3):532-534.

EPA, 1977. Testimony submitted in the supplementary adjudicatory hearing on remand. NPDES Permit Application No. NH 0020338.

Farley, C.A., S.A. Otto, and C.L. Reinisch. 1986. New occurrence of epizootic sarcoma in Chesapeake Bay soft shell clams, *Mya arenaria*. Fish. Bull., U.S. 84(4):851-857.

Field, B. 1982. Structural analysis of fouling community development in the Damariscotta River estuary, Maine. J. Exp. Biol. Ecol. 57:25-33.

Fogarty, M.J. 1988. Time series models of the Maine lobster fishery: the effect of temperature. Can. J. Fish. Aquat. Sci. 45:1145-1153.

Fogarty, M.J., and J.S. Idoine. 1986. Recruitment dynamics in an American lobster (*Homarus americanus*) population. Can. J. Fish. Aquat. Sci. 43:2368-2376.

Fogarty, M.J., and R. Lawton. 1983. An overview of larval American lobster, *Homarus americanus*, sampling programs in New England during 1974-79. pp 9-14. In M.J. Fogarty (ed.) Distribution and relative abundance of American lobster, *Homarus americanus*, larvae: New England investigations during 1974-1979. NOAA. Tech. Rept. NMFS SSRF-775.

Franks, P.J.S., and D.M. Anderson. 1992a. Alongshore transport of a toxic phytoplankton bloom in a buoyancy current: Alexandrium tamarense in the Gulf of Maine. Mar. Biol. 112:153-164.

Franks, P.J.S., and D.M. Anderson. 1992b. Toxic phytoplankton blooms in the southwestern Gulf of Maine: testing hypotheses of physical control using historical data. Mar. Biol. 112:165-174.

Glover, H.E., D.A. Phinney, and C.S. Yentsch. 1986. Photo-synthetic characteristics of picoplankton compared with those of larger phytoplankton populations in various water masses in the Gulf of Maine. Biol. Oceangr. 3:223-248.

Gosner, K.L. 1978. A Field Guide to the Atlantic seashore. Houghton Mifflin Co., Boston, MA. 329 pp.

Grassle, J.F., and J.P. Grassle. 1974. Opportunistic life histories and genetic systems in marine benthic polychaetes. J. Mar. Res. 32(2):253-284.

Green, R.H. 1979. Sampling design and statistical methods for environmental biologists. John Wiley and Sons, N.Y. 257 pp.

Grimes, C.B.. 1975. Entrapment of fishes on intake water screens at a steam electric generating station. Chesapeake Sci. 16:172-177.

Grout, D.E., D.C. McInnes and S.G. Perry. 1989. Impact evaluation of the increase in minimum carapace length on the New Hampshire lobster fishery. New Hampshire Fish and Game Department.

Hall, J.A., and W.F. Vincent. 1990. Vertical and horizontal structure in the picoplankton communities of a coastal upwelling system. Mar. Biol. 106:465-471.

Harding, G.C., K.F. Drinkwater, and W.P. Vass. 1983. Factors influencing the size of American lobster (*Homarus americanus*) stocks along the Atlantic coast of Nova Scotia, Gulf of St. Lawrence, and Gulf of Maine: a new synthesis. Can. J. Fish. Aquat. Sci. 40:168-184.

Harding, G.C., J.D. Pringle, W.P. Vass, S. Pearre, and S. Smith. 1987. Vertical distribution and daily movements of larval lobsters *Homarus americanus* over Browns Bank, Nova Scotia. Mar. Ecol. Prog. Ser. 41:29-41.

Harding, G.C., and R.W. Trites. 1988. Dispersal of *Homarus americanus* larvae in the Gulf of Maine from Brown's Bank. Can. J. Fish. Aquat. Sci. 45:416-425.

Harding, G.C., W.P. Vass, and K.F. Drinkwater. 1982. Aspects of larval American lobster (*Homarus americanus*) ecology in St. Georges Bay, Nova Scotia. Can. J. Fish. Aquat. Sci. 39:1117-1129.

Harris, R.J. 1985. A primer of multivariate statistics. Orlando: Academic Press. 575 p.

Haugen, E. [illegible]. Unpublished phytoplankton [illegible]led with MWRA, Deer Island offshore outfall monitoring studies, 1990.

Hillman, R.E. 1986. Summary report on determination of neoplasia in soft shell clams, *Mya arenaria*, near the Seabrook Nuclear Plant. Batelle study no. N-0954-9901 to YAEC. 6 pp.

__________. 1987. Final report on determination of neoplasia in soft-shell clams *Mya arenaria* near the Seabrook Nuclear Plant. Batelle study no. N-0954-9901 to YAEC. 7 pp.

Hull, S.C. 1987. Macroalgal mats and species abundance: a field experiment. Estuar. Coast. and Shelf Sci. 25:519-532.

Jefferies, H.P. 1966. Partitioning of the estuarine environment by two species of *Cancer*. Ecology 47(3):477-481.

Johnson, P.M. and J.M. Sieburth. 1979. Chroococcoid cyanobacteria in the sea: a ubiquitous and diverse phototrophic biomass. Limnological Oceanography, 24(5):928-935.

Joint, I.R. 1986. Physiological ecology of picoplankton in various oceanographic provinces. Can. Bull. Fish. Aquat. Sciences. 214:287-309.

Karlson, B., and P. Nilsson. 1991. Seasonal distribution of picoplanktonic cyanobacteria of Synechococcus type in the eastern Skagerrak. Ophelia 34:171-179.

Katona, S.K. 1971. The developmental stages of *Eurytemora affinis* (Poppe, 1880) (Copepoda, Calanoida) raised in laboratory cultures, including a comparison with the larvae of *Eurytemora americana* Williams, 1906, and *Eurytemora herdmani* Thompson and Scott, 1897. Crustaceana 21:5-20.

Landry, A.M., Jr., and K. Strawn. 1974. Number of individuals and injury rates of fishes caught on revolving screens at the P.H. Robinson Generating Station. Pages 263-271 *in* I.D. Jensen, ed. Entrainment and intake screening. Proceedings of the second entrainment and impingement workshop. Rep. No. 15, Edison Electric Institute.

Larson, B.R., R.L. Vadas, and M. Keser. 1980. Feeding and nutrition ecology of the green sea urchin, *Strongylocentrotus droebachiensis* in Maine, U.S.A. Mar. Biol. 59:49-62.

Letner, M. 1972. Elementary Applied Statistics. Bogden & Quigley. Tarrytown, N.Y. 428 pp.

Lifton, W.S., and J.F. Storr. 1978. The effect of environmental variables on fish impingement. Pages 299-314 *in* I.D. Jensen, ed. Fourth national workshop on entrainment and impingement. Ecological Analysts, Inc., Melville, NY.

Mann, K.H., L.C. Wright, B.E. Welsford, and E. Hatfield. 1984. Responses of the sea urchin *Strongylocentrotus droebachiensis* (O.F. Muller) to waterborne stimuli from potential predators and potential food algae. J. Exp. Mar. Biol. Ecol. 79:233-244.

Marshall, H.G. 1984. Phytoplankton distribution along the eastern coast of the USA, Part V. Seasonal density and cell volume patterns for the northeastern continental shelf. J. Plankt. Res. 6:169-193.

Marshall, H.G., and M.S. Cohen. 1983. Distribution and composition of phytoplankton in northeastern coastal waters of the United States. Estur. Coast. and Shelf Sci. 17:119-131.

Mathieson, A.C., E.J. Hehre, and N.B. Reynolds. 1981. Investigations of New England marine algae. II: The species composition, distribution and zonation of seaweeds in the Great Bay estuary system and the adjacent open coast of New Hampshire. Bot. Marina 24:533-545.

Mathieson, A.C. and E.J. Hehre. 1986. A synopsis of New Hampshire seaweeds. Rhodora 88:1-139.

McCall, P.L. 1977. Community patterns and adaptive strategies of the infaunal benthos of Long Island Sound. J. Mar. Res. 35:221-266.

McLeese, D., and D.G. Wilder. 1958. The activity and catchability of the lobster (*Homarus americanus*) in relation to temperature. J. Fish. Res. Bd. Canada 15:1345-1354.

Morris, J. 1989. Results of clam experiment are clear as mud. Manchester

Union Leader Sunday News, February 19, 1989: p. 3A.

Murphy, L.S., and E.M. Haugen. 1985. The distribution and abundance of phototrophic ultraplankton in the North Atlantic. Limnol. and Oceanogr. 30:47-58.

Nair, K.K.C. and K. Anger. 1980. Seasonal variation in population structure and biochemical composition of *Jassa falcata* off the Island of Helgoland (North Sea). Est. Coast. Mar. Sci. 11:505-513.

National Climatic Data Center. 1990. Local climatological data, annual summary for 1991 with comparative data from Boston, Massachusetts Federal Building, Ashville, NC. 6 pp.

NOAA. 1991a. Marine recreational fishery statistics survey, Atlantic and Gulf coasts, 1987-1989. Current Fisheries Statistics Number 8904. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Fisheries Statistics Division, Silver Spring, MD.

NOAA. 1991b. Status of the fishery resources of the northeastern United States for 1991. NOAA Tech. Memo. NMFS-F-NEC/86. 132 p.

New Hampshire Fish and Game Department. 1992. Monitoring of the American lobster resource and fishery in New Hampshire - 1991. Performance report submitted to the National Marine Fisheries Service Management Division under contract no. NA16FI-0353-02. 26 p.

New England Fishery Management Council. 1983. Final environmental impact statement and regulatory impact review for the American Lobster Fishery Management Plan. March 1983.

Normandeau Associates, Inc. 1976a. Spatial and temporal distribution of the larvae of the soft-shelled clam, *Mya arenaria*, in New Hampshire coastal waters, 1975. Technical Report VI-10.

__________. 1976b. Studies on the soft-shelled clam, *Mya arenaria*, in the Hampton-Seabrook estuary, New Hampshire. Technical Report VII-1.

__________. 1977a. Studies on the soft-shelled clam, *Mya arenaria*, in the vicinity of Hampton-Seabrook estuary, New Hampshire. 1976 Technical Report VII-3.

__________. 1977b. Seabrook Environmental Studies, 1977. Finfish ecology investigations in Hampton-Seabrook estuary and adjoining coastal waters. 1975-1976 Technical Report VII-4.

__________. 1977c. Seabrook Environmental Studies, 1975-1976. Monitoring of plankton and related physical-chemical factors. Technical Report VII-5.

__________. 1977d. Seabrook benthic report. Technical Report VII-6.

__________. 1977e. Summary document: Assessment of anticipated impacts of construction and operation of Seabrook Station on the estuarine, coastal and offshore waters of Hampton-Seabrook, New Hampshire.

__________. 1978a. Seabrook Ecological Studies, 1976-1977. Studies on the soft-shelled clam, *Mya arenaria*, in the vicinity of Hampton-Seabrook estuary, New Hampshire. Technical Report VIII-2.

__________. 1978b. Seabrook Environmental Studies, 1976-1977. Monitoring of plankton and related physical-chemical factors. Technical Report VIII-3.

__________. 1979a. Seabrook Environmental Studies, 1978. Finfish ecology investigations in Hampton-Seabrook estuary and adjoining coastal waters, 1976-1977. Technical Report VIII-4.

__________. 1979b. Seabrook Environmental Studies, July through December 1977. Plankton. Technical Report IX-1.

__________. 1979c. Seabrook Ecological Studies, July through December 1977. Finfish. Technical Report IX-2.

__________. 1979d. Seabrook Ecological Studies, July through December 1977. Benthic. Technical Report IX-3.

__________. 1979e. Seabrook Ecological Studies, 1976-1977. Seabrook benthic report. Technical Report VIII-5.

__________. 1979f. Soft-shell clam, *Mya arenaria*, study. Technical Report X-3.

__________. 1979g. Annual summary report for 1977 hydrographic studies off Hampton Beach, New Hampshire. Technical Report X-1.

__________. 1980a. Seabrook Ecological Studies, January through December 1978. Finfish ecological investigations in Hampton-Seabrook estuary and adjoining coastal waters. Technical Report X-4.

__________. 1980b. Seabrook Environmental Studies. 1978 Seabrook benthic report. Technical Report X-7.

__________. 1980c. Seabrook Ecological Studies, January through December 1978. Plankton. Technical Report X-5.

__________. 1980d. Annual summary report for 1978 hydrographic studies off Hampton Beach, New Hampshire. Preoperational ecological monitoring studies for Seabrook Station. Technical Report X-2.

__________. 1981a. Soft-shell clam, *Mya arenaria*, study. Technical Report XI-1.

__________. 1981b. Seabrook Environmental Studies, 1979. Finfish ecology investigations in Hampton-Seabrook estuary and adjoining coastal waters. Technical Report XI-2.

__________. 1981c. Seabrook Environmental Studies, 1980. Soft-shell clam, *Mya arenaria*, study. Technical Report XII-1.

__________. 1981d. Seabrook plankton studies, January through December 1979. Technical Report XI-3.

__________. 1981e. Seabrook Environmental Studies. 1979 Seabrook benthic report. Technical Report XI-5.

__________. 1981f. Seabrook Environmental Studies. 1980 data report. Technical Report XII-2.

__________. 1982a. Seabrook Environmental Studies. 1981 data report. Technical Report XIII-1.

__________. 1982b. Seabrook Environmental Studies, 1981. Soft-shell clam, *Mya arenaria*, study. Technical Report XIII-II.

__________. 1982c. Seabrook Environmental Studies, 1981. A characterization of baseline conditions in Hampton-Seabrook area, 1975-1981. A preoperational study for Seabrook Station. Technical Report XIII-3.

__________. 1983a. Seabrook Environmental Studies. 1982 data report. Technical Report XIV-1.

__________. 1983b. Seabrook Environmental Studies, 1982. A characterization of baseline conditions in the Hampton-Seabrook area, 1975-1982. A preoperational study for Seabrook Station. Technical Report XIV-II.

__________. 1984a. Seabrook Environmental Studies. 1983 data report. Technical Report XV-1.

__________. 1984b. Seabrook Environmental Studies, 1983. A characterization of baseline conditions in Hampton-Seabrook area, 1975-1983. A preoperational study for Seabrook Station. Technical Report XV-II.

__________. 1985a. Seabrook Environmental Studies. 1984 data report. Technical Report XVI-I.

__________. 1985b. Seabrook Environmental Studies, 1984. A characterization of baseline conditions in the Hampton-Seabrook Area, 1975-1984. Technical Report XVI-II.

__________. 1986. Seabrook Environmental Studies. 1985 data report. Technical Report XVII-I.

__________. 1987a. Seabrook Environmental Studies. 1986 data report. Technical Report XVIII-I.

__________. 1987b. Seabrook Environmental Studies. 1986. A characterization of baseline conditions in the Hampton-Seabrook area. 1975-1986. A preoperational study for Seabrook Station. Technical Report XVIII-II.

__________. 1988a. Seabrook Environmental Studies. 1987 data report. Technical Report XIX-I.

__________. 1988b. Seabrook Environmental Studies. 1987. A characterization of baseline conditions in the Hampton-Seabrook area. 1975-1987. A preoperational study for Seabrook Station. Technical Report XIX-II.

__________. 1989a. Seabrook Environmental Studies. 1988 data report. Technical Report XX-I.

__________. 1989b. Seabrook Environmental Studies. 1988. A characterization of baseline conditions in the Hampton-Seabrook area. 1975-1988. A preoperational study for Seabrook Station. Technical Report XX-II.

__________. 1990a. Seabrook Environmental Studies. 1989 data report. Technical Report XXI-I.

__________. 1990b. Seabrook Environmental Studies. 1989. A characterization of baseline conditions in the Hampton-Seabrook area. 1975-1989. A preoperational study for Seabrook Station. Technical Report XXI-II.

__________. 1991a. Seabrook Environmental Studies. 1990 Data Report. Technical Report XXII-I.

__________. 1991b. Seabrook Environmental Studies, 1990. A characterization of environmental conditions in the Hampton-Seabrook area during the operation of Seabrook Station. Tech. Rep. XXII-II.

NUSCO. 1987. Monitoring the Marine Environment of Long Island Sound at Millstone Nuclear Power Station. Summary of Studies Prior to Unit 3 Operation.

Oprandy, J.J., P.W. Chang, A.D. Promovost, K.R. Cooper, R.S. Brown, and V.J. Yates. 1981. Isolation of a viral agent causing hematopoietic neoplasia in the soft-shell clam, Mya arenaria. J. Invert. Pathol. 38:45-51.

Padmanabhan, M., and G.E. Hecker. 1991. Comparative evaluation of hydraulic model and field thermal plume data, Seabrook Nuclear Power Sation. Alden Research Laboratory, Inc. 12 p.

Pettibone, M.H. 1963. Marine polychaete worms of the New England region. Bull. U.S. Nat. Mus. 227(1):1-356.

Reinisch, C.L., A.M. Charles, and A.M. Stone. 1984. Epizootic neoplasia in soft-shell clams collected from New Bedford Harbor. Hazardous Waste 1:73-81.

Rhoads, D., P.L. McCall, and T.Y. Yingst. 1978. Disturbance and production in the estuarine seafloor. Amer. Sci. 66:577-586.

Richards, R.A., J.S. Cobb, and M.J. Fogarty. 1983. Effects of behavioral interactions on the catchability of American lobster, *Homarus americanus*, and two species of Cancer crab. Fish. Bull., U.S. 81(1):51-60.

Richards, S.W. 1982. Aspects of the biology of *Ammodytes americanus* from the St. Lawrence River to Chesapeake Bay, 1972-75, including a comparison of the Long Island Sound postlarvae with *Ammodytes dubius*. J. Northwest Atl. Fish. Sci. 3:92-104.

Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott. 1991. A list of common and scientific names of fishes from the United States and Canada. 5th ed. Amer. Fish. Soc. Special Pub. 20. 174 pp.

Ropes, J.W. 1969. The feeding habits of the green crab *Carcinus maenas* (L.) U.S. Fish Wildl. Serv. Fish Bull. 67:183-203.

Santos, S.L., and J.L. Simon. 1980. Response of soft-bottom benthos to annual catastrophic disturbance in a South Florida estuary. Mar. Ecol. Prog. Serv. 3(4):347-356.

SAS Institute, Inc. 1985a. SAS User's Guide: Statistics, version 5 edition. SAS Institute, Inc., Cary, N.C. 956 pp.

__________. 1985b. SAS User's Guide: Basics, version 5 edition. SAS Institute, Inc., Cary, N.C. 923pp.

Shapiro, L.P., and E.M. Haugen. 1988. Seasonal distribution and temperature tolerance of Synechococcus in Boothbay Harbor, Maine. Estur. Coast. Shelf Sci. 26:517-525.

Sherman, K., M. Grosslein, D. Mountain, D. Busch, J. O'Reilly and R. Theroux. 1988. The continental shelf ecosystem off the northeast coast of the United States. Chapter 9, pp. 279-337. *In* H. Postma and J.J. Zijlstra, Ecosystems of the World 27. Continental Shelves. Elsevier, Amsterdam.

Sherman, K. 1991. Northwest/northeast Atlantic zooplankton show different trends. in Northeast Fisheries Center End-of-Year Report for 1990. NOAA-NMFS.

Sieburth, J.H.M., Smetacek and J. Lenz. 1978. Pelagic ecosystem structure: heterotrophic compartments of the plankton and their relationship to plankton size fractions. Limnol. Oceanogr. 23:1256-1263.

Sneath, P.H.A., and R.R. Sokal. 1973. Numerical taxonomy. The principles and practice of numerical classification. W.H. Freeman Co., San Francisco. 573 pp.

Sokal, R.R., and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Co., San Francisco. xxi + 776 pp.

Stockner, J.G. 1988. Phototrophic picoplankton: an overview from marine and freshwater ecosystems. Limnol. Oceanogr. 33:765-775.

Suchanek, T.H. 1978. The ecology of Mytilus edulis L. in exposed rocky intertidal communities. J. Exp. Mar. Biol. Ecol. 31:105-120.

Taylor, W. R. 1952. Marine algae of the northeastern coast of North America. The University of Michigan Press, Ann Arbor Press. 509 pp.

Teyssandier, R.G., W.W. Durgin, and G.E. Hecker. 1974. Hydrothermal studies of diffuser discharge in the coastal environment: Seabrook Station. Alden Research Laboratory Report No. 86-24.

Tetra Tech. 1978. Biological effects of once-through cooling. Volume 2; part IV. Ocean Sited Plants.

Thomas, D.I., and G.J. Miller. 1976. Impingement at Oyster Creek Generating Station, Forked River, New Jersey, from September to December 1975. Pages 317-341 *in* L.D. Jensen, ed.

Third national workshop on entrainment and impingement. Ecological Analysts, Melville, NY.

Turner, H.J., Jr. 1949. The soft-shell clam industry of the east coast of the United States. App. I. Report on investigations of the propagation of the soft-shell clam, *Mya arenaria*. WHOI collected reprints 1948, Contribution No. 462, pp. 11-42.

Wahl, M. 1989. Marine epibiosis I. Fouling and antifouling. Some basic aspects. Mar. Ecol. Prog. Ser. 58:178-189.

Wahle, R.A. and R.S. Steneck. 1991. Recruitment habitats and nursery ground of the American lobster *Homarus americanus*: a demographic bottleneck? Mar. Ecol. Prog. Series. 69:231-243.

Watling, L. 1975. Analysis of structural variations in a shallow estuarine deposit-feeding community. J. Exp. Mar. Biol. Ecol. 19:275-313.

Welch, W.R. 1969. Changes in abundance of the green crab, Carcinus m a e n a s (L.) in relation to recent temperature changes. U.S. Fish Wildl. Serv. Fish. Bull. 67:337-345.

Whitlach, R.B. 1977. Seasonal changes in the community structure of the macrobenthos inhabiting the intertidal sand and mud flats of Barnstable Harbor, MA. Biol. Bull. 152:275-294.

Witman, J.D. 1985. Refuges, biological disturbance, and rocky subtidal community structure in New England. Ecol. Monog. 55(4):421-445.

ATTACHMENT

SEABROOK STATION ENVIRONMENTAL STUDIES

BIOLOGICAL PROGRAM

An annual review of the results from studies conducted through 1991 has been completed, evaluating the potential effects of the first 1 1/2 years of Seabrook Station commercial operation on the balanced indigenous populations in the coastal waters of New Hampshire. The fundamental approach has been to investigate whether trends in the biota in the nearfield area during the operational period (August 1990-December 1991) are similar to trends observed in previous years. If differences occurred during the operational period, further investigations were made to determine if they were restricted to the nearfield area or were indicative of an area-wide trend. Any change restricted to the nearfield area warranted additional study to ascertain if the differences noted were related to the operation of Seabrook Station.

Physico-chemical conditions form the foundation for a biological assessment. The average surface temperature at plankton station P2 (Figure 1) in 1991 was the highest observed in the fourteen years of monitoring. However, since continuous temperature data indicate that the thermal plume had dissipated before reaching the thermal monitoring Station ID, temperature increases related to Station operation would not be expected at stations further away (Stations P2 and P5). Bottom temperatures were also higher than average. Significant spacial differences have been apparent in surface and bottom temperatures among the three stations, with temperatures at P5 greater than P2, and temperatures at P2 greater than at P7; this relationship being consistent over the preoperational and operational periods. It is likely that temperatures at Stations P2 and P5 are influenced, to some degree, by the Hampton-Seabrook estuary. Dissolved oxygen in both surface and bottom waters was lower than average, probably a result of increased temperature. Salinity levels in 1990 and 1991 were lower than average by approximately 0.5 ppt. This, however, was consistent at nearfield (P2 and P5), as well as the farfield station (P7), reflecting the unusually high precipitation in the fall of 1991. Nutrient levels in 1991 were similar to previous years.

The entrainment of plankton through the Circulating Water System represents a loss to the various planktonic communities. An evaluation of nearfield plankton communities identified that all were similar to previous years in terms of the seasonal progression of typical species. Some differences were noted in species abundances in comparison to previous years, however, these differences occurred throughout the study area and were not restricted to the nearfield stations. There was no evidence of an effect from entrainment. During 1992, bivalve larvae density levels appeared to be higher than average. The duration of the straight-hinged stage appears to be longer than average before it metamorphoses into the umboned stage. Settling on short term surface panels appears to be delayed by approximately one month, particularly among the bivalves. The phytoplankton community again had a typical spring peak of Skeletonema costatum and blue-greens during 1992. Microzooplankton, macrozooplankton, and general algae collections to date are similar to previous years.

Discharge plume entrainment would most likely affect surface-oriented biota such as lobster larvae, phytoplankton, shallow water benthos, and the surface fouling community. The phytoplankton community has historically shown high variability, both seasonally and annually. This trend continued during the operational period. Community composition was similar throughout the study area, suggesting that these changes are part of an area-wide phenomenon. There was no evidence of an increase in nuisance species. Lobster larvae were more abundant in 1990 and 1991 than previous years, a change that occurred at all three Stations.

Abundances of dominant species and indices of community structure on surface panels during the operational period were similar to previous years, or if different, were similar between nearfield and farfield stations, with one exception. Abundances of the dominant taxon Mytilidae sp. were higher in 1991 only at the nearfield station. However, 1991 densities were lower than the extremely high densities noted prior to plant operation in 1990, representing a return to near-average conditions. The high densities of mytilids may be the result of natural variability, or environmental conditions. Initial results from 1992 indicate densities are depressed throughout the region.

The intertidal and shallow subtidal benthic communities in 1990 and 1991 were generally similar to previous years. Species composition and abundances were consistent with trends observed in previous years. Total August macrofauna abundance and total algae biomass were lower than average at the nearfield intertidal station. This was the result of reduced levels of dominant Chondrus crispus, causing decreased biomass and reducing the amount of substrate for attachment of fauna. When triannual samples were considered, biomass was reduced at both stations (Figure 2), again indicating that this is part of an area-wide trend rather than an effect of plant operation. The only other nearfield difference during the operational period was a reduction in kelps in the shallow subtidal zone, which was more pronounced in the nearfield area. Kelps have been declining in recent years, and this trend has continued during the period of plant operation. Observations by divers indicate that kelps have relocated to a shallower area adjacent to the shallow subtidal station (B17), suggesting that surface oriented biota are not affected by plume entrainment. Changes that occurred in 1990 and 1991 are likely due to natural variability.

The mid-depth and deep benthic communities are monitored in order to determine if there are any effects from increased detritus resulting from the discharge plume. The benthic community in the area of the discharge was similar to previous years in terms of its species composition. Community structure at the mid-depth intake station (B16), during the operational period was different from most previous years, however, this also occurred in 1984 and can be attributed to natural variability. Total macrofaunal density reached its lowest point at the mid-depth intake station in 1991. Total algal biomass was also lower than average at the mid-depth intake station (B16), but higher than average at the deep intake station (B13); showing some changes in the nearfield in 1991. During 1992, large numbers of green sea urchins were still present in Ipswich, Ma., making it difficult to obtain Chondrus samples. Higher numbers of urchins in the immediate study area have not been seen, however. Benthic samples appear lighter in volume than average, continuing last years trend. Large numbers of the gammaridean amphipod Ischyrocerus anguipes also occurred at Station B17.

Epibenthic crustaceans, lobsters, and rock and Jonah crabs, would be susceptible to the effects of larval entrainment, adult impingement, and effects of increased detritus on benthic food sources. Twenty-nine lobsters were impinged in 1991, most after the severe October northeaster storm. Total lobster catch in 1991 at the discharge sampling location (Figure 3) was similar to the preoperational average. Catches of legal-sized lobsters have been influenced by changes in the legal-size limit. 1991 catches were similar to those in 1990, when the last change in legal size limit was enacted. Jonah crab catches were reduced throughout the study area, suggesting an area-wide change. Rock crab catches in 1990 and 1991 were similar to previous years.

A total of 1019 fish were impinged through the operation of the Circulating Water System of Seabrook Station in 1991, an increase over the 499 fish impinged in 1990. Much of the impingement occurred after a strong northeaster storm in late October, which probably increased the vulnerability of fish to intake entrainment and subsequent impingement. The species impinged were typically demersal (lumpfish, flounders, and little skate), although some pollock were also lost. Impingement losses at Seabrook Station were much lower than those measured at other New England power plants and substantially lower than losses from commercial and recreational fishing. Since the begining of 1992, less than 400 fish have been impinged at Seabrook Station.

The demersal and pelagic fish population in coastal New Hampshire waters is experiencing changes consistent with those noted in the Gulf of Maine and Georges Bank. Atlantic cod, yellowtail and winter flounder, and Atlantic whiting have been declining in the Gulf of Maine and are considered over-exploited. Other species that were uncommon in the early years of the study, such as spiny dogfish and skate spp., have become dominants; a trend also noted by the National Marine Fisheries Service. Three species, Atlantic herring, Atlantic mackerel, and pollock, showed differing trends in the study area in comparison to the Gulf of Maine. Catches of all three species, however, have remained stable or increased slightly during the operational period in comparison to recent years. There has been no evidence of an adverse effect from operation of Seabrook Station on the coastal finfish population. During 1992, large numbers of herring were caught in gill nets in June, the first time herring have been caught in many months (Figure 4). These catches were not sustained into subsequent months.

Hampton estuary is monitored primarily to evaluate the effects of Seabrook Station's Settling Basin discharge into the Browns River. The benthic community in 1991 was similar to previous years in terms of community composition, species richness, and total abundance. The composition of the estuarine fish community in 1991 was consistent with previous years. Catch levels of dominants in 1991 were similar to previous years with one exception. Winter flounder catches, which have historically composed only a small percentage of the estuarine fish assemblage, were lower than average in 1990 and 1991. This is also reflected in lower catches throughout the Gulf of Maine. The soft-shell clam population in Hampton Harbor has historically shown changes related to human and green crab predation as well as disease. Trends in the spat and juvenile densities are similar to recent years, suggesting that there is no effect as a result of Station operation. Densities of adults continued to be diminished at Flat 2 (Figure 5), but were similar to the preoperational average at Flat 1. Flat 4 was the only area where no evidence of the naturally occurring lethal viral disease sarcomatous neoplasia was detected.

The results of the analysis of collections through 1991 show some differences during the 1990 and 1991 operational period. None of these changes, however, appear to be the result of the operation of Seabrook Station. Most can be ascribed to natural biological variability.

HYDROLOGICAL PROGRAM

The ocean temperature monitoring program, required by the NPDES permit, continued throughout 1991 expect during the planned station outage months of July-September. The program monitors temperatures both inside and outside a portion of discharge plume, called the "jet-mixing region," as well as a reference point. The jet-mixing region is defined as that area within 300 feet of the submerged diffuser in the direction of flow.

The 1991 data were presented in a report submitted to the EPA and NH DES in early 1992. The results demonstrated permit compliance. Temperatures at all times were less than the NPDES permit limit of 5°F above ambient. This temperature difference is referred in the permit as the delta-t value. In the jet-mixing region, the maximum delta-t occurs at 100% station power level in the winter months during isothermal ocean conditions. The minimum delta-t value occurs in the summer months during thermally stratified ocean conditions. Outside the jet-mixing region, the delta-t values do not vary significantly, regardless of the station power level or the season.

During 1992, temperature monitoring continued until the planned station outage in early September. Preliminary data results are similar to that experienced during 1991.

CHLORINE MINIMIZATION

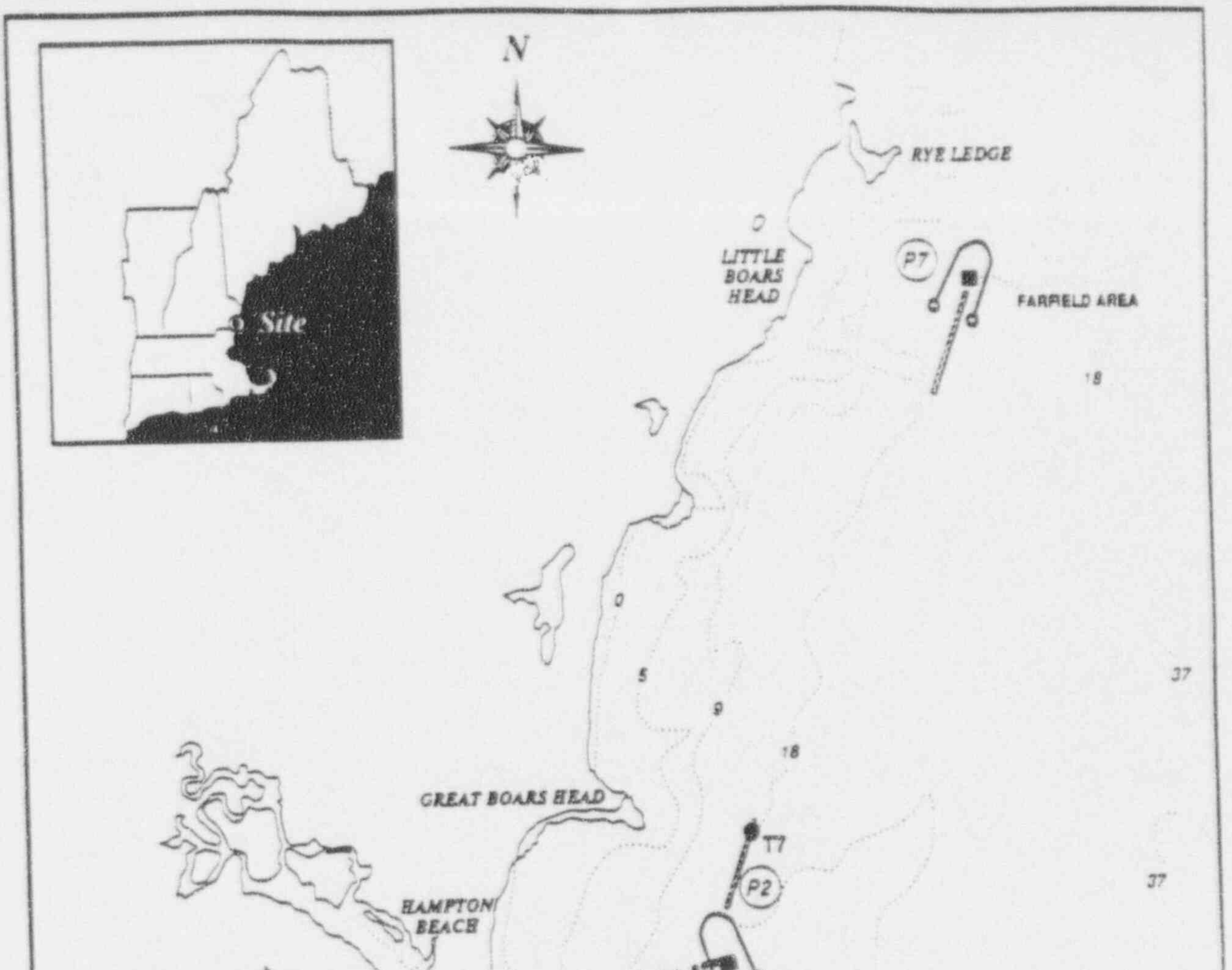
Seabrook Station has continued to manage the use of sodium hypochlorite in accordance with the chlorine minimization program established with the agencies. During the 1991 period, chlorine utilization followed that presented with one notable exception. During

February 1991, an influx in fouling of the Circulating Water System condenser system due to the colonial ectoproct Anguinella palmeda, resulted in the injection of chlorine to promote condenser efficiency. The chlorine plant was shut down from July through early October due to the scheduled maintenance outage. During the period September through mid-December, 1991, the flow meter from the Chlorination Plant became defective, providing erroneously high flow rates. This provided calculated demand rates that are suspect. The replacement of the meter in December 1991 once again provided accurate flow measurements. The effluent limitation for chlorine residual, however, was not exceeded as a result of this malfunction.

On January 6, 1992, the chlorination of the Circulating Water System was terminated in accordance with the schedule of chlorination in an effort to minimize chlorine usage during a period of lower demand. Chlorination of the Service Water System on the other hand was continued due its safety related functions. Circulating Water System chlorination, however, was resumed in February 1992 when indications of main condenser biofouling were indicated. Inspections of biofouling panels positioned within the Intake Transition Structure and the Circulating Water System forebay identified the presence of Anguinella palmeda, a condition that occurred during the same period in 1991. The growth of this colonial species, occurred until the resumption of chlorination; no Service Water System fouling was observed due to its continuous chlorination.

Monitored chlorine residual during 1992, ranged from 0.08 ppm to less than detectable from mid-February through mid-May 1992. After this time, a residual of 0.1 ppm at the Discharge Transition Structure was maintained due to an increase in demand and an observed decrease in condenser efficiency at the lower concentration. Chlorine residuals within the Circulating Water System were maintained until the Station outage began in September 1992. At no time during this period was the 0.20 ppm limit for chlorine discharge exceeded.

During 1992, no significant settlement or macrofouling have been observed. Chlorine injection has effectively precluded mussel development on system biopanels, with only minimal adult populations being reported during inspections of system components. Barnacles and other macrofouling species growth have likewise been minimal.



■ = bivalve larvae and water quality stations

— = ichthyoplankton, phytoplankton and zooplankton stations

∩ = lobster larvae stations

● = continuous temperature stations

E1 = Seabrook Entrainment Station

Figure 1 Plankton and water quality sampling stations.

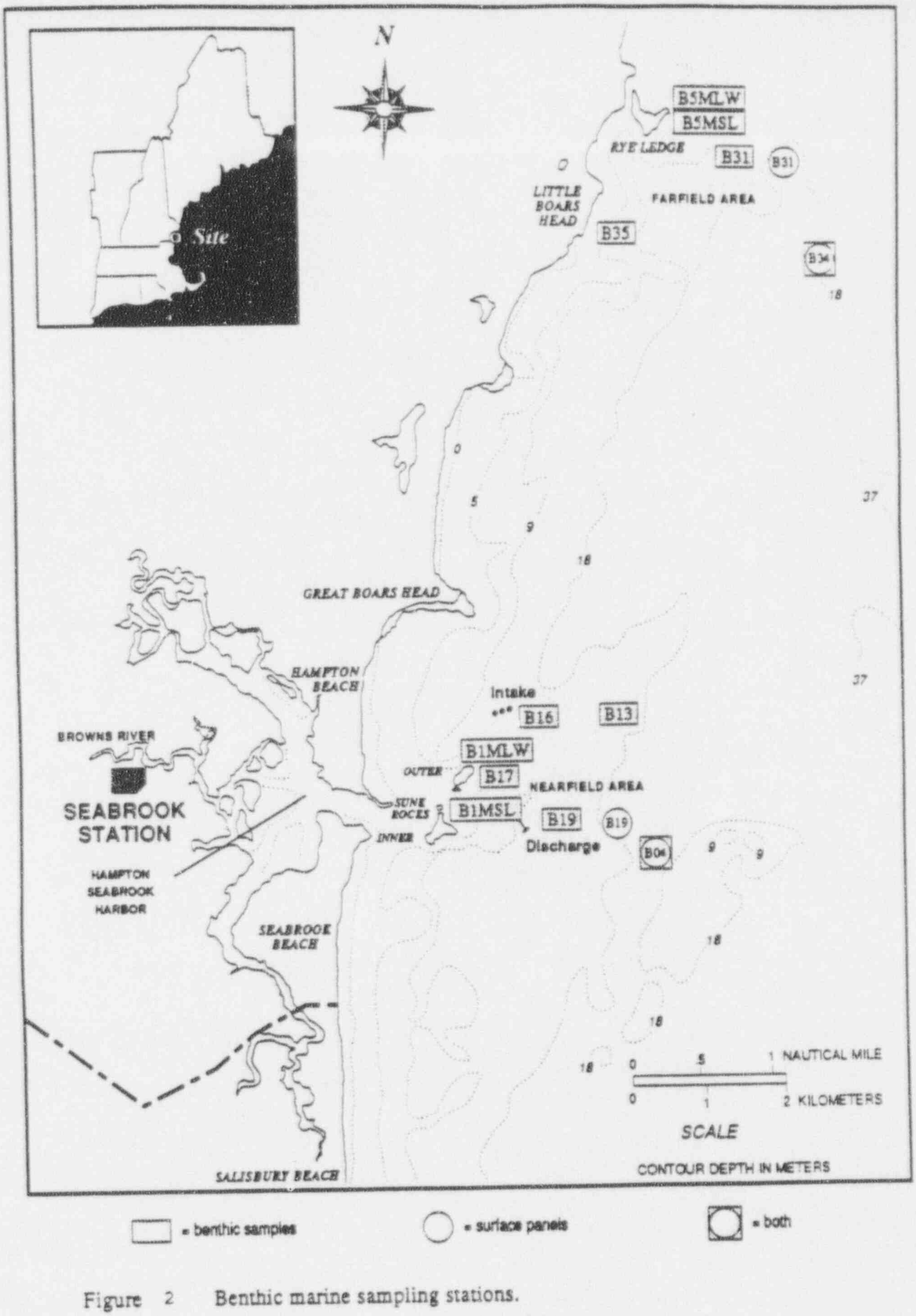


Figure 2 Benthic marine sampling stations.

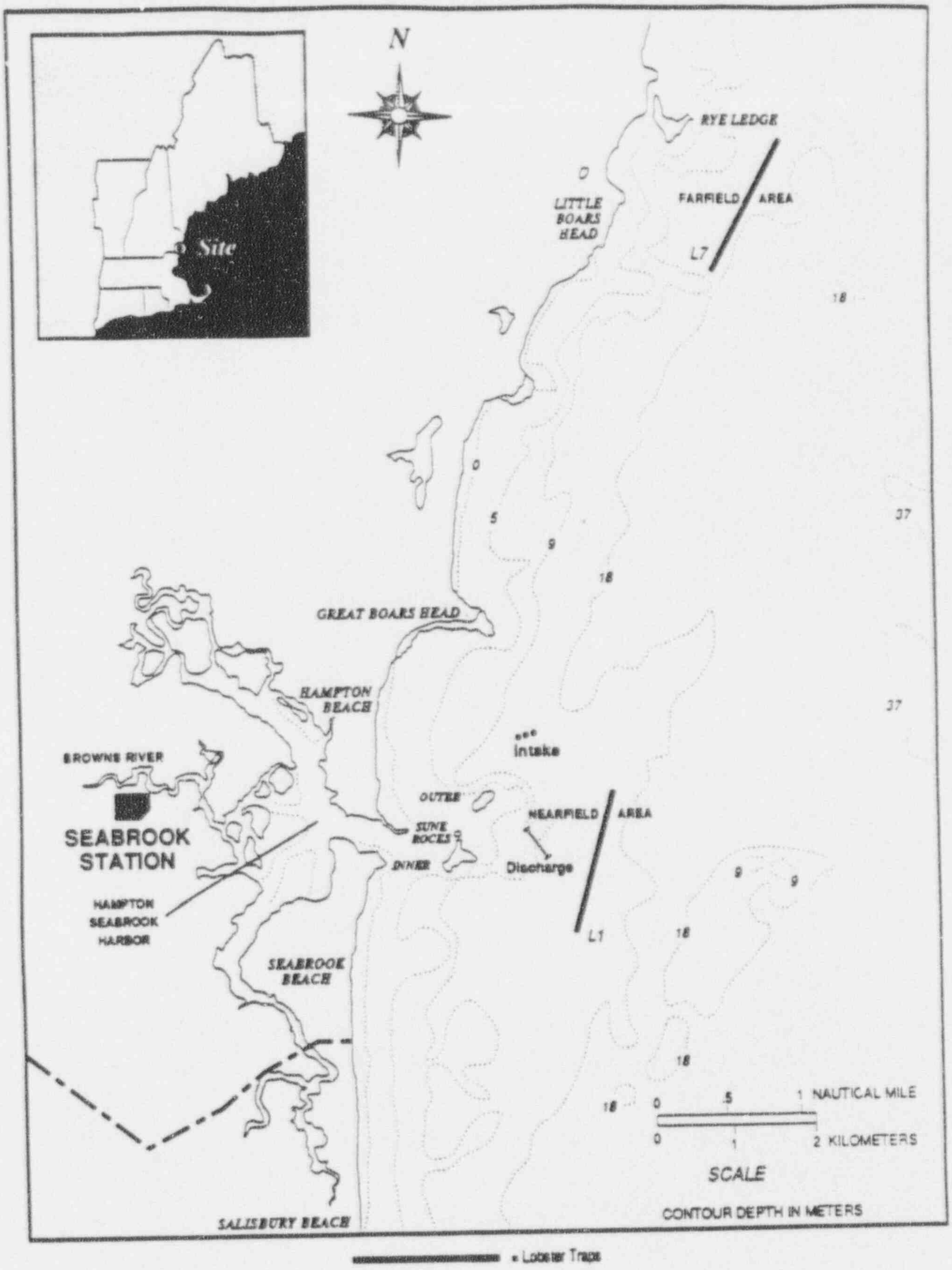


Figure 3 Locations of lobster and rock crab trapping areas.

New Hampshire Yankee
March 12, 1992

ATTACHMENT 3

ENCLOSURE TO NYE-92009
1991 OCEAN TEMPERATURE COMPLIANCE REPORT

SEABROOK STATION NPDES
1991 OCEAN TEMPERATURE COMPLIANCE REPORT

1.0 INTRODUCTION

1.1 Purpose

This report presents ocean temperature data that demonstrates federal/state discharge permit compliance in the receiving waters from the thermal component of the Seabrook Station Circulating Cooling Water System.

1.2 Background

Seabrook Station is a single-unit, 1,150 megawatt nuclear generating facility located in the New Hampshire coastal town of Seabrook. The heat dissipation system for the station is a once-through, ocean intake and submerged diffuser discharge design. Cooling water is taken from and returned to the waters of the Atlantic Ocean via 19-foot diameter intake and discharge tunnels that extend about 7,000 and 5,500 feet offshore, respectively.

The National Pollutant Discharge Elimination System (NPDES) permit sets thermal discharge limits during station operation [1]. Specifically, the thermal component of the discharge shall not increase the temperature of the receiving waters by more than 5°F, except in the near-field jet-mixing region where the 5°F limit applies only at the surface.

Other than the jet-mixing region, defined to be water within 300 feet of the submerged diffuser in the direction of discharge, no further detail is given to a definition of receiving waters. Also, no specifics are given regarding the location of measurement stations.

The permit, however, is very clear in that the limits apply only to temperature rises caused by the addition of heat to the receiving waters. This temperature difference, or delta-t, is the key to demonstrate permit compliance.

1.3 Compliance Demonstration

The analysis of a two-year baseline study of the thermal field around the discharge area prior to station operation showed permit compliance can effectively be defined by using the monthly mean of three thermal monitoring stations [2]. The stations include areas both inside and outside the jet-mixing region as well as a reference point. Stations DS, ID, and T7 on Figure 1.1, respectively, correspond to these areas. Table 1.1 lists the location of each station and the various monitoring depths.

The U.S. Environmental Protection Agency and New Hampshire Department of Environmental Services, Water Supply and Pollution Control Division concurred that compliance is demonstrated if the delta-t value between reference Station T7 and those at DS and ID is 5°F or less for the monthly mean [3, 4].

TABLE 1.1

Seabrook Temperature Monitoring Information

Station	Water Depth (Ft, MLW)	Location	Designation	Sensor Depth (Ft, MLW)
T7	55	42°55'15"N 70°46'46"W	T7UP T7MD T7LO	-2, Surface Following -28, Surface Following -53, MLW
ID	57	42°54'00"N 70°47'15"W	IDUP IDMD IDLO	-2, Surface Following -28, Surface Following -53, MLW
DS	54	42°53'41"N 70°47'12"W	DSUP	-2, Surface Following

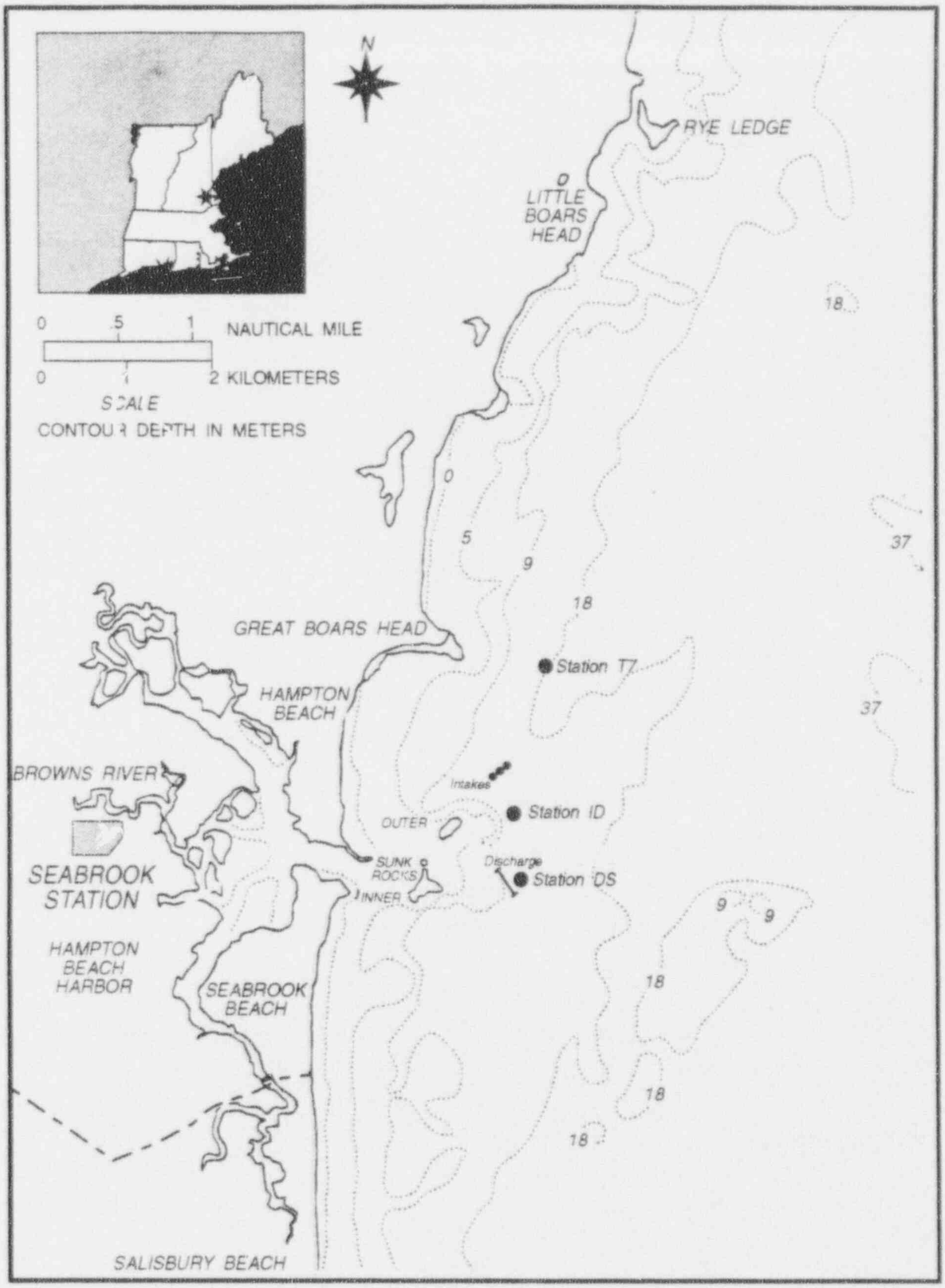


Figure 1.1

E:\CDDATA\CD13\SEABMAP.CDR

2.0 RESULTS

2.1 Station and Instrument Operation

Seabrook Station received its operating license in March 1990, with full-power operation starting in August 1990. Power operation continued through the remainder of 1990 until late July 1991, when a scheduled two-month outage took place. Power operation restarted in October 1991 and continued through the end of 1991.

The average monthly percent of station operation, which accounts for short-term power outages, is listed in Table 2.1 and shown on Figures 2.1 and 2.2.

Ocean temperature data were obtained from sensors at the three monitoring stations via satellite telemetry during each month of station operation. Data recovery during this period is listed in Table 2.1. The average was about 93%. Missing data resulted from instrument malfunction and are identified on the monthly data summary tables located in the appendix.

2.2 Delta-t Values

Table 2.2 summarizes the monthly mean of ocean temperature values between reference Station T7 and Monitoring Stations DS and ID. Positive delta-t values mean the monitoring station is warmer than the reference; negative values mean it is colder. Figure 2.1 illustrates the T7-DS delta-t values and Figure 2.2, the T7-ID delta-t values.

As shown, the delta-t values for all monitoring stations for each month during 1991 are less than 5°F. Consequently, permit compliance is demonstrated.

The largest delta-t values, as expected, occurred at Station DS, located in the thermal discharge jet-mixing region. These values varied depending on both station power level and the season (Figure 2.1). The maximum monthly delta-t, 3.18°F, was for January. This is a result of 100% station power during isothermal ocean conditions. The minimum monthly delta-t, -0.79, at Station DS was for July. This is a result of a lower station power level with thermally stratified ocean conditions. The large volume of (very) cold bottom water entrained by the discharge plume significantly reduces the discharge plume's temperature so that at the surface this mixed volume's temperature is actually less than the reference station.

Outside the jet-mixing region, at Station ID, there is considerably less delta-t variation (Figure 2.2). The values, in fact, are not influenced by either station power level or the season. This feature is the same at each measurement depth (surface, mid, or bottom).

The appendix contains a complete tabular listing for each temperature monitoring station.

<u>TABLE 2.1</u>

<u>Station Power Level and Ocean Temperature</u>

<u>Percent of Operation</u>

Month	Power Level	T7	ID	DS
JAN	100.0	88.9	98.4	100.0
FEB	71.0	95.1	95.7	100.0
MAR	91.4	96.2	96.8	69.8
APR	75.2	98.3	99.2	90.6
MAY	100.0	91.7	92.5	92.5
JUN	74.9	100.0	100.0	100.0
JUL	65.8	100.0	100.0	100.0
AUG	0*	100.0	58.9	100.0
SEP	0*	100.0	75.0	99.3
OCT	70.0	95.1	96.6	96.8
NOV	100.0	64.4	95.6	98.3
DEC	96.0	64.9	100.0	100.0

*Scheduled outage.

TABLE 2.2

Monthly Ocean Temperature* Summary, 1991

	DSUP-T7UP			IDUP-T7UP			IDMD-T7MD			IDLO-T7LO		
Month	DS	T7	ΔT	ID	T7	ΔT	ID	T7	ΔT	ID	T7	ΔT
JAN	43.65	40.47	3.18	40.33	40.50	-0.17	40.70	41.00	-0.30	41.25	42.33	-1.09
FEB	41.69	39.50	2.19	39.64	39.45	0.19	39.54	39.75	-0.21	39.55	40.66	-1.11
MAR	41.20	38.81	2.39	39.11	38.78	0.33	38.35	38.56	-0.21	38.10	38.97	-0.86
APR	44.58	43.46	1.12	43.44	43.17	0.27	41.64	41.80	-0.15	40.70	41.24	-0.55
MAY	50.77	50.37	0.40	50.53	50.37	0.16	46.60	47.10	-0.50	43.37	44.01	-0.63
JUN	56.85	56.66	0.19	56.81	56.66	0.15	52.15	52.63	-0.48	48.47	49.02	-0.55
JUL	58.24	59.03	-0.79	59.22	59.03	0.19	52.23	53.13	-0.90	48.21	48.82	-0.61
AUG	62.34	62.70	-0.36	62.06	61.83	0.23	58.92	58.79	0.13	55.55	55.26	0.29
SEP	60.19	60.25	-0.06	59.62	59.69	-0.07	56.73	56.97	-0.24	53.40	53.59	-0.19
OCT	53.37	53.03	0.34	52.84	53.03	-0.19	51.69	52.05	-0.36	50.50	50.68	-0.18
NOV	51.80	48.80	3.01	48.49	48.81	-0.32	48.94	49.24	-0.29	48.92	**	**
DEC	47.21	44.26	2.95	43.87	44.26	-0.40	44.34	44.79	-0.46	44.47	**	**

*Temperatures in degrees Fahrenheit.

**Data missing, instrument malfunction.

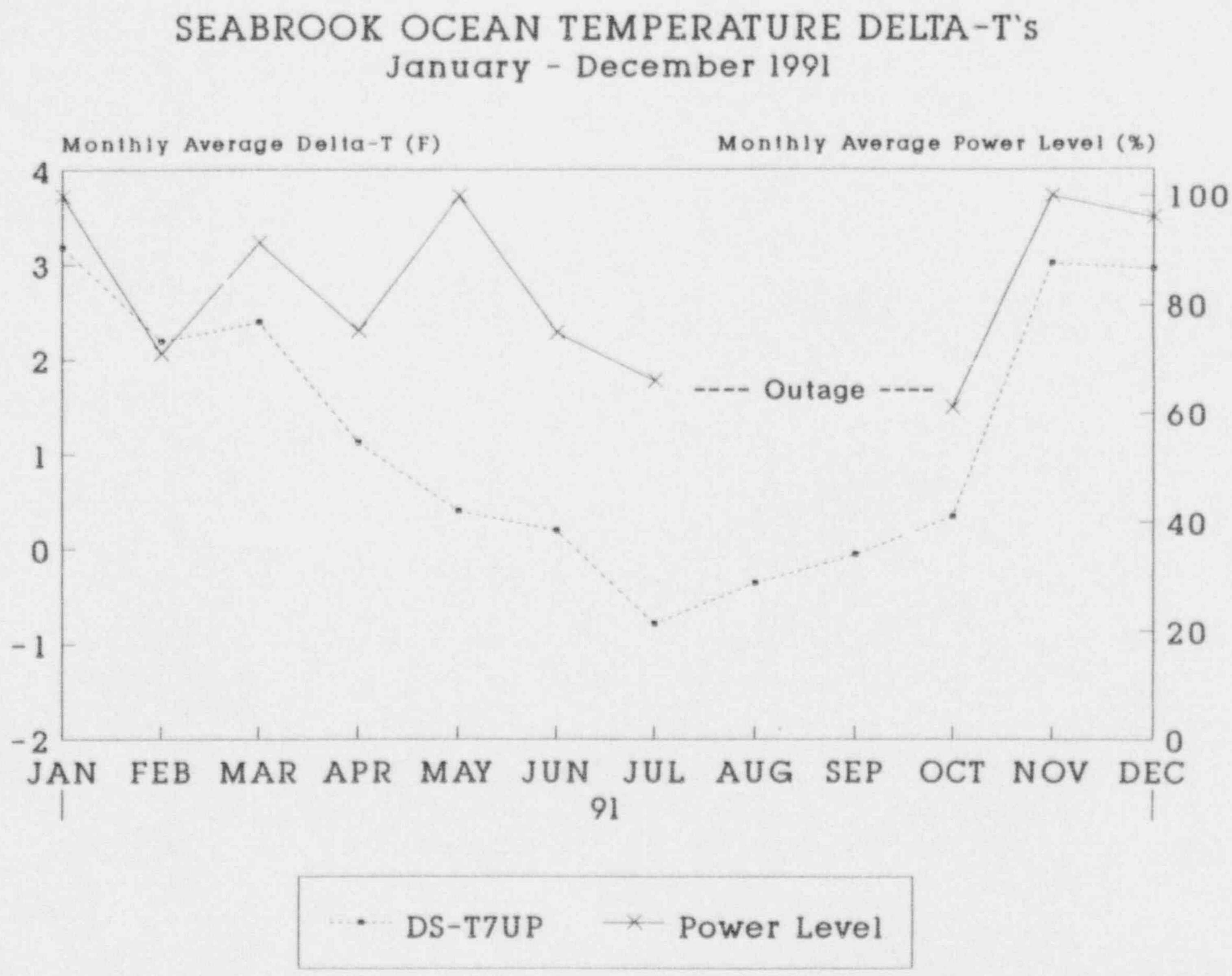

SEABROOK OCEAN TEMPERATURE DELTA-T's
January - December 1991
Monthly Average Delta-T (F)
Monthly Average Power Level (%)
4
3
2
1
0
-1
-2
100
80
60
40
20
0
---- Outage ----
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
91
DS-T7UP
Power Level

Figure 2.1

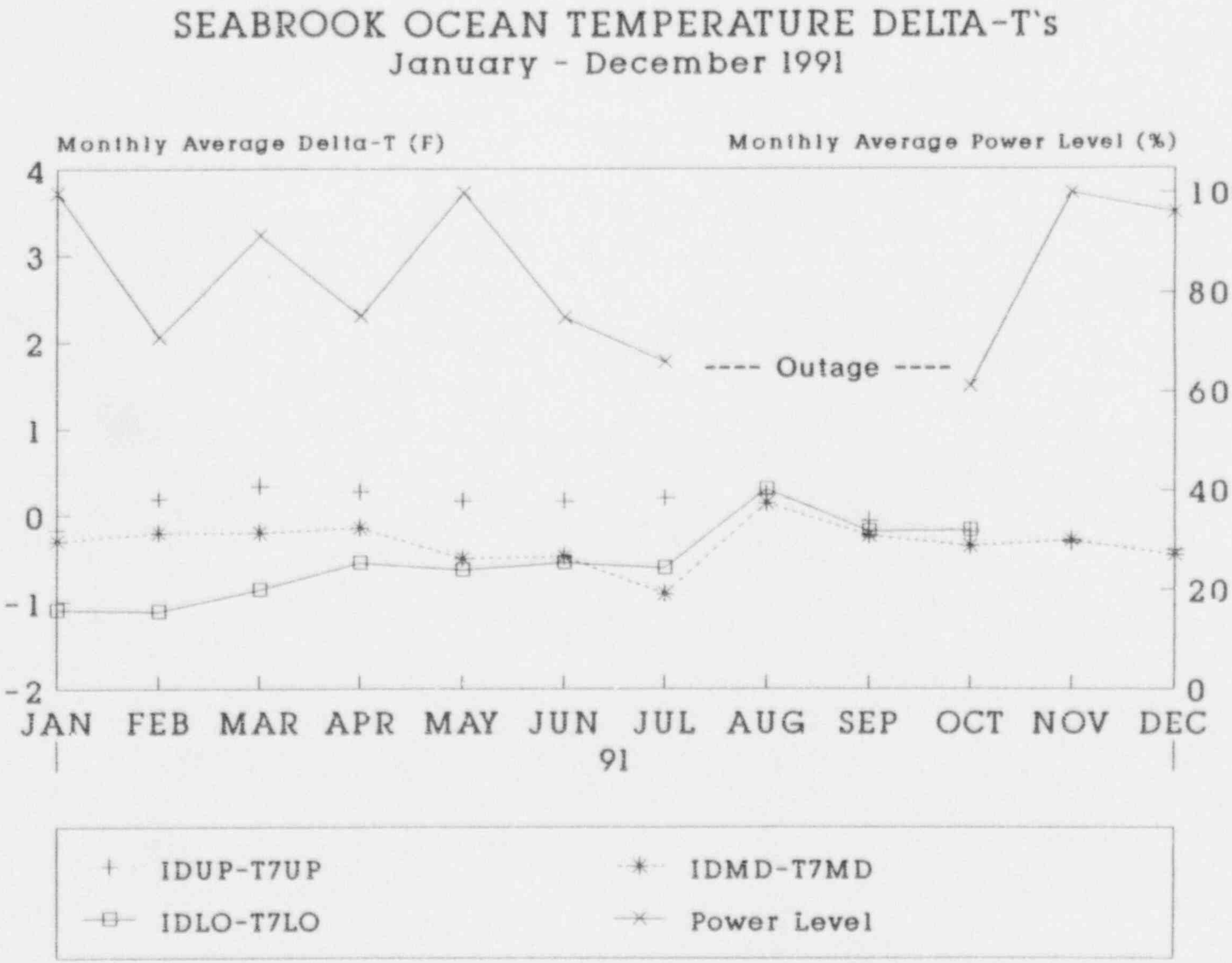

SEABROOK OCEAN TEMPERATURE DELTA-T's
January - December 1991
Monthly Average Delta-T (F)
Monthly Average Power Level (%)
4
3
2
1
0
-1
-2
100
80
60
40
20
0
---- Outage ----
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
91
IDUP-T7UP
IDMD-T7MD
IDLO-T7LO
Power Level

Figure 2.2

3.0 CONCLUSIONS

Based on the results presented in this 1991 report, and previously in 1990 [5, 6], the following conclusions can be made:

1. The delta-t values for all monitoring stations for each month during 1991 are less than 5°F. Permit compliance, therefore, is demonstrated.

2. The largest delta-t values occur inside the thermal discharge jet-mixing region.

3. The delta-t values in the jet-mixing region vary with station power level and season. The maximum delta-t value occurs at 100% station power in the winter months during isothermal ocean conditions. The minimum delta-t value occurs in the summer months during strong thermally stratified ocean conditions.

4. The delta-t values outside the jet-mixing region do not vary significantly, regardless of station power level or the season. This occurs throughout the water column and indicates that there is little or no influence by the thermal discharge plume.

4.0 REFERENCES

1. NPDES Permit No. NH0020338, dated July 26, 1985.

2. "Seabrook Station Thermal Criteria Evaluation," YAEC-1529, Yankee Atomic Electric Company, March 1986.

3. Letter, Public Service Company of New Hampshire SB-20524 to U.S. Environmental Protection Agency, dated March 7, 1986.

4. Letter, U.S. Environmental Protection Agency to Public Service Company of New Hampshire, dated May 22, 1986.

5. Letter, New Hampshire Yankee NYE-91011 to U. S. Environmental Protection Agency, dated April 26, 1991.

6. Letter, New Hampshire Yankee NYE-92003 to U. S. Environmental Protection Agency, dated January 21, 1992.

APPENDIX

Summary of Monthly Ocean Temperature Data

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	1	1	42.86	0.91	46.73	0.82	3.87	0.82	24
91	1	2	43.40	0.51	45.97	0.92	2.57	0.61	24
91	1	3	43.38	0.75	47.89	0.73	4.51	1.03	24
91	1	4	42.17	0.35	45.95	1.50	3.78	1.61	24
91	1	5	43.68	0.46	45.96	0.67	2.27	0.95	24
91	1	6	44.15	0.27	46.26	1.01	2.11	1.01	24
91	1	7	43.04	0.31	46.40	0.83	3.36	0.85	24
91	1	8	42.51	0.16	46.09	1.04	3.58	1.04	24
91	1	9	41.91	0.37	45.56	0.74	3.64	0.54	24
91	1	10	41.56	0.28	45.02	0.24	3.46	0.25	24
91	1	11	40.90	0.84	44.26	0.49	3.36	0.92	24
91	1	12	38.17	0.64	40.76	2.61	2.60	2.54	24
91	1	13	38.40	0.34	42.61	0.49	4.21	0.56	24
91	1	14	38.54	0.13	41.94	0.25	3.40	0.25	24
91	1	15	38.41	0.25	42.21	0.52	3.80	0.56	24
91	1	16	38.22	0.29	42.35	1.11	4.13	1.32	24
91	1	17	39.07	0.37	41.52	1.60	2.45	1.32	24
91	1	18	39.52	0.47	41.48	0.66	1.95	0.56	13
91	1	19	40.03	0.22	42.46	0.65	2.43	0.65	24
91	1	20	39.93	0.25	42.50	0.80	2.57	0.64	24
91	1	21	39.88	0.38	42.27	2.38	2.39	2.04	24
91	1	22	38.75	0.27	41.89	1.72	3.14	1.96	24
91	1	23	38.41	0.40	41.72	1.16	3.32	1.43	24
91	1	24	38.96	0.23	40.78	0.63	1.82	0.69	24
91	1	25	38.93	0.20	42.21	0.56	3.28	0.57	24
91	1	26	38.51	0.59	40.84	1.20	2.33	0.79	24
91	1	27	38.51	0.50	42.13	1.00	3.62	0.83	21
91	1	28	40.51	0.56	43.36	0.65	2.85	0.96	16
91	1	29	40.27	0.66	43.99	0.67	3.72	1.19	24
91	1	30	40.72	0.44	44.12	0.64	3.40	0.88	24
91	1	31	40.47	0.42	44.57	0.60	4.10	0.77	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
43.65	0.93	40.47	0.41	3.18	722

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	1	1	42.86	0.91	43.38	0.77	0.52	1.12	24
91	1	2	43.40	0.51	43.97	0.98	0.57	0.95	24
91	1	3	43.38	0.75	43.23	0.77	-0.16	0.35	24
91	1	4	42.17	0.35	41.91	0.34	-0.26	0.32	24
91	1	5	43.68	0.46	42.94	0.83	-0.74	0.89	24
91	1	6	44.15	0.27	44.20	0.82	0.04	0.94	24
91	1	7	43.04	0.31	42.52	0.37	-0.52	0.41	24
91	1	8	42.51	0.16	42.27	0.20	-0.24	0.17	24
91	1	9	41.91	0.37	41.69	0.26	-0.22	0.29	24
91	1	10	41.56	0.28	41.37	0.21	-0.19	0.21	24
91	1	11	40.90	0.84	41.12	0.63	0.22	1.00	24
91	1	12	38.17	0.64	37.98	0.39	-0.19	0.58	24
91	1	13	38.40	0.34	38.47	0.75	0.07	0.98	24
91	1	14	38.54	0.13	37.97	0.51	-0.57	0.46	24
91	1	15	38.41	0.25	38.38	0.61	-0.03	0.48	24
91	1	16	38.22	0.29	38.32	0.22	0.10	0.42	24
91	1	17	39.07	0.3[illegible]	38.50	0.26	-0.57	0.34	24
91	1	18	39.52	0.47	38.68	0.56	-0.85	0.52	13
91	1	19	40.03	0.22	39.36	0.41	-0.67	0.42	24
91	1	20	39.93	0.25	39.38	0.35	-0.56	0.28	24
91	1	21	39.88	0.38	40.00	0.43	0.13	0.15	24
91	1	22	38.75	0.27	38.70	0.33	-0.05	0.17	24
91	1	23	38.41	0.40	38.02	0.78	-0.38	0.95	24
91	1	24	38.96	0.23	38.66	0.77	-0.31	0.84	24
91	1	25	38.93	0.20	38.62	0.26	-0.31	0.38	24
91	1	26	38.51	0.59	37.23	1.67	-1.28	1.79	24
91	1	27	38.50	0.38	39.33	1.18	0.83	1.20	10
91	1	28	40.51	0.56	40.33	0.91	-0.18	0.96	16
91	1	29	40.27	0.66	40.40	1.14	0.14	1.45	24
91	1	30	40.72	0.44	41.05	0.83	0.33	0.98	24
91	1	31	40.47	0.42	40.75	0.35	0.28	0.71	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
40.50	0.41	40.33	0.61	-0.17	711

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	1	1	43.73	0.34	43.80	0.19	0.06	0.38	24
91	1	2	43.92	0.64	43.87	0.53	-0.06	0.36	24
91	1	3	43.84	0.52	43.84	0.61	0.00	0.33	24
91	1	4	43.78	0.30	43.52	0.61	-0.26	0.45	24
91	1	5	44.69	0.26	44.36	0.18	-0.32	0.28	24
91	1	6	44.57	0.22	43.97	0.22	-0.60	0.24	24
91	1	7	43.90	0.64	43.39	0.66	-0.51	0.23	24
91	1	8	42.60	0.17	42.18	0.21	-0.42	0.22	24
91	1	9	42.27	0.17	41.81	0.23	-0.46	0.27	24
91	1	10	41.97	0.22	41.38	0.20	-0.60	0.32	24
91	1	11	41.05	0.83	41.16	0.39	0.11	0.67	24
91	1	12	38.61	0.28	38.14	0.42	-0.46	0.52	24
91	1	13	39.07	0.26	38.74	0.22	-0.33	0.43	24
91	1	14	38.72	0.22	38.70	0.37	-0.02	0.46	24
91	1	15	38.81	0.26	39.25	0.12	0.44	0.27	24
91	1	16	38.68	0.30	38.52	0.51	-0.17	0.54	24
91	1	17	39.59	0.42	38.83	0.35	-0.76	0.35	24
91	1	18	39.87	0.40	39.51	0.22	-0.36	0.23	13
91	1	19	40.33	0.77	39.72	0.11	-0.60	0.79	24
91	1	20	40.19	0.17	39.99	0.24	-0.20	0.16	24
91	1	21	40.15	0.27	39.91	0.37	-0.24	0.22	24
91	1	22	39.71	0.23	39.25	0.23	-0.46	0.30	24
91	1	23	39.17	0.59	38.89	0.39	-0.28	0.89	24
91	1	24	39.15	0.24	38.79	0.40	-0.36	0.48	24
91	1	25	39.28	0.47	38.53	0.27	-0.75	0.57	24
91	1	26	39.07	0.99	37.63	1.01	-1.44	1.39	22
91	1	27	38.59	0.35	38.81	1.10	0.23	1.09	10
91	1	28	40.96	0.19	40.74	0.28	-0.22	0.34	16
91	1	29	40.35	0.44	40.90	0.19	0.54	0.54	24
91	1	30	41.25	0.14	40.94	0.06	-0.31	0.15	24
91	1	31	41.04	0.19	40.70	0.22	-0.34	0.14	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
41.00	0.37	40.70	0.36	-0.30	709

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	1	1	43.78	0.61	43.23	0.26	-0.55	0.42	24
91	1	2	44.75	0.88	43.94	0.65	-0.81	0.42	24
91	1	3	44.94	0.53	44.35	0.42	-0.59	0.36	24
91	1	4	45.15	0.35	43.63	0.81	-1.52	0.56	24
91	1	5	45.95	0.06	44.63	0.06	-1.32	0.11	24
91	1	6	46.20	0.08	44.51	0.27	-1.69	0.32	24
91	1	7	45.39	0.68	44.66	0.40	-0.73	0.56	24
91	1	8	43.52	0.55	42.28	0.58	-1.24	0.42	24
91	1	9	43.44	0.46	42.06	0.33	-1.38	0.52	24
91	1	10	43.17	0.17	41.82	0.39	-1.34	0.36	24
91	1	11	41.59	0.94	41.08	0.52	-0.52	0.69	24
91	1	12	39.54	0.33	38.45	0.52	-1.09	0.44	21
91	1	13	40.13	0.05	39.38	0.18	-0.74	0.16	17
91	1	14	39.92	0.28	39.34	0.15	-0.58	0.32	24
91	1	15	40.77	0.39	39.37	0.06	-1.40	0.42	24
91	1	16	39.94	0.51	39.22	0.39	-0.72	0.36	20
91	1	17	40.65	0.39	39.03	0.51	-1.62	0.25	18
91	1	18	40.97	0.11	39.71	0.04	-1.26	0.11	6
91	1	19	40.95	0.31	39.89	0.12	-1.06	0.24	18
91	1	20	41.78	0.07	40.16	0.18	-1.62	0.22	21
91	1	21	41.62	0.01	40.40	0.04	-1.22	0.04	5
91	1	22	40.93	0.03	39.62	0.05	-1.31	0.05	6
91	1	23	41.04	0.04	39.79	0.07	-1.25	0.06	11
91	1	24	39.51	0.15	39.27	0.25	-0.24	0.30	9
91	1	25	39.86	0.36	38.53	0.41	-1.33	0.57	17
91	1	26	39.06	0.72	37.67	0.85	-1.39	1.14	22
91	1	27	39.17	0.37	38.11	0.81	-1.06	0.66	9
91	1	28	41.72	0.06	40.93	0.10	-0.79	0.14	16
91	1	29	41.77	0.12	40.99	0.03	-0.78	0.11	23
91	1	30	42.36	0.11	40.95	0.01	-1.41	0.12	19
91	1	31	42.22	0.11	40.90	0.08	-1.32	0.06	12

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
42.33	0.32	41.25	0.31	-1.09	582

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	2	1	40.58	0.21	43.54	0.51	2.96	0.47	24
91	2	2	40.28	0.34	42.38	0.84	2.10	0.65	24
91	2	3	40.90	0.17	43.60	0.42	2.70	0.47	24
91	2	4	41.40	0.40	44.33	0.29	2.92	0.47	24
91	2	5	41.25	0.33	44.26	0.45	3.01	0.43	24
91	2	6	40.84	0.24	43.89	1.84	3.05	1.74	24
91	2	7	40.42	0.04	44.36	0.40	3.94	0.40	24
91	2	8	40.25	0.11	44.59	0.45	4.34	0.43	24
91	2	9	40.53	0.56	44.14	0.58	3.61	0.89	19
91	2	10	40.81	0.32	44.03	0.50	3.22	0.61	24
91	2	11	40.29	0.25	44.85	0.62	4.56	0.60	24
91	2	12	39.67	0.17	41.48	2.19	1.81	2.10	24
91	2	13	39.18	0.27	39.40	0.46	0.22	0.36	24
91	2	14	39.19	0.39	39.03	0.64	-0.16	0.40	24
91	2	15	38.80	0.23	39.91	0.66	1.11	0.61	24
91	2	16	38.52	0.23	39.56	0.43	1.04	0.50	24
91	2	17	38.50	0.38	39.45	0.77	0.95	0.74	24
91	2	18	39.06	0.20	41.27	0.47	2.21	0.32	24
91	2	19	37.92	0.33	39.04	1.68	1.12	1.47	24
91	2	20	38.24	0.33	39.77	1.35	1.53	1.09	24
91	2	21	38.97	0.40	40.58	0.50	1.61	0.67	24
91	2	22	39.60	0.29	40.38	0.36	0.79	0.57	24
91	2	23	39.40	0.17	40.88	0.82	1.47	0.89	24
91	2	24	38.22	0.65	40.51	0.32	2.30	0.54	24
91	2	25	38.21	0.28	40.86	2.03	2.65	2.13	24
91	2	26	38.43	0.15	39.92	2.15	1.49	2.03	24
91	2	27	38.35	0.16	41.92	1.52	3.56	1.56	24
91	2	28	38.38	0.57	39.87	0.69	1.49	1.22	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
41.69	0.85	39.50	0.29	2.19	667

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	2	1	40.61	0.21	40.23	0.48	-0.39	0.38	20
91	2	2	40.30	0.36	40.69	0.89	0.39	0.73	16
91	2	3	40.90	0.17	40.56	0.53	-0.35	0.54	24
91	2	4	41.40	0.40	41.56	1.01	0.16	0.68	24
91	2	5	41.25	0.33	41.68	0.50	0.43	0.30	24
91	2	6	40.84	0.24	41.09	0.44	0.26	0.23	24
91	2	7	40.42	0.04	40.56	0.09	0.14	0.07	24
91	2	8	40.25	0.11	40.41	0.16	0.16	0.09	24
91	2	9	40.31	0.45	40.67	0.75	0.35	0.44	14
91	2	10	40.91	0.20	41.34	0.12	0.43	0.23	13
91	2	11	40.29	0.25	40.74	0.27	0.45	0.20	24
91	2	12	39.67	0.17	39.89	0.29	0.22	0.15	24
91	2	13	39.18	0.27	38.75	0.66	-0.43	0.60	24
91	2	14	39.19	0.39	39.38	0.28	0.19	0.21	24
91	2	15	38.80	0.23	39.20	0.15	0.39	0.19	24
91	2	16	38.52	0.23	38.77	0.39	0.24	0.31	24
91	2	17	38.50	0.38	38.60	1.06	0.10	1.09	24
91	2	18	39.06	0.20	39.07	0.66	0.01	0.53	24
91	2	19	37.92	0.33	38.19	0.35	0.27	0.18	24
91	2	20	38.24	0.33	38.40	0.41	0.16	0.11	24
91	2	21	38.97	0.40	39.23	0.33	0.26	0.21	24
91	2	22	39.60	0.29	39.76	0.15	0.16	0.25	24
91	2	23	39.40	0.17	39.55	0.14	0.15	0.15	24
91	2	24	38.22	0.65	38.95	0.46	0.73	0.48	24
91	2	25	38.21	0.28	38.86	0.54	0.65	0.68	24
91	2	26	38.43	0.15	38.58	0.12	0.15	0.07	24
91	2	27	38.35	0.16	38.47	0.21	0.11	0.14	24
91	2	28	38.38	0.57	38.47	0.68	0.09	0.40	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
39.45	0.28	39.64	0.43	0.19	639

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	2	1	40.73	0.25	40.42	0.37	-0.31	0.29	20
91	2	2	40.28	0.38	40.46	0.59	0.18	0.47	16
91	2	3	41.05	0.11	40.87	0.20	-0.18	0.23	24
91	2	4	41.10	0.13	40.63	0.06	-0.47	0.14	24
91	2	5	41.01	0.33	40.59	0.31	-0.43	0.17	24
91	2	6	40.99	0.30	40.72	0.30	-0.27	0.09	24
91	2	7	40.67	0.09	40.38	0.06	-0.29	0.09	24
91	2	8	40.58	0.06	40.24	0.17	-0.34	0.18	24
91	2	9	40.85	0.14	40.16	0.80	-0.68	0.73	14
91	2	10	41.04	0.24	41.11	0.08	0.07	0.27	13
91	2	11	40.49	0.27	40.64	0.40	0.16	0.28	24
91	2	12	39.84	0.26	39.64	0.27	-0.20	0.16	18
91	2	13	39.39	0.39	39.52	0.38	0.13	0.26	23
91	2	14	39.28	0.38	39.04	0.32	-0.24	0.15	24
91	2	15	39.21	0.18	39.07	0.11	-0.14	0.21	24
91	2	16	38.62	0.20	38.81	0.25	0.19	0.20	24
91	2	17	38.61	0.35	38.88	0.62	0.27	0.52	24
91	2	18	39.10	0.17	39.31	0.23	0.21	0.35	24
91	2	19	38.46	0.25	38.47	0.38	0.01	0.21	24
91	2	20	38.69	0.41	38.69	0.46	0.00	0.22	24
91	2	21	39.25	0.34	39.53	0.24	0.28	0.50	24
91	2	22	39.71	0.15	39.44	0.16	-0.26	0.27	24
91	2	23	39.49	0.15	39.22	0.11	-0.27	0.14	24
91	2	24	38.95	0.17	38.74	0.18	-0.22	0.25	24
91	2	25	38.75	0.62	38.43	0.27	-0.32	0.52	24
91	2	26	40.11	1.58	38.27	0.06	-1.84	1.54	24
91	2	27	39.04	1.06	38.41	0.14	-0.63	1.04	24
91	2	28	38.98	0.03	38.81	0.08	-0.17	0.08	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
39.75	0.32	39.54	0.27	-0.21	632

MONTHLY SUMMARY STATIONS T7LO & IDLO

ΓE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	2	1	41.45	0.50	40.45	0.37	-1.00	0.36	14
91	2	2	41.62	0.25	41.02	0.03	-0.60	0.21	2
91	2	3	41.37	0.72	40.86	0.18	-0.51	0.79	24
91	2	4	41.78	0 03	40.46	0.06	-1.32	0.07	24
91	2	5	41.34	0.34	40.38	0.48	-0.96	0.19	24
91	2	6	41.70	0.05	40.72	0.18	-0.97	0.19	7
91	2	7	41.57	0.04	40.63	0.02	-0.94	0.05	13
91	2	8	41.60	0.02	40.73	0.04	-0.88	0.04	24
91	2	9	41.97	0.85	40.79	0.07	-1.18	0.82	14
91	2	10	42.08	0.04	40.87	0.01	-1.22	0.03	13
91	2	11	42.38	0.43	40.94	0.04	-1.44	0.42	24
91	2	12	41.91	0.41	40.03	0.65	-1.88	0.47	24
91	2	13	41.61	0.15	40.05	0.46	-1.56	0.51	24
91	2	14	40.53	0.40	39.06	0.39	-1.47	0.32	24
91	2	15	40.36	0.25	39.08	0.10	-1.28	0.17	24
91	2	16	40.02	0.12	38.79	0.13	-1.23	0.14	24
91	2	17	40.75	0.48	38.88	0.54	-1.87	0.45	24
91	2	18	40.03	0.98	39.41	0.25	-0.62	0.76	24
91	2	19	39.35	0.21	38.94	0.37	-0.41	0.38	24
91	2	20	39.98	0.26	39.08	0.16	-0.90	0.17	24
91	2	21	40.44	0.04	39.40	0.02	-1.05	0.04	24
91	2	22	40.53	0.07	39.36	0.18	-1.18	0.20	24
91	2	23	40.22	0.19	39.13	0.11	-1.09	0.13	24
91	2	24	39.52	0.52	38.64	0.21	-0.88	0.46	24
91	2	25	39.47	0.37	38.39	0.29	-1.08	0.19	24
91	2	26	39.19	0.12	38.14	0.09	-1.05	0.09	24
91	2	27	39.52	0.09	38.51	0.15	-1.01	0.11	24
91	2	28	39.62	0.04	38.75	0.05	-0.87	0.07	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
40.66	0.28	39.55	0.20	-1.11	591

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	3	1	39.23	0.45	39.78	0.44	0.55	0.35	24
91	3	2	39.97	0.39	41.72	0.72	1.76	0.76	24
91	3	3	40.23	0.39	42.64	1.16	2.41	1.21	24
91	3	4	39.45	0.13	40.09	1.51	0.63	1.55	24
91	3	5	39.25	0.10	42.53	0.47	3.28	0.45	24
91	3	6	39.60	0.52	42.85	0.43	3.25	0.53	21
91	3	7	39.99	0.37	41.85	1.26	1.86	1.45	20
91	3	8	38.91	0.13	43.10	0.19	4.19	0.27	4
91	3	9	38.73	0.19	42.42	0.30	3.69	0.31	24
91	3	10	38.44	0.14	42.24	0.52	3.80	0.46	24
91	3	11	38.19	0.11	40.30	2.00	2.11	2.06	24
91	3	12	38.27	0.19	41.17	1.67	2.90	1.59	24
91	3	13	37.99	0.35	41.95	0.33	3.97	0.43	24
91	3	14	38.21	0.10	39.01	1.91	0.79	1.86	24
91	3	15	37.92	0.05	38.80	1.66	0.89	1.63	24
91	3	16	37.88	0.35	41.53	1.15	3.65	1.24	24
91	3	17	38.33	0.52	41.75	0.67	3.41	0.76	24
91	3	18	38.84	0.12	41.47	0.99	2.63	1.03	24
91	3	19	38.81	0.14	40.27	1.57	1.46	1.61	24
91	3	20	38.49	0.22	41.49	1.43	3.01	1.49	24
91	3	21	38.55	0.29	41.57	0.30	3.02	0.45	24
91	3	22	38.59	0.13	40.97	1.66	2.38	1.76	21
91	3	23			DATA MISSING FOR THIS DAY				
91	3	24			DATA MISSING FOR THIS DAY				
91	3	25			DATA MISSING FOR THIS DAY				
91	3	26	39.29	0.83	41.45	1.94	2.16	1.31	13
91	3	27			DATA MISSING FOR THIS DAY				
91	3	28			DATA MISSING FOR THIS DAY				
91	3	29			DATA MISSING FOR THIS DAY				
91	3	30			DATA MISSING FOR THIS DAY				
91	3	31	39.05	0.36	38.83	0.33	-0.23	0.16	13

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
41.20	1.02	38.81	0.27	2.39	524

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	3	1	39.23	0.45	39.66	0.60	0.43	0.36	24
91	3	2	39.97	0.39	40.26	0.67	0.30	0.62	24
91	3	3	40.23	0.39	40.46	0.49	0.23	0.36	24
91	3	4	39.45	0.13	39.75	0.15	0.29	0.08	24
91	3	5	39.25	0.10	39.54	0.11	0.29	0.13	24
91	3	6	39.62	0.49	39.86	0.77	0.24	0.49	24
91	3	7	39.99	0.36	40.43	0.32	0.44	0.24	21
91	3	8	38.91	0.13	39.18	0.05	0.27	0.12	4
91	3	9	38.73	0.19	38.94	0.18	0.21	0.15	24
91	3	10	38.44	0.14	38.59	0.17	0.15	0.09	24
91	3	11	38.19	0.11	38.33	0.08	0.14	0.12	24
91	3	12	38.27	0.19	38.38	0.22	0.11	0.10	24
91	3	13	37.99	0.35	38.57	0.52	0.58	0.30	24
91	3	14	38.21	0.10	38.43	0.11	0.22	0.07	24
91	3	15	37.92	0.05	38.13	0.09	0.22	0.05	24
91	3	16	37.88	0.35	38.13	0.28	0.25	0.13	24
91	3	17	38.33	0.52	38.91	0.63	0.58	0.49	24
91	3	18	38.84	0.12	39.22	0.24	0.38	0.20	24
91	3	19	38.81	0.14	39.08	0.12	0.27	0.15	24
91	3	20	38.49	0.22	38.72	0.15	0.23	0.12	24
91	3	21	38.55	0.29	38.87	0.71	0.32	0.49	24
91	3	22	38.60	0.13	38.99	0.39	0.39	0.41	24
91	3	23	38.40	0.11	38.64	0.12	0.24	0.07	24
91	3	24	38.22	0.06	38.37	0.06	0.15	0.05	24
91	3	25	38.09	0.08	38.27	0.08	0.18	0.07	24
91	3	26	38.94	0.86	39.10	0.92	0.16	0.65	24
91	3	27	38.98	0.22	39.29	0.31	0.31	0.42	24
91	3	28	38.90	0.25	39.79	0.80	0.90	0.97	24
91	3	29	39.17	0.37	40.07	0.45	0.90	0.44	24
91	3	30	39.04	0.17	39.48	0.51	0.44	0.39	24
91	3	31	38.83	0.40	39.06	0.39	0.23	0.21	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
38.78	0.25	39.11	0.35	0.33	721

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	3	1	39.03	0.09	38.77	0.05	-0.25	0.10	24
91	3	2	39.17	0.17	38.92	0.26	-0.25	0.19	24
91	3	3	39.47	0.36	39.29	0.43	-0.18	0.23	24
91	3	4	39.39	0.22	39.24	0.24	-0.15	0.06	24
91	3	5	39.24	0.13	39.13	0.18	-0.11	0.13	24
91	3	6	39.49	0.33	39.39	0.41	-0.10	0.37	24
91	3	7	39.50	0.32	39.43	0.23	-0.08	0.30	21
91	3	8	38.99	0.14	38.84	0.03	-0.15	0.14	4
91	3	9	38.84	0.10	38.62	0.13	-0.23	0.13	24
91	3	10	38.64	0.09	38.31	0.12	-0.33	0.17	24
91	3	11	38.26	0.11	38.02	0.10	-0.24	0.11	24
91	3	12	38.33	0.12	38.09	0.14	-0.24	0.14	24
91	3	13	38.22	0.10	37.95	0.11	-0.27	0.13	24
91	3	14	38.23	0.09	38.01	0.10	-0.22	0.09	24
91	3	15	37.89	0.06	37.65	0.07	-0.24	0.07	24
91	3	16	37.79	0.20	37.71	0.22	-0.09	0.14	24
91	3	17	37.81	0.17	37.57	0.11	-0.24	0.21	24
91	3	18	37.80	0.06	37.52	0.04	-0.28	0.08	24
91	3	19	38.27	0.30	38.26	0.42	-0.01	0.26	24
91	3	20	38.39	0.23	38.24	0.14	-0.15	0.18	24
91	3	21	38.42	0.18	38.01	0.14	-0.41	0.17	24
91	3	22	38.61	0.10	38.33	0.11	-0.28	0.12	24
91	3	23	38.45	0.15	38.26	0.14	-0.19	0.07	24
91	3	24	38.21	0.02	38.00	0.04	-0.20	0.03	24
91	3	25	38.12	0.06	37.84	0.04	-0.28	0.05	24
91	3	26	38.16	0.04	37.94	0.14	-0.22	0.13	24
91	3	27	38.22	0.19	37.86	0.05	-0.37	0.16	24
91	3	28	38.40	0.22	38.23	0.32	-0.16	0.27	24
91	3	29	38.72	0.25	38.44	0.39	-0.28	0.37	24
91	3	30	39.01	0.11	38.86	0.31	-0.15	0.22	24
91	3	31	38.87	0.17	38.63	0.10	-0.24	0.16	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
38.56	0.16	38.35	0.17	-0.21	721

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	3	1	39.62	0.05	38.77	0.08	-0.86	0.10	24
91	3	2	39.61	0.06	38.74	0.05	-0.87	0.09	24
91	3	3	39.87	0.29	38.99	0.41	-0.88	0.15	24
91	3	4	39.99	0.21	39.15	0.25	-0.84	0.08	21
91	3	5	39.67	0.20	38.79	0.27	-0.88	0.09	16
91	3	6	39.76	0.05	38.91	0.04	-0.85	0.05	24
91	3	7	39.72	0.03	38.93	0.03	-0.79	0.05	21
91	3	8	39.45	0.13	38.73	0.05	-0.73	0.13	4
91	3	9	39.41	0.13	38.49	0.14	-0.92	0.16	24
91	3	10	39.14	0.10	37.87	0.12	-1.28	0.19	24
91	3	11	39.01	0.17	37.94	0.15	-1.08	0.13	24
91	3	12	39.03	0.11	38.08	0.12	-0.96	0.07	24
91	3	13	38.72	0.19	37.81	0.19	-0.91	0.20	24
91	3	14	38.76	0.12	37.90	0.09	-0.86	0.09	24
91	3	15	38.41	0.05	37.54	0.07	-0.87	0.05	24
91	3	16	38.34	0.02	37.54	0.05	-0.80	0.05	24
91	3	17	38.27	0.04	37.40	0.08	-0.87	0.06	24
91	3	18	38.29	0.03	37.40	0.04	-0.89	0.04	24
91	3	19	38.31	0.02	37.45	0.02	-0.86	0.02	24
91	3	20	38.41	0.14	37.60	0.08	-0.81	0.08	24
91	3	21	38.66	0.04	37.81	0.07	-0.85	0.07	24
91	3	22	38.85	0.14	38.05	0.15	-0.80	0.05	24
91	3	23	38.87	0.08	38.17	0.11	-0.70	0.07	24
91	3	24	38.72	0.01	37.91	0.04	-0.81	0.03	24
91	3	25	38.63	0.05	37.76	0.06	-0.87	0.05	24
91	3	26	38.56	0.04	37.72	0.01	-0.84	0.04	24
91	3	27	38.53	0.03	37.73	0.01	-0.80	0.02	24
91	3	28	38.56	0.04	37.76	0.07	-0.80	0.06	24
91	3	29	38.67	0.04	37.93	0.05	-0.74	0.07	24
91	3	30	39.44	0.40	38.60	0.44	-0.84	0.26	24
91	3	31	39.52	0.07	38.68	0.03	-0.84	0.06	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
38.97	0.10	38.10	0.11	-0.86	710

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	4	1	DATA MISSING FOR THIS DAY						
91	4	2	40.62	0.23	41.17	1.08	0.55	0.89	4
91	4	3	40.20	0.27	40.00	0.48	-0.20	0.29	17
91	4	4	40.89	0.81	40.38	0.84	-0.52	0.68	24
91	4	5	40.39	0.49	39.84	0.41	-0.56	0.46	24
91	4	6	40.81	0.75	40.44	0.73	-0.37	0.21	24
91	4	7	41.92	0.75	41.74	0.74	-0.19	0.62	24
91	4	8	41.91	0.67	43.72	1.79	1.81	1.41	24
91	4	9	42.91	0.91	44.19	1.16	1.28	0.76	24
91	4	10	41.72	0.19	42.90	1.62	1.18	1.48	21
91	4	11	41.49	0.29	44.88	0.52	3.39	0.72	22
91	4	12	41.44	0.59	43.78	1.65	2.35	2.16	24
91	4	13	41.93	0.19	45.01	1.39	3.08	1.34	24
91	4	14	42.42	0.59	46.04	0.45	3.62	0.45	24
91	4	15	42.84	0.32	44.45	0.63	1.61	0.73	24
91	4	16	43.33	0.53	44.15	0.80	0.82	0.73	24
91	4	17	43.07	0.40	45.01	1.62	1.93	1.95	24
91	4	18	42.72	0.13	45.33	1.86	2.61	1.91	24
91	4	19	42.98	0.18	45.33	1.75	2.35	1.75	24
91	4	20	43.39	0.30	45.62	1.83	2.24	1.69	24
91	4	21	43.14	0.19	42.89	0.23	-0.24	0.29	21
91	4	22	43.38	0.13	45.52	0.68	2.14	0.67	16
91	4	23	43.77	0.47	44.75	0.45	0.98	0.59	24
91	4	24	45.19	1.59	45.62	1.32	0.42	0.91	24
91	4	25	46.15	1.09	46.46	1.31	0.31	0.93	24
91	4	26	47.13	1.06	47.55	0.91	0.42	0.58	24
91	4	27	48.63	0.66	47.70	1.14	-0.93	0.98	24
91	4	28	47.86	1.16	48.76	0.75	0.90	1.40	24
91	4	29	47.17	0.69	48.06	0.65	0.90	1.04	24
91	4	30	47.11	0.58	47.18	0.35	0.08	0.71	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
44.58	1.01	43.46	0.56	1.12	653

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	4	1	39.28	0.17	39.53	0.22	0.25	0.10	24
91	4	2	39.95	0.56	40.20	0.56	0.25	0.32	24
91	4	3	39.98	0.42	40.11	0.50	0.13	0.25	24
91	4	4	40.89	0.81	41.14	0.88	0.25	0.21	24
91	4	5	40.39	0.49	40.85	0.62	0.46	0.84	24
91	4	6	40.81	0.75	41.86	0.77	1.05	0.44	24
91	4	7	41.92	0.75	42.25	0.90	0.33	0.49	24
91	4	8	41.91	0.67	42.07	0.47	0.16	0.39	24
91	4	9	42.91	0.91	43.23	0.85	0.31	0.53	24
91	4	10	41.75	0.21	42.06	0.33	0.31	0.40	24
91	4	11	41.57	0.38	41.86	0.30	0.30	0.14	24
91	4	12	41.44	0.59	41.72	0.39	0.28	0.45	24
91	4	13	41.93	0.19	42.13	0.26	0.20	0.14	24
91	4	14	42.42	0.59	42.57	0.54	0.15	0.23	24
91	4	15	42.84	0.32	42.99	0.27	0.14	0.29	24
91	4	16	43.33	0.53	43.27	0.62	-0.06	0.32	24
91	4	17	43.07	0.40	43.54	0.24	0.47	0.42	24
91	4	18	42.72	0.15	42.94	0.24	0.22	0.21	24
91	4	19	42.98	0.18	43.40	0.43	0.42	0.30	24
91	4	20	43.39	0.30	43.64	0.40	0.25	0.42	24
91	4	21	43.15	0.18	43.25	0.16	0.10	0.23	24
91	4	22	43.35	0.12	43.81	0.55	0.46	0.51	24
91	4	23	43.77	0.47	43.65	0.39	-0.12	0.30	24
91	4	24	45.19	1.59	44.87	1.52	-0.32	0.72	24
91	4	25	46.15	1.09	46.70	1.30	0.55	0.73	24
91	4	26	47.13	1.06	47.91	1.00	0.78	0.38	24
91	4	27	48.63	0.66	48.21	0.74	-0.42	0.63	24
91	4	28	47.86	1.16	48.48	0.53	0.63	0.76	24
91	4	29	47.17	0.69	47.76	0.74	0.59	0.85	24
91	4	30	47.11	0.58	47.17	0.26	0.07	0.52	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
43.17	0.57	43.44	0.57	0.27	720

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	4	1	39.20	0.31	39.01	0.30	-0.19	0.13	24
91	4	2	38.98	0.14	38.85	0.18	-0.13	0.17	24
91	4	3	39.24	0.16	38.91	0.27	-0.33	0.21	24
91	4	4	39.02	0.08	38.79	0.10	-0.23	0.11	24
91	4	5	39.03	0.24	38.78	0.12	-0.25	0.20	24
91	4	6	38.99	0.21	39.00	0.35	0.01	0.50	24
91	4	7	39.53	1.04	39.49	0.79	-0.04	0.48	24
91	4	8	40.96	0.46	41.14	0.28	0.18	0.34	24
91	4	9	41.38	0.40	41.41	0.52	0.03	0.33	24
91	4	10	41.85	0.05	41.60	0.31	-0.25	0.34	3
91	4	11	41.35	0.22	41.40	0.22	0.05	0.11	9
91	4	12	41.34	0.47	41.21	0.25	-0.13	0.28	24
91	4	13	42.03	0.06	41.66	0.11	-0.36	0.12	24
91	4	14	42.29	0.30	42.13	0.31	-0.16	0.36	24
91	4	15	41.42	0.31	40.89	0.62	-0.53	0.56	24
91	4	16	41.55	0.60	40.88	0.64	-0.67	0.37	24
91	4	17	42.74	0.14	42.58	0.24	-0.15	0.29	24
91	4	18	42.70	0.14	42.46	0.13	-0.24	0.16	24
91	4	19	42.75	0.22	42.55	0.18	-0.21	0.15	24
91	4	20	43.40	0.21	43.20	0.41	-0.19	0.35	24
91	4	21	43.19	0.18	43.11	0.40	-0.09	0.47	24
91	4	22	42.77	0.22	43.03	0.55	0.26	0.48	24
91	4	23	42.39	0.21	42.21	0.26	-0.18	0.16	24
91	4	24	42.38	0.73	42.58	0.77	0.21	0.52	24
91	4	25	42.98	0.51	42.96	0.59	-0.03	0.69	24
91	4	26	42.78	0.49	42.24	0.46	-0.54	0.54	24
91	4	27	43.30	2.71	42.83	2.08	-0.47	0.68	24
91	4	28	47.08	1.54	47.14	0.93	0.06	1.04	24
91	4	29	44.00	0.78	44.49	1.50	0.50	1.04	24
91	4	30	43.07	1.00	42.55	0.63	-0.52	0.87	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
41.80	0.47	41.64	0.48	-0.15	684

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	4	1	39.56	0.14	38.61	0.06	-0.95	0.15	24
91	4	2	39.40	0.05	38.55	0.05	-0.85	0.05	24
91	4	3	39.34	0.05	38.54	0.06	-0.80	0.06	24
91	4	4	39.31	0.10	38.50	0.04	-0.81	0.09	24
91	4	5	39.09	0.09	38.42	0.04	-0.67	0.06	24
91	4	6	38.91	0.04	38.27	0.06	-0.64	0.06	24
91	4	7	39.23	0.71	38.62	0.86	-0.61	0.19	24
91	4	8	41.23	0.48	41.30	0.37	0.06	0.63	24
91	4	9	40.38	0.97	40.18	1.04	-0.20	0.73	24
91	4	10	42.31	0.24	41.47	0.20	-0.84	0.26	24
91	4	11	41.48	0.29	40.79	0.39	-0.69	0.17	24
91	4	12	41.43	0.60	40.64	0.52	-0.78	0.27	24
91	4	13	41.46	0.51	41.37	0.32	-0.08	0.34	24
91	4	14	40.90	0.22	40.59	0.29	-0.31	0.45	24
91	4	15	40.43	0.16	39.90	0.24	-0.53	0.14	24
91	4	16	40.60	0.19	39.80	0.18	-0.80	0.20	24
91	4	17	41.96	0.78	41.11	0.71	-0.85	0.36	24
91	4	18	42.16	0.64	42.19	0.14	0.03	0.74	21
91	4	19	42.96	0.18	42.22	0.10	-0.74	0.10	21
91	4	20	43.33	0.31	42.86	0.36	-0.46	0.30	24
91	4	21	43.60	0.19	42.93	0.16	-0.67	0.25	23
91	4	22	42.70	0.44	42.30	0.21	-0.41	0.49	24
91	4	23	41.87	0.09	41.35	0.30	-0.52	0.27	24
91	4	24	41.82	0.15	41.33	0.14	-0.49	0.21	24
91	4	25	41.79	0.03	41.53	0.13	-0.26	0.14	24
91	4	26	41.79	0.02	41.37	0.08	-0.42	0.08	24
91	4	27	41.69	0.14	41.32	0.21	-0.37	0.16	24
91	4	28	43.09	1.54	42.16	1.21	-0.93	0.88	24
91	4	29	42.24	0.34	41.90	0.31	-0.34	0.31	24
91	4	30	41.62	0.15	41.22	0.14	-0.40	0.21	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
41.24	0.33	40.70	0.30	-0.55	713

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	5	1	47.78	0.47	47.99	0.90	0.22	0.52	24
91	5	2	48.33	0.86	48.28	0.31	-0.05	0.85	24
91	5	3	46.41	0.60	46.32	0.70	-0.09	0.54	24
91	5	4	46.87	0.60	46.59	0.64	-0.28	0.35	24
91	5	5	47.97	0.71	50.40	1.42	2.43	1.16	24
91	5	6	48.48	0.42	48.81	0.73	0.32	0.80	24
91	5	7	48.40	0.30	48.04	0.60	-0.36	0.50	24
91	5	8	47.30	0.63	47.50	0.50	0.20	0.47	24
91	5	9	48.85	0.77	49.17	0.98	0.32	0.56	24
91	5	10	50.15	1.23	49.83	1.27	-0.32	0.51	24
91	5	11	51.28	1.01	50.99	1.11	-0.29	0.75	24
91	5	12	46.43	2.38	46.65	1.28	0.22	1.50	24
91	5	13	50.81	1.17	50.03	1.13	-0.77	0.91	24
91	5	14	51.71	1.15	50.42	1.37	-1.28	0.83	21
91	5	15	DATA MISSING FOR THIS DAY						
91	5	16	50.35	0.46	49.25	0.73	-1.11	0.37	4
91	5	17	46.13	1.50	47.02	1.17	0.89	1.16	24
91	5	18	46.24	0.66	47.34	1.95	1.10	1.39	24
91	5	19	47.42	0.70	49.55	0.84	2.14	0.48	24
91	5	20	49.47	1.11	50.37	0.80	0.90	0.72	24
91	5	21	49.17	0.64	50.19	0.39	1.02	0.82	24
91	5	22	51.79	1.55	51.11	1.24	-0.68	0.95	24
91	5	23	51.93	0.84	53.68	1.78	1.76	2.34	24
91	5	24	51.68	0.80	52.97	0.68	1.29	1.31	24
91	5	25	52.13	1.21	51.73	0.59	-0.40	1.05	24
91	5	26	[illegible]	0.70	53 62	1.83	0.27	1.44	24
91	5	27	53.33	0.58	54.61	0.68	1.28	0.94	24
91	5	28	55.15	1.16	55.88	0.78	0.72	1.18	24
91	5	29	56.36	0.75	57.16	0.77	0.80	1.16	24
91	5	30	57.95	1.02	57.97	1.01	0.02	0.73	24
91	5	31	58.11	0.48	58.48	0.46	0.37	0.52	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
50.77	0.96	50.37	0.88	0.40	697

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	5	1	47.78	0.47	47.80	0.76	0.03	0.52	24
91	5	2	48.33	0.86	48.37	0.36	0.04	0.77	24
91	5	3	46.41	0.60	46.43	0.69	0.02	0.50	24
91	5	4	46.87	0.60	46.79	0.66	-0.08	0.33	24
91	5	5	47.97	0.71	48.17	1.10	0.21	0.56	24
91	5	6	48.48	0.42	48.70	0.64	0.22	0.58	24
91	5	7	48.40	0.30	48.40	0.45	-0.01	0.27	24
91	5	8	47.30	0.63	47.45	0.29	0.15	0.52	24
91	5	9	48.85	0.77	48.91	0.76	0.07	0.39	24
91	5	10	50.15	1.23	50.29	1.47	0.14	0.50	24
91	5	11	51.28	1.01	51.20	1.03	-0.07	0.74	24
91	5	12	46.43	2.38	46.78	1.79	0.35	1.03	24
91	5	13	50.81	1.17	50.33	1.26	-0.48	1.04	24
91	5	14	51.71	1.15	51.10	1.24	-0.60	0.72	21
91	5	15	DATA MISSING FOR THIS DAY						
91	5	16	50.35	0.46	50.73	1.17	0.37	0.71	4
91	5	17	46.13	1.50	46.17	1.53	0.03	0.86	24
91	5	18	46.24	0.66	46.56	0.96	0.32	0.47	24
91	5	19	47.42	0.70	48.15	1.02	0.73	0.54	24
91	5	20	49.47	1.11	49.66	0.89	0.18	0.81	24
91	5	21	49.17	0.64	51.06	0.95	1.89	1.18	24
91	5	22	51.79	1.55	51.39	1.52	-0.40	0.79	24
91	5	23	51.93	0.84	51.84	0.62	-0.08	0.47	24
91	5	24	51.68	0.80	52.77	1.02	1.09	1.31	24
91	5	25	52.13	1.21	52.86	0.83	0.73	1.46	24
91	5	26	53.35	0.70	52.88	0.79	-0.47	0.80	24
91	5	27	53.33	0.58	53.68	0.33	0.35	0.57	24
91	5	28	55.15	1.16	54.78	1.18	-0.38	0.46	24
91	5	29	56.36	0.75	56.39	0.95	0.03	0.37	24
91	5	30	57.95	1.02	58.26	0.81	0.31	0.56	24
91	5	31	58.11	0.48	58.32	0.47	0.20	0.37	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
50.37	0.88	50.53	0.92	0.16	697

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	5	1	45.94	1.51	44.95	0.84	-0.99	1.09	24
91	5	2	44.20	1.66	43.06	1.04	-1.14	1.41	24
91	5	3	44.45	1.32	44.24	0.90	-0.22	1.01	24
91	5	4	46.61	0.52	46.20	0.84	-0.41	0.56	24
91	5	5	47.18	0.40	47.11	0.28	-0.07	0.36	24
91	5	6	47.02	0.67	46.17	0.95	-0.85	0.52	24
91	5	7	44.13	1.76	44.08	1.98	-0.05	0.97	21
91	5	8	43.08	1.80	42.48	1.65	-0.60	1.06	21
91	5	9	45.29	1.79	45.23	1.55	-0.06	0.78	24
91	5	10	44.17	1.36	43.42	1.19	-0.75	0.91	24
91	5	11	44.25	1.40	43.42	0.88	-0.84	0.97	24
91	5	12	41.94	0.91	41.71	0.95	-0.24	0.58	24
91	5	13	43.74	0.59	42.97	0.48	-0.77	0.30	24
91	5	14	44.30	0.47	43.59	0.42	-0.72	0.39	21
91	5	15	DATA MISSING FOR THIS DAY						
91	5	16	43.98	0.22	42.29	0.16	-1.69	0.31	4
91	5	17	42.81	0.89	42.35	0.60	-0.46	0.65	24
91	5	18	45.62	0.33	45.31	0.40	-0.31	0.48	24
91	5	19	46.38	0.68	46.07	0.72	-0.31	0.68	24
91	5	20	46.86	0.49	46.31	0.41	-0.56	0.59	24
91	5	21	46.35	0.49	45.85	0.38	-0.50	0.51	24
91	5	22	47.06	1.22	45.99	0.74	-1.07	0.73	24
91	5	23	50.21	1.30	49.97	2.18	-0.24	1.39	24
91	5	24	48.13	1.00	48.29	1.09	0.16	0.63	24
91	5	25	46.51	0.41	45.75	0.46	-0.75	0.49	24
91	5	26	50.42	2.32	50.14	2.53	-0.28	1.31	24
91	5	27	51.45	1.47	51.22	1.31	-0.24	0.65	24
91	5	28	53.12	0.44	53.07	0.56	-0.05	0.57	24
91	5	29	53.81	1.12	53.50	1.12	-0.31	0.64	24
91	5	30	54.77	1.50	54.01	1.44	-0.76	1.75	24
91	5	31	55.50	1.66	54.49	1.96	-1.01	1.36	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
47.10	1.06	46.60	1.00	-0.50	691

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	5	1	41.76	0.22	41.25	0.19	-0.50	0.20	24
91	5	2	41.65	0.11	41.05	0.12	-0.61	0.18	24
91	5	3	41.92	0.31	41.34	0.38	-0.59	0.26	24
91	5	4	44.84	2.61	43.86	2.40	-0.98	0.73	24
91	5	5	44.88	2.07	45.61	1.99	0.73	1.61	24
91	5	6	41.91	0.15	41.56	0.31	-0.34	0.27	24
91	5	7	41.47	0.12	40.94	0.17	-0.53	0.11	21
91	5	8	41.37	0.10	40.78	0.43	-0.59	0.42	16
91	5	9	41.78	0.29	40.95	0.25	-0.83	0.28	24
91	5	10	41.59	0.16	40.80	0.20	-0.79	0.19	24
91	5	11	41.57	0.20	40.83	0.15	-0.74	0.18	24
91	5	12	41.37	0.13	40.70	0.35	-0.67	0.38	24
91	5	13	42.16	0.56	41.68	0.52	-0.48	0.63	24
91	5	14	41.81	0.21	41.25	0.36	-0.56	0.49	21
91	5	15	DATA MISSING FOR THIS DAY						
91	5	16	42.63	0.13	41.69	0.15	-0.95	0.10	4
91	5	17	41.99	0.46	41.34	0.43	-0.65	0.23	24
91	5	18	45.42	0.75	43.98	0.87	-1.44	0.48	24
91	5	19	45.33	0.88	44.98	0.45	-0.35	0.85	24
91	5	20	45.33	0.34	44.65	0.32	-0.68	0.51	24
91	5	21	45.03	0.82	44.26	0.45	-0.77	0.72	24
91	5	22	45.13	0.59	44.17	0.43	-0.96	0.51	24
91	5	23	47.30	2.50	46.46	2.19	-0.84	2.99	24
91	5	24	44.89	0.75	44.67	0.80	-0.22	0.40	24
91	5	25	44.14	0.39	43.51	0.42	-0.63	0.73	24
91	5	26	45.91	1.25	44.84	1.56	-1.06	1.11	24
91	5	27	45.95	1.07	45.43	1.13	-0.53	1.32	24
91	5	28	46.51	0.88	46.05	0.76	-0.46	0.89	24
91	5	29	47.33	1.19	46.35	1.05	-0.98	1.36	24
91	5	30	47.33	0.99	46.46	0.94	-0.86	1.34	24
91	5	31	47.27	0.77	46.86	0.86	-0.41	1.38	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
44.01	0.70	43.37	0.69	-0.63	686

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	6	1	58.27	1.02	59.52	1.00	1.25	0.79	24
91	6	2	58.84	0.55	58.80	0.64	-0.05	0.55	24
91	6	3	59.51	0.83	59.81	0.91	0.30	0.66	24
91	6	4	57.19	1.03	57.10	0.85	-0.09	0.45	24
91	6	5	55.77	0.21	57.73	0.78	1.95	0.76	24
91	6	6	56.92	1.20	58.43	0.24	1.51	1.00	24
91	6	7	59.21	1.20	58.83	0.83	-0.38	0.96	24
91	6	8	58.56	0.43	57.98	0.14	-0.58	0.40	24
91	6	9	58.61	0.65	59.01	0.72	0.40	0.75	24
91	6	10	56.49	1.07	56.24	0.85	-0.25	1.00	24
91	6	11	54.54	1.20	54.36	1.20	-0.18	0.95	24
91	6	12	54.02	1.64	53.03	0.99	-1.00	1.10	24
91	6	13	47.76	1.69	50.23	1.25	2.47	1.31	24
91	6	14	49.99	1.69	51.15	0.74	1.17	1.24	24
91	6	15	52.75	0.93	52.74	1.16	-0.01	0.89	24
91	6	16	52.89	0.60	55.06	1.28	2.17	1.49	24
91	6	17	53.31	0.42	55.56	1.69	2.26	1.64	24
91	6	18	55.26	1.29	56.93	0.32	1.67	1.33	24
91	6	19	55.64	0.69	56.84	0.65	1.21	0.25	24
91	6	20	57.42	0.83	57.10	0.39	-0.32	0.90	24
91	6	21	57.69	0.51	56.82	0.58	-0.87	0.55	24
91	6	22	58.78	0.74	58.71	0.74	-0.07	0.94	24
91	6	23	59.85	0.98	58.87	1.19	-0.98	0.69	24
91	6	24	60.56	0.73	60.23	0.62	-0.33	0.53	24
91	6	25	61.56	1.16	59.99	1.40	-1.56	1.03	24
91	6	26	60.93	0.86	58.87	1.82	-2.05	1.59	24
91	6	27	57.92	0.75	56.73	1.56	-1.19	1.41	24
91	6	28	56.07	1.46	55.92	1.35	-0.15	1.12	24
91	6	29	55.26	1.66	55.42	1.86	0.17	1.39	24
91	6	30	58.20	1.37	57.54	1.88	-0.66	0.90	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
56.85	0.99	56.66	0.98	0.19	720

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	6	1	58.27	1.02	58.07	0.63	-0.19	0.50	24
91	6	2	58.84	0.55	58.71	0.44	-0.13	0.36	24
91	6	3	59.51	0.83	59.48	0.83	-0.03	0.62	24
91	6	4	57.19	1.03	57.18	0.89	0.00	0.35	24
91	6	5	55.77	0.21	56.14	0.33	0.37	0.27	24
91	6	6	56.92	1.20	57.29	1.25	0.38	0.54	24
91	6	7	59.21	1.20	58.61	1.29	-0.60	0.78	24
91	6	8	58.56	0.43	58.11	0.30	-0.45	0.39	24
91	6	9	58.61	0.65	58.22	0.88	-0.39	0.55	24
91	6	10	56.49	1.07	56.76	0.91	0.27	1.35	24
91	6	11	54.54	1.20	55.39	0.85	0.85	1.31	24
91	6	12	54.02	1.64	54.11	1.83	0.09	1.45	24
91	6	13	47.76	1.69	48.53	2.11	0.78	1.31	24
91	6	14	49.99	1.69	49.50	1.16	-0.48	0.73	24
91	6	15	52.75	0.93	52.56	1.39	-0.19	0.70	24
91	6	16	52.89	0.60	52.96	0.29	0.06	0.66	24
91	6	17	53.31	0.42	53.08	0.35	-0.23	0.22	24
91	6	18	55.26	1.29	54.91	1.10	-0.35	0.67	24
91	6	19	55.64	0.69	55.93	0.35	0.29	0.57	24
91	6	20	57.42	0.83	58.39	1.59	0.98	0.79	24
91	6	21	57.69	0.51	58.26	0.33	0.56	0.36	24
91	6	22	58.78	0.74	58.67	0.75	-0.11	0.31	24
91	6	23	59.85	0.98	59.97	0.92	0.12	0.46	24
91	6	24	60.56	0.73	60.69	0.57	0.13	0.40	24
91	6	25	61.56	1.16	61.76	1.00	0.21	0.47	24
91	6	26	60.93	0.86	61.21	1.17	0.28	1.02	24
91	6	27	57.92	0.75	58.37	1.20	0.45	1.02	24
91	6	28	56.07	1.46	57.18	1.33	1.11	1.26	24
91	6	29	55.26	1.66	55.89	1.62	0.63	0.81	24
91	6	30	58.20	1.37	58.31	1.55	0.11	1.12	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
56.66	0.98	56.81	0.97	0.15	720

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	6	1	56.82	0.30	56.68	0.46	-0.14	0.42	24
91	6	2	55.93	0.66	54.41	1.68	-1.52	1.83	24
91	6	3	53.75	0.96	52.32	1.79	-1.42	1.78	24
91	6	4	56.65	1.02	56.27	1.87	-0.38	1.12	24
91	6	5	55.50	0.16	55.57	0.40	0.07	0.30	24
91	6	6	55.39	0.33	55.25	0.27	-0.14	0.16	24
91	6	7	54.67	0.25	55.00	0.85	0.33	0.73	24
91	6	8	53.94	0.29	54.36	0.79	0.42	0.86	24
91	6	9	54.56	1.02	54.64	0.74	0.07	0.99	24
91	6	10	50.67	1.25	51.12	1.38	0.45	0.85	24
91	6	11	48.49	0.99	48.39	1.46	-0.10	0.91	24
91	6	12	46.97	0.54	46.47	0.80	-0.50	0.87	24
91	6	13	46.19	0.71	46.29	0.70	0.09	0.92	24
91	6	14	47.77	0.81	47.14	0.81	-0.63	0.44	24
91	6	15	49.66	1.54	48.95	1.33	-0.70	0.61	24
91	6	16	52.31	0.35	52.32	0.45	0.01	0.48	24
91	6	17	53.20	0.41	53.02	0.47	-0.18	0.12	24
91	6	18	53.34	0.19	53.25	0.33	-0.09	0.27	24
91	6	19	54.08	0.68	53.31	0.42	-0.77	0.63	24
91	6	20	53.73	0.66	53.37	0.49	-0.36	0.42	24
91	6	21	53.01	0.91	51.93	0.94	-1.08	0.98	24
91	6	22	54.90	1.65	54.19	0.81	-0.71	1.13	24
91	6	23	55.26	1.88	53.67	1.52	-1.59	1.34	24
91	6	24	55.59	1.51	54.25	0.83	-1.34	1.42	24
91	6	25	53.98	0.88	52.30	1.67	-1.69	1.34	24
91	6	26	51.61	0.70	51.37	1.25	-0.24	1.04	24
91	6	27	49.99	0.67	49.23	0.89	-0.76	0.60	24
91	6	28	49.39	0.64	48.81	0.63	-0.58	0.90	24
91	6	29	49.66	1.49	48.97	1.63	-0.69	0.56	24
91	6	30	51.80	1.69	51.60	1.48	-0.20	0.67	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
52.63	0.84	52.15	0.97	-0.48	720

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	6	1	48.24	2.25	47.82	1.46	-0.42	2.06	24
91	6	2	46.62	0.34	46.41	0.62	-0.21	0.78	24
91	6	3	47.32	0.79	46.11	0.71	-1.21	1.05	24
91	6	4	54.59	4.32	52.90	4.65	-1.68	1.05	24
91	6	5	55.56	0.26	54.51	0.50	-1.05	0.59	24
91	6	6	55.11	0.24	54.07	0.09	-1.04	0.24	24
91	6	7	54.21	0.95	53.64	0.18	-0.56	0.86	24
91	6	8	48.91	1.15	50.08	1.61	1.17	1.25	24
91	6	9	50.12	0.97	50.17	0.98	0.05	1.25	24
91	6	10	46.53	1.04	46.94	1.08	0.40	0.50	24
91	6	11	45.25	0.70	45.13	0.83	-0.12	0.56	24
91	6	12	44.40	0.17	43.90	0.19	-0.49	0.20	24
91	6	13	44.29	0.76	43.79	0.63	-0.50	0.31	24
91	6	14	46.33	0.44	45.50	0.41	-0.83	0.59	24
91	6	15	47.17	0.62	45.97	0.52	-1.20	0.48	24
91	6	16	50.43	1.52	49.72	1.75	-0.71	1.28	24
91	6	17	53.08	1.76	52.34	0.49	-0.74	1.50	24
91	6	18	51.24	1.25	51.39	1.34	0.15	1.22	24
91	6	19	50.55	1.30	50.57	0.69	0.03	1.86	24
91	6	20	49.26	1.41	48.89	0.71	-0.37	1.20	24
91	6	21	48.73	0.89	47.75	0.48	-0.98	1.13	24
91	6	22	49.06	0.62	48.07	0.50	-0.99	0.72	24
91	6	23	49.14	0.63	48.21	0.59	-0.93	0.89	24
91	6	24	49.04	0.52	48.33	0.76	-0.71	0.81	24
91	6	25	48.47	0.19	48.07	0.41	-0.41	0.47	24
91	6	26	47.98	0.24	47.47	0.35	-0.50	0.36	24
91	6	27	47.42	0.36	46.89	0.34	-0.53	0.29	24
91	6	28	47.20	0.42	46.45	0.24	-0.75	0.36	24
91	6	29	46.72	0.52	46.04	0.17	-0.68	0.48	24
91	6	30	47.70	0.53	47.06	0.90	-0.63	0.85	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
49.02	0.91	48.47	0.81	-0.55	720

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	7	1	56.10	0.65	55.57	0.87	-0.53	0.57	24
91	7	2	56.48	0.85	56.83	1.26	0.35	1.00	24
91	7	3	56.46	0.33	57.15	1.89	0.70	2.02	24
91	7	4	56.91	1.51	57.44	0.97	0.53	2.09	24
91	7	5	57.87	0.46	58.21	0.39	0.34	0.65	24
91	7	6	58.56	0.56	57.92	0.43	-0.64	0.48	24
91	7	7	59.64	0.23	59.04	0.60	-0.60	0.72	24
91	7	8	59.04	1.05	59.07	0.52	0.03	1.09	24
91	7	9	56.36	0.93	57.24	0.87	0.89	0.42	24
91	7	10	56.30	0.32	56.76	1.25	0.45	1.20	24
91	7	11	58.47	0.85	57.21	1.02	-1.26	1.26	24
91	7	12	59.27	0.54	58.44	0.91	-0.83	0.67	24
91	7	13	59.44	0.16	57.31	1.13	-2.14	1.14	24
91	7	14	60.26	0.69	59.41	1.22	-0.85	0.95	24
91	7	15	59.90	0.57	59.82	0.80	-0.08	0.49	24
91	7	16	61.17	0.98	59.82	1.33	-1.35	1.40	24
91	7	17	60.13	0.82	58.90	1.81	-1.23	1.31	24
91	7	18	60.98	1.53	59.38	2.65	-1.60	1.91	24
91	7	19	61.14	1.89	58.78	2.19	-2.35	1.68	24
91	7	20	63.80	0.85	59.04	2.87	-4.75	2.49	24
91	7	21	62.22	2.03	58.64	2.19	-3.58	2.38	24
91	7	22	61.08	0.93	60.25	2.36	-0.82	1.79	24
91	7	23	57.21	2.93	55.86	1.83	-1.35	1.58	24
91	7	24	56.63	2.23	55.20	1.69	-1.44	2.24	24
91	7	25	57.86	1.42	55.91	1.94	-1.95	2.22	24
91	7	26	57.60	0.65	58.16	2.02	0.56	1.87	24
91	7	27	59.88	0.88	59.71	1.02	-0.17	1.08	24
91	7	28	60.21	1.04	59.71	1.30	-0.50	0.66	24
91	7	29	60.46	0.70	60.34	0.65	-0.12	0.47	24
91	7	30	59.47	0.65	60.23	0.68	0.76	1.04	21
91	7	31	DATA MISSING FOR THIS DAY						

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
58.24	1.36	59.03	0.97	-0.79	717

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	7	1	56.10	0.65	56.04	0.53	-0.06	0.41	24
91	7	2	56.48	0.85	57.04	0.54	0.56	0.81	24
91	7	3	56.46	0.33	56.83	0.65	0.37	0.47	24
91	7	4	56.91	1.51	57.38	1.19	0.47	1.04	24
91	7	5	57.87	0.46	58.66	0.32	0.78	0.52	24
91	7	6	58.56	0.56	58.23	0.48	-0.33	0.22	24
91	7	7	59.64	0.23	59.10	0.32	-0.54	0.27	24
91	7	8	59.04	1.05	59.16	0.71	0.12	0.64	24
91	7	9	56.36	0.93	57.04	1.18	0.68	0.59	24
91	7	10	56.30	0.32	56.71	0.65	0.40	0.73	24
91	7	11	58.47	0.85	58.64	1.34	0.17	0.64	24
91	7	12	59.27	0.54	59.84	0.73	0.57	0.57	24
91	7	13	59.44	0.16	58.91	0.24	-0.53	0.20	24
91	7	14	60.26	0.69	60.05	0.96	-0.21	0.48	24
91	7	15	59.90	0.57	59.97	0.39	0.08	0.42	24
91	7	16	61.17	0.98	61.14	0.78	-0.03	0.63	24
91	7	17	60.13	0.82	60.77	1.22	0.65	1.33	24
91	7	18	60.98	1.53	61.49	1.94	0.52	1.18	24
91	7	19	61.14	1.89	61.97	1.75	0.84	1.52	24
91	7	20	63.80	0.85	62.89	1.36	-0.90	1.12	24
91	7	21	62.22	2.03	61.38	1.34	-0.84	1.67	24
91	7	22	61.08	0.93	62.03	1.56	0.95	1.23	24
91	7	23	57.21	2.93	58.11	2.18	0.90	2.16	24
91	7	24	56.63	2.23	56.74	1.33	0.11	2.06	24
91	7	25	57.86	1.42	57.63	0.75	-0.23	1.10	24
91	7	26	57.60	0.65	58.70	1.62	1.10	1.41	24
91	7	27	59.88	0.88	59.70	0.90	-0.19	1.17	24
91	7	28	60.21	1.04	60.06	1.15	-0.15	0.79	24
91	7	29	60.46	0.70	60.28	0.69	-0.18	0.63	24
91	7	30	59.47	0.65	60.22	0.74	0.75	1.03	21
91	7	31	DATA MISSING FOR THIS DAY						

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
59.03	0.97	59.22	0.98	0.19	717

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	7	1	51.53	1.89	51.08	1.85	-0.45	0.78	24
91	7	2	52.30	1.58	51.10	1.78	-1.20	0.95	24
91	7	3	54.20	2.11	53.44	2.82	-0.75	1.16	24
91	7	4	54.32	0.41	54.01	0.34	-0.30	0.59	24
91	7	5	55.30	0.54	54.61	0.46	-0.69	0.46	24
91	7	6	57.67	0.90	56.67	0.89	-1.00	0.57	24
91	7	7	56.72	1.39	56.36	1.55	-0.36	0.79	24
91	7	8	53.34	1.59	51.61	1.22	-1.74	0.97	24
91	7	9	53.24	2.07	52.47	1.73	-0.77	1.73	24
91	7	10	53.43	1.10	51.62	1.35	-1.81	1.04	24
91	7	11	53.04	0.76	51.51	0.46	-1.53	0.74	24
91	7	12	53.21	1.03	51.54	1.07	-1.67	0.83	24
91	7	13	53.32	1.16	52.03	0.83	-1.30	0.96	24
91	7	14	54.01	1.40	52.76	1.47	-1.25	1.46	24
91	7	15	54.37	1.19	52.69	0.89	-1.67	1.08	24
91	7	16	55.24	1.12	53.85	1.70	-1.38	1.47	24
91	7	17	52.49	1.32	51.77	1.47	-0.71	1.21	24
91	7	18	51.68	1.34	51.88	1.86	0.20	0.87	24
91	7	19	51.31	0.93	50.56	1.35	-0.76	0.93	24
91	7	20	51.77	1.01	51.81	1.52	0.04	1.16	24
91	7	21	51.53	0.64	51.50	1.82	-0.03	1.41	24
91	7	22	52.77	1.45	51.73	1.60	-1.04	1.32	24
91	7	23	50.48	0.94	50.03	1.32	-0.45	1.08	24
91	7	24	49.82	0.78	49.01	0.75	-0.81	0.59	24
91	7	25	50.81	0.57	49.85	1.05	-0.95	0.77	24
91	7	26	51.63	1.47	50.20	0.80	-1.43	1.03	24
91	7	27	52.83	1.28	52.12	1.75	-0.71	0.83	24
91	7	28	52.16	0.99	51.35	1.28	-0.81	1.10	24
91	7	29	53.36	0.73	52.24	0.70	-1.12	1.00	24
91	7	30	56.37	2.02	55.84	2.29	-0.54	1.19	21
91	7	31	DATA MISSING FOR THIS DAY						

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
53.13	1.19	52.23	1.33	-0.90	717

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	7	1	47.19	0.50	46.66	0.46	-0.53	0.43	24
91	7	2	47.86	0.48	47.59	1.42	-0.26	1.15	24
91	7	3	49.85	2.43	48.53	1.99	-1.32	1.18	24
91	7	4	51.91	1.30	51.20	1.29	-0.71	1.69	24
91	7	5	51.69	1.22	51.22	1.40	-0.47	2.36	24
91	7	6	48.86	1.90	49.54	1.51	0.68	2.57	24
91	7	7	48.44	0.74	48.27	0.63	-0.17	0.95	24
91	7	8	48.00	0.24	47.25	0.56	-0.76	0.49	24
91	7	9	48.04	0.64	47.02	0.79	-1.02	0.56	24
91	7	10	48.26	0.83	47.61	0.48	-0.65	0.83	24
91	7	11	48.77	0.64	47.86	0.68	-0.91	0.67	24
91	7	12	48.36	0.80	48.10	0.71	-0.26	0.72	24
91	7	13	48.59	0.35	48.06	0.58	-0.53	0.64	24
91	7	14	48.82	0.49	48.47	0.90	-0.34	0.87	24
91	7	15	49.03	0.48	48.55	0.80	-0.48	0.93	24
91	7	16	49.43	0.68	48.86	0.90	-0.57	1.27	24
91	7	17	47.97	0.38	47.92	0.46	-0.05	0.43	24
91	7	18	48.19	0.52	47.60	0.46	-0.59	0.54	24
91	7	19	48.43	0.49	47.65	0.41	-0.78	0.68	24
91	7	20	48.83	0.31	47.95	0.47	-0.88	0.47	24
91	7	21	48.13	0.29	47.94	0.47	-0.19	0.42	24
91	7	22	48.55	0.51	47.99	0.40	-0.56	0.73	24
91	7	23	48.37	0.52	47.65	0.40	-0.72	0.56	24
91	7	24	48.15	0.39	47.20	0.23	-0.95	0.44	24
91	7	25	48.42	0.55	47.45	0.29	-0.97	0.46	24
91	7	26	48.30	0.36	47.71	0.20	-0.59	0.28	24
91	7	27	48.89	0.39	48.19	0.50	-0.70	0.81	24
91	7	28	48.79	0.34	48.30	0.42	-0.49	0.67	24
91	7	29	49.81	0.46	48.47	0.52	-1.34	0.56	24
91	7	30	51.09	1.30	49.68	0.93	-1.41	1.45	21
91	7	31	DATA MISSING FOR THIS DAY						

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
48.82	0.68	48.21	0.71	-0.61	717

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91 8 1			DATA MISSING FOR THIS DAY				
91 8 2			DATA MISSING FOR THIS DAY				
91 8 3			DATA MISSING FOR THIS DAY				
91 8 4			DATA MISSING FOR THIS DAY				
91 8 5			DATA MISSING FOR THIS DAY				
91 8 6			DATA MISSING FOR THIS DAY				
91 8 7			DATA MISSING FOR THIS DAY				
91 8 8			DATA MISSING FOR THIS DAY				
91 8 9			DATA MISSING FOR THIS DAY				
91 8 10			DATA MISSING FOR THIS DAY				
91 8 11			DATA MISSING FOR THIS DAY				
91 8 12			DATA MISSING FOR THIS DAY				
91 8 13			DATA MISSING FOR THIS DAY				
91 8 14			DATA MISSING FOR THIS DAY				
91 8 15			DATA MISSING FOR THIS DAY				
91 8 16			DATA MISSING FOR THIS DAY				
91 8 17			DATA MISSING FOR THIS DAY				
91 8 18			DATA MISSING FOR THIS DAY				
91 8 19			DATA MISSING FOR THIS DAY				
91 8 20			DATA MISSING FOR THIS DAY				
91 8 21			DATA MISSING FOR THIS DAY				
91 8 22			DATA MISSING FOR THIS DAY				
91 8 23			DATA MISSING FOR THIS DAY				
91 8 24	62.41	0.72	62.45	0.34	0.04	0.56	6
91 8 25	62.25	0.63	62.53	0.87	0.28	0.66	24
91 8 26	62.30	0.68	62.45	0.51	0.15	0.58	24
91 8 27	60.52	0.66	60.46	0.59	-0.07	0.79	24
91 8 28	61.28	1.03	61.39	1.36	0.11	1.04	24
91 8 29	64.66	2.35	62.97	1.82	-1.70	1.99	24
91 8 30	65.80	0.81	64.74	1.41	-1.06	0.91	24
91 8 31	62.16	2.36	61.84	1.54	-0.32	1.84	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
62.34	1.05	62.70	1.15	-0.36	174

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 8 1			DATA MISSING FOR THIS DAY				
91 8 2			DATA MISSING FOR THIS DAY				
91 8 3			DATA MISSING FOR THIS DAY				
91 8 4			DATA MISSING FOR THIS DAY				
91 8 5			DATA MISSING FOR THIS DAY				
91 8 6			DATA MISSING FOR THIS DAY				
91 8 7			DATA MISSING FOR THIS DAY				
91 8 8			DATA MISSING FOR THIS DAY				
91 8 9			DATA MISSING FOR THIS DAY				
91 8 10			DATA MISSING FOR THIS DAY				
91 8 11			DATA MISSING FOR THIS DAY				
91 8 12			DATA MISSING FOR THIS DAY				
91 8 13			DATA MISSING FOR THIS DAY				
91 8 14			DATA MISSING FOR THIS DAY				
91 8 15			DATA MISSING FOR THIS DAY				
91 8 16			DATA MISSING FOR THIS DAY				
91 8 17			DATA MISSING FOR THIS DAY				
91 8 18			DATA MISSING FOR THIS DAY				
91 8 19			DATA MISSING FOR THIS DAY				
91 8 20			DATA MISSING FOR THIS DAY				
91 8 21			DATA MISSING FOR THIS DAY				
91 8 22			DATA MISSING FOR THIS DAY				
91 8 23			DATA MISSING FOR THIS DAY				
91 8 24	62.41	0.72	62.82	0.57	0.40	0.85	6
91 8 25	62.25	0.63	62.49	0.72	0.24	0.42	24
91 8 26	62.20	0.52	62.20	0.22	0.00	0.46	9
91 8 27			DATA MISSING FOR THIS DAY				
91 8 28			DATA MISSING FOR THIS DAY				
91 8 29			DATA MISSING FOR THIS DAY				
91 8 30			DATA MISSING FOR THIS DAY				
91 8 31	60.76	1.49	61.04	1.07	0.28	1.14	16

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
61.83	0.84	62.06	0.65	0.23	55

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 8 1			DATA MISSING FOR THIS DAY				
91 8 2			DATA MISSING FOR THIS DAY				
91 8 3			DATA MISSING FOR THIS DAY				
91 8 4			DATA MISSING FOR THIS DAY				
91 8 5			DATA MISSING FOR THIS DAY				
91 8 6			DATA MISSING FOR THIS DAY				
91 8 7			DATA MISSING FOR THIS DAY				
91 8 8			DATA MISSING FOR THIS DAY				
91 8 9			DATA MISSING FOR THIS DAY				
91 8 10			DATA MISSING FOR THIS DAY				
91 8 11			DATA MISSING FOR THIS DAY				
91 8 12			DATA MISSING FOR THIS DAY				
91 8 13			DATA MISSING FOR THIS DAY				
91 8 14			DATA MISSING FOR THIS DAY				
91 8 15			DATA MISSING FOR THIS DAY				
91 8 16			DATA MISSING FOR THIS DAY				
91 8 17			DATA MISSING FOR THIS DAY				
91 8 18			DATA MISSING FOR THIS DAY				
91 8 19			DATA MISSING FOR THIS DAY				
91 8 20			DATA MISSING FOR THIS DAY				
91 8 21			DATA MISSING FOR THIS DAY				
91 8 22			DATA MISSING FOR THIS DAY				
91 8 23			DATA MISSING FOR THIS DAY				
91 8 24	58.79	0.33	60.12	0.82	1.33	0.67	6
91 8 25	60.28	0.64	60.13	1.06	-0.15	1.02	24
91 8 26	58.71	0.43	58.46	0.58	-0.26	0.29	9
91 8 27			DATA MISSING FOR THIS DAY				
91 8 28			DATA MISSING FOR THIS DAY				
91 8 29			DATA MISSING FOR THIS DAY				
91 8 30			DATA MISSING FOR THIS DAY				
91 8 31	56.60	2.09	56.93	1.65	0.33	1.30	16

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
58.79	0.87	58.92	1.03	0.13	55

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 8 1			DATA MISSING FOR THIS DAY				
91 8 2			DATA MISSING FOR THIS DAY				
91 8 3			DATA MISSING FOR THIS DAY				
91 8 4			DATA MISSING FOR THIS DAY				
91 8 5			DATA MISSING FOR THIS DAY				
91 8 6			DATA MISSING FOR THIS DAY				
91 8 7			DATA MISSING FOR THIS DAY				
91 8 8			DATA MISSING FOR THIS DAY				
91 8 9			DATA MISSING FOR THIS DAY				
91 8 10			DATA MISSING FOR THIS DAY				
91 8 11			DATA MISSING FOR THIS DAY				
91 8 12			DATA MISSING FOR THIS DAY				
91 8 13			DATA MISSING FOR THIS DAY				
91 8 14			DATA MISSING FOR THIS DAY				
91 8 15			DATA MISSING FOR THIS DAY				
91 8 16			DATA MISSING FOR THIS DAY				
91 8 17			DATA MISSING FOR THIS DAY				
91 8 18			DATA MISSING FOR THIS DAY				
91 8 19			DATA MISSING FOR THIS DAY				
91 8 20			DATA MISSING FOR THIS DAY				
91 8 21			DATA MISSING FOR THIS DAY				
91 8 22			DATA MISSING FOR THIS DAY				
91 8 23			DATA MISSING FOR THIS DAY				
91 8 24	55.65	0.64	57.01	0.11	1.36	0.64	6
91 8 25	56.71	0.78	57.14	0.35	0.43	0.80	24
91 8 26	56.18	0.34	56.74	0.47	0.56	0.78	9
91 8 27			DATA MISSING FOR THIS DAY				
91 8 28			DATA MISSING FOR THIS DAY				
91 8 29			DATA MISSING FOR THIS DAY				
91 8 30			DATA MISSING FOR THIS DAY				
91 8 31	52.41	1.74	51.94	0.80	-0.47	1.13	16

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
55.26	0.87	55.55	0.43	0.29	55

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91	9	1	61.34	0.96	61.57	1.20	0.23	1.11	24
91	9	2	61.65	0.68	61.22	0.86	-0.43	0.46	24
91	9	3	60.27	0.91	60.07	0.59	-0.20	0.52	24
91	9	4	57.23	1.04	57.71	0.81	0.48	0.73	24
91	9	5	59.98	2.44	60.74	2.25	0.77	1.48	24
91	9	6	61.95	1.28	61.77	1.11	-0.18	0.45	24
91	9	7	63.36	0.87	63.03	0.98	-0.33	0.25	24
91	9	8	64.15	0.72	64.19	0.82	0.04	0.46	24
91	9	9	63.77	0.39	63.78	0.67	0.01	0.57	24
91	9	10	62.65	1.67	62.87	0.87	0.22	1.19	24
91	9	11	59.41	1.57	59.51	1.21	0.10	0.93	24
91	9	12	60.78	1.22	60.48	1.43	-0.30	0.92	24
91	9	13	60.71	0.87	61.06	0.79	0.35	0.57	24
91	9	14	60.35	0.70	60.10	1.01	-0.25	0.57	24
91	9	15	59.72	0.63	59.61	0.56	-0.11	0.34	24
91	9	16	59.06	0.96	59.35	0.79	0.29	0.86	24
91	9	17	58.79	0.92	58.84	0.76	0.05	0.46	24
91	9	18	61.80	1.91	61.96	1.78	0.16	1.41	24
91	9	19	61.57	1.68	61.12	1.36	-0.45	0.62	21
91	9	20	61.60	1.07	61.64	0.99	0.03	0.39	24
91	9	21	61.55	0.12	61.25	0.19	-0.30	0.15	24
91	9	22	61.05	0.48	60.57	0.41	-0.48	0.28	24
91	9	23	59.45	0.46	59.24	0.87	-0.21	0.76	24
91	9	24	58.42	0.79	57.59	0.97	-0.83	0.99	24
91	9	25	58.19	0.47	57.75	0.60	-0.44	0.56	24
91	9	26	58.88	0.66	58.34	0.54	-0.54	0.42	24
91	9	27	58.26	0.32	58.05	0.21	-0.21	0.26	24
91	9	28	57.37	0.41	58.27	0.82	0.90	0.82	24
91	9	29	57.46	1.19	57.65	1.02	0.20	0.59	24
91	9	30	56.86	0.79	56.45	0.78	-0.41	0.48	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
60.19	0.91	60.25	0.94	-0.06	717

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	9	1	61.34	0.96	61.64	0.97	0.30	1.03	24
91	9	2	61.71	0.71	61.37	0.83	-0.33	0.27	21
91	9	3	60.15	1.07	60.06	0.72	-0.10	0.70	16
91	9	4	57.23	1.04	57.88	0.92	0.65	1.03	24
91	9	5	59.98	2.44	60.60	2.15	0.62	1.06	24
91	9	6	61.95	1.28	61.97	0.90	0.02	0.46	24
91	9	7	62.49	0.08	62.19	0.14	-0.30	0.10	9
91	9	8	DATA MISSING FOR THIS DAY						
91	9	9	DATA MISSING FOR THIS DAY						
91	9	10	DATA MISSING FOR THIS DAY						
91	9	11	58.96	1.41	59.37	1.23	0.41	0.53	16
91	9	12	60.78	1.22	60.65	1.12	-0.13	0.55	24
91	9	13	60.71	0.87	60.84	0.82	0.13	0.45	24
91	9	14	60.35	0.70	60.38	0.77	0.03	0.51	24
91	9	15	59.72	0.63	59.54	0.65	-0.19	0.36	24
91	9	16	58.06	0.16	58.55	0.24	0.48	0.27	9
91	9	17	DATA MISSING FOR THIS DAY						
91	9	18	DATA MISSING FOR THIS DAY						
91	9	19	61.03	1.57	60.94	1.32	-0.10	0.63	16
91	9	20	61.60	1.07	61.69	1.02	0.08	0.31	24
91	9	21	61.55	0.12	61.33	0.22	-0.21	0.22	24
91	9	22	61.05	0.48	60.76	0.47	-0.29	0.21	24
91	9	23	59.45	0.46	59.00	0.81	-0.44	0.49	24
91	9	24	58.42	0.79	57.46	1.02	-0.96	0.92	24
91	9	25	58.19	0.47	57.67	0.54	-0.51	0.42	24
91	9	26	58.88	0.66	58.32	0.59	-0.56	0.35	24
91	9	27	58.26	0.32	57.91	0.23	-0.36	0.25	24
91	9	28	57.37	0.41	57.94	0.76	0.57	0.70	24
91	9	29	57.46	1.19	57.65	0.88	0.19	0.58	24
91	9	30	56.86	0.79	56.44	0.80	-0.42	0.39	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
59.69	0.84	59.62	0.81	-0.07	543

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	9	1	60.14	0.92	59.98	1.14	-0.16	1.32	24
91	9	2	59.59	0.40	59.78	0.59	0.20	0.53	21
91	9	3	55.26	0.79	55.69	1.25	0.43	0.79	16
91	9	4	53.62	0.82	53.65	1.20	0.03	0.83	24
91	9	5	54.48	1.56	53.88	1.35	-0.60	0.70	24
91	9	6	57.43	1.33	57.02	1.39	-0.41	0.51	24
91	9	7	59.39	1.25	59.27	1.24	-0.12	0.90	9
91	9	8	DATA MISSING FOR THIS DAY						
91	9	9	DATA MISSING FOR THIS DAY						
91	9	10	DATA MISSING FOR THIS DAY						
91	9	11	56.28	1.66	55.97	1.76	-0.31	0.78	16
91	9	12	57.94	1.58	57.27	2.07	-0.67	1.12	24
91	9	13	58.71	1.17	58.17	1.14	-0.53	0.59	24
91	9	14	56.81	2.04	57.07	2.15	0.26	0.87	24
91	9	15	55.04	0.65	54.52	0.77	-0.51	0.52	24
91	9	16	53.89	0.65	53.49	0.48	-0.40	0.44	9
91	9	17	DATA MISSING FOR THIS DAY						
91	9	18	DATA MISSING FOR THIS DAY						
91	9	19	56.50	1.84	56.17	1.84	-0.33	0.77	16
91	9	20	58.78	1.13	58.48	1.07	-0.30	0.61	24
91	9	21	60.38	1.13	60.01	1.29	-0.37	0.72	24
91	9	22	59.97	0.89	59.37	1.00	-0.60	0.93	24
91	9	23	55.04	1.69	54.95	1.48	-0.09	0.38	16
91	9	24	53.33	0.18	52.95	0.43	-0.38	0.39	24
91	9	25	57.16	1.95	56.74	1.94	-0.43	0.34	24
91	9	26	58.69	0.34	58.24	0.26	-0.44	0.37	24
91	9	27	57.19	1.29	57.05	1.55	-0.14	0.76	24
91	9	28	55.82	1.04	56.15	1.88	0.33	1.05	24
91	9	29	55.66	1.49	56.13	1.88	0.46	0.88	24
91	9	30	55.41	0.58	54.76	0.43	-0.65	0.44	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
56.97	1.14	56.73	1.26	-0.24	535

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	9	1	56.51	2.60	56.28	2.85	-0.23	2.55	24
91	9	2	56.46	1.59	56.99	0.77	0.52	1.72	21
91	9	3	52.11	0.26	52.69	0.55	0.58	0.70	16
91	9	4	51.21	0.90	51.68	0.33	0.47	0.73	24
91	9	5	51.52	0.84	51.14	0.56	-0.39	0.91	24
91	9	6	52.56	0.61	51.64	0.58	-0.92	0.69	24
91	9	7	54.55	1.07	52.73	0.54	-1.82	0.81	9
91	9	8	DATA MISSING FOR THIS DAY						
91	9	9	DATA MISSING FOR THIS DAY						
91	9	10	DATA MISSING FOR THIS DAY						
91	9	11	52.04	1.34	52.31	0.81	0.27	0.60	16
91	9	12	53.95	1.05	53.45	1.18	-0.50	1.71	24
91	9	13	54.33	1.08	54.01	0.64	-0.32	1.28	24
91	9	14	52.63	1.11	53.24	0.68	0.60	0.93	24
91	9	15	51.58	0.30	51.97	0.43	0.39	0.61	24
91	9	16	51.63	0.30	51.70	0.26	0.08	0.42	9
91	9	17	DATA MISSING FOR THIS DAY						
91	9	18	DATA MISSING FOR THIS DAY						
91	9	19	52.46	0.40	52.54	0.60	0.08	0.89	16
91	9	20	54.07	0.93	53.26	0.84	-0.82	0.78	24
91	9	21	55.76	1.52	54.25	0.80	-1.50	1.50	24
91	9	22	55.72	0.81	54.73	1.25	-0.99	1.38	24
91	9	23	52.46	0.95	53.01	1.10	0.55	0.42	16
91	9	24	51.25	0.17	51.38	0.26	0.13	0.33	24
91	9	25	55.51	2.38	55.15	2.38	-0.36	0.46	24
91	9	26	56.75	1.22	56.23	0.74	-0.52	1.51	24
91	9	27	53.39	0.79	53.98	1.33	0.59	0.84	24
91	9	28	53.25	0.36	52.88	0.28	-0.38	0.32	24
91	9	29	52.98	0.68	52.99	0.36	0.02	0.56	24
91	9	30	53.07	0.77	52.71	0.29	-0.36	0.66	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
53.59	0.96	53.40	0.82	-0.19	535

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91 10 1	55.21	0.83	55.02	1.19	-0.19	0.66	24
91 10 2	54.70	0.84	54.21	1.35	-0.49	0.81	24
91 10 3	55.94	1.20	56.23	1.07	0.29	0.84	24
91 10 4	57.24	1.68	57.82	1.04	0.58	1.04	24
91 10 5	57.23	0.35	57.10	0.45	-0.13	0.35	24
91 10 6	56.09	0.40	55.57	0.58	-0.52	0.36	24
91 10 7	52.80	1.05	52.30	0.97	-0.50	0.41	24
91 10 8	51.61	0.43	50.73	0.29	-0.89	0.43	24
91 10 9	52.10	0.47	51.04	0.39	-1.06	0.54	24
91 10 10	52.16	0.48	51.91	0.71	-0.25	0.69	24
91 10 11	52.85	0.67	52.28	1.09	-0.57	0.67	24
91 10 12	53.08	0.53	52.91	0.51	-0.17	0.25	24
91 10 13	52.16	0.16	51.93	0.35	-0 23	0.22	24
91 10 14	51.95	0.13	51.33	0.44	-0.62	0.36	24
91 10 15	51.90	0.30	51.79	0.41	-0.11	0.25	21
91 10 16	52.11	0.12	51.60	0.15	-0.51	0.15	24
91 10 17	52.04	0.25	51.72	0.25	-0.33	0.13	24
91 10 18	52.24	0.52	52.69	0.87	0.45	0.49	24
91 10 19	52.71	0.61	53.19	0.26	0.48	0.59	24
91 10 20	52.27	0.17	54.31	0.28	2.04	0.31	24
91 10 21	51.58	0.09	53.60	0.30	2.02	0.32	24
91 10 22	51.93	0.40	53.17	0.30	1.24	0.28	24
91 10 23	52.21	0.52	53.94	0.32	1.73	0.60	21
91 10 24	52.85	0.15	54.94	0.09	2.09	0.20	4
91 10 25	53.33	0.62	55.13	0.34	1.80	0.71	24
91 10 26	54.31	0.80	55.17	0.31	0.86	0.82	24
91 10 27	53.65	0.41	55.00	0.50	1.34	0.58	24
91 10 28	52.64	0.48	53.39	1.53	0.75	1.27	24
91 10 29	51.26	0.14	54.11	1.01	2.85	1.12	24
91 10 30	50.61	0.17	50.69	1.24	0.09	1.15	24
91 10 31	50.87	0.13	50.94	0.98	0.07	0.98	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
53.37	0.63	53.03	0.49	0.34	718

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 10 1	55.21	0.83	54.99	1.27	-0.22	0.71	24
91 10 2	54.70	0.84	54.41	1.00	-0.29	0.59	24
91 10 3	55.94	1.20	56.17	0.94	0.23	0.73	24
91 10 4	57.24	1.68	57.41	1.15	0.17	1.08	24
91 10 5	57.23	0.35	57.02	0.47	-0.21	0.35	24
91 10 6	56.09	0.40	55.71	0.50	-0.38	0.42	24
91 10 7	52.80	1.05	52.78	0.70	-0.02	0.43	24
91 10 8	51.61	0.43	51.05	0.37	-0.56	0.25	24
91 10 9	52.10	0.47	51.37	0.37	-0.73	0.42	24
91 10 10	52.16	0.48	52.09	0.65	-0.07	0.61	24
91 10 11	52.85	0.67	52.52	1.04	-0.33	0.57	24
91 10 12	53.08	0.53	52.99	0.37	-0.09	0.29	24
91 10 13	52.16	0.16	52.11	0.17	-0.05	0.13	24
91 10 14	51.95	0.13	51.58	0.26	-0.37	0.15	24
91 10 15	51.90	0.28	51.60	0.44	-0.30	0.23	24
91 10 16	52.11	0.12	51.78	0.14	-0.33	0.14	24
91 10 17	52.04	0.25	51.77	0.26	-0.28	0.15	24
91 10 18	52.24	0.52	52.21	0.52	-0.03	0.17	24
91 10 19	52.71	0.61	52.55	0.51	-0.17	0.22	24
91 10 20	52.27	0.17	52.11	0.20	-0.16	0.16	24
91 10 21	51.58	0.09	51.70	0.35	0.11	0.34	24
91 10 22	51.93	0.40	51.87	0.48	-0.06	0.24	24
91 10 23	52.21	0.52	52.49	0.56	0.28	0.39	21
91 10 24	52.85	0.15	52.92	0.24	0.07	0.16	4
91 10 25	53.33	0.62	53.40	0.63	0.06	0.49	24
91 10 26	54.31	0.80	53.76	0.50	-0.55	0.61	24
91 10 27	53.65	0.41	53.71	0.40	0.06	0.34	24
91 10 28	52.64	0.48	52.47	0.66	-0.16	0.30	24
91 10 29	51.26	0.14	50.97	0.21	-0.29	0.10	24
91 10 30	50.61	0.17	49.97	0.47	-0.63	0.46	24
91 10 31	50.87	0.13	50.61	0.15	-0.27	0.19	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
53.03	0.49	52.84	0.52	-0.19	721

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 10 1	53.57	1.64	53.73	1.50	0.15	0.38	24
91 10 2	51.59	0.50	51.49	0.39	-0.10	0.65	24
91 10 3	52.23	0.40	51.62	0.45	-0.61	0.43	24
91 10 4	52.94	0.54	52.47	0.80	-0.47	0.54	24
91 10 5	53.73	0.91	53.35	0.56	-0.39	0.61	24
91 10 6	53.19	1.05	52.37	0.68	-0.82	0.70	24
91 10 7	51.23	0.61	50.86	0.69	-0.37	0.48	24
91 10 8	51.16	0.40	50.36	0.34	-0.81	0.39	24
91 10 9	51.81	0.32	51.12	0.25	-0.70	0.26	24
91 10 10	51.20	0.67	50.71	0.33	-0.49	0.46	24
91 10 11	51.60	1.27	51.17	1.00	-0.43	0.43	24
91 10 12	52.44	1.03	52.30	0.89	-0.14	0.62	24
91 10 13	51.90	0.61	51.37	0.79	-0.53	0.69	24
91 10 14	51.57	0.55	51.11	0.30	-0.46	0.49	24
91 10 15	51.78	0.30	51.36	0.37	-0.42	0.36	24
91 10 16	51.29	0.53	51.12	0.53	-0.18	0.32	24
91 10 17	52.23	0.30	51.81	0.39	-0.42	0.22	24
91 10 18	52.29	0.14	52.10	0.14	-0.20	0.15	24
91 10 19	52.31	0.12	52.15	0.17	-0.17	0.19	24
91 10 20	52.52	0.12	52.23	0.17	-0.30	0.14	24
91 10 21	52.20	0.15	51.89	0.23	-0.31	0.28	24
91 10 22	52.38	0.09	51.92	0.10	-0.46	0.07	24
91 10 23	52.24	0.07	52.08	0.30	-0.16	0.34	21
91 10 24	52.30	0.02	52.12	0.44	-0.18	0.43	4
91 10 25	52.11	0.15	52.00	0.22	-0.11	0.27	24
91 10 26	51.92	0.21	51.77	0.20	-0.15	0.32	24
91 10 27	51.79	0.19	51.65	0 28	-0.14	0.29	24
91 10 28	52.54	0.45	52.25	0.42	-0.29	0.19	24
91 10 29	51.58	0.14	51.27	0.23	-0.30	0.14	24
91 10 30	50.94	0.16	50.40	0.31	-0.53	0.25	24
91 10 31	51.16	0.14	50.73	0.12	-0.42	0.16	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
52.05	0.45	51.69	0.44	-0.36	721

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 10 1	51.39	1.71	52.02	1.24	0.63	0.84	24
91 10 2	49.42	0.50	49.63	0.40	0.22	0.77	24
91 10 3	50.36	0.31	50.00	0.34	-0.36	0.55	24
91 10 4	50.30	0.29	50.26	0.31	-0.04	0.47	24
91 10 5	50.73	0.28	50.51	0.34	-0.22	0.30	24
91 10 6	50.72	0.43	50.60	0.36	-0.13	0.38	24
91 10 7	49.42	0.44	49.75	0.37	0.33	0.30	24
91 10 8	49.65	0.31	49.16	0.17	-0.49	0.33	24
91 10 9	50.52	0.30	50.01	0.28	-0.51	0.40	24
91 10 10	49.36	0.26	49.65	0.40	0.30	0.38	24
91 10 11	49.78	0.90	49.29	0.42	-0.49	0.77	24
91 10 12	50.13	0.67	49.78	0.59	-0.35	0.50	24
91 10 13	49.99	0.26	49.53	0.28	-0.46	0.48	24
91 10 14	50.04	0.35	49.39	0.18	-0.66	0.26	24
91 10 15	50.53	0.39	50.15	0.62	-0.38	0.56	24
91 10 16	49.87	0.49	49.78	0.25	-0.09	0.34	21
91 10 17	51.05	1.07	50.62	1.14	-0.44	0.35	24
91 10 18	52.14	0.39	51.99	0.14	-0.15	0.41	24
91 10 19	51.59	0.16	51.44	0.14	-0.15	0.23	24
91 10 20	51.65	0.13	51.52	0.16	-0.13	0.26	24
91 10 21	51.89	0.21	51.62	0.24	-0.28	0.26	24
91 10 22	51.91	0.21	51.70	0.14	-0.21	0.14	24
91 10 23	51.29	0.36	51.52	0.04	0.23	0.34	21
91 10 24	50.94	0.16	51.07	0.14	0.12	0.17	4
91 10 25	50.83	0.22	50.78	0.16	-0.05	0.17	24
91 10 26	50.66	0.21	50.57	0.07	-0.09	0.20	24
91 10 27	50.51	0.19	50.44	0.08	-0.07	0.18	24
91 10 28	51.69	0.88	51.45	0.86	-0.24	0.22	24
91 10 29	51.37	0.13	51.06	0.26	-0.31	0.21	24
91 10 30	50.83	0.43	50.18	0.37	-0.65	0.46	16
91 10 31	DATA MISSING FOR THIS DAY						

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
50.68	0.42	50.50	0.35	-0.18	686

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91 11 1	51.03	0.02	51.95	1.72	0.92	1.71	21
91 11 2	51.16	0.06	54.31	0.34	3.15	0.31	13
91 11 3	51.56	0.22	54.52	0.45	2.96	0.32	16
91 11 4	51.31	0.11	54.93	0.50	3.62	0.55	24
91 11 5	50.86	0.27	54.21	1.92	3.35	1.85	24
91 11 6	50.47	0.10	53.63	1.07	3.16	1.13	24
91 11 7	50.21	0.14	53.82	0.34	3.61	0.40	24
91 11 8	50.00	0.13	53.88	0.51	3.89	0.49	24
91 11 9	49.57	0.13	52.47	1.93	2.90	1.93	24
91 11 10	49.12	0.11	52.61	0.33	3.49	0.37	24
91 11 11	48.32	0.40	49.39	1.67	1.06	1.84	24
91 11 12	47.94	0.17	51.29	0.26	3.35	0.32	24
91 11 13	48.05	0.04	51.53	0.16	3.48	0.16	24
91 11 14	47.80	0.18	51.25	0.49	3.45	0.46	24
91 11 15	48.13	0.12	50.88	0.50	2.75	0.54	24
91 11 16	48.36	0.09	51.33	0.89	2.97	0.83	24
91 11 17	48.30	0.08	51.90	0.49	3.60	0.50	24
91 11 18	48.19	0.07	50.96	0.46	2.77	0.43	24
91 11 19	47.85	0.20	50.52	0.46	2.67	0.46	24
91 11 20	48.03	0.29	51.17	0.49	3.13	0.40	24
91 11 21	48.99	0.57	51.55	0.64	2.56	0.47	24
91 11 22	49.12	0.34	51.49	1.61	2.37	1.52	24
91 11 23	48.56	0.10	50.10	1.99	1.54	2.01	24
91 11 24	48.13	0.14	51.88	0.74	3.74	0.79	24
91 11 25	47.98	0.16	50.35	0.84	2.37	0.96	24
91 11 26	47.92	0.17	51.42	1.42	3.50	1.48	24
91 11 27	46.36	0.60	50.14	1.13	3.78	0.81	24
91 11 28	47.01	0.84	50.12	0.60	3.11	0.69	24
91 11 29	48.22	0.11	51.55	0.63	3.32	0.67	24
91 11 30	47.69	0.56	51.08	1.56	3.38	1.35	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
51.80	0.87	48.80	0.22	3.01	698

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 11 1	51.03	0.02	50.53	0.46	-0.50	0.46	21
91 11 2	51.16	0.06	51.26	0.94	0.10	0.89	13
91 11 3	51.56	0.22	51.19	0.51	-0.38	0.61	16
91 11 4	51.31	0.11	51.16	0.97	-0.15	0.90	24
91 11 5	50.86	0.27	50.59	0.47	-0.27	0.35	24
91 11 6	50.47	0.10	50.22	0.60	-0.24	0.67	24
91 11 7	50.21	0.14	50.28	0.56	0.07	0.61	24
91 11 8	50.00	0.13	50.16	0.78	0.16	0.81	24
91 11 9	49.57	0.13	49.24	0.42	-0.33	0.37	24
91 11 10	49.12	0.11	48.30	0.67	-0.82	0.69	24
91 11 11	48.32	0.40	47.65	0.57	-0.67	0.37	24
91 11 12	47.94	0.17	47.57	0.46	-0.38	0.32	24
91 11 13	48.05	0.04	47.82	0.21	-0.23	0.24	24
91 11 14	47.80	0.18	47.64	0.27	-0.17	0.26	24
91 11 15	48.13	0.12	47.62	0.50	-0.52	0.53	24
91 11 16	48.36	0.09	47.58	0.50	-0.78	0.43	24
91 11 17	48.30	0.08	47.80	0.18	-0.50	0.22	24
91 11 18	48.19	0.07	47.61	0.86	-0.58	0.83	24
91 11 19	47.85	0.20	47.46	0.75	-0.39	0.81	24
91 11 20	47.98	0.28	47.93	0.64	-0.05	0.60	21
91 11 21	49.28	0.47	49.18	0.29	-0.10	0.34	16
91 11 22	49.12	0.34	48.67	0.58	-0.46	0.45	24
91 11 23	48.56	0.10	48.03	0.11	-0.52	0.12	24
91 11 24	48.13	0.14	47.73	0.17	-0.40	0.08	24
91 11 25	47.98	0.16	47.46	0.35	-0.51	0.31	24
91 11 26	47.92	0.17	47.27	0.45	-0.66	0.48	24
91 11 27	46.36	0.60	46.60	0.98	0.24	0.86	24
91 11 28	47.01	0.84	47.09	0.59	0.08	0.99	24
91 11 29	48.22	0.11	48.17	0.75	-0.05	0.74	24
91 11 30	47.69	0.56	47.37	0.94	-0.32	0.83	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
48.81	0.21	48.49	0.55	-0.32	687

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 11 1	51.30	0.04	50.95	0.18	-0.35	0.18	21
91 11 2	51.48	0.11	51.00	0.08	-0.48	0.07	13
91 11 3	51.72	0.08	51.51	0.05	-0.21	0.10	16
91 11 4	51.78	0.21	51.64	0.08	-0.14	0.20	24
91 11 5	51.27	0.42	51.04	0.44	-0.24	0.32	24
91 11 6	50.83	0.13	50.53	0.11	-0.30	0.19	24
91 11 7	50.89	0.19	50.71	0.05	-0.19	0.21	24
91 11 8	50.64	0.33	50.40	0.18	-0.23	0.29	24
91 11 9	49.88	0.14	49.54	0.38	-0.34	0.34	24
91 11 10	49.51	0.09	48.75	0.54	-0.76	0.57	24
91 11 11	48.81	0.26	48.34	0.35	-0.47	0.22	24
91 11 12	48.34	0.07	48.15	0.30	-0.19	0.32	24
91 11 13	48.38	0.08	48.24	0.17	-0.15	0.15	24
91 11 14	47.98	0.21	48.31	0.15	0.33	0.24	24
91 11 15	48.42	0.14	48.28	0.28	-0.14	0.37	24
91 11 16	48.78	0.14	48.38	0.18	-0.40	0.20	24
91 11 17	48.58	0.08	48.19	0.13	-0.39	0.16	24
91 11 18	48.36	0.14	47.90	0.54	-0.46	0.54	24
91 11 19	48.24	0.21	47.29	0.20	-0.95	0.29	24
91 11 20	47.95	0.21	48.13	0.52	0.18	0.55	21
91 11 21	48.85	0.06	48.59	0.06	-0.27	0.06	16
91 11 22	49.14	0.27	48.93	0.40	-0.21	0.25	24
91 11 23	48.83	0.09	48.49	0.09	-0.34	0.07	24
91 11 24	48.45	0.15	48.21	0.13	-0.24	0.10	24
91 11 25	48.46	0.06	48.20	0.10	-0.26	0.12	24
91 11 26	48.47	0.29	48.04	0.30	-0.43	0.48	24
91 11 27	47.66	0.39	47.47	0.71	-0.18	0.82	24
91 11 28	48.43	0.52	48.23	0.50	-0.20	0.21	24
91 11 29	49.05	0.07	48.62	0.13	-0.43	0.14	24
91 11 30	48.41	0.32	48.07	0.26	-0.33	0.23	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
49.24	0.18	48.94	0.25	-0.29	687

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 11 1			DATA MISSING FOR THIS DAY				
91 11 2			DATA MISSING FOR THIS DAY				
91 11 3			DATA MISSING FOR THIS DAY				
91 11 4			DATA MISSING FOR THIS DAY				
91 11 5			DATA MISSING FOR THIS DAY				
91 11 6			DATA MISSING FOR THIS DAY				
91 11 7			DATA MISSING FOR THIS DAY				
91 11 8			DATA MISSING FOR THIS DAY				
91 11 9			DATA MISSING FOR THIS DAY				
91 11 10			DATA MISSING FOR THIS DAY				
91 11 11			DATA MISSING FOR THIS DAY				
91 11 12			DATA MISSING FOR THIS DAY				
91 11 13			DATA MISSING FOR THIS DAY				
91 11 14			DATA MISSING FOR THIS DAY				
91 11 15			DATA MISSING FOR THIS DAY				
91 11 16			DATA MISSING FOR THIS DAY				
91 11 17			DATA MISSING FOR THIS DAY				
91 11 18			DATA MISSING FOR THIS DAY				
91 11 19			DATA MISSING FOR THIS DAY				
91 11 20			DATA MISSING FOR THIS DAY				
91 11 21			DATA MISSING FOR THIS DAY				
91 11 22			DATA MISSING FOR THIS DAY				
91 11 23			DATA MISSING FOR THIS DAY				
91 11 24			DATA MISSING FOR THIS DAY				
91 11 25			DATA MISSING FOR THIS DAY				
91 11 26			DATA MISSING FOR THIS DAY				
91 11 27			DATA MISSING FOR THIS DAY				
91 11 28			DATA MISSING FOR THIS DAY				
91 11 29			DATA MISSING FOR THIS DAY				
91 11 30			DATA MISSING FOR THIS DAY				

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
91 12 1	48.19	0.38	50.51	1.34	2.32	1.06	24
91 12 2	48.04	0.21	51.15	1.23	3.10	1.14	24
91 12 3	46.90	0.57	49.81	1.52	2.90	1.13	24
91 12 4	46.48	0.34	49.12	0.83	2.64	1.05	24
91 12 5	46.27	0.38	48.31	0.60	2.04	0.46	24
91 12 6	45.53	0.93	49.25	1.61	3.72	2.31	24
91 12 7	44.41	0.73	47.41	1.61	3.00	1.85	24
91 12 8	44.99	0.98	49.04	1.16	4.05	1.05	19
91 12 9	45.47	0.35	48.39	1.67	2.92	1.46	21
91 12 10	45.15	0.67	49.70	0.68	4.55	0.48	19
91 12 11	45.16	0.47	48.97	0.42	3.81	0.61	24
91 12 12	45.99	0.46	49.10	1.44	3.11	1.71	24
91 12 13	46.93	0.64	49.46	0.79	2.53	0.39	24
91 12 14	47.35	0.94	51.10	0.49	3.75	1.23	24
91 12 15	46.98	0.25	48.83	0.83	1.85	0.92	24
91 12 16	46.66	0.19	49.49	0.79	2.83	0.95	24
91 12 17	44.12	0.56	48.66	0.95	4.54	0.86	24
91 12 18	42.90	0.58	46.45	0.78	3.56	1.10	24
91 12 19	42.67	0.26	47.33	0.71	4.66	0.80	24
91 12 20	43.19	0.07	46.68	0.42	3.49	0.38	24
91 12 21	43.01	0.10	45.68	0.51	2.67	0.58	24
91 12 22	42.76	0.36	46.22	0.59	3.45	0.61	24
91 12 23	42.23	0.45	44.74	0.82	2.51	0.84	24
91 12 24	42.39	0.26	43.98	0.38	1.59	0.35	24
91 12 25	41.29	0.39	44.66	0.72	3.37	1.02	24
91 12 26	41.23	0.12	44.33	0.93	3.10	0.90	24
91 12 27	41.24	0.36	43.39	0.84	2.15	0.97	24
91 12 28	41.75	0.29	43.91	0.45	2.15	0.48	24
91 12 29	41.84	0.25	44.29	0.66	2.45	0.81	24
91 12 30	41.15	0.11	41.10	0.70	-0.05	0.70	24
91 12 31	40.40	0.31	43.63	1.17	3.23	1.23	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
47.21	0.89	44.26	0.42	2.95	731

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	12	1	48.19	0.38	47.98	0.52	-0.20	0.44	24
91	12	2	48.04	0.21	47.72	0.17	-0.33	0.21	24
91	12	3	46.90	0.57	46.39	0.43	-0.52	0.45	24
91	12	4	46.48	0.34	45.85	0.42	-0.62	0.54	24
91	12	5	46.27	0.38	45.36	1.18	-0.91	1.21	24
91	12	6	45.53	0.93	45.32	0.78	-0.21	1.11	24
91	12	7	44.41	0.73	43.39	0.68	-1.02	0.68	24
91	12	8	44.99	0.98	45.75	1.60	0.76	0.93	19
91	12	9	45.47	0.35	45.17	0.48	-0.31	0.34	21
91	12	10	45.15	0.67	45.87	0.60	0.72	0.46	19
91	12	11	45.16	0.47	45.31	0.34	0.15	0.30	24
91	12	12	45.99	0.46	45.48	0.43	-0.51	0.30	24
91	12	13	46.93	0.64	46.63	0.50	-0.30	0.35	24
91	12	14	47.35	0.94	47.83	1.18	0.48	0.71	24
91	12	15	46.98	0.25	46.26	0.47	-0.72	0.54	24
91	12	16	46.66	0.19	45.93	0.82	-0.73	0.89	24
91	12	17	44.12	0.56	44.07	0.83	-0.05	0.49	24
91	12	18	42.90	0.58	42.38	0.49	-0.52	0.70	24
91	12	19	42.67	0.26	42.20	0.22	-0.47	0.18	24
91	12	20	43.19	0.07	42.25	0.68	-0.94	0.68	24
91	12	21	43.01	0.10	41.87	0.49	-1.14	0.50	24
91	12	22	42.76	0.36	42.38	0.60	-0.39	0.56	24
91	12	23	42.23	0.45	42.22	0.59	-0.01	0.84	24
91	12	24	42.39	0.26	42.19	0.39	-0.20	0.35	24
91	12	25	41.29	0.39	41.12	0.48	-0.17	0.35	24
91	12	26	41.23	0.12	41.31	0.46	0.08	0.52	24
91	12	27	41.24	0.36	40.47	0.44	-0.77	0.43	24
91	12	28	41.75	0.29	40.55	0.65	-1.20	0.55	24
91	12	29	41.84	0.25	41.20	0.29	-0.64	0.37	24
91	12	30	41.15	0.11	40.61	0.23	-0.54	0.30	24
91	12	31	40.40	0.31	39.79	0.42	-0.62	0.38	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
44.26	0.42	43.87	0.58	-0.40	731

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91	12	1	48.74	0.10	48.56	0.35	-0.18	0.41	24
91	12	2	48.71	0.27	48.26	0.20	-0.45	0.17	24
91	12	3	47.42	0.31	46.75	0.48	-0.67	0.34	24
91	12	4	47.12	0.26	46.49	0.24	-0.63	0.32	24
91	12	5	46.55	0.34	46.22	0.66	-0.33	0.57	24
91	12	6	47.08	0.74	46.92	0.21	-0.15	0.77	24
91	12	7	45.29	0.36	45.26	0.96	-0.03	0.84	24
91	12	8	45.81	0.58	46.67	0.50	0.86	0.54	22
91	12	9	46.54	0.30	46.47	0.10	-0.07	0.36	5
91	12	10	45.72	0.08	45.54	0.08	-0.19	0.05	4
91	12	11	46.30	0.49	45.95	0.54	-0.35	0.24	24
91	12	12	47.43	0.22	47.14	0.20	-0.30	0.36	24
91	12	13	47.98	0.18	47.16	0.15	-0.82	0.23	24
91	12	14	48.01	0.20	47.73	0.10	-0.29	0.19	24
91	12	15	47.37	0.10	46.76	0.39	-0.61	0.33	24
91	12	16	46.94	0.21	46.35	0.41	-0.59	0.42	24
91	12	17	45.05	0.61	44.74	0.74	-0.31	0.30	24
91	12	18	43.65	0.61	43.05	0.43	-0.60	0.59	24
91	12	19	43.39	0.51	42.57	0.24	-0.81	0.58	24
91	12	20	43.41	0.08	42.89	0.11	-0.53	0.15	24
91	12	21	43.21	0.08	42.58	0.30	-0.63	0.28	24
91	12	22	43.02	0.37	42.59	0.21	-0.44	0.48	24
91	12	23	42.79	0.14	42.69	0.38	-0.10	0.43	24
91	12	24	42.63	0.30	42.71	0.46	0.08	0.45	24
91	12	25	41.84	0.48	41.33	0.50	-0.50	0.42	24
91	12	26	41.32	0.14	41.07	0.58	-0.25	0.59	24
91	12	27	41.29	0.36	40.26	0.16	-1.02	0.45	24
91	12	28	41.90	0.33	40.31	0.27	-1.59	0.39	24
91	12	29	42.04	0.24	41.04	0.29	-0.99	0.35	24
91	12	30	41.29	0.13	40.76	0.19	-0.53	0.26	24
91	12	31	41.01	0.14	40.48	0.11	-0.53	0.21	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
44.79	0.30	44.34	0.34	-0.46	703

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
91 12 1	DATA MISSING FOR THIS DAY						
91 12 2	DATA MISSING FOR THIS DAY						
91 12 3	DATA MISSING FOR THIS DAY						
91 12 4	DATA MISSING FOR THIS DAY						
91 12 5	DATA MISSING FOR THIS DAY						
91 12 6	DATA MISSING FOR THIS DAY						
91 12 7	DATA MISSING FOR THIS DAY						
91 12 8	DATA MISSING FOR THIS DAY						
91 12 9	DATA MISSING FOR THIS DAY						
91 12 10	DATA MISSING FOR THIS DAY						
91 12 11	DATA MISSING FOR THIS DAY						
91 12 12	DATA MISSING FOR THIS DAY						
91 12 13	DATA MISSING FOR THIS DAY						
91 12 14	DATA MISSING FOR THIS DAY						
91 12 15	DATA MISSING FOR THIS DAY						
91 12 16	DATA MISSING FOR THIS DAY						
91 12 17	DATA MISSING FOR THIS DAY						
91 12 18	DATA MISSING FOR THIS DAY						
91 12 19	DATA MISSING FOR THIS DAY						
91 12 20	DATA MISSING FOR THIS DAY						
91 12 21	DATA MISSING FOR THIS DAY						
91 12 22	DATA MISSING FOR THIS DAY						
91 12 23	DATA MISSING FOR THIS DAY						
91 12 24	DATA MISSING FOR THIS DAY						
91 12 25	DATA MISSING FOR THIS DAY						
91 12 26	DATA MISSING FOR THIS DAY						
91 12 27	DATA MISSING FOR THIS DAY						
91 12 28	DATA MISSING FOR THIS DAY						
91 12 29	DATA MISSING FOR THIS DAY						
91 12 30	DATA MISSING FOR THIS DAY						
91 12 31	DATA MISSING FOR THIS DAY						

The following is a list of 1992 EPA NPDES exceedences. Included are the causes and actions either taken or recommended to help ensure subsequent sample compliance.

DATE	DISCHARGE POINT	EXCEEDENCE	CAUSE	PREVENTIVE MEASURES
01/30	Oil Separator Vault OSV #1 (022)	Ph = 9.2 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize inputs.
02/06	OSV #1 (022)	Ph = 9.1 Limit 6.0 - 9.0	See Above	See Above
02/13	OSV #1 (022)	pH = 9.4 Limit 6.0 - 9.0	See Above	See Above
02/20	OSV #1 (022)	pH = 9.6 Limit 6.0 - 9.0	See Above	See Above
02/26	Settling Basin (002)	pH = 9.6 Limit 6.5 - 8.0	Elevated pH due to algal growth, heavy rains/snow caused basin to overflow	Weir was already raised to highest position to limit flow, unable to batch basin due to winter conditions. Implementation of DCR 90-52 would have helped alleviate this exceedence.
02/27	Settling Basin (002)	pH = 9.0 Limit 6.5 - 8.0 Turbidity = 33 NTU Limit < 25 NTU	See Above (pH) Turbidity due to site run off	See Above
02/27	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize inputs.
02/28	Settling Basin (002)	pH = 9.0 Limit 6.5 - 8.0	Elevated pH due to algal growth, heavy rains/snow caused basin to overflow	Weir was already raised to highest position to limit flow, unable to batch basin due to winter conditions. Implementation of DCR 90-52 would have helped alleviate this exceedence.
02/29	Settling Basin (002)	pH = 9.1 Limit 6.5 - 8.0	See Above	See Above
03/01	Settling Basin (002)	pH = 8.8 Limit 6.5 - 8.0	See Above	See Above
03/02	Settling Basin (002)	pH = 9.0 Limit 6.5 - 8.0	See Above	See Above
03/03	Settling Basin (002)	pH = 9.1 Limit 6.5 - 8.0	See Above	See Above
03/04	Settling Basin (002)	pH = 9.2 Limit 6.5 - 8.0	See Above	See Above
03/05	Settling Basin (002)	pH = 9.1 Limit 6.5 - 8.0	See Above	See Above
03/05	OSV #1 (022)	pH = 9.7 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize inputs.

DATE	DISCHARGE POINT	EXCEEDENCE	CAUSE	PREVENTIVE MEASURES
03/06	Settling Basin (002)	pH = 9.7 Limit 6.5 - 8.0	Elevated pH due to algal growth, heavy rains/snow caused basin to overflow	Weir was already raised to highest position to limit flow, unable to batch basin due to winter conditions. Implementation of DCR 90-52 would have helped alleviate this exceedence.
03/07	Settling Basin (002)	pH = 9.5 Limit 6.5 - 8.0	See Above	See Above
03/08	Settling Basin (002)	pH = 9.5 Limit 6.5 - 8.0	See Above	See Above
03/09	Settling Basin (002)	pH = 9.2 Limit 6.5 - 8.0	See Above	See Above
03/10	Settling Basin (002)	pH = 9.3 Limit 6.5 - 8.0	See Above	See Above
03/11	Settling Basin (002)	pH = 8.6 Limit 6.5 - 8.0	See Above	See Above
03/12	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize inputs.
03/19	OSV #1 (022)	pH = 9.5 Limit 6.0 - 9.0	See Above	See Above
03/23	Settling Basin (002)	pH = 9.3 Limit 6.5 - 8.0	Elevated pH due to algal growth, heavy rains/snow caused basin to overflow	Weir was already raised to highest position to limit flow, unable to batch basin due to winter conditions. Implementation of DCR 90-52 would have helped alleviate this exceedence.
03/24	Settling Basin (002)	pH = 9.3 Limit 6.5 - 8.0	See Above	See Above
03/24	Sewage Treatment Plant (021)	Chlorine = 7.2 ppm Limit $\leq$ 5.0 ppm	Chlorine analyzer bypass valve was found open causing a no flow/low chlorine read condition	Suspect the bypass valve was inadvertently bumped open. Valve was isolated and then later repositioned to preclude "bumping" again.
03/25	Settling Basin (002)	pH = 9.3 Limit 6.5 - 8.0	Elevated pH due to algal growth, heavy rains/snow caused basin to overflow	Weir was already raised to highest position to limit flow, unable to batch basin due to winter conditions. Implementation of DCR 90-52 would have helped alleviate this exceedence.
03/26	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize inputs.
03/26	Settling Basin (002)	pH = 9.3 Limit 6.5 - 8.0	Elevated pH due to algal growth, heavy rains/snow caused basin to overflow	Weir was already raised to highest position to limit flow, unable to batch basin due to winter conditions. Implementation of DCR 90-52 would have helped alleviate this exceedence.

DATE	DISCHARGE POINT	EXCEEDENCE	CAUSE	PREVENTIVE MEASURES
03/27	Settling Basin (002)	pH = 9.1 Limit 6.5 - 8.0	See Above	See Above
03/28	Settling Basin (002)	pH = 9.0 Limit 6.5 - 8.0	See Above	See Above
03/29	Settling Basin (002)	pH = 8.9 Limit 6.5 - 8.0	See Above	See Above
03/30	Settling Basin (002)	pH = 9.0 Limit 6.5 - 8.0	See Above	See Above
03/31	Settling Basin (002)	pH = 8.9 Limit 6.5 - 8.0	See Above	See Above
04/01	Settling Basin (002)	pH = 9.2 Limit 6.5 - 8.0	See above	See Above
04/02	Settling Basin (002)	pH = 9.2 Limit 6.5 - 8.0	See Above	See Above
04/02	OSV #1 (022)	pH = 9.9 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize inputs.
04/03	Settling Basin (002)	pH = 8.8 Limit 6.5 - 8.0	Elevated pH due to algal growth, heavy rains/snow caused basin to overflow	Weir was already raised to highest position to limit flow, unable to batch basin due to pump problems. Implementation of DCR 90-52 would have helped alleviate this exceedence.
04/04	Settling Basin (002)	pH = 8.9 Limit 6.5 - 8.0	See Above	See Above
04/05	Settling Basin (002)	pH = 8.9 Limit 6.5 - 8.0	See Above	See Above
04/06	Settling Basin (002)	pH = 9.0 Limit 6.5 - 8.0	See Above	See Above
04/07	Settling Basin (002)	pH = 9.1 Limit 6.5 - 8.0	See Above	See Above
04/08	Settling Basin (002)	pH = 9.4 Limit 6.5 - 8.0	See Above	Settling Basin weir was raised to its highest position to limit flow. Batching operations in progress to isolate flow over weir.
04/09	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize inputs.
04/16	OSV #1 (022)	pH = 9.7 Limit 6.0 - 9.0	See Above	See Above
04/23	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	See Above	See Above
04/30	OSV #1 (022)	pH = 9.7 Limit 6.0 - 9.0	See Above	See Above

DATE	DISCHARGE POINT	EXCEEDENCE	CAUSE	PREVENTIVE MEASURES
05/07	OSV #1 (022)	pH = 9.6 Limit 6.0 - 9.0	See Above	See Above
05/14	OSV #1 (022)	pH = 9.3 Limit 6.0 - 9.0	See Above	See Above
05/21	OSV #1 (022)	pH = 9.4 Limit 6.0 - 9.0	See Above	See Above
05/28	OSV #1 (022)	pH = 9.5 Limit 6.0 - 9.0	See Above	See Above
06/04	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	See Above	See Above
06/11	OSV #1 (022)	pH = 10.0 Limit 6.0 - 9.0	See Above	See Above
06/18	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	See Above	See Above
06/25	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	See Above	See Above
07/02	OSV #1 (022)	pH = 9.9 Limit 6.0 - 9.0	See Above	See Above
07/16	OSV #1 (022)	pH = 9.9 Limit 6.0 - 9.0	See Above	See Above
07/23	OSV #1 (022)	pH = 9.9 Limit 6.0 - 9.0	See Above	See Above
07/30	OSV #1 (022)	pH = 10.0 Limit 6.0 - 9.0	See Above	See Above
08/05	Sewage Treatment Plant	BOD = 46 ppm Limit ≤ 45 ppm	Plant was operating with only one lagoon in service due to maintenance on the other lagoon. This reduced plant efficiency.	RES 92-390 was submitted to scope a new aeration system for STP lagoons. The current system suffers frequent failures. This RES has been placed on HOLD temporarily to determine the cost effectiveness of Station operation of the STP vs. tying into the Town of Seabrook line.
08/06	OSV #1 (022)	pH = 9.9 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit nenewal is addressing this parameter. Unable to neutralize inputs.
08/13	OSV #1 (022)	pH = 10.0 Limit 6.0 - 9.0	See Above	See Above
08/20	OSV #1 (022)	pH = 10.0 Limit 6.0 - 9.0	See Above	See Above
08/27	OSV #1 (022)	pH = 10.0 Limit 6.0 - 9.0	See Above	See Above
09/03	OSV #1 (022)	pH = 10.0 Limit 6.0 - 9.0	See Above	See Above

DATE	DISCHARGE POINT	EXCEEDENCE	CAUSE	PREVENTIVE MEASURES
09/16	Sewage Treatment Plant	BOD = 47 ppm Limit ≤ 45 ppm	Unknown, suspect seasonal turnover of lagoons - a natural phenomenon	All STP operations were within specification, preventive measures not applicable.
09/24	OSV #3	pH = 5.6 Limit 6.0 - 9.0	A tanker with stagnant, air saturated potable water was discharged into the vault: This was pH depressed water.	All future discharges of this nature will be sampled for compliance prior to placing in the effluent stream. Non-compliance sources will be neutralized for permit compliance.
10/29	OSV #1 (022)	pH = 10.0 Limit 6.0 - 9.0	Secondary Plant Leakage	NPDES permit renewal is addressing this parameter. Unable to neutralize the inputs.
12/01	OSV #1 (022)	pH = 9.8 Limit 6.0 - 9.0	See Above	See Above
12/02	OSV #1 (022)	pH = 10.2 Limit 6.0 - 9.0	See Above	See Above
12/09	OSV #1 (022)	pH = 10.2 Limit 6.0 - 9.0	See Above	See Above
12/22	OSV #1 (022)	pH = 9.6 Limit 6.0 - 9.0	See Above	See Above
12/30	OSV #1 (022)	pH = 9.9 Limit 6.0 - 9.0	See Above	See Above

ATTACHMENT 5

North Atlantic
Energy Service Corporation

P.O. Box 300
Seabrook, NH 03874
Telephone (603) 474-9521

NYE-93006

March 19, 1993

Mr. Edward K. McSweeney, Chief
Wastewater Management Branch
United States Environmental Protection Agency
John F. Kennedy Building
Boston, Massachusetts 02203

References: (a) Seabrook Station NPDES Permit No. NH0020338

(b) North Atlantic letter NYE-93002 dated January 20, 1993, "Ocean Temperature Compliance Program Modification," R. J. DeLoach to T. E. Landry

Subject: 1992 Ocean Temperature Compliance Report

Dear Mr. McSweeney:

Enclosed is a report summarizing ocean temperature data acquired during the period of January 1, 1992 to December 31, 1992. This report is submitted to demonstrate compliance with the thermal component of the station discharge as required by Part I A.1.n(2) of the NPDES permit. Compliance is demonstrated using the methodology described in our March 7, 1986 letter, and approved by the EPA on May 22, 1986.

North Atlantic previously requested a modification to the ocean temperature compliance program on January 20, 1993 [Reference (b)]. The proposed program modification involved a reduction in the number of ocean temperature monitoring stations from the current three stations to two stations. North Atlantic renews its January 20, 1993 request to modify the ocean temperature compliance program and would greatly appreciate a response from the EPA on this matter in the near future.

Should you have any questions regarding the enclosed report, please contact Mr. James M. Peschel, Regulatory Compliance Manager, at (603) 474-9521, extension 3772.

Very truly yours,

R. J. DeLoach
R. J. DeLoach
Executive Director -
Engineering and Licensing

RJD:ALL/act

Enclosure

cc: Mr. Ted C. Feigenbaum
Senior Vice President and
Chief Nuclear Officer
North Atlantic Energy Service Corporation
P.O. Box 300
Seabrook, NH 03874

Mr. T. E. Landry
Permit Compliance Section
Environment Protection Agency
John F. Kennedy Building
Boston, MA 02203

Mr. Jeffrey G. Andrews, Supervisor
Industrial Permits Section
Department of Environmental Services
Water Supply and Pollution Control Division
State of New Hampshire
6 Hazen Drive, P.O. Box 95
Concord, NH 03301

North Atlantic
March 19, 1993

ENCLOSURE TO NYE-93006
1992 OCEAN TEMPERATURE COMPLIANCE REPORT

SEABROOK STATION NPDES

1992 OCEAN TEMPERATURE COMPLIANCE REPORT

1.0 INTRODUCTION

1.1 Purpose

This report presents ocean temperature data that demonstrates federal/state discharge permit compliance in the receiving waters from the thermal component of the Seabrook Station Circulating Cooling Water System.

1.2 Background

Seabrook Station is a single-unit, 1,150 megawatt nuclear generating facility located in the New Hampshire coastal town of Seabrook. The heat dissipation system for the station is a once-through, ocean intake and submerged diffuser discharge design. Cooling water is taken from and returned to the waters of the Atlantic Ocean via 19-foot diameter intake and discharge tunnels that extend about 7,000 and 5,500 feet offshore, respectively.

The National Pollutant Discharge Elimination System (NPDES) permit sets thermal discharge limits during station operation [1]. Specifically, the thermal component of the discharge shall not increase the temperature of the receiving waters by more than 5°F, except in the near-field jet-mixing region where the 5°F limit applies only at the surface.

Other than the jet-mixing region, defined to be water within 300 feet of the submerged diffuser in the direction of discharge, no further detail is given to a definition of receiving waters. Also, no specifics are given regarding the location of measurement stations.

The permit, however, is very clear in that the limits apply only to temperature rises caused by the addition of heat to the receiving waters. This temperature difference, or delta-t, is the key to demonstrate permit compliance.

1.3 Compliance Demonstration

The analysis of a two-year baseline study of the thermal field around the discharge area prior to station operation showed permit compliance can effectively be defined by using the monthly mean of three thermal monitoring stations [2]. The stations include areas both inside and outside the jet-mixing region as well as a reference point. Stations DS, ID, and T7 on Figure 1.1, respectively, correspond to these areas. Table 1.1 lists the location of each station and the various monitoring depths.

The U.S. Environmental Protection Agency and New Hampshire Department of Environmental Services, Water Supply and Pollution Control Division concurred that compliance is demonstrated if the delta-t value between reference Station T7 and those at DS and ID is 5°F or less for the monthly mean [3, 4].

TABLE 1.1

Seabrook Temperature Monitoring Information

Station	Water Depth (Ft, MLW)	Location	Designation	Sensor Depth (Ft, MLW)
T7	55	42°55'15"N 70°46'46"W	T7UP T7MD T7LO	-2, Surface Following -28, Surface Following -53, MLW
ID	57	42°54'00"N 70°47'15"W	IDUP IDMD IDLO	-2, Surface Following -28, Surface Following -53, MLW
DS	54	42°53'41"N 70°47'12"W	DSUP	-2, Surface Following

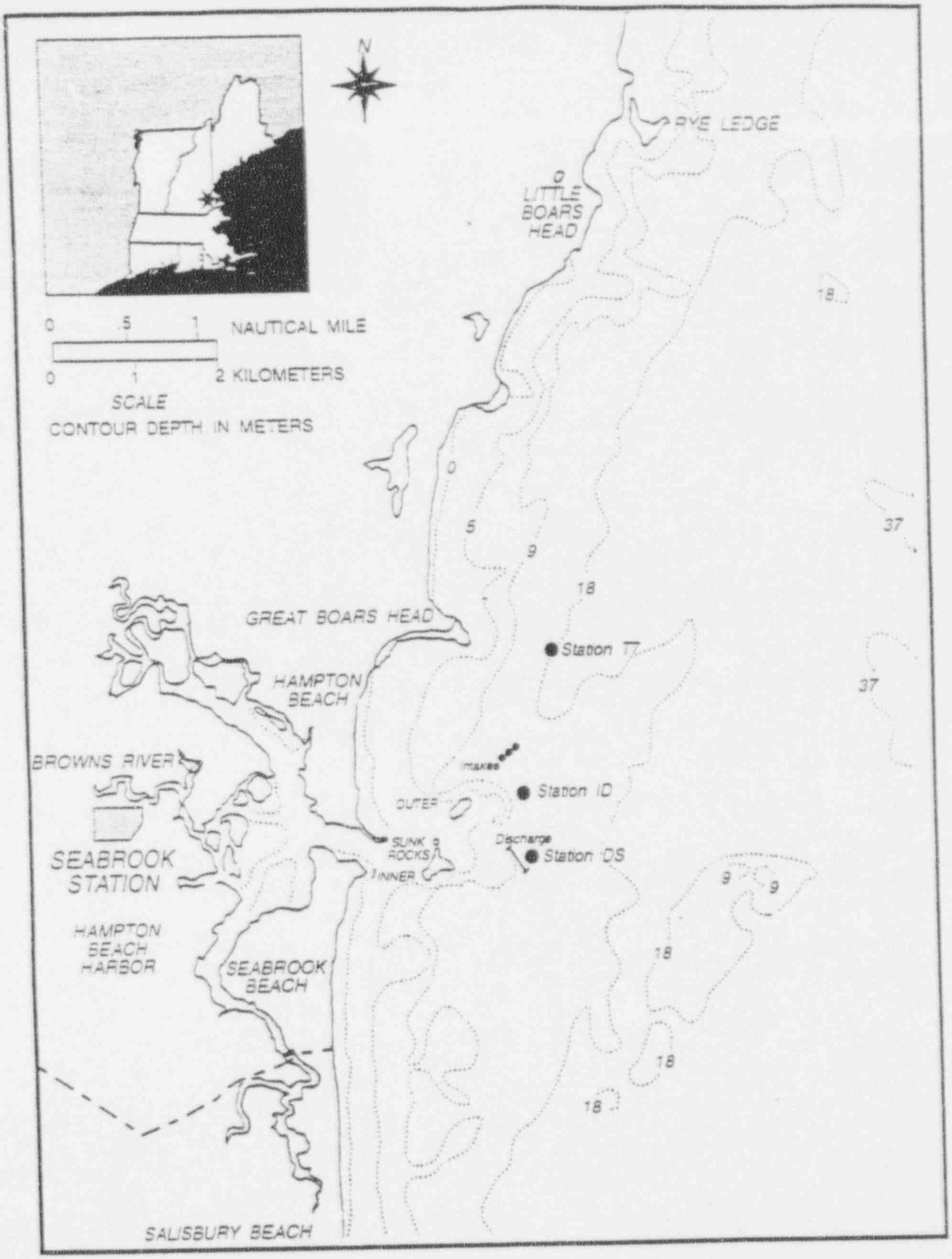


Figure 1.1

E:\CDDATA\CD13\SEABMAP.CDR

2.0 RESULTS

2.1 Station and Instrument Operation

Seabrook Station received its operating license in March 1990, with full-power operation starting in August 1990. Power operation during 1992 continued through the year until early September, when a scheduled two-month outage took place. Power operation restarted in November and continued through the end of 1992.

The average monthly percent of station operation, which accounts for short-term power outages, is listed in Table 2.1 and shown on Figures 2.1 and 2.2.

Ocean temperature data were obtained from sensors at the three monitoring stations via satellite telemetry during each month of station operation. Data recovery during this period is listed in Table 2.1. The average was about 85%. Missing data resulted from instrument malfunction and are identified on the monthly data summary tables located in the appendix.

2.2 Delta-t Values

Table 2.2 summarizes the monthly mean of ocean temperature values between reference Station T7 and Monitoring Stations DS and ID. Positive delta-t values mean the monitoring station is warmer than the reference; negative values mean it is colder. Figure 2.1 illustrates the T7-DS delta-t values and Figure 2.2, the T7-ID delta-t values.

As shown, the delta-t values for all monitoring stations for each month during 1992 are less than 5°F. Consequently, permit compliance is demonstrated.

The largest delta-t values, as expected, occurred at Station DS, located in the thermal discharge jet-mixing region. These values varied depending on both station power level and the season (Figure 2.1). The maximum monthly delta-t, 3.27°F, was for February. This is a result of 100% station power during isothermal ocean conditions. The minimum monthly delta-t, -0.62, at Station DS was for July. This is a result of thermally stratified ocean conditions. The large volume of cold bottom water entrained by the discharge plume significantly reduces the discharge plume's temperature so that at the surface this mixed volume's temperature is actually less than the reference station.

Outside the jet-mixing region, at Station ID, there is considerably less delta-t variation (Figure 2.2). The values generally are confined to between $\pm 1°F$ and are not influenced by either station power level or the season. This feature is the same at each measurement depth (surface, mid, or bottom).

The appendix contains a complete tabular listing for each temperature monitoring station.

TABLE 2.1

1992 Station Power Level and Ocean Temperature

Data Availability

Month	Station Power Level (%)	Temperature Data Available (%)		
		T7	ID	DS
JAN	100.0	60.7	100.0	100.0
FEB	100.0	75.3	90.5	100.0
MAR	100.0	61.1	61.1	88.3
APR	100.0	66.7	66.1	36.6
MAY	100.0	85.7	85.6	57.4
JUN	100.0	100.0	100.0	100.0
JUL	100.0	100.0	100.0	96.2
AUG	99.7	100.0	98.9	98.0
SEP	79.3*	66.1**	100.0**	99.1**
OCT	0*	0**	0**	0**
NOV	63.3*	66.5**	100.0**	98.9**
DEC	82.9	64.7	99.9	98.2

* Scheduled Outage (9/7/92 - 11/14/92)
** Annual Maintenance and Recalibration (9/15/92 - 11/11/92)

TABLE 2.2

Monthly Ocean Temperature* Summary, 1992

	DSUP-T7UP			IDUP-T7UP			IDMD-T7MD			IDLO-T7LO		
Month	DS	T7	ΔT	ID	T7	ΔT	ID	T7	ΔT	ID	T7	ΔT
JAN	42.84	39.78	3.06	39.34	39.78	-0.44	39.99	40.46	-0.47	39.48	39.81	-0.33
FEB	40.54	37.26	3.27	37.05	37.11	-0.06	37.40	**	-	37.36	37.51	-0.16
MAR	40.90	37.68	3.22	**	37.71	-	37.41	**	-	37.57	37.61	-0.04
APR	42.67	39.66	3.02	**	40.97	-	40.34	**	-	39.72	39.66	0.06
MAY	50.94	50.58	0.36	49.19	50.60	-1.41	46.61	46.64	-0.03	43.15	42.96	0.20
JUN	53.49	53.31	0.18	52.81	53.31	-0.49	49.34	49.63	-0.29	46.47	46.33	0.14
JUL	56.86	57.48	-0.62	57.63	57.57	0.06	51.68	52.35	-0.67	47.57	47.31	0.26
AUG	60.09	58.45	1.63	**	53.06	-	53.77	54.31	-0.54	50.14	49.58	0.56
SEP	57.25	54.84	2.41	53.97	54.97	-1.01	51.97	52.52	-0.55	49.63	49.43	0.20
OCT	***	***	-	***	***	-	***	***	-	***	***	-
NOV	48.21	45.67	2.54	45.37	45.70	-0.34	45.74	45.82	-0.09	47.52	47.89	-0.37
DEC	45.17	42.10	3.06	41.47	42.09	-0.62	41.97	42.50	-0.54	42.37	**	-

* Temperature in degrees Fahrenheit.
** Data missing, instrument malfunction.
*** Annual maintenance and recalibration.

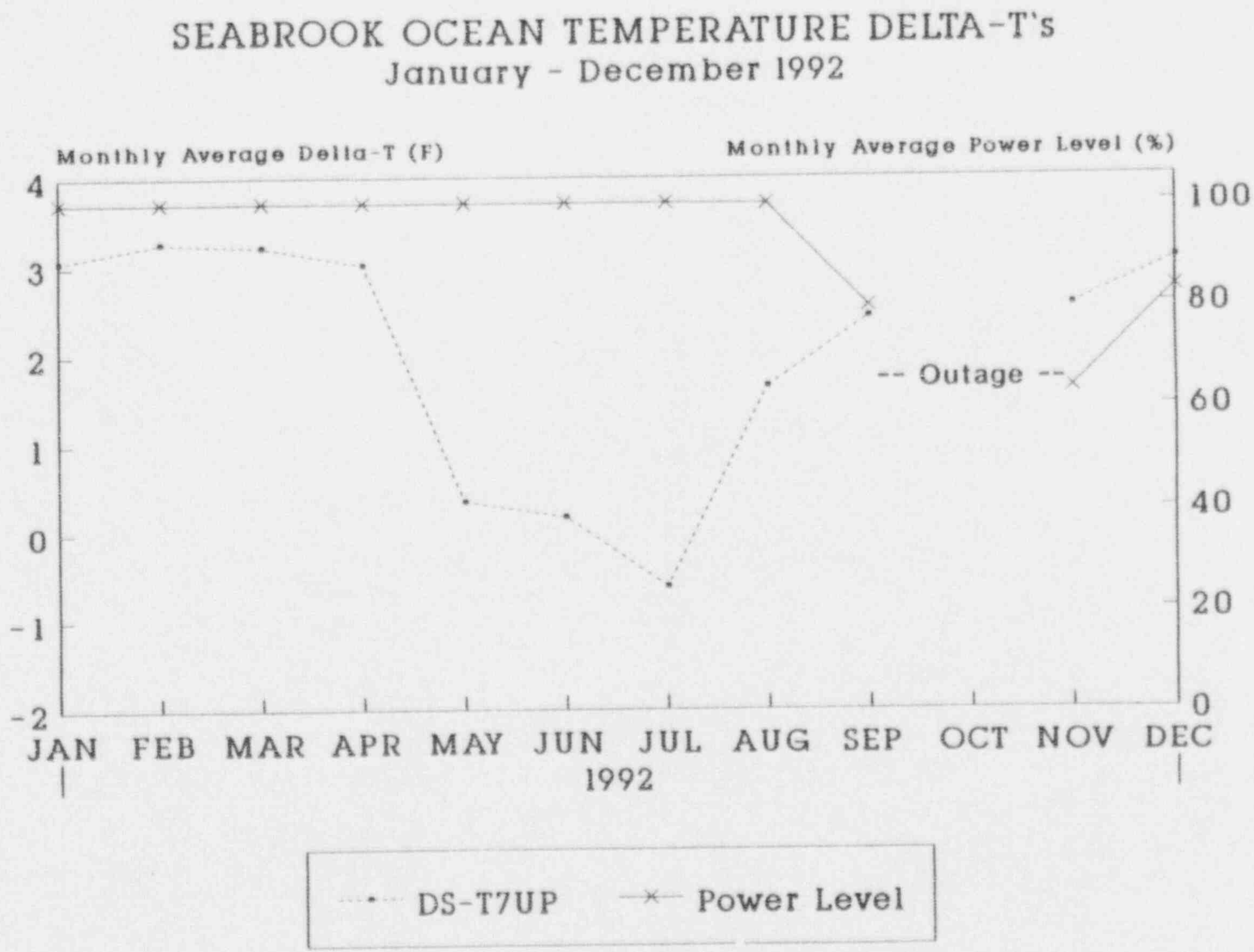

SEABROOK OCEAN TEMPERATURE DELTA-T's
January - December 1992
Monthly Average Delta-T (F)
Monthly Average Power Level (%)
4
3
2
1
0
-1
-2
100
80
60
40
20
0
-- Outage --
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1992
DS-T7UP
Power Level

Figure 2.1

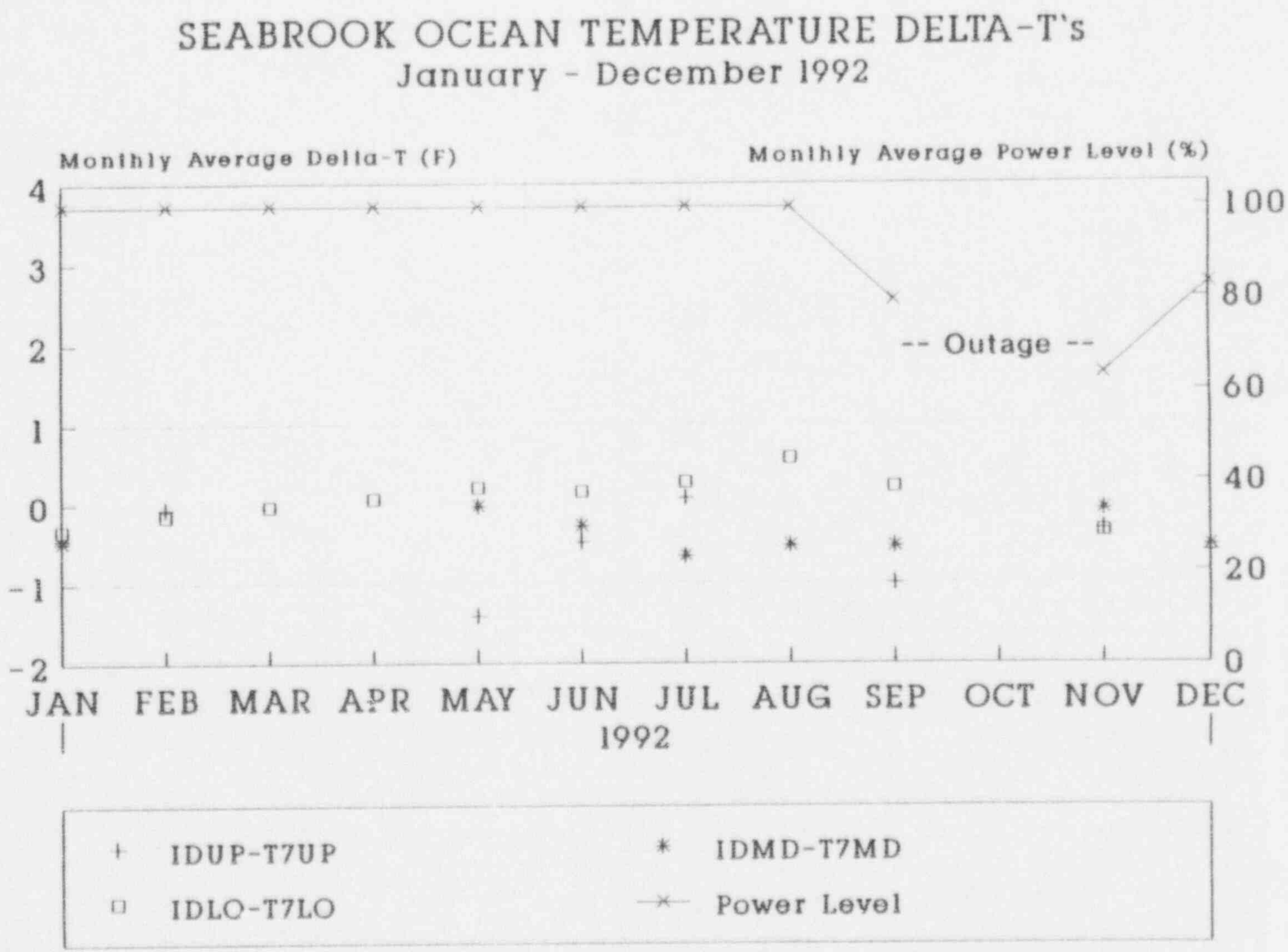

SEABROOK OCEAN TEMPERATURE DELTA-T's
January - December 1992
Monthly Average Delta-T (F)
Monthly Average Power Level (%)
4
3
2
1
0
-1
-2
100
80
60
40
20
0
-- Outage --
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1992
IDUP-T7UP
IDMD-T7MD
IDLO-T7LO
Power Level

Figure 2.2

3.0 CONCLUSIONS

Based on the results presented in this 1992 report, and previously in 1990 and 1991 [5, 6, 7], the following conclusions can be made:

1. The delta-t values for all monitoring stations for each month during 1992 are less than 5°F. Permit compliance, therefore, is demonstrated.

2. The largest delta-t values occur inside the thermal discharge jet-mixing region.

3. The delta-t values in the jet-mixing region vary with station power level and season. The maximum delta-t value occurs at 100% station power in the winter months during isothermal ocean conditions. The minimum delta-t value occurs in the summer months during strong thermally stratified ocean conditions.

4. The delta-t values outside the jet-mixing region do not vary significantly, regardless of station power level or the season. This occurs throughout the water column and indicates that there is little or no influence by the thermal discharge plume.

4.0 REFERENCES

1. NPDES Permit No. NH0020338, dated July 26, 1985.

2. "Seabrook Station Thermal Criteria Evaluation," YAEC-1529, Yankee Atomic Electric Company, March 1986.

3. Letter, Public Service Company of New Hampshire SB-20524 to U.S. Environmental Protection Agency, dated March 7, 1986.

4. Letter, U.S. Environmental Protection Agency to Public Service Company of New Hampshire, dated May 22, 1986.

5. Letter, New Hampshire Yankee NYE-91011 to U. S. Environmental Protection Agency, dated April 26, 1991.

6. Letter, New Hampshire Yankee NYE-92003 to U. S. Environmental Protection Agency, dated January 21, 1992.

7. Letter, New Hampshire Yankee NYE-92009 to U.S. Environmental Portection Agency, dated March 12, 1992.

APPENDIX

Summary of Monthly Ocean Temperature Data

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92	1	1	40.10	0.42	44.12	0.28	4.02	0.53	24
92	1	2	39.27	0.44	43.31	1.47	4.04	1.47	24
92	1	3	40.10	0.35	44.09	1.63	3.99	1.83	24
92	1	4	40.65	0.15	40.35	0.14	-0.30	0.09	24
92	1	5	40.67	0.12	42.10	2.16	1.44	2.06	24
92	1	6	40.71	0.06	44.82	0.48	4.11	0.51	24
92	1	7	40.93	0.22	44.54	0.84	3.61	0.67	24
92	1	8	41.12	0.04	44.82	0.45	3.70	0.47	24
92	1	9	40.66	0.27	44.18	0.41	3.53	0.36	24
92	1	10	40.46	0.22	43.91	0.56	3.44	0.45	24
92	1	11	40.88	0.10	44.05	0.38	3.17	0.42	24
92	1	12	40.01	0.27	42.61	0.88	2.60	0.94	24
92	1	13	39.58	0.83	42.19	0.41	2.61	0.74	24
92	1	14	39.90	0.30	42.34	1.03	2.44	1.06	24
92	1	15	40.14	0.19	42.27	0.64	2.13	0.71	24
92	1	16	40.41	0.32	43.89	0.56	3.48	0.66	24
92	1	17	39.81	0.95	42.31	1.25	2.51	0.75	24
92	1	18	39.01	0.72	42.33	1.13	3.32	0.91	24
92	1	19	39.21	0.71	40.96	0.83	1.75	0.89	24
92	1	20	38.82	0.99	42.46	1.35	3.63	1.25	24
92	1	21	39.82	0.23	41.03	0.95	1.20	1.09	9
92	1	22			DATA MISSING FOR THIS DAY				
92	1	23			DATA MISSING FOR THIS DAY				
92	1	24			DATA MISSING FOR THIS DAY				
92	1	25	41.06	0.10	44.33	0.57	3.27	0.53	14
92	1	26	39.74	1.37	42.33	2.31	2.58	1.20	24
92	1	27	37.37	0.21	41.76	2.54	4.39	2.64	24
92	1	28	38.02	0.40	40.03	2.38	2.01	2.68	24
92	1	29	37.92	0.48	42.41	0.53	4.49	0.59	24
92	1	30	38.78	0.38	42.11	0.57	3.33	0.82	24
92	1	31	39.34	0.17	43.33	0.58	3.99	0.55	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
42.84	0.98	39.78	0.39	3.06	647

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	1	1	40.79	0.40	40.24	0.29	-0.54	0.29	24
92	1	2	40.90	0.65	40.26	0.57	-0.64	0.40	24
92	1	3	40.95	0.41	40.54	0.55	-0.41	0.22	24
92	1	4	40.78	0.14	40.28	0.20	-0.50	0.16	24
92	1	5	40.84	0.09	40.42	0.12	-0.42	0.08	24
92	1	6	40.87	0.06	40.60	0.13	-0.27	0.11	24
92	1	7	41.25	0.12	41.01	0.18	-0.23	0.26	24
92	1	8	41.26	0.06	40.81	0.04	-0.45	0.06	24
92	1	9	40.84	0.20	40.17	0.30	-0.67	0.26	24
92	1	10	41.07	0.26	40.33	0.21	-0.74	0.39	24
92	1	11	41.00	0.10	40.18	0.18	-0.82	0.21	24
92	1	12	40.21	0.21	39.44	0.51	-0.77	0.53	24
92	1	13	39.84	0.77	38.79	0.25	-1.05	0.85	24
92	1	14	39.68	0.23	39.96	0.63	0.28	0.57	24
92	1	15	40.46	0.34	39.81	0.25	-0.65	0.49	24
92	1	16	41.39	0.26	39.90	0.22	-1.49	0.37	17
92	1	17	40.47	0.94	39.65	0.37	-0.83	0.83	18
92	1	18	DATA MISSING FOR THIS DAY						
92	1	19	DATA MISSING FOR THIS DAY						
92	1	20	DATA MISSING FOR THIS DAY						
92	1	21	DATA MISSING FOR THIS DAY						
92	1	22	DATA MISSING FOR THIS DAY						
92	1	23	DATA MISSING FOR THIS DAY						
92	1	24	DATA MISSING FOR THIS DAY						
92	1	25	41.27	0.11	40.52	0.20	-0.74	0.21	14
92	1	26	40.59	0.73	40.23	0.52	-0.36	0.51	24
92	1	27	39.32	0.20	39.24	0.30	-0.09	0.18	24
92	1	28	38.76	0.50	38.50	0.60	-0.26	0.33	24
92	1	29	39.44	0.29	39.23	0.41	-0.21	0.25	24
92	1	30	39.88	0.21	39.85	0.09	-0.03	0.21	24
92	1	31	39.80	0.18	39.95	0.10	0.15	0.15	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
40.46	0.31	39.99	0.30	-0.47	553

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92 1 1	40.10	0.42	44.12	0.28	4.02	0.53	24
92 1 2	39.27	0.44	43.31	1.47	4.04	1.47	24
92 1 3	40.10	0.35	44.09	1.63	3.99	1.83	24
92 1 4	40.65	0.15	40.35	0.14	-0.30	0.09	24
92 1 5	40.67	0.12	42.10	2.16	1.44	2.06	24
92 1 6	40.71	0.06	44.82	0.48	4.11	0.51	24
92 1 7	40.93	0.22	44.54	0.84	3.61	0.67	24
92 1 8	41.12	0.04	44.82	0.45	3.70	0.47	24
92 1 9	40.66	0.27	44.18	0.41	3.53	0.36	24
92 1 10	40.46	0.22	43.91	0.56	3.44	0.45	24
92 1 11	40.88	0.10	44.05	0.38	3.17	0.42	24
92 1 12	40.01	0.27	42.61	0.88	2.60	0.94	24
92 1 13	39.58	0.83	42.19	0.41	2.61	0.74	24
92 1 14	39.90	0.30	42.34	1.03	2.44	1.06	24
92 1 15	40.14	0.19	42.27	0.64	2.13	0.71	24
92 1 16	40.41	0.32	43.89	0.56	3.48	0.66	24
92 1 17	39.81	0.95	42.31	1.25	2.51	0.75	24
92 1 18	39.01	0.72	42.33	1.13	3.32	0.91	24
92 1 19	39.21	0.71	40.96	0.83	1.75	0.89	24
92 1 20	38.82	0.99	42.46	1.35	3.63	1.25	24
92 1 21	39.82	0.23	41.03	0.95	1.20	1.09	9
92 1 22	DATA MISSING FOR THIS DAY						
92 1 23	DATA MISSING FOR THIS DAY						
92 1 24	DATA MISSING FOR THIS DAY						
92 1 25	41.06	0.10	44.33	0.57	3.27	0.53	14
92 1 26	39.74	1.37	42.33	2.31	2.58	1.20	24
92 1 27	37.37	0.21	41.76	2.54	4.39	2.64	24
92 1 28	38.02	0.40	40.03	2.38	2.01	2.68	24
92 1 29	37.92	0.48	42.41	0.53	4.49	0.59	24
92 1 30	38.78	0.38	42.11	0.57	3.33	0.82	24
92 1 31	39.34	0.17	43.33	0.58	3.99	0.55	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
42.84	0.98	39.78	0.39	3.06	647

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	1	1	40.10	0.42	39.78	1.00	-0.32	1.28	24
92	1	2	39.27	0.44	38.95	0.35	-0.32	0.43	24
92	1	3	40.10	0.35	39.35	0.51	-0.75	0.21	24
92	1	4	40.65	0.15	40.15	0.14	-0.50	0.14	24
92	1	5	40.67	0.12	40.14	0.15	-0.53	0.09	24
92	1	6	40.71	0.06	40.35	0.29	-0.36	0.29	24
92	1	7	40.93	0.22	40.58	0.25	-0.35	0.26	24
92	1	8	41.12	0.04	40.63	0.12	-0.49	0.12	24
92	1	9	40.66	0.27	40.37	0.60	-0.29	0.64	24
92	1	10	40.46	0.22	39.93	0.21	-0.54	0.20	24
92	1	11	40.88	0.10	40.03	0.20	-0.85	0.23	24
92	1	12	40.01	0.27	39.70	0.70	-0.31	0.77	24
92	1	13	39.58	0.83	39.51	0.55	-0.07	0.98	24
92	1	14	39.90	0.30	40.16	0.69	0.27	0.83	24
92	1	15	40.14	0.19	39.57	0.19	-0.57	0.31	24
92	1	16	40.41	0.32	39.69	0.24	-0.71	0.17	24
92	1	17	39.81	0.95	38.55	1.51	-1.26	1.53	24
92	1	18	39.01	0.72	38.17	0.90	-0.83	1.06	24
92	1	19	39.21	0.71	37.46	0.90	-1.75	0.66	24
92	1	20	38.82	0.99	39.48	1.37	0.65	1.25	24
92	1	21	39.82	0.23	39.97	0.33	0.15	0.40	9
92	1	22	DATA MISSING FOR THIS DAY						
92	1	23	DATA MISSING FOR THIS DAY						
92	1	24	DATA MISSING FOR THIS DAY						
92	1	25	41.06	0.10	40.39	0.26	-0.67	0.32	14
92	1	26	39.74	1.37	39.52	0.95	-0.22	0.86	24
92	1	27	37.37	0.21	37.34	0.26	-0.03	0.11	24
92	1	28	38.02	0.40	37.69	0.41	-0.33	0.41	24
92	1	29	37.92	0.48	37.49	0.39	-0.43	0.38	24
92	1	30	38.78	0.38	38.35	0.76	-0.43	0.55	24
92	1	31	39.34	0.17	39.03	0.27	-0.32	0.31	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
39.78	0.39	39.34	0.52	-0.44	647

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	1	1	40.79	0.40	40.24	0.29	-0.54	0.29	24
92	1	2	40.90	0.65	40.26	0.57	-0.64	0.40	24
92	1	3	40.95	0.41	40.54	0.55	-0.41	0.22	24
92	1	4	40.78	0.14	40.28	0.20	-0.50	0.16	24
92	1	5	40.84	0.09	40.42	0.12	-0.42	0.08	24
92	1	6	40.87	0.06	40.60	0.13	-0.27	0.11	24
92	1	7	41.25	0.12	41.01	0.18	-0.23	0.26	24
92	1	8	41.26	0.06	40.81	0.04	-0.45	0.06	24
92	1	9	40.84	0.20	40.17	0.30	-0.67	0.26	24
92	1	10	41.07	0.26	40.33	0.21	-0.74	0.39	24
92	1	11	41.00	0.10	40.18	0.18	-0.82	0.21	24
92	1	12	40.21	0.21	39.44	0.51	-0.77	0.53	24
92	1	13	39.84	0.77	38.79	0.25	-1.05	0.85	24
92	1	14	39.68	0.23	39.96	0.63	0.28	0.57	24
92	1	15	40.46	0.34	39.81	0.25	-0.65	0.49	24
92	1	16	41.39	0.26	39.90	0.22	-1.49	0.37	17
92	1	17	40.47	0.94	39.65	0.37	-0.83	0.83	18
92	1	18	DATA MISSING FOR THIS DAY						
92	1	19	DATA MISSING FOR THIS DAY						
92	1	20	DATA MISSING FOR THIS DAY						
92	1	21	DATA MISSING FOR THIS DAY						
92	1	22	DATA MISSING FOR THIS DAY						
92	1	23	DATA MISSING FOR THIS DAY						
92	1	24	DATA MISSING FOR THIS DAY						
92	1	25	41.27	0.11	40.52	0.20	-0.74	0.21	14
92	1	26	40.59	0.73	40.23	0.52	-0.36	0.51	24
92	1	27	39.32	0.20	39.24	0.30	-0.09	0.18	24
92	1	28	38.76	0.50	38.50	0.60	-0.26	0.33	24
92	1	29	39.44	0.29	39.23	0.41	-0.21	0.25	24
92	1	30	39.88	0.21	39.85	0.09	-0.03	0.21	24
92	1	31	39.80	0.18	39.95	0.10	0.15	0.15	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
40.46	0.31	39.99	0.30	-0.47	553

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92 1 1	DATA MISSING FOR THIS DAY						
92 1 2	DATA MISSING FOR THIS DAY						
92 1 3	DATA MISSING FOR THIS DAY						
92 1 4	DATA MISSING FOR THIS DAY						
92 1 5	DATA MISSING FOR THIS DAY						
92 1 6	DATA MISSING FOR THIS DAY						
92 1 7	DATA MISSING FOR THIS DAY						
92 1 8	DATA MISSING FOR THIS DAY						
92 1 9	DATA MISSING FOR THIS DAY						
92 1 10	DATA MISSING FOR THIS DAY						
92 1 11	DATA MISSING FOR THIS DAY						
92 1 12	DATA MISSING FOR THIS DAY						
92 1 13	DATA MISSING FOR THIS DAY						
92 1 14	DATA MISSING FOR THIS DAY						
92 1 15	DATA MISSING FOR THIS DAY						
92 1 16	DATA MISSING FOR THIS DAY						
92 1 17	DATA MISSING FOR THIS DAY						
92 1 18	DATA MISSING FOR THIS DAY						
92 1 19	DATA MISSING FOR THIS DAY						
92 1 20	DATA MISSING FOR THIS DAY						
92 1 21	DATA MISSING FOR THIS DAY						
92 1 22	DATA MISSING FOR THIS DAY						
92 1 23	DATA MISSING FOR THIS DAY						
92 1 24	DATA MISSING FOR THIS DAY						
92 1 25	41.08	0.20	40.43	0.40	-0.64	0.30	14
92 1 26	40.11	0.61	39.63	0.26	-0.48	0.82	24
92 1 27	39.75	0.13	38.93	0.58	-0.81	0.61	24
92 1 28	39.09	0.75	38.71	0.81	-0.38	0.30	24
92 1 29	39.47	0.20	39.32	0.37	-0.15	0.19	24
92 1 30	39.77	0.08	39.89	0.06	0.12	0.12	24
92 1 31	39.92	0.20	39.84	0.12	-0.08	0.12	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
39.81	0.31	39.48	0.37	-0.33	158

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92 2 1			DATA MISSING FOR THIS DAY				
92 2 2			DATA MISSING FOR THIS DAY				
92 2 3			DATA MISSING FOR THIS DAY				
92 2 4			DATA MISSING FOR THIS DAY				
92 2 5			DATA MISSING FOR THIS DAY				
92 2 6			DATA MISSING FOR THIS DAY				
92 2 7			DATA MISSING FOR THIS DAY				
92 2 8			DATA MISSING FOR THIS DAY				
92 2 9			DATA MISSING FOR THIS DAY				
92 2 10			DATA MISSING FOR THIS DAY				
92 2 11			DATA MISSING FOR THIS DAY				
92 2 12			DATA MISSING FOR THIS DAY				
92 2 13			DATA MISSING FOR THIS DAY				
92 2 14			DATA MISSING FOR THIS DAY				
92 2 15			DATA MISSING FOR THIS DAY				
92 2 16			DATA MISSING FOR THIS DAY				
92 2 17			DATA MISSING FOR THIS DAY				
92 2 18	36.96	0.04	40.36	1.88	3.41	1.90	3
92 2 19	37.15	0.14	39.58	1.95	2.42	1.88	24
92 2 20	37.12	0.13	41.18	0.52	4.06	0.50	24
92 2 21	37.09	0.21	41.19	0.75	4.10	0.77	24
92 2 22	37.13	0.07	41.16	0.47	4.04	0.48	24
92 2 23	37.24	0.23	41.60	0.48	4.36	0.42	24
92 2 24	37.07	0.10	38.45	2.04	1.38	2.03	24
92 2 25	36.98	0.07	42.02	0.40	5.04	0.40	24
92 2 26	37.04	0.16	40.25	1.85	3.21	1.78	24
92 2 27	37.38	0.44	40.28	0.64	2.90	1.04	24
92 2 28	37.91	0.22	40.45	0.87	2.54	0.91	24
92 2 29	37.82	0.14	39.76	1.62	1.95	1.68	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
40.54	1.12	37.26	0.16	3.27	267

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	2	1			DATA MISSING FOR THIS DAY				
92	2	2			DATA MISSING FOR THIS DAY				
92	2	3			DATA MISSING FOR THIS DAY				
92	2	4			DATA MISSING FOR THIS DAY				
92	2	5			DATA MISSING FOR THIS DAY				
92	2	6			DATA MISSING FOR THIS DAY				
92	2	7			DATA MISSING FOR THIS DAY				
92	2	8			DATA MISSING FOR THIS DAY				
92	2	9			DATA MISSING FOR THIS DAY				
92	2	10			DATA MISSING FOR THIS DAY				
92	2	11			DATA MISSING FOR THIS DAY				
92	2	12			DATA MISSING FOR THIS DAY				
92	2	13			DATA MISSING FOR THIS DAY				
92	2	14			DATA MISSING FOR THIS DAY				
92	2	15			DATA MISSING FOR THIS DAY				
92	2	16			DATA MISSING FOR THIS DAY				
92	2	17			DATA MISSING FOR THIS DAY				
92	2	18	36.96	0.04	37.00	0.11	0.04	0.15	3
92	2	19	37.15	0.14	37.02	0.18	-0.13	0.15	24
92	2	20	37.12	0.13	37.24	0.18	0.12	0.12	24
92	2	21	37.06	0.22	36.86	0.89	-0.20	0.96	20
92	2	22			DATA MISSING FOR THIS DAY				
92	2	23			DATA MISSING FOR THIS DAY				
92	2	24			DATA MISSING FOR THIS DAY				
92	2	25			DATA MISSING FOR THIS DAY				
92	2	26			DATA MISSING FOR THIS DAY				
92	2	27			DATA MISSING FOR THIS DAY				
92	2	28			DATA MISSING FOR THIS DAY				
92	2	29			DATA MISSING FOR THIS DAY				

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
37.11	0.13	37.05	0.34	-0.06	71

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92 2 1	DATA MISSING FOR THIS DAY						
92 2 2	DATA MISSING FOR THIS DAY						
92 2 3	DATA MISSING FOR THIS DAY						
92 2 4	DATA MISSING FOR THIS DAY						
92 2 5	DATA MISSING FOR THIS DAY						
92 2 6	DATA MISSING FOR THIS DAY						
92 2 7	DATA MISSING FOR THIS DAY						
92 2 8	DATA MISSING FOR THIS DAY						
92 2 9	DATA MISSING FOR THIS DAY						
92 2 10	DATA MISSING FOR THIS DAY						
92 2 11	DATA MISSING FOR THIS DAY						
92 2 12	DATA MISSING FOR THIS DAY						
92 2 13	DATA MISSING FOR THIS DAY						
92 2 14	DATA MISSING FOR THIS DAY						
92 2 15	DATA MISSING FOR THIS DAY						
92 2 16	DATA MISSING FOR THIS DAY						
92 2 17	DATA MISSING FOR THIS DAY						
92 2 18	DATA MISSING FOR THIS DAY						
92 2 19	DATA MISSING FOR THIS DAY						
92 2 20	DATA MISSING FOR THIS DAY						
92 2 21	DATA MISSING FOR THIS DAY						
92 2 22	DATA MISSING FOR THIS DAY						
92 2 23	DATA MISSING FOR THIS DAY						
92 2 24	DATA MISSING FOR THIS DAY						
92 2 25	DATA MISSING FOR THIS DAY						
92 2 26	DATA MISSING FOR THIS DAY						
92 2 27	DATA MISSING FOR THIS DAY						
92 2 28	DATA MISSING FOR THIS DAY						
92 2 29	DATA MISSING FOR THIS DAY						

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	2	1	DATA MISSING FOR THIS DAY						
92	2	2	DATA MISSING FOR THIS DAY						
92	2	3	DATA MISSING FOR THIS DAY						
92	2	4	DATA MISSING FOR THIS DAY						
92	2	5	DATA MISSING FOR THIS DAY						
92	2	6	DATA MISSING FOR THIS DAY						
92	2	7	DATA MISSING FOR THIS DAY						
92	2	8	DATA MISSING FOR THIS DAY						
92	2	9	DATA MISSING FOR THIS DAY						
92	2	10	DATA MISSING FOR THIS DAY						
92	2	11	DATA MISSING FOR THIS DAY						
92	2	12	DATA MISSING FOR THIS DAY						
92	2	13	DATA MISSING FOR THIS DAY						
92	2	14	DATA MISSING FOR THIS DAY						
92	2	15	DATA MISSING FOR THIS DAY						
92	2	16	DATA MISSING FOR THIS DAY						
92	2	17	DATA MISSING FOR THIS DAY						
92	2	18	36.85	0.05	36.88	0.07	0.03	0.11	3
92	2	19	37.01	0.14	36.95	0.07	-0.06	0.15	24
92	2	20	37.28	0.10	37.24	0.10	-0.04	0.09	24
92	2	21	37.37	0.08	37.39	0.07	0.03	0.10	24
92	2	22	37.42	0.07	37.38	0.06	-0.05	0.07	24
92	2	23	37.43	0.07	37.45	0.05	0.01	0.08	24
92	2	24	37.13	0.14	37.15	0.51	0.01	0.47	24
92	2	25	37.23	0.04	37.07	0.04	-0.16	0.05	24
92	2	26	37.46	0.11	37.27	0.14	-0.19	0.06	24
92	2	27	37.92	0.29	37.73	0.19	-0.19	0.13	24
92	2	28	38.34	0.03	37.66	0.10	-0.68	0.10	24
92	2	29	38.16	0.25	37.70	0.12	-0.46	0.27	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
37.51	0.11	37.36	0.13	-0.16	267

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92	3	1	37.11	0.33	39.59	1.20	2.49	1.02	21
92	3	2	36.85	0.30	40.93	0.35	4.08	0.39	16
92	3	3	36.42	0.20	40.43	0.57	4.01	0.53	24
92	3	4	36.74	0.38	40.83	0.61	4.09	0.40	24
92	3	5	37.18	0.42	41.02	0.66	3.85	0.52	24
92	3	6	37.56	0.15	41.38	1.14	3.82	1.24	24
92	3	7	37.72	0.08	40.55	1.57	2.83	1.59	24
92	3	8	37.93	0.12	40.65	1.68	2.72	1.65	24
92	3	9	38.19	0.26	41.51	0.81	3.32	0.75	24
92	3	10	38.39	0.12	41.36	0.41	2.97	0.46	13
92	3	11	38.45	0.11	40.23	0.52	1.78	0.46	13
92	3	12	37.74	0.19	39.31	0.37	1.58	0.38	24
92	3	13	37.94	0.21	40.29	0.44	2.35	0.35	24
92	3	14	37.80	0.11	40.88	0.59	3.08	0.57	24
92	3	15	37.74	0.24	41.92	0.48	4.18	0.48	24
92	3	16	37.14	0.17	41.29	0.33	4.15	0.33	24
92	3	17	37.03	0.26	40.51	0.65	3.48	0.84	21
92	3	18	DATA MISSING FOR THIS DAY						
92	3	19	DATA MISSING FOR THIS DAY						
92	3	20	DATA MISSING FOR THIS DAY						
92	3	21	DATA MISSING FOR THIS DAY						
92	3	22	DATA MISSING FOR THIS DAY						
92	3	23	DATA MISSING FOR THIS DAY						
92	3	24	37.13	0.05	40.97	0.13	3.84	0.09	4
92	3	25	37.42	0.29	40.74	0.46	3.32	0.53	24
92	3	26	37.98	0.52	40.33	0.75	2.35	1.12	13
92	3	27	38.47	0.39	40.59	0.94	2.12	1.01	24
92	3	28	38.40	0.19	42.00	0.57	3.60	0.72	24
92	3	29	37.88	0.08	42.15	0.50	4.27	0.49	24
92	3	30	38.16	0.28	41.58	0.32	3.42	0.41	24
92	3	31	38.58	0.11	40.92	1.65	2.34	1.70	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
40.90	0.71	37.68	0.22	3.22	533

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	3	1	DATA MISSING FOR THIS DAY						
92	3	2	DATA MISSING FOR THIS DAY						
92	3	3	DATA MISSING FOR THIS DAY						
92	3	4	DATA MISSING FOR THIS DAY						
92	3	5	DATA MISSING FOR THIS DAY						
92	3	6	DATA MISSING FOR THIS DAY						
92	3	7	DATA MISSING FOR THIS DAY						
92	3	8	DATA MISSING FOR THIS DAY						
92	3	9	DATA MISSING FOR THIS DAY						
92	3	10	DATA MISSING FOR THIS DAY						
92	3	11	DATA MISSING FOR THIS DAY						
92	3	12	DATA MISSING FOR THIS DAY						
92	3	13	DATA MISSING FOR THIS DAY						
92	3	14	DATA MISSING FOR THIS DAY						
92	3	15	DATA MISSING FOR THIS DAY						
92	3	16	DATA MISSING FOR THIS DAY						
92	3	17	DATA MISSING FOR THIS DAY						
92	3	18	DATA MISSING FOR THIS DAY						
92	3	19	DATA MISSING FOR THIS DAY						
92	3	20	DATA MISSING FOR THIS DAY						
92	3	21	DATA MISSING FOR THIS DAY						
92	3	22	DATA MISSING FOR THIS DAY						
92	3	23	DATA MISSING FOR THIS DAY						
92	3	24	DATA MISSING FOR THIS DAY						
92	3	25	DATA MISSING FOR THIS DAY						
92	3	26	DATA MISSING FOR THIS DAY						
92	3	27	DATA MISSING FOR THIS DAY						
92	3	28	DATA MISSING FOR THIS DAY						
92	3	29	DATA MISSING FOR THIS DAY						
92	3	30	DATA MISSING FOR THIS DAY						
92	3	31	DATA MISSING FOR THIS DAY						

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	3	1	DATA MISSING FOR THIS DAY						
92	3	2	DATA MISSING FOR THIS DAY						
92	3	3	DATA MISSING FOR THIS DAY						
92	3	4	DATA MISSING FOR THIS DAY						
92	3	5	DATA MISSING FOR THIS DAY						
92	3	6	DATA MISSING FOR THIS DAY						
92	3	7	DATA MISSING FOR THIS DAY						
92	3	8	DATA MISSING FOR THIS DAY						
92	3	9	DATA MISSING FOR THIS DAY						
92	3	10	DATA MISSING FOR THIS DAY						
92	3	11	DATA MISSING FOR THIS DAY						
92	3	12	DATA MISSING FOR THIS DAY						
92	3	13	DATA MISSING FOR THIS DAY						
92	3	14	DATA MISSING FOR THIS DAY						
92	3	15	DATA MISSING FOR THIS DAY						
92	3	16	DATA MISSING FOR THIS DAY						
92	3	17	DATA MISSING FOR THIS DAY						
92	3	18	DATA MISSING FOR THIS DAY						
92	3	19	DATA MISSING FOR THIS DAY						
92	3	20	DATA MISSING FOR THIS DAY						
92	3	21	DATA MISSING FOR THIS DAY						
92	3	22	DATA MISSING FOR THIS DAY						
92	3	23	DATA MISSING FOR THIS DAY						
92	3	24	DATA MISSING FOR THIS DAY						
92	3	25	DATA MISSING FOR THIS DAY						
92	3	26	DATA MISSING FOR THIS DAY						
92	3	27	DATA MISSING FOR THIS DAY						
92	3	28	DATA MISSING FOR THIS DAY						
92	3	29	DATA MISSING FOR THIS DAY						
92	3	30	DATA MISSING FOR THIS DAY						
92	3	31	DATA MISSING FOR THIS DAY						

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	3	1	37.11	0.32	37.15	0.44	0.03	0.63	21
92	3	2	36.68	0.37	36.39	0.47	-0.29	0.53	16
92	3	3	36.68	0.28	37.03	0.22	0.35	0.35	24
92	3	4	37.10	0.38	37.18	0.25	0.08	0.34	24
92	3	5	37.50	0.14	37.57	0.11	0.07	0.15	24
92	3	6	37.62	0.17	37.60	0.08	-0.02	0.15	24
92	3	7	37.77	0.07	37.66	0.06	-0.11	0.11	24
92	3	8	37.75	0.02	37.68	0.04	-0.07	0.03	24
92	3	9	37.75	0.02	37.67	0.03	-0.08	0.02	24
92	3	10	37.80	0.05	37.71	0.05	-0.09	0.07	24
92	3	11	37.89	0.04	37.83	0.07	-0.06	0.04	13
92	3	12	38.01	0.17	38.01	0.33	0.00	0.38	24
92	3	13	38.11	0.23	38.22	0.30	0.11	0.41	24
92	3	14	37.87	0.19	37.89	0.26	0.02	0.37	24
92	3	15	38.00	0.11	37.78	0.17	-0.22	0.21	24
92	3	16	36.97	0.42	36.85	0.34	-0.12	0.51	24
92	3	17	37.40	0.42	37.17	0.27	-0.23	0.24	21
92	3	18	DATA MISSING FOR THIS DAY						
92	3	19	DATA MISSING FOR THIS DAY						
92	3	20	DATA MISSING FOR THIS DAY						
92	3	21	DATA MISSING FOR THIS DAY						
92	3	22	DATA MISSING FOR THIS DAY						
92	3	23	DATA MISSING FOR THIS DAY						
92	3	24	37.49	0.03	37.36	0.06	-0.13	0.06	4
92	3	25	37.49	0.04	37.35	0.07	-0.14	0.10	24
92	3	26	37.29	0.05	37.43	0.03	0.14	0.06	24
92	3	27	37.90	0.24	37.71	0.15	-0.19	0.25	24
92	3	28	37.88	0.15	37.74	0.07	-0.14	0.21	24
92	3	29	37.78	0.07	37.81	0.04	0.03	0.07	24
92	3	30	37.82	0.05	37.79	0.04	-0.03	0.07	24
92	3	31	38.16	0.25	38.06	0.26	-0.10	0.16	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
37.61	0.17	37.57	0.17	-0.04	555

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92	4	1	38.92	0.76	40.42	1.48	1.50	0.89	24
92	4	2	39.21	0.25	42.15	1.67	2.94	1.50	24
92	4	3	38.81	0.20	42.82	1.71	4.01	1.81	24
92	4	4	38.65	0.20	41.97	0.58	3.32	0.50	24
92	4	5	38.87	0.22	42.16	1.38	3.29	1.47	24
92	4	6	39.28	0.25	41.45	1.93	2.17	2.03	24
92	4	7	39.67	0.46	42.89	1.44	3.21	1.33	24
92	4	8	39.98	0.26	43.35	0.60	3.38	0.68	24
92	4	9	40.28	0.44	43.73	0.46	3.45	0.40	24
92	4	10	41.11	0.32	43.08	0.49	1.97	0.62	24
92	4	11	41.20	0.47	45.20	1.92	4.00	1.65	24
92	4	12	40.37	0.30	43.21	1.46	2.84	1.25	9
92	4	13	DATA MISSING FOR THIS DAY						
92	4	14	DATA MISSING FOR THIS DAY						
92	4	15	DATA MISSING FOR THIS DAY						
92	4	16	DATA MISSING FOR THIS DAY						
92	4	17	DATA MISSING FOR THIS DAY						
92	4	18	DATA MISSING FOR THIS DAY						
92	4	19	DATA MISSING FOR THIS DAY						
92	4	20	DATA MISSING FOR THIS DAY						
92	4	21	DATA MISSING FOR THIS DAY						
92	4	22	DATA MISSING FOR THIS DAY						
92	4	23	DATA MISSING FOR THIS DAY						
92	4	24	DATA MISSING FOR THIS DAY						
92	4	25	DATA MISSING FOR THIS DAY						
92	4	26	DATA MISSING FOR THIS DAY						
92	4	27	DATA MISSING FOR THIS DAY						
92	4	28	DATA MISSING FOR THIS DAY						
92	4	29	DATA MISSING FOR THIS DAY						
92	4	30	DATA MISSING FOR THIS DAY						

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
42.67	1.26	39.66	0.34	3.02	273

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92 4 1	DATA MISSING FOR THIS DAY						
92 4 2	DATA MISSING FOR THIS DAY						
92 4 3	DATA MISSING FOR THIS DAY						
92 4 4	DATA MISSING FOR THIS DAY						
92 4 5	DATA MISSING FOR THIS DAY						
92 4 6	DATA MISSING FOR THIS DAY						
92 4 7	DATA MISSING FOR THIS DAY						
92 4 8	DATA MISSING FOR THIS DAY						
92 4 9	DATA MISSING FOR THIS DAY						
92 4 10	DATA MISSING FOR THIS DAY						
92 4 11	DATA MISSING FOR THIS DAY						
92 4 12	DATA MISSING FOR THIS DAY						
92 4 13	DATA MISSING FOR THIS DAY						
92 4 14	DATA MISSING FOR THIS DAY						
92 4 15	DATA MISSING FOR THIS DAY						
92 4 16	DATA MISSING FOR THIS DAY						
92 4 17	DATA MISSING FOR THIS DAY						
92 4 18	DATA MISSING FOR THIS DAY						
92 4 19	DATA MISSING FOR THIS DAY						
92 4 20	DATA MISSING FOR THIS DAY						
92 4 21	DATA MISSING FOR THIS DAY						
92 4 22	DATA MISSING FOR THIS DAY						
92 4 23	DATA MISSING FOR THIS DAY						
92 4 24	DATA MISSING FOR THIS DAY						
92 4 25	DATA MISSING FOR THIS DAY						
92 4 26	DATA MISSING FOR THIS DAY						
92 4 27	DATA MISSING FOR THIS DAY						
92 4 28	DATA MISSING FOR THIS DAY						
92 4 29	DATA MISSING FOR THIS DAY						
92 4 30	DATA MISSING FOR THIS DAY						

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92 4 1	DATA MISSING FOR THIS DAY						
92 4 2	DATA MISSING FOR THIS DAY						
92 4 3	DATA MISSING FOR THIS DAY						
92 4 4	DATA MISSING FOR THIS DAY						
92 4 5	DATA MISSING FOR THIS DAY						
92 4 6	DATA MISSING FOR THIS DAY						
92 4 7	DATA MISSING FOR THIS DAY						
92 4 8	DATA MISSING FOR THIS DAY						
92 4 9	DATA MISSING FOR THIS DAY						
92 4 10	DATA MISSING FOR THIS DAY						
92 4 11	DATA MISSING FOR THIS DAY						
92 4 12	DATA MISSING FOR THIS DAY						
92 4 13	DATA MISSING FOR THIS DAY						
92 4 14	DATA MISSING FOR THIS DAY						
92 4 15	DATA MISSING FOR THIS DAY						
92 4 16	DATA MISSING FOR THIS DAY						
92 4 17	DATA MISSING FOR THIS DAY						
92 4 18	DATA MISSING FOR THIS DAY						
92 4 19	DATA MISSING FOR THIS DAY						
92 4 20	DATA MISSING FOR THIS DAY						
92 4 21	DATA MISSING FOR THIS DAY						
92 4 22	DATA MISSING FOR THIS DAY						
92 4 23	DATA MISSING FOR THIS DAY						
92 4 24	DATA MISSING FOR THIS DAY						
92 4 25	DATA MISSING FOR THIS DAY						
92 4 26	DATA MISSING FOR THIS DAY						
92 4 27	DATA MISSING FOR THIS DAY						
92 4 28	DATA MISSING FOR THIS DAY						
92 4 29	DATA MISSING FOR THIS DAY						
92 4 30	DATA MISSING FOR THIS DAY						

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	4	1	38.27	0.03	38.23	0.11	-0.05	0.09	24
92	4	2	38.42	0.42	38.14	0.07	-0.28	0.39	24
92	4	3	38.17	0.11	38.14	0.17	-0.03	0.10	24
92	4	4	38.19	0.04	38.12	0.04	-0.07	0.05	24
92	4	5	38.44	0.27	38.28	0.22	-0.16	0.07	24
92	4	6	39.03	0.09	38.94	0.22	-0.09	0.15	24
92	4	7	39.05	0.05	39.28	0.21	0.23	0.20	24
92	4	8	38.53	0.20	38.70	0.12	0.17	0.09	24
92	4	9	38.83	0.32	39.07	0.31	0.23	0.33	24
92	4	10	38.21	0.07	38.30	0.13	0.09	0.09	24
92	4	11	39.94	1.15	40.51	0.88	0.57	0.48	21
92	4	12	39.77	0.10	39.65	0.13	-0.11	0.20	16
92	4	13	39.75	0.04	39.74	0.07	-0.01	0.06	24
92	4	14	39.89	0.02	39.78	0.04	-0.10	0.04	24
92	4	15	39.92	0.09	39.86	0.10	-0.06	0.17	24
92	4	16	39.85	0.13	39.89	0.10	0.04	0.19	24
92	4	17	40.16	0.30	40.09	0.25	-0.07	0.21	24
92	4	18	40.04	0.10	40.01	0.14	-0.02	0.13	24
92	4	19	39.96	0.10	39.89	0.05	-0.07	0.11	24
92	4	20	39.90	0.01	39.89	0.05	-0.01	0.05	24
92	4	21	39.63	0.32	39.94	0.11	0.32	0.23	24
92	4	22	38.94	0.10	39.30	0.25	0.36	0.20	24
92	4	23	38.95	0.20	38.96	0.13	0.01	0.11	24
92	4	24	39.95	0.34	40.40	1.02	0.45	0.88	24
92	4	25	41.67	0.65	41.80	0.71	0.12	0.35	24
92	4	26	41.35	0.16	41.33	0.06	-0.02	0.19	24
92	4	27	41.28	0.19	41.44	0.27	0.15	0.21	24
92	4	28	41.46	0.05	41.39	0.08	-0.06	0.06	24
92	4	29	41.48	0.03	41.32	0.05	-0.15	0.04	24
92	4	30	40.92	0.58	41.26	0.07	0.34	0.53	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
39.66	0.21	39.72	0.21	0.06	709

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92 5 1			DATA MISSING FOR THIS DAY				
92 5 2			DATA MISSING FOR THIS DAY				
92 5 3			DATA MISSING FOR THIS DAY				
92 5 4			DATA MISSING FOR THIS DAY				
92 5 5			DATA MISSING FOR THIS DAY				
92 5 6			DATA MISSING FOR THIS DAY				
92 5 7			DATA MISSING FOR THIS DAY				
92 5 8			DATA MISSING FOR THIS DAY				
92 5 9			DATA MISSING FOR THIS DAY				
92 5 10			DATA MISSING FOR THIS DAY				
92 5 11			DATA MISSING FOR THIS DAY				
92 5 12			DATA MISSING FOR THIS DAY				
92 5 13			DATA MISSING FOR THIS DAY				
92 5 14	51.23	2.36	50.55	0.77	-0.68	2.64	19
92 5 15	49.99	0.40	51.26	1.05	1.27	1.00	24
92 5 16	49.68	0.28	50.68	0.60	1.00	0.79	24
92 5 17	50.20	0.54	50.78	0.95	0.58	0.56	24
92 5 18	48.45	0.44	48.83	0.55	0.38	0.53	24
92 5 19	48.90	0.60	50.47	1.06	1.53	0.88	24
92 5 20	50.63	1.73	50.52	1.27	-0.11	1.09	24
92 5 21	52.05	1.02	50.13	1.55	-1.92	1.77	24
92 5 22	53.11	1.42	49.69	1.49	-3.42	1.33	24
92 5 23	53.28	1.17	50.94	2.38	-2.34	2.22	24
92 5 24	50.18	0.42	51.08	1.68	0.90	1.66	24
92 5 25	48.63	0.58	51.53	1.69	2.90	1.56	24
92 5 26	48.25	0.42	51.22	0.67	2.97	0.37	24
92 5 27	49.41	0.70	52.43	0.26	3.02	0.62	24
92 5 28	51.01	0.81	52.51	0.69	1.50	0.92	24
92 5 29	52.27	0.94	52.17	0.73	-0.10	0.84	24
92 5 30	52.14	0.48	51.95	0.84	-0.19	0.91	24
92 5 31	51.22	0.49	50.09	0.71	-1.13	0.84	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
50.94	1.05	50.58	0.82	0.36	427

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92 5 1	DATA MISSING FOR THIS DAY						
92 5 2	DATA MISSING FOR THIS DAY						
92 5 3	DATA MISSING FOR THIS DAY						
92 5 4	DATA MISSING FOR THIS DAY						
92 5 5	DATA MISSING FOR THIS DAY						
92 5 6	DATA MISSING FOR THIS DAY						
92 5 7	DATA MISSING FOR THIS DAY						
92 5 8	DATA MISSING FOR THIS DAY						
92 5 9	DATA MISSING FOR THIS DAY						
92 5 10	DATA MISSING FOR THIS DAY						
92 5 11	DATA MISSING FOR THIS DAY						
92 5 12	DATA MISSING FOR THIS DAY						
92 5 13	DATA MISSING FOR THIS DAY						
92 5 14	51.78	2.15	51.18	1.41	-0.59	3.19	16
92 5 15	49.99	0.40	48.74	0.60	-1.26	0.62	24
92 5 16	49.68	0.28	47.62	1.05	-2.06	1.14	24
92 5 17	50.20	0.54	49.57	1.72	-0.63	1.53	24
92 5 18	48.45	0.44	47.06	1.10	-1.39	1.21	24
92 5 19	48.90	0.60	46.81	2.22	-2.09	2.06	24
92 5 20	50.63	1.73	47.71	2.17	-2.93	2.11	24
92 5 21	52.05	1.02	49.14	1.99	-2.91	1.57	24
92 5 22	53.11	1.42	49.66	2.21	-3.45	2.45	24
92 5 23	53.28	1.17	50.84	2.12	-2.45	2.09	24
92 5 24	50.18	0.42	47.74	2.44	-2.44	2.49	24
92 5 25	48.63	0.58	47.70	1.70	-0.93	2.17	24
92 5 26	48.25	0.42	48.65	0.56	0.40	0.47	24
92 5 27	49.41	0.70	50.62	1.44	1.21	1.50	24
92 5 28	51.01	0.81	50.40	1.07	-0.61	0.99	24
92 5 29	52.27	0.94	51.33	0.91	-0.94	1.21	24
92 5 30	52.14	0.48	51.22	0.93	-0.91	0.91	24
92 5 31	51.22	0.49	50.16	0.65	-1.06	0.85	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
50.60	0.81	49.19	1.46	-1.41	424

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92 5 1			DATA MISSING FOR THIS DAY				
92 5 2			DATA MISSING FOR THIS DAY				
92 5 3			DATA MISSING FOR THIS DAY				
92 5 4			DATA MISSING FOR THIS DAY				
92 5 5			DATA MISSING FOR THIS DAY				
92 5 6			DATA MISSING FOR THIS DAY				
92 5 7			DATA MISSING FOR THIS DAY				
92 5 8			DATA MISSING FOR THIS DAY				
92 5 9			DATA MISSING FOR THIS DAY				
92 5 10			DATA MISSING FOR THIS DAY				
92 5 11			DATA MISSING FOR THIS DAY				
92 5 12			DATA MISSING FOR THIS DAY				
92 5 13			DATA MISSING FOR THIS DAY				
92 5 14	49.30	3.71	47.53	0.70	-1.77	3.52	16
92 5 15	48.12	0.80	48.34	1.43	0.22	0.75	24
92 5 16	47.32	1.49	47.23	1.76	-0.09	1.83	24
92 5 17	45.75	0.60	45.50	0.56	-0.25	0.84	24
92 5 18	45.16	0.56	44.99	0.39	-0.18	0.37	24
92 5 19	47.57	0.85	47.64	1.03	0.07	0.57	24
92 5 20	44.94	0.87	45.09	1.55	0.14	1.13	24
92 5 21	43.74	1.01	43.63	1.11	-0.11	0.66	24
92 5 22	42.69	0.29	42.92	0.42	0.23	0.46	24
92 5 23	42.45	0.19	42.64	0.63	0.20	0.58	24
92 5 24	46.37	3.90	46.51	4.18	0.14	0.77	24
92 5 25	47.86	0.57	48.48	1.18	0.62	1.12	24
92 5 26	48.34	0.45	48.07	0.65	-0.26	0.38	24
92 5 27	49.38	0.69	49.17	0.28	-0.21	0.49	24
92 5 28	49.31	0.56	49.51	1.15	0.20	1.10	24
92 5 29	47.97	0.30	48.15	1.13	0.18	1.04	24
92 5 30	48.12	0.52	47.97	0.53	-0.15	0.59	24
92 5 31	46.05	0.76	45.89	1.17	-0.16	0.85	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
46.64	1.01	46.61	1.10	-0.03	424

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	5	1	39.87	0.21	40.58	0.44	0.71	0.60	24
92	5	2	40.56	0.78	40.70	0.64	0.13	0.46	24
92	5	3	40.91	0.65	40.95	0.50	0.04	0.71	24
92	5	4	40.87	0.50	40.77	0.34	-0.11	0.28	24
92	5	5	43.11	1.45	43.62	1.85	0.51	0.82	24
92	5	6	44.25	0.68	44.01	0.64	-0.24	0.31	24
92	5	7	44.12	0.29	44.46	0.53	0.35	0.61	24
92	5	8	43.70	0.88	43.94	0.30	0.23	0.89	24
92	5	9	43.71	1.19	43.89	0.89	0.19	1.52	24
92	5	10	45.15	1.06	44.22	1.14	-0.93	0.53	24
92	5	11	45.37	0.64	45.23	0.77	-0.14	0.75	24
92	5	12	44.82	1.03	44.73	0.37	-0.09	1.05	24
92	5	13	43.44	2.11	44.91	0.85	1.47	1.94	24
92	5	14	43.28	3.10	42.24	0.52	-1.04	3.12	24
92	5	15	41.54	0.39	41.96	0.48	0.42	0.52	24
92	5	16	41.90	0.67	42.03	0.58	0.13	0.46	24
92	5	17	42.84	0.82	42.71	0.50	-0.14	0.50	24
92	5	18	42.14	0.57	42.42	0.67	0.28	0.63	24
92	5	19	42.70	0.74	42.24	0.36	-0.46	0.71	24
92	5	20	41.12	0.21	41.51	0.40	0.39	0.40	24
92	5	21	40.70	0.26	41.09	0.16	0.39	0.25	24
92	5	22	40.88	0.16	41.09	0.22	0.21	0.26	24
92	5	23	40.73	0.10	40.95	0.26	0.22	0.21	24
92	5	24	41.34	1.22	42.09	2.72	0.74	2.33	24
92	5	25	45.41	0.87	46.49	1.47	1.08	1.41	24
92	5	26	47.47	0.65	46.93	0.62	-0.54	0.53	24
92	5	27	47.15	1.25	47.72	0.52	0.57	1.49	24
92	5	28	45.63	0.71	44.90	0.49	-0.73	0.76	24
92	5	29	44.35	1.08	44.39	0.34	0.04	1.00	24
92	5	30	41.61	0.63	43.48	1.01	1.87	0.87	24
92	5	31	41.02	0.14	41.53	0.32	0.52	0.29	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
42.96	0.81	43.15	0.67	0.20	744

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92 6 1	50.97	0.28	51.22	0.58	0.25	0.72	24
92 6 2	52.38	1.12	54.12	0.89	1.74	1.52	24
92 6 3	51.26	0.51	53.23	0.47	1.98	0.68	24
92 6 4	53.19	1.06	53.29	1.05	0.10	0.98	24
92 6 5	52.60	0.29	52.67	0.30	0.07	0.28	24
92 6 6	53.22	0.39	55.56	1.24	2.34	1.17	24
92 6 7	54.40	1.47	56.08	0.42	1.68	1.30	24
92 6 8	56.06	1.47	55.17	0.70	-0.89	1.03	24
92 6 9	55.19	0.63	56.08	0.54	0.89	1.03	24
92 6 10	54.03	0.85	56.80	0.65	2.77	1.18	24
92 6 11	55.17	0.88	56.52	0.79	1.35	0.49	24
92 6 12	55.08	0.91	55.75	0.69	0.67	0.98	24
92 6 13	53.68	0.58	54.05	0.66	0.37	0.85	24
92 6 14	52.29	1.17	52.86	0.79	0.57	1.08	24
92 6 15	52.29	1.20	53.09	1.29	0.80	0.81	24
92 6 16	53.72	0.99	54.31	0.77	0.59	1.22	24
92 6 17	55.04	1.18	54.27	1.16	-0.76	1.28	24
92 6 18	55.94	1.05	54.26	0.93	-1.69	1.13	24
92 6 19	51.16	1.08	51.50	0.37	0.34	1.01	24
92 6 20	51.10	0.85	51.34	0.68	0.24	0.73	24
92 6 21	52.76	1.34	51.31	1.21	-1.46	1.05	24
92 6 22	53.34	1.99	51.19	0.90	-2.15	1.91	24
92 6 23	51.28	0.74	52.03	0.54	0.75	0.49	24
92 6 24	51.30	0.41	53.14	0.42	1.84	0.71	24
92 6 25	52.33	0.95	52.00	0.60	-0.32	0.88	24
92 6 26	53.40	0.96	52.54	1.11	-0.86	1.22	24
92 6 27	53.83	1.18	51.92	0.73	-1.91	1.06	24
92 6 28	54.77	1.18	52.92	0.78	-1.85	1.30	24
92 6 29	55.37	1.28	53.39	0.74	-1.98	0.87	24
92 6 30	52.07	1.43	52.01	0.68	-0.06	1.11	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
53.49	0.76	53.31	0.98	0.18	720

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	6	1	50.97	0.28	50.70	0.25	-0.27	0.21	24
92	6	2	52.38	1.12	51.13	1.00	-1.25	1.12	24
92	6	3	51.26	0.51	51.31	1.07	0.05	0.90	24
92	6	4	53.19	1.06	52.26	1.27	-0.93	0.91	24
92	6	5	52.60	0.29	52.79	0.72	0.19	0.87	24
92	6	6	53.22	0.39	52.08	0.40	-1.14	0.72	24
92	6	7	54.40	1.47	52.89	0.81	-1.51	1.09	24
92	6	8	56.06	1.47	54.39	0.72	-1.67	1.38	24
92	6	9	55.19	0.63	54.67	0.74	-0.52	0.55	24
92	6	10	54.03	0.85	54.76	1.00	0.73	0.91	24
92	6	11	55.17	0.88	55.67	0.97	0.50	0.79	24
92	6	12	55.08	0.91	56.41	0.77	1.33	1.19	24
92	6	13	53.68	0.58	53.28	0.77	-0.40	0.95	24
92	6	14	52.29	1.17	51.64	0.88	-0.64	1.14	24
92	6	15	52.29	1.20	52.43	1.42	0.14	0.97	24
92	6	16	53.72	0.99	53.65	1.07	-0.07	1.12	24
92	6	17	55.04	1.18	55.38	0.96	0.34	1.03	24
92	6	18	55.94	1.05	54.81	1.44	-1.13	1.06	24
92	6	19	51.16	1.08	49.91	1.13	-1.25	1.18	24
92	6	20	51.10	0.85	50.04	0.84	-1.06	0.78	24
92	6	21	52.76	1.34	51.71	1.66	-1.05	1.05	24
92	6	22	53.34	1.99	53.26	1.91	-0.08	1.53	24
92	6	23	51.28	0.74	51.47	1.27	0.19	1.01	24
92	6	24	51.30	0.41	52.15	0.65	0.85	0.61	24
92	6	25	52.33	0.95	52.03	0.78	-0.30	0.75	24
92	6	26	53.40	0.96	53.14	1.22	-0.26	1.06	24
92	6	27	53.83	1.18	53.14	0.52	-0.69	1.29	24
92	6	28	54.77	1.18	52.83	0.48	-1.94	1.25	24
92	6	29	55.37	1.28	53.50	0.81	-1.87	1.64	24
92	6	30	52.07	1.43	50.93	0.92	-1.14	1.21	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
53.31	0.98	52.81	0.95	-0.49	720

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	6	1	50.10	1.99	50.26	1.47	0.16	0.59	24
92	6	2	50.31	0.47	50.47	0.70	0.15	0.66	24
92	6	3	49.83	0.53	49.88	0.56	0.05	0.38	24
92	6	4	48.82	0.93	48.76	1.17	-0.06	1.01	24
92	6	5	52.66	0.75	52.19	1.07	-0.47	0.78	24
92	6	6	52.68	0.62	52.49	0.51	-0.19	0.39	24
92	6	7	52.36	0.77	52.41	0.58	0.05	0.64	24
92	6	8	51.36	0.42	50.84	0.24	-0.53	0.51	24
92	6	9	51.65	0.90	51.62	0.61	-0.03	0.76	24
92	6	10	52.76	1.22	52.54	0.95	-0.22	0.78	24
92	6	11	52.49	0.87	52.31	1.35	-0.18	0.90	24
92	6	12	50.69	0.38	50.23	0.42	-0.46	0.27	24
92	6	13	49.30	0.40	49.22	0.44	-0.07	0.40	24
92	6	14	48.28	0.20	48.19	0.23	-0.09	0.27	24
92	6	15	49.71	1.63	48.82	1.36	-0.90	0.95	24
92	6	16	51.00	0.89	50.58	0.75	-0.41	0.64	24
92	6	17	49.86	0.62	49.42	0.63	-0.44	0.69	24
92	6	18	48.75	0.62	48.65	1.00	-0.10	0.57	24
92	6	19	47.12	0.64	47.03	0.90	-0.09	0.78	24
92	6	20	46.40	0.30	46.17	0.41	-0.23	0.42	24
92	6	21	46.72	0.52	46.43	0.74	-0.30	0.45	24
92	6	22	47.08	0.80	47.05	1.29	-0.03	1.03	24
92	6	23	48.35	0.93	48.42	0.97	0.08	0.92	24
92	6	24	49.68	0.72	49.27	0.53	-0.41	0.52	24
92	6	25	48.80	0.86	48.04	0.66	-0.76	0.49	24
92	6	26	48.44	1.52	47.49	1.65	-0.95	1.11	24
92	6	27	48.29	0.62	47.31	0.65	-0.98	0.51	24
92	6	28	49.08	0.79	48.37	0.67	-0.71	0.86	24
92	6	29	49.17	0.70	49.03	0.49	-0.15	0.60	24
92	6	30	47.03	0.61	46.65	0.78	-0.38	0.74	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
49.63	0.77	49.34	0.79	-0.29	720

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	6	1	45.72	3.78	44.81	3.42	-0.90	2.03	24
92	6	2	47.49	1.69	48.17	1.28	0.68	2.34	24
92	6	3	44.68	1.42	44.99	1.44	0.32	1.75	24
92	6	4	43.84	0.75	43.87	0.51	0.03	0.78	24
92	6	5	49.87	3.31	49.62	3.03	-0.26	2.23	24
92	6	6	50.97	0.81	51.41	0.65	0.44	0.71	24
92	6	7	49.84	0.81	50.34	0.20	0.50	0.78	24
92	6	8	48.77	0.18	48.74	0.28	-0.03	0.30	24
92	6	9	49.11	0.27	48.90	0.37	-0.20	0.21	24
92	6	10	49.31	0.26	49.37	0.35	0.06	0.31	24
92	6	11	48.99	0.38	49.02	0.18	0.03	0.45	24
92	6	12	47.90	0.56	48.53	0.35	0.64	0.49	24
92	6	13	46.33	0.26	46.81	0.56	0.48	0.44	24
92	6	14	46.57	0.17	46.32	0.24	-0.25	0.31	24
92	6	15	46.84	0.62	46.73	0.45	-0.11	0.63	24
92	6	16	46.47	0.29	46.41	0.47	-0.05	0.51	24
92	6	17	45.74	0.44	46.11	0.19	0.37	0.40	24
92	6	18	46.01	0.34	45.94	0.36	-0.07	0.39	24
92	6	19	44.37	0.52	45.09	0.46	0.72	0.36	24
92	6	20	43.77	0.20	44.11	0.15	0.33	0.19	24
92	6	21	44.05	0.42	44.17	0.44	0.12	0.42	24
92	6	22	44.51	0.27	44.39	0.33	-0.13	0.33	24
92	6	23	44.63	0.33	44.81	0.25	0.18	0.27	24
92	6	24	46.10	0.63	45.85	0.73	-0.26	0.59	24
92	6	25	44.55	0.70	45.07	0.43	0.52	0.60	24
92	6	26	44.22	0.42	44.56	0.42	0.34	0.64	24
92	6	27	44.76	0.38	44.95	0.60	0.19	0.76	24
92	6	28	44.60	0.21	45.04	0.29	0.44	0.45	24
92	6	29	45.13	0.37	44.98	0.32	-0.15	0.35	24
92	6	30	44.70	0.21	44.86	0.26	0.16	0.23	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
46.33	0.70	46.47	0.63	0.14	720

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
92	7	1	52.53	1.85	51.56	1.14	-0.97	1.23	24
92	7	2	53.77	0.74	54.03	1.24	0.26	0.79	24
92	7	3	54.27	0.63	54.54	1.22	0.27	1.14	24
92	7	4	52.99	0.75	53.69	0.91	0.70	0.64	24
92	7	5	52.54	0.51	53.17	1.12	0.63	0.93	24
92	7	6	54.40	0.92	54.25	0.84	-0.14	0.97	24
92	7	7	55.14	0.70	55.49	0.81	0.35	0.64	24
92	7	8	56.01	0.74	55.13	1.83	-0.88	2.06	24
92	7	9	54.14	1.80	54.25	2.35	0.11	1.07	24
92	7	10	52.87	0.85	53.67	1.35	0.81	0.82	24
92	7	11	55.74	1.55	55.67	1.91	-0.07	1.07	21
92	7	12	DATA MISSING FOR THIS DAY						
92	7	13	DATA MISSING FOR THIS DAY						
92	7	14	56.80	0.13	56.23	0.41	-0.57	0.52	4
92	7	15	57.01	0.26	58.68	0.71	1.68	0.51	24
92	7	16	57.98	0.88	59.67	1.20	1.69	0.59	24
92	7	17	58.84	0.65	60.26	0.44	1.42	0.98	20
92	7	18	60.55	1.24	59.55	0.94	-0.99	1.09	24
92	7	19	62.79	1.08	60.63	1.10	-2.16	1.15	24
92	7	20	64.83	0.68	62.78	1.23	-2.05	1.13	21
92	7	21	62.43	0.19	59.32	0.22	-3.11	0.30	4
92	7	22	63.20	0.74	61.97	1.63	-1.23	1.23	20
92	7	23	61.77	0.31	59.63	1.20	-2.14	1.32	24
92	7	24	61.91	1.03	60.13	1.86	-1.78	1.69	24
92	7	25	62.03	0.62	59.63	1.91	-2.40	1.59	24
92	7	26	60.69	0.70	57.09	1.43	-3.60	1.41	24
92	7	27	56.69	0.79	55.86	1.14	-0.83	1.10	24
92	7	28	55.38	1.38	54.95	1.05	-0.43	0.82	24
92	7	29	57.72	1.04	56.01	1.02	-1.71	0.86	24
92	7	30	57.14	1.99	55.48	2.04	-1.65	0.55	12
92	7	31	60.57	0.40	58.88	2.68	-1.69	2.45	19

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
56.86	1.27	57.48	0.87	-0.62	625

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	7	1	52.53	1.85	49.99	1.15	-2.54	1.46	24
92	7	2	53.77	0.74	52.55	1.50	-1.21	1.06	24
92	7	3	54.27	0.63	53.30	0.81	-0.98	1.12	24
92	7	4	52.99	0.75	53.30	0.55	0.31	0.45	24
92	7	5	52.54	0.57	53.32	0.74	0.78	0.83	24
92	7	6	54.40	0.92	54.49	0.95	0.09	0.71	24
92	7	7	55.14	0.70	55.51	0.78	0.37	1.00	24
92	7	8	56.01	0.74	56.73	1.10	0.72	0.84	24
92	7	9	54.14	1.80	54.65	2.54	0.50	1.76	24
92	7	10	52.87	0.85	53.79	1.52	0.92	1.62	24
92	7	11	55.74	1.55	55.90	1.65	0.16	0.62	21
92	7	12	DATA MISSING FOR THIS DAY						
92	7	13	DATA MISSING FOR THIS DAY						
92	7	14	56.80	0.13	56.69	0.35	-0.12	0.46	4
92	7	15	57.01	0.26	57.05	0.54	0.04	0.50	24
92	7	16	57.98	0.88	58.20	1.01	0.22	0.83	24
92	7	17	58.89	0.61	59.45	1.30	0.56	1.04	24
92	7	18	60.55	1.24	61.25	1.82	0.70	0.99	24
92	7	19	62.79	1.08	62.53	1.76	-0.26	1.89	24
92	7	20	64.83	0.68	61.91	2.91	-2.92	2.65	21
92	7	21	62.43	0.19	60.39	0.68	-2.04	0.50	4
92	7	22	63.30	0.72	63.57	2.38	0.28	2.05	24
92	7	23	61.77	0.31	60.30	1.40	-1.47	1.30	24
92	7	24	61.91	1.03	61.70	2.53	-0.21	2.08	24
92	7	25	62.03	0.62	62.67	1.66	0.65	1.25	24
92	7	26	60.69	0.70	59.95	1.68	-0.74	1.21	24
92	7	27	56.69	0.79	56.58	1.66	-0.11	1.30	24
92	7	28	55.38	1.38	57.67	2.08	2.28	1.51	24
92	7	29	57.72	1.04	58.65	2.27	0.93	1.91	24
92	7	30	57.80	1.95	59.20	3.60	1.40	2.02	18
92	7	31	60.80	0.61	62.31	1.32	1.51	0.94	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
57.57	0.87	57.63	1.53	0.06	644

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	7	1	47.51	0.98	46.75	0.84	-0.76	0.82	24
92	7	2	50.50	1.41	50.03	1.32	-0.47	1.39	24
92	7	3	50.88	1.43	50.27	1.31	-0.61	0.78	24
92	7	4	49.36	1.25	49.10	1.02	-0.26	0.77	24
92	7	5	50.52	1.60	49.15	1.32	-1.37	1.06	24
92	7	6	50.79	0.63	50.21	0.70	-0.57	0.92	24
92	7	7	51.98	1.05	51.16	0.89	-0.82	0.64	24
92	7	8	52.64	0.92	52.12	0.86	-0.51	0.84	24
92	7	9	50.12	2.12	49.91	2.08	-0.21	0.69	24
92	7	10	50.15	1.59	49.69	2.00	-0.46	1.35	24
92	7	11	52.37	1.34	51.19	1.41	-1.18	0.72	21
92	7	12			DATA MISSING FOR THIS DAY				
92	7	13			DATA MISSING FOR THIS DAY				
92	7	14	53.09	0.44	52.15	1.27	-0.94	1.70	4
92	7	15	55.83	0.79	55.21	0.87	-0.61	0.67	24
92	7	16	56.35	1.56	56.18	1.69	-0.17	0.76	24
92	7	17	57.20	0.58	56.45	0.90	-0.75	0.84	24
92	7	18	55.12	1.45	54.27	1.36	-0.85	0.80	24
92	7	19	54.84	1.05	54.34	1.12	-0.50	1.18	24
92	7	20	56.05	1.05	55.11	2.17	-0.94	2.12	21
92	7	21	52.60	0.38	51.32	0.34	-1.28	0.23	4
92	7	22	55.04	1.80	54.14	2.20	-0.90	0.96	24
92	7	23	53.52	1.30	52.10	1.07	-1.41	0.95	24
92	7	24	53.94	1.52	53.68	1.85	-0.26	1.18	24
92	7	25	53.38	1.23	52.75	1.46	-0.63	1.22	24
92	7	26	51.92	0.86	51.14	1.09	-0.77	0.80	24
92	7	27	50.08	0.75	49.65	0.57	-0.42	0.62	24
92	7	28	50.22	1.33	49.37	1.14	-0.85	1.31	24
92	7	29	50.83	1.14	50.54	1.09	-0.29	0.85	24
92	7	30	49.53	0.82	49.05	0.57	-0.48	0.74	18
92	7	31	52.46	3.33	51.59	2.25	-0.87	1.38	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
52.35	1.23	51.68	1.27	-0.67	644

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
92	7	1	44.87	0.31	45.01	0.45	0.14	0.64	24
92	7	2	45.17	0.30	45.52	0.66	0.35	0.59	24
92	7	3	46.03	0.63	46.03	0.64	0.00	0.63	24
92	7	4	46.68	0.46	46.60	0.50	-0.09	0.36	24
92	7	5	45.81	0.75	45.88	0.33	0.08	0.79	24
92	7	6	46.82	0.48	46.98	0.72	0.15	0.51	24
92	7	7	47.69	0.90	47.52	0.64	-0.17	1.17	24
92	7	8	48.14	0.46	48.48	0.84	0.34	1.10	24
92	7	9	46.74	1.18	47.13	1.15	0.39	0.53	24
92	7	10	45.88	0.40	46.03	0.72	0.15	0.88	24
92	7	11	47.35	0.65	46.98	0.34	-0.37	0.71	21
92	7	12			DATA MISSING FOR THIS DAY				
92	7	13			DATA MISSING FOR THIS DAY				
92	7	14	47.89	0.12	47.95	0.47	0.06	0.46	4
92	7	15	49.37	0.65	49.52	1.14	0.15	1.14	24
92	7	16	49.80	1.62	49.45	0.64	-0.36	1.56	24
92	7	17	50.05	1.25	50.70	1.34	0.65	1.77	24
92	7	18	47.60	0.51	48.29	0.71	0.69	0.87	24
92	7	19	48.23	0.90	48.30	0.78	0.08	0.96	24
92	7	20	49.00	0.65	49.50	0.75	0.50	0.68	21
92	7	21	47.84	0.20	47.81	0.43	-0.03	0.62	4
92	7	22	47.91	0.52	48.32	0.67	0.41	0.54	24
92	7	23	47.96	0.38	48.39	0.69	0.44	0.66	24
92	7	24	48.35	0.44	48.50	0.50	0.15	0.70	24
92	7	25	48.32	0.29	48.51	0.45	0.19	0.58	24
92	7	26	47.56	0.27	48.05	0.34	0.49	0.46	24
92	7	27	46.38	0.56	47.23	0.46	0.85	0.72	24
92	7	28	45.83	0.49	46.43	0.56	0.60	0.96	24
92	7	29	46.26	0.66	46.82	0.59	0.55	0.74	24
92	7	30	46.22	0.29	46.74	0.44	0.51	0.55	18
92	7	31	47.26	0.87	47.47	0.60	0.20	0.82	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
47.31	0.59	47.57	0.64	0.26	644

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
1992	8	1	55.85	4.01	56.67	2.39	0.82	2.40	21
1992	8	2	52.78	1.28	55.18	0.70	2.40	1.17	23
1992	8	3	52.46	0.84	55.02	0.68	2.56	0.78	24
1992	8	4	53.18	0.66	54.99	0.72	1.81	0.63	17
1992	8	5	51.48	0.82	53.56	0.61	2.09	0.89	16
1992	8	6	53.55	1.84	54.48	1.00	0.93	1.51	24
1992	8	7	55.35	1.13	55.35	1.14	0.00	1.10	22
1992	8	8	56.60	0.65	56.35	0.97	-0.25	0.65	24
1992	8	9	57.10	0.39	56.36	0.90	-0.73	0.73	24
1992	8	10	56.56	0.68	59.61	0.40	3.05	0.88	24
1992	8	11	57.11	0.48	57.35	0.71	0.24	0.78	23
1992	8	12	58.30	0.90	58.27	1.20	-0.03	0.92	24
1992	8	13	58.30	0.38	61.01	0.83	2.71	0.82	24
1992	8	14	59.10	0.86	62.48	0.48	3.37	0.99	24
1992	8	15	59.62	0.32	62.62	0.77	3.00	0.88	20
1992	8	16	59.30	0.05	63.03	1.75	3.73	1.74	12
1992	8	17	59.70	0.31	64.33	0.37	4.63	0.30	24
1992	8	18	60.46	0.59	64.89	0.32	4.44	0.57	24
1992	8	19	61.02	0.58	64.30	0.41	3.27	0.80	24
1992	8	20	60.36	0.31	63.47	0.48	3.11	0.56	24
1992	8	21	61.19	0.69	63.84	0.86	2.66	0.93	24
1992	8	22	62.09	0.81	63.53	0.71	1.44	0.80	24
1992	8	23	63.40	0.80	64.05	1.23	0.65	1.29	24
1992	8	24	63.85	1.25	63.49	1.20	-0.36	0.97	24
1992	8	25	62.05	1.58	62.39	1.27	0.34	1.05	24
1992	8	26	63.93	1.69	63.06	2.08	-0.87	1.33	24
1992	8	27	65.86	0.47	66.48	0.91	0.62	0.93	24
1992	8	28	64.93	1.33	63.28	1.47	-1.65	1.98	24
1992	8	29	57.11	2.45	58.44	1.97	1.33	0.94	18
1992	8	30	53.75	1.75	56.57	1.33	2.82	0.92	24
1992	8	31	51.28	1.40	54.90	1.07	3.62	1.03	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
60.09	1.00	58.45	1.01	1.63	700

Prepared by RB

Reviewed by JRS

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992 8 1	DATA MISSING FOR THIS DAY						
1992 8 2	DATA MISSING FOR THIS DAY						
1992 8 3	DATA MISSING FOR THIS DAY						
1992 8 4	DATA MISSING FOR THIS DAY						
1992 8 5	DATA MISSING FOR THIS DAY						
1992 8 6	DATA MISSING FOR THIS DAY						
1992 8 7	DATA MISSING FOR THIS DAY						
1992 8 8	DATA MISSING FOR THIS DAY						
1992 8 9	DATA MISSING FOR THIS DAY						
1992 8 10	DATA MISSING FOR THIS DAY						
1992 8 11	DATA MISSING FOR THIS DAY						
1992 8 12	DATA MISSING FOR THIS DAY						
1992 8 13	DATA MISSING FOR THIS DAY						
1992 8 14	DATA MISSING FOR THIS DAY						
1992 8 15	DATA MISSING FOR THIS DAY						
1992 8 16	DATA MISSING FOR THIS DAY						
1992 8 17	DATA MISSING FOR THIS DAY						
1992 8 18	DATA MISSING FOR THIS DAY						
1992 8 19	DATA MISSING FOR THIS DAY						
1992 8 20	DATA MISSING FOR THIS DAY						
1992 8 21	DATA MISSING FOR THIS DAY						
1992 8 22	DATA MISSING FOR THIS DAY						
1992 8 23	DATA MISSING FOR THIS DAY						
1992 8 24	DATA MISSING FOR THIS DAY						
1992 8 25	DATA MISSING FOR THIS DAY						
1992 8 26	DATA MISSING FOR THIS DAY						
1992 8 27	DATA MISSING FOR THIS DAY						
1992 8 28	DATA MISSING FOR THIS DAY						
1992 8 29	DATA MISSING FOR THIS DAY						
1992 8 30	DATA MISSING FOR THIS DAY						
1992 8 31	DATA MISSING FOR THIS DAY						

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
53.06	1.60	DATA MISSING FOR THIS DAY			

Prepared by FXB

Reviewed by [illegible]

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992	8	1	50.05	1.57	49.63	0.90	-0.42	1.12	24
1992	8	2	49.27	0.60	49.30	1.06	0.03	0.64	24
1992	8	3	48.95	0.32	48.82	0.46	-0.12	0.46	24
1992	8	4	48.87	0.47	48.43	0.51	-0.44	0.44	21
1992	8	5	48.49	0.55	48.07	0.68	-0.42	0.73	16
1992	8	6	48.96	0.56	48.40	0.83	-0.56	0.69	24
1992	8	7	50.63	0.80	49.78	0.85	-0.85	0.70	24
1992	8	8	50.58	0.78	50.35	0.80	-0.23	0.79	24
1992	8	9	51.01	0.91	50.75	0.73	-0.25	0.78	24
1992	8	10	54.86	1.19	54.65	1.20	-0.21	1.15	24
1992	8	11	52.18	0.92	51.59	0.76	-0.59	0.79	24
1992	8	12	53.34	1.10	52.27	1.21	-1.06	0.83	24
1992	8	13	57.07	1.86	56.83	1.63	-0.25	0.87	24
1992	8	14	58.22	0.62	57.90	0.74	-0.32	0.75	24
1992	8	15	58.56	1.05	57.25	2.30	-1.30	2.72	24
1992	8	16	59.43	0.25	56.98	3.29	-2.45	3.47	24
1992	8	17	59.40	0.16	59.13	0.26	-0.28	0.25	24
1992	8	18	59.77	0.47	59.41	0.41	-0.36	0.27	24
1992	8	19	59.60	0.33	59.36	0.51	-0.25	0.41	24
1992	8	20	59.02	0.58	58.21	0.78	-0.81	0.58	24
1992	8	21	58.54	0.79	58.22	1.46	-0.32	0.85	24
1992	8	22	57.54	1.16	57.05	1.79	-0.49	1.18	24
1992	8	23	57.64	1.39	57.27	2.08	-0.37	1.09	24
1992	8	24	56.02	1.25	55.83	1.97	-0.19	1.06	24
1992	8	25	54.12	1.03	53.51	1.30	-0.60	0.82	24
1992	8	26	55.06	1.35	54.20	1.44	-0.86	0.84	24
1992	8	27	56.31	1.09	55.43	0.94	-0.88	0.74	24
1992	8	28	55.51	1.19	54.50	1.24	-1.00	0.95	24
1992	8	29	52.89	1.94	51.74	1.89	-1.15	2.08	24
1992	8	30	50.16	1.03	50.20	1.56	0.04	0.93	24
1992	8	31	48.97	1.25	49.18	1.63	0.21	0.73	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
54.31	0.92	53.77	1.20	-0.54	733

Prepared by FxB

Reviewed by JS

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992	8	1	46.66	1.05	47.31	0.92	0.65	0.61	24
1992	8	2	46.29	1.23	46.45	0.40	0.16	1.42	24
1992	8	3	47.04	0.31	47.06	0.30	0.02	0.46	24
1992	8	4	46.57	0.44	46.77	0.29	0.20	0.41	21
1992	8	5	45.05	0.24	45.95	0.21	0.90	0.29	16
1992	8	6	46.23	0.50	46.09	0.58	-0.14	0.40	24
1992	8	7	47.12	0.44	47.15	0.76	0.03	0.56	24
1992	8	8	47.45	0.36	47.42	0.61	-0.03	0.53	24
1992	8	9	48.02	0.78	48.15	0.84	0.13	0.81	24
1992	8	10	48.69	0.68	49.00	1.39	0.31	1.63	24
1992	8	11	47.44	0.49	48.20	0.63	0.76	0.51	24
1992	8	12	47.83	0.47	47.97	0.48	0.14	0.81	24
1992	8	13	49.68	0.94	48.80	0.92	-0.88	1.02	24
1992	8	14	49.79	0.88	50.16	0.71	0.37	1.11	24
1992	8	15	50.73	1.99	51.99	4.73	1.27	3.68	24
1992	8	16	56.87	3.19	60.74	2.55	3.87	5.35	24
1992	8	17	56.61	0.83	57.06	0.68	0.45	1.21	24
1992	8	18	57.35	0.30	57.46	0.47	0.11	0.68	24
1992	8	19	56.02	1.37	56.28	0.89	0.26	1.39	24
1992	8	20	50.81	2.23	52.47	1.87	1.65	2.41	24
1992	8	21	50.75	1.38	50.59	0.65	-0.16	1.35	24
1992	8	22	49.82	1.35	50.06	0.51	0.24	1.13	24
1992	8	23	50.36	1.01	50.24	0.91	-0.12	1.08	24
1992	8	24	49.80	0.76	50.15	0.30	0.35	0.76	24
1992	8	25	49.14	0.58	49.70	0.46	0.56	0.52	24
1992	8	26	49.39	0.66	49.93	0.84	0.54	0.64	24
1992	8	27	50.00	0.40	50.24	0.65	0.24	0.80	24
1992	8	28	50.61	1.45	50.82	1.05	0.21	0.78	24
1992	8	29	49.22	0.93	53.23	5.88	4.01	5.24	24
1992	8	30	47.60	0.51	48.11	0.76	0.50	0.83	24
1992	8	31	46.12	0.70	46.85	0.51	0.74	0.56	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
49.58	0.92	50.14	1.06	0.56	733

Prepared by FLB

Reviewed by JGS

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
1992	9	1	50.64	1.10	53.68	0.77	3.04	1.19	24
1992	9	2	51.37	0.93	54.44	1.15	3.07	1.33	24
1992	9	3	52.05	0.60	55.57	0.76	3.52	0.76	24
1992	9	4	52.50	0.23	56.97	1.17	4.46	1.19	24
1992	9	5	54.34	1.65	56.29	0.23	1.96	1.59	24
1992	9	6	56.27	0.25	56.49	0.24	0.22	0.28	24
1992	9	7	56.22	0.51	57.93	1.23	1.71	1.27	24
1992	9	8	56.28	0.26	58.08	0.97	1.80	0.92	24
1992	9	9	56.67	1.29	58.68	1.15	2.01	0.82	24
1992	9	10	56.79	0.85	58.16	1.13	1.38	0.86	24
1992	9	11	55.55	0.72	57.33	1.06	1.79	0.69	24
1992	9	12	55.28	0.68	58.59	0.97	3.31	0.62	24
1992	9	13	56.29	0.79	59.18	0.84	2.88	0.52	24
1992	9	14	57.00	0.42	59.56	0.68	2.56	0.49	24
1992	9	15	56.18	0.46	58.62	0.48	2.43	0.23	9
1992	9	16			DATA MISSING FOR THIS DAY				
1992	9	17			DATA MISSING FOR THIS DAY				
1992	9	19			DATA MISSING FOR THIS DAY				
1992	9	20			DATA MISSING FOR THIS DAY				
1992	9	21			DATA MISSING FOR THIS DAY				
1992	9	22			DATA MISSING FOR THIS DAY				
1992	9	23			DATA MISSING FOR THIS DAY				
1992	9	24			DATA MISSING FOR THIS DAY				
1992	9	25			DATA MISSING FOR THIS DAY				
1992	9	26			DATA MISSING FOR THIS DAY				
1992	9	27			DATA MISSING FOR THIS DAY				
1992	9	28			DATA MISSING FOR THIS DAY				
1992	9	29			DATA MISSING FOR THIS DAY				
1992	9	30			DATA MISSING FOR THIS DAY				

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
57.25	0.86	54.84	0.72	2.41	345

Prepared by FXB

Reviewed by [signature]

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992	9	1	50.64	1.10	48.80	1.43	-1.83	2.30	24
1992	9	2	50.92	0.80	51.61	0.83	0.69	0.90	10
1992	9	3	52.05	0.60	50.32	0.76	-1.73	0.71	24
1992	9	4	52.50	0.23	51.25	0.60	-1.25	0.75	24
1992	9	5	54.34	1.65	51.29	0.77	-3.04	1.10	24
1992	9	6	56.27	0.25	52.60	0.60	-3.66	0.55	24
1992	9	7	56.22	0.51	53.93	0.65	-2.30	0.62	24
1992	9	8	56.28	0.26	54.50	0.66	-1.78	0.51	24
1992	9	9	56.67	1.29	55.34	1.05	-1.33	1.02	24
1992	9	10	56.79	0.85	54.87	0.98	-1.92	1.15	24
1992	9	11	55.55	0.72	55.24	0.61	-0.31	0.56	24
1992	9	12	55.28	0.68	56.16	1.23	0.88	0.86	24
1992	9	13	56.29	0.79	57.75	1.16	1.46	0.53	24
1992	9	14	57.00	0.42	59.01	1.06	2.00	0.89	24
1992	9	15	56.18	0.46	57.95	0.59	1.77	0.34	9
1992	9	16	DATA MISSING FOR THIS DAY						
1992	9	17	DATA MISSING FOR THIS DAY						
1992	9	19	DATA MISSING FOR THIS DAY						
1992	9	20	DATA MISSING FOR THIS DAY						
1992	9	21	DATA MISSING FOR THIS DAY						
1992	9	22	DATA MISSING FOR THIS DAY						
1992	9	23	DATA MISSING FOR THIS DAY						
1992	9	24	DATA MISSING FOR THIS DAY						
1992	9	25	DATA MISSING FOR THIS DAY						
1992	9	26	DATA MISSING FOR THIS DAY						
1992	9	27	DATA MISSING FOR THIS DAY						
1992	9	28	DATA MISSING FOR THIS DAY						
1992	9	29	DATA MISSING FOR THIS DAY						
1992	9	30	DATA MISSING FOR THIS DAY						

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
54.97	0.71	53.97	0.86	-1.01	331

Prepared by ELB

Reviewed by [illegible]

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992	9	1	48.73	1.08	48.24	1.09	-0.48	1.04	24
1992	9	2	49.69	1.16	49.12	1.10	-0.57	0.84	24
1992	9	3	50.83	0.92	50.21	1.19	-0.63	0.85	24
1992	9	4	52.29	0.40	52.39	0.50	0.10	0.52	24
1992	9	5	52.48	0.21	52.20	0.31	-0.28	0.25	24
1992	9	6	53.34	0.40	52.88	0.32	-0.47	0.22	24
1992	9	7	53.72	0.22	53.30	0.21	-0.42	0.32	24
1992	9	8	53.69	0.20	53.23	0.27	-0.46	0.29	24
1992	9	9	53.35	0.31	52.81	0.49	-0.54	0.33	24
1992	9	10	53.19	0.69	52.56	0.74	-0.63	0.45	24
1992	9	11	51.55	0.33	50.90	0.37	-0.65	0.38	24
1992	9	12	53.45	1.13	52.09	1.36	-1.36	0.66	24
1992	9	13	54.73	0.87	53.89	1.37	-0.84	0.74	24
1992	9	14	54.18	0.84	53.68	0.98	-0.50	0.83	24
1992	9	15	52.69	0.85	52.37	0.67	-0.33	0.46	9
1992	9	16			DATA MISSING FOR THIS DAY				
1992	9	17			DATA MISSING FOR THIS DAY				
1992	9	19			DATA MISSING FOR THIS DAY				
1992	9	20			DATA MISSING FOR THIS DAY				
1992	9	21			DATA MISSING FOR THIS DAY				
1992	9	22			DATA MISSING FOR THIS DAY				
1992	9	23			DATA MISSING FOR THIS DAY				
1992	9	24			DATA MISSING FOR THIS DAY				
1992	9	25			DATA MISSING FOR THIS DAY				
1992	9	26			DATA MISSING FOR THIS DAY				
1992	9	27			DATA MISSING FOR THIS DAY				
1992	9	28			DATA MISSING FOR THIS DAY				
1992	9	29			DATA MISSING FOR THIS DAY				
1992	9	30			DATA MISSING FOR THIS DAY				

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
52.52	0.64	51.97	0.73	-0.55	345

Prepared by FxB

Reviewed by [illegible]

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992	9	1	45.59	0.27	46.05	0.26	0.46	0.40	24
1992	9	2	46.61	0.45	46.72	0.46	0.11	0.35	24
1992	9	3	47.87	0.85	47.60	0.76	-0.27	0.51	24
1992	9	4	51.20	1.10	51.26	1.39	0.06	0.70	24
1992	9	5	51.09	0.42	51.41	0.19	0.32	0.28	24
1992	9	6	50.78	0.43	51.59	0.43	0.81	0.76	24
1992	9	7	51.29	0.29	51.24	0.41	-0.05	0.37	24
1992	9	8	51.11	0.16	51.02	0.44	-0.09	0.38	24
1992	9	9	50.25	0.83	50.45	0.31	0.20	0.69	24
1992	9	10	49.79	0.77	50.13	0.27	0.34	0.56	24
1992	9	11	47.68	0.56	48.78	0.67	1.10	0.55	24
1992	9	12	48.82	0.70	48.47	0.41	-0.35	0.55	24
1992	9	13	49.76	0.75	49.63	0.52	-0.13	0.87	24
1992	9	14	49.99	0.57	50.19	0.63	0.21	0.82	24
1992	9	15	49.76	0.63	50.29	0.49	0.53	0.35	9
1992	9	16			DATA MISSING FOR THIS DAY				
1992	9	17			DATA MISSING FOR THIS DAY				
1992	9	19			DATA MISSING FOR THIS DAY				
1992	9	20			DATA MISSING FOR THIS DAY				
1992	9	21			DATA MISSING FOR THIS DAY				
1992	9	22			DATA MISSING FOR THIS DAY				
1992	9	23			DATA MISSING FOR THIS DAY				
1992	9	24			DATA MISSING FOR THIS DAY				
1992	9	25			DATA MISSING FOR THIS DAY				
1992	9	26			DATA MISSING FOR THIS DAY				
1992	9	27			DATA MISSING FOR THIS DAY				
1992	9	28			DATA MISSING FOR THIS DAY				
1992	9	29			DATA MISSING FOR THIS DAY				
1992	9	30			DATA MISSING FOR THIS DAY				

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
49.43	0.59	49.63	0.51	0.20	345

Prepared by EXB
Reviewed by [signature]

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
1992 11 1			DATA MISSING FOR THIS DAY				
1992 11 2			DATA MISSING FOR THIS DAY				
1992 11 3			DATA MISSING FOR THIS DAY				
1992 11 4			DATA MISSING FOR THIS DAY				
1992 11 5			DATA MISSING FOR THIS DAY				
1992 11 6			DATA MISSING FOR THIS DAY				
1992 11 7			DATA MISSING FOR THIS DAY				
1992 11 8			DATA MISSING FOR THIS DAY				
1992 11 9			DATA MISSING FOR THIS DAY				
1992 11 10			DATA MISSING FOR THIS DAY				
1992 11 11	46.96	0.06	48.01	0.08	1.06	0.11	8
1992 11 12	46.89	0.19	47.77	0.10	0.88	0.17	10
1992 11 13	47.06	0.35	47.87	0.32	0.81	0.25	23
1992 11 14	46.01	0.32	47.40	0.42	1.39	0.46	24
1992 11 15	46.43	0.51	47.46	0.38	1.03	0.63	24
1992 11 16	45.61	0.18	47.45	0.27	1.84	0.28	24
1992 11 17	45.81	0.37	47.72	0.74	1.90	0.86	24
1992 11 18	45.61	0.15	47.76	0.98	2.15	0.98	24
1992 11 19	45.61	0.47	47.99	0.62	2.38	0.68	24
1992 11 20	44.70	0.23	48.02	1.11	3.32	1.11	24
1992 11 21	44.78	0.34	48.08	0.66	3.30	0.66	24
1992 11 22	46.13	0.58	48.42	0.55	2.28	0.83	24
1992 11 23	46.16	0.17	50.60	1.01	4.44	0.96	24
1992 11 24	45.75	0.16	50.02	0.82	4.27	0.81	24
1992 11 25	45.51	0.26	48.50	0.67	2.99	0.72	24
1992 11 26	45.31	0.08	49.21	1.23	3.89	1.23	24
1992 11 27	45.13	0.18	48.60	1.41	3.46	1.50	24
1992 11 28	45.62	0.19	46.44	0.19	0.82	0.19	24
1992 11 29	44.62	0.43	47.67	0.42	3.05	0.51	24
1992 11 30	45.25	0.34	48.78	0.34	3.52	0.33	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
48.21	0.62	45.67	0.28	2.54	449

Prepared by FXB

Reviewed by JMS

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992 11 1	DATA MISSING FOR THIS DAY						
1992 11 2	DATA MISSING FOR THIS DAY						
1992 11 3	DATA MISSING FOR THIS DAY						
1992 11 4	DATA MISSING FOR THIS DAY						
1992 11 5	DATA MISSING FOR THIS DAY						
1992 11 6	DATA MISSING FOR THIS DAY						
1992 11 7	DATA MISSING FOR THIS DAY						
1992 11 8	DATA MISSING FOR THIS DAY						
1992 11 9	DATA MISSING FOR THIS DAY						
1992 11 10	DATA MISSING FOR THIS DAY						
1992 11 11	46.98	0.10	47.08	0.25	0.10	0.26	16
1992 11 12	46.98	0.25	46.79	0.19	-0.19	0.16	13
1992 11 13	47.08	0.35	47.18	0.33	0.10	0.35	24
1992 11 14	46.01	0.32	45.97	0.49	-0.04	0.52	24
1992 11 15	46.43	0.51	46.06	0.44	-0.37	0.50	24
1992 11 16	45.61	0.18	45.76	0.50	0.15	0.46	24
1992 11 17	45.81	0.37	45.71	0.42	-0.11	0.55	24
1992 11 18	45.61	0.15	44.54	0.44	-1.07	0.50	24
1992 11 19	45.61	0.47	44.39	0.33	-1.22	0.59	24
1992 11 20	44.70	0.23	44.08	0.70	-0.62	0.72	24
1992 11 21	44.78	0.34	44.51	1.18	-0.28	1.04	24
1992 11 22	46.13	0.58	46.16	0.56	0.03	0.56	24
1992 11 23	46.16	0.17	45.59	0.37	-0.57	0.32	24
1992 11 24	45.75	0.16	44.97	0.25	-0.78	0.25	24
1992 11 25	45.51	0.26	45.47	0.72	-0.04	0.75	24
1992 11 26	45.31	0.08	45.12	0.46	-0.20	0.43	24
1992 11 27	45.13	0.18	45.23	0.17	0.10	0.26	24
1992 11 28	45.62	0.19	44.91	0.25	-0.71	0.15	24
1992 11 29	44.62	0.43	44.48	0.50	-0.14	0.69	24
1992 11 30	45.25	0.34	44.59	0.20	-0.67	0.36	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
45.70	0.28	45.37	0.44	-0.34	461

Prepared by FKB

Reviewed by JMS

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992 11 1	DATA MISSING FOR THIS DAY						
1992 11 2	DATA MISSING FOR THIS DAY						
1992 11 3	DATA MISSING FOR THIS DAY						
1992 11 4	DATA MISSING FOR THIS DAY						
1992 11 5	DATA MISSING FOR THIS DAY						
1992 11 6	DATA MISSING FOR THIS DAY						
1992 11 7	DATA MISSING FOR THIS DAY						
1992 11 8	DATA MISSING FOR THIS DAY						
1992 11 9	DATA MISSING FOR THIS DAY						
1992 11 10	DATA MISSING FOR THIS DAY						
1992 11 11	47.31	0.24	47.29	0.03	-0.01	0.24	16
1992 11 12	47.42	0.17	47.06	0.12	-0.36	0.14	10
1992 11 13	46.64	0.41	46.69	0.43	0.05	0.35	24
1992 11 14	45.97	0.25	45.94	0.38	-0.02	0.35	24
1992 11 15	45.77	0.39	46.33	0.47	0.55	0.30	24
1992 11 16	45.65	0.28	45.92	0.44	0.27	0.36	24
1992 11 17	45.40	0.46	45.74	0.28	0.34	0.29	24
1992 11 18	45.10	0.59	45.09	0.63	-0.01	1.15	24
1992 11 19	45.92	0.20	45.13	0.26	-0.79	0.41	24
1992 11 20	45.87	0.12	45.47	0.33	-0.40	0.42	24
1992 11 21	45.51	0.26	45.41	0.25	-0.09	0.38	24
1992 11 22	45.38	0.33	45.53	0.22	0.15	0.23	24
1992 11 23	45.93	0.42	45.70	0.29	-0.23	0.21	24
1992 11 24	45.85	0.16	45.36	0.24	-0.49	0.21	24
1992 11 25	45.63	0.09	45.44	0.12	-0.20	0.15	24
1992 11 26	45.45	0.28	45.55	0.08	0.10	0.25	24
1992 11 27	45.67	0.16	45.61	0.07	-0.06	0.19	24
1992 11 28	45.72	0.14	45.61	0.10	-0.12	0.18	24
1992 11 29	45.89	0.10	45.67	0.13	-0.22	0.19	24
1992 11 30	45.80	0.09	45.48	0.11	-0.32	0.10	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
45.82	0.26	45.74	0.25	-0.09	458

Prepared by F+B

Reviewed by [signature]

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992 11 1	DATA MISSING FOR THIS DAY						
1992 11 2	DATA MISSING FOR THIS DAY						
1992 11 3	DATA MISSING FOR THIS DAY						
1992 11 4	DATA MISSING FOR THIS DAY						
1992 11 5	DATA MISSING FOR THIS DAY						
1992 11 6	DATA MISSING FOR THIS DAY						
1992 11 7	DATA MISSING FOR THIS DAY						
1992 11 8	DATA MISSING FOR THIS DAY						
1992 11 9	DATA MISSING FOR THIS DAY						
1992 11 10	DATA MISSING FOR THIS DAY						
1992 11 11	47.97	1.49	47.71	0.09	-0.27	1.51	16
1992 11 12	47.73	0.92	47.18	0.05	-0.55	0.96	9
1992 11 13	DATA MISSING FOR THIS DAY						
1992 11 14	DATA MISSING FOR THIS DAY						
1992 11 15	DATA MISSING FOR THIS DAY						
1992 11 16	DATA MISSING FOR THIS DAY						
1992 11 17	DATA MISSING FOR THIS DAY						
1992 11 18	DATA MISSING FOR THIS DAY						
1992 11 19	DATA MISSING FOR THIS DAY						
1992 11 20	DATA MISSING FOR THIS DAY						
1992 11 21	DATA MISSING FOR THIS DAY						
1992 11 22	DATA MISSING FOR THIS DAY						
1992 11 23	DATA MISSING FOR THIS DAY						
1992 11 24	DATA MISSING FOR THIS DAY						
1992 11 25	DATA MISSING FOR THIS DAY						
1992 11 26	DATA MISSING FOR THIS DAY						
1992 11 27	DATA MISSING FOR THIS DAY						
1992 11 28	DATA MISSING FOR THIS DAY						
1992 11 29	DATA MISSING FOR THIS DAY						
1992 11 30	DATA MISSING FOR THIS DAY						

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
47.89	1.21	47.52	0.07	-0.37	25

Prepared by EKB

Reviewed by JMS

MONTHLY SUMMARY STATIONS DSUP & T7UP

DATE			MEAN (T7)	S.DEV (T7)	MEAN (DS)	S.DEV (DS)	MEAN (DS-T7)	S.DEV (DS-T7)	N
1992	12	1	45.31	0.20	48.48	0.64	3.17	0.56	24
1992	12	2	45.06	0.63	47.55	1.73	2.50	1.30	24
1992	12	3	43.97	0.09	44.68	0.72	0.72	0.72	24
1992	12	4	44.11	0.32	46.56	0.75	2.45	0.54	24
1992	12	5	44.27	0.35	48.55	1.03	4.28	1.06	24
1992	12	6	43.40	0.27	47.28	1.11	3.88	0.91	24
1992	12	7	43.50	0.37	46.86	0.66	3.36	0.45	24
1992	12	8	43.64	0.28	47.11	0.69	3.47	0.64	24
1992	12	9	42.07	0.65	45.21	0.21	3.14	0.74	24
1992	12	10	41.66	0.49	46.50	0.41	4.84	0.63	24
1992	12	11	40.72	0.41	43.66	2.56	2.93	2.80	24
1992	12	12	41.28	0.62	41.72	0.51	0.44	0.50	21
1992	12	13	40.18	0.16	40.94	0.21	0.76	0.23	13
1992	12	14	40.14	0.10	40.86	0.15	0.72	0.21	21
1992	12	15	39.93	0.10	41.29	0.35	1.35	0.28	24
1992	12	16	40.60	0.45	42.21	0.33	1.61	0.29	24
1992	12	17	41.30	0.15	44.24	1.21	2.94	1.12	24
1992	12	18	41.85	0.21	46.51	0.62	4.66	0.56	24
1992	12	19	41.82	0.19	45.50	1.00	3.68	1.11	24
1992	12	20	41.71	0.42	45.02	0.59	3.31	0.54	24
1992	12	21	42.21	0.11	46.60	0.45	4.39	0.39	24
1992	12	22	41.75	0.47	45.37	0.61	3.62	0.93	24
1992	12	23	42.43	0.18	46.26	0.59	3.82	0.59	24
1992	12	24	42.61	0.16	45.92	1.01	3.31	1.01	24
1992	12	25	41.78	0.71	44.92	1.06	3.15	0.85	17
1992	12	26	41.35	0.69	44.72	0.54	3.36	0.77	24
1992	12	27	41.47	0.39	44.75	0.55	3.28	0.82	24
1992	12	28	41.66	0.12	44.70	0.59	3.04	0.66	24
1992	12	29	41.01	0.43	45.16	0.61	4.15	0.78	24
1992	12	30	41.13	0.52	44.55	2.24	3.42	1.83	24
1992	12	31	39.98	0.22	43.55	1.89	3.57	2.10	24

MEAN (DS)	S.DEV (DS)	MEAN (T7)	S.DEV (T7)	MEAN (DS-T7)	N
45.17	0.83	42.10	0.34	3.06	720

Prepared by FB

Reviewed by [signature]

MONTHLY SUMMARY STATIONS T7UP & IDUP

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992 12 1	45.31	0.20	45.13	0.50	-0.18	0.60	24
1992 12 2	45.06	0.63	44.58	0.77	-0.48	0.68	24
1992 12 3	43.97	0.09	43.13	0.09	-0.83	0.12	24
1992 12 4	44.11	0.32	43.50	0.33	-0.61	0.38	24
1992 12 5	44.27	0.35	43.38	0.33	-0.89	0.32	24
1992 12 6	43.40	0.27	42.65	0.29	-0.75	0.29	24
1992 12 7	43.50	0.37	42.88	0.37	-0.63	0.53	24
1992 12 8	43.64	0.28	42.60	0.55	-1.04	0.63	24
1992 12 9	42.07	0.65	41.56	0.63	-0.51	1.09	24
1992 12 10	41.66	0.49	41.22	0.66	-0.44	0.47	24
1992 12 11	40.72	0.41	40.32	0.90	-0.40	1.16	24
1992 12 12	41.20	0.63	40.37	0.43	-0.83	0.48	24
1992 12 13	40.48	0.45	39.77	0.21	-0.70	0.35	21
1992 12 14	40.14	0.10	39.58	0.10	-0.55	0.17	21
1992 12 15	39.93	0.10	39.72	0.31	-0.21	0.24	24
1992 12 16	40.60	0.45	40.47	0.40	-0.12	0.37	24
1992 12 17	41.30	0.15	40.88	0.45	-0.42	0.50	24
1992 12 18	41.85	0.21	41.16	0.31	-0.69	0.17	24
1992 12 19	41.82	0.19	41.01	0.63	-0.81	0.62	24
1992 12 20	41.71	0.42	41.55	0.64	-0.16	0.90	24
1992 12 21	42.21	0.11	41.65	0.35	-0.55	0.39	24
1992 12 22	41.75	0.47	41.97	0.89	0.23	1.13	24
1992 12 23	42.43	0.18	41.28	0.67	-1.15	0.67	24
1992 12 24	42.61	0.16	41.68	0.39	-0.93	0.44	24
1992 12 25	41.78	0.71	41.56	0.76	-0.21	0.76	17
1992 12 26	41.35	0.69	40.99	0.73	-0.36	0.70	24
1992 12 27	41.47	0.39	39.93	0.23	-1.54	0.41	24
1992 12 28	41.66	0.12	39.59	0.36	-2.07	0.42	24
1992 12 29	41.01	0.43	40.60	0.63	-0.42	0.84	24
1992 12 30	41.13	0.52	40.88	0.99	-0.25	0.67	24
1992 12 31	39.98	0.22	39.48	0.20	-0.50	0.12	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
42.09	0.35	41.47	0.49	-0.62	731

Prepared by FXB

Reviewed by JRS

MONTHLY SUMMARY STATIONS T7MD & IDMD

DATE			MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992	12	1	45.47	0.16	45.22	0.08	-0.25	0.13	24
1992	12	2	45.03	0.09	45.06	0.21	0.02	0.24	24
1992	12	3	44.45	0.40	44.29	0.68	-0.17	0.39	24
1992	12	4	45.33	0.26	45.67	0.72	0.34	0.68	24
1992	12	5	44.80	0.37	44.95	0.91	0.15	0.72	24
1992	12	6	43.62	0.23	43.25	0.17	-0.37	0.30	24
1992	12	7	43.84	0.29	43.88	0.19	0.03	0.30	24
1992	12	8	43.80	0.26	42.96	0.40	-0.84	0.33	24
1992	12	9	43.19	0.33	42.11	0.31	-1.08	0.42	24
1992	12	10	41.70	0.44	41.47	0.77	-0.23	0.54	24
1992	12	11	40.93	0.41	40.58	0.75	-0.34	1.02	24
1992	12	12	41.41	0.62	40.73	0.44	-0.67	0.43	24
1992	12	13	40.73	0.43	40.14	0.25	-0.59	0.29	21
1992	12	14	40.37	0.05	39.97	0.07	-0.40	0.08	16
1992	12	15	40.34	0.35	40.07	0.23	-0.27	0.30	24
1992	12	16	41.65	0.58	40.78	0.38	-0.87	0.32	24
1992	12	17	42.24	0.13	41.50	0.22	-0.73	0.18	24
1992	12	18	42.29	0.11	41.66	0.17	-0.62	0.15	24
1992	12	19	42.12	0.17	41.50	0.22	-0.62	0.35	24
1992	12	20	42.39	0.17	41.77	0.39	-0.62	0.30	24
1992	12	21	42.41	0.15	42.01	0.10	-0.40	0.22	24
1992	12	22	42.50	0.23	42.14	0.17	-0.36	0.27	24
1992	12	23	42.84	0.12	42.24	0.30	-0.60	0.32	24
1992	12	24	42.81	0.16	42.01	0.21	-0.81	0.24	24
1992	12	25	42.17	0.48	41.77	0.47	-0.41	0.69	13
1992	12	26	41.45	0.73	41.34	0.61	-0.11	0.64	24
1992	12	27	41.68	0.38	40.15	0.25	-1.52	0.41	24
1992	12	28	41.86	0.10	39.85	0.22	-2.00	0.26	24
1992	12	29	41.20	0.37	40.18	0.42	-1.02	0.56	24
1992	12	30	41.05	0.33	40.46	0.43	-0.59	0.33	24
1992	12	31	40.85	0.31	40.30	0.29	-0.56	0.20	24

MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	N
42.50	0.30	41.97	0.36	-0.54	722

Prepared by FRB

Reviewed by

MONTHLY SUMMARY STATIONS T7LO & IDLO

DATE	MEAN (T7)	S.DEV (T7)	MEAN (ID)	S.DEV (ID)	MEAN (ID-T7)	S.DEV (ID-T7)	N
1992 12 1	DATA MISSING FOR THIS DAY						
1992 12 2	DATA MISSING FOR THIS DAY						
1992 12 3	DATA MISSING FOR THIS DAY						
1992 12 4	DATA MISSING FOR THIS DAY						
1992 12 5	DATA MISSING FOR THIS DAY						
1992 12 6	DATA MISSING FOR THIS DAY						
1992 12 7	DATA MISSING FOR THIS DAY						
1992 12 8	DATA MISSING FOR THIS DAY						
1992 12 9	DATA MISSING FOR THIS DAY						
1992 12 10	DATA MISSING FOR THIS DAY						
1992 12 11	DATA MISSING FOR THIS DAY						
1992 12 12	DATA MISSING FOR THIS DAY						
1992 12 13	DATA MISSING FOR THIS DAY						
1992 12 14	DATA MISSING FOR THIS DAY						
1992 12 15	DATA MISSING FOR THIS DAY						
1992 12 16	DATA MISSING FOR THIS DAY						
1992 12 17	DATA MISSING FOR THIS DAY						
1992 12 18	DATA MISSING FOR THIS DAY						
1992 12 19	DATA MISSING FOR THIS DAY						
1992 12 20	DATA MISSING FOR THIS DAY						
1992 12 21	DATA MISSING FOR THIS DAY						
1992 12 22	DATA MISSING FOR THIS DAY						
1992 12 23	DATA MISSING FOR THIS DAY						
1992 12 24	DATA MISSING FOR THIS DAY						
1992 12 25	DATA MISSING FOR THIS DAY						
1992 12 26	DATA MISSING FOR THIS DAY						
1992 12 27	DATA MISSING FOR THIS DAY						
1992 12 28	DATA MISSING FOR THIS DAY						
1992 12 29	DATA MISSING FOR THIS DAY						
1992 12 30	DATA MISSING FOR THIS DAY						
1992 12 31	DATA MISSING FOR THIS DAY						

Prepared by FJD

Reviewed by [illegible signature]