New Jersey Department of Environmental Protection W.P.

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COMPARISON OF NATURAL AND ALTERED ESTUARINE SYSTEMS

The Field Data - Volume I

Center for Coastal and Environmental Studies
Rutgers - The State University of New Jersey

New Jersey Department of Environmental Protection,
Division of Fish, Game, and Shellfisheries, and
Division of Coastal Resources

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COMPARISON OF NATURAL AND ALTERED ESTUARINE SYSTEMS: The Field Data - Volumes I and II

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COMPARISON OF NATURAL AND ALTERED ESTUARINE SYSTEMS: The Field Data - Volumes I and II

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USERS GUIDE TO THE FIELD DATA - VOLUMES I AND II

The Estuarine Evaluation Project was a cooperative venture by Rutgers - the State University and the New Jersey Department of Environmental Protection. Its purpose was to study how a lagoon home development built on a salt marsh would affect the processes, functions, and conditions normally found in such an area. The specific site chosen is presently known as Village Harbour; however, at the time of the study, it was called Beach Haven West. It is located in Ocean County near Manahawkin, New Jersey. The investigation was multifaceted and was conducted from 1973 through 1977.

The results of this study are presented in a two-part format. The first part is a two volume set which is titled "The Field Data". The data represent a compilation of the documents submitted by the principal investigators in fulfillment of their project responsibilities. The purpose of these reports is to establish data sets of the many components forming the estuarine system and to investigate the individual units. The second part entitled "Analysis", draws upon selected portions of the field data to evaluate the effects of and the changes brought about by the lagoon development's presence.

In assembling the two volumes of field data, certain guidelines were employed. The principal objective was the preservation of the intent and meaning of the original investigator. To accomplish this, the two volumes were organized as a compilation of the original research reports with a minimum of editing or modification. This was to ensure the integrity and logic of each report was retained as the author intended. In general, changes were made only to maintain a standard format. Major changes were subject to the approval of the original authors. This guideline served to reinforce the direct connection between the report and the researcher who authored it. It also assured the scientific validity of the subsequent analysis. One consequence of this minimum change policy was the retention of the units system employed by the investigator. The problem of dealing in the British and metric systems concurrently was not deemed significant enough to warrant the extensive changes required. Another guideline concerned the choice of documents in the field data volumes. If a number of reports were produced over the course of the investigation, the summary versions of the reports were included. If such superseding documents were unavailable, all available reports were appended and placed in the compilation.

It is intended that the contents of the reports in the two field data volumes are the responsibility of the original authors. All manuscripts were subject to author review and approval prior to publication. The compilers of the field data assume responsibility only for the accurate transferal of text from the submitted original reports into the final format.

Within the field data volumes, the taxonomic nomenclature follows Gosner (1971) for the estuarine benthic invertebrates and Bailey et al. (1960) for the fish. Note that the editors consider *Nassarius obsoletus* and *Ilyanassa obsoleta* synonymous as are *Phragmites communis* and *Phragmites australis*.

Because the report sizes in the field data volumes varied considerably, two types of organization were employed. Those reports under 30 pages were written in a condensed format. Features such as separate title pages, table of contents,

list of figures, list of tables, and separate acknowledgement and abstract pages (when requested), were used only in the larger reports. Condensation of the format size was a primary objective in the smaller reports.

Appendices are found in reports of all sizes and were employed to include (1) additional data not referred to in the report itself (see the Durand et al. and Good et al. reports); (2) raw data (see the Haskin and Ray report); and (3) figures and/or tables which would disrupt the text if placed in the body of the report because of the number of pages involved (see McClain et al. report).

The specific organization of the field data contribution is as follows:

1) Users Guide

2) Order of Reports

3) Abstracts

4) Compiled Reports

The order of the abstracts and the compiled reports followed as much as possible their sequence of use in the analysis. This order follows.

ORDER OF REPORTS

Report No.		
1	J. Durand, T. Sugihara, and C. Yearsley	ESTUARINE EVALUATION STUDY: PRIMARY AQUATIC PRODUCTION AND NITROGEN. FOUR YEAR REPORT, 1973-1977.
2	R. Good and B. Frasco	ESTUARINE EVALUATION STUDY: A FOUR YEAR REPORT ON PRODUCTION AND DECOMPOSITION DYNAMICS OF SALT MARSH COMMUNITIES OF THE MANAHAWKIN MARSHES, OCEAN COUNTY, NEW JERSEY.
3	D. Slate	MARSH PRODUCTIVITY: SUBMERGED SALT POND VEGETATION.
4	H. Haskin and G. Ray	ESTUARINE EVALUATION STUDY: BENTHIC INVERTEBRATES. FOUR YEAR REPORT, 1973-1977.
5	F. Ferrigno, L. Widjeskog, and E. Tomlin	MARSH PRODUCTIVITY: SURFACE INVERTEBRATE POPULATION INDICES.
6	J.R. Trout	MARSH PRODUCTIVITY: SURFACE INVERTEBRATE POPULATION INDICES.
7	J. McClain, J. Makai, and P. Himchak	STUDIES OF THE MANAHAWKIN BAY - LITTLE EGG HARBOR SYSTEM: (1) FINFISH STUDY: (2) PHYSICAL - CHEMICAL STUDY; AND (3) USE STUDY.
8	P. Festa	ANALYSIS OF THE FISH FORAGE BASE IN THE LITTLE EGG HARBOR ESTUARY.
9	R. Bosenberg	RODENT POPULATIONS.
10	J. Penkala and J. Sweger	WILDLIFE INDEXES: AVIAN DENSITY AND DIVERSITY.
11	L. Widjeskog and F. Ferrigno	WILDLIFE INDEXES: NESTING SURVEY.
12	J.R. Trout	WILDLIFE INDEXES: STATISTICAL ANALYSIS OF THE NESTING SURVEY DATA.
13	W. Shoemaker and F. Ferrigno	WILDLIFE INDEXES: WATERFOWL USE AND HARVEST.
14	J. Applegate, S. Salmore, and J. Blydenburg	RECREATIONAL USE OF NEW JERSEY'S WETLANDS BY THE CITIZENS OF NEW JERSEY.
15	J. Applegate and S. Sterner	A STUDY OF THE RECREATIONAL USE OF NEW JERSEY'S MARINE ENVIRONMENT.
16	S. Sterner and J. Applegate	ESTIMATES OF THE 1975 SPORT HARVEST OF MARINE FISHES.

ABSTRACTS

The abstracts are short, generally less than 250 words, and are intended to speed access by the reader to the individual reports of interest. The abstracts cover discrete research areas and may draw upon more than one report in the collation for their basis.

Abstract of the Primary Aquatic Productivity and Nitrogen: Four Year Report 1973-1977 study prepared by James Durand, Teruo Sugihara, and Charles Yearsley.

This study compares aspects of stratification, the nitrogen cycle, and primary production in a salt marsh system and an adjacent developed area near Manahawkin, New Jersey. Greater and more prolonged stratification is associated with the increased depths found in the lagoon development. The lower portions of the stratified water columns are subject to periodic anoxia and high ammonia-N levels. In all areas, the organic nitrogen fraction is the dominant nitrogen form found generally followed by ammonia-N, nitrate-N, and nitrite-N. In addition to nitrogen standing stocks, processes such as nitrogen fixation, excretion, and ammonification were also studied and partial nitrogen budgets constructed. Primary production studies were done on the microflora associated with the marsh surface, intertidal zone, and benthic sediments as well as the phytoplankton. The phytoplankton community is the greatest importance in both the natural and developed areas. Enrichment studies show the summer phytoplankton productive capacity to be nitrogen limited. High rates of production are also associated with the bulkhead algae community; however, its limited distribution minimizes its absolute total contribution. The productive capacity of the marsh surface edaphic algae community is directly related to light incidence. Consequently, the habitats with decreased grass canopy densities, like the *Spartina alterniflora* forms, have higher rates of primary production. In addition, the *S. alterniflora* short form occupies 60% of the marsh surface which magnifies the contribution of its edaphic algae to the total salt marsh productivity. As in the rest of this study, water column depth is stressed as a critical factor to production because of its relationship to the size of the euphotic zone, turbidity, and the type of biological activity possible in the benthos.

Abstract of the research on the production and decomposition dynamics of the salt marsh communities of the Manahawkin marshes performed by Ralph Good, Barry Frasco, Kay Smith, and William Brown.

In the Manahawkin salt marsh-estuarine ecosystem, vascular plant primary production and the fate of this biomass were studied from 1973 to 1976. All phases of both processes were subsequently related to environmental parameters. Using the harvest method, estimates of annual aboveground net production (g dry wt$\cdot m^{-2} \cdot yr^{-1}$) are as follows: tall form *Spartina alterniflora*, 825-735; short form *S. alterniflora*, 444-574; *S. patens*, 535-618; and *Distichlis spicata*, 613-644. Belowground production is generally about 5 times greater than aboveground. Total net primary production of short form *S. alternatiflora* on an energy basis is estimated at 16.0 kcal$\cdot m^{-2} \cdot yr^{-1}$, or 5.12 x 10^9 kcal for the entire marsh. These figures compared favorably with results for the world's most productive ecosystems. Standing crops of crude fiber, nitrogen-free extract, crude fat (aboveground material only), and crude protein (belowground material only) are shown to be a function of dry matter biomass. The accumulation of crude protein in aboveground

material at the beginning of the growing season is thought to be a storage mechanism for potentially limiting nitrogen. Approximately 90% of the annual net primary production of the vascular plants remained at the end of the growing season. Based upon the analyses of plant material placed in litter bags and left on the marsh, a general decomposition pattern is described for the majority of study sites. Decomposition rates, however, vary with the type of plant material and the environmental regime. The amount of aboveground material in g dry wt$\cdot m^{-2} \cdot month^{-1}$ entering the detrital food chain during the first year of decomposition is as follows: tall form *S. alterniflora*, 44 (6.0%); short form *S. alterniflora*, 20 (4.5%); and *S. patens*, 8 (1.5%). Additional biomass losses during the growing season are estimated from phenological studies, and are probably about 10% of the net aboveground production. Chemical analyses of decompositional material reveal at nearly all study sites, percent crude fat decreased and percent crude protein increased with time. The latter is attributed to colonization of the plant material by bacteria and fungi. The balance of production, decomposition, detrital export, accumulation, and incorporation into peat with seasonal tidal fluctuations and sea level changes are discussed in their relation to marsh stability.

Abstract of the 1976 Submerged Salt Pond Vegetation study prepared by Dennis Slate.

The purpose of the salt pool submerged vegetation study is to delineate the physical and chemical parameters which could be used to predict the presence or absence of *Ruppia maritima* and to measure the production of *Ruppia* in the salt pools of the Manahawkin marsh. Three parameters, depth, salinity, and surface area, accurately predicted 21 or 24 attempts. *Ruppia* occurs generally in ponds of large surface area, increased depth, and lower salinity. Peak *Ruppia* biomass occurs in late July - early August. The biomass estimates range from 0.04 to 79.60 g dry wt$\cdot m^{-2}$ with an overall mean of 30.2 g dry wt$\cdot m^{-2}$.

Abstract of the Benthic Invertebrates: Four Year Report 1973-1977 study prepared by Harold Haskin and Gary Ray.

During July 1973 - February 1975, an inventory of natural or undisturbed creeks, partially disturbed waterways, and fully lagooned waterways in the Manahawkin, New Jersey area quantified the distribution of benthic invertebrate species within the study area. During July 1975 - March 1977, emphasis was placed on the study of distribution, population structure, growth, production, and food web relationships of the dominant benthic species. All sampling was done on a seasonal basis using a ponar dredge (0.05 m^2).

A total of 185 species were collected. The two major dominant species are *Ampelisca abdita* and *Streblospio benedicti*. These two account for approximately 60 and 9% of all the organisms collected, respectively. The 20 most numerous species account for approximately 90% of the total collection. Of the taxonomic groups, the Crustacea are the most numerous, followed by the Polychaeta and the Mollusca.

Total species listings for each waterway type are nearly identical; however, species in the dredged and partially disturbed waterways were lost and replaced at a greater rate than in the natural creeks. Numbers of individuals and biomass

estimates are inversely related to degree of development or disturbance. The creeks have 9 times the individuals and 25 times the biomass of the lagoon community. Species distribution is apparently affected by hydrographic factors, sediment characteristics, and distance from the bay. Seasonal fluctuations in species, number of individuals, and biomass seem related to reproductive patterns of the dominant species and also to predation pressure. Production for the natural creek and lagooned waterways is estimated at 3.0 and 0.3 $kcal \cdot m^{-2} \cdot year^{-1}$, respectively.

Abstract of the research on surface invertebrate populations in the Cedar Run area performed by Fred Ferrigno, Lee Widjeskog, Earl Tomlin, and J. Richard Trout.

A preliminary study was conducted during August 1974 on the marsh surface invertebrate populations inhabiting 10 major cover types within the Cedar Run marsh evaluation study area. Point and interval estimates of the population densities within each cover type as well as total yield for the marsh complex were obtained for the following invertebrates: *Modiolus demissus, Melampus bidentatus, Uca pugnax, Philoscia vittata, Orchestia grillus,* ants, true bugs, crickets, grasshoppers, leaf-hoppers, and spiders. The most prevalent invertebrates in terms of density and frequency of occurrence are *Melampus, Philoscia,* leaf-hoppers, *Orchestia,* and the spiders (in decreasing order of importance). These account for approximately 99% of the total yield (6,327,992 organisms, SD = 456,175) from the study area. About 96% of this total marsh population occurs within the extensive *Spartina alterniflora* (short form) and *S. patens* covers types. Invertebrates are scarce in stands of *Phragmites australis, Scirpus olneyi,* and *Panicum virgatum,* and also in the incompletely lagooned area at Popular Point.

Abstract of the 1976 Manahawkin Bay - Little Egg Harbor System: Finfish Study; Physical-Chemical Study; and Use Study prepared by John McClain, John Makai, and Peter Himchak.

The purpose of the finfish study is to inventory the fish inhabiting the Manahawkin Bay - Little Egg Harbor system. The combined data of all the collection methods (seine, trawl, and gill net) indicate the five most numerous species in decreasing order are the bay anchovy, the Atlantic silverside, the fourspine stickleback, the mummichog, and the tidewater silverside. Together they comprise 80% of the total catch. Altogether 66 species of finfish were collected.

The purpose of the physical-chemical study is to describe the Manahawkin Bay - Little Egg Harbor system in terms of its morphology, biota, and physicochemical factors. Water quality in the system is good. In general, reduced oxygen levels are not found in the bay but are found in some of the creeks and especially in the lagoons. The dissolved oxygen levels in the lagoons are manifestations of temperature stratification. The bay lacks both temperature and salinity vertical gradients. Horizontal salinity gradients and seasonal salinity variation are greatest in the creeks. The data indicate high coliform counts of unknown origin in certain areas (most of these areas were in the developed sites). DDT, DDT metabolites, and certain heavy metals are present in animal tissue samples with higher levels found in the sediments tested.

The purpose of the use study is to determine the ways in which the Manahawkin Bay - Little Egg Harbor system is used by man. During the first study period (July 1973 - February 1974), it is estimated over 1.58 x 10^5 man-days of activity occurred in the study area with a resulting harvest in excess of 4.4 x 10^5 fish, 1.4 x 10^7 shellfish, and 300 waterfowl. Between June 1974 and May 1975, excluding November and December 1974, an estimated 2.3 x 10^5 mandays of activity produced a harvest of over 4.5 x 10^5 fish and over 1.9 x 10^7 clams.

Abstract of the 1978 Analysis of the Fish Forage Base in the Little Egg Harbor Estuary study prepared by Patrick Festa.

The purpose of this study is to identify the forage base and the allocation of this forage base among the Little Egg Harbor fish through stomach contents analysis. The forage base consists of 142 taxa which support at least 64 fish species. The trophic relationships present are complex because of the flexible dietary habits of the fish surveyed (55 species). Forage populations of particular importance include the class Polychaeta, the order Calanoida, the suborder Gammeridea, the order Mysidacea, the infraorder Panaeidae, and the class Osteichthyes. Some of the food chain associations indicated are *Mercenaria*-winter flounder; *Cymadusa*-pipefish; and calanoid copepod-sand lance-striped bass. The utilization of the forage base is analyzed in terms of use of a given forage item and also in terms of forage items consumed by a given fish species. Habitat area and seasonal aspects are also examined.

Abstract of the 1977 Rodent Populations study prepared by Robert Bosenberg.

Trapping of the rodents on the Cedar Run marsh was conducted periodically from April 1975 to June 1977. Total trapping effort using both live and killing traps amounted to 18,610 trap nights. Rodent species captured include the meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethica*), house mouse (*Mus musculus*), Norway rat (*Rattus norvegicus*), and the meadow jumping mouse (*Zapus hudsonius*). *Microtus* was the only mouse species captured in sufficient numbers to permit population density estimates. Peak densities of this species occur in July. Densities are greater in the incompletely lagooned section than in either the mosquito-ditched or natural marsh areas. Population densities are similar for the latter two sections. Densities within different vegetation cover types are related to the marsh alteration type in which they occur. A significant decline in *Microtus* numbers occurred in the incompletely lagooned area due to the effects of Hurricane Belle. The relation between *Microtus* populations and topographic relief, cover effects, predation, availability of nesting sites, and food resources are discussed. Muskrats are found to be restricted to the *Scirpus*-dominated vegetation located near the marsh-upland ecotone. The average number of huts observed in November of 1975 and 1976 was 21.5. Estimates of muskrat density for the area of marsh bordering and upland exceed five animals per hectare, and the total population for the Cedar Run study area probably exceeds 114 individuals. Due to the low capture success for the Norway rat, no reliable population estimates are possible.

Abstract of the 1976 Wildlife Indexes: Avian Density and Diversity study prepared by Joseph Penkala and Joseph Sweger.

Bird censuses were conducted during the spring and fall migration periods within the following major vegetational associations of the Cedar Run marsh: upland-marsh ecotone, *Iva frutescens - Spartina patens, S. alterniflora,* and the marsh interface with Cedar Run and Little Egg Harbor. Six visits were made during the period 20 April - 8 August 1975 and the line transect - mean flushing distance method used to determine the diversity and density of the avifauna. A total of 976 birds comprised of 87 different species were observed during the study period. Species which are typically considered to be summer residents are most prevalent. Sharp-tailed sparrows have the highest density of any species, followed by the red-winged blackbird and barn swallows. The laughing gull is the most abundant of the larger species. Reliable density estimates of most species are not possible due to their infrequent occurrence. The *S. alterniflora* habitat accounts for the greatest number of birds observed and has the highest species diversity, averaging 68.3 individuals and 17 species observed per visit. The upland-marsh ecotone has the lowest diversity and density.

Abstract of the research on bird nesting in the Cedar Run area performed by Lee Widjeskog, Fred Ferrigno, and J. Richard Trout.

During August 1974, nine major vegetation cover types of the Cedar Run marsh study area were surveyed to determine the species and density of nesting birds. Point and interval estimates of the number of nests for each species within a cover type as well as estimates of the total number of nests for each cover type and for the entire marsh were obtained. A total of 149 nests were actually observed, and the estimated number for the entire marsh is 2,739.5 (SD = 361.0). Nesting species, in decreasing order of importance, include the sea-side and sharp-tailed sparrows (*Ammospiza maritima* and *A. caudacuta*), clapper rail (*Rallus longirostris*), willet (*Catoptrophorus semipalmatus*), long-billed marsh wren (*Telmatodytes palustris*), red-winged blackbird (*Agelaius phoeniceus*), and the black duck (*Anas rubripes*). Sparrows account for 64% of the estimated total. Nests occurring within the extensive areas of short form *Spartina alterniflora* and *S. patens* account for 44% (1,213.9 nests) and 40% (1,099.6 nests), respectively, of the total marsh estimate. Although the density of clapper rail nests is high (13.29 nests$\cdot$ha^{-1}) in tall form *S. alterniflora*, the overall importance of this cover type is minimized by its small areal contribution. Very little nesting occurred in stands of *Scirpus olneyi, Panicum virgatum,* or *Distichlis spicata*, and no bird species were observed to be utilizing either *Phragmites australis* or dredge spoil areas.

Abstract of the 1974 Wildlife Indexes: Waterfowl Use and Harvest study prepared by William Shoemaker and Fred Ferrigno.

During the fall and winter of 1973-74, waterfowl utilization and harvest data were obtained for the Cedar Run study area. Monthly aerial waterfowl counts were carried out from September to January. Hunter counts and bag checks were conducted on Saturdays and one day of each week from October to January. Waterfowl populations in the immediate study area increase from 800 in September to a maximum of 3,200 in December with a grand tally of 9,270 birds. This represents an increase from 1.46 to 5.86 birds per hectare of marsh. Black ducks are the most

abundant, accounting for 35.3% of the total. Greater and lesser scaup are next in importance (20.5%). Within the surrounding ecosystem of Little Egg Harbor and its bordering salt marshes, the waterfowl population increases from 1,600 in September to 20,000 in December, with a total count of 50,050 birds. Dominant species are the brant (21.8%), greater and lesser scaup (21.0%), black ducks (19.2%), and bufflehead (15.0%). Hunter use of the study area amounts to 874 man-days and 1.61 hunters per hectare of marsh for a total harvest of 2,407 waterfowl. Hunter success was 2.65 birds per hunter-day and 4.4 waterfowl per hectare of marsh. Diving ducks, primarily the scaup, are the preferred species. The greater scaup accounts for 76.8% of the total estimated harvest. These results demonstrate the Cedar Run marsh and adjacent bay to be a prime wintering area for waterfowl and also one with a considerable recreational value in terms of hunter use and success.

Abstract of the 1974 and 1975 annual reports submitted on the Recreational Use of New Jersey's Wetlands by New Jersey Citizens prepared by James Applegate, Stephen Salmore, and John Blydenburg and James Applegate and Stephen Salmore, respectively.

The primary objective of this study is to quantify the recreational benefits provided by New Jersey's wetlands to New Jersey residents. Univariate analysis indicates wildlife observation is the most popular salt marsh activity in which 15% of the New Jersey population participated. It is followed by crabbing (12%), picnicking/other (12%), fishing (10%), clamming (5%), and hunting (3%). Subsequent cluster analysis divided the salt marsh users into grouping which could be combined into more inclusive categories. The activity categories chosen were extractive (fishing, hunting, crabbing, and clamming), appreciative (wildlife observation and picnicking/other), and nonexclusive (occasional participants but not exclusively in one activity). Of the approximately 19% of the New Jersey population which utilized the wetlands (under this analysis), 6.6, 5.6, and 7.2% belong to the appreciative, nonexclusive, and extractive categories, respectively. Other more restrictive groupings were examined as were the origin of the participants in the various activities and man-day estimates of marine environment use. The estimated means of man-days of recreation (in millions of man-days) provided by crabbing, estuary fishing, ocean fishing, surf fishing, and clamming are 2.5, 2.0, 1.7, 1.1, and 1.0, respectively.

Abstract of the Estimates of the 1975 Sport Harvest of Marine Fishes prepared by Stephen Sterner and James Applegate in 1976.

Utilization of the stocks of bluefish, weakfish, fluke, white perch, striped bass, mackerel, whiting, cod, pollack, winter flounder, and tuna were estimated for either the 1 January - 1 June 1975 period for the 1 July - 20 December 1975 period. These estimates were referenced to the type of fishing done (ocean, river/bay, or surf) and who the fishing was done by (those who fish 10 days or less annually or those who fish more).

During the 1 January - 1 June 1975 period estimates were made on the striped bass, mackerel, whiting, cod, pollack, winter flounder, and weakfish harvests. Winter flounder (1.62×10^5 fish), mackerel (1.19×10^5 fish), and striped bass (9.9×10^3 fish) lead the combined fishing effort (for both types of fishermen) for the bay/river, ocean, and surf fishing categories, respectively.

During the 1 July - 20 December 1975 period estimates were made on the bluefish, weakfish, striped bass, tuna, fluke, and white perch harvests. Bluefish, with a mean combined catch of 3.44×10^5 are taken most frequently by ocean fishermen. Striped bass (5.8×10^4 fish) dominate the surf fishing while fluke (1.85×10^5 fish) lead the harvest by bay and river fishermen.

1. ESTUARINE EVALUATION STUDY: PRIMARY AQUATIC PRODUCTION AND NITROGEN. FOUR YEAR REPORT, 1973 - 1977.

James B. Durand, Teruo Sugihara, and Charles E. Yearsley[1]

[1]The first author is a Professor with the Department of Biology, Camden College of Arts and Sciences, Rutgers University. The other authors are graduate students also associated with that department. This report was prepared for the New Jersey Division of Fish, Game, and Shellfisheries with funds provided in part by the New Jersey Division of Marine Services during the period 1973 to 1977.

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INTRODUCTION

The purpose of this study was to ecologically evaluate the natural marshes and adjacent developed areas at Beach Haven West near Manahawkin, New Jersey. This report deals with studies of primary productivity and nitrogen in the salt marshes and lagoons of the system. Our efforts, therefore, have been focused on processes of fundamental importance at the base of the trophic series.

Primary production, especially that of the phytoplankton, provides a major source of organic materials for the aquatic systems. Detrital output from surrounding salt marsh surfaces is probably of less significance in this area than in areas subjected to a greater tidal range. The major rooted vegetation is the short form of *Spartina alterniflora*. The presence of this form indicates regular tidal flooding occurs but subsequent drainage is poor. Consequently, the main mechanism for transport from the marsh surface is of reduced effectiveness. The tall form of *S. alterniflora* is restricted in distribution to a narrow band along the edges of creeks. Good drainage is also restricted to that limited area.

Nitrogen was studied as the nutrient of importance because other work of ours has shown nitrogen to be the nutrient most often present in limiting concentrations. Phosphorus has been shown to be limiting only rarely or only in nitrogen enriched experiments. Modification of the cycling of nitrogen, therefore, could be of significance to the energy flow through the system.

In this report, we present an overall view of the system documented by selected data collected during the 4 years of the study.

METHODS

The term of study was from June 1973 through June 1977. In this report, June 1973 to June 1974 is referred to as year I; June 1974 to June 1975, as year II; June 1975 to June 1976, as year III; and June 1976 to June 1977, as year IV.

The early part of the study consisted of a broad sampling program covering the area shown in Figure 1 for an entire year. The study provided background data on the area and led to the identification of smaller systems on which later studies were concentrated. In this report, we have used only selected data from earlier years. Some figures and tables have been taken directly from the annual reports. In some cases, new figures and tables have been constructed. All figures and tables from the annual reports are appended to this report.

Physical Factors

STATION LOCATIONS -- Figure 1 and Table 1 show all stations sampled during the 4 years of the study. Stations were visited according to various schedules. Stations of year I were distributed over the entire area from Dinner Point Creek on the south through Beach Haven West on the north. The same stations were used in year II. In that year, stations were classified as major or minor. Major stations were located in the Meyers Creek System and in Lagoon System A. The other stations in Lagoon Systems B and E and in Dinner Point Creek were classified as minor stations. Major stations were sampled about twice a month; minor stations, once a month. In year III, stations were located only in the Meyers system and in Lagoon System A. In this year, sampling of the various parameters occurred according to the schedule shown in Figure 2. All samples in the groups between vertical bars were pooled. Such pooled measures were used in an analysis on a

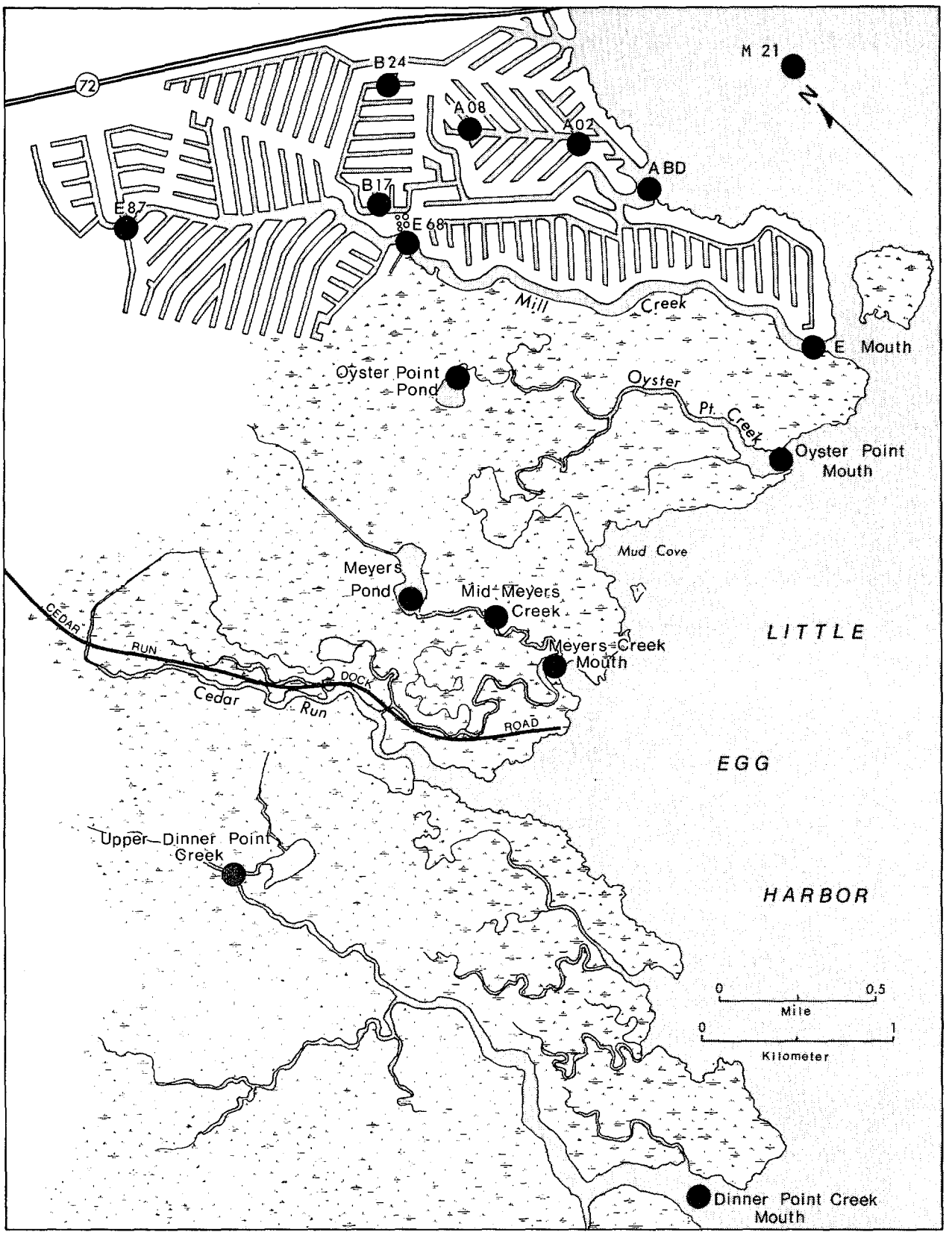


Fig. 1. Station locations.

quarterly basis. In year IV, stations in Lagoon System B were added to those of year III.

Table 1. Sampling sites for all 4 study years.

Station number	Station name	Year I 73-74	II 74-75	III 75-76	IV 76-77
1	M 21	x	x*	x	x
2	ABD	x	x*	x	x
3	A02			x	x
4	A08	x	x*	x	x
5	B17				x
6	B24	x	x*		x
7	Mill Creek Mouth (E Mouth)	x	x		
8	E68	x	x		
9	E87	x	x		
10	Oyster Point Creek Mouth	x			
11	Oyster Point Creek Pond	x			
12	Meyers Creek Mouth	x	x*	x	x
13	Mid Meyers Creek		x*	x	x
14	Meyers Pond	x	x*	x	x
15	Dinner Point Creek Mouth	x	x		
16	Upper Dinner Point Creek	x	x		

* An asterisk (*) indicates a particular station was sampled more frequently than stations without an asterisk for that year.

STUDY AREA STATISTICS -- Surface dimensions of lagoon and marsh systems were obtained from aerial photos. Vegetation coverage was determined by analysis of aerial photos. Bathymetry of Lagoon Systems A and B was measured with a "Shakespeare" fish finder by recording depths on the longitudinal and transverse lines. Soundings were recorded to the nearest 0.3 m and were referenced to high water. Bathymetry of Meyers Creek and Pond was measured with a graduated pole, and the measures were referenced to mean high water.

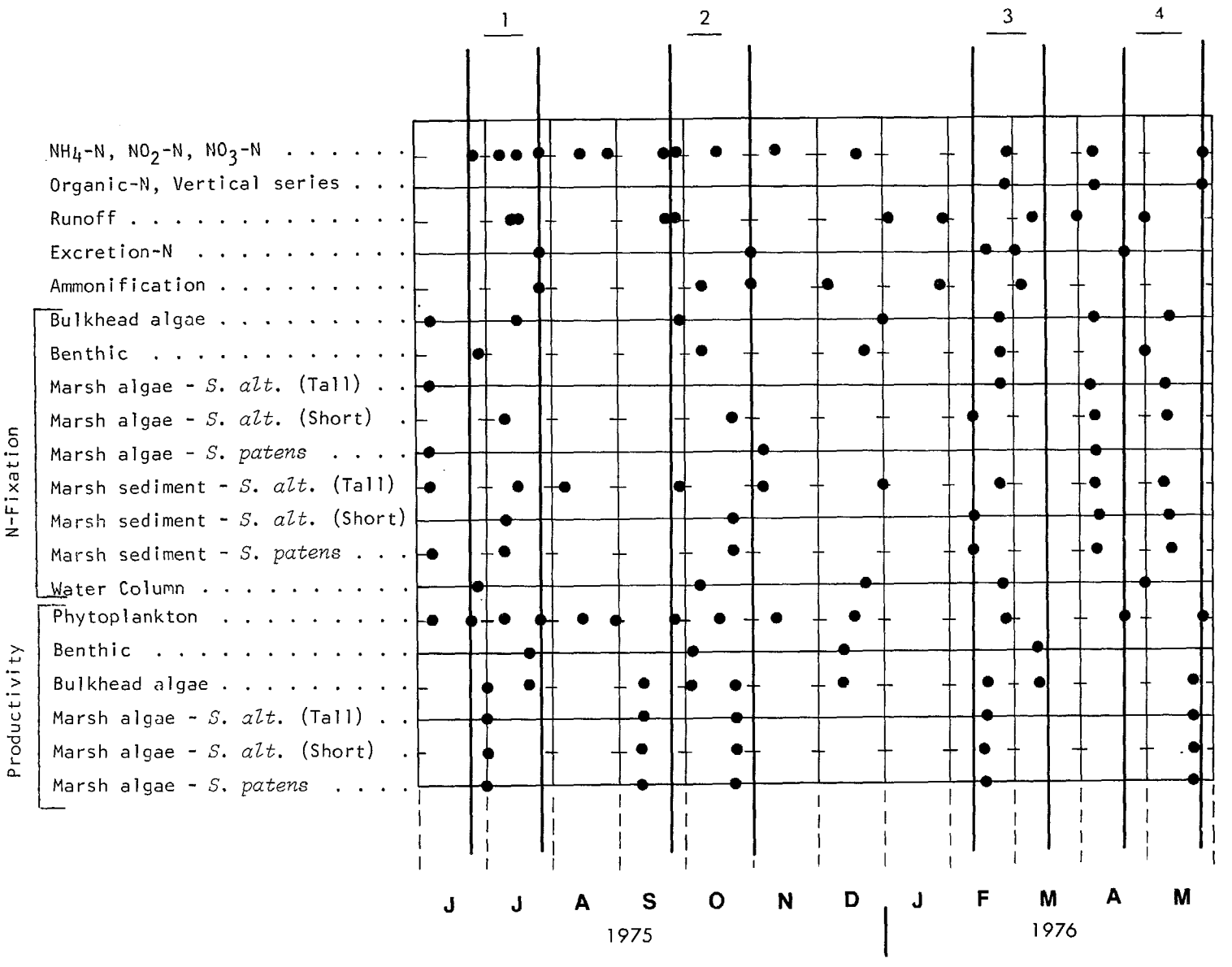


Fig. 2. Sampling schedule. The columns labeled 1 through 4 represent pooled data periods.

In Figure 3 is a diagram to show the terminology used in this report with respect to general sampling sites.

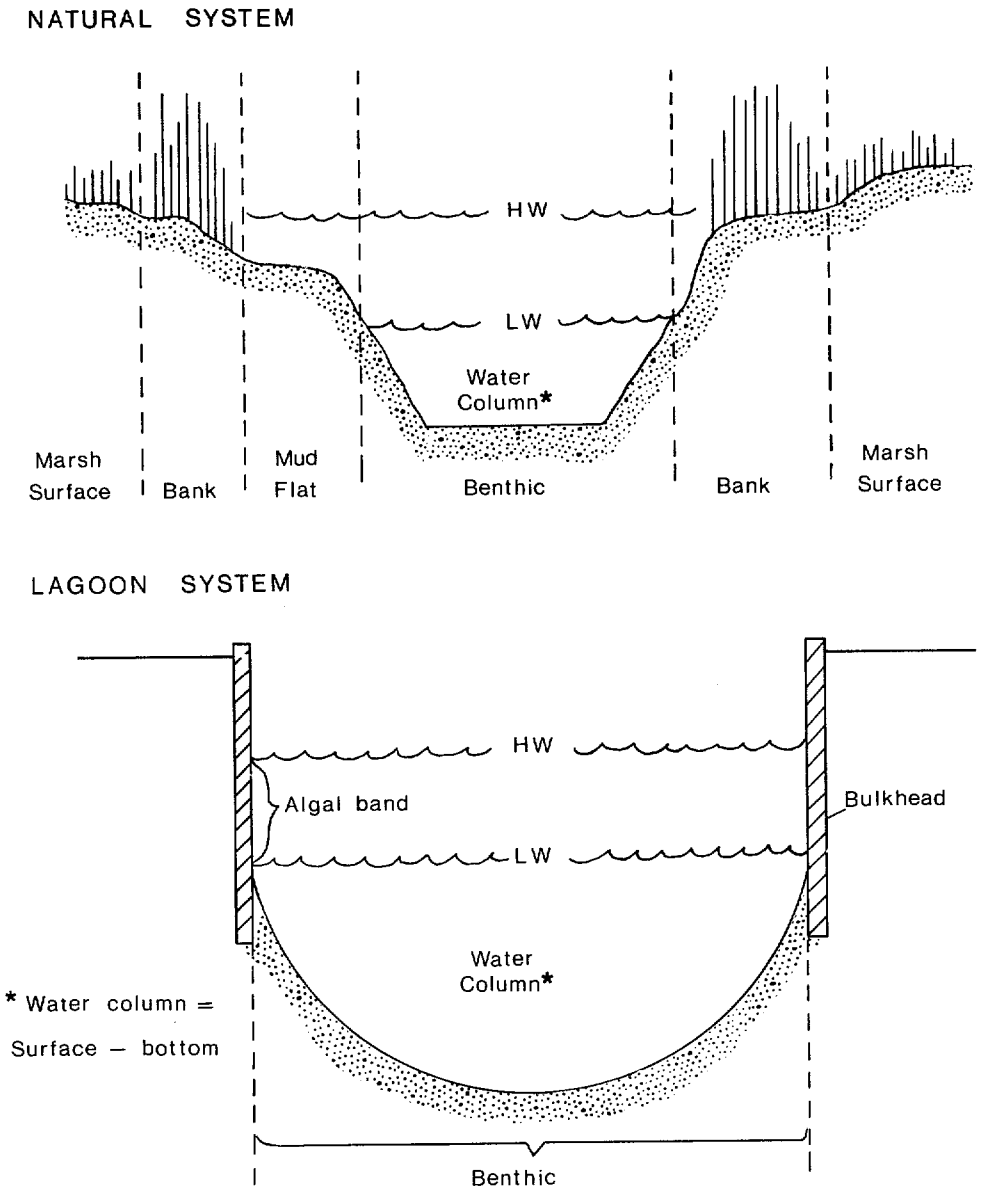


Fig. 3. Cross sections of the natural and lagoon systems.

TEMPERATURE, SALINITY, TRANSPARENCY, AND DISSOLVED OXYGEN -- At all stations, water temperature was measured at the surface each time a station was visited and at 1.0 m intervals to the bottom where the water was sufficiently deep. On occasion, sampling programs were carried out which included a large number of stations located throughout all the lagoon systems, A through E, of Beach Haven West. Temperature was measured with a Yellow Springs Instrument thermistor.

Salinity was determined according to the method described in Harvey (1955). Surface samples were taken at all stations each time they were visited. Bottom

samples were routinely taken except at shallow stations. Salinity samples were frequently taken at 1.0 m intervals to the bottom at A08, A02, and B24.

Water transparency was routinely estimated by Secchi disc. Occasionally, a Whitney underwater photometer was used. In later years, a Licor underwater photometer was used to measure the amount of photosynthetically active solar radiation, 300 - 700 nm, in the water column.

Dissolved oxygen samples were taken according to a schedule similar to that for salinity. The azide modification of the Winkler method was used to determine dissolved oxygen.

Nitrogen

NUTRIENT SERIES -- Surface samples for analysis of ammonia-N (NH_3-N), nitrite-N (NO_2-N), nitrate-N (NO_3-N), organic-N (Org-N: total, soluble, and particulate forms) and total phosphorus (Tot-P) were taken in an acid cleaned bucket. Subsurface samples were taken by Van Dorn bottle. Surface and bottom samples were taken routinely. Frequently, samples were taken at 1.0 m intervals from surface to bottom in the lagoons. Within the lagoons, sampling was done at both the mouth and upper ends. In this study, the upper end data were used to confirm the mouth data trends.

Samples were stored in the dark in insulated acid cleaned containers until filtered a short time later. Either glass fiber (GF/C) or Millipore filters were used. Filtrates were frozen and stored in acid cleaned Nalgene bottles. Samples were frozen in the Nalgene bottles without filtration for analysis of total organic-N and total phosphorus.

Chemical analyses were made by the following methods:

NO_3-N	Wood, Richards, and Armstrong (1967); Jenkins and Medsker (1964)
NO_2-N	Bendschneider and Robinson (1952)
NH_3-N	Solorzano (1969)
Org-N	Kjeldahl digestion after Strickland and Parsons (1968), followed by Solorzano's NH_3-N method
Total Phosphorus	Persulfate digestion (Menzel and Corwin 1965) followed by the ascorbic acid method of Murphy and Riley (1962)

Once the concentrations were determined, the appropriate volumes for the layers sampled were applied to calculate the total amount present at the site. This necessitated a "bottom to top" approach in applying the volumes. Tidal fluctuations involved changes only in the top layer volume while the bottom layer volumes remained unchanged. Sampling at a low tide stage sometimes caused the number of layers sampled to be less than the number of layers dictated by the bathymethy work. When this occurred, the surface layer volume was omitted.

NITROGEN FIXATION -- The acetylene reduction procedure (after Stewart, Fitzgerald, and Burris 1967) with certain modifications (Waughman 1971; Schell and Alexander 1970) was employed in the estimation of nitrogen fixation rates. The theoretical conversion of 3 moles C_2H_4 to 2 moles NH_3-N was applied to convert ethylene production to nitrogen fixation. A standard field incubation time (1300 hours) was established. This was to minimize the interfering rate changes resulting from differing intensities and angles of illumination occurring over the course of the day. The light intensities were also adjusted by screening to duplicate the in situ radiation for each site sampled. The sample analysis was done with a flame ionization detector equipped gas chromatograph. A 1.8 m stainless steel column with a 3.2 mm inside diameter was packed with 80/100 mesh Poropak N and utilized in the analysis of ethylene levels. The samples were calibrated against pure ethylene standard curves.

Because the acetylene reduction rates were on an hourly basis, it was necessary to extend the rates for 24 hours to calculate a nitrogen contribution. This actually produced a minimum estimate of nitrogen fixation since the standard incubation time was at a period of minimal activity. This deduction was based on literature references and limited diel work by our group which indicated high light intensity could suppress the midday rates below the 24 hour mean rate. Samples of known surface area were taken from the communities listed below except in the case of the water column communities where volume served as the reference base. These referenced rates were then applied to the existing distribution of their particular communities.

Communities tested in Lagoons A02 and A08 were:

1) Upper bulkhead algal community
2) Lower bulkhead algal community
3) Lagoon water column community
4) Benthic sediment community

Communities tested in the natural marsh system were:

1) *Spartina alterniflora* (short form) algal community
2) *Spartina alterniflora* (short form) substrate community
3) *Spartina patens/Distichlis spicata* algal community
4) *Spartina patens/Distichlis spicata* substrate community
5) *Spartina alterniflora* (tall form) bank algal community
6) *Spartina alterniflora* (tall form) bank substrate community
7) Creek water community
8) Benthic sediment community
9) Salt pool community

Representative sites for the above communities were selected in the Meyers Creek system and in the lagoons. Samples within these sites were randomly chosen. Sampling was done according to the schedule shown in Figure 2.

EXCRETION -- In this study, excretion was defined primarily as the elimination of metabolic waste products. Because the majority of the organisms in both the lagoon and creek systems were ammonotelic, excretion would affect primarily stocks of ammonia-N. This neglected solid fecal matter except for that fraction which rapidly converted to inorganic ammonia-N. While nitrogenous compounds in fecal matter would eventually be coverted to ammonia-N, the short term

(approximately 24 hours) contribution an organism made to the available nitrogen pool was measured in these experiments. Only for a limited number of experiments were total organic-N contribution and, therefore, fecal deposition measured. Since it was not possible to evaluate all organisms, certain species were selected. *Modiolus demissus*, *Ilyanassa obsoleta*, and mixed natural zooplankton populations (primarily *Acartia* sp.) were chosen for study. Excretion in this study, therefore, represented only a fraction of the actual amount of nitrogen recycled by organismal metabolism.

Excretion rates by *Modiolus demissus*, *Ilyanassa obsoleta*, and mixed natural zooplankton populations were determined for various sites in the Meyers Creek system and Lagoon System A. Ammonia-N was measured by the phenol hypochlorite method (Solorzano 1969). Total organic-N levels were also measured for some of the *Modiolus* and *Ilyanassa* samples. The Kjeldahl digestion procedure of Strickland and Parsons (1968) followed by a Solorzano ammonia-N determination was used. The major portion of the ammonia-N work was done in the third study year on a quarterly basis (Figure 2). Organic-N experiments were confined to the latter quarter of year III.

The *Modiolus* sampling was restricted primarily to the Mid Meyers Creek station. There was no need for a Lagoon System A station because *Modiolus* was not present in the lagoon system to any significant extent. The *Modiolus* were selected using a randomly knotted cord laid perpendicular to the creek bank at randomly chosen intervals. Specimens closest to each knot on the cord were used.

Ilyanassa obsoleta were collected from Mid Meyers Creek, Meyers Pond, Mid Lagoon A02, and Mid Lagoon A08 by means of a dip net dragged along the sediment surface perpendicular to the water current direction.

Zooplankton were collected using 2 methods. Prior to April 1975, the site water was poured through a plankton net using a bucket of known volume. From April 1975 on, diagonal tows with a Clarke Bumpus plankton sampler equipped with a #20 net were used. The main sites sampled were Mid Meyers Creek, Lagoon A02, and Lagoon A08. Meyers Pond was too shallow to tow the Clarke Bumpus sampler without considerable bottom influence and was therefore discontinued as a sampling site. The data selected for this report were those whose filter volumes were approximately 200 liters. Occasionally, smaller volumes were filtered to determine the effects of crowding on excretion.

The *Modiolus* and *Ilyanassa* were washed and scrubbed with a wire brush to remove all epiphytic algae. Organisms were placed in glass fiber filtered site water and allowed to acclimate. Subsequently, the mussels and snails were transferred to acid cleaned vessels containing known amounts of filtered site water. The organisms were again allowed to acclimate prior to the beginning of the incubation.

It was not possible to separate the zooplankton from the epiphytic algae and detritus collected with the zooplankton. To minimize this problem, collections were made avoiding unnecessary entrapment of these materials. The sample brought to the laboratory was resuspended in a known volume of filtered site water and placed in an acid cleaned container prior to incubation.

Initial ammonia-N samples were taken from each bottle. After a 24 hour incubation at ambient temperature and light, ammonia-N samples were taken again. Controls consisting of filtered site water were similarly run. Changes in

ammonia-N concentration in the experimental bottles were corrected for changes in the control bottles.

The rates were used to calculate the contribution each population made to the nitrogen levels at the respective sites. *Modiolus* and *Ilyanassa* rates were extrapolated using estimates of the number of organisms present. The *Modiolus* population was estimated to be 1,653,453 for the entire Meyers Creek system. This value was derived from the data of Ray and Kiesel (pers. comm.).[2] The *Ilyanassa* estimates were based on a dredge survey made on 19 February 1976 (Table 2).

Table 2. *Ilyanassa* population estimates.

	Snails per m^2	m^2	Total estimated population
Meyers Creek	24.40	23,000	5.612×10^5
Meyers Pond	24.00	43,000	1.032×10^6
Lagoon A02	36.70	6,763	2.482×10^5
Lagoon A08	40.00	9,067	3.627×10^5

The zooplankton rates were extrapolated using the volume of water filtered through the Clarke Bumpus or the plankton net and the volume of the water at the site as determined by the bathymetry work.

AMMONIFICATION -- Ammonification is usually considered to be the return of ammonia-N to the system through the biological processes that lead to the breakdown of organic nitrogenous compounds. Such processes are generally carried out by microorganisms, such as bacteria. In these experiments, ammonification is the result of the activities of the entire benthic community - bacteria as well as protozoa, nematodes, and whatever else might have been there. For the most part, the organisms were small; few large organisms were found in the sediments used in the experiments.

Benthic sediments of given area from a given site were suspended in a series of BOD bottles. After a period of equilibration, ammonia-N concentrations in a pair of bottles was measured. This was taken as the initial ammonia-N concentration. The remaining BOD bottles were incubated in the dark for 24 hours at ambient temperature. At that time, the ammonia-N concentration was determined in the remaining bottles. The difference between initial and final ammonia-N concentrations was taken as the ammonification rate per unit area.

RUNOFF -- Runoff in the lagoon system had four basic sources: rain falling directly on the lagoon water surface; precipitation channeled into the lagoon via road drainage systems; rainfall delivered by drainage pipes into the lagoon from the roofs of individual homes; and rain flowing into the lagoon after impinging on unpaved land. Sampling was conducted on a quarterly basis at the locations where

[2] This work was done in connection with the benthic invertebrate population study done for this project.

owner permission was given for access to the above types of runoff. Only the first three runoff sources were tested. Coincident with these sampling trips, direct rainfall was also collected in the area of Lagoon System A.

Attempts at measuring marsh drainage unfortunately were unsatisfactory. Therefore, rainfall data will be applied to the marsh system in an attempt to provide an estimate of the nitrogen input by precipitation.

Based on precipitation records and surface area, the volume of rainfall involved with a given type of runoff was calculated and used to extrapolate the concentration of the relevant nitrogen fraction. This method underestimated nitrogen input because the sampling evaluated the middle of a storm period. This "cleansing" effect of the rainfall was not sampled.

Primary Productivity

OXIDIZABLE CARBON -- Oxidizable carbon was measured by the wet oxidation of residues contained on glass-fiber filters (Reeve - Angel, 0.1 μ), according to the method of Strickland and Parsons (1968).

SESTON -- Seston was determined according to the method of Strickland and Parsons (1968). Residue retained on glass-fiber filters were dried at 100°C for a measure of total dry weight. Ignition at 500°C for one hour was used in estimating combustible organic matter.

PLANT PIGMENTS -- Plant pigments were estimated according to the method of Strickland and Parsons (1968), using 0.8 μ pore size Millipore filters.

COMMUNITY PRODUCTION -- Phytoplankton -- The primary productivity of surface phytoplankton populations was measured using a light-dark bottle technique and changes in dissolved oxygen concentration. Incubations were carried out in a lighted BOD incubator at ambient temperature for 24 hours. After study year I, subsamples of surface populations were also subjected for 24 hours to a graded light intensity series of natural radiation, either in a tidal creek at the Little Egg Station or in an outside water bath with a flow-through circulation of creek water. Bottles incubated in the creek were placed at varying depths corresponding to a relative intensity range of 100%, 50%, 25%, 10%, and 1% surface intensity. Bottles incubated in the water bath were also subjected to this range of natural illumination by using light attenuators made of plastic screening.

The results of the graded light intensity series (expressed in terms of ml $O_2 \cdot l^{-1} \cdot day^{-1}$) were then plotted against the depth to produce a productivity profile. Subsequent planimetry permitted an estimate of productivity and respiration on an areal basis (ml $O_2 \cdot m^{-2} \cdot day^{-1}$).

The depths assigned to the transparency series were approximated from Secchi disc readings using the following relationships: $k = 1.7/S$ (Poole and Atkins 1929), where k is the extinction coefficient (m^{-1}) and S is the depth (m) of the Secchi reading (S); and $I = I_o e^{-kD}$, where D is the depth (m), and e is the base of the natural logarithms. I_o and I are the light intensities at the surface and at depth, D, of the water column.

The response of phytoplankton to various nutrient enrichments was determined using a modified Ryther and Guillard (1959) enrichment mixture. Bottles were incubated both under natural light conditions (50% I_o) and artificial illumination, together with nonenriched controls.

Benthic Algae-- Production by the benthic microflora was examined at the following stations: Meyers Creek mouth, Mid Meyers Creek, Meyers Pond, A12 mouth, ABD, and A08 mouth. Pyrex tubes (30.5 cm long, 3.8 cm inside diameter) were used to obtain cores of the sediments. The water overlying the cores was retained since earlier experiments on replacing the water column with filtered water resulted in excessive disturbance of the mud-water interface. The cores were incubated for 12 hours in laboratory incubators, both in the light and in the dark and were periodically shaken on a specially designed shaker mechanism in order to insure a homogeneous water column above the sediment. After incubation, subsamples of the water column were withdrawn and Winkler titrations performed.

Marsh Surface Algae -- The productive capacity of the marsh surface algal communities was examined in stands of *Spartina alterniflora* (tall and short forms), *S. patens*, and from an exposed mudflat located at the Mid Meyers Creek location. Using a specially constructed coring device, marsh surface cores were obtained in Pyrex tubes. The experimental design was basically the same as that employed in the benthic studies, except that the marsh surface cores were covered with filtered creek water of known oxygen content.

Bulkhead Algae --Bulkhead algal production was examined along the main channel of Lagoon System A (upper, mid, and lower main channel). Circular mats of the algal community of known surface area were removed from the bulkheads and placed in light-dark BOD bottles. These were later filled with filtered lagoon water of known oxygen content and incubated for 12 hours in the laboratory incubators.

Changes in the oxygen content of the water column over a known surface area of benthic, marsh surface, and bulkhead community were then converted to ml $O_2 \cdot m^{-2} \cdot 24h^{-1}$. The respiratory rates so measured are indicative of total community response and incorporate algal, bacterial, faunal, as well as sediment chemical demands. In addition, such production estimates are necessarily "potential" rates, due to the use of artificial illumination and the stimulation of only submerged conditions.

Measures of light penetration through the three dominant plant canopies of the marsh surface were obtained with a Whitney Underwater Meter (LMA-8A) prior to 17 February. A Licor quantum meter (LI-170) and sensor (LI-190S) subsequently were used to estimate the photosynthetically active radiation. The sensor of the latter instrument was much smaller and the disruptive influence upon placement under a plant canopy was greatly diminished.

RESULTS

Physical Factors

STUDY AREA STATISTICS -- In Figure 4 are shown the longitudinal plots of depths measured along the central axis of each lagoon in Lagoon System A. In Table 3, selected calculated features for Lagoon System A and the Meyers Creek system are compared. An important feature is the irregularity of the bottom topography of lagoons. Numerous potholes, coupled with the presence of slow currents, tend to trap water and thereby lead to stagnation.

In addition, the mean depth of the lagoons is generally greater than that of the neighboring bay. In effect, the lagoon system comes to represent one large pothole as long as the sill depth is less than that of the lagoon system. The sill depth of Lagoon System A is 2 m. Mean depth of the system is 3 m.

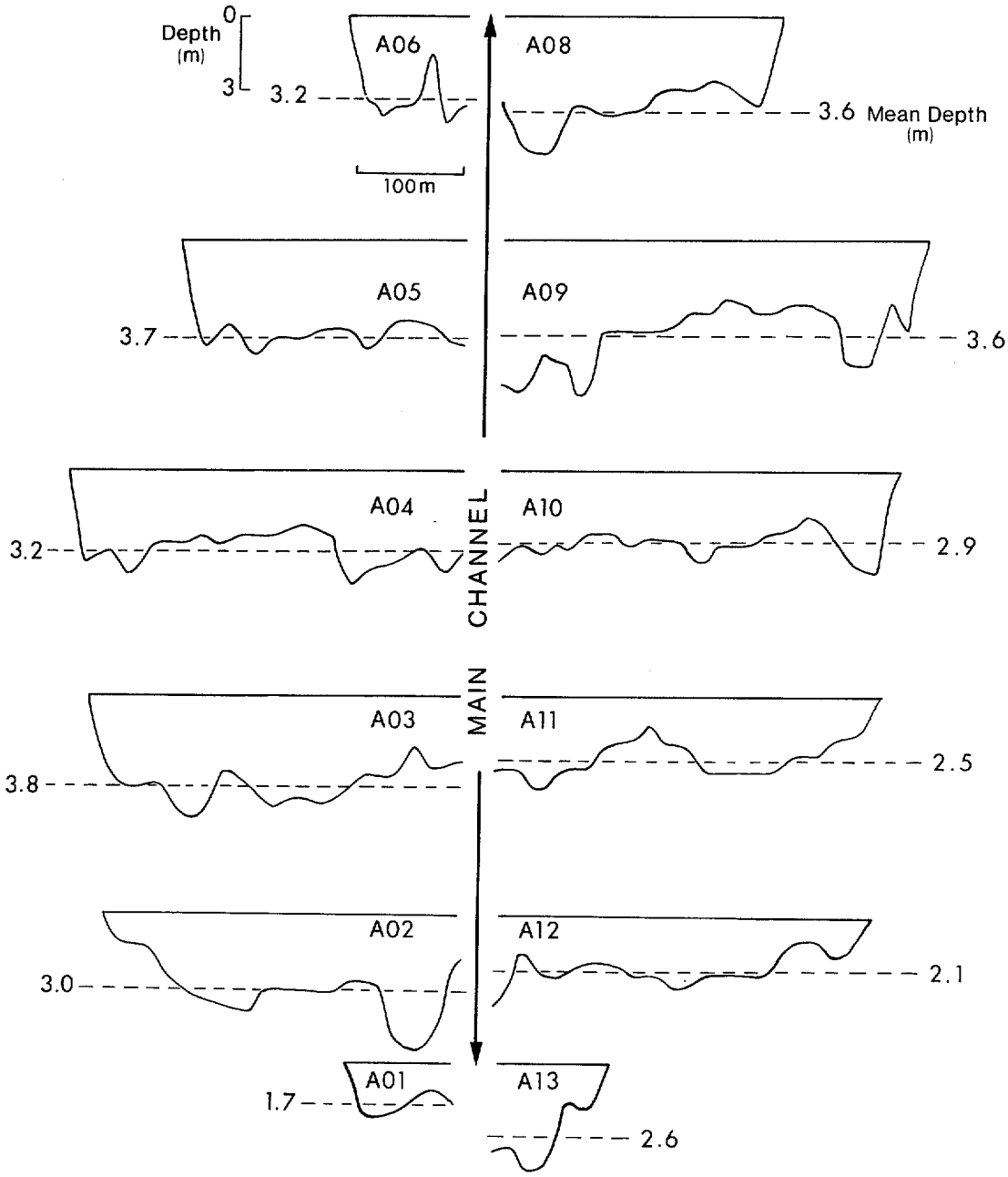


Fig. 4. Longitudinal sections of lagoons in Lagoon System A.

Whereas the tidal prism volume of the lagoons is about 25% of the high water volume, for Meyers Pond and Creek, it is about 50% (Figure 5). Tidal flushing of the Meyers Creek system therefore, is greater than that for the lagoon system. Another important point is that the tidal prism volume of Meyers Pond is approximately the low water volume of Meyers Creek. Essentially, Meyers Creek at low water is filled with Meyers Pond water. Therefore, at high water, a substantial fraction of Meyers Creek must be bay water. A lesser fraction, but still appreciable fraction, of Meyers Pond at high water is bay water since mixing of Creek and Bay water must occur in Meyers Creek during flood tide.

Table 3. Bathymetry and other features of the Meyers Creek system and Lagoon System A.

Parameter	Meyers Pond	Meyers Creek	A08	A02	Lagoon System A
Mean depth (m)	.42	1.2	3.6	3.0	3.0
Perimeter (m)	1,255	2,348	445	619	8,287
Tide range (m)	.46	.46	.46	.46	.46
Area water surface (m^2)	43,000	23,000	6,763	9,067	148,566
Drainage area (m^2)	200,365	223,517	18,208	26,941	284,720
Volume (m^3):					
High water	18,000	22,000	14,800	16,000	190,100
Low water	7,500	12,600	11,700	12,500	147,504
Tidal prism	10,500	9,400	3,100	3,500	42,596
Volume (m^3) for the interval:					
0.0-0.5 m	12,800		3,600	4,200	71,000
0.5-1.5 m	5,200		4,900	5,800	102,000
1.5-2.5 m			3,400	3,600	58,000
2.5-3.5 m			2,300	1,600	24,000
3.5-4.5 m			500	600	7,000
4.5-5.5 m			100	200	1,000
Percent volume greater than 3 m			10.1	8.8	6.5

Though the ratio of (tidal prism volume/high water volume) of A08 and A02 are similar (Table 2), A02 is undoubtedly influenced by bay water to a greater degree than A08 because A02 is nearer the entrance to the lagoon system.

In Table 4, data for the drainage of Meyers Creek system and Lagoon System A are given. The drainage for Lagoon System A is from roof tops, gravel yards, and black top road surfaces. Much of this drainage flowed through drain pipes and storm sewer pipes into the lagoons. In contrast, the Meyers Creek system drainage area was salt marsh. The greatest area was covered by *Spartina alterniflora* (short form). The next greatest area was covered by *S. patens*. *Spartina*

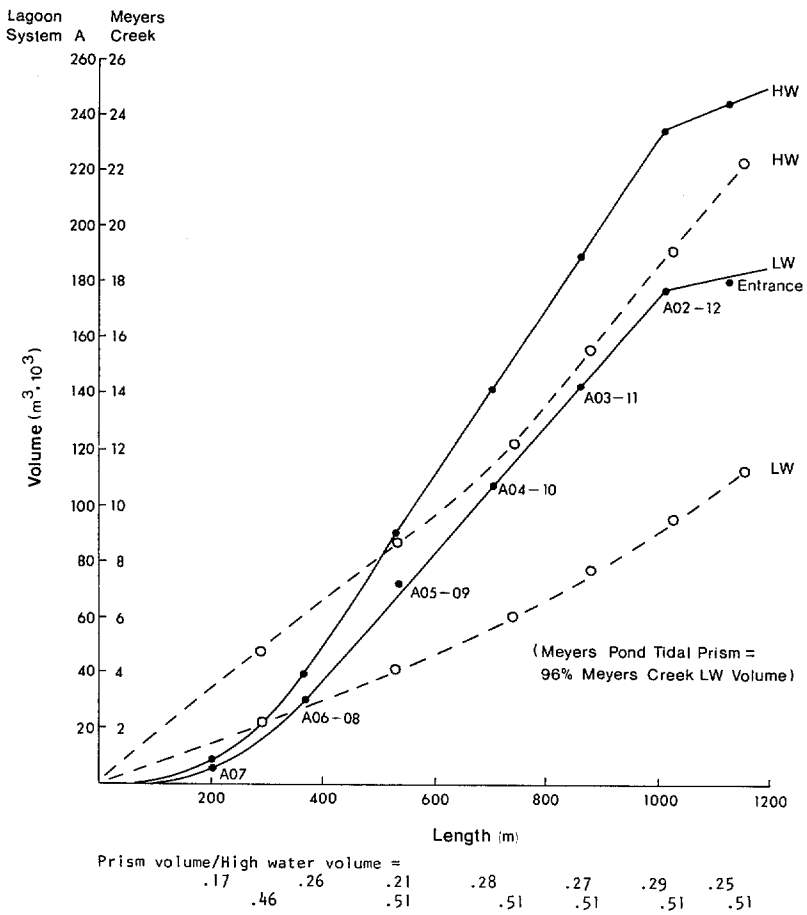


Fig. 5. Lagoon System A and Meyers Creek system. High and low water volumes, and tidal prisms. (Meyers System = o---o, Lagoon System A = •——•).

alterniflora (tall form) was found only along the edge of the creek and accounted for only about 1% of the drainage area.

TEMPERATURE -- Water temperature data are given in Figures 6, 7, and 8. Surface temperatures were essentially the same at all stations. At low temperatures, around 5°C, temperatures in the ponds and lagoons were slightly higher than those in the bay. This probably reflected daytime warming of the smaller water volumes in the ponds and lagoons. Seasonal variation was from a winter low of -0.2°C to a summer high of slightly over 30°C.

In Figure 6, water temperatures have been contoured for Lagoons A02 and A08. Thermal stratification was marked at A08 for an appreciable part of the year in the spring and summer. Stratification was less well developed at A02, nearer the junction of the lagoon system with the bay. The extent of development of thermal stratification throughout all lagoon systems is shown in Figures 7 and 8. Surface temperatures were higher than bottom temperatures in the summer. Bottom temperatures were higher than surface temperatures in the winter. Inverse thermal stratification was common in the winter. Some of the stations sampled for Figure 8 were covered by about 5 cm of soft ice. Thermal stratification appears to be a feature of lagoons, even in the winter months.

Table 4. Drainage areas in the marsh and lagoon systems.

Site	Area (m^2)	Percent of total (%)
Meyers Creek system:		
Total marsh surface	448,259	100.0
Spartina patens	169,561	37.8
Spartina alterniflora (short)	278,698	62.2
Spartina alterniflora (tall)	4,070	.9
Lagoon System A:		
Total drainage area*	284,720	100.0
Lagoon A02 drainage area	26,941	9.5
Lagoon A08 drainage area	18,208	6.4

* The term drainage area within the lagoon system refers to the sum of road, ground, and roof surface present.

SALINITY -- In Figure 9 are plotted the surface salinity values from stations near the mouths of the lagoon systems, the creeks, and for the bay (M 21) for year I. The seasonal pattern is clear. The lowest salinities occurred during the winter; the highest salinities, in late summer and early fall. Measurements in the summer of 1976, not shown here, gave a record high salinity for A08 of more than 30 $^{o}/oo$. This occurred during a period of very low rainfall. The occurrence of Hurricane Belle resulted in a return to lower, more normal, salinities.

It is also seen in Figure 9 that E Mouth (Mouth of Mill Creek) exhibited the lowest salinities and the greatest seasonal variation of all the stations plotted. These data reflect the influence of fresh water flow through Mill Creek. On the other hand, rather high salinities were observed at Dinner Point Creek Mouth, frequently higher than those recorded for other stations. Apparently, little fresh water enters through Dinner Point Creek.

In Figure 10, the salinity data of Meyers Pond, M 21, A02, and A08 are plotted. Meyers Pond salinities are generally lower than those of M 21 because of upland drainage. Maximum differences, as might be expected, occurred at the time of maximum precipitation. Salinities at A02 and A08 are contoured in Figure 10. Marked salinity stratification occurred at both stations in early fall and late spring. During the summer and fall, salinity stratification was the rule below about the 2-3 m depth. At the deeper station, B24, the difference between surface and bottom salinities was pronounced during the greater part of the year (Figure 11). Bottom salinities at this station varied very little during the year. However, station B24 is extremely isolated from the entrance to the Lagoon System B. Also, a large storm sewer pipe enters the lagoon next to station B24.

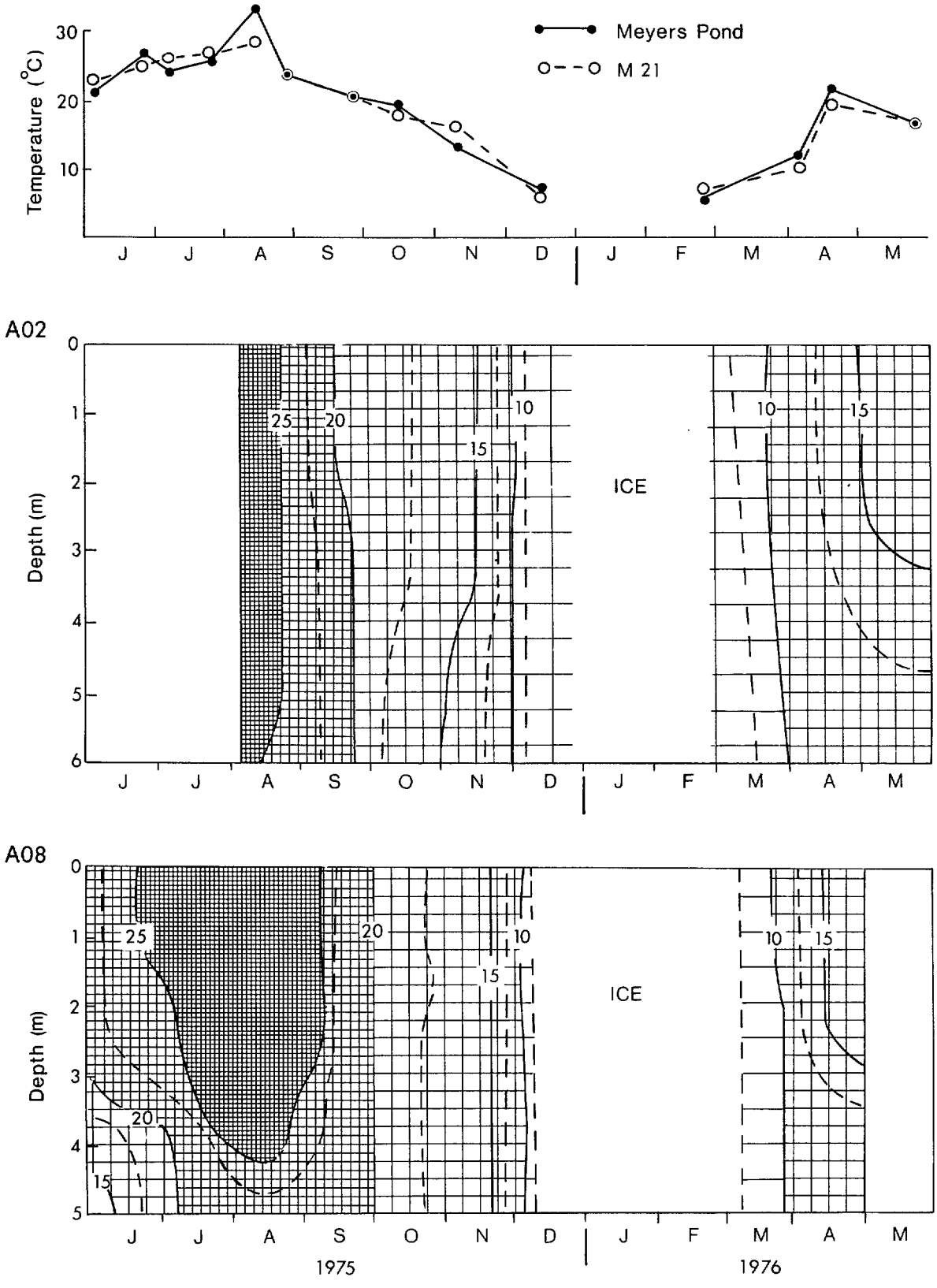


Fig. 6. Water temperatures at the surface of M 21 and Meyers Pond and vertical profiles of Lagoons A02 and A08 in °C.

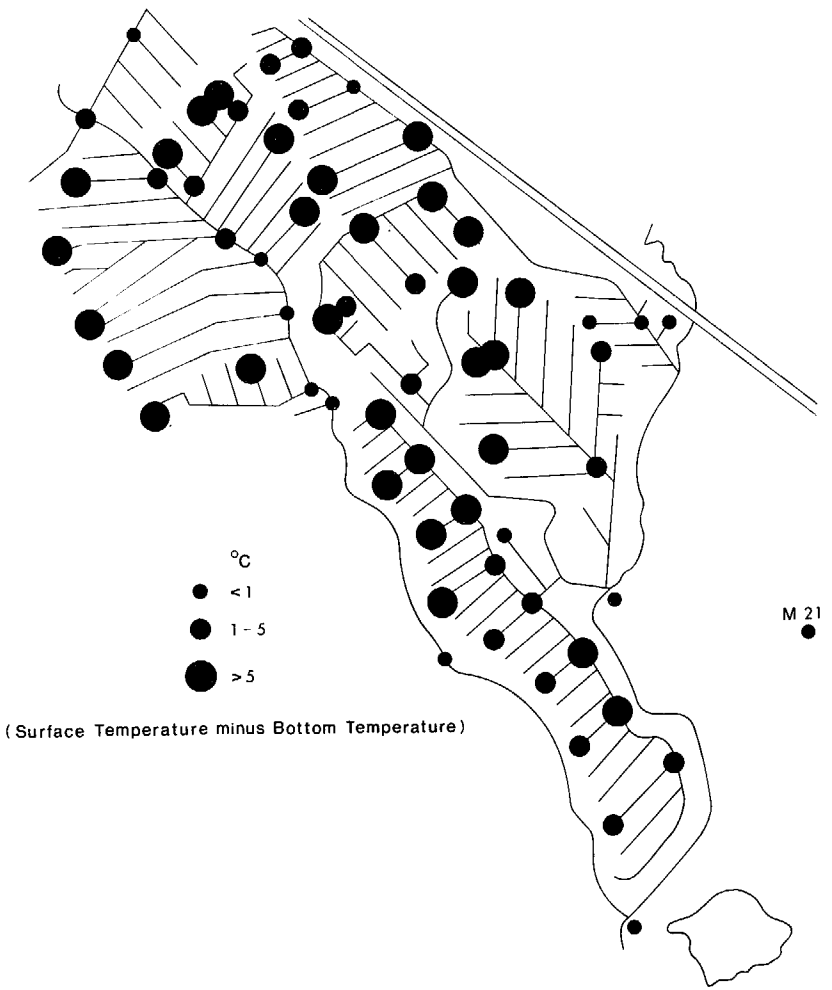


Fig. 7. Temperature stratification (°C): (Surface temperature minus bottom temperature) in the lagoon systems on 9 July 1974.

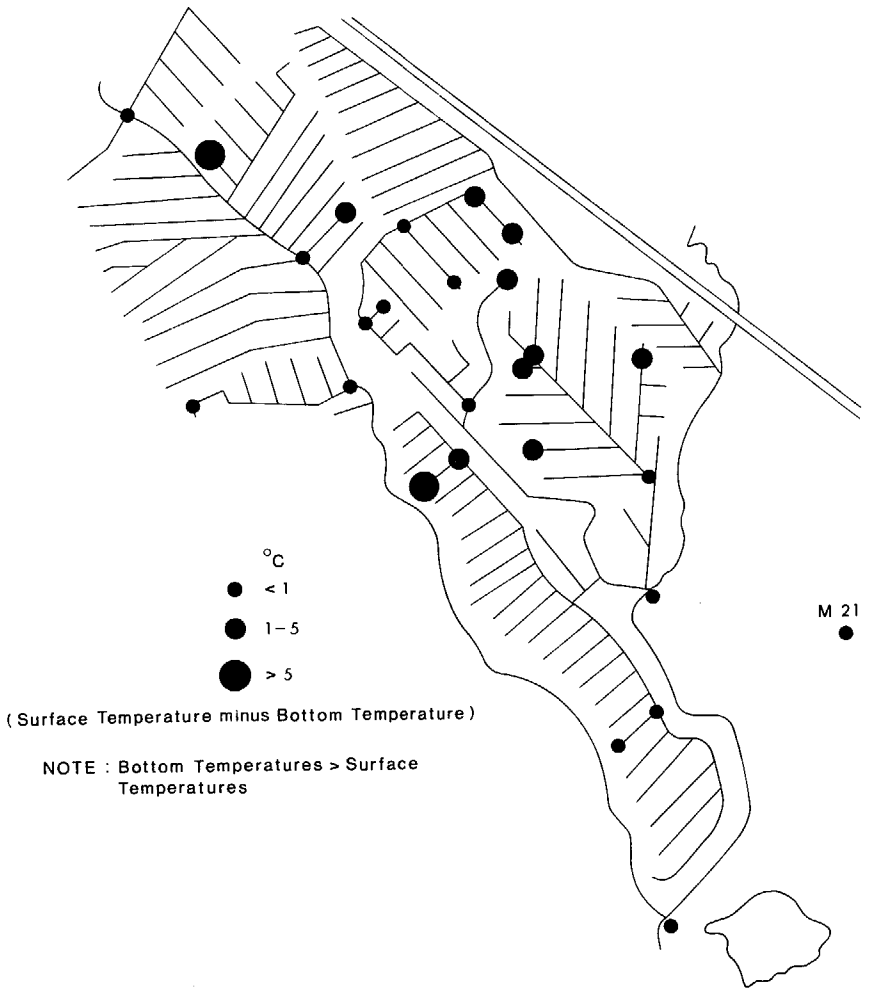


Fig. 8. Temperature stratification (°C): (Surface temperature minus bottom temperature) in the lagoon systems on 8 February 1975. Absolute value of the difference is indicated.

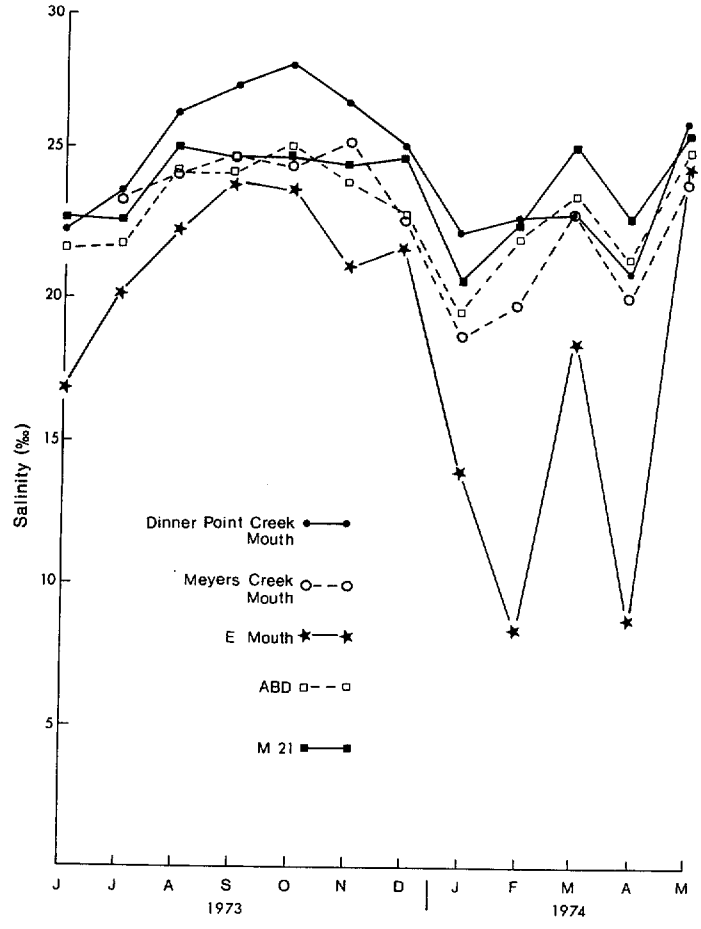


Fig. 9. Monthly mean surface salinity at the mouths of the major systems.

In Figures 12 and 13, the extent of salinity stratification throughout the lagoon systems is shown. Stratification is most common at those stations that are most removed from the lagoon system entrance to the bay except for System C. Greatest stratification was observed in Lagoon System E. The main axis of Lagoon System E is Mill Creek. Undoubtedly, the fresh water flow in Mill Creek accentuates the salinity stratification in those lagoons.

Stratification, by preventing vertical mixing, insures that water below sill depth for the lagoon system is trapped within the system.

TRANSPARENCY -- Secchi disc measurements of water transparency are plotted on a time line in Figure 14. Data are plotted for two years and for stations representative of the bay, a salt marsh pond, and a lagoon. A period of relatively high transparency occurred at the bay station, M 21, in the summer and early fall. Generally, lower transparency occured after that. Little seasonal variation occurred in the salt marsh pond which was characterized by lowest transparency of all areas. Maximum transparency in the lagoon occurred in late fall and early winter.

DISSOLVED OXYGEN — In Figure 15, surface dissolved oxygen concentrations for Meyers Pond and M 21 are plotted on a time line, and vertical profiles of dissolved

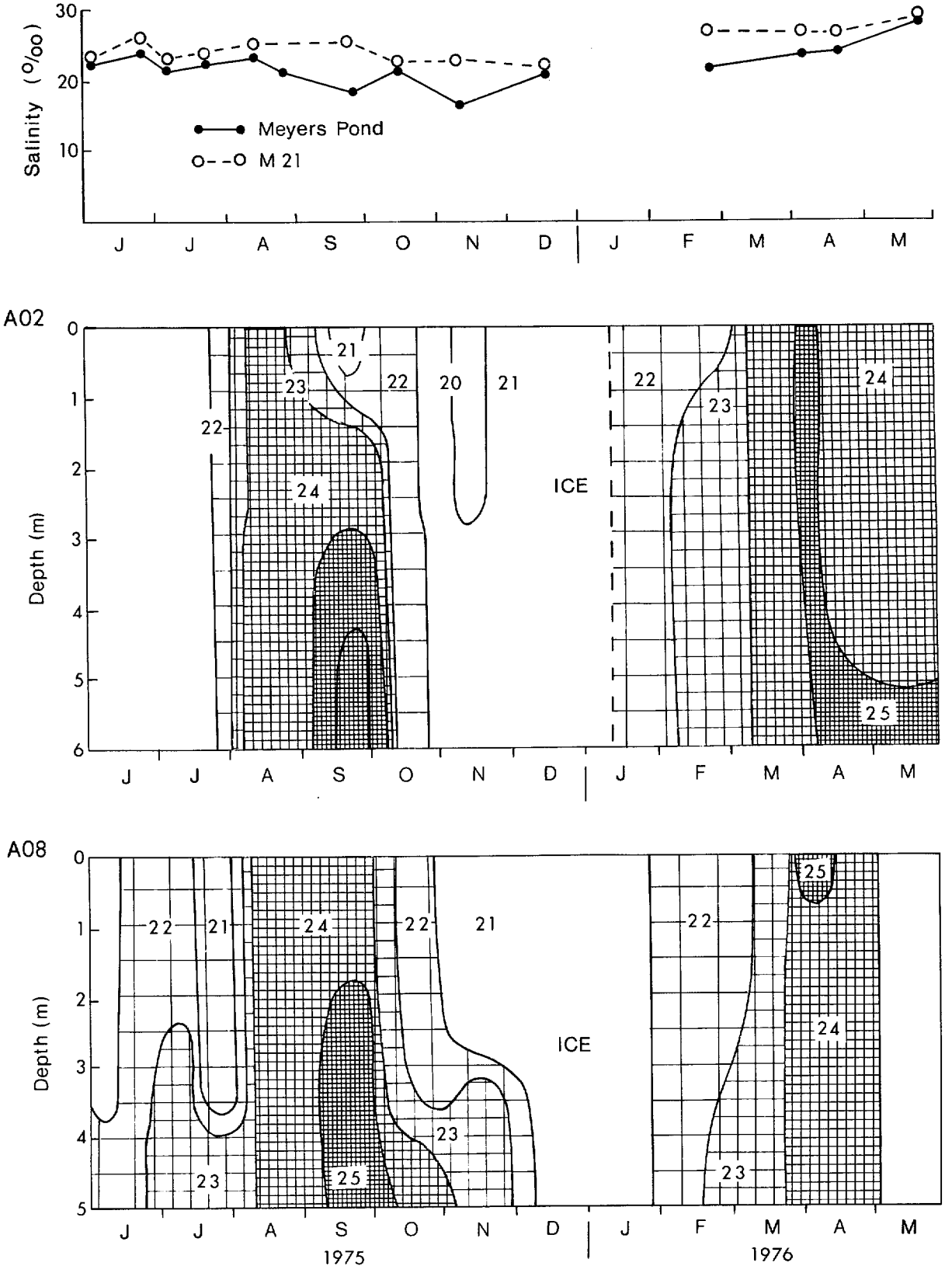


Fig. 10. Salinity at the surface of M 21 and Meyers Pond and vertical profiles of Lagoons A02 and A08 in o/oo.

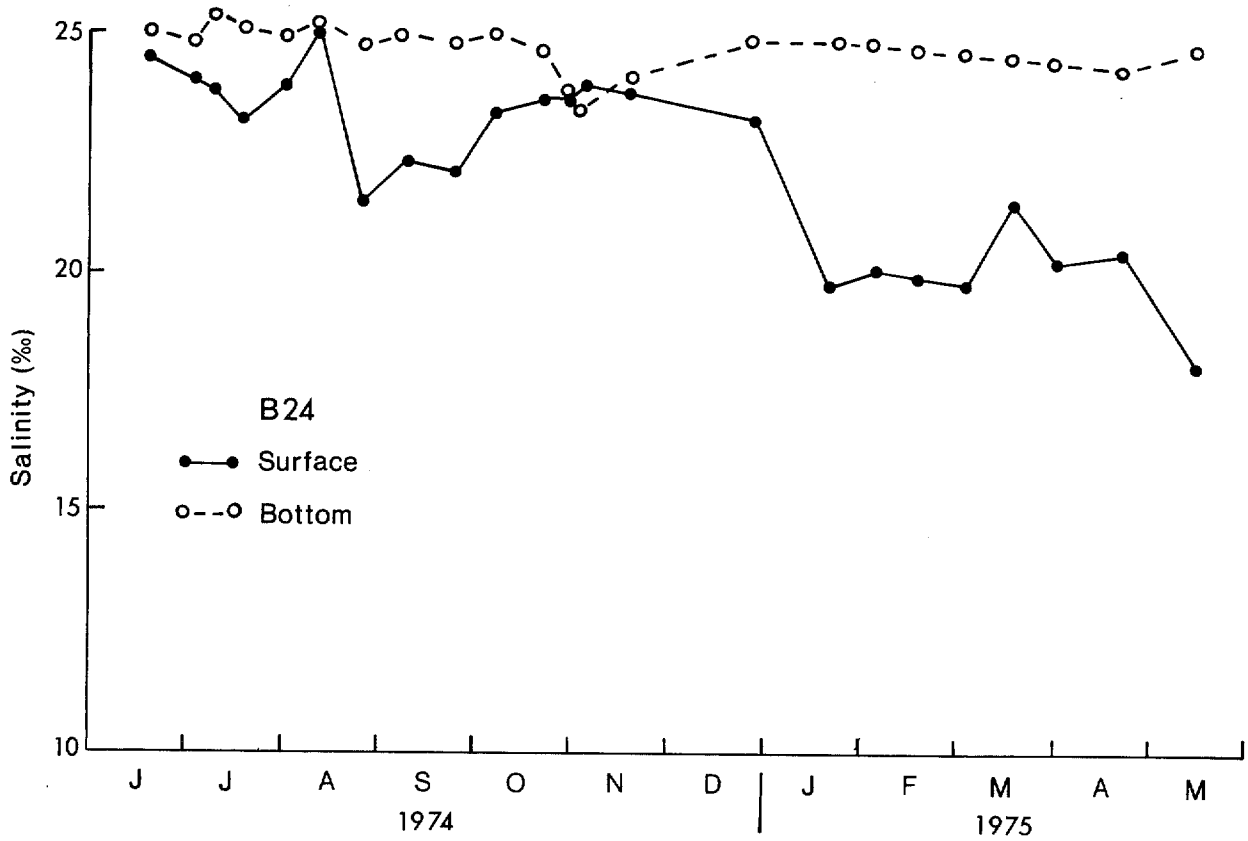


Fig. 11. Salinity at the surface and bottom of Lagoon B24.

oxygen are contoured for lagoons A02 and A08. Surface dissolved oxygen concentrations were maximum in the winter and minimum in the summer. Meyers Pond surface values were especially low in the summer though no zero concentrations were observed. Dissolved oxygen concentrations in the lagoons fell to less than 1 ml $O_2 \cdot l^{-1}$ frequently at bottom depths and remained low for appreciable periods of time. The periods of low dissolved oxygen occurred both in the summer and in the winter. In Figure 16, zero oxygen concentrations are shown for long periods at A08 and B24. Lagoon B24 is deeper than A08 and is further from the entrance to the lagoon system.

The extent of the development of low oxygen concentrations at bottom depths throughout all the lagoon systems is shown in Figures 17 and 18. It is clear in the July survey low dissolved oxygen levels occurred at bottom depths at most lagoons. In contrast, oxygen levels at stations along Mill Creek are not low. Though fewer stations were sampled in the February survey, low dissolved oxygen concentrations were often found at lagoon stations. Again, it appeared that, the more remote the station from the lagoon system entrance, the greater the chance that bottom dissolved oxygen would be low.

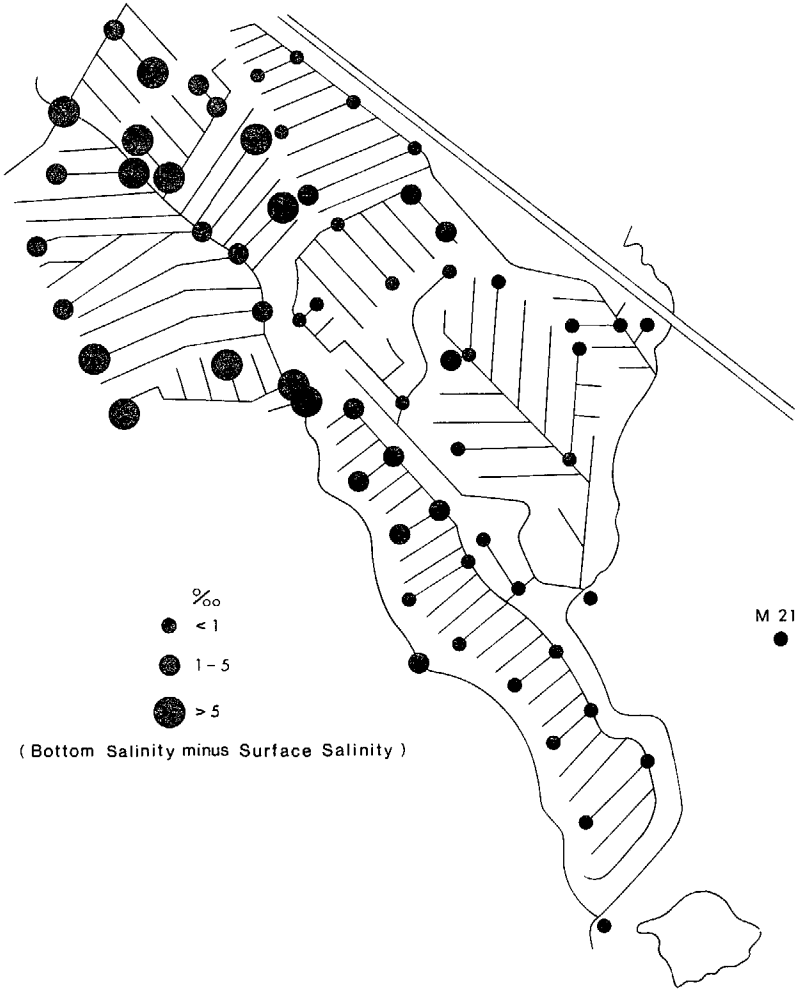


Fig. 12. Salinity stratification: (Bottom salinity minus surface salinity) in the lagoon systems on 9 July 1974.

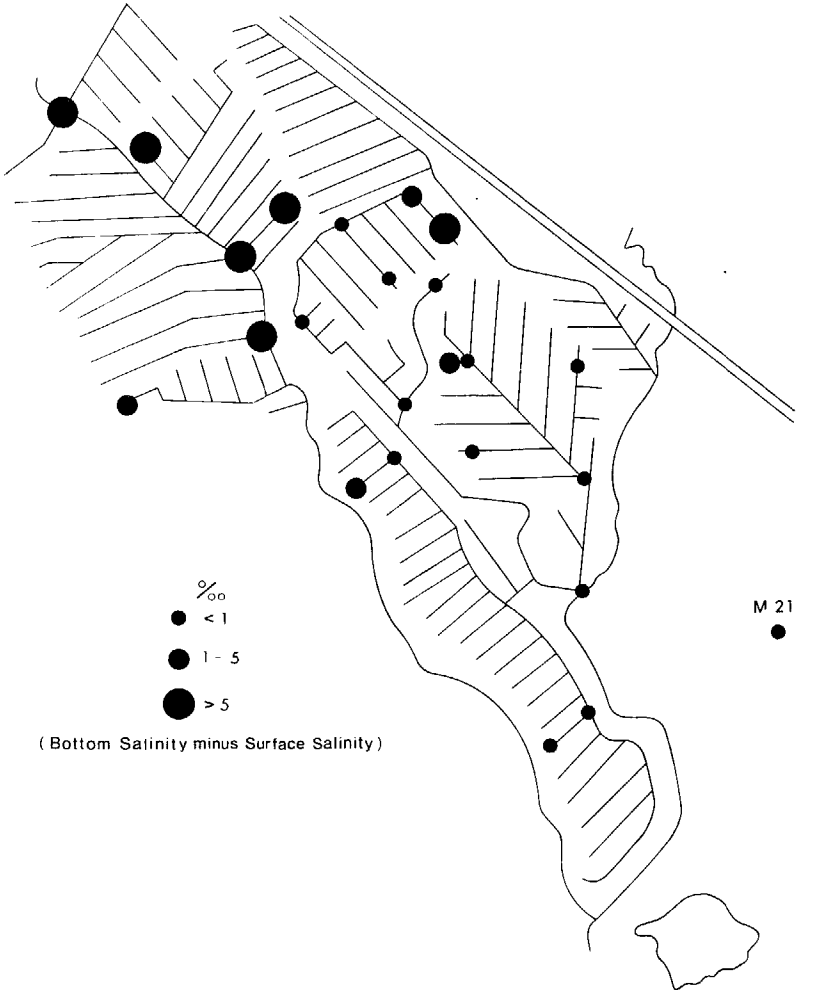


Fig. 13. Salinity stratification: (Bottom salinity minus surface salinity) in the lagoon systems on 8 February 1975.

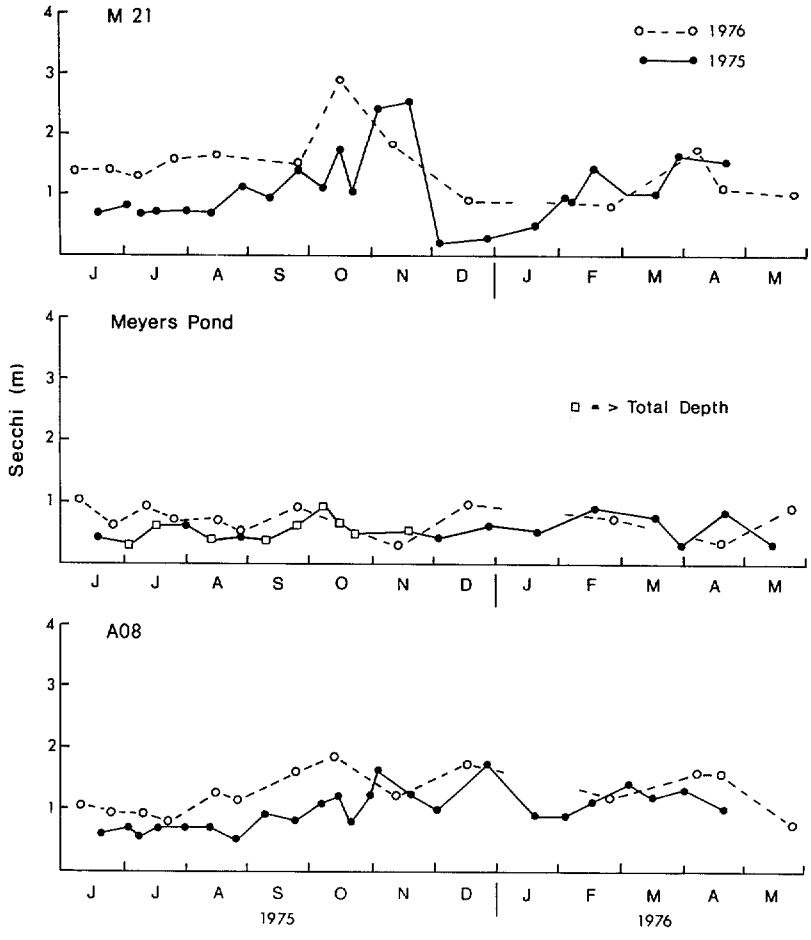


Fig. 14. Secchi disc readings at M 21, Meyers Pond, and A08.

Nitrogen

NUTRIENT SERIES -- Ammonia-N -- Ammonia-N was the predominant inorganic nitrogen compound found in the study area waters (Table 5). Only occassionally did the proportion of the remaining inorganic nitrogen compounds exceed the proportion of ammonia-N present. The prevalence of ammonia-N was particularly noticeable at the deeper lagoon stations such as B24 bottom, A08 mouth bottom, and A02 mouth bottom where anaerobic or low oxygen conditions were often present.

Ammonia-N concentrations at Marker 21, the bay control station, were generally 1.0 μg-atom NH_3-N·l^{-1} or less and only on rare occasions exceed 2.0 μg-atom NH_3-N·l^{-1}. This was typical of the study area as generally low ammonia-N levels were found at the surface at all stations. The upper stations in the Meyers, Dinner Point, and Mill Creek (E) systems had the highest surface ammonia-N concentrations. Excluding station E68, which was influenced by a nearby sewage outfall, surface ammonia-N concentrations ranged as high as 23.9 μg-atom·l^{-1} but were usually 10.0 μg-atom·l^{-1} or less. Concentrations at the creek mouth stations, while somewhat higher than at M 21, were generally lower than the upper end concentrations and were usually less than 5.0 μg-atom NH_3-N·l^{-1} (Table 6). This apparently resulted from the mixing of nitrogen poor bay water with the ammonia-N enriched creek water. The only vertical sampling in the creeks was done at the

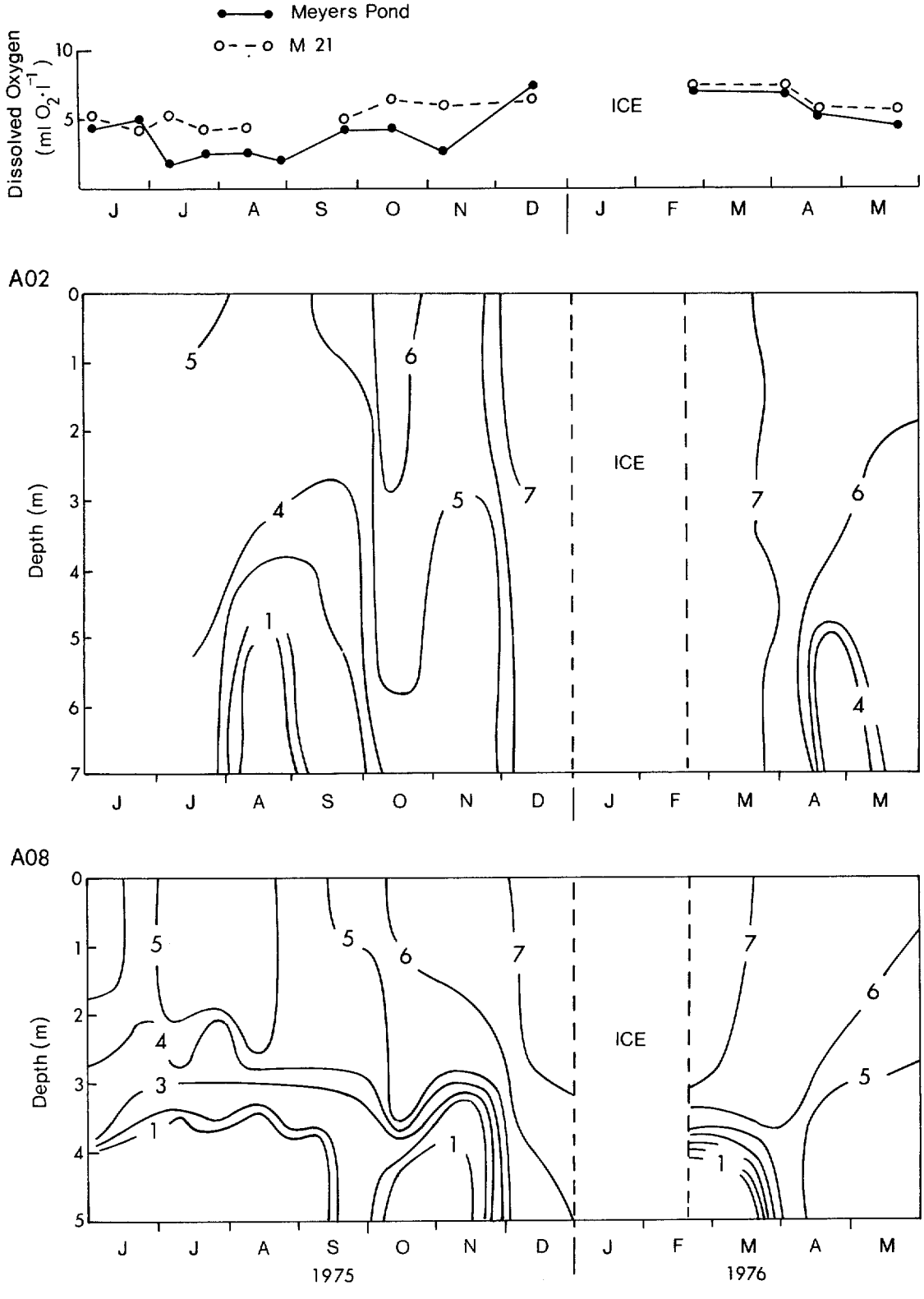


Fig. 15. Dissolved oxygen concentrations at the surface of M 21 and Meyers Pond and vertical profiles of Lagoons A02 and A08 in ml $O_2 \cdot l^{-1}$.

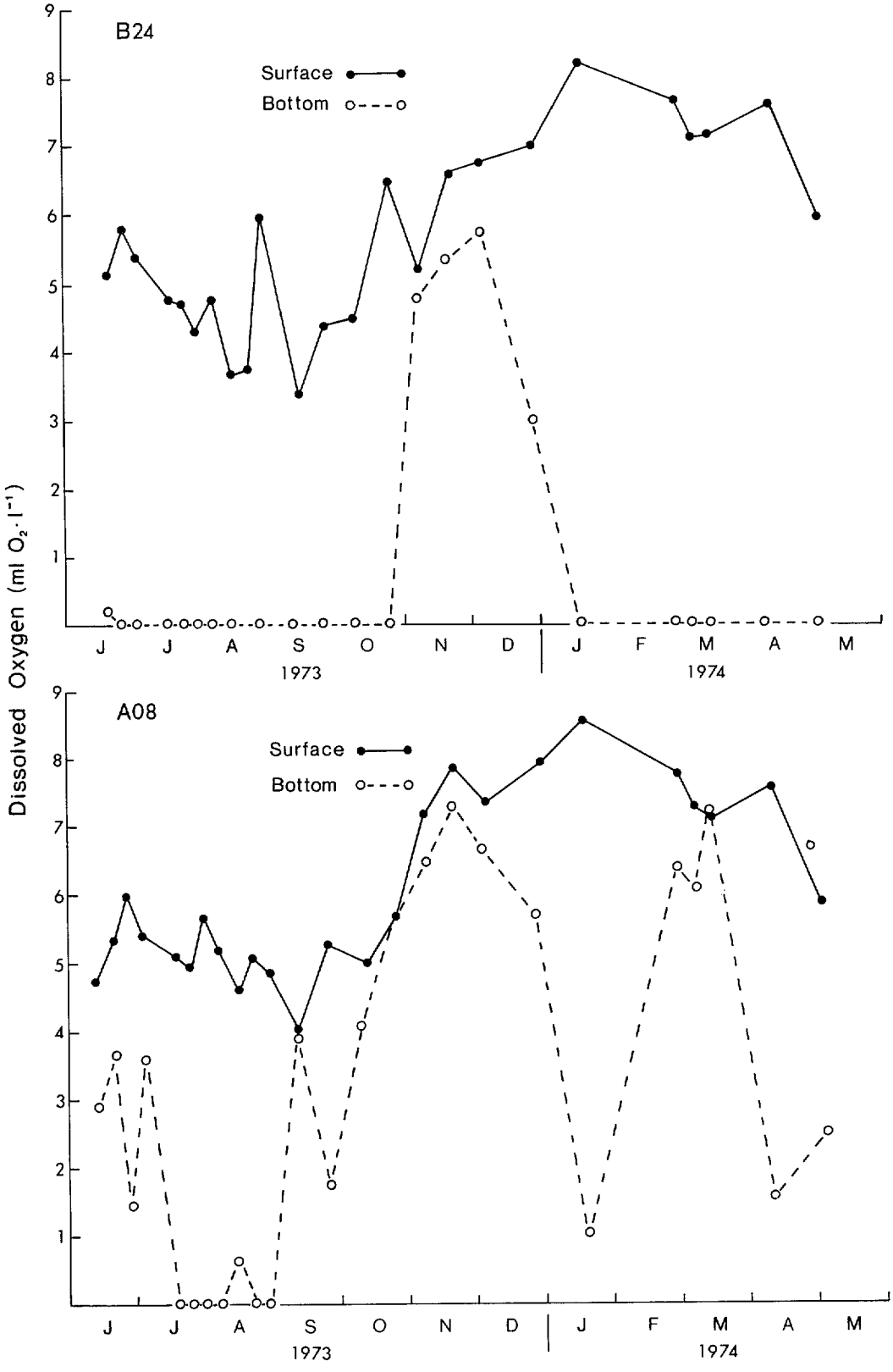


Fig. 16. Dissolved oxygen concentrations at the surface and bottom of Lagoons B24 and A08.

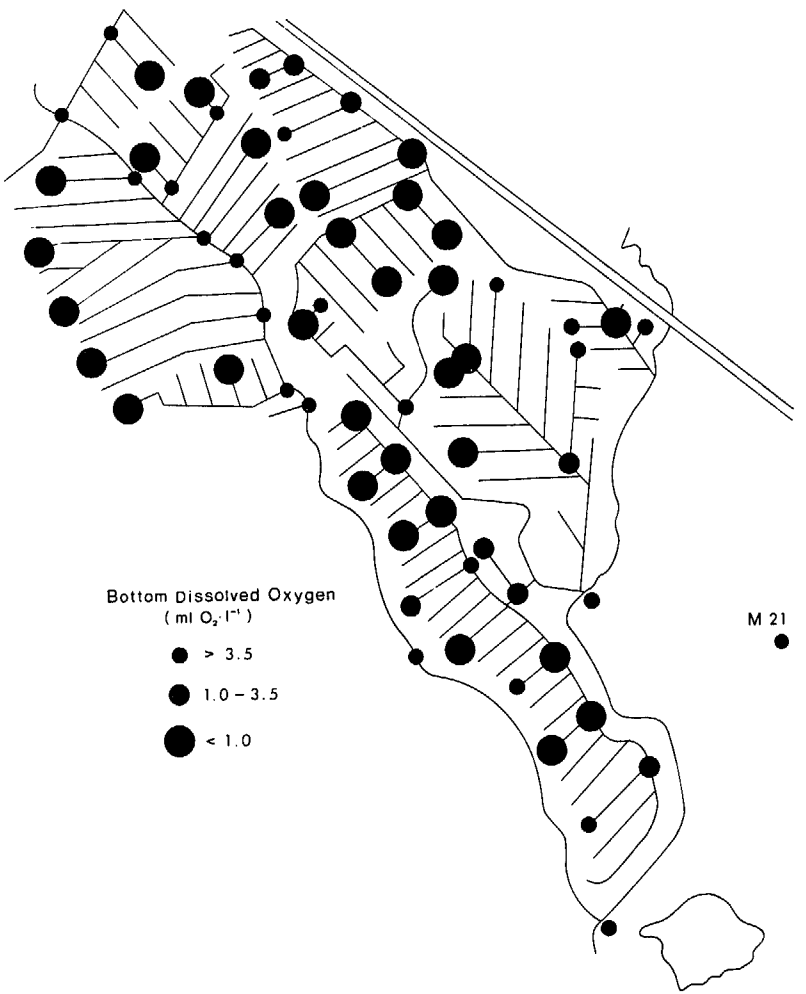


Fig. 17. Dissolved oxygen concentrations at the bottom of the lagoon systems on 9 July 1974.

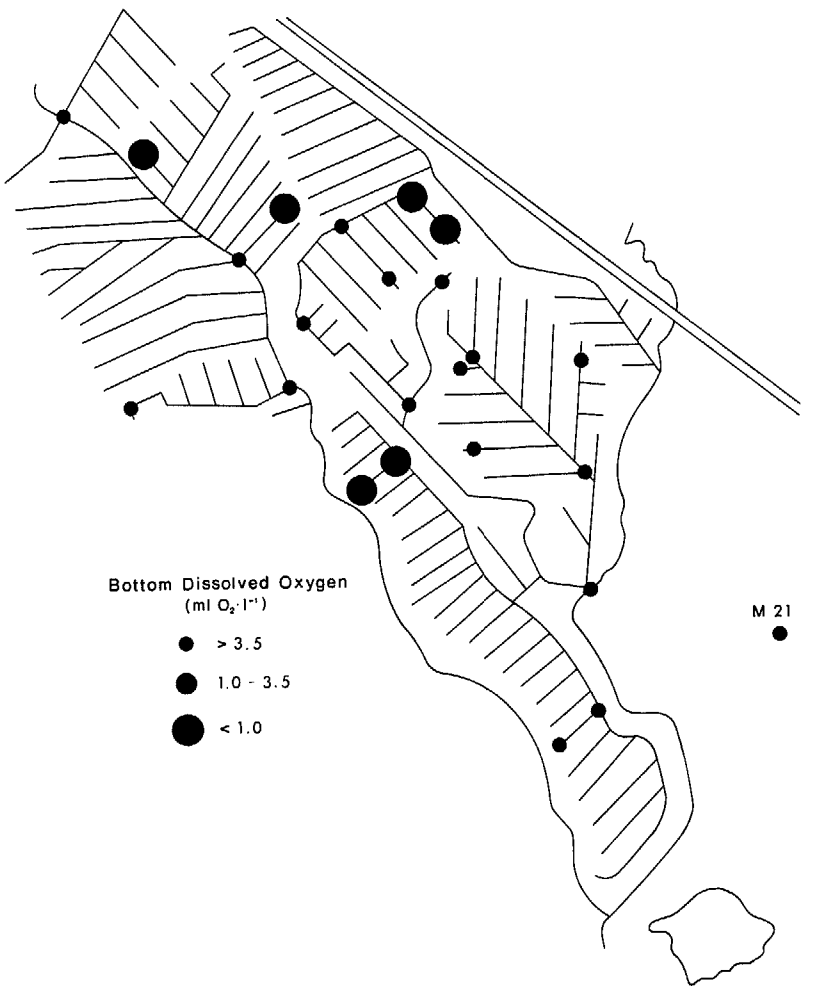


Fig. 18. Dissolved oxygen concentrations at the bottom of the lagoon systems on 8 February 1975.

Table 5. The proportion of the total inorganic nitrogen (TI-N) composed of ammonia-N (NH_3-N).*

Station	Study year: I	II	III	Study mean
Dinner Point Creek mouth surface	.66	.63		.65
Upper Dinner Point Creek surface	.85	.84		.85
Meyers Creek mouth surface	.52	.64	.82	.66
Mid Meyers Creek surface			.84	.84
Meyers Pond surface	.86	.77	.81	.81
M 21 surface	.42	.52	.83	.59
ABD surface	.64	.47	.76	.62
A02 mouth surface			.57	.57
A02 mouth bottom			.97	.97
A08 mouth surface	.53	.52	.74	.60
A08 mouth bottom	.99	.97	.98	.98
B24 surface	.62	.54		.58
B24 bottom	1.00	1.00		1.00

* The proportions were calculated by dividing the annual mean NH_3-N concentration by the annual mean TI-N concentration. Annual means were based on all available monthly means.

E mouth and E68 stations. The creek water was found to be moving downstream in a layer on top of the penetrating bay water. The deeper bay-related water was nitrogen poor compared to the upper layer. This lack of mixing also helped explain why the E mouth surface values were so rich in ammonia-N compared to the other creek mouths. Probably, the creeks serve as an ammonia-N source for the bay. There was no suggestion of a similar function in the lagoons where ammonia-N levels were comparable to those of M 21 and there was no evidence of a concentration gradient leading to the bay.

Aside from the lack of a concentration gradient, vertical sampling showed the ammonia-N distribution in the lagoon systems differed in other ways from that in the creek systems. Because the lagoons were deeper and vertical mixing forces were reduced compared to those in the creeks, stratification in the water column occurred. Ammonia-N accumulated at these deeper sites in proportion to the length and degree of stratification. The A02 mouth station was infrequently stratified and showed only slightly raised ammonia-N levels. In contrast, the B24 station had some concentrations in excess of 200 μg-atom NH_3-N$\cdot l^{-1}$ because of the nearly continuous stratification (Figure 19). The A08 mouth station was intermediate

Table 6. Monthly mean ammonia-N concentrations in μg-atom NH_3-N·l^{-1}.

Date	Marker 21	Meyers Creek mouth	Meyers Pond	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth	E68	E87
6/73	1.3			1.9	6.2	7.2	7.4	3.0
7/73	0.7	1.3	2.5	0.8	3.6	2.6	13.6	2.3
8/73	0.8	0.6	0.8	0.5	1.8	2.1	5.9	1.3
9/73	0.6	0.5	0.8	0.8	1.3	2.3	2.7	2.6
10/73	0.4	0.9	0.5	0.4	0.4	0.7	3.1	2.3
11/73	1.4	1.9	4.6	2.7	12.0	0.9	3.2	3.3
12/73	0.3	1.5	6.7	0.5	4.3	0.8	27.1	5.4
1/74	0.4	2.2	1.8	1.5	1.4	5.0	8.9	7.7
2/74	0.6	0.0	6.6	0.1	11.5	5.1	8.4	5.4
3/74	0.1	0.2	10.0	0.0	6.2	0.8	8.7	5.5
4/74	0.1	0.6	0.5	0.1	5.2	3.3	2.9	4.2
5/74	0.2	0.3	0.8	0.1	1.7	0.0	12.3	1.3
6/74	0.0	0.0	0.4	0.0	1.7	0.0	0.0	0.0
7/74	0.8	0.8	2.0	0.7	5.2	0.4	1.0	2.1
8/74	0.7	1.5	1.0	3.0	6.6	1.3	0.6	1.1
9/74	1.3	4.7	6.6	5.9	5.8	0.5	3.3	1.4
10/74	0.7	0.9	2.5	0.8	5.4	5.0	8.3	4.2
11/74	0.8	1.5	1.8	0.9	16.7	6.8	12.1	7.7
12/74	0.5	1.6	1.0	0.1	1.6	0.6	0.0	2.5
1/75	0.7	3.0	4.2	3.6	5.6	5.8	6.6	4.5
2/75	0.5	0.9	1.6	0.3	2.7	8.8	9.8	8.0
3/74	0.4	1.1	0.6	0.5	2.7	7.5	10.9	5.7
4/75	0.6	0.4	5.2	3.0	10.2	3.2	17.2	5.5

to these two sites with respect to stratification and ammonia-N concentrations (Figure 20). High concentrations of ammonia-N were confined to within 2.0 meters of the bottom at B24 and 1.0 meter at A08 mouth.

At B24, peak ammonia-N concentrations occurred at the bottom in the late summer - early fall. Concentrations dropped to levels below 20 μg-atom NH_3-N·l^{-1} at B24 when stratification broke down in late fall. Following the fall overturn, concentrations again increased to the late summer levels. The main periods of stratification at A08 were during the summer, when it was strongest, and during the winter. Peak bottom concentrations ranged as high as 265 μg-atom NH_3-N·l^{-1} in the summer and 66.3 μg-atom NH_3-N·l^{-1} in the winter. Concentrations were generally below 5 μg-atom NH_3-N·l^{-1} for the remainder of the year. The nearly year round low surface concentrations in the lagoons resulted from several processes including photosynthetic demand and nitrification. At the B24 station, the surface values did increase during the periods of destratification. Apparently, the bottom ammonia-N enriched the entire water column. The relation between lower surface salinities and increased surface ammonia-N concentrations also suggested there was an input from runoff. The overall increase amounted to an additional 5 to 10 μg-atom·l^{-1} at the surface. At the A08 mouth site, no similar increase was detected. For the most part, surface concentrations remained below 2.0 μg-atom NH_3-N·l^{-1}.

The seasonal ammonia-N trends for the creek systems were subject to variation from year to year. There was a relationship between increased upper end ammonia-N concentrations and reduced surface salinities. Increased concentrations resulted from either storm activity and/or normal upland drainage and could account for the variation observed in seasonal patterns. At E87, the highest ammonia-N concentrations were observed in the winter and reached values around 8.0 μg-atom·l^{-1}. Concentrations at E68 were often the highest measured for the E System and showed a more irregular seasonal pattern than that observed at E87. The mouth of the E System approximated the pattern at E87 but incorporated some of the peaks from E68 (Figure 21). The general pattern was for concentrations as high as 13.0 μg-atom NH_3-N·l^{-1} at Meyers Pond and 7.5 μg-atom NH_3-N·l^{-1} at the mouth station to occur in the fall to early winter period and lower levels to occur for the remainder of the time.

Nitrite-N -- Nitrite-N occurred in low concentration and had little effect on the level of available nutrients. Concentrations were usually below 0.5 μg-atom NO_2-N·l^{-1} and frequently were zero. The presence of nitrite-N, however, did indicate periods of nitrification. The simultaneous presence of increased levels of both compounds strongly implicated nitrification as the causative process. Nitrification occurred primarily during September to February but was also indicated in June at some sites.

Nitrate-N -- Nitrate-N was the second most abundant inorganic nitrogen compound. In general, most systems had concentrations of less than 1.0 μg-atom NO_3-N·l^{-1}. Most of the nitrate-N was associated with the E System. Elevated values at E87 suggested a connection between nitrate-N and upland drainage (Figure 22). Again, the sewage plant at E68 probably accounted for the higher and more irregular values found at the E68 site. Disregarding extreme values, similarities between the E68 and E87 seasonal patterns suggested the outfall represented an addition to the upland source of nitrate-N. Nitrate-N was also associated with periods of destratification at B24. The elevated nitrate-N levels could have resulted from nitrification. Because the increased NO_3-N concentrations were coincident with reduced

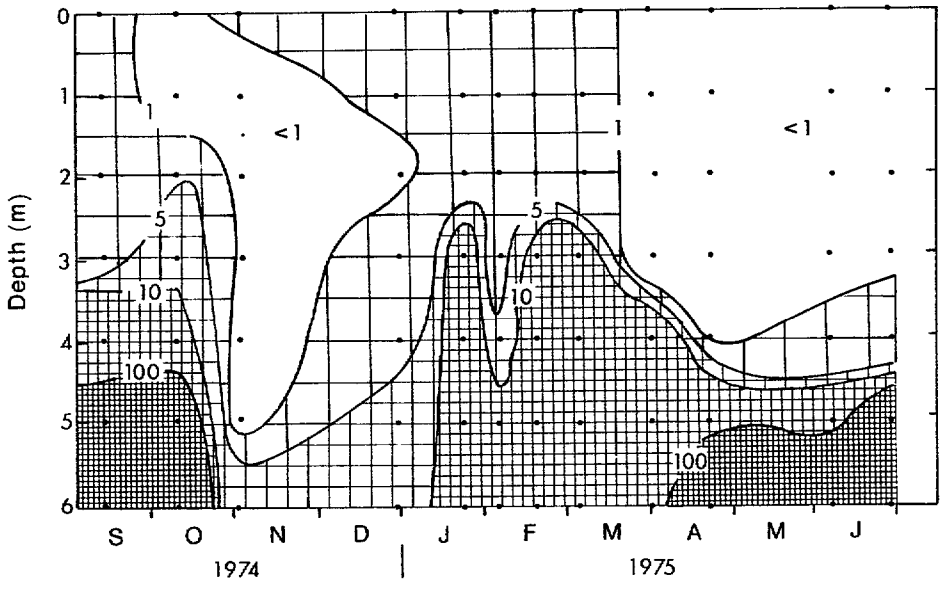


Fig. 19. Ammonia-N contours for Lagoon B24 in µg-atom NH_3-N·l^{-1}.

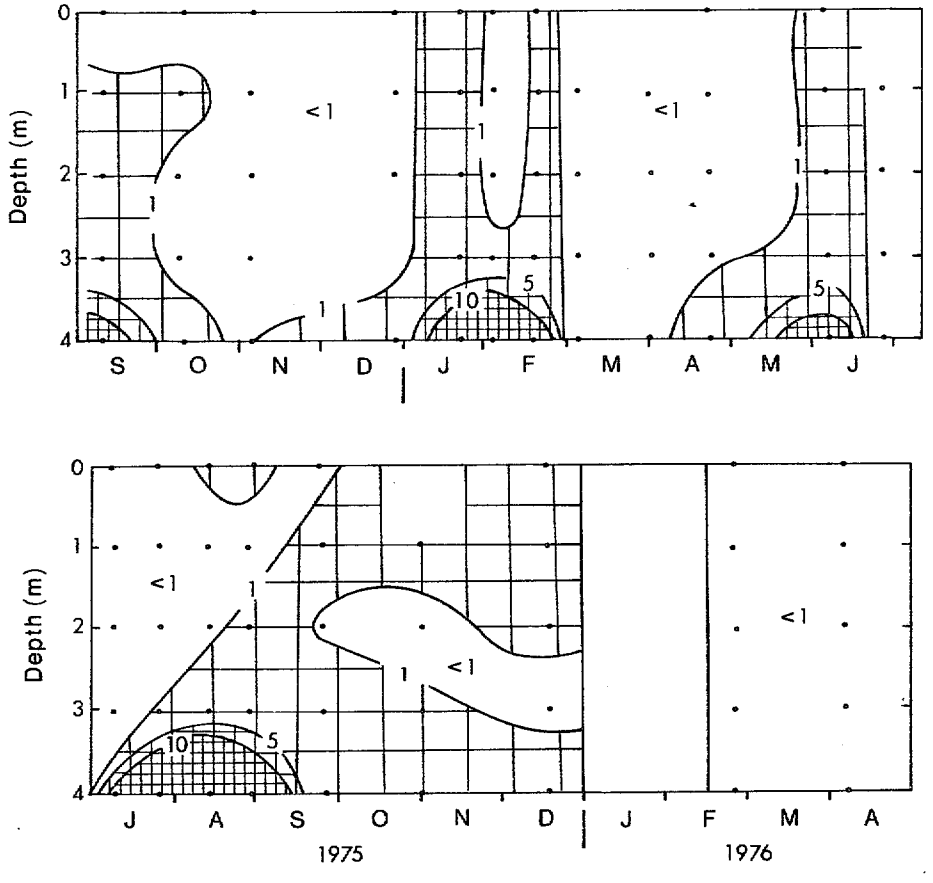


Fig. 20. Ammonia-N contours for Lagoon A08 in µg-atom NH_3-N·l^{-1}.

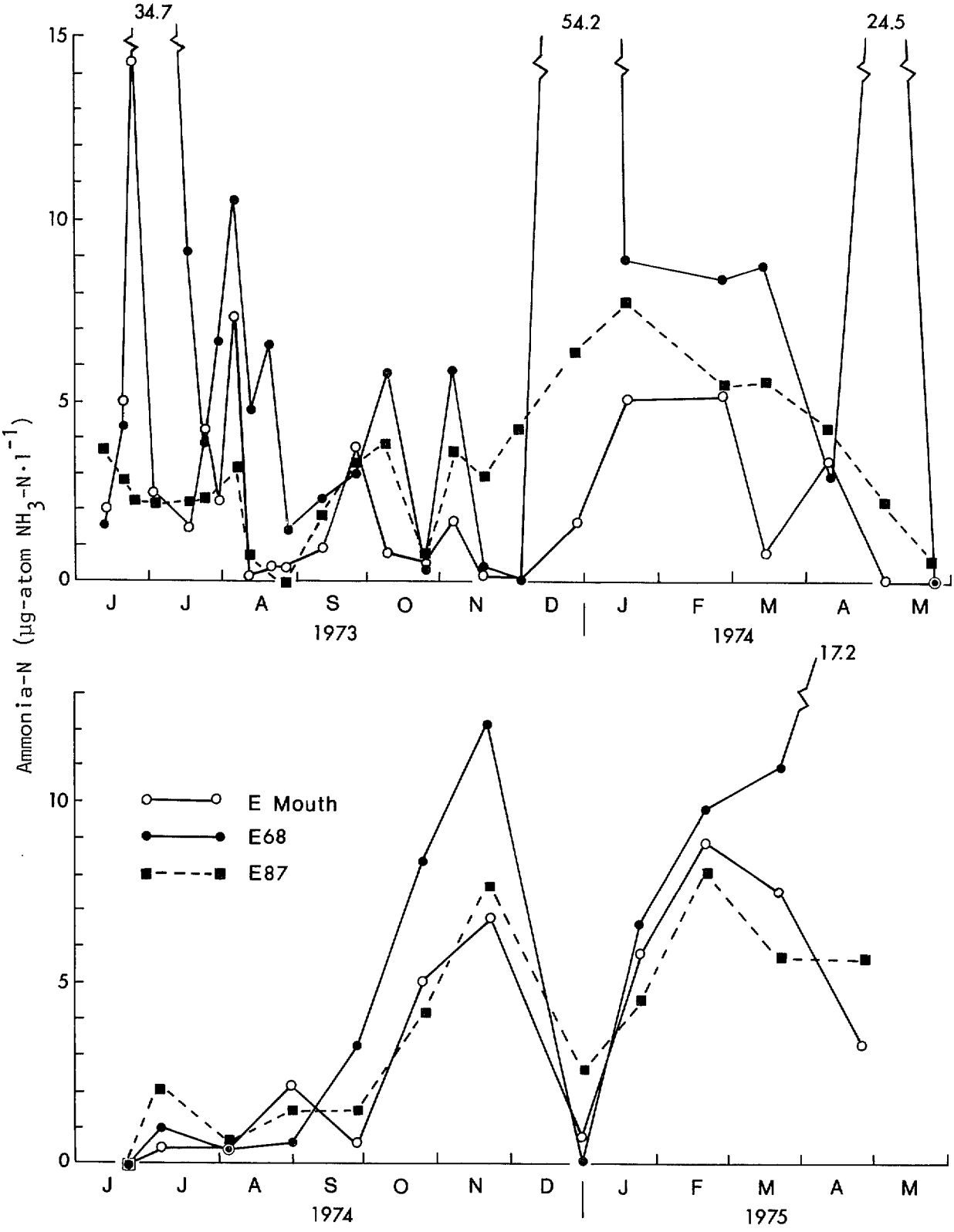


Fig. 21. The ammonia-N seasonal patterns for the E system.

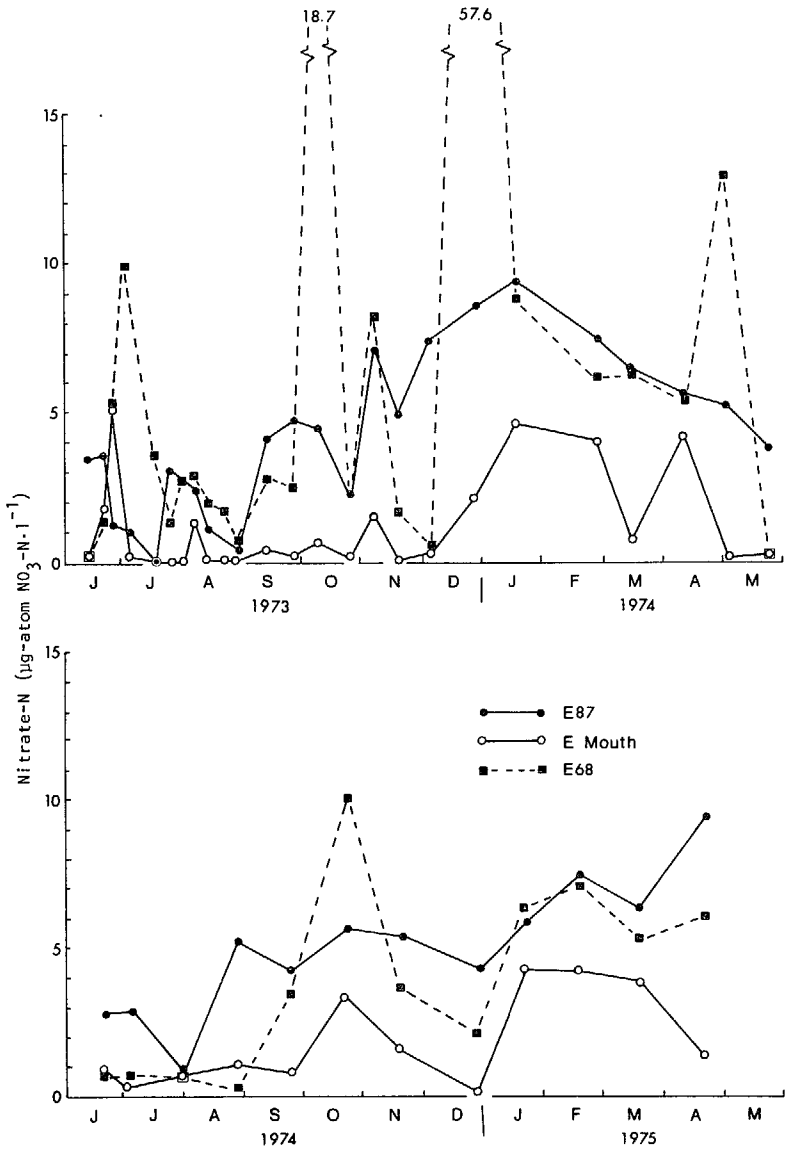


Fig. 22. The seasonal nitrate-N pattern for the E System.

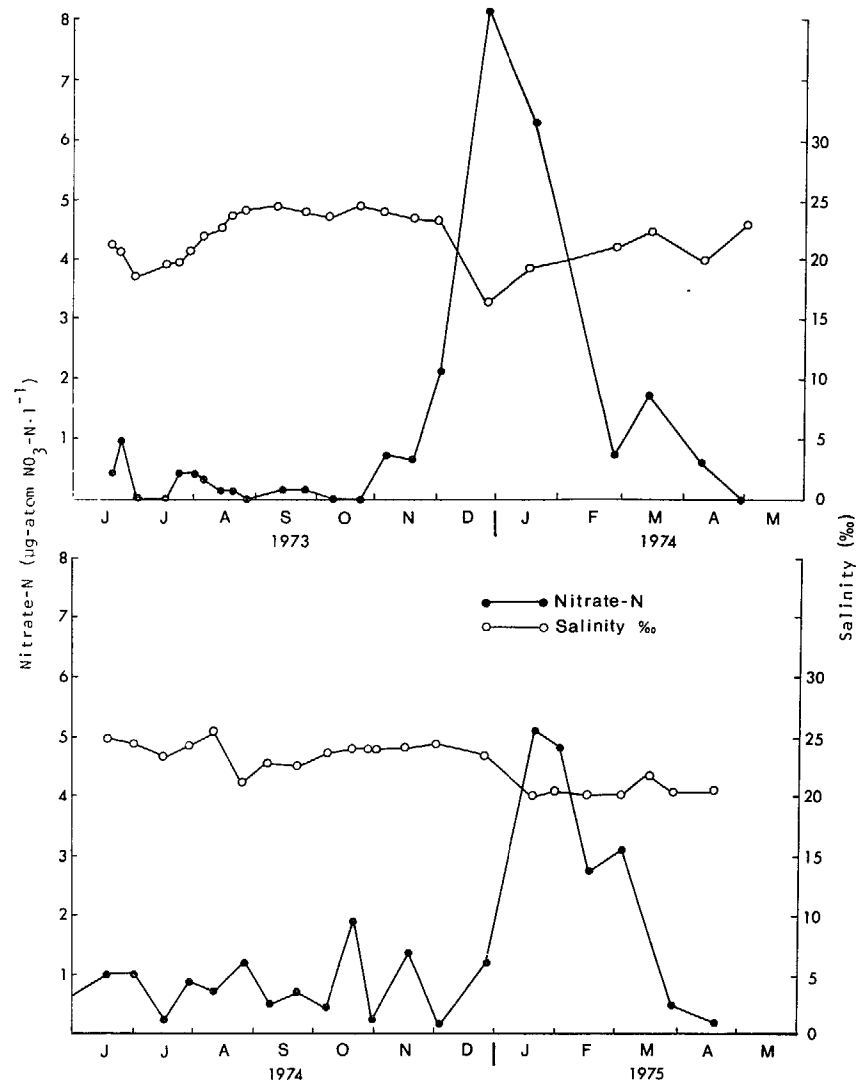


Fig. 23. The seasonal patterns for salinity and nitrate-N at the surface of B24.

surface salinities, the nitrate-N could have also resulted in part from storm drainage (Figure 23). Seasonal trends at all the stations tended to be variable from year to year, but there was a general tendency for winter values to exceed summer values.

Organic-N -- Total organic nitrogen was the most abundant form of nitrogen in both the marsh and lagoon systems. In study year III, total organic-N composed over 82 % of the nitrogen present within the Meyers Creek system and Lagoon System A (Table 7).

Table 7. Nitrogen standing stocks in $\mu g\text{-atom} \cdot 10^6$ for the Meyers Creek and lagoon systems during study year III.

Site	Quarter	NH_3-N	NO_2-N	NO_3-N	Org-N (total)	Total N	Org-N / Total N
Meyers Creek	1	42.9	0.0	2.2	1,084.6	1,129.7	.96
	2	152.9	2.2	28.6	841.5	1,025.2	.82
	3	5.5	2.2	4.4	804.1	816.2	.99
	4	22.0	0.0	2.2	711.7	735.9	.97
Meyers Pond	1	31.1	0.0	2.7	918.5	952.3	.96
	2	120.6	1.8	22.5	982.8	1,127.7	.87
	3	21.6	2.7	14.4	720.9	759.6	.95
	4	22.5	0.0	1.8	629.1	653.4	.96
Lagoon A02	1	13.9	0.2	4.7	655.6	674.4	.97
	2	32.7	0.5	22.6	567.6	623.4	.91
	3	6.9	2.8	9.0	619.2	637.9	.87
	4	0.6	0.0	0.2	568.9	569.7	1.00
Lagoon A08	1	44.2	0.1	4.0	684.0	732.3	.93
	2	20.0	0.0	8.8	506.0	534.8	.95
	3	13.2	0.8	2.7	679.8	696.5	.98
	4	6.5	0.0	0.7	690.8	698.0	.99

Seasonal patterns at the surface at M 21 and the creek system stations were similar. Typically, in study year I, the sites had relatively uniform levels of total organic-N from June 1973 to January of 1974. However, at some sites, the values from the latter part of the period showed a tendency to be slightly lower than in the first part. A peak in total organic-N was recorded at many of the systems from January through March, but the peak was irregular with respect to time and magnitude. Following this, another increase of longer duration and higher concentrations occurred in the summer and extended into the early fall. A decrease in concentration then occurred after which concentrations leveled off and remained relatively uniform through the winter of study year II. This level was maintained through study year III within the Meyers Creek system and at M 21.

In the E System, there was a decrease rather than a "January-March peak" in study year I. In addition, no summer peak was detected at E87, and the average total organic-N concentration at E87 were the lowest found in the study area. Normally, the E87 values were less than 30 μg-atom Org-N$\cdot 1^{-1}$ and averaged around 10 to 20 μg-atom Org N$\cdot 1^{-1}$ for the entire year. The remaining E System sites had total organic-N values averaging as follows: 30 to 40 μg-atom$\cdot 1^{-1}$ from the summer through the fall of study year I; around 20 μg-atom 1^{-1} during the January-March 1974 period; 60 to 70 μg-atom$\cdot 1^{-1}$ in the summer of study year II; and 20 to 30 μg-atom$\cdot 1^{-1}$ thereafter.

In contrast, the upper end of Dinner Point Creek system had slightly higher organic-N values. The seasonal pattern of the mouth site averaged 30 to 40 μg-atom Org-N$\cdot 1^{-1}$ from June 1973 to June 1974; had a 1974 summer maximum around 60 μg-atom$\cdot 1^{-1}$; declined to less than 20 μg-atom$\cdot 1^{-1}$; and were around 30 to 40 μg-atom Org-N$\cdot 1^{-1}$ thereafter. While the values for the last phase were similar, the upper end concentrations for the June to January period in study year I were approximately 40 to 70 μg-atom Org-N$\cdot 1^{-1}$ and 60 to 80 μg-atom Org-N$\cdot 1^{-1}$ in the summer of 1974. The upper end peak occurred in late December and the mouth peak in the end of February (Figure 24).

The Meyers Creek system stations were comparable to each other except for some additional minor peaks during study year III and the end of study year II at Meyers Pond. The Meyers Creek stations and especially the mouth site were similar in magnitude as well as pattern to Dinner Point Creek mouth. The major difference was a more extended and slightly higher 1974 summer maximum (60 to 100 μg-atom Org-N$\cdot 1^{-1}$) at the Meyers Creek stations. The seasonal trend at Marker 21 also approximated that of the Dinner Point Creek mouth. The only difference between these two was the absence of the irregular presummer peak in the M 21 pattern.

The seasonal total organic-N pattern for the lagoon surface sites appeared to be high, variable summer peaks followed by relatively stable levels for the remainder of the year. This trend was well illustrated by the first two years at the A08 and B24 sites (Figure 25). However, in study year III, the summer peak really was not evident. The lagoon bottom stations showed the same pattern as the corresponding surface sites. A summer peak of limited duration was detected in the bottom layer in the third study year; the peak was observed only at A08 and not A02 or B24.

NITROGEN FIXATION -- Terrestial marsh sites were subdivided into algal and substrate (nonalgal) communities according to whether algae were or were not

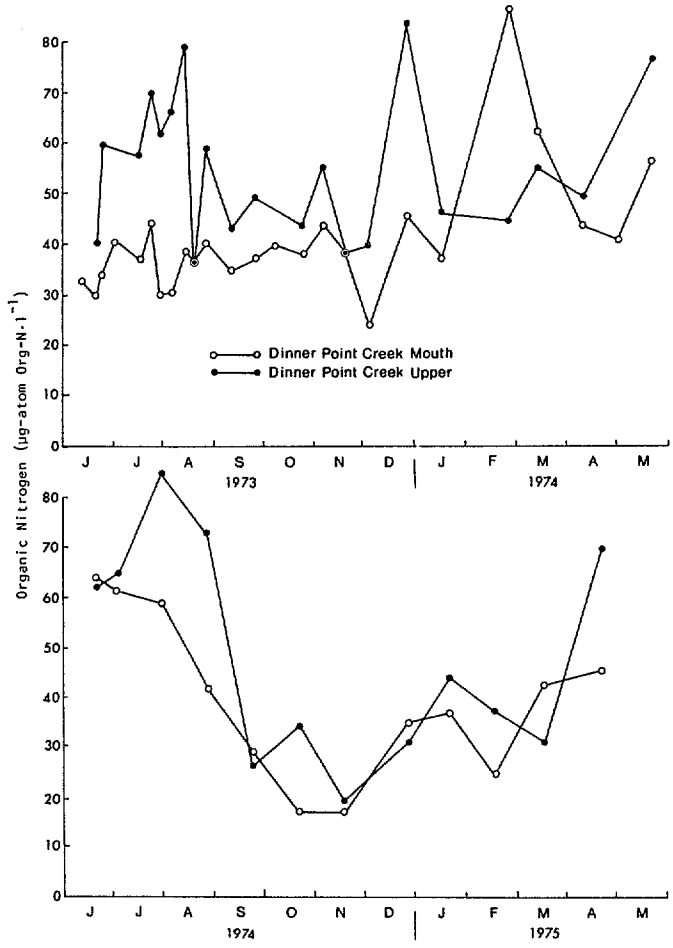


Fig. 24. Total organic nitrogen seasonal patterns in the Dinner Point Creek system.

visible to the naked eye on the surface. Typically, higher rates of ethylene production (i.e. nitrogen fixation) were associated with the algal mats than the substrate (Figure 26.). Rates were computed to be as high as 303 µg-atom NH_3-N·h·$^{-1}$ ·m^{-2} in certain areas.

Algal mats were most often found in the *Spartina alterniflora* short form (SAS) areas. Maximum algal cover occurred in the spring and fall quarters. Minimum cover occurred in the winter quarter. Although the winter minimum algal cover coincided with the seasonal low for nitrogen fixation rates, times of maximum algal cover did not coincide with times of maximum nitrogen fixation rates. Peak nitrogen fixation rates occurred in the latter part of the summer. The *Spartina patens/Distichlis spicata* (SP/DS) areas generally lacked algal mats on the marsh surface. Apparently, the grass cover prevented the sunlight from penetrating,eliminating the possibility of algal growth. Only in the limited areas where the macrophyte cover was degenerating were algae present. The *Spartina alterniflora* tall form/bank (SAT/B) zone on Meyers Creek had little algae associated with it. Meyers Pond bank areas, however, had large algal bands which were active nitrogen fixers.

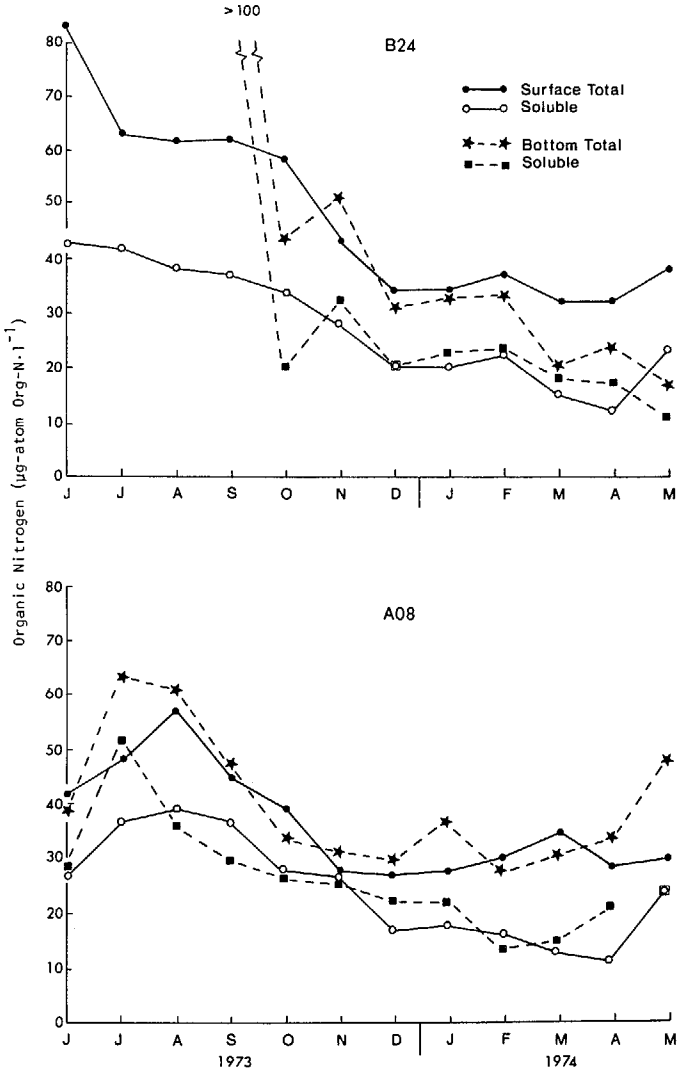


Fig. 25. Monthly mean organic-N concentrations in Lagoons B24 and A08.

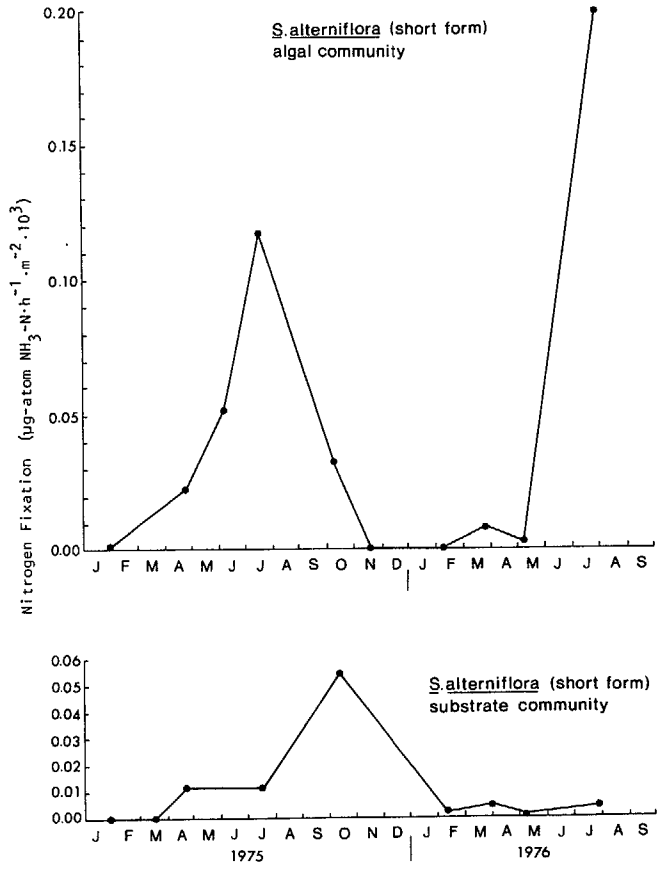


Fig. 26. The seasonal variation in the nitrogen fixation rates of the *S. alterniflora* (short form) communities.

The nitrogen fixation rates for the corresponding substrate communities were low, usually below 5 μg-atom NH_3-N·h^{-1}·m^{-2}. Only twice did the rates exceed 50 μg-atom NH_3-N·h^{-1}·m^{-2} at any marsh site. These occurred during the fall quarter in the bank community at Meyers Pond and in the SAS community.

On an annual basis, nitrogen fixation by the benthic sediment community and the water column community were the lowest encountered in marsh systems. The water column community had the lower rate, essentially zero.

The lagoon system differed from the marsh system because most marsh surface fixation was eliminated by housing and associated construction. The SAS algal mats were replaced by paved surfaces and house lots and the SAT/B zone communities by bulkheading. Algal communities were present on the intertidal portion of the bulkheading, and we considered them to correspond to the SAT/B zone algal communities.

These bulkhead associations dominated the nitrogen fixation process in the lagoon system. The upper portion of this zone was primarily a blue-green algal crust and had a fixation rate as high as 575 μg-atom NH_3-N·h^{-1}·m^{-2}. As with the marsh surface algae, minimum rates were detected in the winter quarter (Figure 27). The lower part of the zone, which was mostly green algae, had a peak rate of only 96 μg-atom NH_3-N·h^{-1}·m^{-2} and, generally, did not exceed 30 μg-atom NH_3-N·h^{-1}·m^{-2}. Nitrogen fixation rates for the benthic sediments and water column communities were minimal.

The SAS zone contributed the greatest amounts of newly fixed nitrogen not only because it had the highest combined algal/substrate fixation rate, but also because it was the dominant cover type (Table 8). This contribution was predominantly from the algal community which fixed 2.5 times more nitrogen annually than the substrate community (7.1 to 2.8 μg-atom NH_3-N·day^{-1}·10^7 respectively for the Meyers Creek system). The relatively low rate of the SP/DS substrate community was also magnified by the areal importance of its cover type. This community was third highest in the contribution of fixed nitrogen with 5.0 x 10^6 μg-atom NH_3-N·day^{-1} despite its low fixation rate. The remaining communities, the SAT/B zone, benthic sediments, and water column were considered to contribute nitrogen to the water column. The input from each of these types was much lower with a combined total input of 4.4 x 10^6 μg-atom NH_3-N·day^{-1}. Again, distribution either moderated or increased the significance of these processes. Only because the low benthic sediment and water column community rates were applied to a large portion of the system were they significant. Because the SAT/B zone rates were representative of a relatively small region, the amount of nitrogen fixed was low.

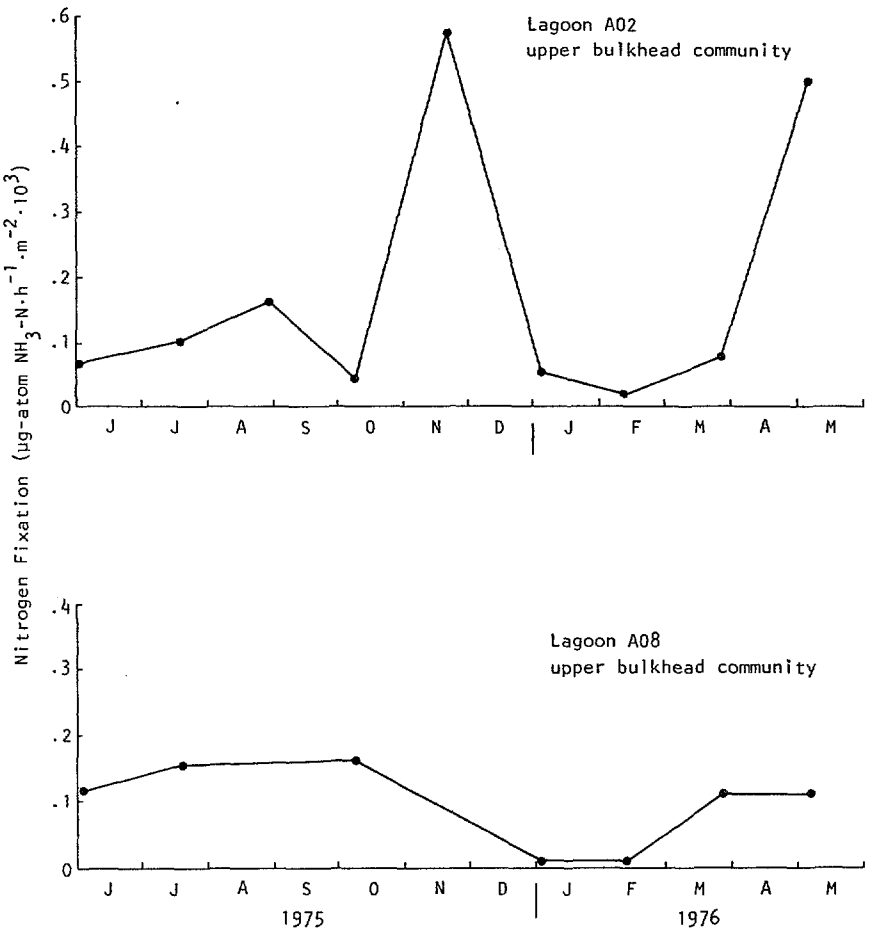


Fig. 27. The seasonal nitrogen fixation rates in the upper bulkhead algal communities within the Lagoon System A in µg-atom NH_3-N·h^{-1}·m^{-2}·10^3.

The algal SAS community fixed 2.5 times more nitrogen annually than the substrate community in the Meyers Creek system. Similarly, in the SAT/B zone, the algal components fixed twice as much as the substrate community along Meyers Creek despite very limited abundance and nearly 7 times as much along the Meyers Pond perimeter where algal mats were prevalent.

The high rates of the bulkhead algal community were applied to relatively small areas. This minimized the importance of this type of nitrogen fixer. On the other hand, the importance of the low benthic sediment and water column rates was probably overmagnified as it was in the creek system. Nonetheless, algal nitrogen fixation still dominated the nitrogen contributions to the system (Table 8).

EXCRETION -- *Modiolus* excretion data indicated minimum rates occurred in the warmer months and maximum rates in the cooler months. The range was from 1.6 to 12.1 µg-atom NH_3-N·$organism^{-1}$·day^{-1}. Using a population estimate of 1,653,453

Table 8. Nitrogen inputs resulting from nitrogen fixation in μgat NH_3-N· day^{-1}. 10^4 for study year III.

Site Quarter:	1	2	3	4	Annual mean
Meyers Creek:					
S. alterniflora short form:					
Algal community	6,061	10,824	0	798	4,421
Substrate community	3,693	2,493	274	286	1,687
S. patens/D. spicata					
Substrate community	702	44	0	28	194
S. alterniflora tall form/bank zone:					
Algal community	0	7	0	0	2
Substrate community	2	0	0	0	1
Benthic sediment community	73	18	8	7	27
Water column community	0	0	0	159*	40*
Meyers Pond:					
S. alterniflora short form:					
Algal community	3,711	6,628	0	489	2,700
Substrate community	2,261	1,445	301	292	1,075
S. patens/D. spicata					
Substrate community	1,125	71	0	44	310
S. alterniflora tall form/bank zone:					
Algal community	993	79	3	6	270
Substrate community	23	114	0	17	39
Benthic sediment community	165	233	0	24	106
Water column community	0	0	253*	0	63*

* The data with a * are probably artifacts of the extrapolation and should more properly be considered as zero.

Table 8. Continued.

Site	Quarter: 1	2	3	4	Annual mean
Lagoon A02:					
Bulkhead algal community:					
Upper zone	24.4	58.7	7.5	84.6	43.8
Lower zone	5.0	7.5	0.5	32.3	11.3
Benthic sediment community	18.4	14.7	0.0	3.8	9.2
Water column community:					
0-2 m	0.0	0.0	0.0	154.0*	38.5*
Greater than 2 m		0.0	46.0*	17.3*	15.8*
Lagoon A08:					
Bulkhead algal community:					
Upper zone	18.2	20.3	0.4	15.1	13.5
Lower zone	1.9	0.8	0.4	4.5	1.9
Benthic sediment community	8.1	5.6	2.5	4.9	5.3
Water column community:					
0-2 m	0.0	0.0	9.4*	105.0*	28.6*
Greater than 2 m		0.0	11.4*	0.0	2.9*

* The data with a * are probably artifacts of the extrapolation and should more properly be considered as zero.

organisms in the Meyers Creek system the total daily contribution of ammonia-N could be extrapolated (Table 9).

Organic-N excretion rates were determined for the April 1976 sampling. The mean rate was 9.4 μg-atom Org-N·organism^{-1}·day^{-1}. This accounted for over 60% of the nitrogen excreted by the mussels on this sampling. Extrapolation of the data yielded a total organic-N contribution of 15.58 x 10^6 μg-atom·day^{-1} in the Meyers Creek system. If this estimate is taken as representative of the entire year, this would add 5.69 x 10^9 μg-atom Org-N to the 3.31 x 10^9 μg-atom NH_3-N excreted per year by *Modiolus* in this system.

Ilyanassa obsoleta excretion data indicated maximum rates occurred around April, while minimum rates were found around the October period. The rates ranged from around 0.4 to 2.8 μg-atom NH_3-N·organism^{-1}·day^{-1}. The seasonal pattern was

Table 9. Total daily ammonia-N contribution by the Meyers Creek system *Modiolus demissus* population in μgat NH_3-N·day^{-1}·10^6.

Study year	Quarter	Meyers Creek	Meyers Pond	Total
II	2	4.8	2.1	6.9
	3	8.6	3.7	12.3
	4	7.9	3.4	11.3
III	1	1.8	0.8	2.6
	2	4.7	2.0	6.7
	3	14.0	6.1	20.1
	4	4.8	2.1	6.9
Overall	Mean*	6.3	2.8	9.1
	Mean #	6.7	2.9	9.6

* These values are the average of the quarterly values for study year III.

\# These values are the average of all available quarterly values.

quite similar at all stations, and the rates at all stations were also similar as seen in Table 10.

The data on organic-N, as in the case of *Modiolus*, indicated a significant portion of the excreted nitrogen was in the organic-N form (Table 10). Extrapolating the data for the entire year suggested 70 to 75% of the excreted nitrogen was in that form.

The zooplankton excretion data were fairly consistent for the three experimental sites with regards to seasonal trends. Excretion rates were highest in the summer and spring quarters with the spring generally having the highest rates associated with it. Minimum excretion rates were found in both the fall and winter. The rates ranged from 0 to 140 μg-atom NH_3-N·l^{-1}·day^{-1}·10^{-3} (Table 11).

AMMONIFICATION -- Within their respective systems, the Meyers Pond and Mid Lagoon A02 sites generally had the highest ammonia-N production rates (Figure 28).

Seasonal trends were similar for stations in the Meyers Creek system. Minimum ammonification rates occurred in the winter followed by higher rates in the spring and summer. This pattern was not as evident in the lagoons because the A02 site showed a spring increase in ammonification prior to the other stations while the A08 site failed to show any increase at all. The highest rates were found in the spring of 1976. The spring increase was greatest at the Lagoon A02

Table 10. *Ilyanassa obsoleta* excretion summary table.

Site	Study year	Quarter	Total NH_3-N contributed at the site in $\mu g\text{-atom}\cdot day^{-1}\cdot 10^5$	Total Org-N contributed at the site in $\mu g\text{-atom}\cdot day^{-1}\cdot 10^5$	Total Org-N / Total-N
Meyers Creek	II	2	2.4		
		3	5.1		
		4	7.7		
	III	1	5.7		
		2	3.0		
		3	7.5	7.2	.49
		4	9.2	21.4	.70
	III	Mean	6.4	14.3	.69
Meyers Pond	II	4	15.5		
	III	1	10.5		
		2	5.8		
		3	8.9	11.1	.56
		4	22.4	52.2	.70
	III	Mean	11.9	31.7	.73
Lagoon A02	II	3	4.1		
		4	4.1		
	III	1	2.3		
		2	2.0		
		3	4.8		
		4	7.4	13.9	.65
	III	Mean	4.1	13.9	.77
Lagoon A08	II	4	3.8		
	III	1	3.1		
		2	1.5		
		3	2.7		
		4	7.7	12.4	.62
	III	Mean	3.8	12.4	.77

Table 11. Ammonia-N excretion rates for mixed natural zooplankton populations in μg-atom NH_3-N$\cdot l^{-1} \cdot day^{-1} \cdot 10^{-3}$.

Date	Mid Meyers Creek	Lagoon A02	Lagoon A08
10/74	1.6		
11/74	0.2	1.1	1.0
12/74	0.9	1.2	0.5
4/75	18.5	55.1	110.5
7/75	27.2	0.8	10.9
10/75	4.3	2.7	2.4
2/76	0.0	12.0	3.0
4/76	57.7	139.9	86.1

Note: Ice prevented sampling from late December 1975 to mid February 1976.

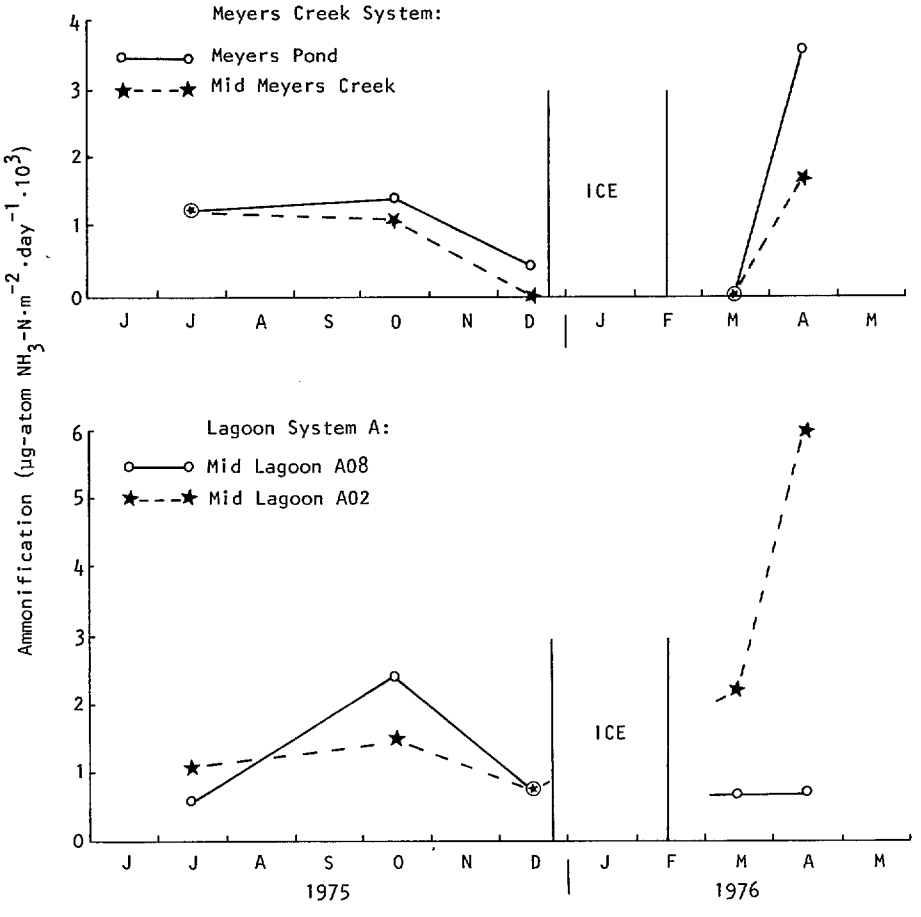
site where a study high rate of over 6.0 x 10^3 μg-atom NH_3-N$\cdot m^{-2} \cdot day^{-1}$ was reached. The maximum rate at this time in the Meyers Creek system was much less at 3.5 x 10^3 μg-atom NH_3-N$\cdot m^{-2} \cdot day^{-1}$.

RUNOFF -- The data in Table 12 show the amounts of nitrogen introduced via precipitation and/or runoff. Although referenced to a daily time frame, the values were actually based on a calculated annual sum. This was in turn derived from the actual rainfall and the mean concentrations of ammonia-N, nitrite-N, nitrate-N, and organic-N for each quarter. Total organic-N data were not available for direct rainfall due to insufficient sample volume.

Productivity

OXIDIZABLE CARBON -- Oxidizable carbon data for the study years I-IV at A08, B24, M 21, ABD, Meyers Pond, and Meyers Creek mouth are presented in Figure 29. Natural creek areas, including Oyster Point and Dinner Point, were characterized by considerable seasonal fluctuation. A predominant seasonal cycle was not observed at these stations since peak concentrations were often recorded several times throughout the year. Meyers Creek system, for instance, had high carbon levels during several seasons at the creek mouth and pond. The upper end of Dinner Point Creek did not have such a pronounced seasonal variability or the exceptionally high carbon values recorded for the other natural areas. Record levels greater than 10^4 mg$\cdot m^{-3}$ were observed in February 1974 at Dinner Point Creek mouth and Meyers Creek mouth; and also in September 1976 at Meyers Pond.

Various seasonal peaks were also observed in the bay (M 21) where high concentrations were frequent during the winter and spring. Annual variation was also noted. Summer peaks were recorded in 1974 and 1976, while carbon levels were consistently less than 2.0 x 10^3 mg$\cdot m^{-3}$ during the summers of 1973 and 1975.



Statistical data: Annual means ± 1 SE

Mid Meyers Creek	0.8 ± 0.3
Meyers Pond	1.3 ± 0.6
Mid Lagoon A02	2.5 ± 0.9
Mid Lagoon A08	0.9 ± 0.2

Fig. 28. Ammonification rates for study year III in µg-atom NH_3-N·m^{-2}· day^{-1}·10^3.

Values for the major stations (ABD, A02, A08, B17, and B24) did not demonstrate the great variability observed in the creeks. These stations generally had higher concentrations during the summer, especially in 1976 when exceptional carbon levels were noted throughout the entire Manahawkin area. Peaks during other times of the year were infrequent, such that a seasonal pattern was more pronounced in the lagoons than in the shallower natural areas.

The Mill Creek system had the lowest carbon levels, with E87 frequently less than 10^3 mg·m^{-3}. Higher values were observed downstream. Summer peaks were recorded at E68 and E mouth, and spring minima consistently occurred throughout the creek.

Table 12. Summary of nitrogen inputs resulting from precipitation in μg-atom·day^{-1}·10^5.

Site	Input Type	Total Inorganic-N	Total Inorganic-N	Total Nitrogen
Meyers Creek: Water column	Direct	11.4		
Meyers Creek: Marsh surface	Direct	110.9		
Meyers Pond: Water column	Direct	21.3		
Meyers Pond: Marsh surface	Direct	99.3		
Lagoon A02: Water column	Direct	4.5		
	Roof runoff	1.2	0.7	1.8*
	Road runoff	1.2	1.7	3.0*
Lagoon A08: Water column	Direct	3.4		
	Roof runoff	0.9	0.6	1.5
	Road runoff	0.9	1.3	2.3*

* Total nitrogen was not computed by adding the two preceding columns. A * indicates there was a roundoff difference between the method used and the sum of the preceding columns.

SESTON -- Measures of suspended particulate matter (total seston, combustible organic matter, and residual ash) were begun in May 1976 and were continued on a regular basis until May 1977. The surface total and organic seston data for all stations are given in Table 13. Though considerable fluctuations occurred in the concentration of total seston, especially in the shallow Meyers system, seasonal patterns were similar at all stations. The pattern was characterized by maximal levels during June-July-August and minimal levels during March-April-May. For any particular sampling date, concentrations throughout the Meyers system were generally very similar, as were those throughout the lagoons. The Meyers Creek system with an annual range of 5.8 - 161.0 mg·l^{-1}, frequently had much higher seston levels than the lagoons, which had an annual range of 3.8 - 39.0 mg·l^{-1}.

The seasonal pattern of suspended organic matter at all stations followed closely that of the total seston, with highest concentrations appearing during the summer. However, concentrations of suspended organic matter in the lagoons and in the Meyers system were more similar. The annual range in the Meyers Creek system and in the lagoons was 2.0 - 30.5 mg·l^{-1} and 2.1 - 23.0 mg·l^{-1}, repectively.

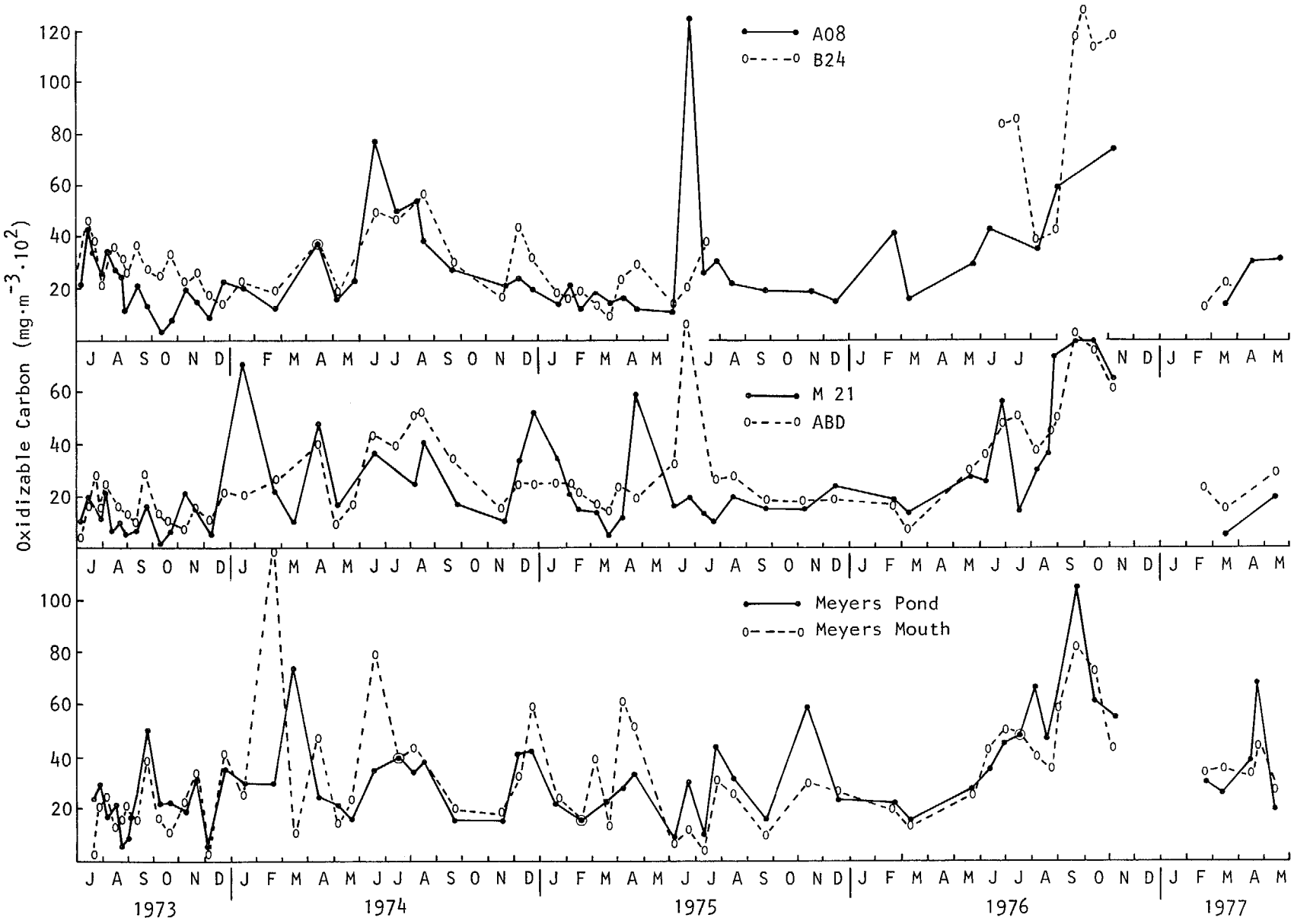


Fig. 29. Oxidizable carbon concentrations.

Table 13. Suspended particular matter ($mg \cdot l^{-1}$) from May 1976 to May 1977. All surface values.

Date	Meyers Mouth		Mid Meyers		Meyers Pond		M21		ABD	
	Total	Org	Total	Org	Total	Org	Total	Org	Total	Org
5/12/76	63.4	11.3			29.0	8.0			5.8	3.3
6/9	23.2	7.4	22.4	6.8	22.1	5.5	16.2	5.6	16.4	8.0
6/30	34.2	9.2	32.2	9.0	26.4	6.2	26.5	6.8	18.2	6.2
7/15	33.7	9.4	40.6	8.2	44.4	8.6	27.1	6.2	45.2	11.5
7/28	51.2	16.8	42.6	13.4	54.0	16.4	29.8	10.7	43.0	16.0
8/3	55.0	11.0	66.5	13.5	161.0	30.5	15.5	7.0	9.2	4.4
8/18	23.0	7.1	23.9	9.2	25.8	9.2	26.2	8.4	25.8	7.6
8/31	24.8	11.8	34.8	15.5	32.0	13.5	22.9	10.3	17.4	10.0
9/28	18.4	11.6	30.4	12.8	46.2	14.9	19.8	9.6	22.1	10.7
10/11	29.7	11.4	30.0	8.9	21.0	8.4	26.5	10.0	19.8	8.8
11/2	19.7	8.9	19.8	9.5	22.0	10.3	22.6	7.7	20.3	8.0
2/23/77	22.0	5.4			15.6	7.0			15.2	6.2
3/8	7.6	2.8	7.9	2.7	6.1	2.0	10.3	4.7	6.1	2.4
3/16	49.2	12.4	52.8	11.6	30.0	5.6	13.4	3.8	10.4	3.4
4/13	27.6	5.2	42.2	8.0	24.0	5.8				
4/19	27.2	5.8			57.0	9.0				
5/12	24.0	6.2	10.8	3.2	5.8	2.2	16.6	4.6	6.0	4.2

Note: Total = Total suspended particulate matter; Org = Combustible organic matter

Table 13. Continued.

Date	A02		A08		B17		B24	
	Total	Org	Total	Org	Total	Org	Total	Org
5/12/76					3.8	2.9	7.9	3.5
6/8-6/9	11.0	7.1	15.2	9.3	32.2	13.2	19.4	10.4
6/30-7/1	12.3	7.8	17.3	11.8	23.4	9.0	39.0	21.6
7/15					25.4	10.4	25.1	10.6
7/28					26.2	15.3	24.8	15.4
8/3	11.2	6.6	37.0	23.0	33.8	20.8	35.5	22.5
8/18					11.2	7.0	12.0	7.9
8/31	18.3	11.8	18.3	11.2	14.0	7.3	14.0	7.0
9/13	17.7	11.3	18.0	11.5				
9/28					14.8	11.3	14.8	11.9
10/11					13.1	8.9	16.3	11.1
11/2	12.8	7.8	13.0	9.0	18.0	8.2	12.2	6.2
2/23/77					7.6	4.6	7.0	3.6
3/8					5.6	2.1	5.6	2.8
3/16	8.0	4.2	6.8	3.0	7.0	4.6	6.6	4.2
4/13	22.0	5.0	22.8	6.0				
5/12	5.0	3.4	4.0	3.8				

Note: Total = total suspended particulate matter; Org = combustible organic matter

The results from this year of data have demonstrated a significant contrast in the relative proportion of surface total particulates contributed by organic and inorganic fractions for the developed and natural areas. Whereas only about 31% (annual average) of this material in the Meyers system was organic, approximately 57% was contributed by the organic fraction within the lagoons. Values for M 21 and ABD were 36% and 43%, respectively.

The vertical distribution of total and organic seston in the lagoons frequently demonstrated discrete maxima within the water column, though not necessarily coinciding with each other. Vertical patterns were not as dramatic as some of the chemical data, but seemed to occur most clearly under condition of well-developed stratification.

PIGMENTS -- The seasonal pattern of surface chlorophyll *a* concentrations at A08, M 21, and Meyers Pond are presented in Figure 30. Chlorophyll *a* and pheophytin concentrations at A02 and A08 from July 1975 to June 1976 are contoured in Figures 31 and 32. Nearly all stations in the Manahawkin area were characterized by relatively high summer concentrations. The duration of this period and the magnitude of the standing crop demonstrated a certain degree of annual variation. This was especially true for the bay, in which rather minimal levels of chlorophyll *a* were observed during the summers of 1973 and 1975, similar to the findings for oxidizable carbon. Peak standing crops also varied from year to year in the lagoons and creeks, reaching exceptional levels at all stations during the summer of 1976. At this time, chlorophyll *a* frequently exceeded 20 $mg \cdot m^{-3}$ for extended periods of time, and clearly surpassed the previous years of observation. A record level of 130.5 $mg \cdot m^{-3}$ was noted at B24 on 30 June 1976. Other stations which typically had very high summer pigment levels included Meyers Pond, Oyster Point Pond, and E68. In contrast to the outfall site on Mill Creek, E87 had relatively low levels of chlorophyll *a*, similar to the results for oxidizable carbon. Such periods of high standing crop were generally followed by an abrupt decline around October. However, minimal levels were generally not extended throughout the winter, for winter peaks were frequently recorded. Such peaks even approached summer levels at times. Usually accompanying these increased pigment levels was a greater productive capacity of the phytoplankton, especially when measured under conditions of artificial illumination.

Pheophytin, indicative of plant decomposition products, was an important component of the plant pigments throughout the study period for the entire Manahawkin area. Pheophytin levels were especially prominent below the euphotic zone of well-stratified lagoons during the summer (Figures 31 and 32). In addition, significant quantities of active chlorophyll *a* were also observed below the euphotic zone in regions of total darkness, low dissolved oxygen concentrations, and high NH_3-N concentrations. This was most striking at B24. Rapid changes in concentration with depth appeared to be linked to changes taking place in temperature and salinity (i.e. density) and dissolved oxygen. The lesser degree of stratification at A02 was reflected in the less frequent development of pronounced vertical patterns.

BULKHEAD ALGAL PRODUCTION -- Seasonal patterns of bulkhead algal net production and respiration for the upper, mid, and lower sections of the Lagoon System A main channel are presented in Figure 33. The seasonal patterns were similar at each of the three stations. Net production was generally highest during the period May-September for 1976 and also demonstrated a return to such high summer levels in May 1977. Maximal rates for 1975 were observed in October-December. The low levels of net production on 7 July 1975 followed a period of heavy rainfall,

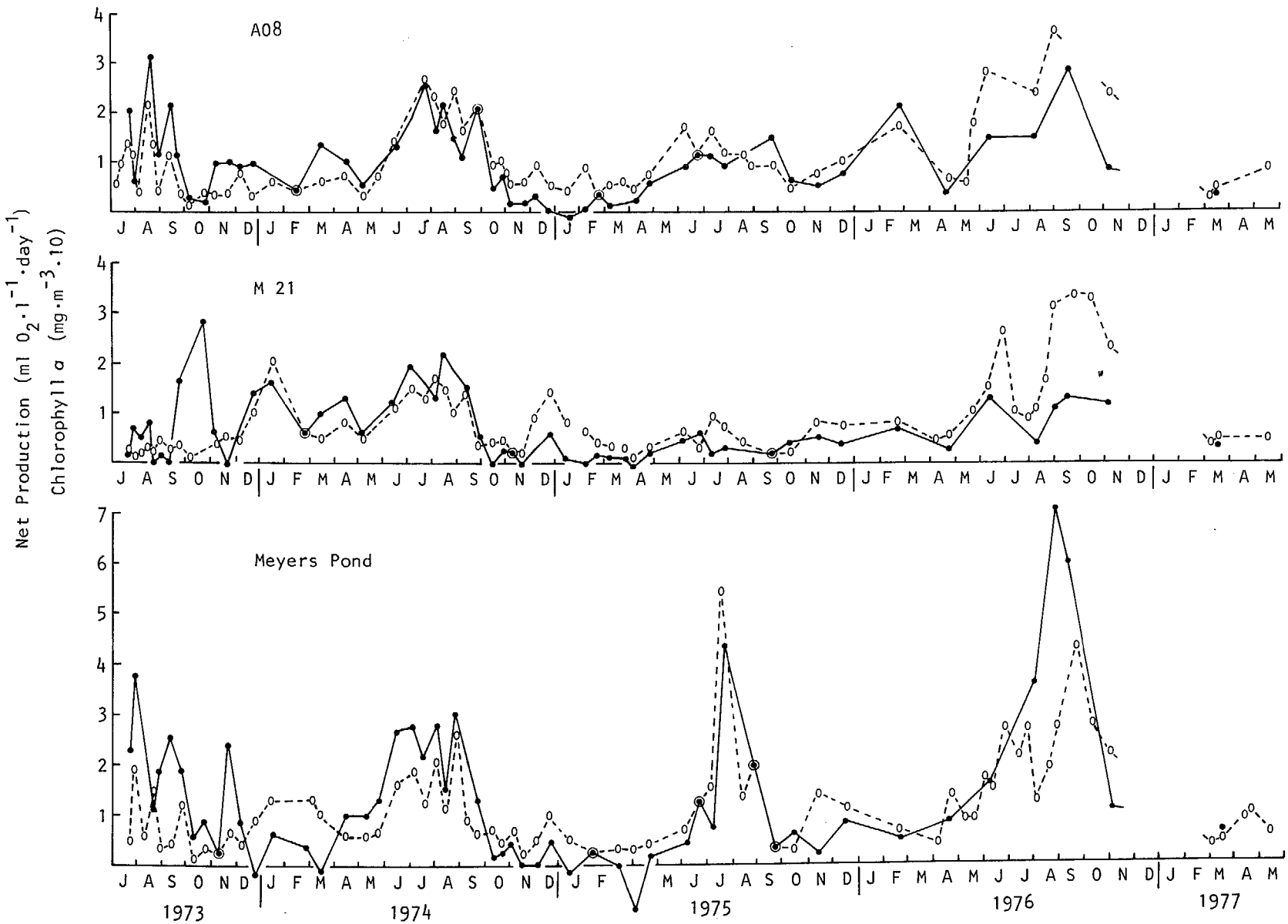


Fig. 30. Phytoplankton net production (•——•) and chlorophyll *a* (o----o) values.

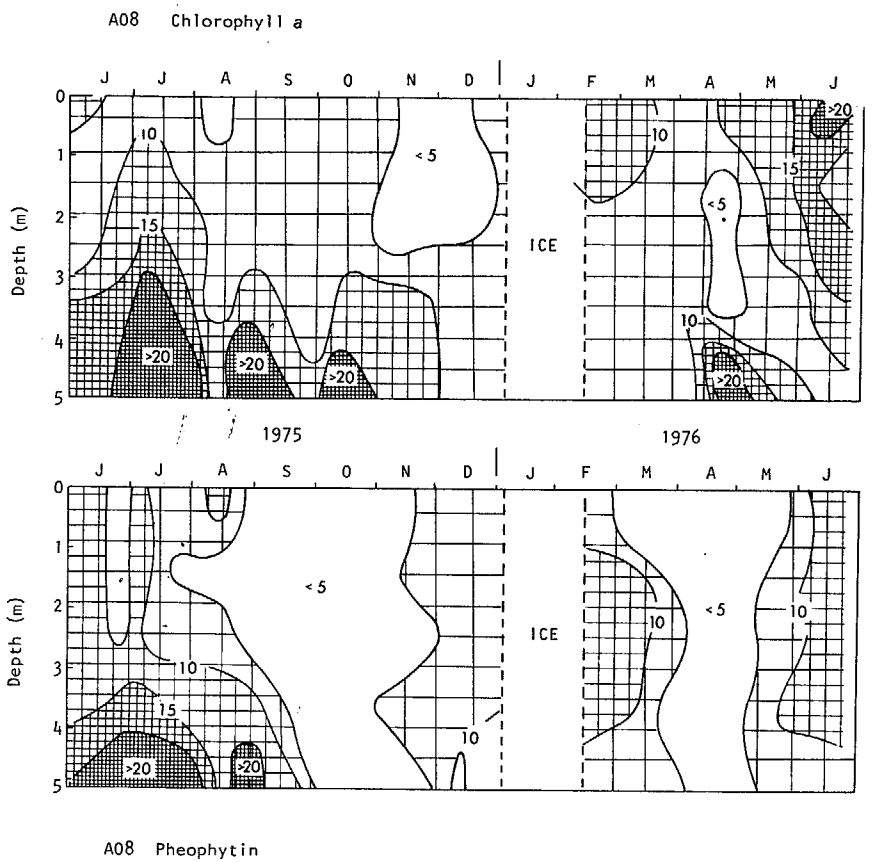


Fig. 31. Plant pigment levels ($mg \cdot m^{-3}$) at Lagoon A08 contoured.

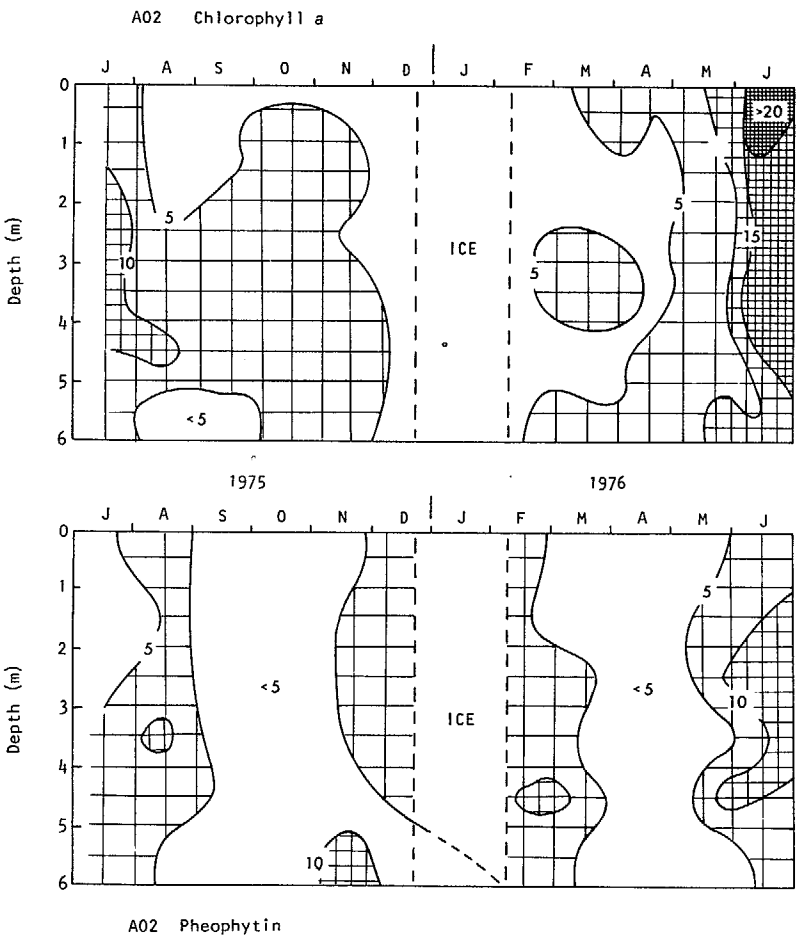


Fig. 32. Plant pigment levels ($mg \cdot m^{3}$) at Lagoon A02 contoured.

exceeding 11 cm during 11-15 July (NOAA Environmental Data Service, Tuckerton Station). The results for this sampling run are possibly not representative.

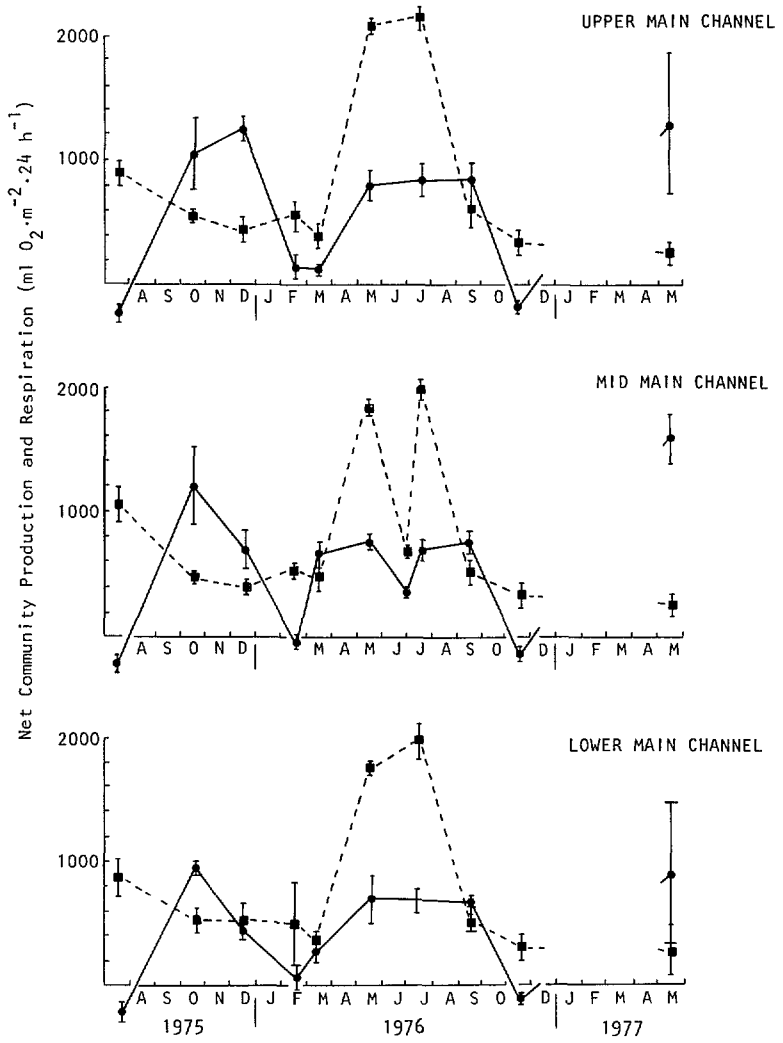


Fig. 33. Net community production (•——•) and respiration (▪---▪) of the bulkhead algal community from July 1975 to May 1977. Vertical lines represent 2 SD.

Respiration rates were maximal during May and July of 1976 when water temperatures were approximately 15°C and 26°C, respectively. The results for early July 1976 at the mid station may reflect the abnormal conditions at this time as a result of an extensive period of negligible rainfall and high salinities (>29 °/oo). During the summer, respiration of the bulkhead algal community accounted for approximately 50-60% of the gross production on a 24 hour basis. Minimal rates were observed during the winter of 1975-76 and also in November 1976 when water temperatures had already declined to less than 0.0°C.

Though the seasonal patterns and magnitude of net production and respiration were similar at each station, considerable variability did occur on certain occasions. To what extent this reflects a nonuniform distribution in the standing crop crop of the algal community at a particular station or a varied physiological response is not known.

The development and rejuvenation of these mats in the spring of 1976 and 1977 appeared to be delayed as a result of extensive ice cover in the lagoons. It is believed that the physical stress of this ice and its denuding action upon the bulkheads severely affected this algal community during this period.

MARSH SURFACE ALGAL PRODUCTION -- Seasonal soil temperatures and light penetration for the three dominant plant canopies and an exposed mudflat are presented in Table 14. Soil temperatures followed closely the trend in water temperature of the nearby Meyers Creek. These values demonstrated significant differences at times and would be influenced by such factors as relative isolation, air temperature, shading, and greenhouse effects. Those recorded in the *S. patens* zone, often the lowest values observed on any particular data, were sometimes as much as 5°C lower than in the *S. alterniflora* (short form) zone. In February 1975 and November 1976, the soil surface was almost completely frozen. In February 1976, ice was still present in patches under the dense canopy of *S. patens*, but had already disappeared from the other stands.

Since the mudflat area was always sampled at times of near or complete exposure, the percentage of incoming radiation ($\%I_o$) reaching the surface is given as 100%. This would necessarily change with varying tidal stages and turbidity conditions. Very little solar radiation was capable of penetrating the *S. patens* canopy throughout the year (0-5%) and visible algal mats were generally absent.

The presence of such mats under canopies of *S. alterniflora* (tall and short form), however, appeared indicative of the more favorable light conditions there. During the period of February 1976 to September 1976, light penetration through these stands progressively diminished from 30-60% I_o to 6-16% I_o as a result of *Spartina* growth and canopy closure.

Net community production and respiration for the four experimental sites are presented in Figure 34. Net production was highest during the summers of 1975 and 1976 at all stations, though the magnitude and duration of this active period varied considerably. The net production of the *S. patens* zone was characteristically negligible during the summer and negative during the rest of the year. These findings indicate the overriding influence of total community respiration upon any photosynthetic capability of the microflora. The absence of any significant autotrophic activity (Gross production/Respiration > 1) probably reflects the limiting light conditions persistent throughout the year.

The level of net production and its seasonal pattern in the two *S. alterniflora* zones were very similar. Maximal rates of 200-300 ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$ were typical from May to September of 1975-76. Negligible activity was recorded during the winter when freezing of the marsh surface occurred.

The net productivity of the mudflat community was approximately 4 - 5 times greater than the *S. alterniflora* zones during the summer, exceeding 800 ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$. Such high rates were comparable to those recorded for the bulkhead algal communities. The most active period for the mudflat microflora was not reached until July of each year, in contrast to April-May for the *S. alterniflora* edaphic communities. At this time of considerable growth, large populations *Ilyanassa* sp. were observed grazing upon the surface.

Respiration of the marsh surface communities generally followed the seasonal trends described for net production. This was most clearly seen in the *S.*

Table 14. Marsh surface soil temperatures (°C) and percent incident light (% I_o) that penetrates the vegetation. *

	Spartina alterniflora tall form		*Spartina alterniflora* short form		*Spartina patens*		Mudflat	
Date	Temp.	%I_o	Temp.	%I_o	Temp.	%I_o	Temp.	%I_o
5/20/76	14.4	18	16.9	34	11.4	< 1	14.7	100
7/15	24.7	10	25.7	23	21.7	< 1	23.0	100
9/13	18.7	6	20.5	16	19.9	< 1	19.3	100
11/24	0.4	20	0.0	15	0.4	< 1	0.0	100
5/12/77	11.8	30	11.7	35	9.5	< 1	13.2	100

* All values represent the average of five observations.

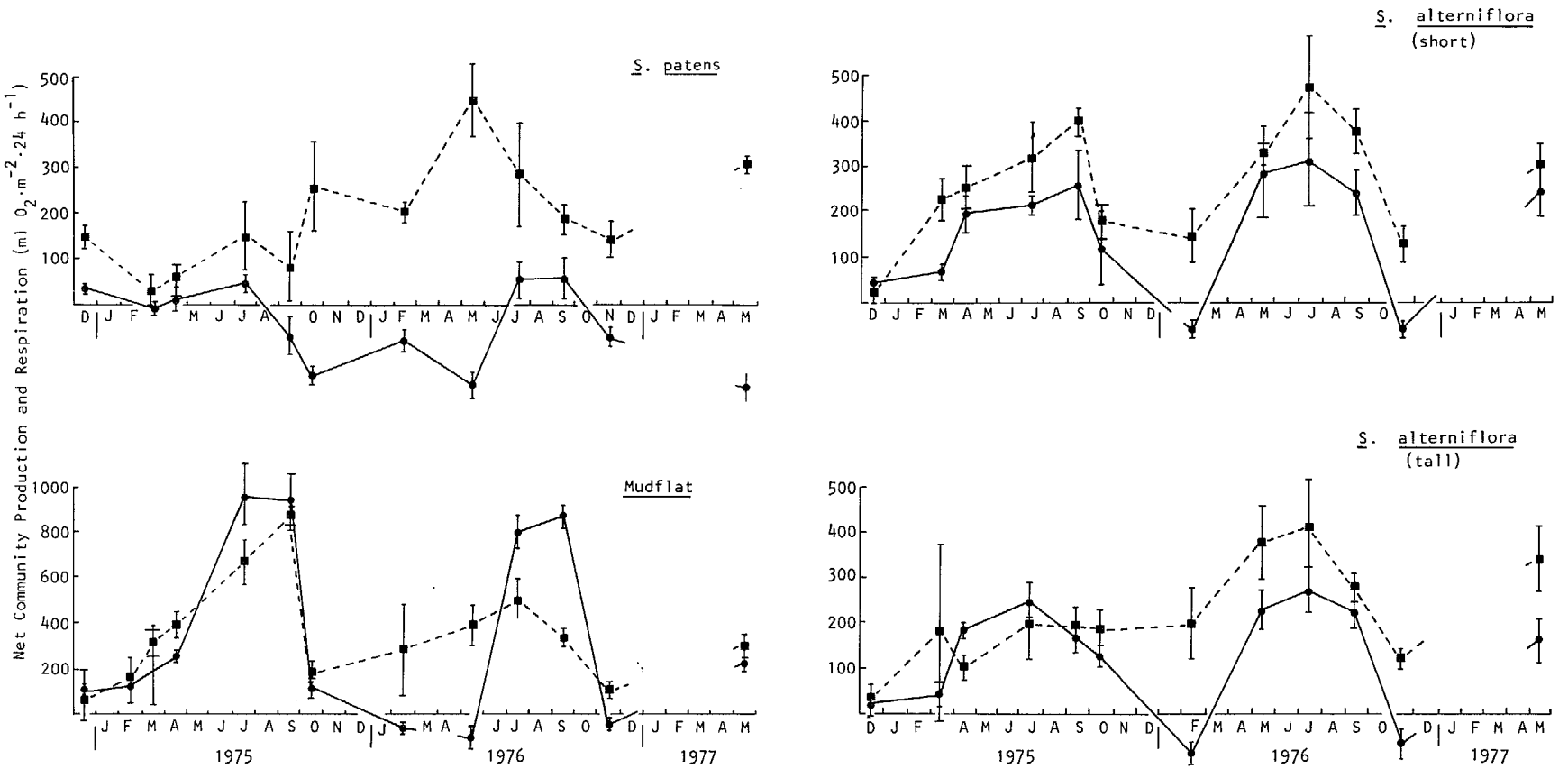


Fig. 34. Net community production (•——•) and respiration (▪---▪) of the marsh surface algal community from December 1974 to May 1977. Vertical lines represent ± 2 SD.

alterniflora (short form) zone and in the mudflat, where clearly defined summer peaks were recorded each year.

Typical summer levels approximated 400 ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$ in the *S. alterniflora* stands, while considerably greater rates were noted for the mudflat in 1975, exceeding 800 ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$.

Since October 1975, the marginal photosynthetic activity of the *S. patens* station has been accompanied by rather substantial respiratory levels, especially during the summer of 1976. The difference between the two summers cannot be explained at this time.

In contrast to the minimal net production rates during the winter, significant rates of oxygen uptake were often recorded. Microbiota respiration accounted for a large proportion of the gross productivity (usually greater than 50%) of these communities all year round.

BENTHIC ALGAL PRODUCTION -- Seasonal patterns of benthic respiration are presented in Figure 35. Negative net productivity was generally observed at all stations throughout the study period and appears indicative of a major proportion of non-photosynthetic microbiota present in the sediments. Even in the Meyers system where favorable light conditions would seem to provide a relatively favorable habitat for benthic microflora, only occasional periods of net production were observed. Such results emphasize the overriding importance of total community respiration upon the photosynthetic capacity of the algae.

A period of pronounced summer activity was observed at ABD, A12, and in the Meyers system, typical summer levels approached 700 ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$ at these lagoon stations and at Meyers Creek mouth. Higher rates (exceeding 10^3 ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$) were observed at Meyers Pond. Respiration rates in the pond were considerably greater than at the mouth, especially from April to October of 1975. The relatively low activity at the mouth during this period compared to the summer of 1976 cannot be explained. The decline in benthic respiration at Meyers Pond on 17 July 1975 may reflect the unusual amount of rainfall prior to this sampling run. Uptake rates during the winter at these stations were greatly diminished.

The results for A08 were complicated by the presence of anaerobic conditions during the summer. Under such conditions, no changes in oxygen concentration could be detected in either light or dark-incubated cores. During the winter, however, relatively high rates of oxygen uptake were noted at A08, especially in December 1975. Respiratory rates at this time approximated summer levels at Meyers Creek mouth, ABD, and A12. It is significant that just prior to the development of a well-stratified water column and anaerobic conditions at the lagoon bottom, very high sediment respiration rates were recorded.

PHYTOPLANKTON PRODUCTION -- A general seasonal trend in phytoplankton production was observed in the entire Manahawkin area. This was characterized by a relatively pronounced period of summer activity usually followed by an abrupt decline around October, similar to the results for chlorophyll *a*. Minimal rates for production, on a per unit volume basis, were recorded during the winter, though significant winter activity was sometimes observed. Annual variations also occurred and were expecially noticeable in the magnitude and duration of the summer growth period. The seasonal patterns of net productivity at A08, M 21, and

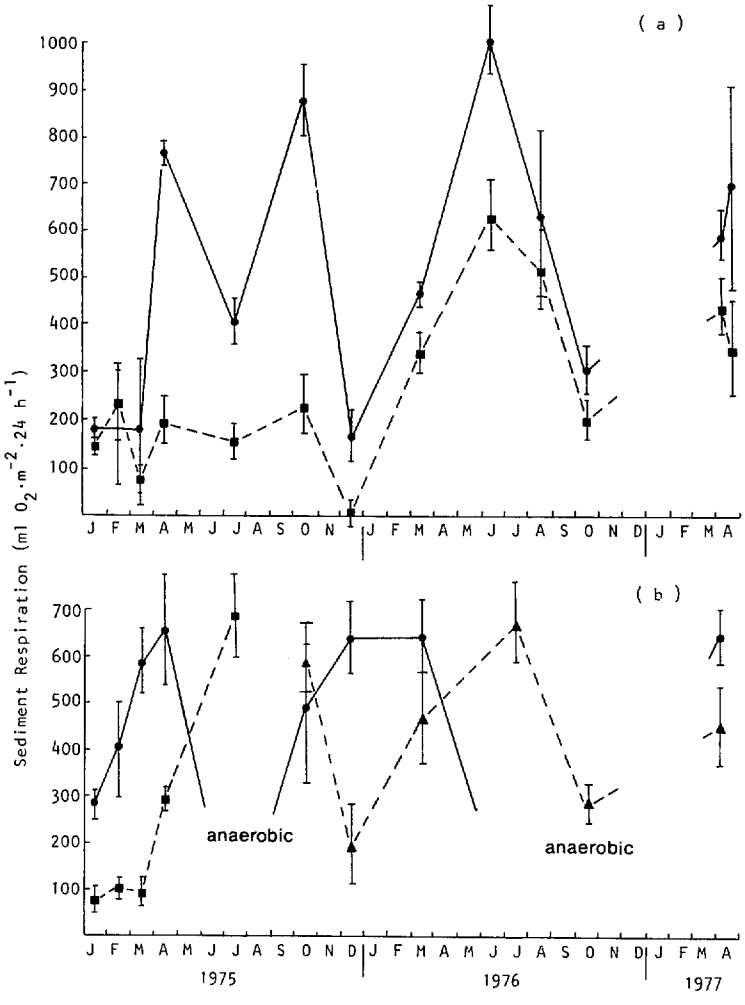


Fig. 35. Benthic sediment respiration: (a) Meyers Pond (●——●) and Meyers Creek mouth (■--■); (b) A08 mouth (●——●), A12 mouth (▲---▲), and ABD (■--■). Vertical lines represent ± 2 SD.

Meyers Pond for the study years I-IV are presented in Figure 30. Such seasonal patterns correlated fairly well with the seasonal distribution of standing crop. The bay station was only moderately active during the summers of 1974 and 1976 with net productivity rates of 1.0-2.0 ml $O_2 \cdot l^{-1} \cdot day^{-1}$. Phytoplankton production at this station was greatly diminished during the rest of the study period such that net productivity levels less than 1.0 ml $O_2 \cdot l^{-1} \cdot day^{-1}$ were common.

The summer productive capacity of the natural creeks was much greater than the bay, on a per unit volume basis. Tremendous bursts of activity were recorded in the shallow, turbid ponds located at the upper ends of the creek systems. Net productivity rates exceeding 3.0 ml $O_2 \cdot l^{-1} \cdot day^{-1}$ at Meyers Pond and Oyster Point Pond were frequent, and even rates as high as 7.0 ml $O_2 \cdot l^{-1} \cdot day^{-1}$ were observed. The phytoplankton production in the Meyers system was felt to be typical of a tidal creek in the Manahawkin area based upon additional results gathered from the Dinner Point and Oyster Point Creeks. This system also had a certain degree of annual variation in the magnitude of the summer peak, with exceptional activity noted during the summer of 1976.

The phytoplankton production in the lagoons was also very high during the summer, especially at the remote station B24. Though the record levels of photosynthesis occurring in the ponds were not observed, net productivity levels of 2.0-3.0 ml $O_2 \cdot l^{-1} \cdot day^{-1}$ were common. Usual departures from the general seasonal trend were noted at B24 (22 October 1974) at the end of October turnover, and at A08 on 26 February 1976 when exceptionally high growth rates were recorded.

The results for Mill Creek, which received sewage effluent from a secondary treatment plant, varied along the length of the system. High net productivity was observed from May to September at the mouth and at E68, which is adjacent to the outfall site. The summer rates at the latter station were comparable to those in the ponds. Negligible production occurred throughout the year at the oligohaline station, E87.

The respiration of the phytoplankton community also had a pronounced seasonal pattern with highest levels occurring during the summer. An interesting contrast was observed during this period between the lagoon stations and Meyers Creek system in terms of the fraction of incorporated photosynthetic products being required for self-maintenance, i.e. (Respiration/gross production or R/GP). During the summer of 1974, for example, the following values of R/GP were observed (Table 15).

Table 15. Respiration/gross production values.

Station	Range	Average
Meyers Creek mouth	0.19-0.42	0.31
Meyers Pond	0.19-0.36	0.29
A08	0.36-0.54	0.47
B24	0.39-0.72	0.52

These values were greater than the 5-15% range commonly described as characteristics of healthy algal cultures with no gross nutrient deficiencies (Strickland 1960).

A measure of phytoplankton respiration independent of other organisms was not possible. A distinct correlation was noted between net production (NP) and gross production (GP), approximating a 1:1 relationship. High rates of gross productivity were generally not a result of aberrantly high respiration rates, but high photosynthetic rates. If respiration was largely nonalgal, high GP rates with low NP rates would have been observed.

Potential phytoplankton production measured in a lighted, constant temperature incubator showed good agreement with the seasonal patterns determined under conditions of natural illumination. However, net productivity during the fall and winter was significantly higher under artificial illumination and would appear to substantiate the relatively good photosynthetic potential of the phytoplankton during such periods of low temperature, low light intensity, and short daylight periods. Such a contrast was not observed in respiration when measured under controlled laboratory conditions and in the outside water bath. This enhanced photosynthetic response was particularly noticeable during December 1974 at M 21 when

net productivity levels approached those of the previous summer. This enhancement accounts for the general observation made in the first annual report on the ability of the Manahawkin phytoplankton populations to maintain positive NP rates throughout the year, since only laboratory incubations were carried out in study year I. This ability was later shown to be less likely under conditions of natural winter illumination.

The summer productive capacity in the bay, lagoons, and creeks was affected by the addition of inorganic nitrogen (NO_3 - N + NH_3-N) as presented in Figure 36. Severalfold increases in net productivity after nitrogen enrichment were common at all stations during the summer. Such effects were usually not observed in the fall or winter, whether measured under natural or artificial light conditions. Indications of other limiting nutrients, including phosphorus, were rare.

Experiments on the response of the surface phytoplankton populations to varying degrees of natural light attentuation demonstrated maximum photosynthetic rates at 50% I_o. Surface (100% I_o) inhibition was common at all stations. The productivity profiles which were constructed permitted the calculation of compensation depths (D_c), expressed on a 24 hour basis. These values are listed in Table 16 and represent the depth at which total photosynthesis equals respiration, i.e., zero net carbon assimilation or growth. The light intensity at this depth is referred to as the 'compensation light intensity', I_c. The data indicate a greater average depth of the euphotic zone in the lagoons. Though greater light attenuation in the turbid, shallower areas is a major factor, it should also be pointed out that such D_c values are theoretical, since the euphotic zone can only be as deep as the total depth of the area in question. Whereas the average depth of the euphotic zone at M 21 and in the Meyers system was greater than the mean depth, in the lagoons it only lies within the top 2.0 meters of the water column. The relationship between D_c and the total depth will be shown to be crucial in the overall balance between photosynthesis and respiration beneath a square meter of water surface.

The similarity in I_c values (Table 16) suggests a similarity in the photosynthetic behavior of the phytoplankton communities at these different stations in relation to the reduction in light intensity. These values were considerably greater than the theoretical values of 1% I_o commonly employed as an approximation of the compensation depth.

Phytoplankton production per unit area (ml $O_2 \cdot m^{-2} \cdot day^{-1}$) is presented in Table 17 and Figure 37. These figures reflect not only the variation in per unit volume rates in the graded light intensity series, but also the differences in mean depth to which a productivity profile is extended. The seasonal patterns of gross productivity were generally similar to those previously described for per unit volume rates, with highest rates occurring during the summer. Net productivity was frequently negative in the deep lagoon stations. This resulted from an inability of the phytoplankton to compensate for very high respiratory demands. Such demands resulted not only from high per unit volume respiration rates, but also from the relatively greater depths to which such rates had to be extrapolated, and the significant proportion of the water column lying in an aphotic zone. Negative net production was not entirely restricted to the summer, for it was also frequently observed during the fall and winter at A08 and B24. The shallower lagoon stations of B17 (2.4m) and ABD (3.0m), maintained positive net production during the summer.

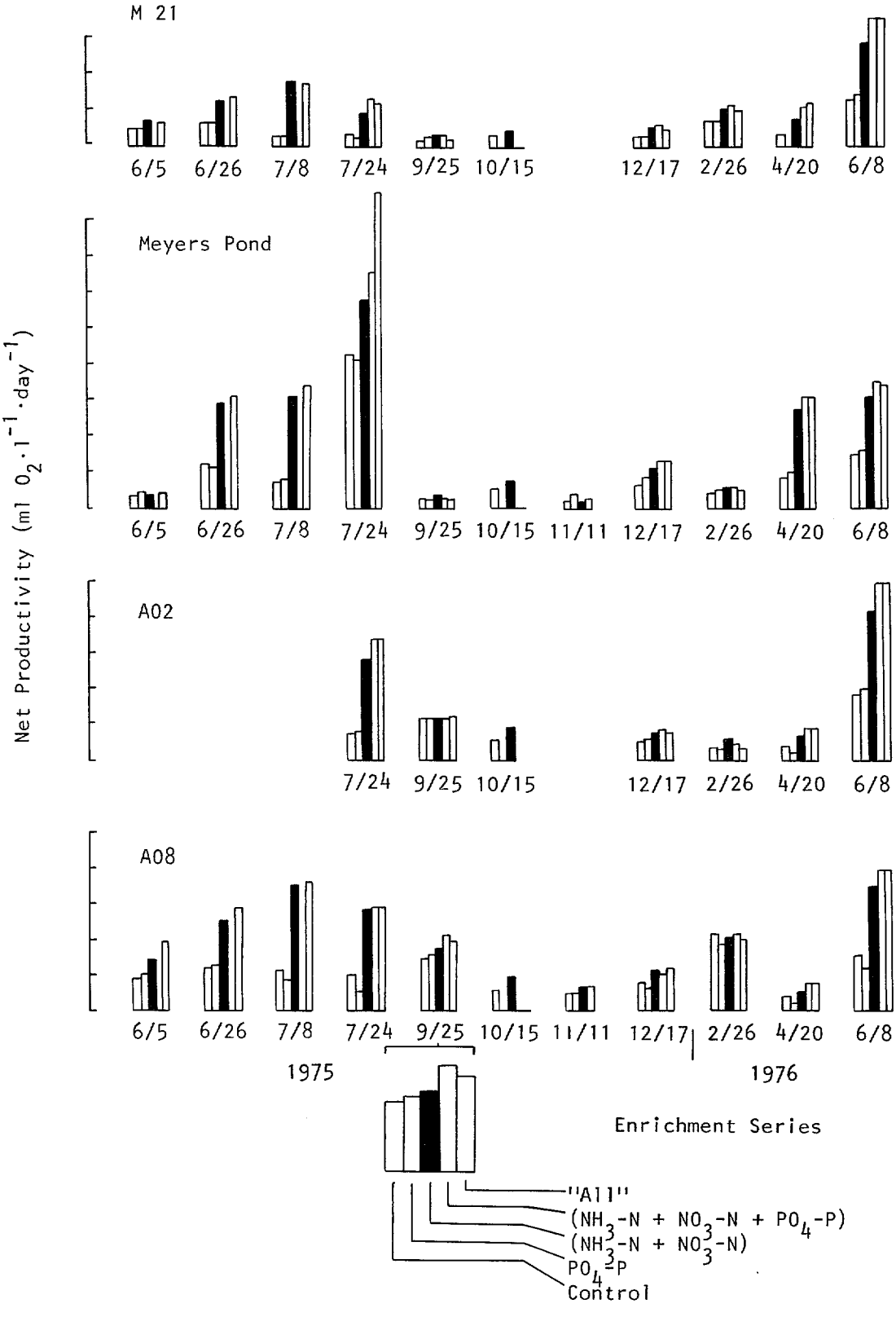


Fig. 36. Phytoplankton production and nutrient enrichment experiments at M 21, Meyers Pond, A02, and A08.

Table 16. Average compensation depths (D_c) and compensation light intensities (I_c) for phytoplankton from 24 July 1975 to 16 March 1977.

Stations	Mean depth (m)	D_c (m)	$\frac{D_c}{\text{Mean depth}}$	I_c (%I_o)
Meyers Pond	0.42	1.08	2.57	10
M 21	1.00	1.55	1.55	13
ABD	2.00	1.57	0.78	11
A08	3.60	1.72	0.48	12
B24	4.00	1.60	0.40	11

Seasonal patterns of photosynthesis and respiration per square meter in the Meyers system were very similar to those rates on a per unit volume basis. Substantial amounts of net production occurred during the summer, especially in Meyers Pond, when very high photosynthetic rates compensated, to some extent, for the very shallow depth. In constrast to the deep lagoon stations, negative net production occurred infrequently.

DISCUSSION

General

In this marsh system, there are basically two types of creek drainages. Creeks with upland sources generally show a marked axial salinity gradient because of fresh water input. Those that do not extend into the upland show a reduced salinity gradient because they drain only marshland. Usually, the water draining from a marsh is tidal in origin. Rainfall in the immediate vicinity would account for only a small part of the marsh drainage over the course of a year. In the Manahawkin area, Mill Creek is an example of the first type of creek drainage; Dinner Point Creek and Meyers Creek are examples of the second type. In both cases, tidal flow is the major hydrologic force rather than fresh water input.

Apparently, it matters little, as far as stratification is concerned, whether a lagoon is in communication with a reasonably fast flowing creek or with the bay where currents are reduced. Stratification is as common and severe in the lagoons of E system as in the other lagoons systems. There is no justification in locating lagoons in upstream areas just because there is a high flow rate in the creek. As a matter of fact, locating the lagoons upstream increases their remoteness from the bay. In those systems communicating directly with the bay, e.g. Lagoon Systems A and B, severity of stratification seems to be related to the remoteness of location.

On the other hand, the shallowness of Meyers Pond results in almost complete flushing into the creek each tide. The short length of Meyers Creek and the completeness of vertical mixing permit a high exchange of water with the bay; water does not tend to become trapped in the Meyers Creek system. The high benthic respiration requirements in the summer are met in part by the import of oxygen rich water. Such water is brought into the pond with each flood tide. A

Table 17. Summary of production data in ml $O_2 \cdot m^{-2} \cdot day^{-1}$.

Date	Meyers Pond			Mid Meyers Creek			M21			ABD		
	GP	R	NP	GP	R	NP	GP	R	NP	GP	R	NP
9/25/74	722	168	554				787	260	527	2,526	1,280	1,246
10/15	213	142	71				279	240	39	689	400	289
10/22	213	126	87				435	260	175	927	640	287
11/4	312	168	144				418	200	218	738	680	58
11/19	49	50	-1				90	120	-30	221	440	-219
12/3	25	17	8				98	80	18	394	280	114
12/27	336	126	210				492	280	212	820	560	260
1/21/75	16	76	-60				197	240	-43	197	400	-203
2/18	107	0	107				320	120	200	164	80	84
3/18	74	76	-2				221	140	81	402	240	162
4/1							287	360	-73	1,788	680	1,108
4/22	131	58	73				385	100	285	1,025	200	825
6/5	369	176	193				927	520	407	3,649	2,880	769
6/25	869	344	525				1,041	480	561	1,960	1,120	840
7/8	754	462	292				1,050	880	170	2,649	2,320	329
7/24	2,345	336	2,009	1,886	576	1,310	541	240	301	2,780	1,520	1,260
9/25	230	110	120	344	192	152	394	200	194	836	560	276
10/15	262	0	262	697	96	601	230	0	230	812	0	812
12/17	459	126	333	1,099	432	667	574	320	254	959	600	359
2/26/76	328	68	260	754	264	490	738	220	518	861	480	381
4/20	558	252	306	1,132	432	700	525	300	225	1,328	840	488
6/8	853	210	643	2,353	768	1,585	1,558	380	1,178	2,878	1,080	1,798
8/3	1,779	470	1,309	1,435	1,176	259	1,164	1,040	124	3,149	2,520	629
8/31	3,018	454	2,564	2,845	1,152	1,693	1,263	1,000	263	3,780	2,280	1,500
9/13	2,624	520	2,104	3,255	1,344	1,911	1,394	1,200	194	2,575	2,520	55
11/2	574	210	364	1,214	504	710	1,099	320	779	984	680	304
3/16/77	271	59	212	344	192	152	336	20	316	599	80	519

Table 17. Continued.

	A02			A08			B17			B24		
	GP	R	NP	GP	R	NP	GP	R	NP	GP	R	NP
9/25/74				3,460	2,160	1,300				2,124	2,160	-36
10/15				1,615	1,872	-257				1,419	3,040	-1,621
10/22				1,509	1,224	285				4,330	2,960	1,370
11/4				1,115	2,016	-901				1,804	2,080	-276
11/19				640	1,224	-584				558	1,280	-722
12/3				574	288	286				1,337	800	537
12/27				820	864	-44				886	1,200	-314
1/21/75				279	720	-441				148	400	-252
2/18				418	144	274				262	160	102
3/18				853	720	133				1,279	960	319
4/1				2,025	1,800	225				1,886	1,360	526
4/22				1,591	432	1,159				1,000	480	520
6/5				2,731	2,880	-149				1,681	2,080	-399
6/25				2,862	2,592	270				2,280	3,200	-920
7/8				2,936	4,464	-1,528				2,886	6,080	-3,194
7/24	2,107	2,340	-233	3,460	5,040	-1,580						
9/25	2,739	1,200	1,539	4,477	1,440	3,037						
10/15	853	60	793	877	432	445						
12/17	1,542	1,020	522	2,025	792	1,233						
2/26/76	1,041	780	261	4,674	2,304	2,370						
4/20	1,681	1,140	541	1,968	1,152	816						
6/8	4,772	2,760	2,012	4,346	3,888	458						
8/3	3,821	4,140	-319	2,919	5,256	-2,337	4,395	3,360	1,035	4,936	6,240	-1,304
8/31	3,050	4,320	-1,270	2,132	5,472	-3,340	3,313	3,120	193	4,576	6,080	-1,504
9/13	3,895	4,200	-305	3,387	5,472	-2,085	4,149	3,360	789	4,567	6,080	-1,513
11/2	1,082	1,320	-238	1,320	2,016	-696	1,591	960	631	1,386	2,400	-1,014
3/16/77	812	300	512	853	360	493	1,214	336	878	1,164	560	604

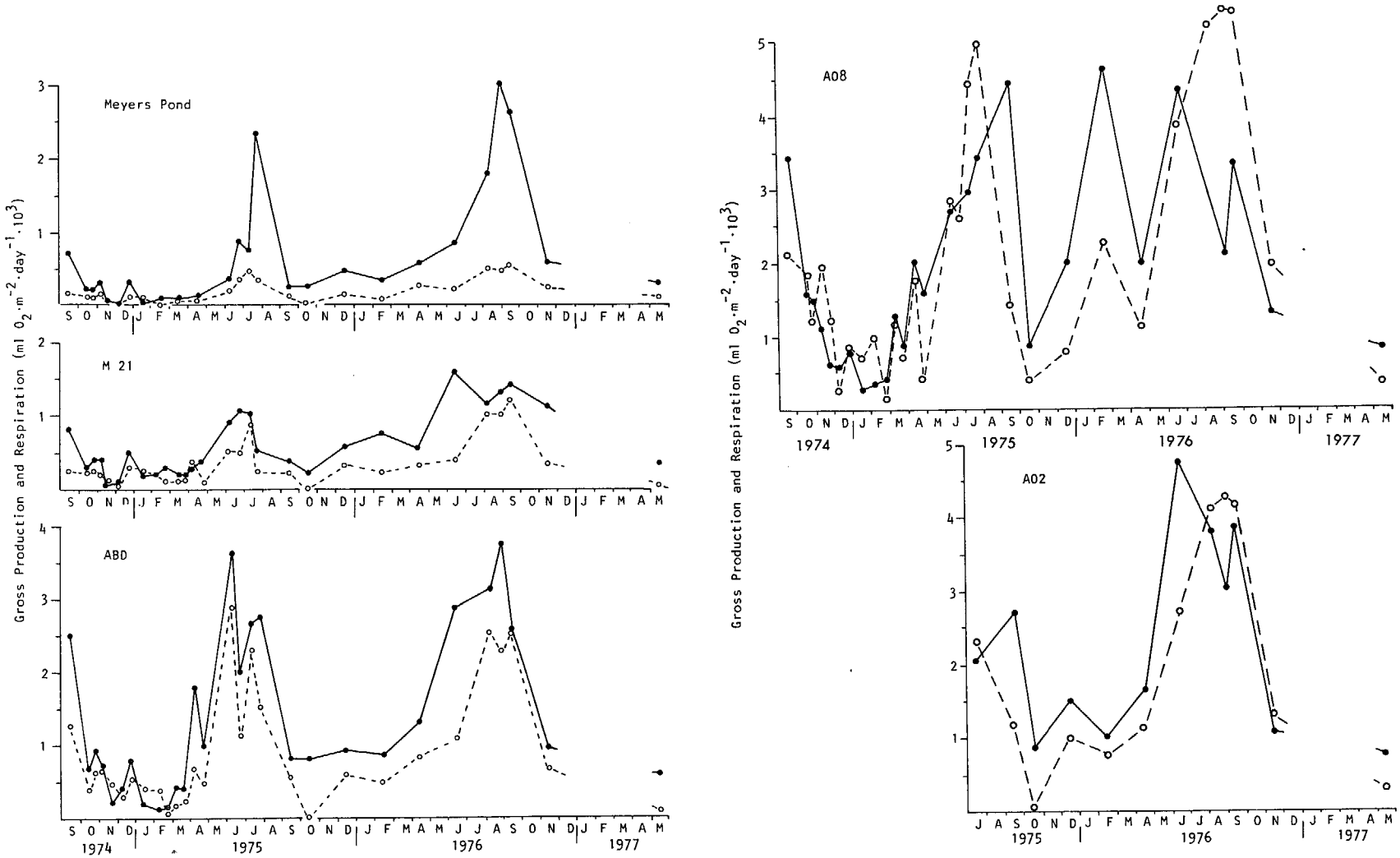


Fig. 37. Phytoplankton gross production (•——•) and respiration (o---o) in ml $O_2 \cdot m^{-2} \cdot day^{-1} \cdot 10^3$.

portion of this water originates in the bay. Such an exchange does not occur in the lagoon systems. Poor flushing, increased depth, and stratification all tend to magnify the effects of benthic respiration demands on the water column in the lagoons. The bottom water is retained in the lagoons, and since the compensation depth is usually less than the depth of stratification, photosynthetic oxygenation is restricted to the surface layers. In the same way, metabolic products can accumulate on the bottom during periods of stratification. Buildings along the lagoons offer protection from wind stirring and thereby reduce mixing. Such protection is not provided the shallow marsh ponds.

The rich benthic fauna of ponds contributes to the cycling of materials. The periodic creation of anaerobic conditions on the bottom in lagoons certainly must prevent the development of an equally rich benthic community. The degree to which this interferes with cycling is not known.

The occurrence of a seasonal cycle in lagoon salinity values indicates that even though flushing is low, exchange with the bay does occur. The return of salinity levels to high values after periods of high runoff requires an input of higher salinity water from the bay.

The creeks are bordered to varying degrees with *Spartina alterniflora* tall form. In some cases, the tall form border is absent. Behind the border are extensive areas of short form. The presence of the short form indicates that, although tidal flooding does occur, poor drainage conditions exist. Consequently, there probably is only minimal transport of materials off the marsh surface.

Nitrogen

INORGANIC AND ORGANIC FRACTIONS -- The occurrence of peak inorganic nitrogen concentrations coupled with reduced surface salinities in the creek systems suggested the inorganic nitrogen concentrations were related to storm activity and/or upland drainage. Precipitation, surface runoff, and upland drainage could have depressed the surface salinities and transported nutrients. Alternatively, storm related wind and wave disturbance of the bottom could have increased the amounts of inorganic nitrogen in the water column. In either case, the seasonal trend would be irregular from year to year because of the variability of storm occurrence. Any of these explanations or a combination of them could account for the elevated ammonia-N and nitrate-N concentrations seen at the upper ends of the creek systems; factors related to the individual systems would also influence the observed levels.

Such was the case in the Mill Creek System (Lagoon System E). Mill Creek was the only system studied with a continuous stream flow. Following the fall reduction of upland community primary production, increased amounts of inorganic nutrients were transported downstream by the creek. To a degree, this increased transport masked the storm-related inputs and resulted in a more extended interval of raised ammonia-N and nitrate-N concentrations at E87 compared to the upper ends of the other systems. The inorganic nitrogen seasonal trends were further complicated by the sewage plant at E68. The sewage outfall probably accounted for the irregular nature of the peaks and the high levels reached at the E68 site. The influence of this contribution extended downstream to the creek mouth where corresponding peaks, although diminished in size, were sometimes observed.

The Dinner Point Creek drainage, while relatively large in size, was confined mainly to the marsh. Examination of U.S.G.S. topographic maps indicated there was no significant upland area within the Dinner Point Creek drainage basin. Large

differences in salinity occurred between the mouth and upper ends with some over 10 $^{o}/oo$. Many of these differences were attributable to storm drainage. Other cases could be explained by the lack of complete tidal mixing at the upper end station. It was likely the observed nutrient levels resulted primarily from tidal-related forces or storm activity in the immediate area. This accounted for the more irregular nutrient peak patterns seen at the upper end site compared to E87. The lack of flow also eliminated the "salt wedge" effect seen in Mill Creek and allowed for greater mixing with the nitrogen poor bay water at the mouth site. Greater damping or alteration of upper end trends was the net effect. The lower surface values observed at Dinner Point Creek mouth relative to the E mouth surface station resulted from this effect as well as the absence of any sewage outfall on Dinner Point Creek.

The situation in the Meyers Creek system was similar to that in Dinner Point Creek. Except for local rainfall and runoff, there was limited upland drainage. Reduction of upper end salinity variations was again seen at the mouth site.

Within the lagoons, nitrate-N and ammonia-N varied in their distribution patterns. The anaerobic conditions during periods of stratification favored the accumulation of ammonia-N. This was best seen at station B24. Nitrate-N could be found in the lower layers when the water column was destratified; however, the main concentrations usually were in the upper part of the water column. Enrichment of the upper layers occurred following breakdown of stratification. At such times accumulated ammonia-N circulated throughout the water column, and nitrification resulted in elevated nitrate-N values.

The situation at the A08 mouth site was different. Ammonia-N accumulated on the bottom during periods of stratification. Stratification was intermittent at the A08 mouth station and the water column vacillated between stratified and nonstratified conditions. Perhaps the similarity in trends and values for the surface and bottom nitrate-N concentrations was a result of this. Also unlike B24 the surface nitrate-N and bottom ammonia-N concentrations did not maintain an inverse relationship. For the winter-spring periods the relation could even possibly be interpreted as being direct. Aside from diffusion and subsequent nitrification, a concurrent process was the nutrient addition associated with storm activity. Surface salinity reductions in the lagoons could only result from freshwater input associated with rainfall. The periods of observed salinity reductions in the winter and fall coincided with elevated nutrient values. The implication was part or all of these increased concentrations were attributed to runoff/precipitation. Such values seemed possible based on the nitrogen runoff contributions determined in this study.

On a per square meter basis, the lagoons were much richer in nitrogen than the other systems because of the greater depths in the lagoons. The increased depth allowed a greater volume of water per unit area. It also permitted stratification which led to elevated ammonia-N concentrations in the lower part of the water column. Considering that nitrogen probably limits the aquatic primary production, this would seem to be a potentially beneficial attribute; however, the increased levels were confined to the bottom of the lagoons. The inorganic nitrogen was available neither to the bay, because of the lack of circulation, nor locally to the upper part of the water column because of the presence of a thermocline and/or halocline.

The inorganic nitrogen stocks were the net product of a number of processes and factors. It was difficult to state which process was the most responsible. The observed concentrations could have been a function of regeneration rates alone. Alternatively, photosynthetic demands greater than the existing rate of nutrient regeneration could account for low levels of a specific compound. The converse would also be true. Seasonal variations could further complicate matters. Increased rates of summer versus winter photosynthesis and evapotranspiration would have to be recognized. The effects of a given nutrient input and salinity depression caused by rainfall would be moderated more rapidly in the summer than in the winter. While precipitation effects could be readily detected in the winter, they might be less obvious in the summer. Concurrent processes were also difficult to discriminate between.

The total organic-N component was important not only because it was the largest nitrogen fraction but also because it represented a major nutrient reservoir. Eventually, decomposition processes would convert the organic-N into ammonia-N. However, the release of this utilizable form would be over a long time increasing its effective availability. Not unexpectedly there was an apparent relationship between the seasonal organic-N patterns and some of the primary production factors measured. For example, the chlorophyll *a* variations in the lagoons seemed to be related to the total organic-N changes. While not the only source of organic-N, primary production by the phytoplankton would probably be the major source in the water column.

Our research indicated the following general trends regarding nitrogen compounds:

1) The surface waters of both creek and lagoon systems were generally poor in all forms of inorganic nitrogen.

2) Ammonia-N was the predominant form of inorganic nitrogen, followed by nitrate-N and then nitrite-N.

3) The organic nitrogen fraction was the dominant nitrogen form in terms of abundance.

4) The bottom of the lagoons accumulated high concentrations of ammonia-N during periods of stratification.

5) The extremely high ammonia-N concentrations were applicable to a relatively small volume of the total water column.

6) The creeks, and in particular Mill Creek, were implicated as sources of inorganic nitrogen compounds based on concentration gradients.

7) Increased surface ammonia-N levels correlated with decreased surface salinities.

8) Increased nitrate-N levels could be related to nitrification and/or reduced surface salinities.

NITROGEN FIXATION -- Nitrogen fixation was a significant process despite the relatively low rates observed. Its importance stemmed from its singular position as a mechanism for the introduction of previously nonutilizable nitrogen into the system. Other input processes functioned only as recycling mechanisms of already

fixed nitrogen. Only nitrogen fixation increased the absolute standing stocks of fixed nitrogen. The reduction of this capability in the lagoon complex was a major difference between the developed and the marsh areas and represented a disadvantage for the lagoon systems. The importance of this difference was emphasized by the nitrogen poor condition of the surface waters in the study area and the limitation this placed on photosynthetic rates. The reduced nitrogen fixing capability was primarily related to the loss of marsh surface in the developed areas. The amount of "new" nitrogen, while not supplying the bulk of the primary production nitrogen demand, probably did much over a long time span to characterize the overall production types and amounts currently present.

The seasonal variation observed in nitrogen fixation was not unexpected as the enzyme system is known to be cold labile. Also, the reduction of photosynthetic processes during the winter meant a reduction in the input of energy to the nitrogen fixation process. Within the marsh surface (SAS, SAT/B, and SP-DS) and bulkhead (lower) communities, seasonal patterns for net photosynthesis and nitrogen fixation were very similar. Minimal activity was observed in these areas during the winter period at which time visible algal cover was also at a minimum. Maximum nitrogen fixation rates in the *Spartina alterniflora* stands (SAS and SAT/B) occurred during the June-July period, and in May for the lower bulkhead community. High net photosynthetic rates also occurred in May but extended to September. Photosynthesis and nitrogen fixation in the benthic sediments were consistently low. Though marginal rates were observed under *S. patens* throughout the year, somewhat higher levels were observed in July for both nitrogen fixation and photosynthesis.

The similarity in seasonal trends is plausible since nitrogen fixation requires an energy input from photosynthesis. However, the correlation between these processes is dependent upon the relative proportion of the nitrogen fixers and non-nitrogen fixers in the community at any one time. The presence of non-fixing autotrophs may have been the reason the period of high photosynthetic activity was more prolonged than that for nitrogen fixation.

Our nitrogen fixation data are comparable to those of Whitney et al. (1975) and Van Raalte et al. (1974) among others. Whitney et al. (1975) found nitrogen fixation rates of approximately 5 μg-atom $N \cdot m^{-2} \cdot h^{-1}$ for marsh surface sediments in the summer. This differed by only a factor of 2 from our calculated summer value of approximately 11 μg-atom $N \cdot m^{-2} \cdot h^{-1}$ for the SAS substrate community. Considering site and inherent sample variation, this was a minor difference. Our SAS substrate community values peaked in the fall of 1975 following a period of slightly elevated levels during the spring-summer period. Possibly this was due to an increase in the population or activity of the heterotrophic bacterial nitrogen fixers present. Such an explanation was reasonable based on the data of Marsho et al. (1975) for a *Typha* marsh. They attributed most of the nitrogen fixation occurring in the Rhode River Estuary marsh sediments to bacterial activity. In evaluating the potential nitrogen fixation capability of these sediments, they found a seasonal variation approximating our in situ trends. They suggested the fall increase was a response to accumulated organic compounds by the nitrogen fixing bacteria. Perhaps this was also what caused our fall peak in nitrogen fixation activity. The Flax Pond data (Whitney et al. 1975) indicated a nitrogen fixation rate around 8 μg-atom $N \cdot m^{-2} \cdot h^{-1}$ during the summer for the SAT substrate community. Our summer values for this zone ranged from less than 1 to about 18 μg-atom $N \cdot m^{-2} \cdot h^{-1}$ depending on the site chosen. If all three sites were pooled with equal weight, the mean was approximately 6 μg-atom $N \cdot m^{-2} \cdot h^{-1}$. Concerning

the algal mats on the marsh surface, the approximate summer nitrogen fixation rates found by a number of researchers are indicated in Table 18.

Table 18. Nitrogen fixation rates on the marsh surface.

Researchers	Date	Location	Rate (μg-atom $N \cdot m^{-2} \cdot h^{-1}$)
Whitney et al.	1975	New York	200
This report	1977	New Jersey	120
Van Raalte et al.	1974	Massachusetts	70

In terms of rate the algal mats were the dominant nitrogen fixers in both the developed and undeveloped areas examined in the present study. This was also true of several other studies where marsh surface substrate and algal communities were compared. Research on benthic sediment community nitrogen fixation in many different environments has indicated only low rates are generally found. The results found at Meyers' Creek system also support this statement as does the following (Table 19).

Table 19. Benthic sediment nitrogen fixation.

Researchers	Date	Location	Rate (μg-atom $N \cdot g$ dry $wt^{-1} \cdot h^{-1}$)
This report	1977	Meyers Pond, N.J.	0.000353
		Meyers Creek, N.J.	0.000107
Brooks et al.	1971	Waccasassa estuary, Fla.	0.000219
Marsho et al.	1975	Rhode River estuary, Md.	0.000171
Keirn and Brezonik	1971	Various Fla. lakes	0.000024 - 0.004214
Howard et al.	1970	Lake Erie, Ohio	0.000833

The water column community in the Manahawkin area was determined to have negligible nitrogen fixation capacity. Often in freshwater studies high nitrogen fixation activity is associated with the water column, particularly with blooms of blue-green algal species like *Anabaena*. The only marine algal form proposed as a nitrogen fixer is *Trichodesmium*. Accordingly, nitrogen fixation is less frequently observed in the marine water column. In the temperate nearshore environments a nitrogen fixation capacity is mainly associated with benthic or primarily terrestial communities. It is possible to transplant organisms from these zones to the water column because of the interchange that exists between terrestial, benthic, and aquatic zones in an estuarine environment. This would provide organisms capable of nitrogen fixation to be associated with the water column at least on a temporary basis. Despite this mechanism, in the Manahawkin

study area the nitrogen fixation rates were extremely low within the water column and at the limit of detection of our methodology. Because of the variation encountered the observed rates were determined to be essentially zero.

EXCRETION -- Johannes (1965) has emphasized the importance of excretion by animals versus bacterial decomposition in nutrient regeneration. In our work with animal excretion we did not differentiate between the various nitrogen loss mechanisms (removal of metabolic wastes, osmoregulation, reproduction, discharge of unassimilated material, etc.). We were primarily interested in the total nitrogen contribution made by the organisms. We also did not examine the nitrogen compounds not detected by the ammonia-N and Kjeldahl-N methods utilized. Because the literature indicated aquatic invertebrates were primarily ammonotelic, we felt we detected the majority of the excreted nitrogen compounds using the above methods. Given these restrictions, it was found the total nitrogen contribution via excretion, as defined by us, was significant. Of this contribution, a larger than expected portion was total organic-N for *Modiolus demissus* and *Ilyanassa obsoleta* (also known as *Nassarius obsoletus*). Bishop (1976) indicated as a general rule ammonia-N comprised 65-70% of the total excreted nitrogen compounds for most aquatic invertebrates with urea, uric acid, amino acids, and other composing the remainder. More specifically, for *Modiolus* sp. Lum and Hammen (1964) found excretion rates of 3.1 μg-atom NH_3-N·9 tissue^{-1}·day^{-1} and 1.0 μg-atom amino acid·g tissue^{-1}·day^{-1}.[3] They also stated their amino acid excretion rates were probably low based on recovery experiments. They further indicated in several of the experiments amino acid excretion exceeded ammonia-N excretion. Corroborating data were supplied by Nicol (1969) who indicated ammonia-N composed only 10% of the total nonprotein nitrogen excreted by *Mytilus edulis*, a species similar to *Modiolus*. While we feel our "excess" organic-N excretion was in part due to the broad nature of this category as defined by us, perhaps the high excretion rates we observed could be explained by the high and sometimes variable amino acid excretion encountered by Lum and Hammen. Regarding ammonia-N loss, for a time comparable to when the Lum and Hammen work was done, we obtained a rate of 2.0 μg-atom NH_3-N·g dry wt^{-1}·day^{-1}. In contrast to this, Nixon et al. (1976) found much higher rates, on the order of 3.6 μg-atom NH_3-N·g dry wt^{-1}·h^{-1}. However, their methodology, particularly their shorter incubation time, differed from that used by Lum and Hammen (1964) and us.

At most stations, the zooplankton ammonia-N excretion was at a minimum in the winter and attained a maximum in the spring which extended somewhat into the summer. Possibly this spring peak was associated with the increased availability of food. In other zooplankton excretion studies, a fall excretion pulse excretion was detected, we did not. Sage and Herman (1972) indicated the zooplankton population in nearby Sandy Hook Bay peaks in the late spring and fall. It is therefore likely our sampling schedule missed the fall population and related excretion peak if one occurred.

Like the zooplankton, *Ilyanassa obsoleta* excretion peaked during the spring quarter. Perhaps this was a reflection of a postwinter increase in metabolic activity or the increase of available food amounts and/or types. This trend was consistent for all sites tested.

AMMONIFICATION -- In this study, ammonification was defined as the production of ammonia-N from the degradation of organic matter. Our intent was to monitor this process and to roughly estimate its importance in nitrogen cycling. Although

[3]Note: It is unknown whether "tissue" is dry weight tissue or wet weight tissue.

labeled ammonification, the rates actually resulted from a variety of processes of benthic organisms. Besides decompositional processes, excretion by various benthic populations would be included. Because we were estimating a net rate, adsorption to sediment fractions by mineralized nitrogen, nitrification, and denitrification would also be a part of the rate but as losses. The ammonification rates thus represented ammonification in a very broad sense, because they reflected the net degradation of organic matter to ammonia-N on a community basis and not by microorganismal populations alone.

The data from the third study year indicated the following:

1) It was readily apparent that of the "inputs" studied ammonification was the dominant nitrogen source.

2) In general, the sites investigated showed declines in the rates of ammonia-N production during the winter. This suggested, as other investigators have hypothesized, the process was in part temperature related.

3) Because there was no trend relative to upper or lower ends of the systems tested, factors other than remote point distance (i.e. distance from the bay) probably determined the ammonification rate of a specific site. Although we did not ascertain the specific factors, bottom substrate composition and microorganism environment probably were involved.

Conclusions must be made cautiously. Even between experimental replicates there were discrepancies caused by the inherent variability of the methodology used raising questions about the accuracy of the measurements. Because "disturbed" substrate systems were employed to derive the ammonification rates, it was difficult to establish several systems with identical parameters and conditions. The use of "disturbed" sediment systems relatively soon after collection might have resulted in erroneously high initial ammonia-N concentrations caused by sampling disturbance. This could have led to the determination of artificially low ammonification rates. Such an error was implied by a comparison of the Manahawkin rates to those of Rowe et al. (1975). The Manahawkin rates were lower than the mean coastal sediment ammonia-N flux rate of 3,456 μg-atom NH-N$\cdot m^{-2}\cdot day^{-1}$ they determined. It is possible, however, these discrepancies can be explained by site differences or because the methods used to determine the rates were based on different principles. Nixon et al. (1976) cite ammonia releases of 150 to 250 μg-atom NH_3-N$\cdot m^{-2}\cdot h^{-1}$ for Narragansett Bay which extrapolates to 3600-6000 μg-atom NH_3-N$\cdot m^{-2}\cdot day^{-1}$. Rowe et al. determined a summer flux rate of 2,030 μg-atom NH_3-N$\cdot m^{-2}\cdot day^{-1}$ for Eel Pond, presumably a salt marsh type site. Evidently, site differences cause a lot of variation in the ammonification rate. Because our mean rates differ by only a factor of 2 or 3 and our individual measures approximate the published data, we are confident our figures are acceptable estimates.

RUNOFF -- Based on Table 12, road runoff was a greater source of nitrogen than roof runoff. This was not unexpected as road drainage would travel farther over surfaces with potentially higher accumulations of nitrogen than roof runoff. Also road runoff carried a higher proportion of organic nitrogen than roof runoff. At Lagoons A02 and A08, 38% of the nitrogen contributed by roof runoff was organic-N while 57% of that contributed by road runoff was organic-N. Organic-N represented a significant part of the total nitrogen contributed via runoff. Whipple and Hunter (1977) also emphasized the importance of imported organic matter in urban storm runoff, indicating contributions of hundreds of milligrams per liter of suspended sediments and large amounts of B.O.D. and nutrients were common.

They commented the organic shock loads to the receiving bodies of water could be massive. In studying the mineralization of this type of tranported material, Cowen et al. (1976) stressed the importance of the organic fraction because of the potentially large amounts of nitrogen that would be released upon decomposition.

Yard runoff was not measured due to the lack of a means to collect subsurface and ground level sheet flows. Probably this type of runoff would be more similar to road runoff than roof runoff. If this were true, an additional input of 6 to 7 times the road runoff input would be expected provided all the water percolated into the lagoons.

NITROGEN BUDGET -- Quarterly nitrogen budgets were organized into three sections, (1) standing stocks; (2) inputs measured; and (3) calculated requirements. Separate budgets were derived for Meyers Creek, Meyers Pond, Lagoon A02, and Lagoon A08. Subdivisions were made between terrestial (the marsh surface) and aquatic (areas interfaced with or within the water column) zones where appropriate. Budgets were based on data from study year III (Tables 20, 21, 22, 23).

Of the nitrogen standing stock categories, total organic-N was the dominant fraction at all four sites, more than 82% of the nitrogen was in this form. In general, greater levels of total organic-N were found in the Meyers Creek system than in the Lagoon A system. Although shallower than the lagoons, the larger volume of the Meyers Creek system accounted for much of the observed difference. If concentration was the sole determinant of the total organic-N present, the order would have been Lagoon A02 (37 μg-atom Org-N$\cdot l^{-1}$), Meyers Pond (39 μg-atom Org-N$\cdot l^{-1}$), Lagoon A08 (45 μg-atom Org-N$\cdot l^{-1}$), and Meyers Creek (45 μg-atom Org-N$\cdot l^{-1}$).

While the organic-N fraction is significant to the nitrogen budget on a long-term basis, the inorganic-N fraction is of greater importance in terms of daily nitrogen flux because of its availability. At both Meyers Creek system sites a large pulse of inorganic nitrogen was observed in the second quarter. This was probably a result of storm related activity and the fall shutdown of the primary producers. The lagoon sites presented a less consistent pattern. While Lagoon A02 exhibited a peak inorganic nitrogen level during the second quarter, at Lagoon A08 a first quarter peak was recorded followed by a high level of inorganic nitrogen during the second quarter. While the fall patterns at both A02 and A08 could be explained as parallels to the creek system phenomena, the summer maximum at A08 could not. Elevated nitrate-N levels played a part in determining the sizes of the fall increases, but this was not the case at A08 during the summer maximum. Here, ammonia-N comprised over 90% of the inorganic nitrogen present as opposed to under 70% in the second quarter. The ammonia-N level was more than 2 times higher than it had been in any other period. The first quarter increase resulted from a mechanism distinct from that which produced the fall increases and which was peculiar to A03 and not A02. We believe this mechanism to be stratification. Stratification would account for the preponderance of ammonia-N in the composition of the first quarter peak, the occurrence of the increase during the summer, and the failure to observe a similar peak at A02. It is important to remember while nitrate-N assumes importance on occasion, as in the fall increases, ammonia-N is usually the most prevalent inorganic nitrogen compound found.

The nitrogen input rates to the water column indicate ammonification is the dominant process followed by excretion, runoff, and nitrogen fixation. It seems, therefore, the on site nitrogen recycling processes are much more important on a

Table 20. Nitrogen budget for Lagoon A02.

Classification Quarter:	1	2	3	4
Standing Stock in μg-atom $N \cdot 10^6$				
Inorganic nitrogen:				
NH_3-N	13.9	32.7	6.9	0.6
NO_2-N	0.2	0.5	2.8	0.0
NO_3-N	4.7	22.6	9.0	0.2
Sum of inorganic nitrogen stocks	18.8	55.8	18.7	0.8
Organic nitrogen:				
Total Organic-N	655.5	567.6	619.2	568.9
Sum of all nitrogen standing stocks:	674.4	623.4	637.9	569.7
Inputs in 10^6 μg-atom $N \cdot day^{-1} \cdot 10^6$				
Ammonification (NH_3-N)	10.2	21.8	20.2	54.8
Excretion:				
Zooplankton (NH_3-N)	0.0	0.0	0.2	2.0
Ilyanassa (NH_3-N)	0.2	0.2	0.4	0.6
(Org-N)				1.4*
Sum of all excretion (NH_3-N)	0.2	0.2	0.6	2.6
(Total-N)	1.6	1.6	2.0	4.0
Nitrogen fixation (NH_3-N):				
Water column	0.5	0.8	0.1	1.2
Runoff/precipitation:				
Inorganic-N (NH_3-N + NO_2 -N + NO_3 -N)				
Water column		0.7#		
Organic-N (Total organic-N)				
Water column		0.2#		
Sum of all inputs:				
Water column (Inorganic-N)	11.6	23.5	21.6	59.3
(Organic-N)	1.6	1.6	1.6	1.6

* This value will be applied to the entire year.

\# This value is based on the data accumulated during the entire year and will be applied to the entire year.

Table 21. Nitrogen budget for Lagoon A08.

Classification	Quarter: 1	2	3	4
Standing Stocks in μg-atom $N \cdot 10^6$:				
Inorganic nitrogen:				
NH_3-N	44.2	20.0	13.2	6.5
NO_2-N	0.1	0.0	0.8	0.0
NO_3-N	4.0	8.8	2.7	0.7
Sum of inorganic nitrogen stocks	48.3	28.8	16.7	7.2
Organic nitrogen:				
Total Organic-N	684.0	506.0	679.8	698.0
Sum of all nitrogen standing stocks	732.3	534.8	696.5	698.0
Inputs in μg-atom $N \cdot day^{-1} \cdot 10^6$				
Ammonification (NH_3-N):	4.2	10.4	4.7	4.9
Excretion:				
Zooplankton (NH_3-N)	0.2	0.0	0.0	1.2
Ilyanassa (NH_3-N)	0.4	0.2	0.4	1.0
(Org-N)				1.2*
Sum of all excretion (NH_3-N)	0.6	0.2	0.4	2.2
(Total-N)	1.8	1.4	1.6	3.4
Nitrogen fixation (NH_3-N):				
Water column	0.3	0.3	0.0	0.2
Runoff/precipitation:				
Inorganic-N (NH_3-N + NO_2-N + NO_3-N)				
Water column		0.5#		
Organic-N (Total organic-N)				
Water column		0.2#		
Sum of all inputs				
Water column (Inorganic-N)	5.6	11.4	5.6	7.8
(Organic-N)	1.4	1.4	1.4	1.4

* This value will be applied to the entire year

\# This value is based on the data accumulated during the entire year and will be applied to the entire year.

Table 22. Nitrogen budget for Meyers Creek.

Classification	Quarter: 1	2	3	4
Standing Stocks in μg-atom N·10^6:				
Inorganic nitrogen:				
NH_3-N	42.9	152.9	5.5	22.0
NO_2-N	0.0	2.2	2.2	0.0
NO_3-N	2.2	28.6	4.4	2.2
Sum of organic nitrogen stocks	45.1	183.7	12.1	24.2
Organic nitrogen:				
Total organic-N	1,084.6	841.5	804.1	711.7
Sum of all standing stocks:	1,129.7	1,025.2	816.2	735.9
Inputs in 10^6 μg-atom N·day^{-1}·10^6				
Ammonification (NH_3-N):	28.9	25.2	1.5	39.8
Excretion:				
Zooplankton (NH_3-N)	0.6	0.1	0.0	1.3
Modiolus (NH_3-N)	1.8	4.7	14.0	4.8
(Org-N)		10.9*		
Ilyanassa (NH-N)	0.6	0.3	0.8	0.9
(Org-N)		1.4*		
Sum of all excretion (NH_3-N)	3.0	5.1	14.8	7.0
(Total-N)	15.3	17.4	27.1	19.3
Nitrogen fixation (NH_3-N):				
Marsh surface	104.6	133.6	2.7	11.1
Water column	0.8	0.3	0.1	0.1
Runoff/precipitation:				
Inorganic-N (NH_3-N + NO_2-N + NO_3-N)				
Marsh surface		11.1*		
Water column		1.1*		
Sum of all inputs:				
Marsh surface (Inorganic-N)	115.7	144.7	13.8	22.2
Water column (Inorganic-N)	33.8	31.7	17.5	48.0
(Organic-N)	12.8	12.3	12.3	12.3

*This value is based on all the available data and will be applied to the entire year.

Table 23. Nitrogen budget for Meyers Pond.

Classification	Quarter: 1	2	3	4
Standing stocks in μg-atom N·10^6				
Inorganic nitrogen:				
NH_3-N	31.1	120.6	21.6	22.5
NO_2-N	0.0	1.8	2.7	0.0
NO_3-N	2.7	22.5	14.4	1.8
Sum of inorganic nitrogen stocks	33.8	144.9	38.7	24.3
Organic nitrogen:				
Total Organic-N	918.5	982.8	720.9	629.1
Sum of all standing stocks	952.3	1,127.7	759.6	653.4
Inputs in 10^6 μg-atom N·day^{-1}·10^6				
Ammonification (NH_3-N):	54.1	59.4	0.0	155.3
Excretion:				
Zooplankton (NH-N)	0.5	0.1	0.0	1.0
Modiolus (NH_3-N)	0.8	2.0	6.1	2.1
(Org-N)		4.7*		
Ilyanassa (NH-N)	1.1	0.6	0.9	2.2
(Org-N)		3.2*		
Sum of all excretion (NH_3-N)	2.4	2.7	7.0	5.3
(Total-N)	10.3	10.6	14.9	13.2
Nitrogen fixation (NH_3-N):				
Marsh surface	71.0	81.4	3.0	8.3
Water column	11.8	4.3	0.0	0.5
Runoff/precipitation:				
Inorganic-N (NH_3-N + NO_2-N + NO_3-N)				
Marsh surface				
water column				
Sum of all inputs:				
Marsh surface (Inorganic-N)	80.9	91.3	12.9	18.2
Water column (Inorganic-N)	70.4	68.5	9.1	163.2
(Organic-N)	7.9	7.9	7.9	7.9

*This value is based on all the available data and will be applied to the entire year.

short term basis than those which provide nitrogen previously unavailable or from allochthonous sources. Other workers including Haines et al. (1976) have contended this. The only inputs to the marsh surface measured were nitrogen fixation and nitrogen from direct precipitation. Nitrogen fixation was found to exceed the precipitation contribution on an overall basis.

Comparing the two systems in terms of these processes, the lack of certain components in the lagoon system is apparent. The lack of a *Modiolus* population in the lagoons accounts for the smaller excretion contribution made there. The contributions made by the *Ilyanassa* and mixed zooplankton populations were roughly equivalent both within and between systems. The lack of a biologically functional marsh surface in the lagoon system is another obvious difference between the two areas. Because of this a great deal of nitrogen fixing capability is lost. The failure for other zones to compensate represents a restriction of the introduction of "new" nitrogen into the system.

In discussing the nitrogen fluxes it is important to note the various inputs and requirements derived are not all inclusive. The vast majority of the species and the number of organisms present were untested. It is, therefore, likely that a significant fraction of the total excretion was not included in the estimates of contributed nitrogen. Similar gaps exist in the net production data which were utilized to calculate the demand placed on the nitrogen resources. Production by macrophytic algae was not included. On the marsh surface production in the salt pools and certain epiphytic plant zones were also untested. The "budget" outlined then is only an estimate of the stocks and fluxes occurring in the respective systems.

Within the water column, the phytoplankton exerted the greatest nitrogen demand in both systems. The limited distribution of the bulkhead algal community in the lagoon system negated to an extent its high rate of nitrogen demand. The bank zone algal community was a parallel to this in the creek system. Reflecting the importance of their microbial populations, the benthic algal communities in both systems generally exhibited a negative net production throughout the year. This represented a contribution of nitrogen shown as a reduced demand rather than an input. It meant microbial respiration returned more nitrogen than the primary producers incorporated. The microbial component was also a factor in the phytoplankton community. At the surface a 1:1 ratio of net production to gross production was typically observed. However, on a water column basis, the 1:1 ratio was not maintained, and negative net production values were sometimes detected during the year. These values resulted from high respiratory activity which occurred primarily in the lower water column. This in turn suggested the respiration was nonalgal in nature and would logically be microbial in origin. Table 24 shows the total nitrogen demand of the bulkhead algal, bank zone algal, benthic algal, and phytoplankton communities at their respective sites. The nitrogen demand was greatest in the Meyers Creek system, particularly in the summer and spring quarters. The total available inorganic nitrogen supply would have been depleted within one day at these times if there were no inputs into the standing stock compartment. It was the high phytoplankton production that created the bulk of this nitrogen demand. In the lagoons relatively low nitrogen demand were exerted during the summer season. This resulted in part from the depth of the lagoon sites. The compensation depth in the lagoons during the summer was around 2.0 m or less. This meant a significant portion of the water column was exerting a respiratory demand offsetting the effect of high production rates in the surface layers; and resulting in a low overall net production and nitrogen requirement. Downward shifts of the compensation depth appeared to increase the nitrogen demand

in the fall at the lagoons. In addition, there was a major increase in the rates of bulkhead algal production at this time. The negative fall quarter value at Meyer's Pond was due to exceptionally high benthic respiration. A high respiration rate also caused a low nitrogen demand value at the Meyers Creek site. The large nitrogen requirement at A08 during the winter was the result of a major burst of phytoplankton production, observed only at A08, and continued bulkhead community activity. In the spring, the lagoon values were again unexpectedly low considering the trends shown in the Meyers Creek system. The Meyers Creek system sites showed increases in nitrogen demand because of rising primary production rates in both phytoplankton and bank zone algal communities. At A08, this was not the case as benthic respiration and the loss of bulkhead algal and phytoplankton community production caused a reduced nitrogen requirement. Subsequent primary production increases during the period after the fourth quarter indicated the spring increase in the lagoons was delayed in comparison with the creek system pattern.

Table 24. Nitrogen requirements in 10^6 μg-atom per day based on net oxygen production by water column related plant communities exclusive of rooted vegetation.

Site	Quarter 1	2	3	4
Meyers Creek	67.3	5.5	27.7	35.2
Meyers Pond	84.8	-35.3*	18.5	24.5
Lagoon A02	6.4	19.5	4.2	5.8
Lagoon A08	3.3	26.6	33.2	5.5

* A negative value indicates an input of nitrogen to the system.

Analysis of the nitrogen demand in relation to the nitrogen supply is shown in Table 25. Where the values exceed 1.00 the estimated demand exceeds the measured supply.

In the Meyers Creek system, summer was a period of high nitrogen requirements. Despite relatively high nitrogen inputs, this demand exceeded the supply capabilities. In the second quarter, the supply exceeded the demand, probably because production fell off sharply in October while high inputs of nitrogen continued. In addition, extremely high benthic respiration rates were recorded. In the winter period, large decreases in ammonification reduced the total inorganic nitrogen input. There was also a reduction of the "nitrogen input" attributable to benthic community respiration. In the spring, increases in primary production were outweighed by increased nitrogen input. Of particular importance was the return of high rates of ammonification.

In the lagoons, nitrogen supply exceeded demand during the summer because of the high respiration values shown by the combined water column communities. The higher nitrogen requirements during the fall at A02 and during the fall and winter at A08 were a reflection of a decrease in microbial respiration relative to the gross primary production. Of particular interest was the fact that the bulkhead algae, benthic algae, and phytoplankton all reached maximum rates during

Table 25. Ratio of the nitrogen requirements of the water related plant communities (exclusive of rooted vegetation) and their nitrogen supply. The ratio is calculated by dividing the demand by the supply.

Site Quarter	1	2	3	4
Meyers Creek	1.99	0.17	1.58	0.73
Meyers Pond	1.20	-*	2.03	0.15
Lagoons A02	0.55	0.83	0.19	0.10
Lagoon A08	0.59	2.33	5.93	0.71

* The negative value indicates there is a net contribution of nitrogen.

the winter quarter at A08. The low demand/supply ratio in the winter quarter at A02 resulted not only from a low primary production nitrogen demand but an unusually high benthic community respiration. The spring period ratios were mainly attributable to ammonification rate increases at A02 and high benthic respiration at A08.

The nitrogen supply and demand values discussed here do not take into account nitrogen uptake by the *Spartina alterniflora* tall form which is also associated with the water column. Doing so would place an additional 2.0×10^7 μg-atom N·day^{-1} requirement at the Meyers Pond site and 4.0×10^7 μg-atom N·day^{-1} at the Meyers Creek station for the late spring to early fall period. This was calculated from the data of Good and Frasco (1977) assuming a growing season of 182.5 days and using their estimate of the nitrogen content of the plant material for the fall time period. Because net production belowground was estimated to be 5 times the aboveground, a factor of 6 was applied to this derived figure to give the total net production of both above and belowground compartments.

Similar calculations for the *Spartina alterniflora* short form and *Spartina patens/Distichlis spicata* marsh surface communities led to an estimated demand of 4.2×10^9 μg-atom N·day^{-1} for the same period of time. This far exceeds the estimates of nitrogen supply and indicates on site recycling must provide most of the nitrogen required.

Productivity

Seasonal patterns in several standing crop indices, including chlorophyll *a*, oxidizable carbon, particulate organic nitrogen, and organic seston, occurred in both natural and developed areas. These patterns, though more pronounced for some parameters and some stations than others, occurred with some degree of regularity from year to year. Concentrations generally were found to be highest during the active summer period of the phytoplankton and were primarily attributed to local production. The resuspension of bottom deposits by wind stirring is believed to be a factor in the fluctuation of such particulates in the shallow creeks and bays. The high levels of oxidizable carbon recorded during the winter in such areas may be of importance to higher trophic levels.

In addition, annual variation was noted in the summer magnitude of the standing crop parameters and coincided with similar changes in phytoplankton productivity. This was especially noticeable in the bay during the summers of 1973 and 1975 when phytoplankton standing crop and productivity were greatly diminished.

Preliminary statistical analysis for study year IV indicate that although surface chlorophyll *a* is not a good indicator of the suspended organic matter, it was significantly correlated with the amount of available energy stored in the crop, i.e., oxidizable carbon (correlation coefficients of +.83 and +.88 in the Meyers and lagoon systems, respectively). The seasonal distribution of chlorophyll *a* also coincided especially well with phytoplankton net productivity.

Measures of total seston incorporated a large array of possible sources (plankton, detritus, suspended organisms from benthic and fouling communities, resuspended minerals, etc.). It was observed that the relative proportion contributed by organic and inorganic sources was significantly different in the natural and developed areas. This would seem to reflect the importance of depth and the susceptibility to resuspension of bottom deposits, thereby increasing disproportionately the inorganic material in the water column. This wind stirring effect was believed to account for not only the wide fluctuation of total seston in the natural creek but also for the relative predominance of inorganic matter in the water. The presence of such suspended material could have an important effect upon the transparency of the water, and therefore on the productive capacity of the phytoplankton.

From the results for the quarterly periods during study year III, the producers of the aquatic system were rated according to the percentage of total production they accounted for. According to those findings, it was clear that the producer category of greatest importance was the phytoplankton in both developed and natural areas.

The summer productive capacity of the phytoplankton throughout the Manahawkin area was shown to be nitrogen limited, as determined by a nutrient enrichment technique. Such limitation occurred at times when the productive capacity of the phytoplankton was high, especially in the ponds. Such responses were not observed during the winter and probably reflected the effects of reduced light intensity and duration, lower phytoplankton standing crop, and increased stocks of inorganic nitrogen. In contrast, phosphorus was rarely limiting.

The turbidity in the creeks was often greater than in the lagoons. Average compensation depths for the Meyers Creek system and for the bay were greater than the total depth, thereby placing the entire water column within the photic zone. Thus, the overall shallowness of such areas permitted net production throughout the water column. One might even consider such extremely shallow depths as at Meyers Pond (0.42 m) to be suboptimal, since the phytoplankton are capable of carrying out net production at over twice that depth (D_c = 1.08 m). Such a limitation is counteracted, to some extent, during the very active summer periods when high photosynthetic rates per unit volume occur.

Total depth was also a critical factor in the lagoon systems where a significant proportion of the water column lay in the aphotic zone. This placed a considerably greater respiratory burden upon the actively growing populations located within the top 2.0 m. As a result, negative net production per square meter was common at the deeper lagoon stations, especially during the summer.

Such depths affected not only the areal production of the phytoplankton but also placed strict limits on the type of biological activity possible in the benthos. The aphotic conditions which generally prevailed ruled out benthic producers, while the high benthic respiration rates were probably a major factor in the frequent development of anaerobic conditions. In addition, no compensatory input of oxygen by the phytoplankton was possible below the euphotic zone.

The high oxygen uptake rates accorded in the sediments of Meyers Pond also had an effect upon dissolved oxygen levels in the overlying water. Low oxygen concentrations were characteristic of the pond during summer. High rates of phytoplankton production throughout the entire water column could not compensate for the high demands of the benthos, and considerable undersaturation occurred. Aerobic conditions prevailed as a result of the high degree of tidal flushing and the input of bay water during the flood tide.

The respiration of the sediment biota exceeded photosynthetic activity of the microalgae such that sediment cores exposed to the light demonstrated a decline in oxygen content. This phenomenon was even observed at the very shallow Meyers Pond station where favorable light conditions at the bottom persisted throughout the year. Based upon preliminary studies involving the addition of antibiotics to dark cores, a large proportion of this respiration is bacterial activity. The importance of this benthic metabolism lies not only in its effect upon the oxygen levels in the overlying water column, but also in its role involving nutrient regeneration and mineralization. The efficiency of this cycling by the benthic communities will of course depend upon the availability of the released nutrients for further utilization.

In contrast to the benthic subsystem, some of the marsh surface edaphic communities were capable of net productivity during the summer. Such a productive capacity was directly related to the amount of light penetrating the canopy of marsh grass. Another important factor affecting the total contribution of algal mats in the salt marsh was the areal distribution of the canopy types. Whereas *Spartina patens* accounted for about 38% of the marsh surface, the importance of the microflora would be minimal since algal growth was limited by light penetration. Significant net production was recorded for the *S. alterniflora* (tall form) and mudflat communities, but the areal distribution of each area only accounted for less than 1% of the marsh surface. Algal production in the *S. alterniflora* (short form) zone was similar to that in the tall form, and reflected more favorable light conditions. Since the short form zone accounted for about 60% of the marsh surface, such algal mats would make a significant contribution to the total primary productivity of the salt marsh.

The production of the bulkhead algal community was comparable to the high levels observed in the mudflat community. However, the distribution within its respective system was also limited, and, therefore, its contribution to the total system production was small.

The relative contribution of autotrophic and heterotrophic metabolism in these productive subsystems is shown in Figure 38, in which total community respiration is plotted against total production (Odum 1956). Values of $GP/R > 1$ are characteristic of an autotrophic-dominated metabolism and involve a net storage of organic matter. Values of $GP/R < 1$ are characteristic of an heterotrophic-dominated metabolism and involve a net loss of organic matter. The diagonal line

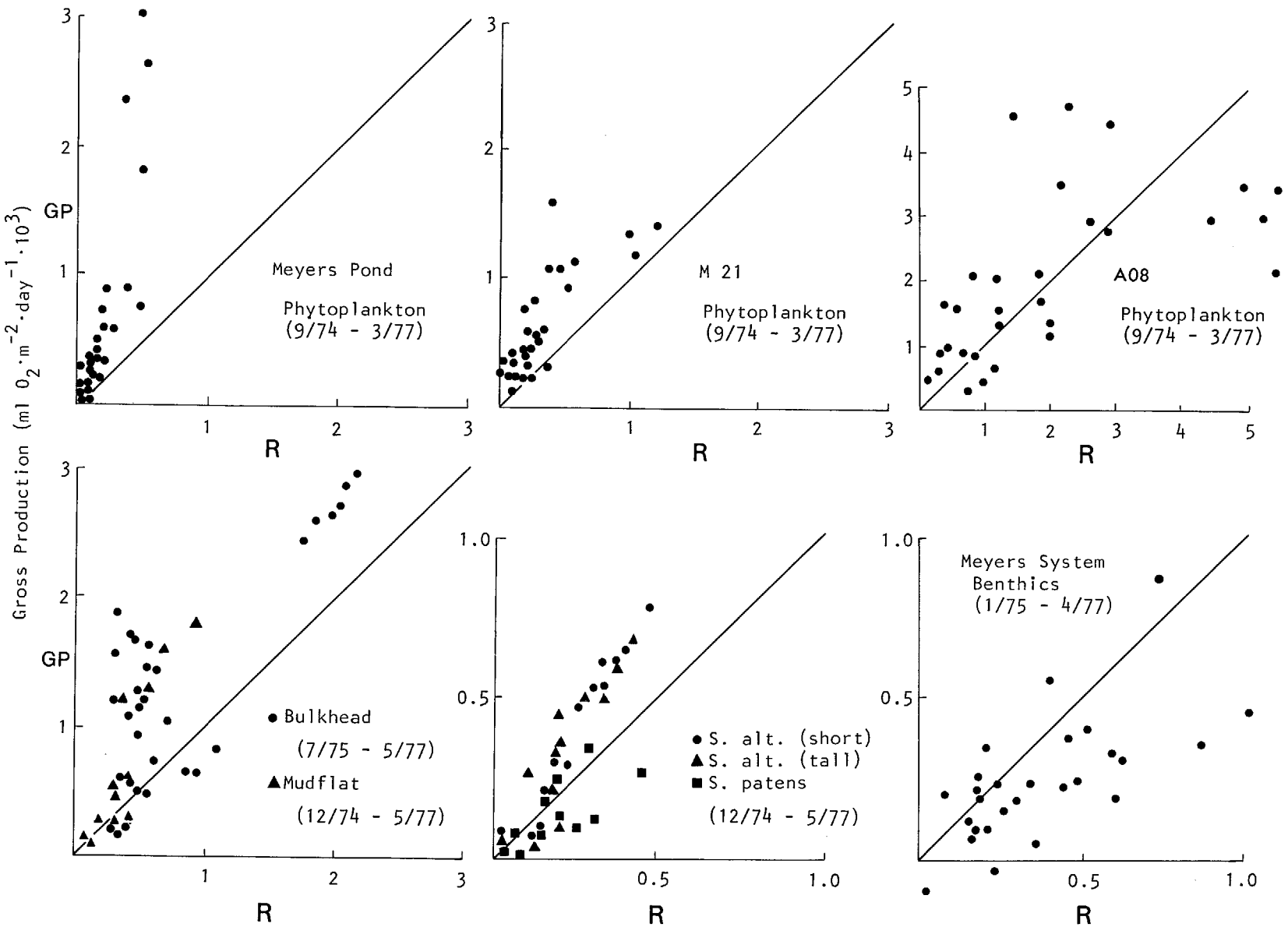


Fig. 38. The relationship between gross production (GP) and respiration (R) for different communities of primary producers. All units: ml $O_2 \cdot m^{-2} \cdot day^{-1} \cdot 10^3$.

represents a GP/R ratio of 1, and the departure of points above this line represents positive net productivity.

The respiration of the phytoplankton communities was probably due in large part to the phytoplankton themselves, as previously mentioned. This was more than compensated for by photosynthesis in the shallower stations such as Meyers Pond and M 21. However, values of GP/R < 1 were frequent in the deeper lagoon stations, especially during the summer. Such a heterotrophic metabolism was prevalent at all benthic stations and in the *Spartina patens* zone. The algal communities associated with *S. alterniflora*, lagoon bulkheads, and the Meyers Creek mudflat were generally autotrophic, but became heterotrophic during the colder parts of the year when photosynthesis was negligible.

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APPENDIX A

Tables and Figures from the June 1974 Estuarine Evaluation Study Annual Report: Primary Aquatic Productivity

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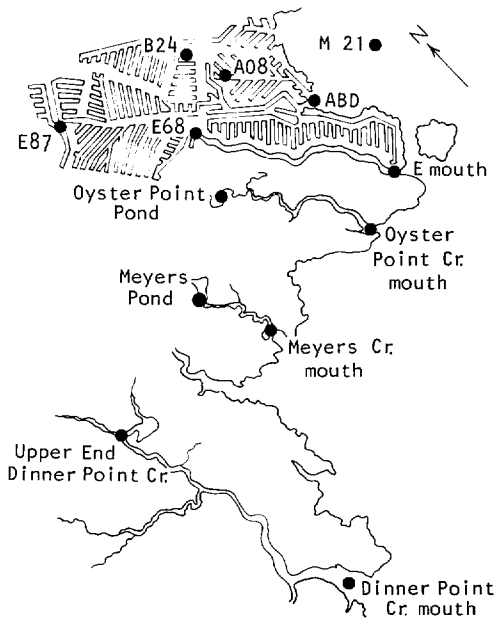

Fig. 1. Station locations.

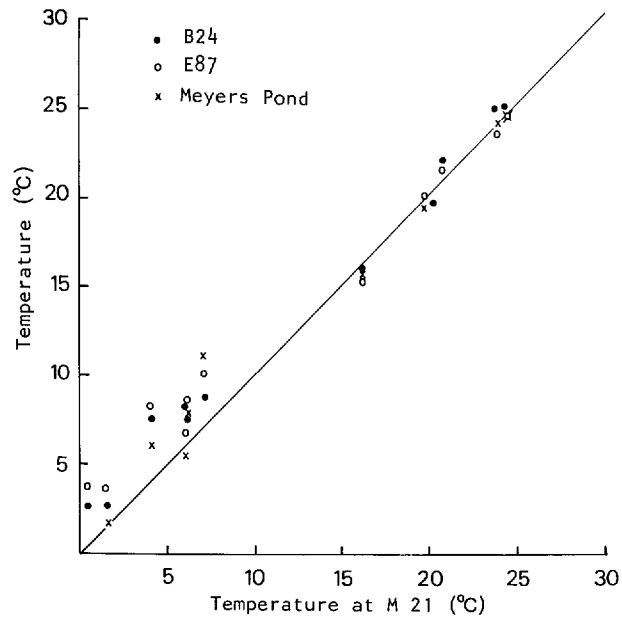

Fig. 2. Surface water temperature: B24, E87, Meyers Pond compared to M 21.

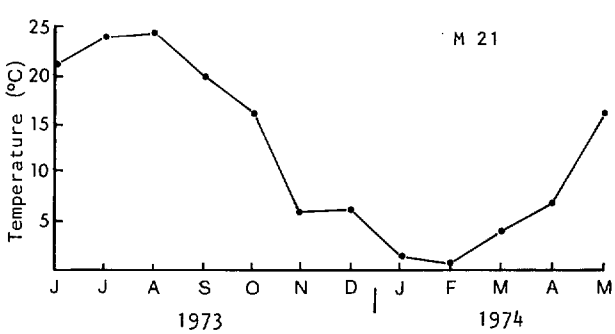

Fig. 3. Seasonal water temperature at M 21 surface.

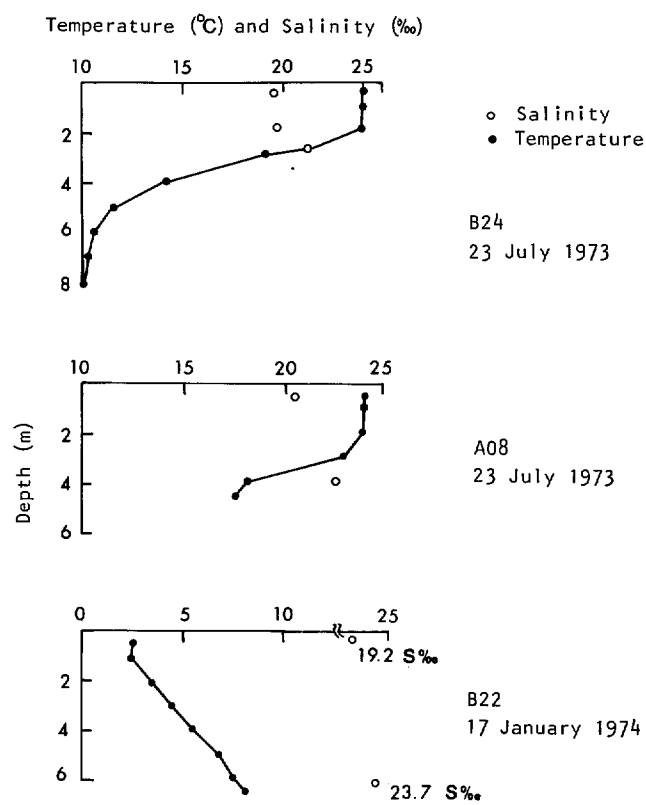

Fig. 4. Temperature and salinity vertical distributions.

(from June 1974 Annual Report)

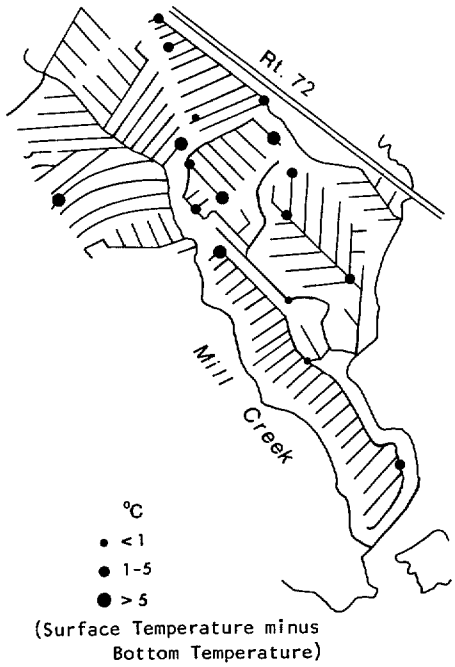

Fig. 5. Temperature stratification; (surface temperature minus bottom temperature) in the lagoon systems on 26 June 1973.

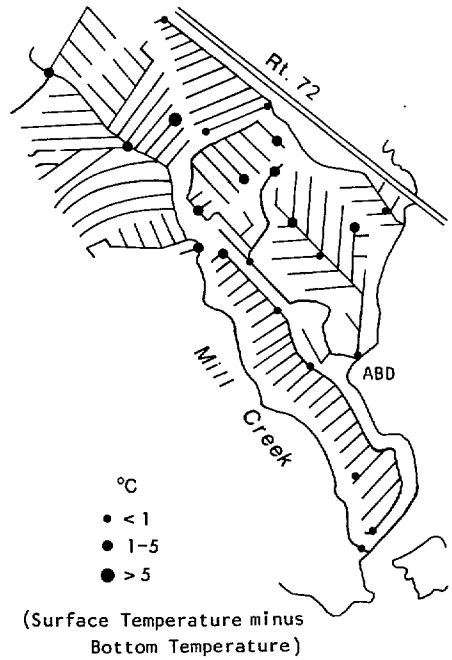

Fig. 6. Temperature stratification; (surface temperature minus bottom temperature) in the lagoon systems on 7 March 1974. Absolute value of the difference is indicated.

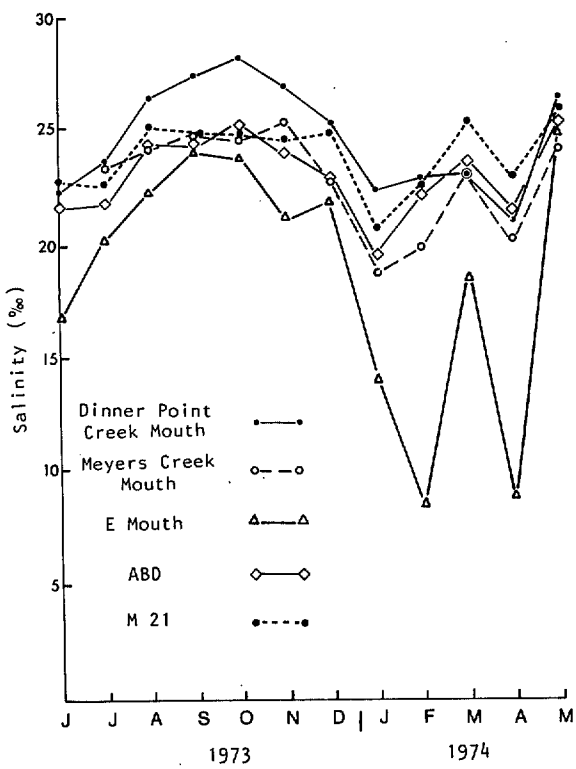

Fig. 7. Monthly mean surface salinity values at the mouths of the major systems.

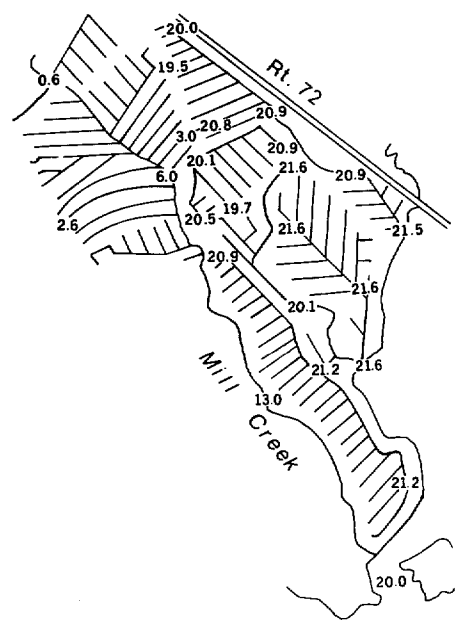

Fig. 8. Surface salinity (°/oo); spatial distribution in the lagoon systems on 26 June 1973.

(from June 1974 Annual Report)

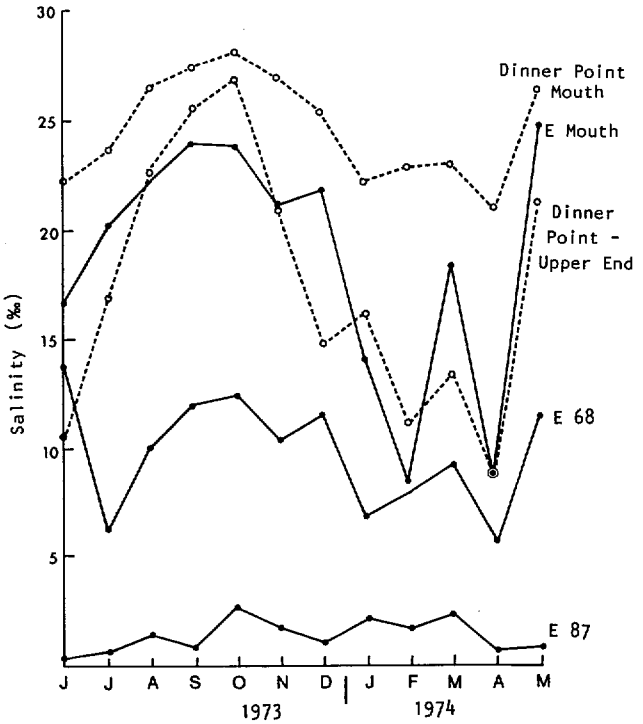

Fig. 9. Monthly mean surface salinity values for Mill Creek and Dinner Point Creek.

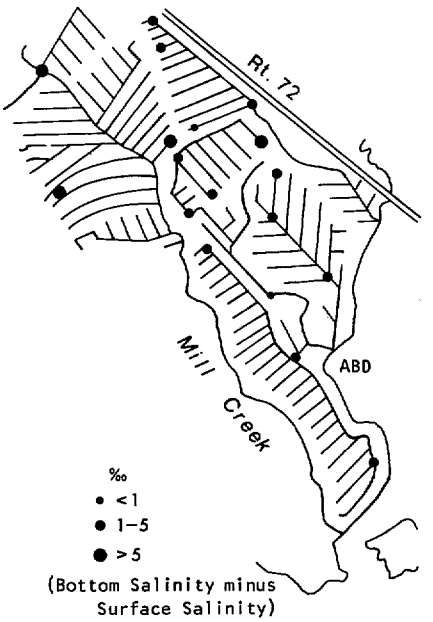

Fig. 10. Salinity stratification; (bottom salinity minus surface salinity) in the lagoon systems on 26 June 1973.

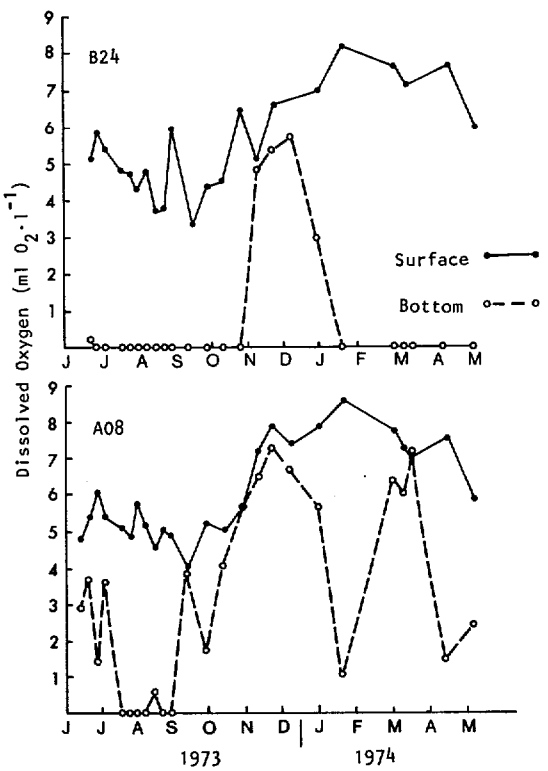

Fig. 11. Monthly mean dissolved oxygen values at the surface and bottom of Lagoons B24 and A08.

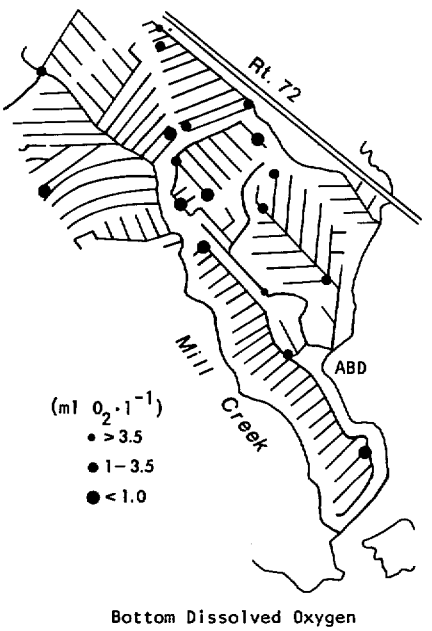

Fig. 12. Dissolved oxygen values at the bottom of the lagoon systems on 26 June 1973.

(from June 1974 Annual Report)

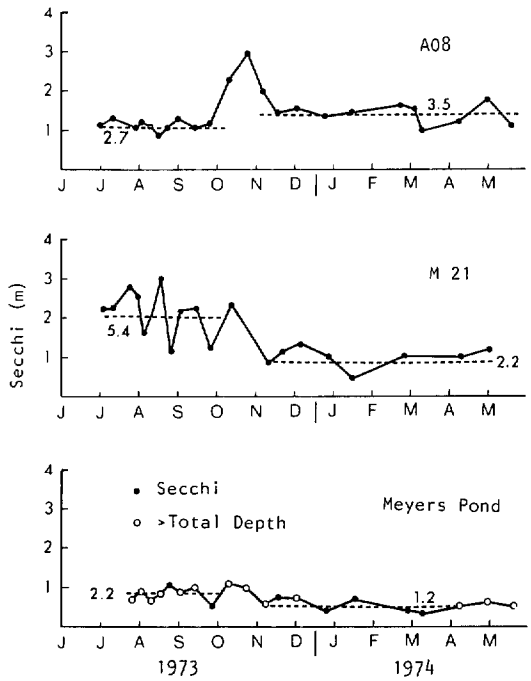

Fig. 13. Secchi disc readings.

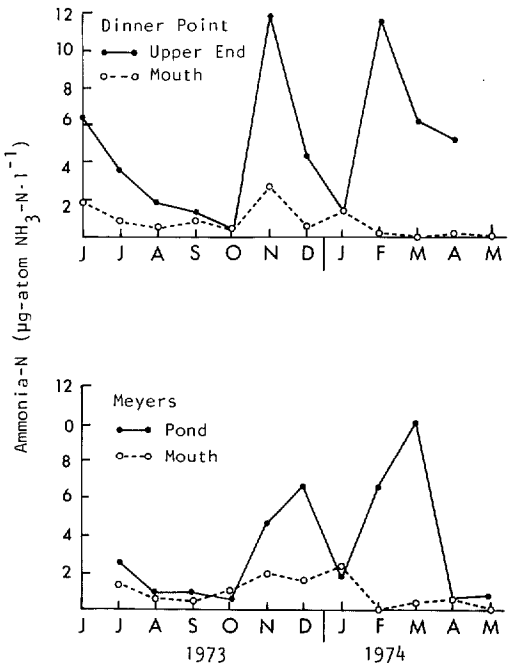

Fig. 14. Monthly mean ammonia-N concentrations in the Dinner Point and Meyers Creek systems.

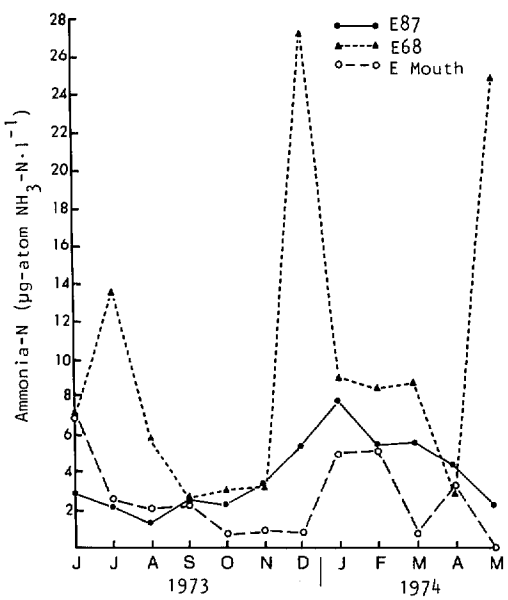

Fig. 15. Monthly mean ammonia-N concentrations in the E system (Mill Creek).

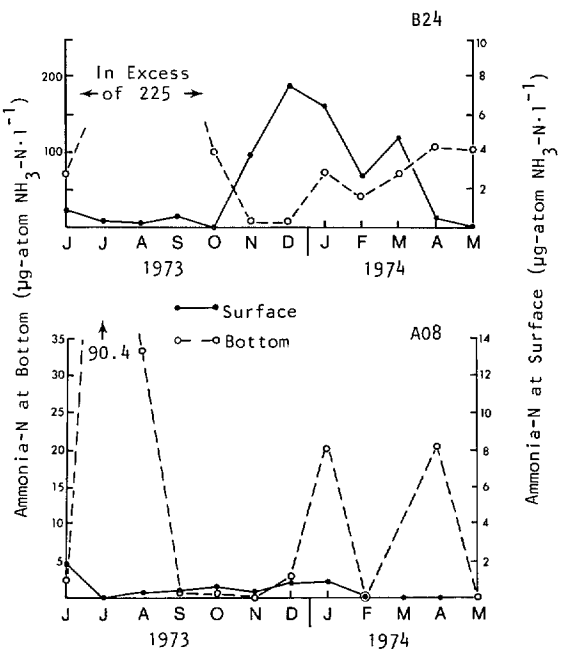

Fig. 16. Monthly mean ammonia-N concentrations at Lagoons B24 and A08.

(from June 1974 Annual Report)

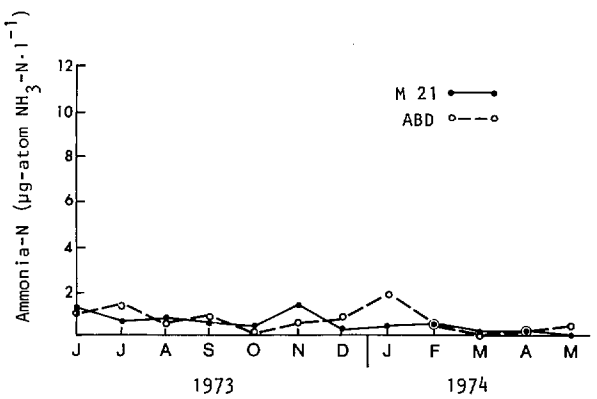

Fig. 17. Monthly mean ammonia-N concentrations at M 21 and ABD.

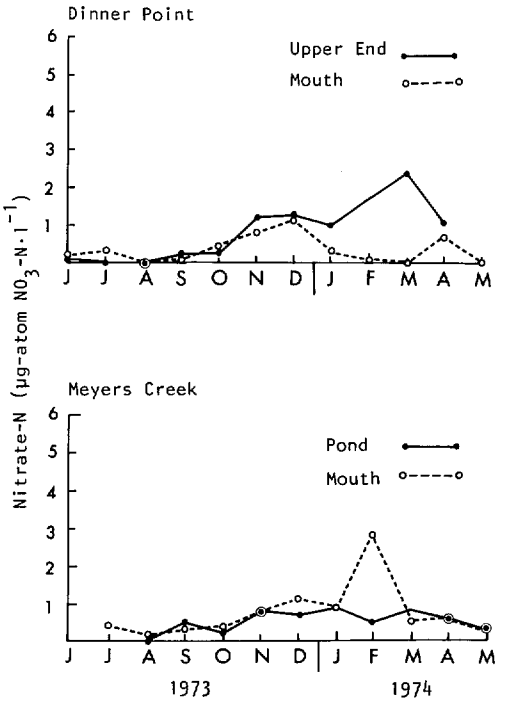

Fig. 18. Monthly mean nitrate-N concentrations in the Dinner Point and Meyers Creek systems.

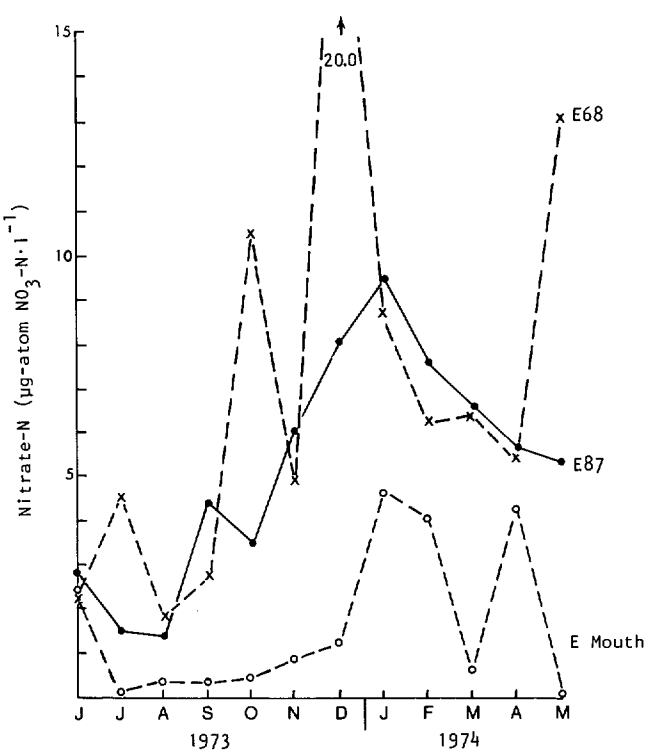

Fig. 19. Monthly mean nitrate-N concentrations in the E system (Mill Creek).

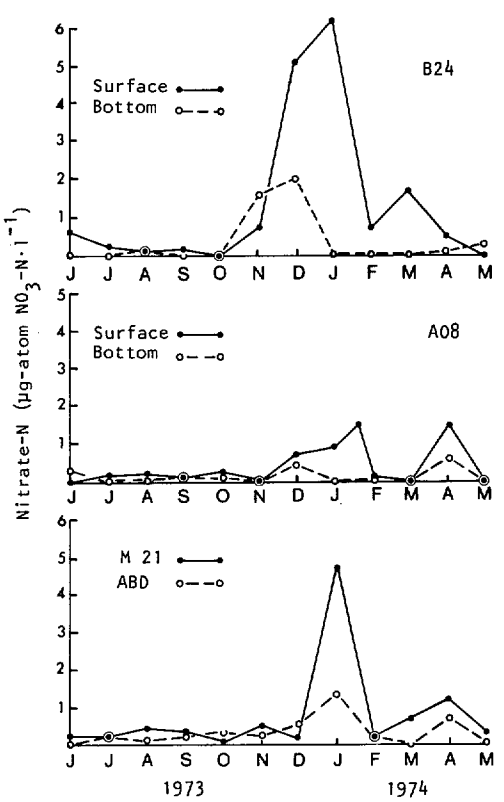

Fig. 20. Monthly mean nitrate-N concentrations at B24, A08, M 21, and ABD.

(from June 1974 Annual Report)

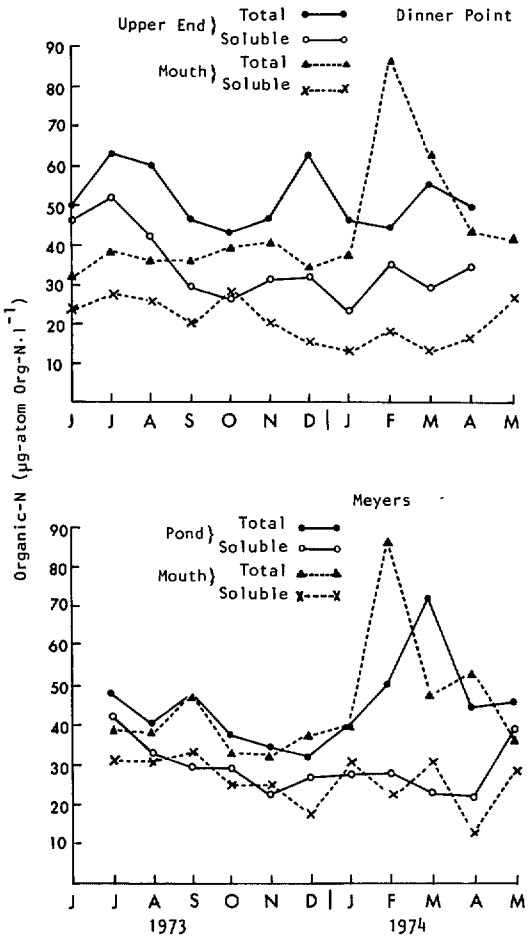

Fig. 21. Monthly mean organic-N concentrations in the Dinner Point and Meyers Creek systems.

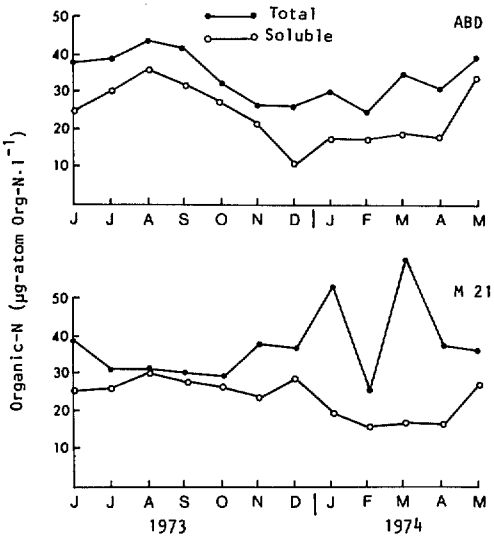

Fig. 23. Monthly mean organic-N concentrations at ABD and M 21.

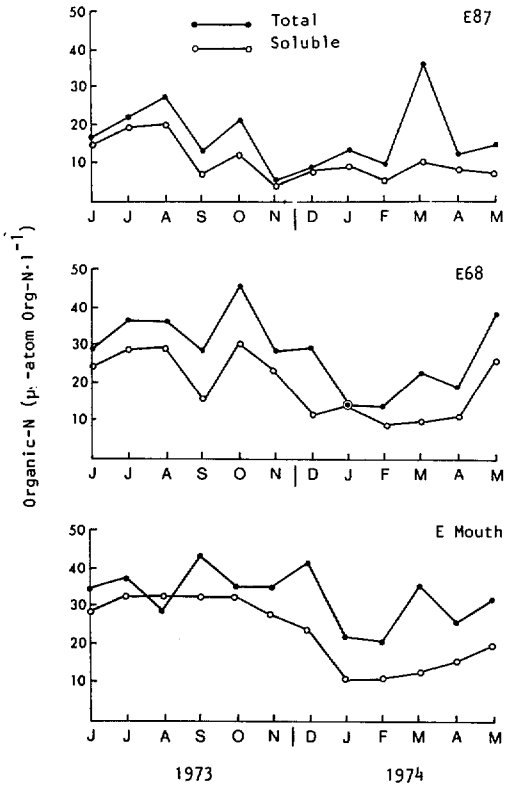

Fig. 22. Monthly mean organic-N concentrations in the E system (Mill Creek).

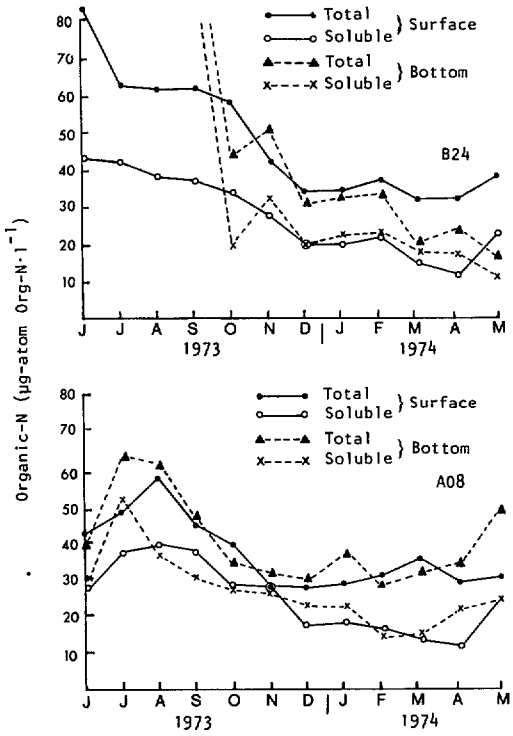

Fig. 24. Monthly mean organic-N concentrations in Lagoons B24 and A08.

(from June 1974 Annual Report)

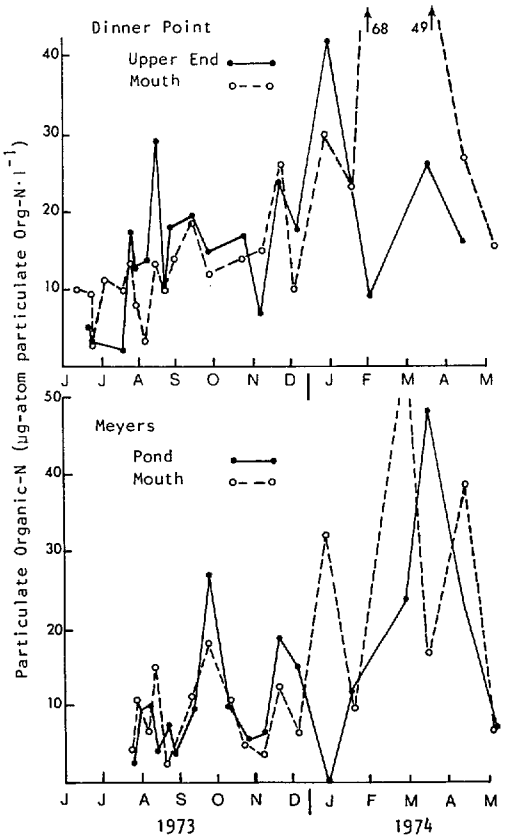

Fig. 25. Particulate organic-N concentrations in the Dinner Point and Meyers Creek systems.

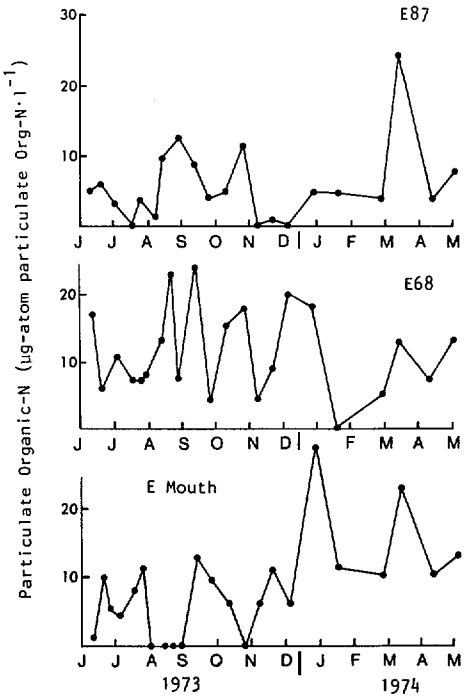

Fig. 26. Particulate organic-N concentrations in the E system (Mill Creek).

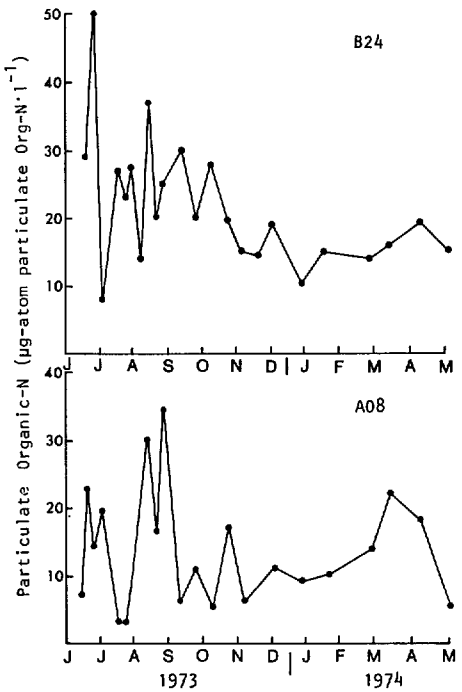

Fig. 27. Particulate organic-N concentration in Lagoons B24 and A08.

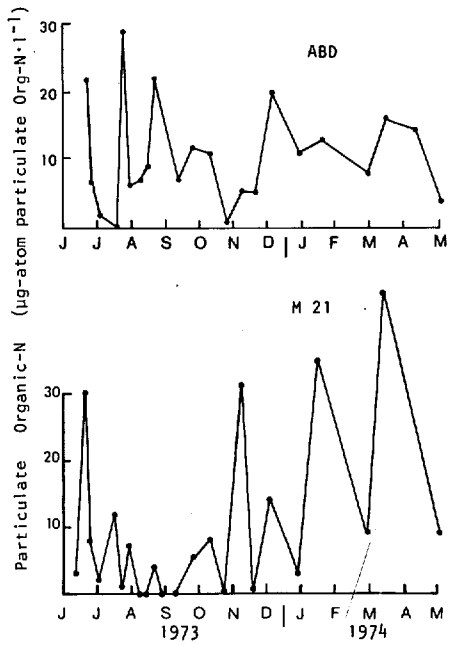

Fig. 28. Particulate organic-N concentrations at ABD and M 21.

(from June 1974 Annual Report)

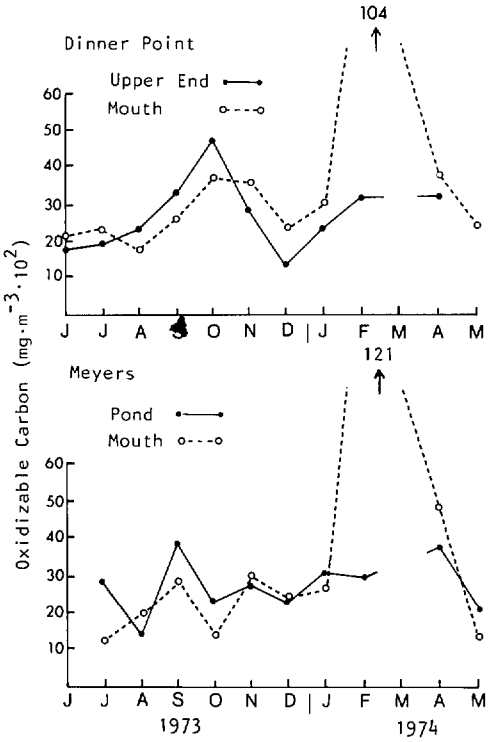

Fig. 29. Monthly mean oxidizable carbon concentrations in the Dinner Point and Meyers Creek systems.

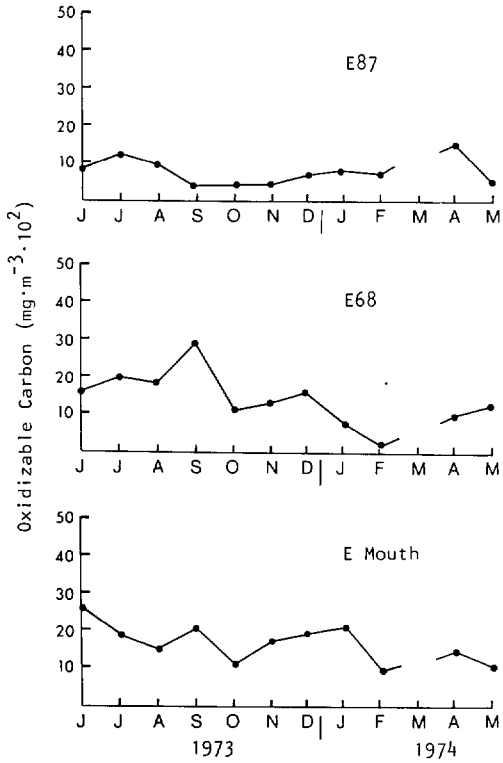

Fig. 30. Monthly mean oxidizable carbon concentrations in the E system (Mill Creek).

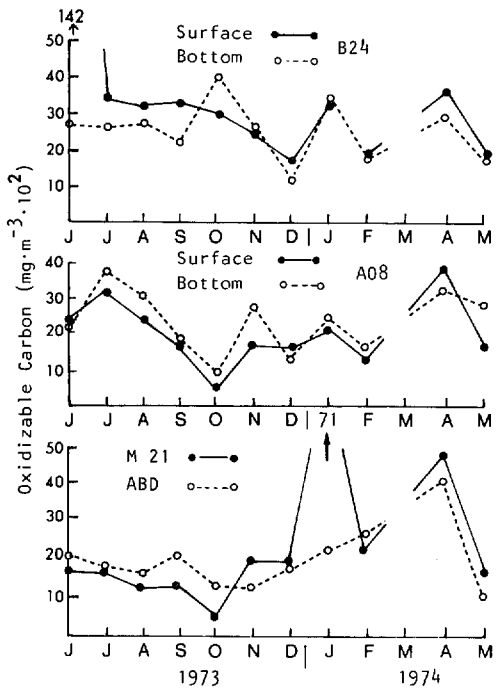

Fig. 31. Monthly mean oxidizable carbon concentrations at Lagoon B24, Lagoon A08, M 21, and ABD.

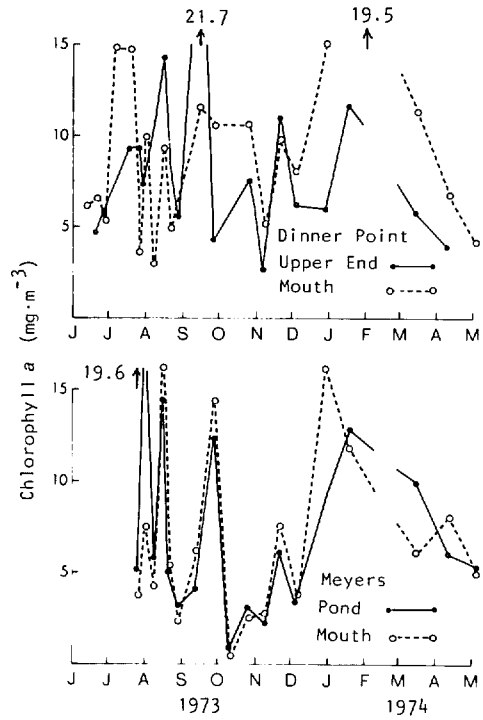

Fig. 32. Chlorophyll *a* concentrations in the Dinner Point and Meyers Creek systems.

(from June 1974 Annual Report)

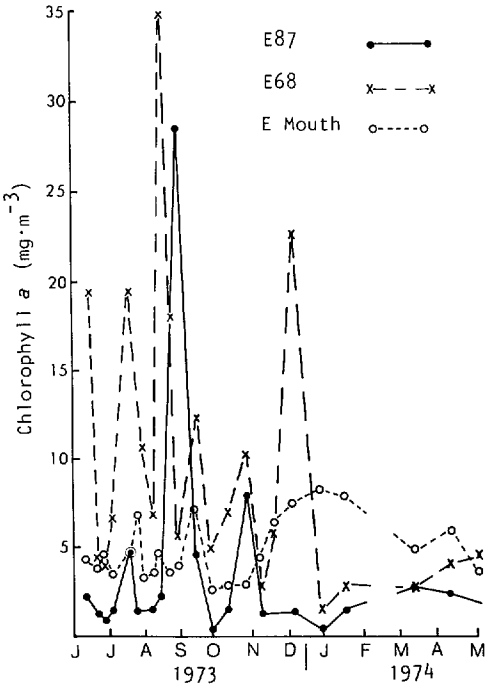

Fig. 33. Chlorophyll *a* concentrations in the E system (Mill Creek).

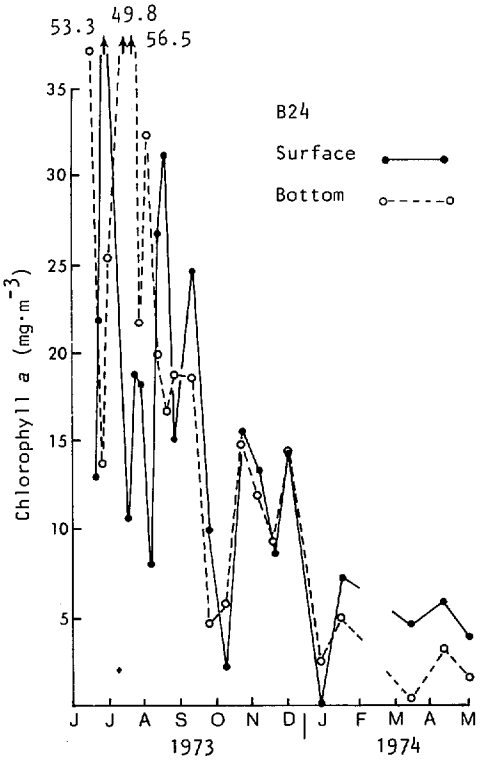

Fig. 34a. Chlorophyll *a* concentrations at Lagoon B24.

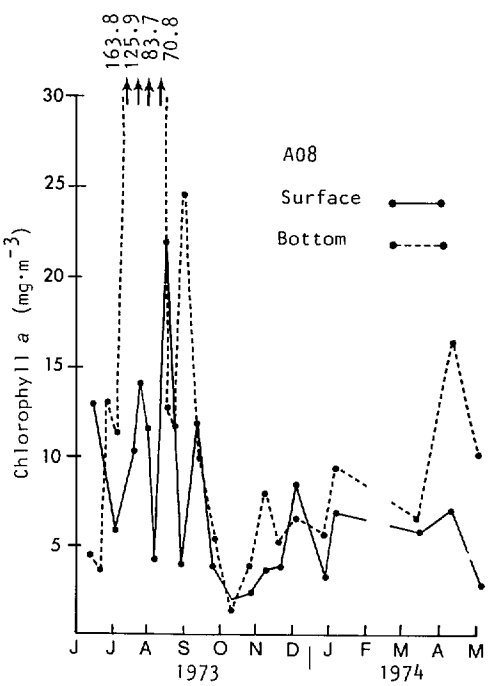

Fig. 34b. Chlorophyll *a* concentrations at Lagoon A08.

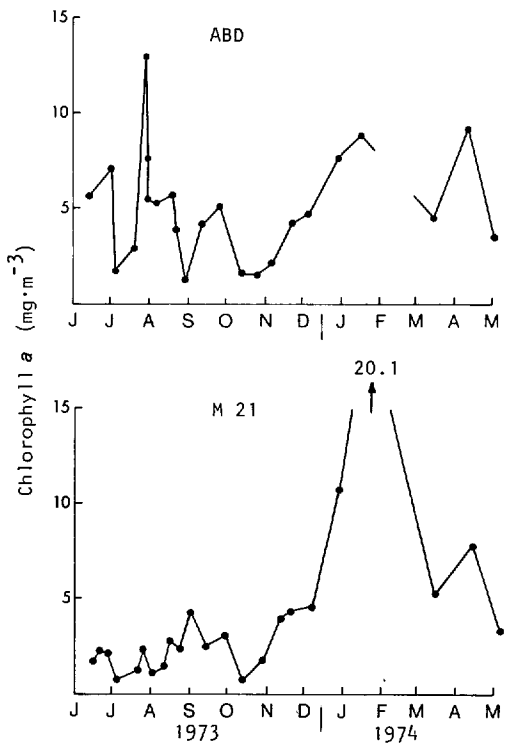

Fig. 35. Chlorophyll *a* concentrations at M 21 and ABD.

(from June 1974 Annual Report)

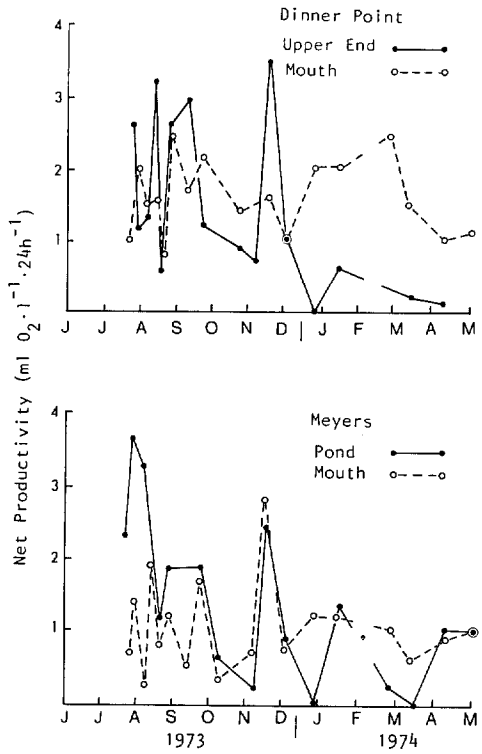

Fig. 36. Net productivity values in the Dinner Point and Meyers Creek systems.

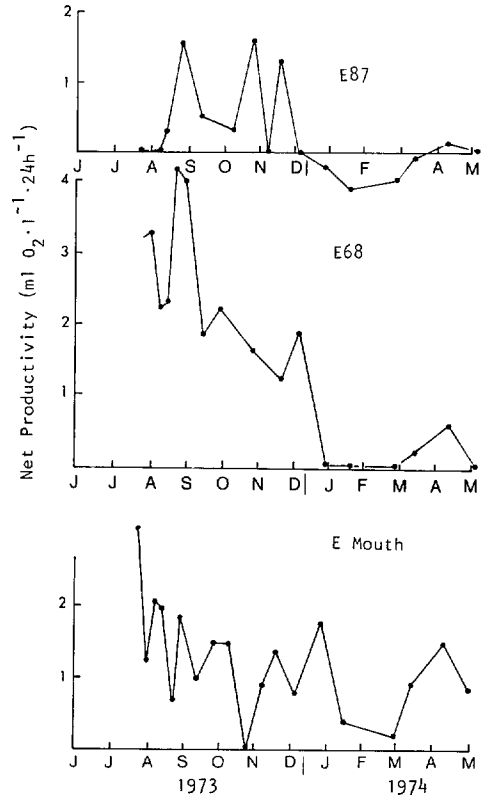

Fig. 37. Net productivity values in the E system (Mill Creek).

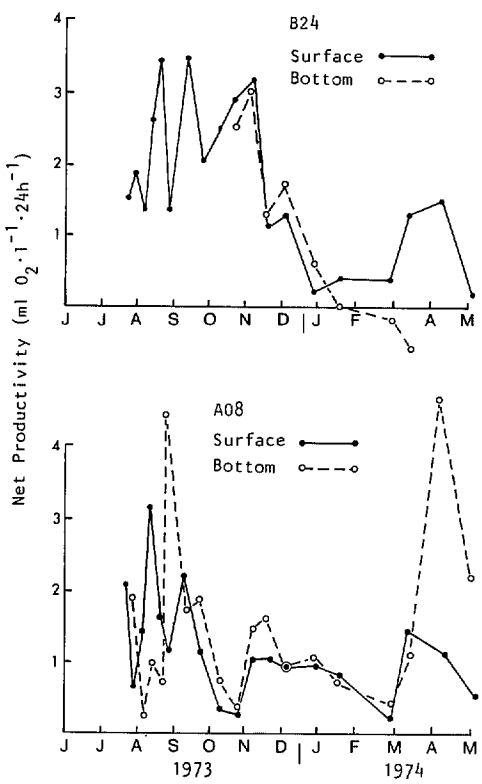

Fig. 38. Net productivity values at Lagoons B24 and A08.

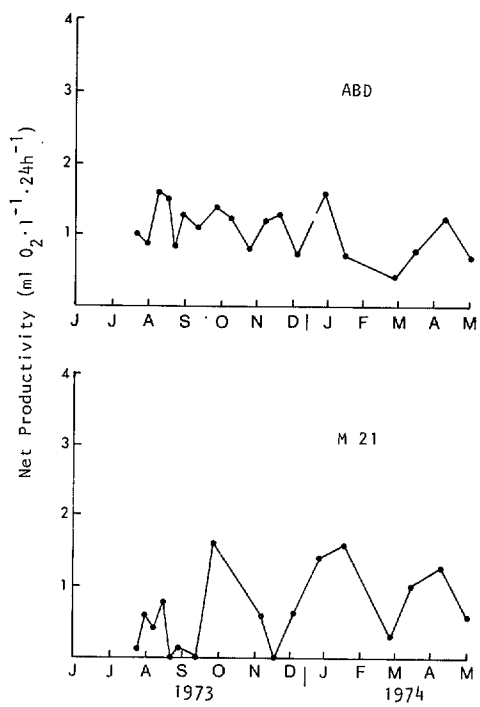

Fig. 39. Net productivity values at M 21 and ABD.

(from June 1974 Annual Report)

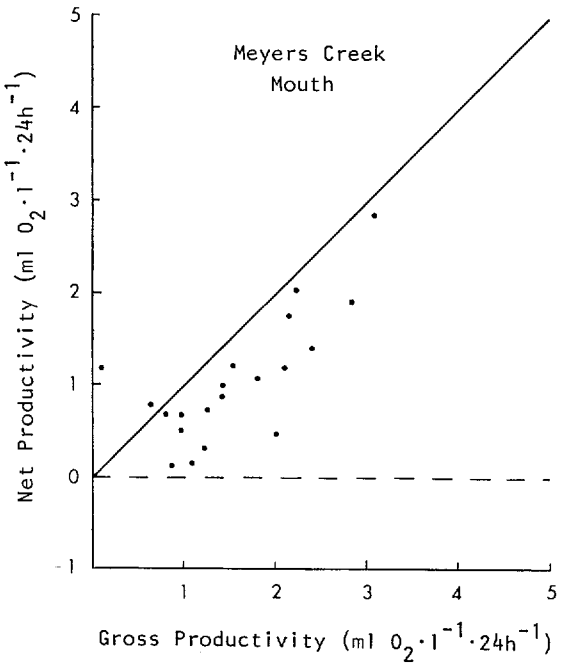

Fig. 40. Net production versus gross production at Meyers Creek mouth.

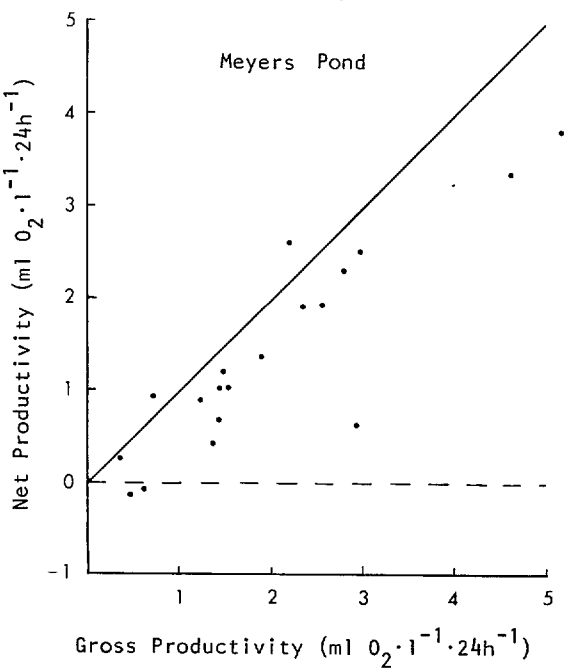

Fig. 41. Net production versus gross production at Meyers Pond.

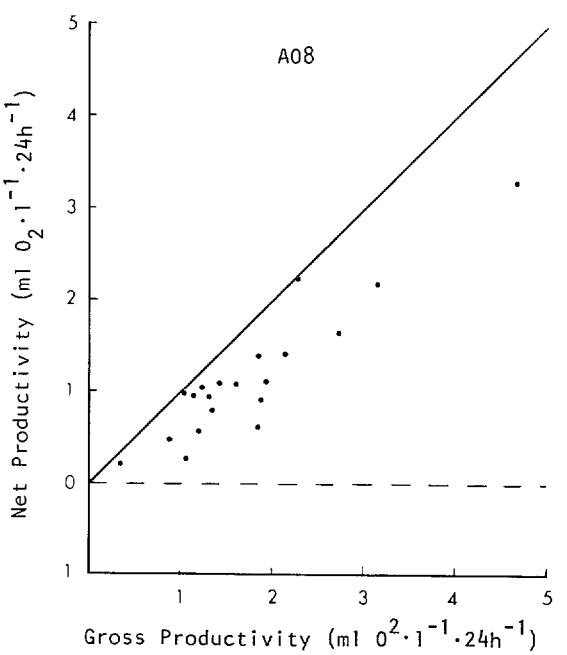

Fig. 42. Net production versus gross production at Lagoon A08.

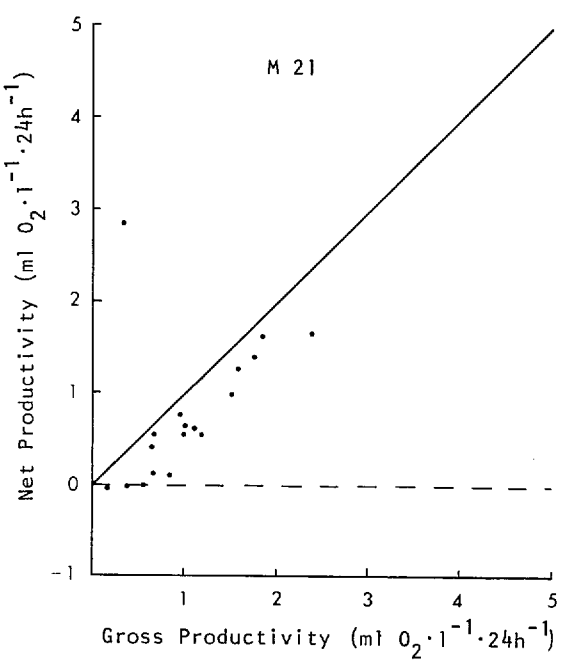

Fig. 43. Net production versus gross production at M 21.

(from June 1974 Annual Report)

Table 1. Surface water temperature (°C) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	23.0	20.9					20.8	23.0	22.7	21.2	22.8	23.2	19.2	22.0	10.5
Jul	23.6	22.8	23.9	23.8	23.4	24.0	23.9	24.7	24.1	23.3	24.0	24.8	20.0	24.9	10.6
Aug	24.8	24.6	24.9	24.4	24.9	24.7	24.4	24.5	24.8	24.5	24.3	25.5	21.9	25.0	10.8
Sep	19.2	18.9	19.8	19.3	19.4	18.5	19.7	18.6	19.3	20.0	19.8	21.5	21.0	20.2	10.3
Oct	12.9	13.0	15.5	15.3	15.7	15.0	16.0	15.9	16.1	15.1	15.2	16.5	16.4	15.8	11.6
Nov	5.2	4.4	5.7	5.3	5.3	3.9	5.9	5.6	6.6	6.6	6.0	7.6	8.0	7.9	8.7
Dec	5.8	7.6	6.0	7.7	6.0	7.8	6.0	6.1	7.5	8.4	6.2	7.3	5.0	7.3	6.5
Jan	2.0	2.0	1.5	1.5	1.5		1.5	1.9	2.5	3.5	1.2	1.2	6.0	2.5	8.0
Feb	3.6	4.0	3.2	5.0	2.5	3.6	0.5	2.5	3.5	3.8	1.4	2.5	2.5	2.5	5.5
Mar	5.0	4.8	5.0	5.8	4.5		4.0	6.5	7.8	8.1	6.1	7.6	6.7	7.4	6.3
Apr	10.2	10.5	10.0	11.0	9.0	10.0	7.0	9.5	9.7	9.8	7.8	8.8	8.0	8.5	7.6
May	18.5	22.6*	19.2	19.4	18.7	22.3*	16.0#	21.7	21.3	20.5	20.7	20.9	18.2	17.0#	8.5#

* No 5/2/74 sample

\# No 5/23/74 sample

(from June 1974 Annual Report)

Table 2. Surface salinity ($^{o}/_{oo}$) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	22.30	10.71					22.83	16.83	13.72	0.43	21.73	21.36	22.66	20.72	23.39
Jul	23.69	16.91	23.43	20.46	21.87	22.77	22.68	20.21	6.16	0.59	21.88	20.61	22.72	19.26	24.80
Aug	26.48	22.57	24.18	22.68	24.11	22.96	25.16	22.34	9.99	1.41	24.42	23.94	24.78	22.83	25.57
Sep	27.36	25.61	24.91	24.71	24.37	23.45	24.93	23.95	12.01	0.83	24.43	23.98	24.51	23.97	25.01
Oct	28.13	26.80	24.56	23.39	24.22	22.68	24.85	23.78	12.43	2.69	25.07	24.75	24.81	23.66	24.76
Nov	26.87	20.86	25.37	22.50	23.50	21.81	24.29	21.06	10.28	1.69	24.04	24.03	24.42	23.44	23.67
Dec	25.25	14.66	22.72	19.14	22.06	20.24	24.90	21.84	11.49	1.02	22.80	22.58	24.37	19.51	23.49
Jan	22.22	16.10	18.64	17.63	18.90		20.45	13.97	6.79	2.12	19.51	19.90	23.35	19.19	23.68
Feb	22.76	11.07	19.70	16.86	20.04	18.31	22.64	8.44	8.03	1.72	22.05	21.96	22.44	20.88	23.40
Mar	22.87	13.29	22.97	18.23	23.16		25.34	18.39	9.17	2.33	23.45	22.81	23.26	21.92	24.20
Apr	20.90	8.81	20.00	20.23	19.78	14.46	22.77	8.79	5.57	0.69	21.23	21.36	22.68	19.70	23.62
May	26.24	21.10	23.99	22.91	25.73	25.31	25.93	24.68	11.53	0.85	25.21	25.04	25.23	22.92	24.19

(from June 1974 Annual Report)

Table 3. Surface dissolved oxygen (ml $O_2 \cdot l^{-1}$) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	5.67	5.40					5.13	5.56	5.01	5.53	5.51	5.43	2.65	5.45	0.08
Jul	4.91	2.08	4.63	3.51	4.96	4.08	5.08	4.68	4.50	4.76	4.77	5.28	0.90	4.80	0.00
Aug	4.58	2.83	4.40	3.42	4.59	4.22	5.01	4.52	5.02	5.44	4.16	4.89	0.14	4.58	0.00
Sep	5.23	4.50	5.04	4.52	4.93	4.30	5.70	4.87	4.95	6.22	4.49	4.66	2.79	3.89	0.00
Oct	5.27	6.34	6.18	4.98	6.02	5.10	6.64	5.50	5.95	6.52	5.94	5.34	4.86	5.51	0.00
Nov	7.09	6.83	6.93	7.30	7.35	4.92	7.70	7.31	7.59	7.97	7.25	7.65	6.91	5.84	5.05
Dec	7.88	8.36	7.75	6.03	5.88	6.99	8.24	8.12	8.35	7.94	8.13	7.72	6.18	6.96	4.33
Jan	8.68	7.05	8.10	7.71	8.65		8.79	8.52	8.17	8.03	8.93	8.59	1.01	8.17	0.00
Feb	7.67	6.58	7.89	7.05	8.31	6.81	8.35	12.15	8.29	8.44	8.00	7.77	6.43	7.67	0.00
Mar	7.84	7.77	7.94	7.19	7.93		7.79	7.65	7.62	7.92	7.32	7.24	6.64	7.08	0.00
Apr	7.52	5.19	7.53	7.44	7.53	4.69	7.11	7.33	7.39	7.43	7.32	7.60	1.53	7.59	0.00
May	5.55	3.28	5.03	4.21	5.26	2.86	5.74	5.30	6.25	6.23	5.53	5.84	2.62	5.94	0.00

(from June 1974 Annual Report)

Table 4. Surface NH_3-N (μg-atom NH_3-N·l^{-1}) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	1.9	6.2					1.3	7.2	7.4	3.0	1.1	1.9	2.5	0.9	70.3
Jul	0.8	3.6	1.3	2.5	0.6	0.2	0.7	2.6	13.6	2.3	1.3	0.1	90.4	0.2	247.2 *
Aug	0.5	1.8	0.6	0.8	0.8	0.4	0.8	2.1	5.9	1.3	0.7	0.3	33.2	0.2	690.7 *
Sep	0.8	1.3	0.5	0.8	0.7	1.5	0.6	2.3	2.7	2.6	0.7	0.3	0.6	0.6	254.9 *
Oct	0.4	0.4	0.9	0.5	0.8	1.1	0.4	0.7	3.1	2.3	0.2	0.5	0.6	0.1	102.3
Nov	2.7	12.0	1.9	4.6	1.2	41.2	1.4	0.9	3.2	3.3	0.6	0.1	0.1	3.9	6.8
Dec	0.5	4.3	1.5	6.7	1.0	10.0	0.3	0.8	27.1	5.4	0.8	0.8	3.1	7.6	8.4
Jan	1.5	1.4	2.2	1.8	1.2		0.4	5.0	8.9	7.7	1.8	0.9	20.3	6.5	57.1
Feb	0.1	11.5	0.0	6.6	0.2	15.3	0.6	5.1	8.4	5.4	0.5	0.1	0.3	2.7	42.4
Mar	0.0	6.2	0.2	10.0	0.0		0.1	0.8	8.7	5.5	0.0	0.0	0.5	4.8	71.7
Apr	0.1	5.2	0.6	0.5	0.4	9.0	0.1	3.3	2.9	4.2	0.1	0.0	20.6	0.4	117.1
May	0.0		0.0	0.7	0.0		0.2	0.0	24.5	2.2	0.3	0.0	0.0	0.0	110.7

* No true mean can be calculated as some sample values exceeded the 350 μg-atom NH_3-N·l^{-1} limit of the method.

(from June 1974 Annual Report)

Table 5. NO_3-N as proportion of total inorganic-N.

Station	Mean NO_3-N / Mean total inorganic-N	Mean NO_3-N (μg-atom NO_3-N$\cdot l^{-1}$)	Mean NH_3-N (μg-atom NH_3-N$\cdot l^{-1}$)
E87	0.56	5.1	3.8
E68	0.45	7.9	10.0
E mouth	0.36	1.6	2.6
Meyers Creek mouth	0.44	0.7	1.0
M 21	0.42	0.7	0.6
Oyster Point Creek mouth	0.37	0.5	0.7
A08 surface	0.31	0.3	0.5
B24 surface	0.28	1.3	2.5
ABD	0.25	0.3	0.7
Dinner Point Creek mouth	0.28	0.3	0.9
Upper Dinner Point Creek	0.17	0.8	5.1
Meyers Pond	0.19	0.5	3.2
Oyster Point Pond	0.11	0.7	9.9

(from June 1974 Annual Report)

Table 6. Surface NO_3-N (μg-atom NO_3-N·l^{-1}) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	0.2	0.1					0.2	2.3	2.2	2.8	0.0	0.0	0.3	0.6	0.0
Jul	0.3	0.0	0.4	0.0	0.1	0.0	0.2	0.1	4.5	1.4	0.2	0.1	0.0	0.2	0.0
Aug	0.0	0.0	0.1	0.0	0.1	0.0	0.4	0.3	1.8	1.3	0.1	0.2	0.0	0.1	0.1
Sep	0.1	0.2	0.3	0.5	0.3	0.5	0.3	0.3	2.7	4.4	0.2	0.1	0.1	0.1	0.0
Oct	0.4	0.3	0.3	0.2	0.1	0.5	0.1	0.4	10.4	3.4	0.3	0.2	0.1	0.0	0.0
Nov	0.8	1.2	0.8	0.8	0.8	0.8	0.5	0.8	4.9	6.0	0.2	0.0	0.0	0.7	1.6
Dec	1.2	1.3	1.1	0.7	1.2	1.2	0.1	1.2	29.0	8.0	0.5	0.7	0.4	5.1	2.0
Jan	0.3	1.0	0.9	0.9	1.2		4.7	4.6	8.7	9.4	1.3	0.9	0.0	6.3	0.0
Feb	0.1	1.7	2.8	0.5	0.4	1.2	0.2	4.0	6.2	7.5	0.2	0.1	0.0	0.7	0.0
Mar	0.0	2.4	0.5	0.8	0.5		0.7	0.6	6.4	6.5	0.0	0.0	0.0	1.7	0.0
Apr	0.7	1.0	0.6	0.6	0.5	1.2	1.2	4.2	5.4	5.6	0.7	1.5	0.6	0.5	0.1
May	0.0		0.3	0.3	0.0		0.3	0.1	13.0	5.3	0.0	0.0	0.0	0.0	0.3

(from June 1974 Annual Report)

Table 7. Surface NO_2-N (µg-atom NO_2-N·l^{-1}) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	0.1	0.1					0.2	0.2	0.3	0.1	0.2	0.2	0.2	0.3	0.6
Jul	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.1	0.1	0.2	0.1	0.5
Aug	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.6
Oct	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Dec	0.1	0.0	0.3	0.0	0.2	0.2	0.1	0.1	0.8	0.1	0.1	0.1	0.1	0.3	0.3
Jan	0.1	0.1	0.1	0.0	0.2		0.0	0.1	0.0	0.1	0.0	0.1	0.4	0.3	0.0
Feb	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.1	0.0	0.1	0.1	0.0		0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0		0.0	0.0	0.1		0.0	0.1	0.9	0.0	0.0	0.0	0.0	0.0	0.0

(from June 1974 Annual Report)

Table 8. Surface total organic nitrogen (μg-atom Org-N·l^{-1}) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	31.8	49.9					38.8	33.8	28.9	16.8	37.5	41.7	39.3	83.0	*
Jul	37.6	63.0	38.5	48.2	33.5	87.4	31.3	36.5	36.9	22.0	39.0	47.7	63.2	63.0	*
Aug	36.2	60.1	38.3	39.5	28.9	77.1	31.1	28.2	37.3	28.4	43.6	58.2	60.6	61.7	*
Sep	35.7	46.0	47.9	47.6	42.9	61.7	30.3	43.3	28.9	14.0	42.0	45.1	47.3	61.6	*
Oct	38.5	42.8	33.0	36.9	31.5	43.2	29.2	34.7	47.3	21.6	31.6	38.6	34.3	57.5	43.6
Nov	40.3	46.4	32.1	34.3	30.1	34.5	37.8	35.4	28.5	5.5	26.2	28.2	31.0	43.0	51.3
Dec	34.4	61.8	36.7	31.6	35.7	38.4	37.2	41.1	29.9	9.9	25.6	27.3	29.5	34.4	31.0
Jan	36.6	45.8	39.3	38.7	28.0		53.5	21.1	14.3	14.2	30.3	27.9	36.9	34.2	33.2
Feb	86.1	44.2	86.2	50.1	63.8	64.0	24.5	19.8	14.0	9.6	24.9	30.0	27.5	36.5	33.1
Mar	62.0	54.9	46.5	70.6	48.8		61.0	35.0	23.4	35.5	35.2	34.8	31.2	31.5	20.2
Apr	43.2	49.1	51.6	43.8	37.3	48.8	37.2	25.4	18.5	12.5	31.2	29.0	33.8	31.6	24.0
May	40.6		35.7	45.1	32.2		36.2	31.9	38.6	15.1	38.6	29.8	47.8	37.9	16.5

* No true mean can be calculated as some sample values exceeded the 350 μg-atom Org-N·l^{-1} limit of the method.

(from June 1974 Annual Report)

Table 9. Surface soluble organic nitrogen (μg-atom Soluble Org-N·l^{-1}) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	24.3	45.5					25.0	28.3	23.7	15.1	23.6	27.2	27.5	43.2	*
Jul	26.9	52.1	31.0	42.4	30.5	61.1	25.9	31.6	28.6	19.7	30.4	36.6	51.2	41.5	*
Aug	26.0	42.2	31.1	33.2	23.2	48.3	31.4	31.8	30.0	20.5	36.0	33.5	35.8	37.7	*
Sep	20.1	28.8	33.4	29.3	31.6	40.8	28.4	32.2	15.0	7.5	32.0	36.7	30.1	36.5	*
Oct	27.3	25.5	25.4	29.2	26.3	30.3	25.9	32.1	30.9	13.3	26.6	27.5	26.8	33.5	19.7
Nov	19.7	31.1	24.4	21.7	21.3	19.3	22.9	27.0	23.0	4.9	21.4	27.2	27.2	28.3	31.9
Dec	14.8	31.8	17.3	25.6	16.1	23.9	29.2	23.4	11.2	8.7	10.1	17.2	22.3	19.9	20.1
Jan	13.2	23.4	29.9	26.7	18.3		18.5	10.2	14.8	9.5	17.3	17.8	22.0	19.5	22.0
Feb	18.0	35.2	22.1	26.8	13.8	43.4	15.1	9.7	9.1	6.2	16.5	15.9	14.4	22.2	22.8
Mar	13.2	28.5	29.8	22.4	15.1		15.7	12.1	10.3	11.0	19.3	12.8	14.0	15.2	18.1
Apr	16.4	33.5	13.2	21.2	15.4	30.1	15.9	15.2	11.2	9.0	17.6	10.7	20.6	12.2	16.7
May	25.9		28.4	37.7	26.2		27.3	19.3	25.5	7.6	34.2	24.3	23.7	23.4	11.2

* No true mean can be calculated as some sample values exceeded the 350 μg-atom Soluble Org-N·l^{-1} limit of the method.

(from June 1974 Annual Report)

Table 10. Surface particulate organic nitrogen (μg-atom Particulate Org-N·l^{-1}) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Creek Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	7.5	4.5					13.9	5.5	11.2	5.3	14.0	14.5	11.8	39.8	*
Jul	10.7	10.9	7.6	5.9	3.1	26.3	5.3	5.6	8.3	2.3	9.0	11.2	12.0	21.6	*
Aug	10.3	17.9	7.2	6.4	5.7	28.8	1.0	0.0	14.2	7.9	12.4	24.7	24.8	24.0	*
Sep	15.6	17.2	14.5	18.3	11.3	20.9	2.3	11.1	14.0	6.5	9.5	8.4	17.2	25.1	*
Oct	11.3	17.3	7.6	7.7	5.2	12.9	3.9	2.9	16.4	8.3	5.6	11.2	7.5	24.0	24.0
Nov	20.6	15.3	7.8	12.6	8.8	15.3	15.4	8.5	5.6	0.6	4.9	5.7	5.0	14.8	19.4
Dec	19.6	30.1	19.4	7.5	19.6	14.5	8.1	17.7	18.7	2.4	15.5	10.1	7.2	14.5	10.9
Jan	23.4	22.4	9.4	12.0	9.7		35.0	10.9	0.0	4.7	13.0	10.1	14.9	14.7	11.2
Feb	68.1	9.0	64.1	23.3	50.0	20.6	9.4	10.1	4.9	3.4	8.4	14.1	13.1	14.3	10.3
Mar	48.8	26.4	16.7	48.2	33.7		45.3	22.9	13.1	24.5	15.9	22.0	17.2	16.3	2.1
Apr	26.8	15.6	38.4	22.6	21.9	18.7	21.3	10.2	7.3	3.5	13.6	18.3	13.2	19.4	7.3
May	14.7		7.3	7.4	6.0		8.9	12.6	13.1	7.5	4.4	5.5	24.1	14.5	5.3

* No true mean particulate organic nitrogen can be calculated because some total and soluble organic nitrogen values exceeded the limits of the method.

Note: Individual negative values of particulate organic nitrogen between 0 and -3.5 were taken as 0 in calculating the means, while all negative values were discarded.

(from June 1974 Annual Report)

Table 10a. Surface particulate organic nitrogen (μg-atom Particulate Org-N·l^{-1}) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Date	Direct Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/13	10.1						3.0	1.2	16.5	4.9		6.8	13.8		
6/20	9.3	5.2					30.3	10.4	5.8	5.6	21.9	23.2	13.0	29.3	14.9
6/25	3.1	3.7					8.3	4.8	-6.7	-5.5	6.0	13.5	8.6	50.3	66.0
7/2	11.7						1.8	4.3	10.9	2.5	1.6	20.0	5.2	8.2	7.8
7/17	9.8	2.3			4.1		11.5	7.7	7.0	0.4	-0.7	2.9	2.6	27.2	-42.2
7/23 7/24	13.5	17.3	4.4	2.4			0.6	10.5	7.0	3.9	28.7	3.2		22.7	11.5
7/30 7/31	7.9	13.2	10.7	9.3	2.0	26.3	7.4	-2.8	8.1		5.5	18.6	28.3	28.1	96.8
8/6 8/7	3.2	13.8	6.4	10.1	2.6		-2.4	-6.8	-13.6	1.1	6.7	19.0	22.7	13.5	25.4
8/13 8/14	13.6	29.6	15.1	3.9	6.6	32.6	-2.7	-2.5	13.0	9.5	8.5	30.3	34.5	36.5	25.0
8/20 8/21	10.0	9.8	2.3	7.9	8.5	48.8	3.9	-1.4	22.8		22.0	16.0	10.3	20.4	9.6
8/27 8/28	14.2	18.3	5.0	3.5	5.1	5.0	0.2	-3.5	6.7	13.0	-6.6	33.5	31.8	25.4	-25.4
9/11 9/13	18.8	19.6	11.0	9.2	11.9	28.6	-0.8	12.9	24.0	9.1	6.5	6.1	14.3	30.1	24.3

Table 10a. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
9/25 9/26	12.3	14.7	18.0	27.4	10.7	13.2	4.6	9.3	3.9	3.8	12.4	10.6	20.1	20.0	-23.3
10/9 10/10	8.7		10.4	9.9	6.1	22.0	7.7	5.7	15.1	4.9	11.2	5.2	10.5	28.0	9.5
10/24 10/25	13.8	17.3	4.8	5.4	4.2	3.8	-1.1	-0.5	17.6	11.7	-1.3	17.1	4.4	19.9	33.7
11/7 11/8	15.0	7.1	3.3	6.4	3.0	22.5	30.8	5.8	3.5	0.3	4.7	5.7	9.9	15.3	22.1
11/19 11/20	26.1	23.5	12.2	18.8	14.5	8.0	-1.0	11.1	7.6	0.9	5.0	-3.6	-2.3	14.2	16.7
12/4	9.6	17.9	6.5	15.0	10.8	13.5	14.3	6.2	19.9	-2.2	19.7	11.2	8.5	19.1	18.0
12/27	29.6	42.2	32.2	-2.9	28.3	15.5	1.8	29.1	17.5	4.7	11.3	9.0	5.9	9.8	3.7
1/17	23.4	22.4	9.4	12.0	9.7		35.0	10.9	-0.5	4.7	13.0	10.1	14.9	14.7	11.2
2/28	68.1	9.0	64.1	23.3	50.0	20.6	9.4	10.1	4.9	3.4	8.4	14.1	13.1	14.3	10.3
3/14	48.8	26.4	16.7	48.2	33.7		45.3	22.9	13.1	24.5	15.9	22.0	17.2	16.3	2.1
4/11	26.8	15.6	38.4	22.6	21.9	18.7	21.3	10.2	7.3	3.5	13.6	18.3	13.2	19.4	7.3
5/2	14.7		7.3	7.4	6.0		8.9	12.6	13.1	7.5	4.4	5.5	24.1	14.5	5.3

(from June 1974 Annual Report)

Table 11. Surface particulate oxidizable carbon ($mg \cdot m^{-3}$) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	2,018	1,770					1,649	2,629	1,637	852	2,017	2,342	2,123	14,206	2,666
Jul	2,261	1,858	1,174	2,705	2,489	2,814	1,587	1,753	2,023	1,341	1,735	3,067	3,652	3,410	2,612
Aug	1,813	2,271	1,906	1,346	1,049	3,905	1,106	1,508	1,855	984	1,519	2,411	2,969	3,187	2,725
Sep	2,615	3,286	2,822	3,843	2,853	3,434	1,214	2,042	3,019	375	1,998	1,717	1,776	3,322	2,206
Oct	3,698	4,783	1,341	2,171	1,616	2,959	417	1,113	1,201	384	1,244	507	913	2,966	3,946
Nov	3,644	2,762	2,907	2,671	2,670	4,422	1,889	1,720	1,411	376	1,246	1,720	2,697	2,544	2,623
Dec	2,335	1,407	2,336	2,199	1,667	2,178	1,945	1,883	1,740	662	1,671	1,626	1,282	1,675	1,221
Jan	3,031	2,378	2,564	3,031	979		7,087	2,072	785	785	2,198	2,104	2,407	2,261	2,355
Feb	10,418	3,201	12,125	2,894	2,199	3,909	2,189	923	171	684	2,633	1,334	1,607	1,925	1,847
Mar															
Apr	3,660	3,172	4,793	3,813	3,348	2,507	4,793	1,495	1,037	1,464	4,104	3,821	3,222	3,630	2,867
May	2,257		1,434	2,135	1,525		1,739	1,098	1,342	427	1,007	1,708	2,776	1,830	1,708

(from June 1974 Annual Report)

Table 12. Surface chlorophyll *a* ($mg \cdot m^{-3}$) except where noted. Monthly averages for all stations from June 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jun	6.07	5.31					1.90	4.15	9.07	1.34	6.46	10.66	6.99	17.50	25.40
Jul	10.85	8.79	5.75	12.43	5.38	30.86	1.20	4.32	12.52	2.42	5.77	10.37	96.11	25.34	38.40
Aug	5.88	9.96	4.68	7.27	8.13	23.41	2.63	3.83	16.27	10.70	4.07	10.94	29.92	20.32	22.00
Sep	11.13	12.98	10.49	8.46	6.61	10.06	2.68	4.74	8.52	2.21	4.74	7.90	7.55	17.57	11.71
Oct	10.67	7.75	1.59	1.89	2.54	2.86	1.08	2.72	8.43	4.62	1.64	2.06	2.47	11.42	10.38
Nov	7.76	7.00	5.29	4.40	3.74	4.93	4.01	5.14	4.24	1.15	3.22	3.54	6.46	11.05	10.64
Dec	11.62	6.18	10.14	6.53	7.08	5.29	7.50	7.69	12.00	0.58	6.35	5.56	5.83	7.59	8.49
Jan	19.51	11.79	12.14	13.03	9.52		20.08	7.72	2.69	1.40	9.15	6.90	9.32	7.41	4.99
Feb															
Mar	11.58	5.95	6.26	10.08	6.96		5.08	4.71	2.45	2.56	4.66	5.74	6.31	4.54	0.43
Apr	6.86	4.02	8.18	6.21	6.95	4.04	7.85	5.76	3.89	2.17	9.45	7.10	16.30	5.81	3.06
May	7.08	10.20	5.53	5.82	4.07	9.12	3.07	5.00	9.51	1.81	4.92	5.55	10.04	3.89	1.60

(from June 1974 Annual Report)

Table 12a. Surface chlorophyll *a* ($mg \cdot m^{-3}$) except where noted, from June 1973 to May 1974.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/13	6.15						1.79	4.23	19.21	2.09		12.99	4.43		
6/20	6.61	4.73					1.97	3.66	4.21	1.05	5.75	10.57	3.49	12.91	37.11
6/25	5.44	5.89					1.93	4.56	3.79	0.88	7.16	8.42	13.04	22.08	13.68
7/2	14.78						0.73	3.18	6.60	1.41	1.59	5.61	11.06	53.25	25.41
7/17	14.98	9.50			5.71		1.15	4.27	19.34	4.69	2.97	10.22	163.84*	10.47	49.75
7/23 7/24	3.57	9.45	3.92	5.26	3.89		1.95	6.68		1.17	13.13	14.11	125.85	19.32	56.50
7/30 7/31	10.05	7.43	7.58	19.59	6.55	30.86	0.97	3.14	11.61		5.38	11.52	83.68	18.30	21.93
8/6 8/7	2.89	10.95	4.27	5.86	1.87		1.45	3.41	6.68	1.47	5.44	4.24	70.79	7.92	32.36
8/13 8/14	9.17	14.51	6.48	15.03	21.94	7.50	2.57	4.63	34.77	2.22	5.78	21.98	12.66	26.94	19.97
8/20 8/21	4.89	8.80	5.56	5.06	6.41	58.22	2.19	3.52	18.34		3.91	13.83	11.59	31.52	16.77
8/27 8/28	6.56	5.59	2.39	3.12	2.30	4.52	4.29	3.74	5.28	28.41	1.15	3.72	24.62	14.90	18.90
9/11 9/13	11.54	21.69	6.33	4.32	4.11	10.84	2.37	7.05	12.26	4.41	4.24	11.92	9.79	25.13	18.74

Table 12a. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
9/25 9/26	10.72	4.26	14.65	12.59	9.10	9.28	2.99	2.42	4.78	0.00	5.24	3.87	5.31	10.00	4.68
10/9 10/10			0.37	0.58	2.43	1.80	0.54	2.65	6.75	1.39	1.60	1.91	1.29	7.23	5.76
10/24 10/25	10.67	7.75	2.81	3.19	2.64	3.91	1.62	2.79	10.11	7.84	1.67	2.21	3.65	15.60	15.00
11/7 11/8	5.09	2.66	2.92	2.47	1.77	2.84	3.66	4.09	2.81	1.10	2.27	3.44	7.88	13.44	11.97
11/19 11/20	10.42	11.34	7.65	6.33	5.71	7.01	4.36	6.18	5.66	1.19	4.16	3.64	5.03	8.65	9.30
12/4	8.08	6.30	3.82	3.67	4.54	3.96	4.43	7.30	22.65	1.15	4.86	8.25	6.38	14.41	14.45
12/27	15.16	6.06	16.45	9.38	9.62	6.62	10.52	8.08	1.34	.00	7.83	2.86	5.28	0.77	2.52
1/17	19.51	11.79	12.14	13.03	9.52		20.08	7.72	2.69	1.40	9.15	6.90	9.32	7.41	4.99
2/28															
3/14	11.58	5.95	6.26	10.08	6.96		5.08	4.71	2.45	2.56	4.66	5.74	6.31	4.54	0.43
4/11	6.86	4.02	8.18	6.21	6.95	4.04	7.85	5.76	3.89	2.17	9.45	7.10	16.30	5.81	3.06
5/2	4.26		5.16	5.53	3.11		3.07	3.59	4.46	1.92	3.76	2.84	9.94	3.89	1.60
5/23	9.89	10.20	5.90	6.10	5.03	9.12		6.41	14.55	1.70	6.08	8.25	10.14		

* Limits of method exceeded.

(from June 1974 Annual Report)

Table 13. Surface net productivity (ml $O_2 \cdot l^{-1} \cdot 24h^{-1}$) except where noted. Monthly averages for all stations from July 1973 to May 1974.

Month	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
Jul	1.52	1.52	1.06	2.99	1.30	3.22	0.38	2.13	3.27	-0.06	0.95	1.35	0.96	1.70	0.00
Aug	1.59	1.93	1.01	2.09	1.18	4.62	0.33	1.66	1.03	0.43	1.30	1.81	1.56	2.16	0.00
Sep	1.97	2.12	1.11	1.87*	1.91	2.87	0.81	1.24	2.02	0.52*	1.21	1.63	1.74	2.78	0.00
Oct	1.37	0.94	0.34*	0.58*	0.77	0.02	-3.12*	0.60	1.56*	0.95	1.00	0.23	0.49	2.70	1.27
Nov	-0.53	2.07	1.74	1.34	1.19	1.68	0.27	1.15	1.16*	0.62	1.24	0.97	1.50	2.17	2.17
Dec	1.50	0.45	0.96	0.35	1.25	0.87	0.98	1.31	0.88	-0.08	1.16	0.93	0.94	0.73	1.15
Jan	1.95	0.60	1.10	0.65	1.13		1.63	0.36	-0.20	-0.50	0.65	0.76	0.65	0.38	-0.01
Feb	2.46	*	2.00	0.38	1.00	0.58	0.54	0.40	0.02	-0.82	0.70	0.46	0.76	0.76	-0.14
Mar	1.50	0.23	0.55	-0.10	0.84		0.99	0.88	0.17	-0.14	0.83	1.35	1.05	1.29	-0.55
Apr	0.98	0.09	0.90	0.98	0.76	0.20	1.26	1.50	0.56	0.11	1.33	1.05	4.48	1.50	0.00
May	2.31	1.81	0.58	1.15	0.68	2.00	0.61	0.79	1.36	-0.08	0.71	0.71	1.89	0.24	0.00

* Production experiments with respiration values less than -0.12 ml $O_2 \cdot l^{-1} \cdot 24\ h^{-1}$ were discarded from monthly mean determinations.

(from June 1974 Annual Report)

Table 13a. Surface net production (ml $O_2 \cdot l^{-1} \cdot 24h^{-1}$) except where noted, from June 1973 to May 1974.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
7/23 7/24	1.01	2.56	0.74	2.26			0.14	3.09	3.24	-0.06	0.98	2.11	0.00	0.52	0.00
7/30 7/31	2.03	1.06	1.38	3.71	1.30	3.22	0.61	1.17	3.29		0.91	0.59	1.91	1.88	0.00
8/6 8/7	1.53	1.30	0.19	3.26	0.44		0.44	2.08	2.23	-0.62	1.55	1.37	0.15	1.27	0.00
8/13 8/14	1.60	3.21	1.89		1.64	7.07	0.76	1.98	2.26	0.28	1.50	3.17	1.00	2.58	0.00
8/20 8/21	0.75	0.58	0.75	1.14	1.18	2.56	0.01	0.67	4.24		0.81	1.60	0.68	3.46	0.00
8/27 8/28	2.48	2.63	1.20	1.87	1.46	4.22	0.10	1.90	4.07	1.63	1.33	1.10	4.41	1.34	0.00
9/11 9/13	1.71	3.00	0.49	2.56	1.71	3.55	0.00	1.02	1.80	0.52	1.05	2.18	1.70	3.53	0.00
9/25 9/26	2.22	1.24	1.73	1.87	2.11	2.18	1.61	1.46	2.24	-0.37	1.37	1.07	1.78	2.03	0.00
10/9 10/10			0.34	0.58	0.22	0.90	-3.12	1.48	2.08	0.33	1.20	0.25	0.67	2.51	0.00

Table 13a. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	Meyers Creek mouth	Meyers Pond	Oyster Point Creek mouth	Oyster Point Pond	M 21	E mouth	E68	E87	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
10/24 10/25	1.37	0.94	0.81	0.90	1.31	-0.87	2.81	-0.28	1.56	1.56	0.79	0.20	0.30	2.88	2.53
11/7 11/8	-2.66	0.65	0.73	0.23	0.57	-0.21	0.55	0.88	4.82	-0.07	1.17	0.96	1.40	3.21	3.04
11/19 11/20	1.60	3.48	2.75	2.45	1.80	3.57	-0.02	1.41	1.16	1.31	1.31	0.98	1.60	1.13	1.29
12/4	1.04	0.99	0.70	0.85	0.61	0.54	0.57	0.81	1.89	0.04	0.72	0.92	0.93	1.26	1.69
12/27	1.95	-0.09	1.22	-0.15	1.88	1.20	1.38	1.80	-0.14	-0.19	1.59	0.94	0.95	0.20	0.61
1/17	1.95	0.60	1.10	0.65	1.13		1.63	0.36	-0.20	-0.50	0.65	0.76	0.65	0.38	-0.01
2/28	2.46	4.78	2.00	0.38	1.00	0.58	0.54	0.40	0.02	-0.82	0.70	0.46	0.76	0.76	-0.14
3/14	1.50	0.23	0.55	-0.10	0.84		0.99	0.88	0.17	-0.14	0.83	1.35	1.05	1.29	-0.55
4/11	0.98	0.09	0.90	0.98	0.76	0.20	1.26	1.50	0.56	0.11	1.33	1.05	4.48	1.50	0.00
5/2	1.14		1.00	0.99	0.53		0.61	0.88	-0.08	-0.04	0.73	0.54	2.13	0.24	0.00
5/23	3.47	1.81	0.16	1.30	0.83	2.00		0.69	2.80	-0.11	0.69	0.88	1.65		

(from June 1974 Annual Report)

APPENDIX B

Tables and Figures from the June 1975 Estuarine Evaluation Study Annual Report: Primary Aquatic Productivity

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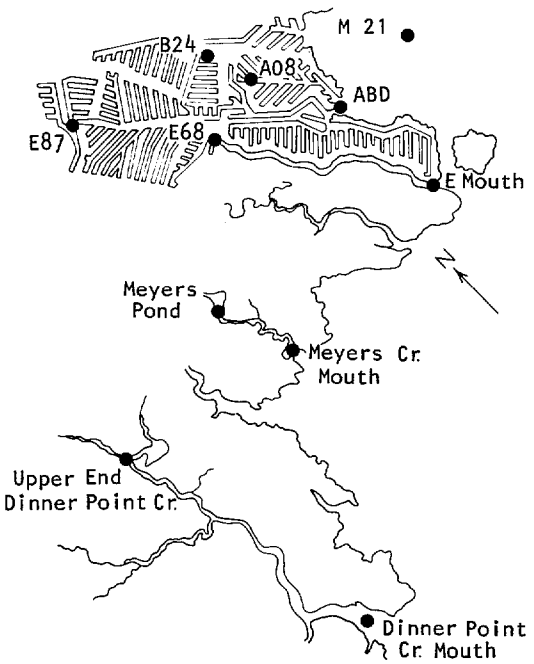

Fig. 1. Station locations.

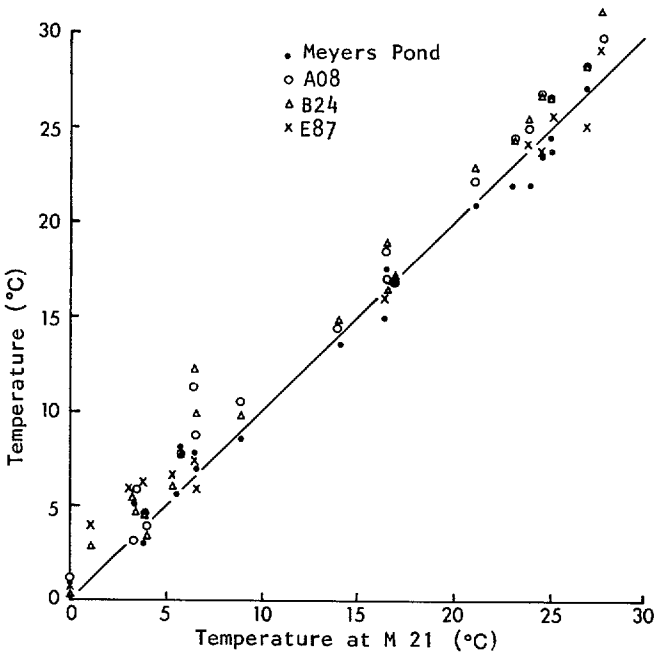

Fig. 2. Surface water temperature: Meyers Pond, A08, B24, E87, versus M 21.

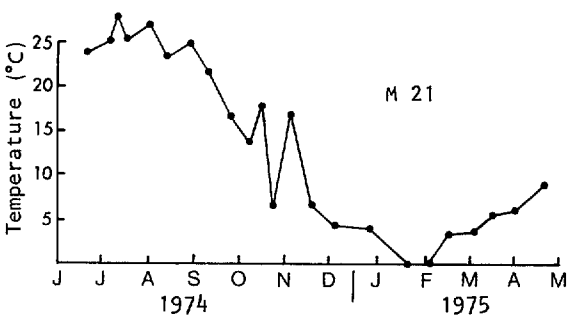

Fig. 3. Seasonal water temperature at M 21 surface.

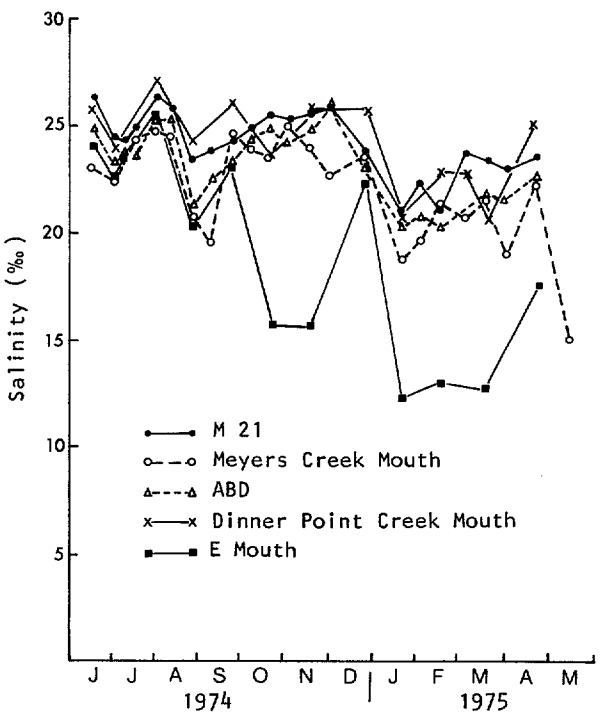

Fig. 4. Surface salinity levels at the mouths of the major systems.

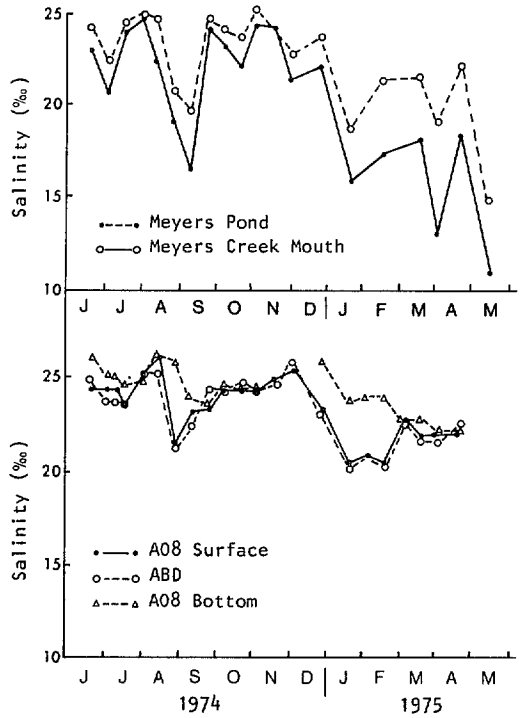

Fig. 5. Salinity levels at Meyers Pond, Meyers Creek mouth, A08, and ABD.

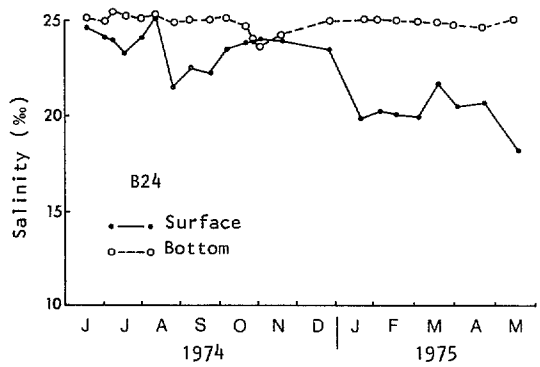

Fig. 6. Salinity levels at the surface and bottom of Lagoon B24.

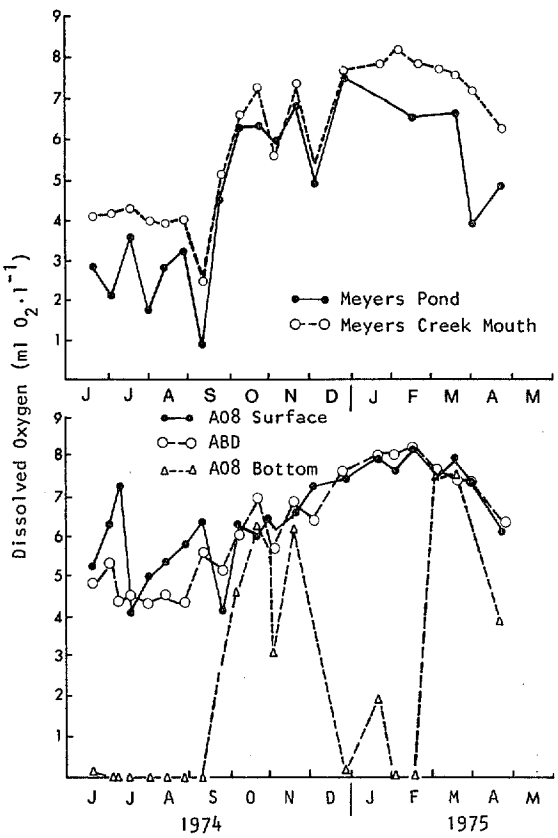

Fig. 7. Dissolved oxygen concentrations at Meyers Pond, Meyers Creek mouth, A08, and ABD.

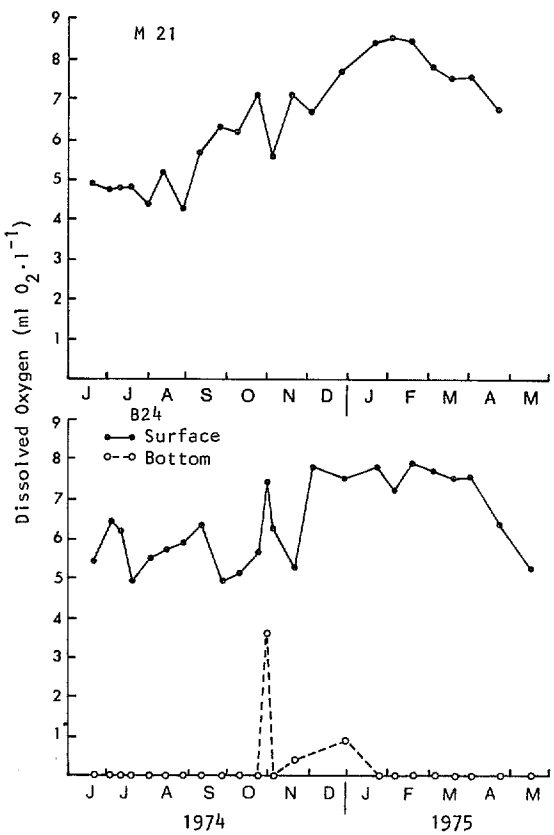

Fig. 8. Dissolved oxygen concentrations at M 21 and Lagoon B24.

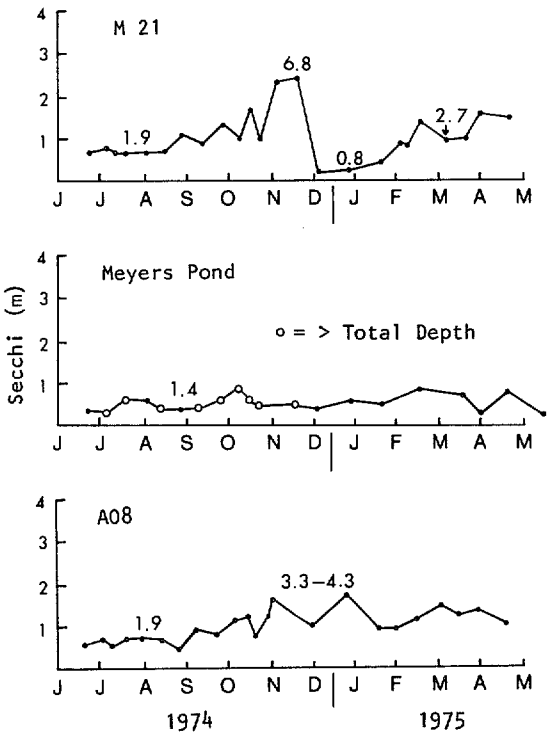

Fig. 9. Secchi disc readings at M 21, Meyers Pond, and Lagoon A08.

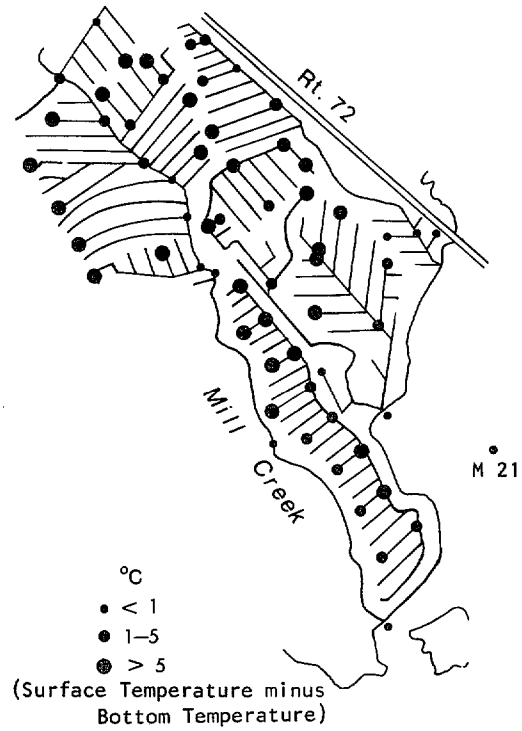

Fig. 10. Temperature stratification (surface temperature minus bottom temperature) in the lagoon systems on 9 July 1974.

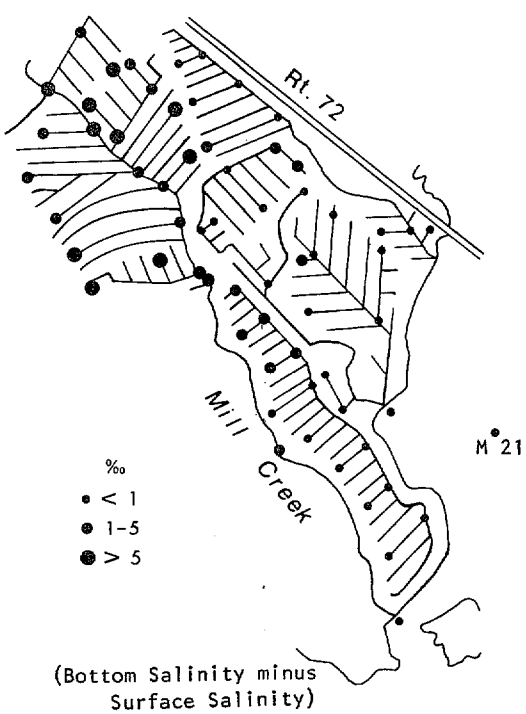

Fig. 11. Salinity stratification (bottom salinity minus surface salinity) in the lagoon systems on 9 July 1974.

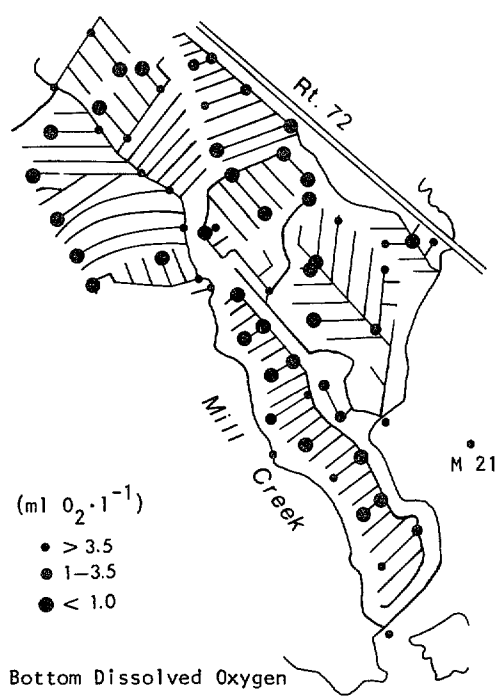

Fig. 12. Dissolved oxygen concentrations at the bottom of the lagoon systems on 9 July 1974.

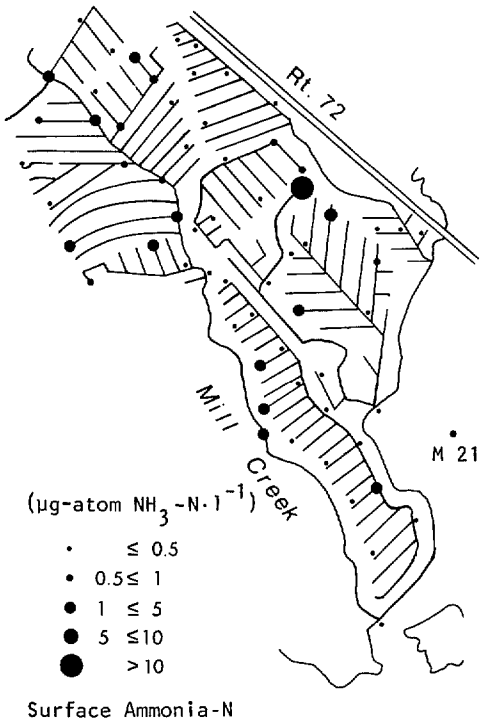

Fig. 13a. Surface NH_3-N concentrations in the lagoon systems on 9 July 1974.

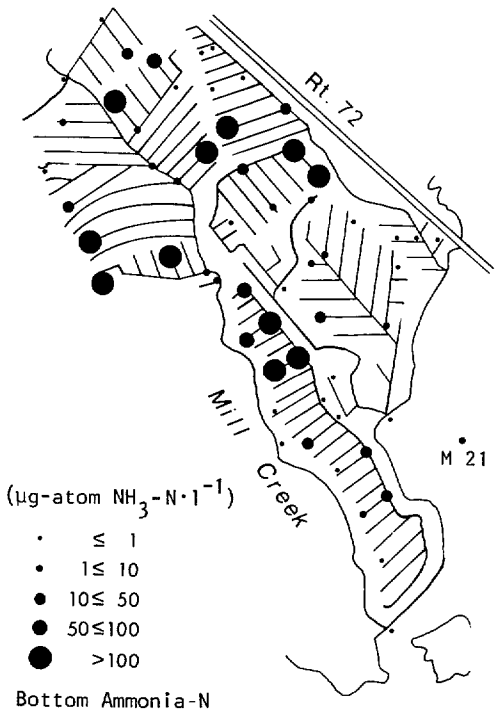

Fig. 13b. NH_3-N concentrations at the bottom of the lagoon systems on 9 July 1974.

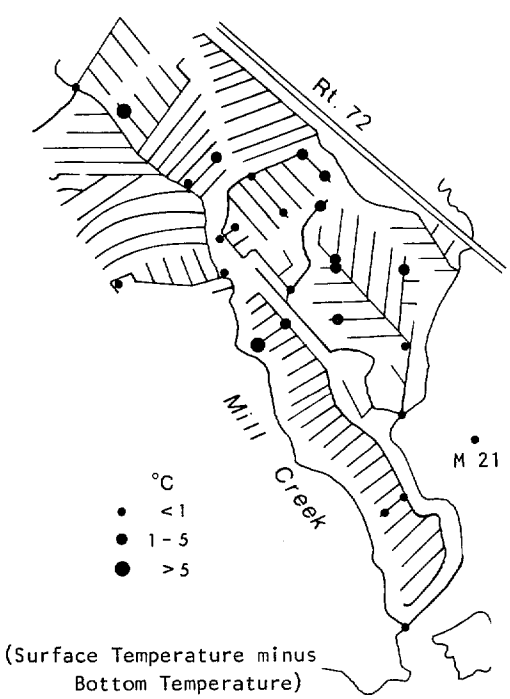

Fig. 14. Temperature stratification (surface temperature minus bottom temperature) in the lagoon systems on 8 February 1975. Absolute value of the difference is indicated.

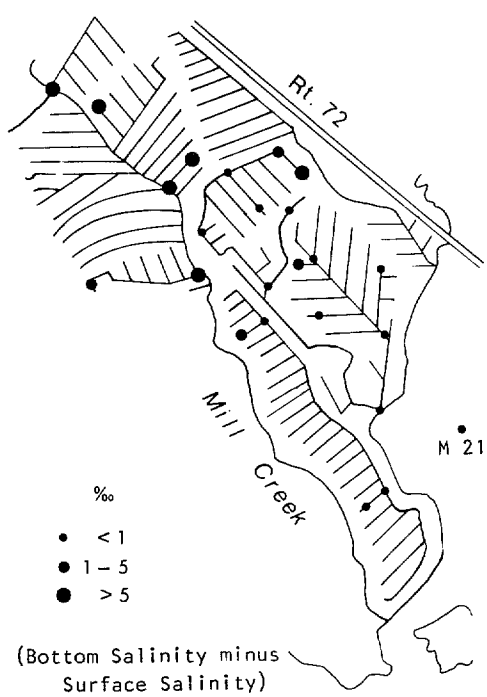

Fig. 15. Salinity stratification (bottom salinity minus surface salinity) in the lagoon systems on 8 February 1975.

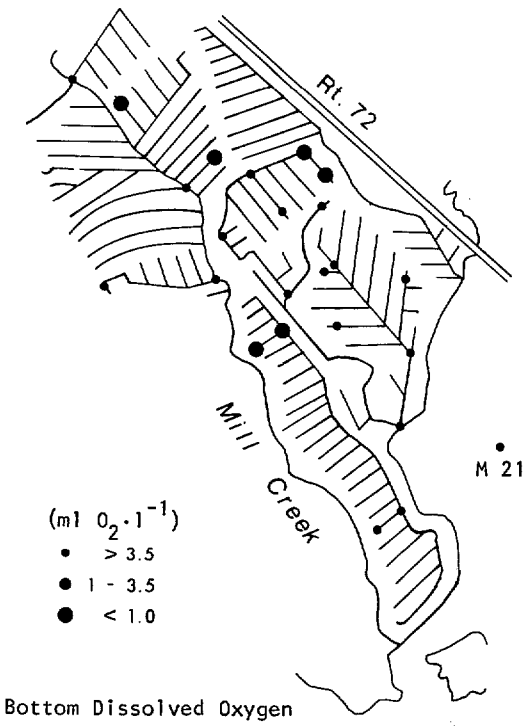

Fig. 16. Dissolved oxygen concentrations at the bottom of the lagoon systems on 8 February 1975.

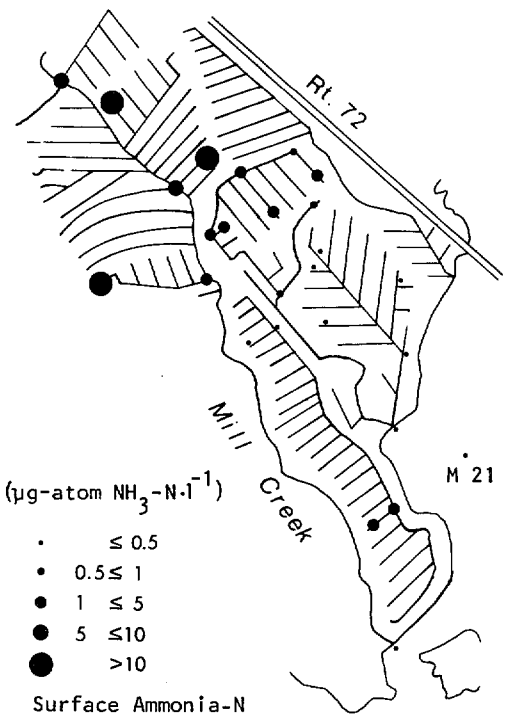

Fig. 17a. Surface NH_3-N concentrations in the lagoon systems on 8 February 1975.

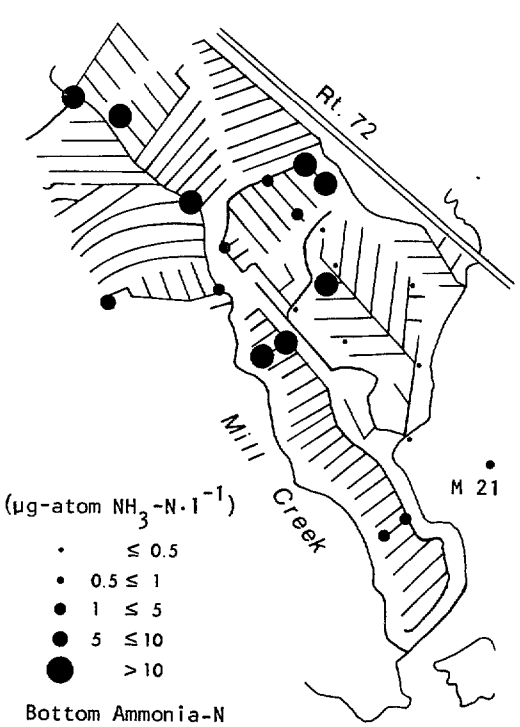

Fig. 17b. NH_3-N concentrations at the bottom of the lagoon systems on 8 February 1975.

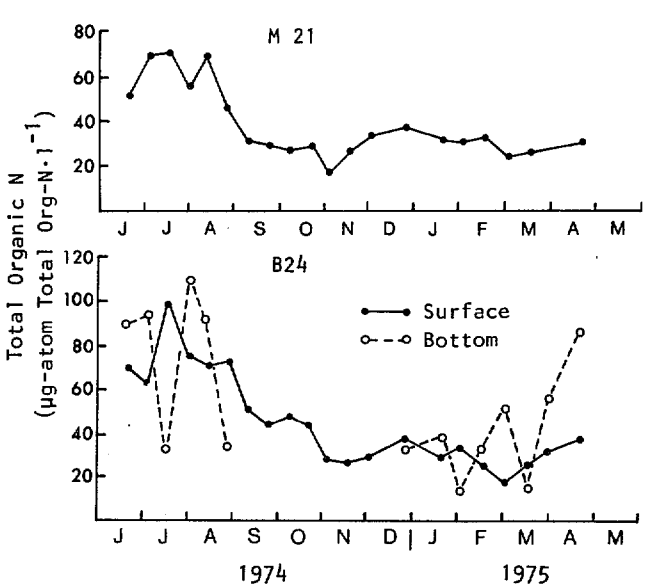

Fig. 18. Total organic-N concentrations at M 21 and Lagoon B24.

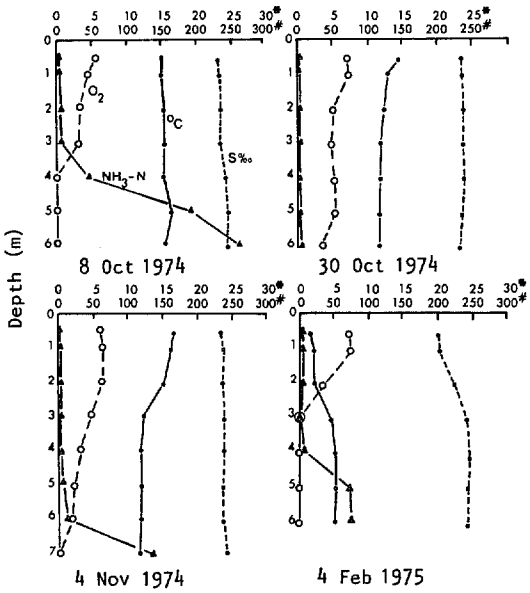

Fig. 19. Vertical distribution of temperature (•——•), salinity (•----•), dissolved oxygen (o---o), and ammonia-N (▲——▲) at Lagoon B24.

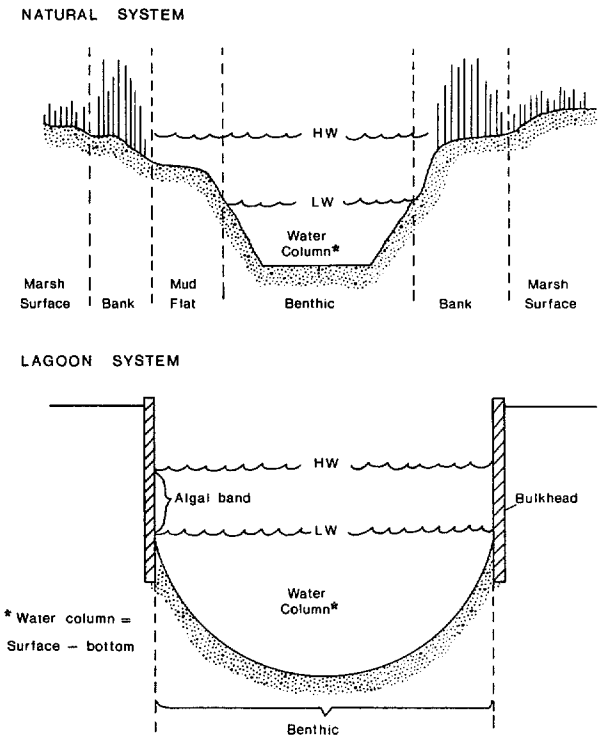

Fig. 20. Cross sections of the natural and lagoon systems.

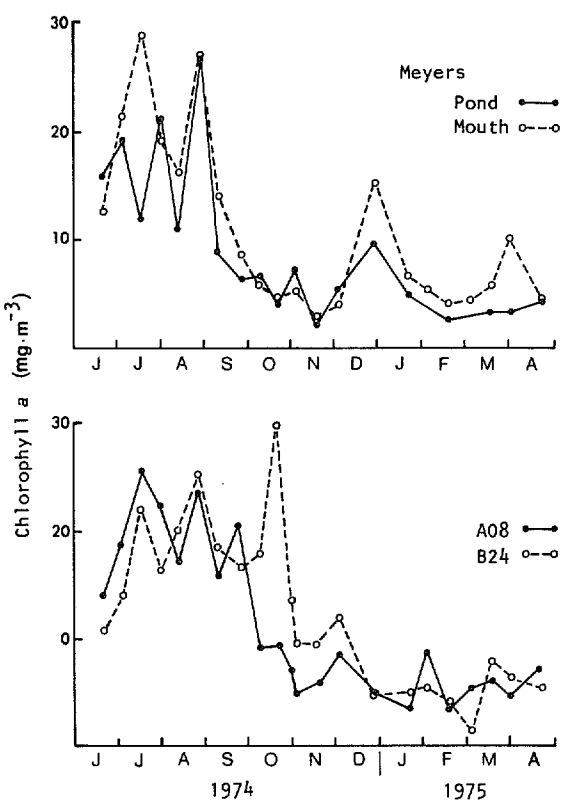

Fig. 21. Chlorophyll *a* concentrations in the Meyers system, Lagoon A08, and Lagoon B24.

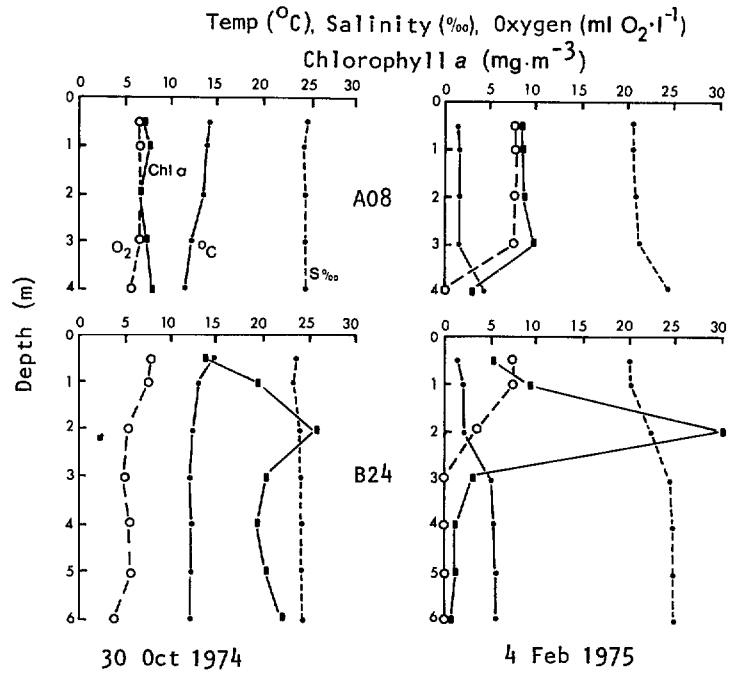

Fig. 22. Vertical distribution of temperature (•——•), salinity (•----•), dissolved oxygen (o---o), and chlorophyll *a* (▪——▪) at Lagoon A08 and B24.

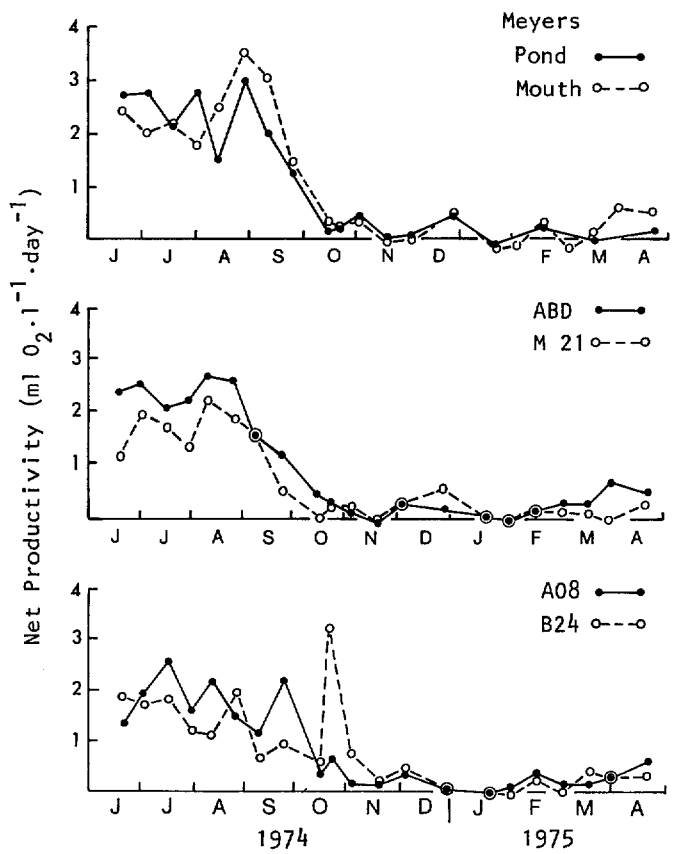

Fig. 23. Net productivity values in the Meyers system, ABD, M 21, A08, and B24.

Table 1. Surface water temperatures (°C), except where noted, from June 1974 to May 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	23.8	22.7	22.1	24.0	25.0	18.0	25.5	14.0
7/3	25.0	24.8	24.5	25.2	26.5	19.0	26.5	15.0
7/9	27.6			27.5	29.7	20.0	31.0	11.2
7/17	25.0	24.8	23.8	25.5	27.0	17.8	25.8	12.0
8/1	26.8	26.0	27.0	27.0	27.9	20.6	27.9	12.1
8/13	23.0	22.6	22.0	23.0	24.5	20.8	24.2	15.5
8/27	24.6	24.0	23.6	25.0	26.7	23.5	26.2	15.9
9/10	21.0	21.3	21.0	21.1	22.2	21.2	23.0	13.5
9/25	16.3	16.0	15.0	16.7	18.5	18.2	19.0	18.7
10/8	13.9	13.6	13.6	13.4	14.4	13.6	14.9	15.4
10/15	16.8	16.9	16.8	16.9	16.9	16.0	17.2	14.2
10/22	6.4	7.9	7.7	8.2	11.2	10.1	12.2	11.7
10/30					14.1	11.5	14.7	12.0
11/4	16.5	16.8	17.5	16.7	17.0	12.0	16.5	12.1
11/19	6.5	7.0	7.0	6.6	8.7	7.7	9.8	9.3
12/3	4.3	3.9	3.5	4.1	3.9	4.5	4.3	5.3
12/27	3.8	3.5	3.0	4.0	4.6	7.6	4.6	6.6
1/21/75	0.0	< 0	< 0	0.0	0.5	7.2	1.2	6.6
2/4	0.0	< 0		0.8	1.1	6.3	1.5	6.5
2/8	1.0			1.0			3.0	7.2
2/18	3.2	4.2	5.1	3.5	3.0	2.1	5.5	7.8
3/4	3.5	4.0		4.9	5.4	5.2	4.5	9.0
3/18	5.3	5.9	5.6	5.6	6.0	5.0	5.9	8.1
4/1	5.7	5.9	8.1	6.7	7.7	6.5	7.8	8.2
4/22	8.9	9.0	8.5	9.7	10.4	9.8	9.8	8.4
5/15							20.3	9.0
5/25			22.0		16.8			

Table 1. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87
6/20/74	23.0	22.0	23.2	23.1	24.1	24.0	24.0
7/3	24.4	24.5	25.0	24.8	25.0	24.5	25.7
7/9			27.7	27.5	28.2	27.4	29.1
7/17							
8/1	27.0	25.0	26.1	26.5	26.0	27.0	25.1
8/13							
8/27	24.1	23.7	24.1	24.3	25.0	25.4	23.8
9/10							
9/25	16.2	14.5	16.2	16.2	18.3	17.7	16.0
10/8							
10/15							
10/22	8.1	8.3	9.0	8.0	9.9	10.5	7.5
10/30							
11/4							
11/19	7.0	8.0	7.3	6.4	4.7	5.0	6.0
12/3							
12/27	4.0	3.0	3.5	3.7	4.6	4.0	6.1
1/21/75	< 0	< 0	0.0	< 0	0.5	1.0	1.0
2/4							
2/8			1.5	1.7	3.1	2.8	4.1
2/18	4.5	5.5	4.0	3.2	5.0	3.0	6.0
3/4							
3/18	5.7	5.2	5.7	5.2	6.1	5.9	6.7
4/1							
4/22	9.2	7.9	10.0	9.8	11.0	11.0	11.0
5/15							
5/25							

(from June 1975 Annual Report)

Table 2. Surface salinity (o/oo), except where noted, from June 1974 to May 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	26.40	24.10	22.91	24.95	24.50	26.30	24.50	25.00
7/3	24.44	22.30	20.55	23.88	24.47	25.18	24.02	24.90
7/9	24.33			23.75	24.50	25.19	23.80	25.34
7/17	24.95	24.42	23.86	23.74	23.63	24.64	23.21	25.13
8/1	26.39	24.79	24.57	25.32	25.35	25.11	23.90	25.02
8/13	25.80	24.60	22.28	25.39	26.34	26.42	24.99	25.10
8/27	23.40	20.59	18.95	21.30	21.35	26.00	20.88	24.81
9/10	23.49	19.60	16.41	22.58	23.19	24.20	22.29	24.90
9/25	24.34	24.60	24.09	23.46	23.43	23.60	22.10	24.94
10/8	24.98	23.99	23.20	24.49	24.50	24.71	23.25	24.99
10/22	25.52	23.57	21.99	24.93	24.53	24.53	23.62	24.60
10/30					24.56	24.65	23.77	23.94
11/4	25.31	25.14	24.34	24.39	24.41	24.63	23.84	24.61
11/19	25.55	24.04	24.07	24.90	25.08	24.98	23.84	24.16
12/3	25.88	22.70	21.18	26.00	25.69		24.32	
12/27	23.86	23.56	21.86	23.07	23.46	25.98	23.15	24.83
1/21/75	21.03	18.61	15.75	20.30	20.38	23.77	19.68	24.84
2/4	22.35	19.58		20.80	20.77	24.15	20.03	24.84
2/18	21.00	21.21	17.20	20.34	20.46	24.09	19.88	24.70
3/4	23.72	20.58		22.55	22.90	22.92	19.84	24.60
3/18	23.28	21.43	17.99	21.76	21.91	22.94	21.43	24.54
4/1	22.94	18.87	12.95	21.62	21.95	22.34	20.18	24.36
4/22	23.26	21.98	18.21	22.63	22.08	22.25	20.37	24.30
5/15		14.76	10.81				18.01	24.69

Table 2. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87 surface	E87 bottom
6/20/74	26.01	21.24	24.09		12.60		1.79	
7/3	24.20	18.21	22.50		11.90	16.67	0.91	
7/9			23.59	23.81	9.82	15.42	1.20	
7/17								
8/1	27.09	22.60	25.57	25.81	11.10	20.07	2.72	12.32
8/13								
8/27	24.29	12.72	20.35	20.87	9.31	13.40	1.59	
9/10								
9/25	26.08	20.19	23.09	23.08	12.99	18.82	2.17	12.38
10/8								
10/22	23.55	14.14	15.83	23.67	7.47	18.63	1.31	14.13
10/30								
11/4								
11/19	25.74	17.71	15.55	23.70	8.11	17.78	3.47	
12/3								
12/27	25.65	23.56	22.44		14.29	20.81	6.14	
1/21/75	20.91	9.16	12.11	20.05	4.28	16.87	0.52	
2/4								
2/18	22.70	13.35	12.94	20.27	4.86	17.90		
3/4								
3/18	20.35	11.75	12.63	20.68	6.26	16.52	1.11	
4/1								
4/22	24.78	16.89	17.49	21.27	9.15	15.70	1.00	
5/15								

(from June 1975 Annual Report)

Table 3. Surface dissolved oxygen (ml $O_2 \cdot l^{-1}$), except where noted, from June 1974 to May 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	4.91	4.07	2.78	4.77	5.17	0.10	5.40	0.00
7/3	4.75	4.16	2.08	5.30	6.30	0.00	6.44	0.00
7/9	4.75			4.38	7.26	0.00	6.16	0.00
7/17	4.79	4.32	3.61	4.59	4.09	0.00	4.92	0.00
8/1	4.35	3.96	1.69	4.35	4.97	0.00	5.45	0.00
8/13	5.21	3.90	2.79	4.51	5.41	0.00	5.74	0.00
8/27	4.30	4.04	3.28	4.36	5.82	0.00	5.88	0.00
9/10	5.70	2.53	0.81	5.61	6.35	0.00	6.29	0.00
9/25	6.29	5.11	4.64	5.17	4.12	2.65	4.89	0.00
10/8	6.15	6.60	6.28	6.05	6.34	4.68	5.07	0.00
10/22	7.06	7.24	6.28	7.04	6.09	6.25	5.56	0.00
10/30					6.50	5.67	7.38	3.63
11/4	5.62	5.62	5.91	5.65	6.15	3.05	6.23	0.00
11/19	7.13	7.25	6.78	6.91	6.58	6.31	5.28	0.41
12/3	6.72	5.32	5.00	6.50	7.32		7.80	
12/27	7.74	7.68	7.48	7.68	7.49	0.14	7.48	0.93
1/21/75	8.38	7.88	7.01	8.06	7.95	1.94	7.81	0.00
2/4	8.51	8.22		8.07	7.74	0.00	7.18	0.00
2/18	8.43	7.85	6.49	8.31	8.24	0.00	7.88	0.00
3/4	7.80	7.82		7.67	7.49	7.53	7.73	0.00
3/18	7.53	7.55	6.60	7.54	7.86	7.59	7.49	0.00
4/1	7.46	7.21	3.94	7.41	7.39	6.08	7.46	0.00
4/22	6.69	6.34	4.86	6.40	6.28	3.95	6.27	0.00
5/15							5.17	0.00

Table 3. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87 surface	E87 bottom
6/20/74	4.55	2.34	4.55		5.04		5.72	
7/3	4.32	1.74	4.88		5.53	4.18	5.65	
7/9			5.02	3.66	6.71	4.56	5.51	7.20
7/17								
8/1	3.94	1.45	3.87	3.86	5.66	3.23	5.94	
8/13								
8/27	4.33	2.53	4.38	4.04	5.40	3.95	5.35	
9/10								
9/25	5.25	4.05	5.58	5.48	4.96	4.42	6.35	3.71
10/8								
10/22	7.41	4.81	6.71	6.90	7.18	5.84	7.64	5.86
10/30								
11/4								
11/19	7.45	5.13	6.73	6.76	7.34	5.96	7.38	
12/3								
12/27	7.47	7.68	7.75	7.82	8.61	7.68	8.46	
1/21/75	8.16	6.08	8.08	8.18	7.88	7.68	8.38	
2/4								
2/18	7.89	5.79	7.96	8.09	7.48	8.10	7.62	
3/4								
3/18	7.00	6.03	7.40	7.22	7.41	7.15	7.50	
4/1								
4/22	6.04	5.35	6.62	6.48	6.78	6.44	6.83	
5/15								

(from June 1975 Annual Report)

Table 4. Secchi disc measurements (m) from June 1974 to May 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08	B24	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth	E68	E87
6/20/74	0.7	0.3	0.4	0.5	0.6	0.3	0.2	0.4	0.4	0.6	0.7
7/3	0.8	0.8	>0.3	0.6	0.7	0.7	0.7	0.7	0.7	0.9	1.0
7/9	0.7			0.7	0.6	0.7			0.5	0.9	0.6
7/17	0.7	0.8	>0.6	0.6	0.7	0.6					
8/1	0.7	0.7	0.6	0.6	0.7	0.7	0.9	0.8	0.7	0.8	0.8
8/13	0.7	0.6	>0.4	0.6	0.7	0.6					
8/27	1.1	0.2	0.4	0.5	0.5	0.6	0.5	0.4	0.5	0.7	0.6
9/10	0.9	>0.5	>0.4	0.8	0.9	0.8					
9/25	1.4	0.9	>0.6	0.9	0.8	0.8	0.6	0.8	0.9	1.2	1.2
10/8	1.1	0.9	>0.9	0.9	1.1	0.8					
10/15	1.7	0.7	>0.6	0.9	1.2	0.9					
10/22	1.0	>0.5	>0.5	1.0	0.8	0.6	0.9	0.5	0.7	0.9	0.9
10/30					1.2	0.9					
11/4	2.4	0.8		1.7	1.6	1.1					
11/19	2.5	1.2	>0.5	1.8	1.2	1.1	>1.0	0.5	1.8	1.3	0.9
12/3	0.2	0.5	0.4	0.5	1.0	1.0					
12/27	0.3	0.2	0.6	1.0	1.7	1.5	0.5	0.6	0.6	1.0	0.8
1/21/75	0.5	0.5	0.5	0.6	0.9	1.4	0.4	0.4	0.7	0.8	0.8
2/4	0.9	0.6		1.0	0.9	1.3					
2/8	0.9			1.1		1.2				1.2	1.3
2/18	1.4	0.9	0.9	1.1	1.1	1.4	0.6	0.7		1.3	1.3
3/4	1.0	0.3		1.3	1.4	1.5					
3/18	1.0	0.7	0.7	0.8	1.2	1.5	0.2	0.3	0.9	0.9	0.9
4/1	1.6	0.2	0.3	1.4	1.3	1.3					
4/22	1.5	1.1	0.8	1.3	1.0	1.2	0.6	0.3	1.2	1.0	1.0
5/15		0.9	0.3			1.0					

(from June 1975 Annual Report)

Table 5. Vertical distribution of temperature (°C), salinity (°/oo), and dissolved oxygen (ml $O_2 \cdot l^{-1}$) at A08 and B24.

Date	Depth (m)	Lagoon A08 (°C)	Lagoon A08 (°/oo)	Lagoon A08 (ml $O_2 \cdot l^{-1}$)	Lagoon B24 (°C)	Lagoon B24 (°/oo)	Lagoon B24 (ml $O_2 \cdot l^{-1}$)
9/10/74	0.5	22.2	23.19	6.35	23.0	22.29	6.29
	1.0	22.2	23.22	5.85	22.8	22.39	6.15
	2.0	21.6	23.60	4.95	22.0	22.48	4.58
	3.0	21.2	23.75	1.87	22.0	23.11	0.00
	4.0	21.2	24.20	0.00	20.6	24.60	0.00
	5.0				17.8	24.64	0.00
	6.0				15.0	24.90	0.00
	7.0				13.5		
10/8	0.5	14.4	24.50	6.34	14.9	23.25	5.07
	1.0	14.4	24.60	6.28	15.0	23.45	4.42
	2.0	14.4	24.58	6.00	15.1	23.70	3.28
	3.0	14.1	24.60	5.21	15.5	23.71	3.16
	4.0	13.7	24.71	4.68	15.6	24.33	0.00
	5.0	13.6			16.3	24.92	0.00
	6.0				15.4	24.99	0.00
10/30	0.5	14.1	24.56	6.50	14.7	23.77	7.38
	1.0	13.6	24.39	6.64	13.0	23.79	7.49
	2.0	13.3	24.47	6.70	12.3	24.12	5.12
	3.0	12.2	24.62	6.64	12.1	24.03	4.99
	4.0	11.5	24.65	5.67	12.1	24.12	5.34
	5.0				12.0	24.04	5.34
	6.0				12.0	23.94	3.63
11/4	0.5	17.0	24.41	6.15	16.5	23.84	6.23
	1.0	16.2	24.24	6.10	16.2	23.85	6.29
	2.0	16.1	24.32	5.88	15.4	23.91	6.24
	3.0	13.2	24.43	5.28	12.3	24.04	4.64
	4.0	12.1	24.63	3.05	12.2	24.02	2.91
	5.0	12.0			12.2	24.14	2.24
	6.0				12.0	23.99	1.58
	7.0				12.0	24.61	0.00
	8.0				12.1		
12/27	0.5	4.6	23.46	7.49	4.6	23.15	7.48
	1.0	4.6	23.42	7.54	4.6	23.03	7.55
	2.0	4.6	23.40	7.48	5.1	23.42	7.08
	3.0	5.8	24.85	4.87	6.4	24.40	2.96
	4.0	6.7	25.98	0.14	6.6	24.65	2.01
	5.0	7.1			6.7	24.75	1.25
	6.0	7.6			6.7	24.83	0.93
	7.0				6.6		
	8.0				6.6		

Table 5. Continued.

Date	Depth (m)	Lagoon A08 (°C)	Lagoon A08 (°/oo)	Lagoon A08 (ml $O_2 \cdot l^{-1}$)	Lagoon B24 (°C)	Lagoon B24 (°/oo)	Lagoon B24 (ml $O_2 \cdot l^{-1}$)
1/21/75	0.5	0.5	20.38	7.95	1.2	19.68	7.81
	1.0	0.6	20.43	7.84	2.0	20.81	7.34
	2.0	2.0	21.54	7.25	4.2	22.09	6.55
	3.0	2.8	21.70	6.99	6.0	24.06	0.69
	4.0	5.5	23.77	1.94	6.2	24.79	0.06
	5.0	7.2			6.2	24.79	0.00
	6.0				6.5	24.84	0.00
2/4	0.5	1.1	20.77	7.74	1.5	20.03	7.18
	1.0	1.3	20.76	7.80	2.1	20.20	7.32
	2.0	1.5	20.80	7.73	2.1	22.37	3.26
	3.0	1.5	21.04	7.60	5.0	24.15	0.00
	4.0	4.9	24.15	0.00	5.4	24.55	0.00
	5.0	6.3			5.6	24.69	0.00
	6.0				5.7	24.84	0.00
	7.0				6.5		
2/18	0.5	3.0	20.46	8.24	5.5	19.88	7.88
	1.0	3.0	20.60	8.20	3.2	20.10	7.81
	2.0	2.0	20.95	7.94	2.8	20.28	7.75
	3.0	1.0	21.10	7.88	5.0	23.49	0.00
	4.0	2.1	24.09	0.00	7.7	24.27	0.00
	5.0				7.8	24.55	0.00
	6.0				7.8	24.70	0.00
	7.0				7.8		
	8.0				7.8		
3/4	0.5	5.4	22.90	7.49	4.5	19.84	7.73
	1.0	5.3	22.85	7.53	4.3	19.88	7.75
	2.0	5.2	22.82	7.47	6.0	20.77	7.23
	3.0	5.2	22.92	7.53	8.2	23.25	0.20
	4.0	5.2			8.9	24.14	0.00
	5.0				9.0	24.39	0.00
	6.0				9.1	24.60	0.00
	7.0				9.0		
	8.0				9.0		
3/18	0.5	6.0	21.91	7.86	5.9	21.43	7.49
	1.0	5.9	21.97	7.96	5.9	21.51	7.48
	2.0	5.9	22.00	7.22	5.9	22.49	7.47
	3.0	5.5	22.94	7.59	6.0	21.61	7.05
	4.0	5.0			6.1	23.84	0.19
	5.0				7.6	24.01	0.00
	6.0				8.0	24.54	0.00
	7.0				8.1		

Table 5. Continued.

Date	Depth (m)	Lagoon A08 (°C)	Lagoon A08 (°/oo)	Lagoon A08 (ml $O_2 \cdot l^{-1}$)	Lagoon B24 (°C)	Lagoon B24 (°/oo)	Lagoon B24 (ml $O_2 \cdot l^{-1}$)
4/1/75	0.5	7.7	21.95	7.39	7.8	20.18	7.46
	1.0	7.6	21.90	7.34	7.8	20.40	7.52
	2.0	7.1	22.02	7.32	8.0	21.03	7.00
	3.0	6.8	22.34	6.08	8.0	21.09	7.19
	4.0	6.5			8.0	22.38	1.80
	5.0				8.0	24.07	0.00
	6.0				8.1	24.26	0.00
	7.0				8.2		
	8.0				8.2		
4/22	0.5	10.4	22.08	6.28	9.8	20.37	6.27
	1.0	10.2	22.12	6.33	10.1	20.77	6.70
	2.0	10.2	22.04	6.00	10.3	20.84	6.76
	3.0	10.2	22.28	5.63	9.0	21.26	6.57
	4.0	10.2	22.25	3.95	8.0	21.40	4.46
	5.0	9.8			8.0	23.70	0.00
	6.0				8.2	24.30	0.00
	7.0				8.4		
	7.5				8.4		
5/15	0.5				20.3	18.01	5.17
	1.0				21.3	20.00	5.24
	2.0				18.9	20.98	5.40
	3.0				15.0	21.58	4.40
	4.0				12.1	22.03	0.56
	5.0				10.0	24.05	0.00
	6.0				9.2	24.69	0.00
	7.0				9.2		
	7.5				9.0		

(from June 1975 Annual Report)

Table 6. Surface NH_3-N (μg-atom NH_3-N·l^{-1}), except where noted, for all stations from June 1974 to April 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	0.0	0.0	0.4	0.0	0.0	7.0	0.3	53.2
7/3	1.4	0.9	3.6	1.0	0.9	27.8	0.7	86.2
7/17	0.1	0.7	0.4	0.0	0.0	61.6	0.1	133.9
8/1	0.3	0.6	0.0	0.2	0.3	15.7	0.3	109.2
8/13	0.3	1.5	0.6	0.2	0.1	50.2	0.5	140.9
8/27	1.5	2.4	2.3	0.2	0.7	79.1	1.2	206.6
9/10	2.0	7.3	10.5	1.6	0.7	11.4	1.2	164.2
9/24	0.5	2.0	2.7	0.2	0.3	4.8	1.3	227.5
10/8	0.7	1.0	1.3	0.7	0.6	3.1	0.1	260.9
10/22	0.6	0.7	3.7	0.5	0.9	0.6	2.6	294.6
11/4	0.8	1.9	1.0	0.6	0.3	1.9	0.7	129.7
11/19	0.7	1.1	2.5	1.5	1.1	1.8	8.0	42.7
12/3	0.9	3.1	1.7	0.5	0.3		1.1	
12/27	0.0	0.0	0.2	0.1	0.0	2.9	3.2	6.3
1/21/75	0.7	3.0	4.2	2.3	3.3	19.0	4.9	22.6
2/4	0.5	0.7		0.6	0.5	66.3	4.0	74.6
2/18	0.4	1.1	1.6	1.3	1.0	55.6	3.1	43.8
3/4	0.5	1.6		0.1	0.1	0.4	1.6	35.4
3/18	0.2	0.5	0.6	0.2	0.4	1.8	2.2	91.6
4/1	1.2	0.6	8.0		0.2		0.5	86.9
4/22	0.0	0.1	2.4	0.1	0.0	4.4	1.3	118.9

Table 6. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87
6/20/74	0.0	1.7	0.0		0.0		0.0
7/3	0.7	5.2	0.4		1.0	2.3	2.1
7/17							
8/1	3.6	1.9	0.4	0.6	0.5	1.9	0.6
8/13							
8/27	2.3	11.3	2.1	4.2	0.6	5.2	1.5
9/10							
9/24	5.9	5.8	0.5	0.2	3.3	5.7	1.4
10/8							
10/22	0.8	5.4	5.0	1.6	8.3	4.9	4.2
11/4							
11/19	0.9	16.7	6.8	2.4	12.1	6.2	7.7
12/3							
12/27	0.1	1.6	0.6	0.4	0.0	3.5	2.5
1/21/75	3.6	5.6	5.8	1.5	6.6	3.8	4.5
2/4							
2/18	0.3	2.7	8.8	0.9	9.8	4.4	8.0
3/4							
3/18	0.5	2.7	7.5	1.9	10.9	6.7	5.7
4/1							
4/22	3.0	10.2	3.2	0.9	17.2	5.3	5.5

(from June 1975 Annual Report)

Table 7. Surface NO_2-N (μg-atom NO_2-N·l^{-1}), except where noted, for all stations from June 1974 to April 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0
7/3	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.2
7/17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8/13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
8/27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
9/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
9/24	0.1	0.1	0.2	0.0	0.1	0.0	0.0	1.1
10/8	0.1	0.1	0.1	0.3	0.0	0.0	0.0	0.3
10/22	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5
11/4	0.1	0.0	0.1	0.2	0.2	0.0	0.0	0.2
11/19	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.4
12/3	0.0	0.0	0.0	0.0	0.0		0.0	
12/27	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
1/21/75	0.3	0.0	0.0	0.1	0.2	0.1	0.5	0.0
2/4	0.1	0.0		0.2	0.2	0.0	0.4	0.0
2/18	0.0			0.2	0.1	0.0		
3/4	0.0	0.0		0.0	0.0	0.0	0.1	0.1
3/18	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
4/1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 7. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87
6/20/74	0.1	0.0	0.0		0.2	0.0	0.0
7/3	0.0	0.1	0.0		0.1		0.0
7/17							
8/1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
8/13							
8/27	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9/10							
9/24	0.6	0.2	0.0	0.0	0.0	0.0	0.0
10/8							
10/22	0.2	0.0	0.0	0.0	0.0	0.0	0.0
11/4							
11/19	0.0	0.0	0.0	0.0	0.1	0.1	0.0
12/3							
12/27	0.0	0.0	0.0	0.0	0.3	0.0	0.0
1/21/75	0.4	0.0	0.0	0.1	0.0	0.1	0.0
2/4							
2/18			0.1	0.1	0.1	0.1	0.0
3/4							
3/18	0.0	0.0	0.1	0.0	0.0	0.0	0.0
4/1							

(from June 1975 Annual Report)

Table 8. Surface NO_3-N (μg-atom NO_3-N·l^{-1}), except where noted, for all stations from June 1974 to May 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	0.7	1.0	0.9	1.0	0.6	1.0	1.0	0.1
7/3	0.2	0.5	0.0	0.3	0.5	0.6	1.0	0.0
7/17	0.4	0.8	0.7	1.3	0.0	1.0	0.2	1.9
8/1	0.5	1.0	1.1	0.5	0.7	0.3	0.9	0.0
8/13	0.7	0.9	0.4	0.8	0.5	0.1	0.7	0.2
8/27	0.6	1.7	1.3	0.9	0.7	0.0	1.2	0.4
9/10	0.8	0.3	0.0	0.2	0.1	0.2	0.5	0.2
9/24	0.3	1.1	0.9	0.5	1.3	0.7	0.7	1.1
10/8	0.3	0.2	0.4	0.2	0.3	0.3	0.4	0.3
10/22	0.4	0.5	0.7	0.3	0.4	0.3	1.9	0.5
11/4	0.6	0.9	0.5	0.3	0.5	0.4	0.4	0.2
11/19	0.2	0.4	0.3	0.3	0.2	0.0	1.4	0.4
12/3	0.1	0.4	0.6	0.3	0.1		0.1	
12/27	0.2	0.2	0.3	0.3	0.2	0.7	1.2	0.4
1/21/75	1.2	1.8	1.6	1.7	1.8	0.7	5.1	0.3
2/4	0.3	0.4		1.6	0.8	0.4	4.8	0.0
2/18	0.1			0.6	0.5	0.5		
3/4	0.6	0.7		0.5	0.5	0.4	3.1	0.4
3/18	0.6	0.4	0.6	0.5	0.5	0.5	1.5	0.4
4/1	0.5	0.7	0.2	0.5	0.5	0.4	0.5	0.5

Table 8. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87
6/20/74	1.1	0.7	0.9		0.8		2.9
7/3	0.5	0.0	0.3		0.7	0.3	3.0
7/17							
8/1	0.4	0.4	0.7	1.0	0.7	0.8	0.9
8/13							
8/27	0.9	2.2	1.1	0.9	0.3	1.0	5.3
9/10							
9/24	1.7	1.6	0.8	1.2	3.5	1.6	4.3
10/8							
10/22	0.4	1.0	3.4	0.7	10.1	2.7	5.7
11/4							
11/19	0.4	0.9	1.6	0.5	3.7	0.9	5.5
12/3							
12/27	0.1	0.2	0.1	0.1	2.1	0.7	4.4
1/21/75	2.2	2.7	4.3	1.6	6.3	2.6	5.9
2/4							
2/18			4.2	0.9	7.1	1.0	7.5
3/4							
3/18	0.7	0.9	3.8	0.9	5.4	2.5	6.4
4/1							

(from June 1975 Annual Report)

Table 9. Surface total organic nitrogen (μg-atom Org-N·l^{-1}), except where noted, for all stations from June 1974 to May 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	51.8	71.1	64.8	85.2	65.3	45.4	69.1	89.4
7/3	69.8	60.4	62.4	65.5	82.1	94.3	61.6	94.4
7/17	70.7	72.7	104.6	92.6	97.5	50.2	99.2	31.6
8/1	57.1	64.6	77.1	76.6	108.2		76.4	108.9
8/13	69.3	69.4	68.1	79.1	64.5	137.8	70.7	91.7
8/27	44.4	79.6	80.3	70.3	63.7	26.0	72.8	35.4
9/10	32.4	60.9	32.6	50.4	65.0	75.7	52.1	
9/24	29.7	25.5	25.4	34.3	38.2	39.7	43.8	
10/8	27.9	31.7	27.1	28.8	42.1	33.3	47.6	
10/22	30.0	15.1	25.0	24.3	25.9	35.8	44.2	
11/4	19.1	21.9	23.8	23.7	30.3	10.2	27.8	120.7
11/19	27.5	21.0	17.9	21.5	24.1	25.8	27.1	
12/3	34.5	22.6	26.9	32.4	21.9		29.0	
12/27	37.8	38.2	34.2	24.3	20.0	24.3	38.4	33.1
1/21/75	33.1	38.2	39.5	27.2	28.9	24.4	28.8	38.5
2/4	31.6	38.8		40.0	35.3	30.7	33.5	13.4
2/18	34.3	35.3	26.1	39.3	28.1	42.2	26.2	32.5
3/4	25.4	34.0		23.4	30.9	30.5	18.1	52.4
3/18	26.9	38.2	33.7	21.8	24.4	34.4	25.7	14.9
4/1		93.8	49.7		31.1	9.1	31.8	56.0
4/22	31.4	35.5	59.4	44.3	51.6	48.0	37.8	87.6

Table 9. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87
6/20/74	63.9	62.0	61.9		52.8		40.5
7/3	61.2	64.6	73.1		60.1	77.4	16.5
7/17							
8/1	58.8	84.6	70.8		65.9	47.0	29.6
8/13							
8/27	41.6	72.9	63.2	60.7	48.3	48.8	
9/10							
9/24	29.0	26.2	30.4	4.0	28.9	2.8	13.6
10/8							
10/22	17.0	34.3	29.9	27.2	14.5	33.8	10.5
11/4							
11/19	16.6	19.2	18.4	19.9	6.9	39.7	23.1
12/3							
12/27	34.9	30.8	33.5	37.2	22.1	19.9	30.0
1/21/75	36.7	43.6	27.9	27.3	21.6	26.5	13.7
2/4							
2/18	24.0	37.2	25.7	40.0	20.7	37.1	23.9
3/4							
3/18	42.0	30.8	11.8	22.2	13.5	10.3	18.7
4/1							
4/22	44.9	69.4	38.7	38.1	35.9	30.6	17.4

(from June 1975 Annual Report)

Table 10. Vertical distribution of NH_3-N, NO_2-N, and NO_3-N in (μg-atom·l^{-1}) A08 and B24.

Date	Depth	Lagoon A08			Lagoon B24		
		NH_3-N	NO_2-N	NO_3-N	NH_3-N	NO_2-N	NO_3-N
9/10/74	0.5	0.7			1.2		
	1.0	1.2					
	2.0	3.4			1.5		
	3.0	1.7			4.7		
	4.0	11.4			40.8		
	5.0						
	6.0				164.2		
10/8	0.5	0.6	0.0	0.3	0.1	0.0	0.4
	1.0	1.2	0.0	0.3	0.7	0.0	0.3
	2.0	0.7	0.0	0.2	5.0	0.0	0.4
	3.0	0.6	0.0	0.2	7.0	0.0	0.3
	4.0	3.1	0.0	0.3	46.7	0.0	0.1
	5.0				194.1	0.0	0.0
	6.0				260.9	0.1	0.3
10/30	0.5	0.6	0.1	0.3	1.1	0.1	0.2
	1.0	0.7	0.1	0.3	0.8	1.7	0.9
	2.0	0.7	0.2	0.4	0.7	0.1	0.2
	3.0	0.7	0.2	0.3	0.7	0.2	0.2
	4.0	0.7	0.1	0.5	0.6	0.2	0.2
	5.0				0.8	0.1	0.3
	6.0				5.6	0.2	0.2
11/4	0.5	0.3	0.2	0.5	0.7	0.0	0.4
	1.0	0.4	0.1	0.4	0.7	0.0	0.4
	2.0	0.7	0.0	0.4	0.7	0.0	0.4
	3.0	0.5	0.0	0.5	1.0	0.0	0.4
	4.0	1.9	0.0	0.4	1.1	0.0	0.5
	5.0				7.2	0.0	0.5
	6.0				9.0	0.0	0.3
	7.0				129.7	0.0	0.2
12/27	0.5	0.0	0.0	0.2	3.2	0.1	1.2
	1.0	0.0	0.0	0.3	2.5	0.0	1.1
	2.0	0.0	0.0	0.2	0.4	0.0	0.7
	3.0	0.0	0.0	0.1	2.6	0.1	0.6
	4.0	2.9	0.1	0.7	2.0	0.0	0.5
	5.0				5.4	0.0	0.4
	6.0				6.3	0.0	0.4

Table 10. Continued.

Date	Depth	Lagoon A08			Lagoon B24		
		NH_3-N	NO_2-N	NO_3-N	NH_3-N	NO_2-N	NO_3-N
1/21/75	0.5	3.3	0.2	1.8	4.9	0.5	5.1
	1.0	3.9	0.1	1.9	5.9	0.3	3.8
	2.0	3.1	0.3	1.1	3.5	0.3	3.0
	3.0	4.3	0.1	1.3	15.0	0.0	0.5
	4.0	19.0	0.1	0.7	14.5	0.0	0.3
	5.0				24.3	0.0	0.3
	6.0				22.6	0.0	0.3
2/4	0.5	0.5	0.2	0.8	4.0	0.4	4.8
	1.0	0.3	0.1	0.8	3.0	0.5	4.4
	2.0	0.3	0.1	0.9	2.6	0.2	2.5
	3.0	1.2	0.0	0.6	3.8	0.0	0.1
	4.0	66.3	0.0	0.4	5.3	0.0	0.1
	5.0				72.7	0.0	0.0
	6.0				74.6	0.0	0.0
2/18	0.5	1.0	0.1	0.5	3.1		
	1.0	1.4	0.1	0.3	3.5		
	2.0	1.4	0.1	0.4	2.6		
	3.0	2.0	0.0	0.5	28.5		
	4.0	55.6			30.4		
	5.0				37.5		
	6.0				45.8		
3/4	0.5	0.1	0.0	0.5	1.6	0.1	3.1
	1.0	0.0	0.0	0.5	1.5	0.2	2.9
	2.0	0.1	0.1	0.6	2.2	0.1	1.6
	3.0	0.4	0.0	0.4	25.5	0.0	0.5
	4.0	1.6			20.9	0.0	0.5
	5.0				28.5	0.0	0.4
	6.0				35.4	0.1	0.4
4/1/75	0.5	0.2	0.0	0.5	0.5	0.0	0.5
	1.0	0.0	0.0	0.4	0.0	0.0	0.4
	2.0	0.1	0.0	0.3	0.1	0.0	0.4
	3.0	0.0	0.0	0.4	0.2	0.0	0.4
	4.0				25.8	0.0	0.6
	5.0				57.9	0.0	0.3
	6.0				86.9	0.0	0.5

(from June 1975 Annual Report)

Table 11. Acetylene reduction (μl $C_2H_4 \cdot min^{-1} \cdot m^{-2}$) by algae and associated substrate.

Date	Incubation temperature (°C)	Meyers system		Lagoon System A
		Bank	Marsh surface	Bulkhead
11/30/74	7.0	0.5		153.6
				151.5
				13.1
				4.3
				1.1
		Y = 0.50*		$\bar{Y}$ = 64.72
12/21/74	5.2		4.4	18.4
			0.1	7.7
				0.5
			$\bar{Y}$ = 2.25	$\bar{Y}$ = 8.87
1/14/74	-1.5		0.7	108.1
			0.0	52.0
				4.6
				4.5
			$\bar{Y}$ = 0.35	$\bar{Y}$ = 42.30
2/15/75	7.8	1.5	0.0	15.8
		0.3		0.4
		0.0		0.0
				0.0
		$\bar{Y}$ = 0.60	$\bar{Y}$ = 0.0	$\bar{Y}$ = 4.05
3/1/75	7.2		19.7	
			3.8	
			0.7	
			0.1	
			0.0	
			0.0	
			$\bar{Y}$ = 4.05	

Table 11. Continued.

Date	Incubation temperature (°C)	Meyers system		Lagoon System A
		Bank	Marsh surface	Bulkhead
3/8/75	7.0		0.3	
			0.2	
			0.0	
			0.0	
			0.0	
			$\overline{Y}$ = 0.10	
3/25/75	15.7			532.9
				336.4
				248.4
				$\overline{Y}$ = 372.57
4/12/75	9.5	7.1 (0.8)#	18.8 (0.1)	365.9
		0.0 (0.4)		92.5
		0.0 (0.2)		56.0
				41.8
				40.5
				5.5
		$\overline{Y}$ = 2.37 (0.47)	$\overline{Y}$ = 18.80 (0.10)	$\overline{Y}$ = 100.37
4/26/75	18.5		12.2 (5.6)	
			7.9 (2.7)	
			4.7 (0.9)	
			$\overline{Y}$ = 8.26 (3.07)	
5/25/75	16.0		26.6	134.5
			24.0	69.6
				46.3
		1.0 (0.5)		35.4
		$\overline{Y}$ = 1.00 (0.5)	$\overline{Y}$ = 25.30	$\overline{Y}$ = 71.45

* $\overline{Y}$ indicates the mean of the values for that date.

The parentheses indicate the substrate acetylene reduction value associated with the adjacent algal value.

(from June 1975 Annual Report)

Table 12. Acetylene reduction rate (μl $C_2H_4 \cdot min^{-1} \cdot m^{-2}$) in substrate samples.

Date	Vegetation zone or location	Incubation temperature (°C)	Rate
Marsh surface soil subsamples:			
9/28/74	*S. patens*	25.5	0.9*
	Distichlis sp.		4.2*
	S. alterniflora		0.3*
1/24/75	*S. alterniflora* tall form	7.8	0.0
			0.2
	S. alterniflora short form		0.0
			0.6
	S. patens		0.0
			0.0
	Distichlis sp.		0.3
			0.0
3/1/75	Nonvegetated mudflat	7.2	12.7
3/8/75	*S. alterniflora* short form	7.0	0.9
4/26/75	*S. patens*	18.5	0.3
			0.0

Table 12. Continued.

Date	Vegetation zone or location	Incubation temperature (°C)	Rate
Benthic sediment samples:			
2/9/75	Lower third Meyers system	2.8	0.1
	Mid third Meyers system		0.0
	Upper third Meyers system		0.2
	Lower third Lagoon System A		0.5
	Mid third Lagoon System A		0.0
	Upper third Lagoon System A		0.0
3/25/75	Lower third Meyers system	11.3	0.0*
	Mid third Meyers system		0.3*
	Upper third Meyers system		0.1*
	Lower third Lagoon System A		0.2*
	Mid third Lagoon System A		0.2*
	Upper third Lagoon System A		0.1*

*Assumed sample area of 6.25 cm^2 with negative values assumed to be 0.

(from June 1975 Annual Report)

Table 13. Acetylene reduction rate (µl $C_2H_4 \cdot min^{-1} \cdot l^{-1}$) in the water column.

Date	Location	Depth (m)	Incubation temperature (°C)	Rate
8/8/74	Meyers Pond	surface	26.0	0.0
10/12/74	Upper Meyers Creek Pool	surface	18.5	0.0258
10/27/74	B24	1.0	11.2	0.0051
		3.0	11.1	0.0036
		5.0	11.1	0.0133
12/21/74	A08	1.0	5.2	0.0
		3.0	5.2	0.0028

Table 14. Invertebrate excretion of inorganic ammonia. Average value per sampling date is indicated.

	Zooplankton (µg-atom NH_3-N·m^{-3}·24 h^{-1})		*Ilyanassa obsoleta* (µg-atom NH_3-N·org^{-1}·24 h^{-1})		*Modiolus* sp. (µg-atom NH_3-N·org^{-1}·24 h^{-1})
Date	Meyers system	Lagoon system	Meyers system	Lagoon system	Meyers system
10/19/74	1.6	0.0	0.43		3.4
11/16/74	0.3	1.5	0.44		9.2
12/14/74	1.7	0.9	0.90	1.2	7.3
4/19/75	28.1	75.4	1.40	1.3	5.2

(from June 1975 Annual Report)

Table 15. Surface particulate oxidizable carbon ($mg \cdot m^{-3}$), except where noted, for all stations from June 1974 to April 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	3,788	7,979	3,512	4,494	7,704	3,531	5,044	3,820
7/17	3,105	4,005	3,948	4,106	4,950	4,158	4,786	1,575
8/1	2,571	4,415	3,497	5,231	5,426	4,651	5,275	757
8/13	4,128	3,784	3,784	5,332	3,937	6,433	5,663	1,514
9/24	1,803	2,093	1,674	3,459	2,834	2,640	2,981	2,061
11/19	1,170	1,650	1,590	1,560	2,100	1,650	1,800	1,680
12/3	3,430	3,262	4,167	2,596	2,441		4,450	
12/27	5,314	6,000	4,286	2,580	2,040	2,520	3,180	1,890
1/21/75	3,617	2,303	2,170	2,524	1,488	1,963	1,860	1,705
2/4	2,201	1,976		2,480	2,077	3,035	1,684	3,410
2/18	1,581	1,581	1,612	2,139	1,178	2,635	1,891	2,914
3/4	1,469	3,940		1,683	1,928	1,928	1,346	1,836
4/1		6,219	2,794	2,387	1,744		2,387	2,387

Table 15. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87
6/20/74	7,704	3,072	5,200		3,264		1,086
7/17							
8/1	860	3,096	3,727	4,243	2,339	3,876	1,564
8/13							
9/24	4,186	1,771	2,576	2,290	2,397	2,157	926
11/19	1,410	2,250	1,800	1,710	1,530	3,960	900
12/3							
12/27	5,150	2,700	3,600	3,480	2,400	2,880	2,820
1/21/75	3,978	2,303	1,594	2,945	974	2,170	531
2/4							
2/18	1,488	1,333	1,612	3,333	1,054	1,798	217
3/4							
4/1							

(from June 1975 Annual Report)

Table 16. Surface chlorophyll a ($mg \cdot m^{-2}$), except where noted, from June 1974 to April 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08 surface	A08 bottom	B24 surface	B24 bottom
6/20/74	10.6	12.7	15.9	16.7	14.0	25.5	10.7	11.9
7/3	14.5	21.2	19.2	20.7	18.6	20.2	14.0	15.4
7/17	12.5	28.9	11.8	24.9	25.6	23.2	22.1	13.3
8/1	15.5	19.0	21.4	24.8	22.5	22.4	16.5	13.4
8/13	14.5	16.2	10.6	20.1	17.2	18.0	20.3	12.6
8/27	10.0	27.4	27.0	22.6	23.9	21.4	25.4	10.1
9/10	14.3	14.0	8.7	16.9	15.8	23.1	18.7	15.2
9/25	3.9	8.5	6.2	10.8	20.8	11.9	16.6	10.9
10/8	3.7	5.7	6.6	6.2	9.1	11.0	18.0	11.0
10/22	4.4	4.5	4.0	4.3	9.5	10.2	30.1	9.5
10/30					7.0	7.8	13.6	22.0
11/4	2.1	5.2	6.9	3.9	4.9	6.8	9.7	11.3
11/19	2.3	2.8	2.1	3.5	5.8	5.8	9.5	7.5
12/3	9.1	3.9	5.2	5.9	8.7		11.9	
12/27	13.9	15.5	9.7	7.2	4.9	4.0	4.7	4.7
1/21/75	8.2	6.7	5.0	5.8	3.5	2.4	4.8	0.6
2/4	6.2	5.6		7.3	8.8	2.9	5.2	1.0
2/18	3.9	4.1	2.6	3.5	3.4	2.6	4.0	0.9
3/4	3.2	4.5		4.3	5.3	7.0	1.3	5.7
3/18	3.1	6.0	3.4	4.7	5.8	9.5	7.5	0.5
4/1	1.3	10.5	3.4	4.4	4.5	5.2	6.2	8.0
4/22	3.4	4.8	4.4	4.6	7.0	12.4	5.0	30.0

Table 16. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth surface	E mouth bottom	E68 surface	E68 bottom	E87
6/20/74	25.1	9.5	17.3		23.7		7.1
7/3	22.7	11.5	17.6		21.6	23.8	2.4
7/17							
8/1	18.0	17.7	22.0	17.8	37.0	34.0	14.5
8/13							
8/27	17.0	18.4	26.5	22.3	45.3	40.9	7.5
9/10							
9/25	8.4	4.7	11.0	11.2	14.4	12.7	8.0
10/8							
10/22	3.9	3.4	7.6	5.6	5.3	8.3	2.6
10/30							
11/4							
11/19	2.8	4.4	3.0	2.8	2.6	19.7	2.2
12/3							
12/27	16.2	11.5	10.1	9.4	13.3	11.3	28.6
1/21/75	7.8	4.1	4.9	6.6	3.1	7.7	1.4
2/4							
2/18	4.3	2.5	2.4	4.3	0.6	2.2	0.4
3/4							
3/18	10.8	3.2	3.1	4.7	1.3	3.8	0.4
4/1							
4/22	4.6	9.5	5.1	4.8	6.3	7.6	4.0

(from June 1975 Annual Report)

Table 17. Chlorophyll *a* ($mg \cdot m^{-3}$) and acid-factor ratio.* Lagoon vertical distribution from September 1974 to April 1975.

Date	Depth (m)	Lagoon A08 Chl *a*	Lagoon A08 665/665[a]	Lagoon B24 Chl *a*	Lagoon B24 665/665[a]
9/10/74	0.5	15.8	1.31	18.7	1.28
	1.0	20.6	1.31		
	2.0	18.8	1.26	26.0	1.27
	3.0	20.1	1.27	35.9	1.30
	4.0	23.1	1.26	38.9	1.22
	5.0				
	6.0			15.2	1.26
10/8	0.5	9.1	1.23	18.0	1.41
	1.0	8.8	1.47	18.9	1.31
	2.0	9.4		13.5	1.28
	3.0	11.2	1.40	16.2	1.30
	4.0	11.0	1.37	21.8	1.19
	5.0			15.6	1.21
	6.0			11.0	1.20
10/30	0.5	7.0	1.41	13.6	1.43
	1.0	7.6	1.32	19.4	1.35
	2.0	6.7	1.44	25.5	1.38
	3.0	7.4	1.43	20.2	1.35
	4.0	7.8	1.35	19.4	1.35
	5.0			20.1	1.32
	6.0			22.0	1.37
11/4	0.5	4.9	1.21	9.7	1.37
	1.0	6.5	1.46	8.5	1.35
	2.0	4.1	1.29	10.1	1.32
	3.0	3.7	1.33	11.2	1.22
	4.0	6.8	1.26	10.8	1.21
	5.0			9.7	1.24
	6.0			9.5	1.24
	7.0			11.3	1.29
12/27	0.5	4.9	1.38	4.7	1.40
	1.0	3.4	1.36	5.1	1.44
	2.0	4.9	1.29	7.3	1.45
	3.0	5.1	1.44	8.1	1.38
	4.0	4.0	1.64	6.5	1.38
	5.0			4.3	1.46
	6.0			4.7	1.31
1/21/75	0.5	3.5	1.27	4.8	1.53
	1.0	3.2	1.44	11.2	1.51
	2.0	3.5	1.39	10.2	1.52
	3.0	4.1	1.45	5.6	1.33

Table 17. Continued.

Date	Depth (m)	Lagoon A08 Chl *a*	Lagoon A08 665/665[a]	Lagoon B24 Chl *a*	Lagoon B24 665/665[a]
1/21/75	4.0	2.4	1.30	1.5	1.00
	5.0			0.7	
	6.0			0.6	
2/4	0.5	8.8	1.37	5.2	1.37
	1.0	8.5	1.45	9.0	1.54
	2.0	8.6	1.42	30.3	1.54
	3.0	9.6	1.47	2.9	1.55
	4.0	2.9	1.13	1.2	1.50
	5.0			1.1	1.33
	6.0			1.0	1.17
2/18	0.5	3.4	1.38	4.0	1.31
	1.0	4.9	1.35	9.0	1.39
	2.0	5.8	1.40	5.0	1.33
	3.0	6.6	1.62	2.6	1.19
	4.0	2.6	1.17	1.2	1.13
	5.0			1.0	1.17
	6.0			0.9	1.25
3/4	0.5	5.3	1.27	1.3	1.00
	1.0	5.2	1.37	2.1	1.07
	2.0	6.3	1.41	5.1	1.33
	3.0	7.0		6.7	1.26
	4.0			2.8	
	5.0			1.2	1.00
	6.0			5.7	1.00
4/1	0.5	4.5	1.50	6.2	1.50
	1.0	4.8	1.48	8.3	1.44
	2.0	6.3	1.45	13.5	1.39
	3.0	5.2	1.43	16.0	1.50
	4.0			21.1	1.46
	5.0			16.9	1.25
	6.0			8.0	1.40
4/22	0.5	7.0	1.23	5.0	1.29
	1.0	7.1	1.31	6.7	1.45
	2.0	9.8	1.42	8.5	1.42
	3.0	10.6	1.41	11.2	1.43
	4.0	12.4	1.31	16.6	1.45
	5.0			70.0	1.35
	6.0			30.0	1.35

* 665/665[a] represents the change in absorption of an acetone extract of plant pigment measured at 665 nm before and after dilute acid treatment. A ratio of 1.00 indicates only chlorophyl degradation products are present; a ratio of 1.70 indicates the absence of such phaeo-pigments.

(from June 1975 Annual Report)

Table 18a. Surface phytoplankton net production* (ml $O_2 \cdot l^{-1} \cdot day^{-1}$) from June 1974 to April 1975.

Date	M 21	Meyers Creek mouth	Meyers Pond	ABD	A08	B24
6/20/74	1.18	2.42	2.72	2.36	1.30	1.84
7/3	1.93	2.01	2.77	2.47	1.90	1.67
7/17	1.65	2.24	2.19	2.05	2.54	1.78
8/1	1.30	1.81	2.77	2.15	1.58	1.15
8/13	2.17	2.55	1.46	2.62	2.16	1.01
8/27	1.84	3.59	3.02	2.53	1.43	1.92
9/10	1.50	3.11	2.06	1.49	1.12	0.63
9/25	0.55	1.51	1.29	1.17	2.19	0.88
10/15	0.03	0.40	0.13	0.48	0.38	0.47
10/22	0.21	0.26	0.23	0.24	0.63	3.17
11/4	0.21	0.32	0.42	0.15	0.12	0.73
11/19	-0.02	-0.11	0.00	-0.05	0.15	0.22
12/3	0.27	0.00	0.02	0.27	0.34	0.42
12/27	0.56	0.51	0.46	0.20	0.04	0.05
1/21/75	0.04	-0.21	-0.17	0.05	-0.03	-0.01
2/4	0.00	-0.12		-0.06	0.07	-0.07
2/18	0.15	0.30	0.23	0.16	0.35	0.20
3/4	0.10	-0.19		0.20	0.13	-0.01
3/18	0.07	0.14	-0.02	0.21	0.16	0.38
4/1	-0.05	0.59	-0.93	0.60	0.27	0.29
4/22	0.21	0.56	0.16	0.43	0.56	0.31

Table 18a. Continued.

Date	Dinner Point Creek mouth	Upper Dinner Point Creek	E mouth	E68	E87
6/20/74	1.92	1.70	2.01	3.19	0.78
7/3	2.23	2.03	2.44	3.27	0.28
7/17					
8/1	1.58	2.09	2.21	2.31	0.47
8/13					
8/27	1.90	4.92	3.15	4.68	-0.42
9/10					
9/25	1.52	0.95	1.14	2.99	0.91
10/15					
10/22	0.28	-0.03	0.41	0.17	0.14
11/4					
11/19	-0.07	-0.13	-0.14	-0.09	-0.08
12/3					
12/27	0.81	0.73	0.35	0.50	0.90
1/21/75	0.01	-0.38	-0.08	0.24	-0.09
2/4					
2/18	0.23	0.19	0.09	-0.04	-0.07
3/4					
3/18	0.30	0.00	0.03	-0.01	0.10
4/1					
4/22	0.37	0.00	0.38	0.08	0.21

* Data for 6/20-8/13/74 are taken from January from laboratory incubations. All other values are natural light incubations at 50% of the incoming radiation.

(from June 1975 Annual Report)

Table 18b. Phytoplankton production (ml $O_2 \cdot m^{-2} \cdot day^{-1}$) at Meyers Creek mouth and Lagoon A08 from September 1974 to April 1975.

Date	Meyers Creek mouth			Lagoon A08		
	GP*	R#	NP†	GP	R	NP
9/25/74	1,607	361	1,246	3,395	2,411	984
10/15	500	262	238	1,615	2,878	-1,263
10/22				1,509	1,363	156
11/4	467	287	180	1,173	2,804	-1,631
11/19	49	197	-148	640	1,673	-1,033
12/3	74	90	-16	574	328	246
12/27	336	525	-189	820	1,369	-549
1/21/75	8	98	-90	279	1,009	-730
2/4	107	172	-65	369	1,312	-943
2/18	476	213	263	426	148	278
3/4	98	205	-107	1,263	1,353	-90
3/18	344	189	155	828	779	49
4/1	410	115	295	2,066	1,984	82
4/22	681	107	574	1,591	549	1,042

* GP = Gross production.

\# R = Respiration.

† NP = Net production.

(from June 1975 Annual Report)

Table 19. Net production and respiration of marsh surface algal mats (ml $O_2 \cdot m^{-2} \cdot 12\ h^{-1}$) from December 1974 to April 1975.

Date		*Spartina alterniflora* tall form	*S. alterniflora* short form	*S. patens*	Meyers Creek mouth mudflat
12/12	NP*	18	44	35	96
	R_{Total}#	13	13	75	31
	R_{Bact}†	4	9	22	9
	% Bacterial	31	69	29	29
	% I_o**	17	41	2	100
2/13	NP				132
	R_{Total}				70
3/12	NP	40	68	-4	191
	R_{Total}	88	114	13	154
	R_{Bact}	58	83	4	77
	% Bacterial	66	73	31	50
	% I_o	36	51	5	100
4/9	NP	180	206	13	246
	R_{Total}	48	132	31	193
	% I_o	7	68	4	100

* NP = Net production.

\# R_{Total} = Total community respiration.

† R_{Bact} = Bacterial respiration.

** % I_o = % incoming radiation reaching marsh surface.

(from June 1975 Annual Report)

Table 20. Net production and respiration of benthic microflora and fauna (ml $O_2 \cdot m^{-2} \cdot 12\ h^{-1}$) from January to April 1975.

Date		Meyers Creek mouth	Meyers Pond	ABD	Lagoon A08
1/14	NP*	-18	22	13	-136
	R_{Total}#	75	92	39	144
2/13	NP	0	79	13	-219
	R_{Total}	118	92	53	202
3/26	NP	140	48	4	-272
	R_{Total}	39	88	48	294
	R_{Bact}†		22	53	158
	% Bacterial		25	>100**	54
4/30	NP	167	83	26	-316
	R_{Total}	96	382	149	329
	R_{Bact}	31	158	39	158
	% Bacterial	32	41	26	48

* NP = Net production.

\# R_{Total} = Total community respiration.

† R_{Bact} = Bacterial respiration.

** Due to the limits of the method, this value probably indicates only bacterial respiration was taking place.

(from June 1975 Annual Report)

Table 21. Sample calculations for daily system totals of nitrogen processed or present in Meyers Creek system and Lagoon System A in April. Rooted vegetation was not included. Quantities presented as g-atom N·system^{-1}·day^{-1}.

Parameter			Meyers Creek system	Lagoon A08
1. STANDING STOCK				
Aquatic NH_3-N			0.044	0.000
NO_2-N			0.000	0.000
NO_3-N			0.044	0.290
Total organic-N			3.0*	24.0*
Total standing stock			3.1	24.3
2. INPUT				
N fixation	Bulkhead algae		0.00	9.50*
	Algal mat:	*S. alternifloraa* short form	130.00*	
		S. alternifloraa tall form	0.23	
		S. patens	0.00	
	Soil:	*S. alternifloraa* short form	24.00*	
		S. alternifloraa tall form	0.12	
		S. patens	0.00	
	Benthic sediments		0.18	1.00
Total input			154.53	10.50
3. EXCRETION				
	Modiolus		1.6	
	Ilyanassa		52.0*	140.0*
	Zooplankton		2.1	44.0
Total excretion			55.7	184.0
4. N REQUIRED				
	Phytoplankton		40.0	270.0*
	Algal mat:	*S. alternifloraa* short form	140.0*	
		S. alternifloraa tall form	1.8	
	Benthic sediments		16.0	2.1
Total N required			197.8	272.1

* Maximum value within a category at a particular site.

(from June 1975 Annual Report)

APPENDIX C

Tables and Figures from the July 1976 Estuarine Evaluation Study Annual Report: Primary Aquatic Productivity and Nitrogen

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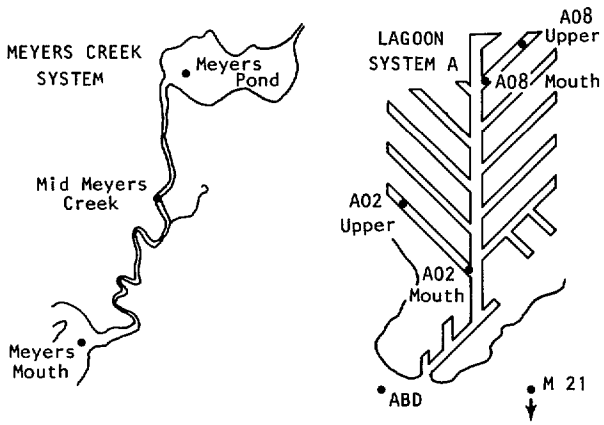

Fig. 1. Station locations.

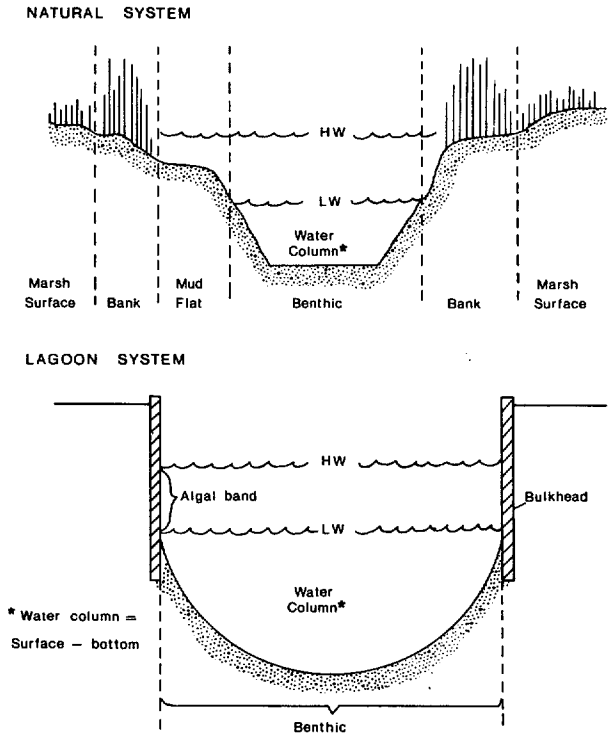

Fig. 2. Cross sections of the natural and lagoon systems.

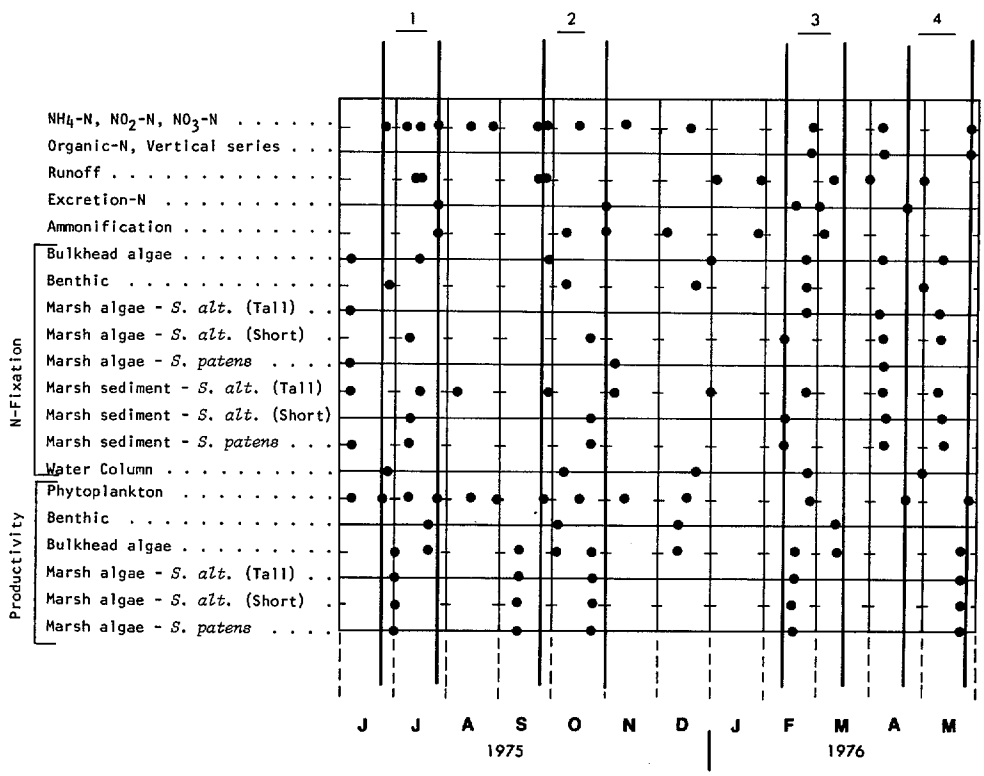

Fig. 3. Sampling schedule. The columns labeled 1 through 4 represent pooled data periods.

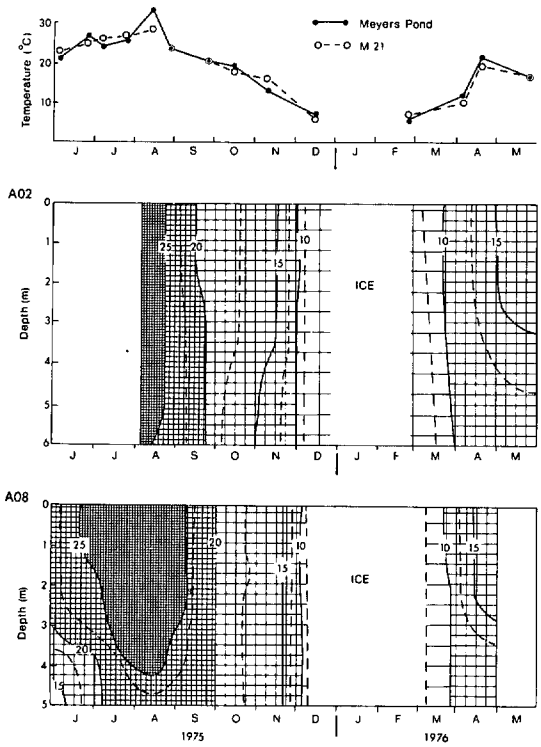

Fig. 4. Water temperature at the surface of M 21 and Meyers Pond and contoured plots for Lagoon A02 and A08 in °C.

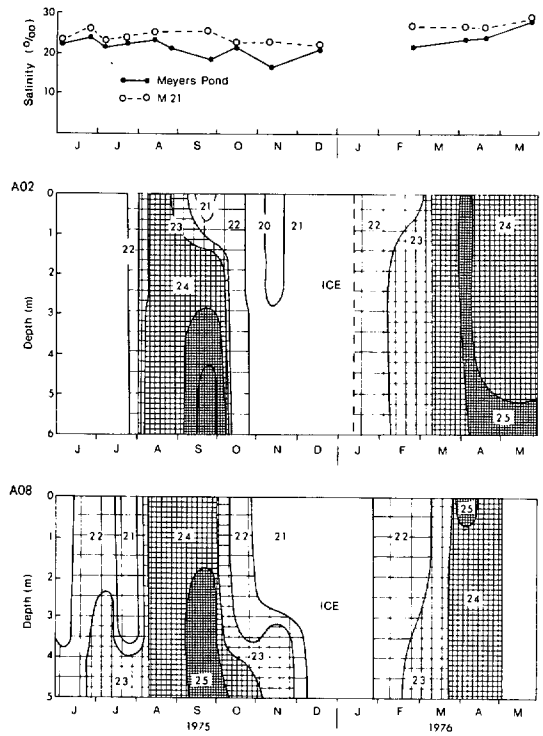

Fig. 5. Salinity at the surface of M 21 and Meyers Pond and contoured plots for Lagoons A02 and A08 in °/oo.

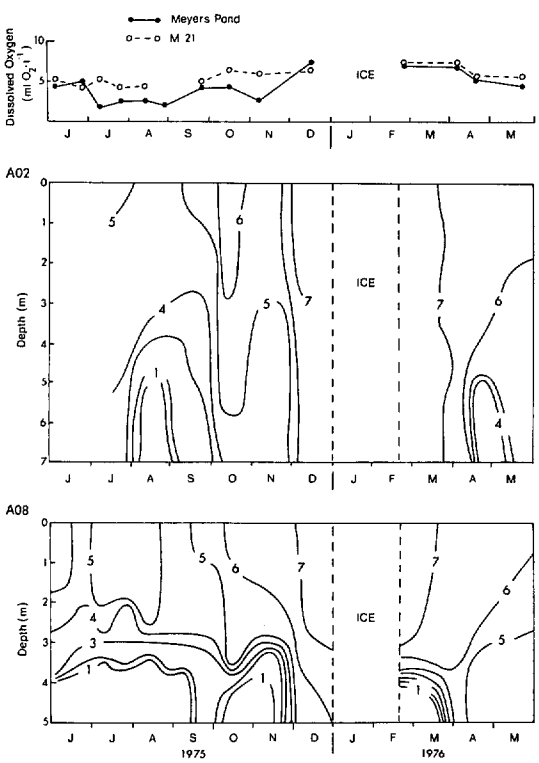

Fig. 6. Dissolved oxygen concentrations at the surface of M 21 and Meyers Pond and contoured plots for Lagoons A02 and A08 in (ml $O_2 \cdot l^{-1}$).

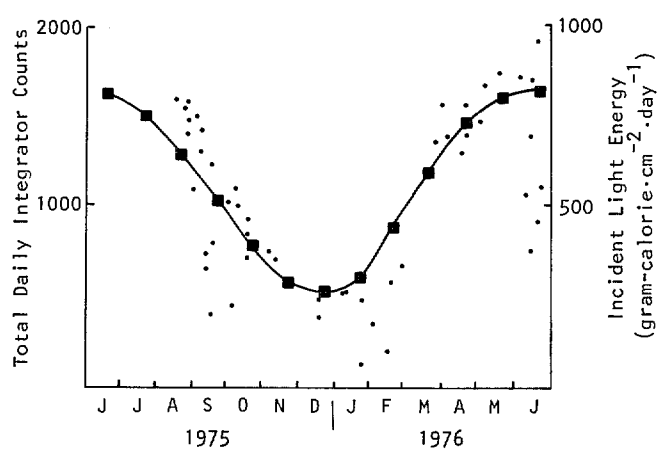

Fig. 7. Incident light energy plots from Kimball's tables (1928) (■—■) and Licor measurements at the Little Egg Research Station.

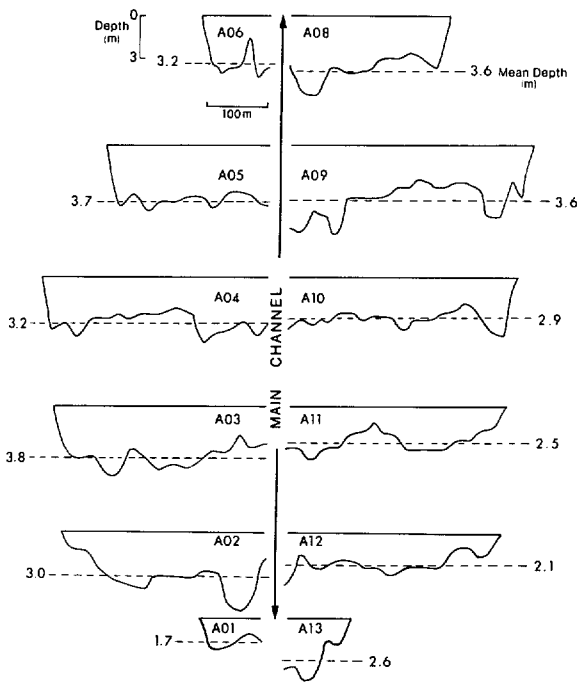

Fig. 8. Longitudinal sections of the lagoons.

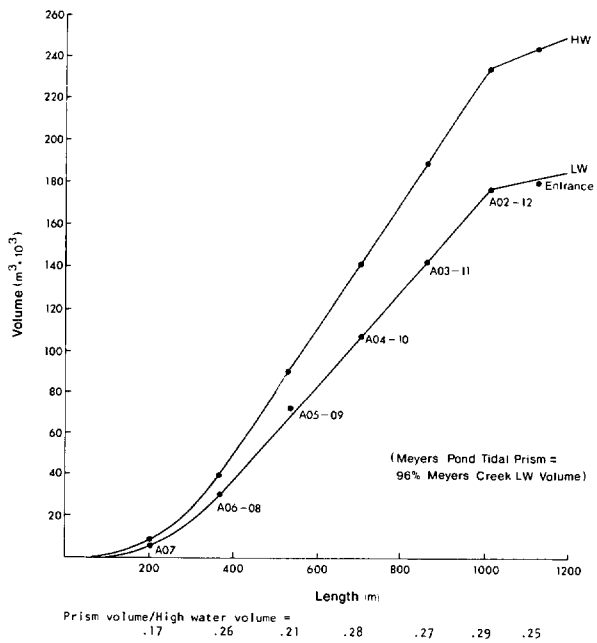

Fig. 9. Lagoon System A volume to system length relationship. High and low water volumes are indicated.

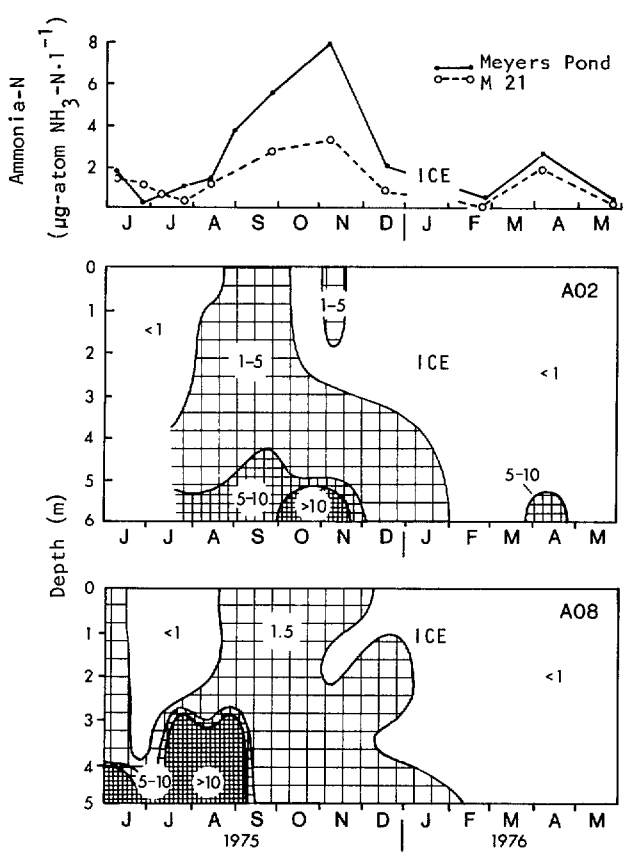

Fig. 10. Ammonia-N concentrations at the surface of M 21 and Meyers Pond and contoured plots for Lagoons A02 and A08 in µg-atom NH_3-N·l^{-1}.

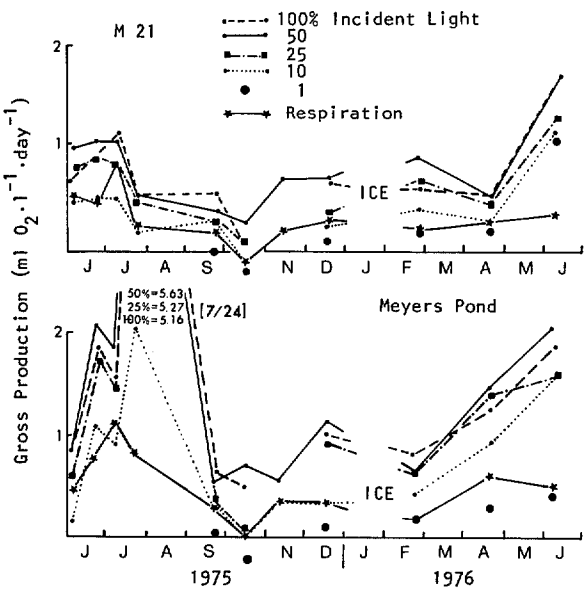

Fig. 11. Gross production values at M 21 and Meyers Pond.

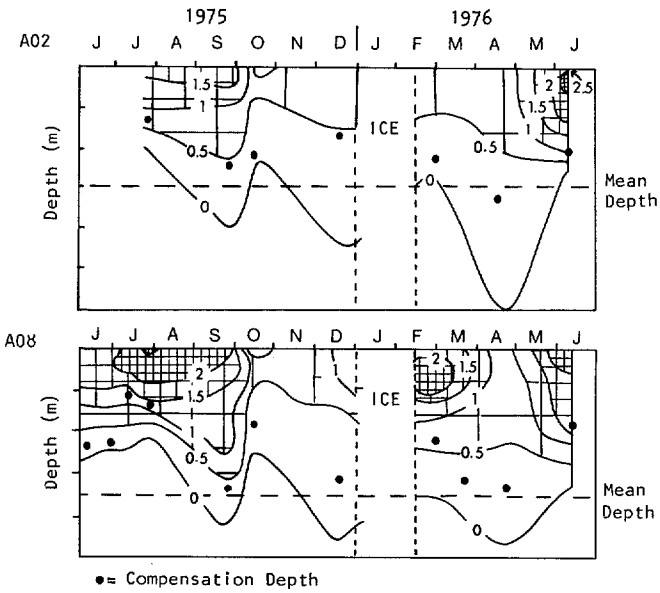

Fig. 12. Gross production values (ml $O_2 \cdot l^{-1}$) at Lagoons A02 and A08.

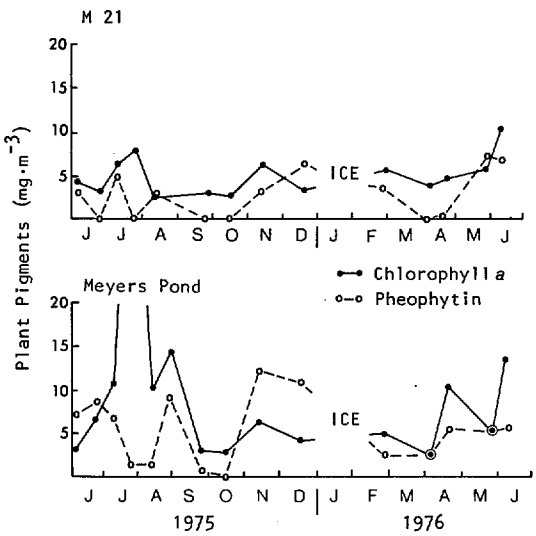

Fig. 13. Plant pigment concentrations at M 21 and Meyers Pond.

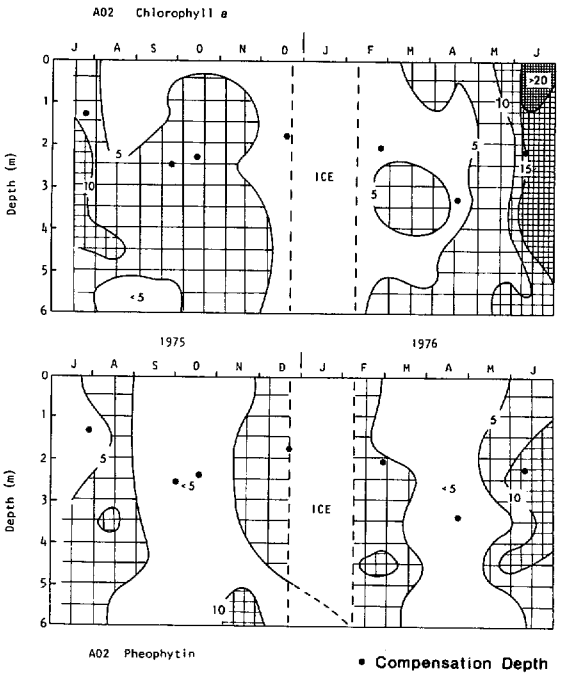

Fig. 14. Contoured plant pigment concentrations ($mg \cdot m^{-3}$) at Lagoon A02.

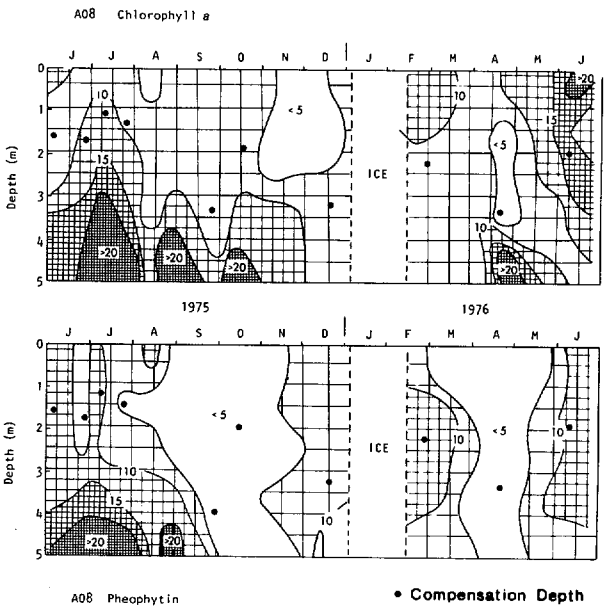

Fig. 15. Contoured plant pigment concentrations ($mg \cdot m^{-3}$) at Lagoon A08.

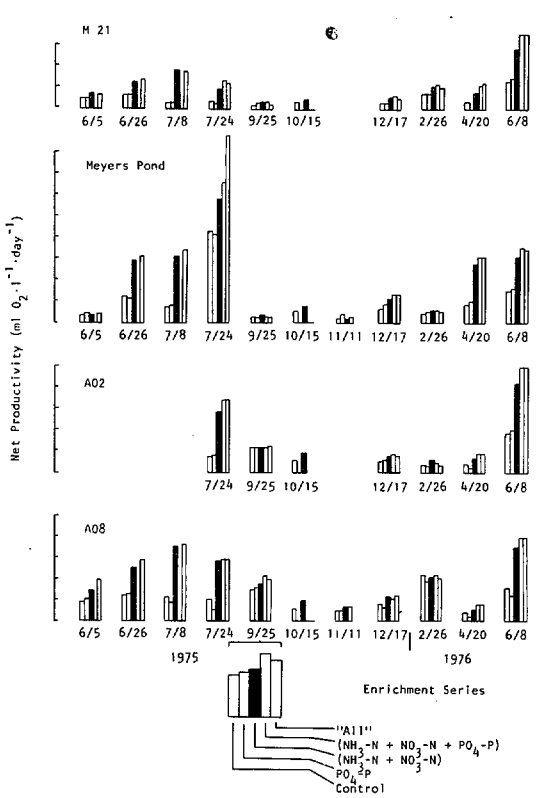

Fig. 16. Production and nutrient enrichment experiments at M 21, Meyers Pond, Lagoon A02, and Lagoon A08.

Table 1. Secchi disc measurements (m).

Date	Meyers Pond	Meyers Creek	A08	A02	ABD	M 21
6/5/75	1.0		1.0		1.4	1.3
6/26	0.7		0.9		0.8	1.3
7/8	0.9		0.9		0.7	1.2
7/24	0.6	0.6	0.8	0.8	0.8	1.5
8/13	0.7	1.0	1.2	1.6	1.1	1.7
8/28	0.5		1.1			
9/25	0.9	0.9	1.5	1.3	1.2	1.3
10/15	>0.6	2.1	1.6	1.8	1.8	2.8
11/11	0.2	0.3	1.1	1.2	1.3	1.7
12/17	0.9	0.9	1.7	1.5	1.1	0.9
2/26/76	0.7	0.8	1.2	1.5	1.1	0.9
4/6	>0.5	1.2	1.5	1.4	1.7	1.7
4/20	0.3	0.6	1.6	1.6	1.4	1.1
5/26	0.9	0.8	0.8	0.8	0.9	0.9
N	12	10	14	10	13	13
$\overline{X}$	0.7	0.9	1.2	1.4	1.2	1.4
S D	0.25	0.48	0.32	0.33	0.34	0.51
($\overline{X}$•mean depth^{-1})	1.67	0.75	0.33	0.47	0.60	1.40

(from July 1976 Annual Report)

Table 2. The % incident light that penetrates the marsh surface vegetation.

Date	*Spartina alterniflora*, tall form	*Spartina alterniflora*, short form	*Spartina patens*
7/1/75	80	68	2
7/15	33	57	5
8/6	43	83	
9/10	2	6	0
9/30	5	12	4
10/23			3
12/29	1	2	0
2/12/76	20	18	0
2/17	37	57	4
4/8	11	8	3
5/10	9	22	1
5/20	18	34	0

(from July 1976 Annual Report)

Table 3. Bathymetry and other features of Meyers system and Lagoon System A.

Parameter	Meyers Pond	Meyers Creek	Lagoon A08	Lagoon A02	Lagoon System A
Mean depth, (m)	0.42	1.20	3.60	3.00	3.00
Perimeter, (m)	1,255	2,348	445	619	8,287
Tide range, (m)	0.46	0.46	0.46	0.46	0.46
Area water surface (m^2)	43,000	23,000	6,763	9,067	148,566
Drainage area (m^2)	200,365	223,517	18,208	26,941	284,720
Volume (m^3)	18,000	22,000	14,800	16,000	190,100
Tidal prism volume (m^3)	10,500	9,400	3,100	3,500	42,596
Volume (m^3) for interval:					
0-1 m			6,300	7,700	92,600
1-2 m			4,000	4,400	57,500
2-3 m			3,000	2,500	27,600
3-4 m			1,200	1,000	10,200
4-5 m			200	300	1,800
5-6 m			100	100	400

(from July 1976 Annual Report)

Table 4. Nitrate-N, (μg-atom NO_3-N$\cdot l^{-1}$) at M 21, Meyers Pond, Lagoon A02, and Lagoon A08.

Location	6/26/75	7/8	7/24	8/13	8/28	9/25	10/15	11/11	12/17	2/26/76	4/6	5/26
M 21:												
Surface	0.1	0.0	0.1	0.0		0.6		0.8	0.0	0.2	0.2	0.1
Meyers Pond:												
Surface	0.1	0.0	0.0	0.0	0.6	1.8		0.7	1.4	0.2	0.1	0.1
Lagoon A02:												
Surface			0.3	0.0		2.3	0.4	0.4	0.0	0.0	0.0	0.0
1 m			0.4	0.0		1.5	0.2	0.0	0.1	0.1	0.1	0.0
2			0.5	0.0		1.2	0.2	0.0	4.4	0.1	0.0	0.0
3			0.5	0.0		0.7	0.1	0.2	0.1	0.2	0.0	0.0
4			0.5	0.0		0.5	0.2	0.0	0.0	0.2	0.0	0.1
5			0.5	0.0		0.5	0.2	0.7	0.2	0.3	0.1	0.0
Lagoon A08:												
Surface	0.2	0.2	0.6	0.0	0.5	0.8	0.3	0.4	0.0	0.2	0.0	0.1
1 m	0.1	0.1	0.5	0.0	0.5	0.4	0.2	0.4	0.4	0.1	0.0	0.1
2	0.1	0.1	0.4	0.0	0.7	0.4	0.0	0.4	0.3	0.2	0.0	0.1
3	0.0	0.0	0.3	0.0	0.4	1.0	1.1	0.5	0.0	0.2	0.1	0.1
4	0.0	0.0	0.2	0.0	0.0	1.4	0.0			0.1	0.1	0.2

(from July 1976 Annual Report)

Table 5. Total organic-N (μg-atom Org-N·l^{-1}) at M 21, Meyers Pond, Lagoon A02, and Lagoon A08.

Location	6/26/75	7/8	7/24	8/13	9/25	10/15	11/11	12/17	2/26/76	4/6	5/26
M 21:											
Surface	33	33	27	36	22		39	39	26	30	38
Meyers Pond:											
Surface	46	40	66	48	36		74	40	40	30	40
Lagoon A02:											
Surface			42	40	43	29	28	49	29	25	46
Bottom			34	42		26	34	36	34	38	37
Lagoon A08:											
Surface	51	41	53	44	40	34	28	39	52	43	51
Bottom	56	104	26	25	36	35	49	45	55	55	

(from July 1976 Annual Report)

Table 6. Nitrogen fixation rates in μg-atom NH_3-N·m^2·24 h^{-1}.

Sample	Quarterly period				$\bar{Y}_Q$*
	July	October	February	May	
Bulkhead algae:					
Upper zone	2,866	2,103	174	9,053	3,549
Lower zone	439	228	56	474	299
Benthic sediment:					
Lagoon System A	17	13	2	3	9
Meyers Creek system	36	38	0	3	19
S. alterniflora, short form:					
Algal mat	2,412	501	7	32	738
Mud substrate	243	882	21	8	289
S. patens:					
Mud substrate	103	7	0	4	28
S. alterniflora, tall form:					
Bank algal mat	7,704	669	24	1	2,100
Bank mud substrate	88	619	1	119	207
Water column:	0	0	0	0	0

* Quarterly mean value

(from July 1976 Annual Report)

Table 7. Nitrogen fixation: total fixation (mg-atom NH_3-N·24 h^{-1}) by each category in the indicated system.

Sample	Quarterly period				
	July	October	February	May	$\overline{Y}_Q$*
Bulkhead algae in Lagoon System A:					
Upper zone	2,802	2,291	123	12,379	4,399
Lower zone	942	456	76	1,247	680
Total	3,744	2,747	199	13,626	5,079
Benthic sediment:					
Lagoon System A	2,482	1,907	260	464	1,278
Meyers Creek system	2,358	2,509	0	175	1,261
S. alterniflora, short form, Meyers system:					
Algal mat	90,080	123,108	1,331	2,321	54,210
Mud substrate	58,583	28,996	1,678	1,733	22,748
Total	148,663	152,104	3,009	4,054	76,958
S. patens Meyers Creek system:					
Mud substrate	17,535	1,161	0	612	4,827
S. alterniflora, tall form, Meyers system:					
Bank algal mat	10,558	1,391	45	3	2,999
Bank mud substrate	255	2,271	2	335	716
Total	10,813	3,662	47	338	3,715
Water column:	0	0	0	0	0

* Quarterly mean value

(from July 1976 Annual Report)

Table 8. Ammonia-N excretion by *Ilyanassa*, rates per organism and rates per Meyers Creek and Meyers Pond.

Rates	Quarterly Period July	October	February	May	$\overline{Y}_Q$*
Meyers Creek:					
(μg-atom NH_3-N·organism^{-1}·24h^{-1})	1.56	4.06	11.95	4.19	5.44
Meyers Creek plus Meyers Pond:					
(mg-atom NH_3-N·24 h^{-1})	1,949	5,071	14,925	5,234	6,795

* Population size: Meyers Pond, 3.753 x 10^5 organisms and Meyers Creek, 8.737 x 10^5 organisms.

Quarterly mean value.

Table 9. Ammonia-N excretion by zooplankton, rates·m^{-3} and rates·system^{-1}. Rates·system^{-1} calculated to mean depth.

Rates	Quarterly period July	October	February	May	$\overline{Y}_Q$*
Volume rates					
(μg-atom NH_3-N·m^{-3}·24 h^{-1}):					
Meyers Creek	27.16	4.60		57.75	22.38
Lagoon A02	2.09	4.08	10.55	139.85	39.14
Lagoon A08	10.92	2.75	3.05	86.05	25.69
Lagoon System A	6.33	3.44	6.95	114.00	32.68
System rates					
(mg-atom NH_3-N·system^{-1}·24 h^{-1}):					
Meyers Creek	597.5	101.2		1,270.5	492.3
Meyers Creek system	1,086.4	184.0		2,310.0	895.1
Lagoon A02	30.5	59.6	154.0	2,041.8	571.5
Lagoon A08	152.9	38.5	42.7	1,204.7	359.7
Lagoon System A	1,562.2	849.0	1,715.3	28,135.2	8,065.4

* Quarterly mean value

(from July 1976 Annual Report)

Table 10. Ammonia-A excretion by *Ilyanassa*, rates·organism^{-1} and rates·system^{-1}.*

Rates	Quarterly period July	October	February	May	$\overline{Y}_Q$ #
Organism rates					
(μg-atom NH_3-N·organism^{-1}·24 h^{-1}):					
Meyers Creek	1.02	0.53	1.34	1.59	1.12
Meyers Pond		0.58	0.86	2.10	1.18
Lagoon A02	0.69	0.58	1.44	2.15	1.22
Lagoon A08	1.13	0.54	0.98	2.75	1.35
Lagoon System A	0.88	0.56	1.24	2.41	1.27
System rates					
(mg-atom NH_3-N·system^{-1}·24 h^{-1}):					
Meyers Creek	563.0	292.6	739.7	877.7	618.3
Meyers Pond		598.6	887.5	2,167.2	1,217.8
Meyers Creek system		891.2	1,627.2	304.9	1,854.4
Lagoon A02	237.7	199.8	496.1	740.8	418.6
Lagoon A08	290.4	138.8	251.9	706.7	347.0
Lagoon System A	4,968.0	3,161.5	7,000.4	13,605.7	7,183.9

* Population size: Meyers Creek system, 24 organisms·m^{-2} and Lagoon System A, 38 organisms·m^{-2}.

\# Quarterly mean value

(from July 1976 Annual Report)

Table 11. Ammonification (ammonia-N regenerated by sediments): rates·m^{-2} and rates·$system^{-1}$.

	Quarterly period				
	July	October	February	May	$\overline{Y}_Q$*
m^2 rates					
(μg-atom NH3-N·m^{-2}·24 h^{-1}):					
Meyers Creek	1,258.0	2,095.4	68.1	1,732.2	1,038.4
Meyers Pond		1,381.6		3,611.4	1,664.3
Lagoon A02	1,127.2	2,406.4	5,260.8	6,038.7	3,708.3
Lagoon A08	614.8	1,537.1	694.7	725.2	893.0
Lagoon System A	908.3	2,035.0	3,310.0	3,768.6	2,505.5
System rates					
(mg-atom NH_3-N·$system^{-1}$·24 h^{-1}·10^3):					
Meyers Creek	28.9	25.2	1.6	39.8	23.9
Meyers Pond		59.4		155.3	71.6
Meyers Creek system		84.6	1.6	195.1	93.8
Lagoon A02	10.2	21.8	47.7	54.8	33.6
Lagoon A08	4.2	10.4	4.7	4.9	6.1
Lagoon System A	134.9	302.3	491.8	559.9	372.2

* Quarterly mean value

(from July 1976 Annual Report)

Table 12. Nitrogen contributed through runoff and rainfall (mg-atom N·quarter^{-1}·10^3).

Sample	Quarterly period July	Quarterly period October
Road runoff:		
Lagoon A02	5.9	2.4
Lagoon A08	4.4	1.6
Roof runoff:		
Lagoon A02	5.3	5.5
Lagoon A08	4.2	5.5
Lagoon surface:		
Lagoon A02	33.4	14.7
Lagoon A08	26.3	10.3
Total:		
Lagoon A02	44.6	22.6
Lagoon A08	34.9	17.4
Meyers Creek system:		
Water surface	248.6	105.8
Marsh surface	1,682.6	718.8
Total	1,931.2	824.6

(from July 1976 Annual Report)

Table 13. Benthic algal community net production (NP) and respiration (R) (ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$).

Parameter		7/17/75	10/2/75	12/11/75	3/12/76
Meyers Pond	NP	159	-523	-64	-85
	R	464	874	170	462
Meyers Creek	NP		-298	-85	-114
	R		356	192	520
Meyers Creek mouth	NP	-85	-266	-105	-88
	R	158	228	6	398
Lagoon A02*	NP		-32	-231	-58
	R		590	198	468
Lagoon A08	NP	#	120	364	-287
	R	#	380	638	638
ABD	NP	-228			
	R	690			

*Benthic data extrapolated from results for Lagoon A12 mouth.

#Bottom depths anaerobic

(from July 1976 Annual Report)

Table 14. Marsh surface algal community and bulkhead algal community net production (NP) and respiration (R) (ml $O_2 \cdot m^{-2} \cdot 24\ h^{-1}$).

Parameter		Sampling data				
Marsh surface algae zone:						
Date		7/1/75	9/10/75	10/23/74	2/17/76	5/20/76
S. patens	NP	44	-71	-158	-79	-170
	R	150	80	258	204	432
S. alterniflora, short form	NP	211	257	120	-53	298
	R	324	398	182	146	316
S. alterniflora, tall form	NP	250	178	129	-85	241
	R	202	188	182	198	356
Bulkhead algae:						
Date		7/17/75	10/2/75	12/11/75	2/17/76	3/12/76
Upper main channel	NP	-237	1,052	1,240	149	373
	R	894	550	432	550	1,438
Mid main channel	NP	-219	1,210	696	-47	146
	R	1,042	446	380	520	422
Lower main channel	NP	-211	947	436	47	281
	R	854	520	492	450	340

(from July 1976 Annual Report)

Table 15. Available inorganic nitrogen: Sum of ammonia-N, nitrate-N, N fixation, ammonification, and excretion.

Rates	Quarterly period				
	July	October	February	May	$\overline{Y}_Q$*
Area rate (m^2-atom $N \cdot m^{-2}$):					
Meyers Pond	1.65	4.68	0.44	3.85	2.66
Meyers Creek	2.50	7.77	0.65	3.30	3.56
Lagoon A02	2.68	7.93	5.70	6.80	5.78
Lagoon A08	3.46	5.49	2.54	1.79	3.32
ABD	2.78	6.72	0.66	3.06	3.31
M 21	2.15	4.52	0.26	2.90	2.46
Volume rate (mg-atom $N \cdot m^{-3}$):					
Meyers Pond	3.95	11.18	1.06	9.19	6.35
Meyers Creek	2.60	8.13	0.68	3.45	3.72
Lagoon A02	1.52	4.49	3.23	3.86	3.28
Lagoon A08	1.58	2.51	1.16	0.82	1.52
ABD	1.39	3.36	0.33	1.53	1.65
M 21	2.15	4.53	0.26	2.90	2.46

*Quarterly mean value

(from July 1976 Annual Report)

Table 16. Nitrogen fractions as percent of available inorganic nitrogen.

Location	NH_3-N	NO_3-N	N fixation	Ammonification	Excretion
July quarter:					
Meyers Pond	16.9	0.8	3.10	76.1	3.0
Meyers Creek	42.1	1.2	2.10	50.2	4.4
Lagoon A02	39.9	13.2	3.70	42.0	1.1
Lagoon A08	60.7	16.7	2.80	17.9	1.9
ABD	36.0	14.4		46.8	2.8
M 21	32.5	4.6		60.4	2.4
October quarter:					
Meyers Pond	49.2	16.1	4.10	29.5	1.1
Meyers Creek	61.5	22.1	0.02	14.1	2.2
Lagoon A02	40.1	28.5	0.80	30.3	0.4
Lagoon A08	50.1	19.7	1.80	28.0	0.5
ABD	61.0	20.8		17.8	0.3
M 21	59.8	13.3		26.6	0.4
February quarter:					
Meyers Pond	37.8	18.9	0.30	15.4	27.6
Meyers Creek	0.0	14.7	0.00	10.5	74.8
Lagoon A02	4.4	1.9	0.03	92.3	1.3
Lagoon A08	54.7	14.5	1.70	27.3	1.7
ABD	61.0	30.5		4.6	4.0
M 21	0.0	78.1		11.7	10.2
May quarter:					
Meyers Pond	1.1	1.8	0.30	93.8	2.9
Meyers Creek	34.8	2.9	2.10	52.5	7.7
Lagoon A02	0.2	0.0	7.10	88.8	4.0
Lagoon A08	17.4	12.4	13.90	40.5	15.8
ABD	0.0	6.5		88.2	5.2
M 21	0.0	3.4		93.0	3.5

(from July 1976 Annual Report)

Table 17. Available inorganic nitrogen as percent of total organic nitrogen.

Location	Quarterly period July	October	February	May	$\overline{Y}_Q$*
Meyers Pond	7.8	31.3	2.6	23.0	16.2
Meyers Creek	6.0	28.9	2.2	8.6	11.4
Lagoon A02	3.6	12.4	11.1	9.2	9.1
Lagoon A08	3.3	7.1	2.2	1.6	3.6
ABD	3.2	11.6	1.1	3.7	4.9
M 21	6.9	20.2	9.8	7.6	11.1

*Quarterly mean value

Table 18. Nitrogen required: Calculated from net oxygen production by phytoplankton community, benthic algal community, and bulkhead or bank algal community.

Location	Quarterly period July	October	February	May	$\overline{Y}_Q$ *
Area rates ($mg\text{-}atom\ N \cdot m^{-2}$):					
Meyers Pond	1.97	-0.82	0.43	0.57	0.54
Meyers Creek	2.93	0.23	1.20	1.53	1.47
Lagoon A02	0.71	2.14	0.45	0.63	0.98
Lagoon A08	0.49	3.93	4.91	0.81	2.54
ABD	1.40	0.70	0.85	0.78	0.93
M 21	0.30	-0.20	1.15	0.38	0.41
Volume rates ($mg\text{-}atom\ N \cdot m^{-3}$):					
Meyers Pond	4.71	-1.96	1.03	1.36	1.29
Meyers Creek	3.06	0.25	1.26	1.60	1.54
Lagoon A02	0.40	1.22	0.26	0.36	0.56
Lagoon A08	0.22	1.80	2.24	0.37	1.16
ABD	0.70	0.35	0.52	0.39	0.49
M 21	0.30	-0.20	1.15	0.38	0.41

*Quarterly mean value

(from July 1976 Annual Report)

Table 19. Percent gross production according to producer community; total producer community respiration as percent gross production.

Location	Phytoplankton	Benthic algae	Bulkhead algae	Bank algae	Respiration
July quarter:					
Meyers Pond	84	15		1	50
Meyers Creek	87	11		2	46
Lagoon A02	99	*	1		82
Lagoon A08	100	*	<1		92
ABD	84	16			80
M 21	66	34			91
October quarter:					
Meyers Pond	41	58		1	154
Meyers Creek	85	10		5	85
Lagoon A02	68	31	1		52
Lagoon A08	78	21	1		38
ABD	105	-5			65
M 21	115	-15			121
February quarter					
Meyers Pond	46	53		<1	76
Meyers Creek	64	35		1	69
Lagoon A02	62	37	<1		81
Lagoon A08	91	9	<1		50
ABD	68	32			75
M 21	64	36			60
May quarter:					
Meyers Pond	59	40		2	76
Meyers Creek	71	25		4	62
Lagoon A02	72	28			81
Lagoon A08	78	22			80
ABD	74	26			75
M 21	63	37			83

*Anaerobic at bottom

(from July 1976 Annual Report)

Table 20. Gross production: Sum of the gross production by phytoplankton community, benthic algal community, and bulkhead or bank algal community.

	Quarterly period				
	July	October	February	May	$\overline{Y}_Q$*
Area rate ($ml\ O_2 \cdot m^{-2}$):					
Meyers Pond	1,581	606	708	953	962
Meyers Creek	2,177	610	1,172	1,599	1,399
Lagoon A02	1,555	1,792	1,098	1,328	1,443
Lagoon A08	2,529	2,419	3,925	1,620	2,623
ABD	2,920	780	1,270	1,170	1,535
M 21	1,340	272	1,147	834	898
Volume rate ($ml\ O_2 \cdot m^{-3}$):					
Meyers Pond	3,777	1,448	1,691	2,277	2,298
Meyers Creek	2,178	611	1,173	1,600	1,391
Lagoon A02	882	1,016	623	753	819
Lagoon A08	1,156	1,105	1,794	740	1,199
ABD	1,460	390	635	585	768
M 21	1,340	272	1,147	834	898

*Quarterly mean value

(from July 1976 Annual Report)

Table 21. Respiration: Sum of the oxygen consumed by phytoplankton community, benthic algal community, and bulkhead or bank algal community.

	Quarterly period				
	July	October	February	May	$\overline{Y}_Q$*
Area rate: ($ml\ O_2 \cdot m^{-2}$):					
Meyers Pond	791	933	538	724	747
Meyers Creek	1,001	519	809	991	830
Lagoon A02	1,275	932	889	1,076	1,043
Lagoon A08	2,327	919	1,963	1,296	1,626
ABD	2,336	507	953	878	1,169
M 21	1,219	329	688	692	732
Volume rate ($ml\ O_2 \cdot m^{-3}$):					
Meyers Pond	1,890	2,229	1,285	1,730	1,784
Meyers Creek	1,046	542	845	1,036	867
Lagoon A02	723	528	504	610	591
Lagoon A08	1,063	420	897	592	743
ABD	1,168	254	477	439	585
M 21	1,219	329	688	692	732

*Quarterly mean value

(from July 1976 Annual Report)

2. ESTUARINE EVALUATION STUDY: A FOUR YEAR REPORT OF PRODUCTION AND DECOMPOSITION DYNAMICS OF SALT MARSH COMMUNITIES OF THE MANAHAWKIN MARSHES, OCEAN COUNTY, NEW JERSEY.

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27 Estimated initial dry root weight, actual dry root weight, and actual-initial dry root weight difference for belowground samples collected from 23 June 1976 to 21 November 1976 at Mud Cove 2.49

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ABSTRACT/SUMMARY

In an effort to evaluate the role of salt marsh systems in contributions to the estuary and in particular the role of a 800 ha tract in Ocean County, New Jersey known as the Manahawkin marshes, the New Jersey Department of Environmental Protection funded Rutgers University for a 4 year period beginning July 1973. Included in the overall study was the section on the production dynamics of the marsh vascular plant system that is reported here.

This marsh plant productivity study was designed to determine the role of vascular plants in the estuarine ecosystem at Manahawkin. Investigation of the contribution of these communities focused on two basic processes: primary production and decomposition. Photosynthetically fixed energy was traced through aboveground, belowground, and decomposing phases to determine the quality and quantity of organic matter formed. Plant tissues from each component and each community were further analyzed to measure energy transfer into various carbon pathways.

Emphasis during the first 2 years of the study was placed on measurement of net primary productivity of growing plants, observations of environmental conditions, and laboratory analysis of plant tissues. The aboveground portion of the *Spartina alterniflora* short form (SAS) plant community, the major vegetation type studied, was found to yield a total of 5×10^3 $kg \cdot ha^{-1}$ annually. The belowground portion of SAS provided an additional 30×10^3 $kg \cdot ha^{-1}$ in the top 30 cm. The total energy content, varying with component, age, and sublevel, was approximately 4.6 $kcal \cdot g^{-1}$. Total energy produced by this form of *Spartina* for the Manahawkin marshes was estimated at 5.12×10^9 kcal (annual net production) which amounts to 16.0×10^3 $kcal \cdot m^{-2}$; comparing favorably with the world's most productive ecosystems. Standing crops of crude fiber and nitrogen free extract (above and belowground), crude fat (aboveground), and crude protein (belowground) were found to be a function of dry weight biomass. Accumulation of crude protein in aboveground material during the early growing season may act to offset shortages of nitrogen at the peak of the growing season.

The 1975-76 study emphasized the decomposition of this production. Decomposition was measured by analyzing bagged plant material left on the marsh to decompose. This material (detritus) formed in the decomposition process represents an energy transfer phase from the primary producer to consumer, which provides the important link in the energy flow system of the marsh. During the study it was observed that the different growth forms of *S. alterniflora* decompose at different rates, the taller forms losing material faster than the short form. There is also some indication that the belowground portions decompose at a rate of only 20% per year.

Chemical analysis of decomposing aboveground material revealed an increase in percent crude protein by the end of the study period. This increase is attributed to microbial colonization of the detritus. It is felt that this colonization makes detritus a good food source for consumers in the estuarine food chain.

Since this study has shown that production exceeds decomposition for the high marsh species at Manahawkin (especially *S. patens*) it is suggested that the net difference becomes incorporated into the marsh peat. It is concluded that marsh stability depends on a balance between production, decomposition,

detrital export, accumulation, and incorporation, all of which must be in balance with seasonal tidal fluctuations and sea level to maintain the marsh on a long-term basis.

INTRODUCTION

Coastal New Jersey is composed of approximately 10^6 ha of tidal wetlands, two-thirds of which are salt marshes with the remainder in the freshwater marsh category. Up to the early part of the 20th Century very little destructive use was made of these marsh areas, but as the population increased so too increased industrial, commercial, and recreational utilization. Salt marshes were utilized as sites for dredge spoil, industrial plants, and more recently marinas and housing. Utilization of marshes for lagoon housing (waterfront living) represents New Jersey's largest loss category in recent years. New Jersey's Wetland Act of 1970 (A505) began the process of regulating the use of the wetland resources. Other Mid-Atlantic states have since enacted laws to regulate usage of their wetlands. Although little was done prior to 1970, the Federal Government had enacted the River and Harbor Act in 1899 (commonly known as the Refuse Act). House Report No. 91-917 (1970) entitled "Our Waters and Wetlands: How the Corps of Engineers Can Help Prevent Their Destruction and Pollution" analyzed how the Corps might more adequately fulfill its responsibilities under the Refuse Act of 1899.

The early regulations were developed without strong documentation of the value of these resources. Over the years there has developed greater evidence for the necessity to preserve our wetlands. Some of the principal findings include the importance of marshes as a source of food for estuarine animals in the form of detritus and the use of the marsh proper as a habitat for a part of the life cycle of many commercial fishes (Keefe and Boynton 1973; Odum 1961; Reed and Moisan 1971). In the last 20 years ecological evidence began to point strongly to a vital link between the terrestrial and marine environments.

In spite of regulations for usage of New Jersey's wetlands in 1970, a number of large salt marsh tracts were being threatened with destruction for lagoon development. The State of New Jersey, Department of Environmental Protection, Division of Fish, Game and Shellfisheries was particularly concerned with a 800 ha tract of tidal marsh in Ocean County, New Jersey known as the Manahawkin marshes (Figure 1) located between Mill Creek on the north, Little Egg Harbor on the east, Cedar Run on the south, and the upland border to the northwest. The area north of Mill Creek was formerly tidal marsh and had been largely developed for waterfront living. The Manahawkin marsh tract is typical of the marshes along this area of New Jersey's coast near Atlantic City dominated by the short form of *Spartina alterniflora* (saltwater cordgrass) with lesser amounts of *Spartina patens* (salt hay) and *Distichlis spicata* (salt grass). Along streams and waterways where the marsh is regularly flooded, the tall form of *Spartina alterniflora* dominates. Thus this wetland "prairie" is dominated by relatively few species with large populations although a number of other species are present in small numbers (Appendix B).

The Department of Environmental Protection asked investigators from the Marine Sciences Center, Rutgers University (presently called the Center for Coastal and Environmental Studies) to carry out a long-term study to evaluate this system under the title Estuarine Evaluation Study. The objectives of the study were to evaluate the role of a New Jersey salt marsh system in the contributions of the estuary: (1) to the food chains of fish and wildlife; (2) as habitat; (3) to recreation; and (4) to food for man and to document this role for use in legal actions. This report has been concerned with the Marsh Plant Productivity phase of the overall study.

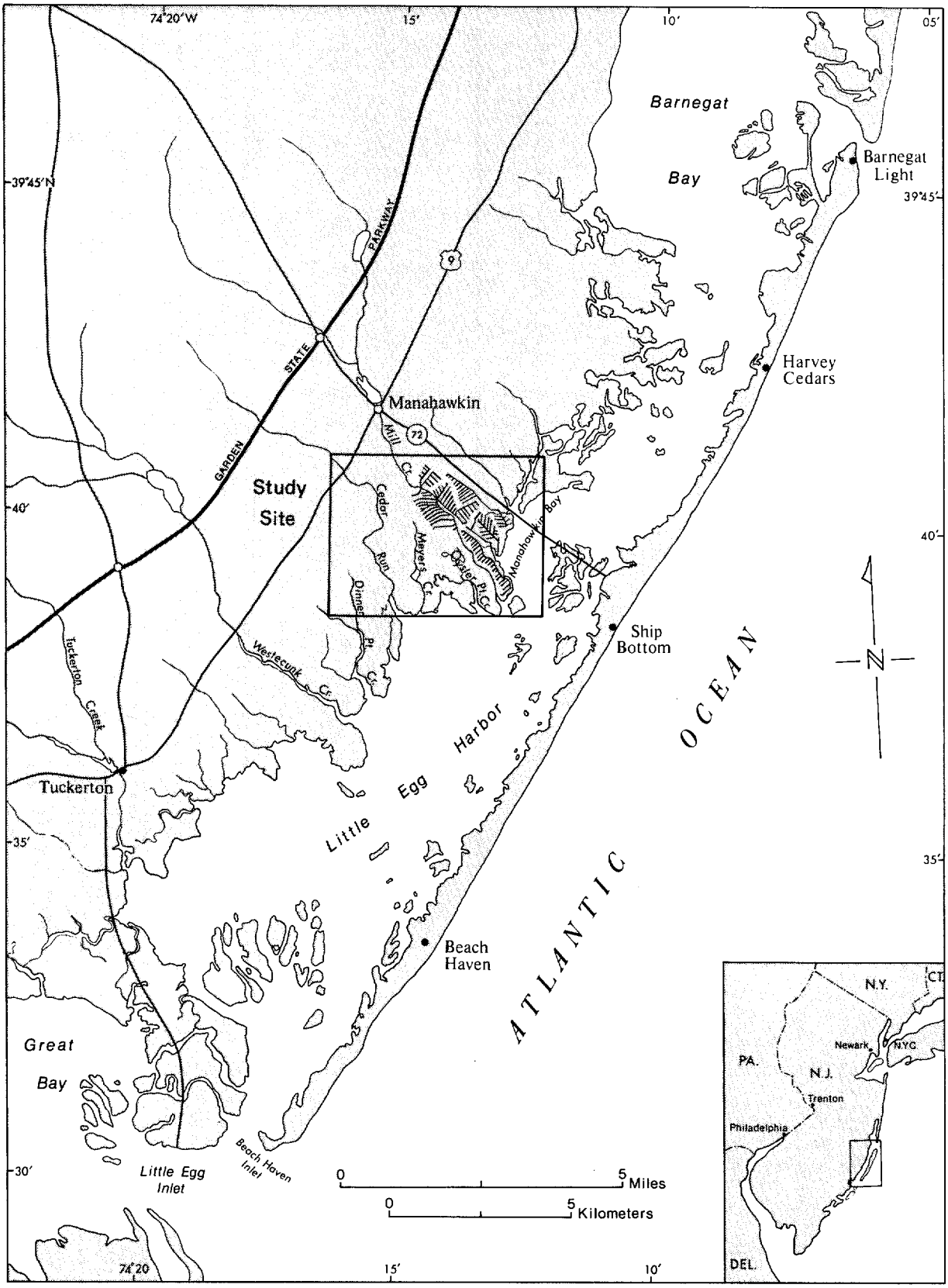

Fig. 1. Location of the general study area, Manahawkin marshes, between Manahawkin and Tuckerton, Ocean County, New Jersey.

Although the initial objectives of this phase were:

1) To obtain estimates of aboveground standing crop of the major communities

2) To determine coverage area of each community type and calculate total production for the study area

3) To determine the environmental factors of salinity, depth of flooding, depth of substrate, and precipitation, and determine their effect on production

4) To compare the value of these marshes with others throughout the Atlantic Coast,

the study was extended to the productivity of the belowground component and its interaction with the aboveground component. This was done since it had been estimated that the belowground component may be 7-9 times the amount of aboveground (de la Cruz 1974). During the third and fourth years the study was further extended to investigate the fate of this total production; namely the decomposition phase. A special phenological study was conducted during the last year to aid in the understanding of biomass losses during the growing season. Throughout the entire study reported here an attempt was made to put the information on an energy flow basis since energy produced as a result of the photosynthetic process represents the ecosystem budgetary unit.

The energy is initially in the form of plant matter making up the roots, stems, and leaves of the marsh plants. Transfer of energy in the form of plant nutrients takes place throughout the year with a large component being translocated to the root and rhizome system at the end of the growing season where it can be used for new plant growth the following year. Some of the remaining plant material undergoes microbial decomposition making it more available to consumer organisms such as detritivores. It may remain relatively intact contributing to the amount of accumulated peat material or may undergo decomposition, a process which represents an energy transfer phase from primary producer to consumer and thus provides the important link in the energy flow system of the estuarine ecosystem. Consequently wherever possible the samples were analyzed for their caloric content and chemical composition.

These are summarized by Odum et al. (1973) who indicated that the role of vascular plant detritus is divided into four distinct processes: (1) production-the sources and quantity of annual net production; (2) degradation-decay and microbial colonization of the dead plant material and detritus formation; (3) export-movement of detritus from source to site of utilization; and (4) utilization-the ingestion and assimilation of portions of the detritial complex by consumers. The degradation process itself has several components: loss of soluble compounds, microbial colonization, and mechanical fragmentation.

Since the quantity of biomass produced by coastal and estuarine salt marsh macrophyte communities is among the highest on earth, their contribution to the productivity of the coastal zone is considered to be highly significant. This report summarizes the dynamics of vascular plant production and decomposition for the Manahawkin marshes.

ENVIRONMENTAL STUDIES

Methods

Environmental data were collected during 1973-1974 at 18 stations and during 1974-1975 at 19 stations described in the Aboveground Production section of this report (Figure 2). In addition, environmental data were collected during 1975-1976 at the major sites (except (6) *S. patens*) described in the "decomposition of end of the season material" section of this report (Figure 3). Collections were made 32 times during 1973-1974, 22 times during 1974-1975, and 15 times during 1975-1976.

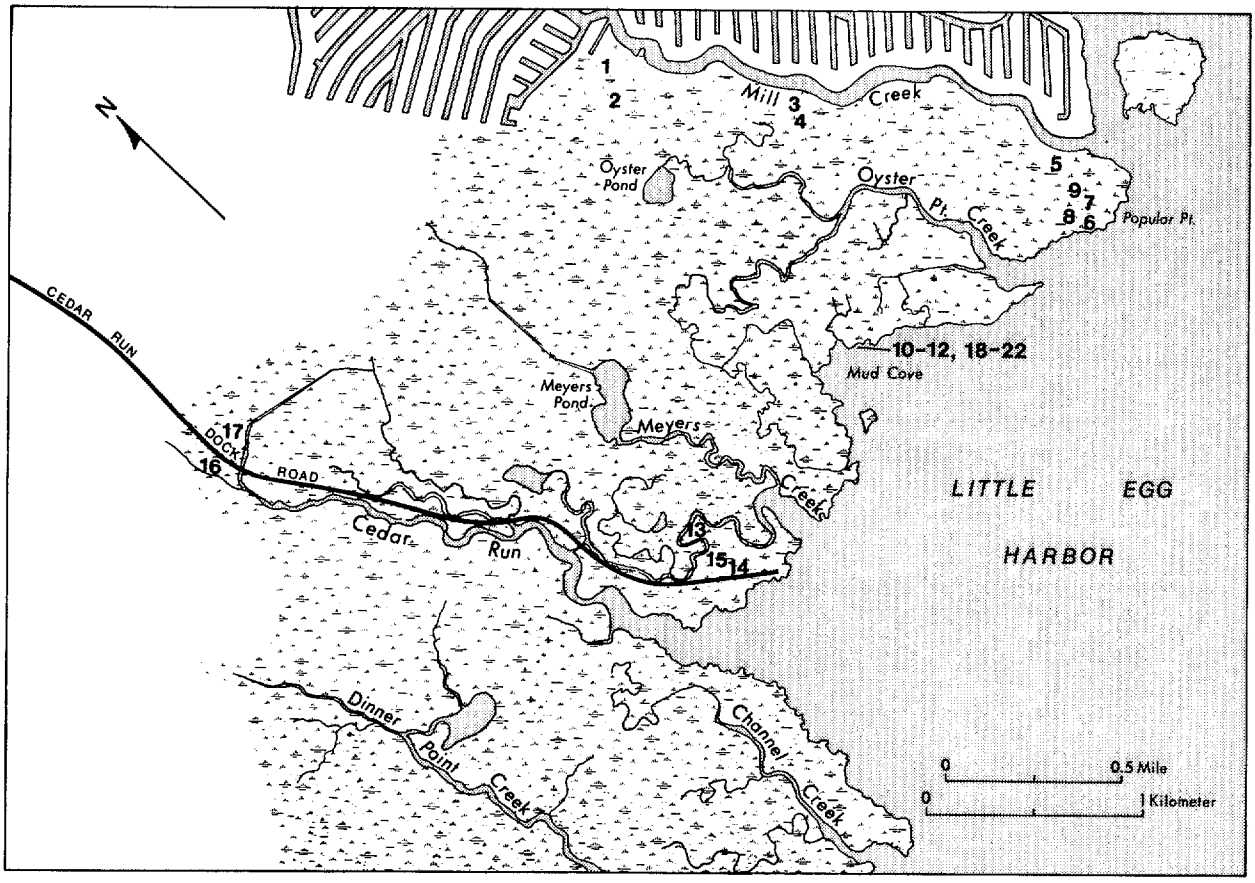

Fig. 2. Map of study area and location of sampling stations for the aboveground and belowground production studies.

Salinity was measured by collecting surface mud samples at each station for each environmental run. During 1975-1976 samples were also taken at 10 cm depth. Using the quantitative procedure described by Good (1965), mud samples were dried, soaked, and filtered; and salinities were calculated based on readings with a RB4-250 Beckman Solubridge conductivity meter.

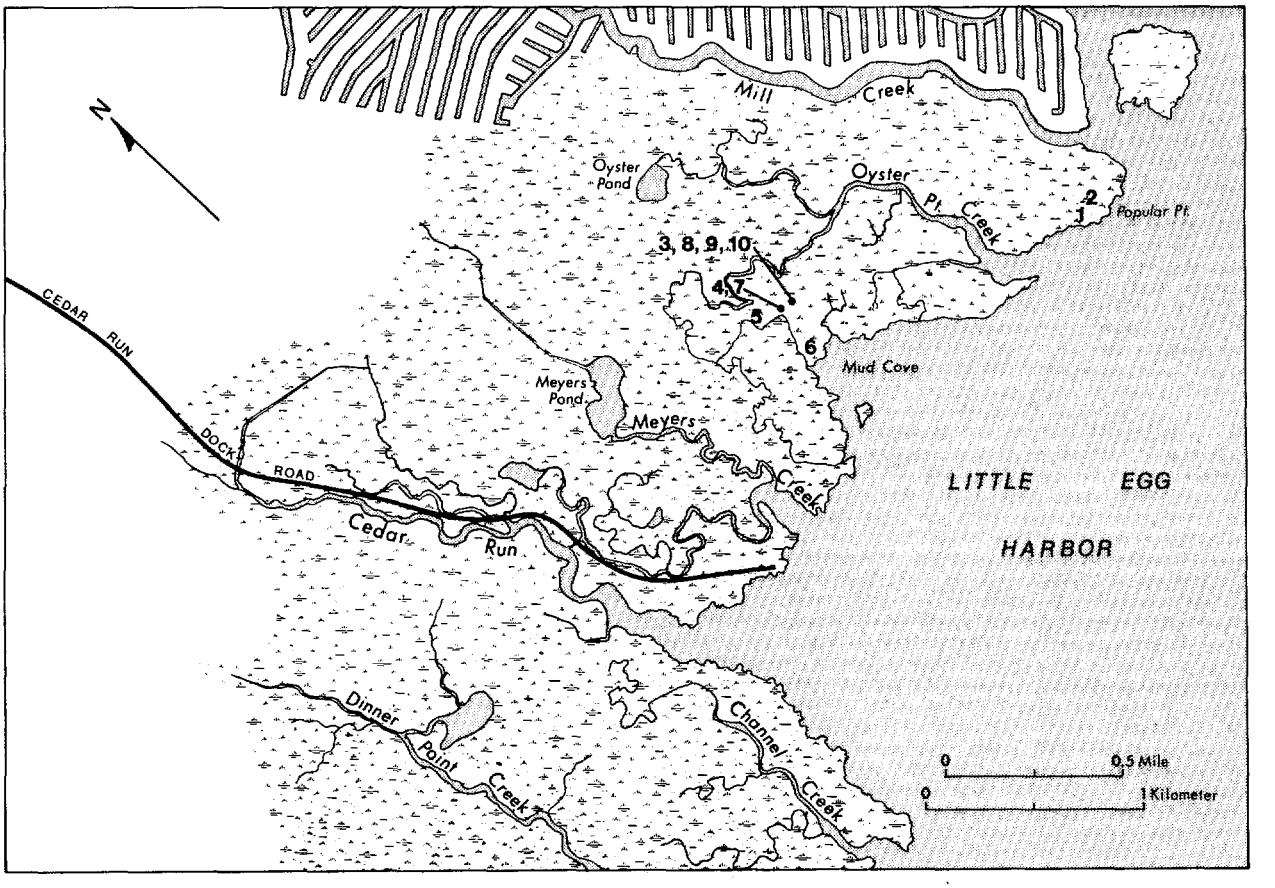

Fig. 3. Location of stations at Manahawkin used for the decomposition studies.

Precipitation data were gathered using Taylor Instrument Company rain gauges installed in five marsh locations during 1973-1974 and 1974-1975. Precipitation differences among the five locations were generally minimal with few instances of variable local storms. Measurements were usually closely related to those of the U.S. Weather Service, Tuckerton Station (U.S. Dept. Commerce 1973-1976).

During 1975-1976, the heights of the four major Mud Cove study sites relative to each other were measured during a high tide. The depth of water was measured at each site and the relative height was calculated using the deepest reading at the tall form *Spartina alterniflora* (SAT) site as the zero point.

An estimate was made of the number of times each site was flooded by tides. The incoming tides were measured every 15 to 20 minutes at these different sites during various times of the study. From the measurements it was possible to roughly estimate the number of high tides reaching each site by using a ratio with the tide table published for Sandy Hook, N.J. (U.S. Dept. Commerce 1976).

Results and Discussion

Table 1 presents average soil salinity values for the five major vegetation types from October 1973-April 1975. Soil salinity values for individual stations can be found in Appendices A, B, and C. Soil salinity results for October 1975-April 1976 are presented in Table 2. Precipitation levels for the entire study period are found in Table 3.

In general, there is a relationship between mud salinity and precipitation levels. During periods of low rainfall, soil salinity increases while heavy rainfall causes a decrease in soil salinity. Variation in rainfall from month to month and year to year has an effect on soil salinity variation within a given vegetation type. (Tables 1, 2, and 3).

The amount and regularity of marsh surface flooding also plays an important role in determining soil salinity. At Mud Cove, using the lowest area in the SAT site as the zero point (which was later found to roughly correspond to the mean low water mark) SAT plants were found from 0 to 15 cm above this point. Intermediate height *Spartina alterniflora* (SAM) plants were found between 28 and 32 cm or 13 to 17 cm above the upper limit of the SAT zone. The plants of the short form *S. alterniflora* (SAS) site were found between 35 and 37 cm or 20 to 22 cm above the SAT zone. A site in a *Spartina patens* site was also measured and was found to be at 44 cm or 29 cm above the SAT zone.

Of the approximately 700 high tides of 1975 all reached the SAT site. The SAM site was covered by 600 to 700, the SAS site by 400 to 600 and *S. patens* by less than 100. An SAS site at Popular Point (PSAS) was found to be equivalent to the SAS site and a SAM site at Popular Point (PSAM) corresponded with the SAT site. These are very rough estimates but do give an indication that there are significant differences in tidal influence among the study sites. *S. patens* sites, which are flooded less than 100 times per year, have the lowest soil salinites (mean = 17.3 ‰). Other high marsh sites (*Distichlis spicata* and *D. spicata/Juncus gerardi* also have low soil salinities (mean = 23.9 and 19.4 ‰). Sites which are flooded more regularly (SAS, SAT) have higher soil salinities (mean = 28.2 and 32.3 ‰). Soil salinity values taken from October 1975 to April 1976 (Table 2) are generally lower than values from 1973-1975 (Table 1). Upon general observation it appears that soil salinities are generally lower in late autumn, winter, and early spring compared to late spring and summer. Mean salinity values for the 1975-76 study are likely lower because summer soil salinity values were not determined.

It was also noticed that the greatest fluctuation in soil salinity during 1973-1975 occurred at SAT sites (Mean $\pm$ SD = 32.3 $\pm$ 15.8 ‰). This is unusual because SAT sites are flooded quite regularly, therefore soil salinity should be very constant. Values presented in Table 1 are means from several stations. One SAT station (Station 5, Appendices A and B) showed much greater fluctuation soil salinity compared to the other SAT stations and is a major reason for the large fluctuation in soil salinity. If this station is not considered, SAT soil salinity at the 1975-1976 SAT and PSAM sites (Table 2) were the smallest (SD = 5.7 and 5.9 ‰ respectively). Fluctuation of soil salinity at intermediately flooded sites (SAS-SAM) should be high (longer periods of time for the marsh soil to dry), and were found to be so (Tables 1 and 2). Variation of soil salinity at infrequently flooded sites (*S. patens, D. spicata/J. gerardi*) was found to be low.

Table 1. Mean mud salinity values (°/oo) for the five major vegetation types from 3 August 1973 to 21 April 1975.

Date	*S. patens*	*S. alterniflora* short	*S. alterniflora* tall	*Distichlis spicata*	*D. spicata/ Juncus*
8-3-73	16.6	26.2	37.5		22.1
8-9-73	25.1	49.9	53.6		18.5
8-16-73	12.6	23.0	22.1	21.4	13.9
8-23-73	18.0	18.4	24.0	9.5	19.7
8-30-73	18.7	24.9	36.0	24.4	21.2
9-7-73	32.6	36.0	93.3	46.4	22.9
9-12-73	30.7	38.5	61.2	58.4	26.3
9-19-73	14.9	18.7	24.0	23.4	18.1
9-26-73	13.1	19.7	20.3	22.0	18.8
10-3-73	14.8	19.8	30.6	24.1	21.3
10-20-73	25.6	43.6	67.0	31.5	35.1
10-27-73	18.6	22.3	28.8	35.7	21.3
11-3-73	19.4	25.0	30.4	26.2	18.4
11-7-73	23.1	28.0	25.3	26.4	25.8
11-14-73	15.0	21.5	31.7	22.1	17.3
11-21-73	26.0	37.3	21.9	21.3	20.0
11-28-73	16.5	20.5	24.4	19.3	18.8
12-8-73	18.6	21.5	27.1	13.7	18.5
12-12-73	15.7	20.6	22.5	33.1	20.5
12-26-73	11.6	15.4	18.2	17.3	11.5
1-17-74	9.7	14.2	12.8	15.1	10.7
1-23-74	8.9	11.1	12.5	12.7	10.4
2-20-74	10.3	13.9	15.4	14.3	13.5
3-6-74	13.5	16.9	19.5	15.2	14.3
3-27-74	11.1	23.6	33.0	10.5	15.0
4-3-74	11.2	17.2	15.7	17.1	13.2
4-17-74	10.3	24.6	33.2	18.7	15.4
4-24-74	14.9	24.7	32.5	14.4	29.1
5-7-74	20.8	25.3	29.7	11.5	16.4
5-16-74	14.5	42.5	36.7	19.4	29.3
5-23-74	16.3	48.6	27.9	18.9	20.1
5-30-74	15.1	25.9	30.5	22.7	23.0
6-5-74	14.2	26.6	23.4	21.7	
6-11-74	19.1	43.5	28.1	13.8	
6-17-74	29.2	58.7	55.1	31.8	
6-25-74	16.1	23.4	25.7	18.0	
7-1-74	15.2	19.0	28.7	23.3	
7-8-74	18.1	40.7	33.3	58.7	
7-15-74	20.1	56.9	56.3	22.7	
7-22-74	22.3	34.9	68.3	27.4	
7-29-74	28.3	52.5	61.7	29.7	
8-5-74	34.3	58.3	69.8	31.5	
8-14-74	15.7	29.5	24.8	23.6	
8-25-74	15.9	21.4	25.6	21.8	
9-9-74	11.7	18.6	17.6	23.4	
10-2-74	16.6	32.3	31.5	34.5	
10-20-74	16.7	24.9	28.8	32.8	

Table 1. Continued.

Date	*S. patens*	*S. alterniflora* short	*S. alterniflora* tall	*Distichlis spicata*	*D. spicata/ Juncus*
11-6-74	11.3	25.5	20.9	27.6	
11-27-74	18.7	27.5	27.6	24.6	
12-30-74	18.2	21.7	23.0	25.7	
1-28-75	6.8	12.7	14.9	12.0	
3-5-75	11.0	21.1	22.3		
4-21-75	13.3	24.1	27.7	22.2	
Mean ± 1SD	17.3±6.1	28.2±12.2	32.3±15.8	23.9±10.2	19.4±5.6

Table 2. Mud salinity (°/oo) at five study sites in the Manahawkin marshes at 0 and 10 cm depths from 13 October 1975 to 26 April 1976.

Date	Depth(cm)	Study sites (1)PSAS	(2)PSAM	(3)SAS	(4)SAM	(5)SAT
10/13/75	0	25.8	23.3	24.1	28.0	21.1
	10	36.6	20.2	29.1	38.3	23.4
10/23/75	0	25.7				
	10	35.5				
10/26/75	0			16.0	18.8	20.6
	10				15.7	21.2
11/11/75	0	25.3	11.7			
	10	30.8	32.8			
11/17/75	0			17.9	17.6	17.9
	10				20.2	18.9
11/25/75	0			14.0	18.1	20.3
	10				17.3	16.3
12/2/75	0	17.0	15.6	16.1	18.3	16.5
	10	24.2	16.8	15.0	16.8	16.1
12/16/75	0			20.8	27.0	26.4
	10				20.8	19.7
12/23/75	0			23.3	21.6	
	10				13.2	
12/30/75	0	18.5	18.8	18.0	14.0	15.0
	10	24.6	20.0	15.6	16.6	20.3
1/13/76	0	6.8	9.8	8.3	6.0	12.9
	10					
2/9/76	0	5.7	13.2	3.4	5.9	10.7
	10					
2/26/76	0			26.6	23.3	21.9
	10			17.7	22.6	20.6
3/25/76	0	23.6	22.3		22.5	22.1
	10	24.7			21.8	22.1
4/26/76	0	58.9	25.1	34.4	49.9	32.2
	10	40.6		60.0	38.1	30.2
Mean ± SD	0	23.0±15.5	17.5±5.7	15.8±8.6	20.8±11.0	19.8±5.9
	10	31.0±6.9	22.5±7.1	27.5±19.0	21.9±8.5	20.8±4.0

Table 3. Monthly precipitation (cm) for the Manahawkin marshes area for 1973-1976.
(Data from the U.S. Weather Service - Tuckerton, N.J.)

	Precipitation (cm)			
	1973	1974	1975	1976
January	10.03	10.52	13.77	12.93
February	10.31	7.19	8.10	7.34
March	7.67	11.48	10.46	3.86
April	15.27	5.82	10.13	3.51
May	10.52	5.44	9.96	6.91
June	16.28	8.18	8.64	1.45
July	9.73	3.96	15.88	7.44
August	4.67	20.47	3.40	16.10
September	13.84	9.50	14.10	4.42
October	6.30	4.37	7.16	17.20
November	3.43	3.43	9.93	3.48
December	15.01	10.59	6.30	5.84
Total	123.06	100.94	117.83	90.47

Soil salinity at 10 cm depth was found to be greater than surface salinities at intermediately flooded sites (PSAS, SAS), and only slightly higher at the more flooded sites (SAM, PSAM, SAT). Variation in soil salinity at 10 cm was less (except PSAM, SAS) than at the surface (Table 2).

ABOVEGROUND PRODUCTION

Methods

The study of marsh plant productivity in the Manahawkin salt marshes was conducted at 18 permanent stations during 1973 and 17 permanent stations in 1974 representing five vegetation types; *Spartina alterniflora* short form (SAS), *S. alterniflora* tall form (SAT), *S. patens*, *Distichlis spicata*, and *Juncus gerardi*. The emphasis placed on each was based on their occurrence and importance in the total study as seen on Department of Environmental Protection aerial maps.

The stations, shown on Figure 2, were selected in generally uniform stands of the desired vegetation type and represent both disturbed and undisturbed areas. Five stations were located on the south side of Mill Creek, opposite Beach Haven West, a former marsh. These stations included two paired stands of SAS (1, 3) and *S. patens* (2, 4) plus one stand of SAT (5). The latter station (5) was located on Popular Point, which was diked but subsequently was under injunction against further construction. This station was maintained for environmental data collection only in 1974. Four additional stations (6, 7, 8, 9) were established in this altered area so that comparisons could be made with similar communities in unaltered marshes. Stations 6 and 8 were stands of *S. patens* while stations 7 and 9 were stands of SAS. Four stations (10, *S. patens*; 11, SAS; 12, SAT; 18, *D. spicata*) were established in the Mud Cove area representing communities in their most natural condition within the study area. Three additional stations (19, 20, 21) were established in 1974 to provide greater input from an undisturbed area while station 11 was maintained for the collection of environmental data only. The remaining stations (13, *S. patens*; 14, SAS; 15, SAT; 16, *S. patens*; 17, *D. spicata/J. gerardi*) were at the opposite end of the study area extending along the Cedar Run Dock Road from the upland border to the bay. Stations 13, 16, and 17 were not sampled in 1974.

Net aerial production was determined using the harvest method (Odum 1971; Milner and Hughes 1968). Four by eight meter plots were established at each station with the exception of SAT stations, where the linear growth pattern along the edges of ditches and streams dictated a linear plot arrangement. Each plot was subdivided into 1 x 1 m subplots and periodic clippings were conducted in alternate subplots in alternate rows to avoid prior disturbance of quadrats by field workers.

During each harvest two subplots per station were clipped with hand shears at 1 to 2 cm above the soil level. Samples were collected at approximately one month intervals between July/August to September/October in 1973 and between May/June to September/October in 1974. Average plant height was measured prior to clipping. During harvesting clipped material was separated into live and litter portions, with all nonliving matter, whether lying on the ground or standing, defined as litter. Dry weights of all harvested grass and litter were obtained after drying at 80°C for 48 hours in a forced draft oven.

Net aerial production of the woody shrubs *Iva frutescens* and *Baccharis halimifolia*, was determined in 1974 by the direct method (Milner and Hughes 1968). The current season's growth increment was harvested after maturity but before leaf or flower fall. Grazing or litter fall of these species is negligible. The annual amount of material incorporated into the woody stems was not estimated and was considered a minor input in terms of energy flow through the marsh ecosystem. Random meter square quadrats were selected and all current shrub growth and associated grasses or annuals were harvested with pruning shears and grass clippers. Samples were processed and stored using the same procedures accorded the grasses. These shrub species, which are traditionally treated as an entity for mapping and descriptive purposes, were identified and processed separately but combined for interpretation.

Percent ash content of the live portion of all harvested samples except woody shrubs was determined by combusting 1 g grass subsamples, prepared with a Wiley mill, in a F-1635 Temco muffle furnace for two hours at 600°C (Reiners and Reiners 1972). In addition, caloric and crude protein analysis of above-

ground material was conducted at three SAS stations (19, 20, 21). Caloric content was measured by combusting ground material in a Parr 1221 adiabatic calorimeter with a temperature controller according to the Parr method (1968). All crude protein analyses were conducted on duplicate desiccated samples and the results presented on an ash-free dry weight basis. Crude protein content was determined by using the standard macro-Kjeldahl method for total organic nitrogen and multiplying the result by 6.25 (Assoc. Offic. Agric. Chem. 1965).

In conjunction with the determination of aboveground production, a community analysis was conducted in three major marsh communities. Plant density at each of the stations was determined by counting the number of culms present in duplicate 25 cm by 25 cm quadrats. The included stations were SAS (2, 4 and 9), SAT (5, 12 and 15), and *S. patens* (1, 3, 6 and 8). Peak mean dry weight per culm was calculated for each station to provide a basis for comparison of stands and vegetation types.

Results and Discussion

Table 4 and Appendix A present 1973 and 1974 peak aboveground standing crop values for all marsh grass stations sampled. Results not only indicate a variation in mean peak aboveground standing crop between vegetation types but variation between stations within a given vegetation type during a given growing season and between growing seasons. For the major vegetation types (SAS, SAT, and *S. patens*), SAT had the greatest mean peak standing crop followed by *S. patens* and SAS in both 1973 and 1974. Variation in peak aboveground standing crop between stations within a given vegetation type, however, was large resulting in overlaps in the range of peak aboveground standing crop values of all vegetation types. Table 5 presents density and culm weight figures for several stands of the dominant vegetation types at Manahawkin. These values may help to explain some variation in aboveground biomass for the stands of SAS. For the three stands sampled, culm$\cdot$m^{-2} varied from 960-2,000. For SAT the variation was from 496-816 culm$\cdot$m^{-2}. Variation for *Spartina patens* stands was even greater ranging from 3,280-11,696. Table 5 also gives the average culm weight for these stands at the densities shown. For all major vegetation types, there was a decrease in average culm weight with increasing culm density. There was, however, no apparent relationship between biomass and culm density or average culm weight.

Peak standing crop values were lower in 1974 at all but one of the stations. The greatest difference between years occurred at SAS stations. Not only was there a decrease in peak standing crop in 1974 but there was also a change in the time when peak standing crop was attained. At SAS and *S. patens* stations, peak standing crop was reached 2-4 weeks earlier in 1974 and 2-4 weeks later at SAT sites. Two possible factors influencing the variation in peak standing crop are precipitation and soil salinity. Good (1965, 1972) showed that increasing soil salinity places a stress on marsh vegetation resulting in reduced growth. Tables 1 and 2 present soil salinity and precipitation levels respectively for the vegetation types for the period August 1973 to April 1975. During the early summer of 1974, precipitation was considerably lower than that of 1973. This in turn resulted in high soil salinity values during July and early August of 1974 due to accumulation of salts from the evaporation of tidal water on the marsh surface. This was particularly noticeable at SAS and SAT stations. High precipitation levels during August of 1974 resulted in a sharp decrease in soil salinity levels. Another possible explanation for the large decrease in aboveground biomass at some stations in 1974 is disturbance. Stations 2, 4, 7 and

Table 4. Comparison of peak aboveground standing crops ($g \cdot m^{-2}$) dry wt. for the major vegetation types at the Manahawkin marshes in 1973 and 1974.

	Station no.	1973 Peak $g \cdot m^{-2}$	Date	1974 Peak $g \cdot m^{-2}$	Date	% Change
S. alterniflora short form	2	669	9/7/73	374	7/3/74	-44%
	4	484	9/7/73	280	8/5/74	-42%
	7	633	9/7/73	408	8/8/74	-36%
	9	442	9/5/73	290	8/8/74	-34%
	11	735	9/5/73	552	8/12/74	-25%
	14	483	9/5/73			
	19			574	7/15/74	
	20			512	7/31/74	
	21			460	7/1/74	
Average peak		574 ± 120 *		444 ± 113		-23%
S. patens	1	613	8/31/73	546	7/29/74	-11%
	3	684	9/12/73	644	7/29/74	- 6%
	6	519	9/4/73	478	8/28/74	- 8%
	8	746	9/4/73	434	7/29/74	-42%
	10	691	8/17/73	572	8/8/74	-17%
	13	694	8/24/73			
	16	380	8/27/73			
Average peak		618 ± 128		535 ± 82		-13%
S. alterniflora tall form	5	1098	8/24/73			
	12	739	8/20/73	678	9/18/74	- 8%
	15	639	8/6/73	669	9/26/74	+ 5%
	22			858	9/26/74	
Average peak		825 ± 241		735 ± 107		-11%
D. spicata	18	644	8/20/73	613	8/12/74	- 5%
D. spicata/ J. gerardi	17	514	8/27/73			

* one standard deviation

9 were either adjacent to lagoon development or occurred at the Popular Point location which was considered highly disturbed (Good and Smith 1974). There was visible evidence of community degradation for SAS stations 7 and 9 due to dikes which prevented tidal circulation. Station 8, *S. patens*, also in the disturbed area, showed a very large decrease in standing crop for 1974. Furthermore station 5 in the disturbed area had such poor growth of SAT that aboveground biomass could not be sampled in 1974. The percent change in peak standing crop attributable to disturbance, however, is difficult to assess.

Standing crop of a salt marsh community has been considered as net production in situations where the sample is taken at the peak of development of the community and no great loss due to harvest by organisms has taken place (Good 1965, and others). A comparison of net production of the Manahawkin area marshes with other Atlantic coast marshes must be made with caution. Turner (1976) and

Table 5. Density and culm weight of representative *Spartina alterniflora* and *Spartina patens* community types found in the study area.

Sample date	Vegetation type, Station	Average (2 samples) culm density per 1/16m^2	Average culm weight (g)	Peak biomass (g·m^{-2})	Culm density per m^2
7/22/74	*S. patens* (1)	669	0.05	546	10,704
7/22/74	" " (3)	655	0.06	644	10,480
6/4/75	" " (6)	205	0.15	477	3,280
7/22/74	" " (8)	731	0.04	434	11,696
7/22/74	SAS (2)	111	0.21	374	1,776
7/22/74	" (4)	125	0.14	280	2,000
7/22/74	" (9)	60	0.30	290	960
7/22/74	SAT (5)	51	0.45	364	816
6/11/75	" (12)	49	0.86	677	784
6/11/75	" (15)	31	1.35	669	496

Kirby and Gosselink (1976) have shown that the method used in determining aboveground protection will greatly effect production values. Turner (1976) also states that changes in production values along a north-south gradient as well as local variation (e.g. tall versus short form *S. alterniflora*) must be taken into consideration when comparing marsh production values. In addition, as shown in this study, yearly variation must also be considered. With this in mind, Table 6 presents a comparison of net aboveground production values found in several marshes in the Mid-Atlantic region. In general, the production values of Manahawkin marshes are comparable to other marshes in this region, especially other New Jersey marshes. The only major exception is net production values for SAT. Peak standing crop values at Manahawkin are similar to those obtained at Great Egg Harbor but are much lower than that of Great Bay. This lower value may be due in part to the lack of extensive stands of the tall form in addition to the apparent lower density of the individual stems in this study area.

Turner (1976) has shown that there is a local variation in net production estimates. This variation is best shown in production values for *Spartina alterniflora* found along stream and creek banks (SAT) compared to *S. alterniflora* found on higher marshland away from the creek banks (SAS). Several factors have been suggested which might influence such variation in production.

A number of workers have shown that nitrogen is a major nutrient limiting the growth of short form *S. alterniflora* but not tall form (Sullivan and Daiber

Table 6. Comparison of net production (g dry wt·m^{-2}) of aboveground parts for a number of salt marsh studies.

	Production (g dry wt·m^{-2})	Date	Location	Author(s)
Spartina alterniflora tall form	827	1969	Long Island, N.Y.	Udell et al.
	1700	1972	Great Bay, N.J.	Good
	1592	1974	Great Bay, N.J.	Squiers and Good
	850	1977	Great Egg Harbor, N.J.	Good
	825	1973	Manahawkin, N.J.	This study
	735	1974	Manahawkin, N.J.	This study
Spartina alterniflora short form	508	1969	Long Island, N.Y.	Udell et al.
	590	1972	Great Bay, N.J.	Good
	558	1973	Maryland and Virginia	Keefe and Boynton
	592	1974	Great Bay, N.J.	Squiers and Good
	548	1977	Great Egg Harbor, N.J.	Good
	574	1973	Manahawkin, N.J.	This study
	444	1974	Manahawkin, N.J.	This study
Spartina alterniflora all forms	300	1965	Cape May, N.J.	Good
	1332	1969	Virginia	Wass and Wright
	427-558	1973	Maryland and Virginia	Keefe and Boynton
	362-573	1976	Virginia	Mendelssohn and Marcellus
Spartina patens	993	1919	Long Island, N.Y.	Harper
	805	1969	Virginia	Wass and Wright
	550	1972	Great Bay, N.J.	Good
	463	1972	Great Bay, N.J.	Nadeau
	618	1973	Manahawkin, N.J.	This study
	535	1974	Manahawkin, N.J.	This study
Distichlis spicata	360	1969	Virginia	Wass and Wright
	670	1972	Great Bay, N.J.	Good
	359	1972	Connecticut	Steever
	644	1973	Manahawkin, N.J.	This study
	613	1974	Manahawkin, N.J.	This study

1974); Valiela and Teal 1974; Woodhouse et al. 1974; Gallagher 1975). Good (1972) reported that salinity stress may be a factor in decreased aboveground production of short form *S. alterniflora*. The highest production values (SAT) were associated with the smallest fluctuation in soil salinity while the lowest production values (SAS) were associated with the largest fluctuation in soil salinity. Steever et al. (1976) found a high statistically significant correlation between tidal amplitude and streamside production estimates at sites along Long Island Sound. It is thought that tidal action may increase *S. alterniflora* aboveground production along creek banks by either keeping soil salinity at a uniform level, increasing input of nutrients to creek bank soils, or removing toxic materials and metabolic wastes.

Information lacking during the first year of this study was aboveground production of the woody composite shrubs *Iva frutescens* and *Baccharis halimifolia* which grow along the lagoon dikes in the Popular Point area as well as throughout the Manahawkin marsh on margins of mosquito control ditches. These shrubs are estimated to occupy about 5% of the marsh. Table 7 shows the standing crop for these shrubs as well as the minor associates growing under them. Although there is considerable variation in the values for *Iva*, the average biomass for the two shrubs is comparable. Shrub production is similar to values for SAT.

Production figures for the major communities are multiplied by the area covered by each species in the study area in Table 8. Of the 551 hectares, *S. alterniflora* short form has the greatest coverage, followed by *S. patens*, *Iva* and *Baccharis* shrubs, *S. alterniflora* tall form, and *D. spicata*. Despite having the lowest peak standing crop per unit area, SAS forms the bulk of the total marsh annual aboveground production. SAT, while having the highest peak standing crop per unit area, covers only a small portion of the Manahawkin marsh area and thus contributes only a small portion of the total marsh annual aboveground production.

Caloric and percent crude protein values for SAS stations 19, 20 and 21 are presented in Table 9. Caloric content of aboveground material remained nearly constant throughout the growing season, averaging 4.4 $kcal \cdot g^{-1}$. Similar results were obtained for SAS by Squiers and Good (1974) at Great Bay, New Jersey (4.5 $kcal \cdot g^{-1}$). Percent crude protein levels decreased throughout the growing season from 9.55% on 5 June 1974 to 4.81% on 23 October 1974 with a secondary peak on 18 September 1974. A similar pattern was reported by Squiers and Good (1974) for SAS. Protein levels decreased from 10.25% to 5.88% during the growing season. Squiers and Good (1974) felt that this pattern of early growing season accumulation of protein (of which nitrogen is a constituent) was of ecological significance. If nitrogen is limiting during the peak of the growing season, early spring accumulation of nitrogen could help offset possible shortages.

BELOWGROUND PRODUCTION

Methods

Belowground productivity studies were conducted in 1974-75 at 17 permanent sampling stations described previously (Figure 2). Net primary production for belowground parts was determined by difference in biomass (Dahlman and Kucera 1965).

Techniques were devised and equipment constructed for this aspect of the marsh plant productivity study. A pipe, 2.65 cm. x 100 cm. was driven into the marsh, filled with water, capped, aerated (to break the vacuum) and extracted with a modified sleeve (4 handles welded onto a sleeve slightly larger than the pipe).

Cores, thus obtained, were divided in half lengthwise, and into segments horizontally to provide data in profile. Cores were divided into 5 cm segments for the upper 20 cm and into 10 cm segments between 20 and 50 cm core depth. One half of the core was dried untreated and the other half was washed over a 1 mm sieve in the laboratory with both halves dried for three days in a forced-draft oven at 55°C. The washing procedure involved pulling apart the mat of roots and rhizomes and washing them repeatedly over a white enamel pan until no

Table 7. Standing crop of the current year's growth for the shrubs, *Iva frutescens*, *Baccharis halimifolia*, and minor associates.

Date	Marsh shrub	Dry wt. ($g \cdot m^{-2}$)	Associates	Live wt. ($g \cdot m^{-2}$)	Total dry wt. (live material ($g \cdot m^{-2}$)
8/21/74	*Baccharis halimifolia*	858	*Spartina patens*	76	934
	" "	775	" "	190	1,002
			Pluchea purpurascens	37	
10/2/74	*Iva frutescens*	1,017	Mixed grasses	324	1,341
	" "	763	" "	192	955
	" "	474	" "	72	546
	" "	951	" "	319	1,270
Mean		806			1,008

further release of trapped soil particles was apparent. Because core material below 30 cm contained substantially more decomposition intermediates and was characterized by generally more variable composition, the material between 30-50 cm depth was collected and processed, but not included in production calculations. Samples were collected at approximately 1 month intervals between April 1974 and September 1975 and approximately bimonthly intervals between September 1975 and April 1976.

Belowground biomass was analyzed with respect to biomass change within the upper 30 cm of each vegetation type as a whole and also to the 0-10, 0-20, 10-20, and 20-30 cm segments. The maximum differences in biomass is the net primary production for the belowground portion. Turnover is the ratio of net primary production to peak biomass.

Samples from the undisturbed SAS grouping of stations 19, 20, and 21 were analyzed calorimetrically and for crude protein. Samples were grouped by collection date. Belowground samples were analyzed to a depth of 20 cm. All analyses were run in duplicate on dry, ground plant matter. Calorimetric determinations, ash content, and crude protein were determined as for the above-ground material.

Table 8. Production in kg on an area basis (aboveground, belowground, and total) for the five major community types at Manahawkin.

	Total area (ha)	Annual production (kg) Aboveground*	Belowground#	Total
S. alterniflora short form	320	16.0×10^5	96.0×10^5	112.0×10^5
S. patens	140	8.1×10^5	38.6×10^5	46.7×10^5
S. alterniflora tall form	9	0.7×10^5	3.0×10^5	3.7×10^5
D. speiata	9	0.6×10^5	2.5×10^5	3.1×10^5
Iva frutescens and *Baccharis halimifolia*	73	5.8×10^5		5.8×10^5
Total	551†	31.2×10^5	140.1×10^5	171.3×10^5

* Aboveground production figures are the average of 1973 and 1974 figures except *Iva* and *Baccharis* which are from 1974 only.

\# Belowground production figures are from 1974-1975.

† (for 90.7% of marsh area; remainder is other species and open water)

For interpretative purposes both the SAS and *S. patens* stations were subdivided into two groups. SAS stations 19, 20, and 21 represent that vegetation type in an undisturbed state and serve as a control or basis for comparison with stations 2, 4, 7, 9 and 14 which represent conditions ranging from undisturbed to transitional (stations 7 and 9 at Popular Point). For *S. patens* the disturbed Popular Point stations 6 and 8 were separated from the remaining stations 1, 3, and 10 which served as a standard.

Results and Discussion

Table 10 presents values for belowground biomass ($kg \cdot m^{-2}$) of the vegetation types studied. Both SAS and *S. patens* stations are divided into two groups, one representing stations in undisturbed areas and the other representing stations in disturbed areas. Although 50 cm cores divided into seven segments were collected for all communities, the discussions are concerned with the first 30 cm taken as a whole. This was done since it was felt that most of the living

Table 9. Energy content ($kcal \cdot g^{-1}$) and percent crude protein for aboveground portions of SAS at stations 19, 20, and 21 from 5 June 1974 to 23 October 1974.

Date	Energy content (kcal·g-1)	Crude protein (%)
5 June 1974	4.3	9.55
1 July 1974		8.31
15 July 1974	4.5	7.85
31 July 1974	4.4	5.97
19 August 1974	4.4	6.25
18 September 1974	4.4	6.99
23 October 1974	4.4	4.81

component occurred in this layer, a judgment which is supported by other workers (Gallagher 1974; Woodhouse et al. 1974). Data broken down into separate segment components can be found in Appendix B.

While initial attempts were made to separate the belowground component into living and nonliving categories, results were unsuccessful so that estimates of living biomass were obtained by analysis of annual change in biomass. The validity of the change in biomass method of measuring belowground net primary production has been challenged on a few points. The most obvious shortcoming is that dry weight changes are a result of three major concurrent processes: increases resulting from growth; decreases resulting from decomposition and consumption; and transient net increases or decreases resulting from translocation in response to seasonal demands or environmental stresses (Smith 1976).

This can be examined in more detail using data obtained from the undisturbed SAS sites. Table 10 shows an increase in belowground biomass from January to April. It is felt that this increase which occurs before peak aboveground biomass (Table 4) is primarily a function of growth. There appears to be a drop in belowground biomass in late spring and early summer which may be due to translocation of materials from the roots to the developing shoots. Belowground biomass remains constant throughout the summer and early autumn before showing a slight increase in October. This October peak may be the result of translocation of material from the shoots to the roots after peak aboveground biomass has been reached (Table 10). From October to January there is a decrease in belowground biomass which may be due to decomposition of root material during late autumn and winter. Smith (1976) continued sampling at these sites for the remainder of 1975 and found that the same general pattern of season belowground biomass changes occurred although there were changes in the actual biomass quantity as well as shifts in the occurrence of certain biomass peaks.

Table 10. Seasonal changes in belowground biomass for the major vegetation types at Manahawkin during 1974-1975.

Date	SAS (19,20,21)*	SAS (2,4,7,9,14)#	*S. patens* (1,3,10)*	*S. patens* (6, 8)#	SAT (5,12,15,22)	*D. spicata* (18)
April 1974		10.53				
May 1974		9.59	8.19	6.06		
June 1974	10.39 11.03		8.76	6.79	8.50	7.35
July 1974	11.10	11.73	11.49	7.82	5.17	8.89
August 1974	11.09	13.18	9.87	8.24	9.74	10.08
September 1974	11.09	11.27			6.98	7.56
October 1974	11.73		10.12	7.13		
November 1974	11.07	10.97				8.19
December 1974	11.27		9.15	7.85	7.27	8.10
January 1975	9.97	12.04				
February 1975	10.22				7.22	7.29
March 1975	11.46		9.39	6.53		
April 1975	12.37	10.29			6.77	8.25
Mean	11.07	11.20	9.57	6.33	7.38	8.21

* Undisturbed sites
\# Disturbed sites

Belowground biomass changes at other sites, followed somewhat different patterns (Table 10). At disturbed SAS stations, the greatest increase in belowground biomass occurred concurrently with aboveground growth reaching a peak in August. Belowground biomass generally declined after the peak throughout the autumn, winter, and early spring reaching levels similar to the previous spring.

A similar pattern was observed for both disturbed and undisturbed *S. patens* sites with belowground biomass showing a low point at the beginning of the growing season and a peak in the summer. The peak was delayed approximately a month at the disturbed site.

At the SAT sites, there was a sharp drop in belowground biomass in July followed by a sharp increase to an August peak. Biomass dropped sharply in late September and remained fairly constant for the remainder of the study period. The sharp decline in belowground biomass in July might be the result of rapid transfer of materials to the shoot for flower production (Squiers and Good 1974). Translocation appears to be quickly reversed in August since the increase in belowground biomass is unlikely to be the result of root growth at this time (Stuckey 1941).

Belowground biomass of *D. spicata* increased from a low point in late winter to a peak in August. Biomass dropped sharply in September followed by a slight increase in November. Biomass then decreased through February.

Table 11 shows the dates of greatest biomass differences, the peak biomass, belowground production, and the turnover rate for the top 30 cm of belowground material for all communities in this study. Percent turnover for the top 30 cm varied from 19.41 for SAS to 39.14 for *D. spicata*. These represent the extremes in years for complete replacement (turnover as discussed by Dahlman and Kucera (1965)) as 5.15 and 2.55 respectively. These turnover rates may well define those habits which are thought to be responsible for different growth response of genetically indistinguishable growth forms of *S. alterniflora* (Shea et al. 1975). A comparison of the two groupings of SAS indicates a shorter turnover for the disturbed stands. The two stand groupings of *S. patens* have quite similar turnover rates. Turnover for *D. spicata* appears to be more similar to SAT than any other community.

Belowground production varied from 2.25 $kg \cdot m^{-2}$ for *S. patens* disturbed sites to 3.59 $kg \cdot m^{-2}$ for SAS disturbed sites. There appears to be no correlation between belowground production and maximum biomass or turnover rate. Only a few studies to date have dealt with belowground production of salt marsh plants. Valiela et al. (1976) working in Massachusetts marshes estimated belowground productivity of *Spartina alterniflora* to be 3.5 $kg \cdot m^{-2}$ and 2.5 $kg \cdot m^{-2}$ for *S. patens*. Woodhouse et al. (1974) found belowground productivity of *S. alterniflora* in North Carolina to range from 1.79 to 2.22 $kg \cdot m^{-2}$. These values are comparable to those obtained in this study. de la Cruz and Hackney (1977) found belowground productivity for *Juncus roemerianus* in Mississippi to be 1.36 $kg \cdot m^{-2}$, a value slightly lower than found in this study. Stroud (1976) estimated belowground production to be 0.46 $kg \cdot m^{-2}$ for short form *S. alterniflora* and 0.50 $kg \cdot m^{-2}$ for tall form. These values are much lower than other reported results.

Table 11. Maximum biomass, belowground production, and turnover rates for the major vegetation types at Manahawkin during 1974-1975.

Vegetation type	Period of greatest difference	Maximum biomass ($kg \cdot m^{-2}$)	Belowground production ($kg \cdot m^{-2}$)	Turnover rate (%)	(Years)
SAS undisturbed	28 Jan-30 April*	12.37	2.40	19.41	5.15
SAS disturbed	16 May-8 August*	13.18	3.59	27.21	3.67
S. patens undisturbed	8 May-29 July*	11.49	3.27	28.50	3.51
S. patens disturbed	8 May-26 August*	8.24	2.25	27.32	3.66
SAT	5 June*-15 July	8.50	3.33	39.14	2.55
D. spicata	12 August*-3 Feb	10.08	2.78	27.63	3.62

* Date of greatest biomass

Net annual above and belowground production values as well as below to aboveground rations are presented in Table 12. If we assume that the method of determining net production of the belowground component is accurate, the net total production per year for the marsh plants as a unit ranges from 2.71 $kg \cdot m^{-2}$ to 3.97 $kg \cdot m^{-2}$. With the exception of SAS disturbed, net annual belowground production is about 5 times greater than aboveground production. Valiela et al. (1976) obtained similar root to shoot ratios: 8.3 for *S. alterniflora* and 4.0 for *S. patens*. Woodhouse et al. (1974) found root:shoot ratios for *S. alterniflora* greater than 3:1. Waisel (1972) noted that halophytes generally have a higher root to shoot ratio than glycophytes.

Table 8 presents total (above and belowground) production values for each community type multiplied by the area covered by each species in the study area. SAS not only covers the largest area (320 hectares) but is also the most important producer both above and belowground giving a value which comprises about two-thirds of the total production. Consequently, any change in the production by SAS will have great impact on the total production for this and similar marsh types.

Caloric content of belowground material down to 20 cm from the undisturbed SAS sites is found in Table 13. For the entire depth, calcric content ranged from 4,621-4,919 (mean = 4,761) $cal \cdot g$ ash-free dry weight during the study period. Caloric values were lowest during the summer, the period of greatest aboveground growth. Caloric content also increased with depth from 4,556 $cal \cdot g^{-1}$ in the 0.5 cm depth to 4,943 $cal \cdot g^{-1}$ in the 15-20 cm depth. Caloric values of belowground material were also higher (≈ 300 than aboveground material (Table 9). Stroud (1976) found mean caloric content of two communities of short form *S. alterniflora* to be 3,819 and 3,969 $cal \cdot g^{-1}$. These values, however, were not on an ash-free basis. If one assumes the ash content of belowground material to be 12.0% (the average ash content of belowground material in the present study), the caloric values on an ash-free dry weight basis are 4,340 and 4,510 $cal \cdot g^{-1}$. Stroud also found belowground caloric values to be lowest in the summer and that belowground material had a higher caloric content than aboveground material.

Table 12. Net annual production ($kg \cdot m^{-2}$) in 1974-1975 for the below and aboveground components of six communities and ratio of below to aboveground.

Vegetation type (Station)	Aboveground ($kg.m^{-2}$)	Belowground ($kg.m^{-2}$)	Total ($kg.m^{-2}$)	Root:shoot ratio
SAS (19, 20, 21)*	0.52	2.40	2.92	5.24:1
SAS (2, 4, 7, 9, 14)#	0.36	3.59	3.59	10.15:1
S. patens (1, 3, 10)[1]	0.59	3.27	3.86	5.58:1
S. patens (6, 8)[2]	0.46	2.25	2.71	5.71:1
SAT (5, 12, 15, 22)	0.64	3.33	3.97	4.53:1
D. spicata (18)	0.62	2.78	3.40	4.50:1

* undisturbed stations
\# disturbed stations

de La Cruz and Hackney (1977) reported for *J. roemarianus* belowground material a mean caloric count of 5,020 cal·g ash-free dry wt^{-1} for the first 20 cm. These investigators also reported that caloric content increased with root depth (although not statistically significant) and that belowground material had a greater caloric value compared to aboveground material.

Table 14 presents crude protein levels of SAS undisturbed site belowground material. Percent crude protein ranged from 4.56 to 5.86% (mean = 5.22) on an ash-free dry weight basis. After the first 10 cm there is an increase in percent crude protein with depth. Percent crude protein levels of belowground material are generally higher than for aboveground material (Table 9).

Smith (1976) analyzed SAS belowground material at Mud Cove for crude protein, crude fat, crude fiber, and nitrogen free extract. It was found that the percentage of crude protein and crude fat remained fairly constant throughout the year at approximately 7% and 1% respectively. Percent crude fiber varied from 32-45% and percent nitrogen free extract from 47-65%. Yearly changes in percent crude fiber and nitrogen free extracts were found to be inversely related. Decreases in percent crude fiber (an indication of the breakdown of structural carbohydrate) were accompanied by increases in percent nitrogen free extract (an indication of an increase in storage carbohydrate) and vice versa. Standing crop of crude protein, crude fiber, and nitrogen free extract were found to be a direct function of belowground dry matter biomass.

Table 13. Caloric values (ash-free) and percent ash for *S. alterniflora*, short form, belowground material by depth at stations 19, 20, and 21 during 1974-1975.

Date	0-5cm (cal·g^{-1})	(% ash)	5-10 cm (cal·g^{-1})	(% ash)	10-15 cm (cal·g^{-1})	(% ash)	15-20 cm (cal·g^{-1})	(% ash)	0-20 cm (cal·g^{-1})
6/5/74	4,631	8.4	4,707	13.4	4,990	13.4	5,349	14.3	4,919
7/1/74	4,500	11.5	4,597	12.8	4,766	13.8	5,153	12.1	4,754
7/31/74	4,390	10.8	4,512	15.5	4,745	15.5	4,860	13.7	4,627
8/19/74	4,552	9.0	4,696	12.0	4,917	11.7	4,340	12.0	4,626
9/18/74	4,459	8.2	4,613	11.0	4,617	12.1	4,794	10.3	4,621
10/23/74	4,557	10.0	4,773	13.0	4,896	13.9	4,981	14.0	4,802
11/27/74	4,683	8.9	4,821	12.5	5,008	14.5	4,952	10.4	4,866
12/30/74	4,609	10.4	4,764	12.2	4,875	12.3	4,917	10.4	4,791
1/28/75	4,501	8.3	4,696	10.6	4,749	12.1	4,957	12.0	4,725
3/5/75	4,661	10.2	4,714	13.7	4,974	15.1	4,989	13.7	4,835
3/30/75	4,577	9.9	4,733	13.2	4,833	13.9	5,079	13.5	4,805
Mean	4,556		4,693		4,852		4,943		4,761

PHENOLOGICAL STUDIES

Methods

The fates of individual stems after the growing season were studied in the five main sites, *Spartina alterniflora* short (PSAS) and medium (PSAM) forms at Popular Point and *S. alterniflora* short (SAS), medium (SAM), and tall (SAT) forms at Mud Cove. These were studied by setting decimeter square quadrats out of each site and selecting individual plants from these. The plants were measured for stem thickness, height of leaf blade from the marsh surface, length of the leaf blade, and leaf blade thickness near the stem. Notes were also kept on color of the leaf and its condition; living or dead, wet or dry. Measurements were taken from 14 October 1975 to 13 January 1976.

A similar study was conducted at the same sites in 1976 to determine the fate of individual stems during the growing season. Results from this study could then be combined with the results of the previous study to give a long-term phenological pattern. The same measurements and observations were taken in this study as in the previous study. Measurements were taken three times in June and once each in July, August, September, and October.

Table 14. Percent (%) crude protein for *S. alterniflora*, short form belowground material at stations 19, 20, and 21 during 1974-1975.

Date	Crude protein (%) Belowground segment (cm) 0-5	5-10	10-15	15-20	0-20
5 June 1974	4.17	4.51	4.69	5.60	4.74
1 July 1974	4.24	3.99	4.79	5.22	4.56
15 July 1974	4.45	4.51	5.22	6.57	5.19
31 July 1974	4.38	4.47	5.54	6.54	5.23
19 Aug 1974	4.30	4.17	4.96	5.60	4.75
18 Sept 1974	4.64	4.70	5.54	5.97	5.21
23 Oct 1974	4.69	4.95	6.12	7.12	5.72
27 Nov 1974	4.27	3.83	4.88	5.81	4.70
30 Dec 1974	5.48	5.27	5.95	6.18	5.72
28 Jan 1975	5.11	5.05	5.16	6.98	5.58
5 Mar 1975	5.66	5.07	6.27	6.44	5.86
10 Mar 1975	4.95	4.86	5.75	6.02	5.40
Mean	4.70	4.62	5.41	6.17	5.22

Results and Discussion

While phenological records were kept, in general, at the five study sites during the 1976 growing season, detailed records were obtained at four sites from a limited number of plants: PSAS (2 plants), PSAM (2 plants), SAM (1 plant), and SAT (1 plant). Since the plants measured at each site were typical for that site, results obtained can be applied to the particular study site in general.

The assignment of *S. alterniflora* into short, medium, or tall form is subjective, therefore the height of plants of a certain assigned height form may vary from one area to another. This is shown in Table 15 where the maximum height of each measured plant at each site is listed. Short form *S. alterniflora* from Popular Point is taller than Mud Cove SAS while PSAM is taller than Mud Cove SAM. These results along with general observations revealed that there was little difference in plant height between the SAM and SAT study sites. These study sites, however, were chosen during the 1975 growing season when there was an obvious height difference in plants from the SAM and SAT sites. Apparently, changing environmental and/or site conditions between 1975 and 1976 caused plants at the SAT site to become more like SAM plants in terms of height. However, differences between plants from the SAM and SAT sites did not allow combining results from each site.

Table 15. Maximum leaf lengths obtained during the 1976 growing season at Popular Point and Mud Cove.

Study site	Plant no.	Maximum height (cm)	Average height (cm)
PSAS	1	36	
	2	27	
			32
SAS			25
PSAM	1	58	
	2	42	
			50
SAM	1	39	
SAT	1	42	

Two patterns of leaf placement were observed. At sites PSAS, SAS, and SAM, the nodes were compressed resulting in leaves which originated quite close to one another at or very near the marsh surface. At sites PSAM and SAT, leaves originated from nodes which were approximately 1 cm apart from one another. It was noted that during the 1976 growing season, the greatest flooding occurred at both SAT and SAM sites. It is not known, however, if there is a connection between flooding pattern and leaf arrangement on the culm.

Leaf lengths and condition of the plants studied are listed in Table 16. Plants at all sites were found to follow the same pattern. An individual leaf will grow to some maximum length. This maximum length within a given site is small at the beginning of the growing season and then increases during the period of maximum growth. At the end of the growing season (September-October), the maximum length of developing leaves begins to decrease (Table 16). As new leaves originate and develop, chlorosis of older full grown leaves develops at the leaf blade tip and progresses toward the plant stem. This is followed by necrosis (death) of the leaf blade originating at the tip and progressing toward the stem. As necrosis of the leaf blade progresses, the blade begins to curl adaxially. When the leaf blade completely dies, it loses its rigidity and lays on the surface of the marsh. Once the leaf reaches the wet marsh surface, decomposition of the blade begins while it is still attached to the plant stem. Eventually the leaf blade will break off of the plant at the sheath. As seen in Table 16, this pattern of leaf growth, dieback, and decay occurred throughout the late spring, summer, and early fall. The presence of dead, decomposing leaves still attached to the plant stem as early as 4 June 1976 indicates that this pattern probably occurs from the beginning of the growing season.

This dieback and decay pattern during the growing season is of importance when considering net aboveground primary production. As shown by Bradbury and

Table 16. Leaf lengths and leaf condition of plants from 4 June 1976 to 10 October 1976 at Popular Point and from 20 July 1976 to 10 October 1976 at Mud Cove.

Study site	Date of observation 6/14/76	6/16/76	6/20/76	7/20/76	8/17/76	9/14/76	10/10/76
	(Leaf length (cm) in order of oldest to youngest leaf)						
PSAS plant #1	8.5*	9.0*	9.0*	#	#	#	#
	7.0*	7.0*	7.0*	#	#	#	#
	12.0	14.0*	14.0*	#	#	#	#
	19.0	23.0	23.0	#	#	#	#
	21.0	29.0	28.0	28.5*	17.0*	17.0*	
	25.5	29.0	30.0	30.1*	28.0*	28.5*	29.0*
			25.0	33.5	32.0	32.0	32.0*
			14.0	35.2	36.0	34.5	34.5*
				29.7	36.5	36.5	36.5
				18.7	†	†	†
PSAS plant #2	5.0*	5.0*	5.0*	#	#	#	#
	13.0	16.0	16.0*	#	#	#	#
	17.0	22.0	21.0	21.0	14.0*	#	#
	16.0	20.0	26.0	26.8	20.5*	17.5*	18.0*
	7.0	15.0	20.0	27.0	26.0*	27.0*	27.0*
			8.0	25.9	27.5	27.5	27.5*
				15.9	25.5	25.2	25.5
					24.9	24.5	24.5
					17.5	20.0	20.0
						14.0	14.8
							6.5
PSAM plant #1	11.0*	#	#	#	#	#	#
	20.0	21.5*	21.0*	#	#	#	#
	27.0	28.0	12.0*	#	#	#	#
	17.0	29.5	27.0	28.5*	#	#	#
		20.5	28.0	34.9	35.5*	#	#
		8.0	21.0	41.2	41.5	41.5*	13.0*
			8.0	45.7	45.5	45.5	33.5*
				43.4	43.7	44.0*	17.0*
				45.5	46.2	46.0	44.0
				30.8	46.2	45.2	48.5
					48.0	48.0	48.0
					41.0	47.0	47.5
					20.0	38.5	38.0
						29.5	29.0

* Leaf blade completely dead
\# Leaf blade no longer attached to plant
† Central portion of stem broken off

Table 16. Continued.

Study site	Date of observation 6/4/76	6/16/76	6/20/76	7/20/76	8/17/76	9/14/76	10/10/76
	(Leaf length (cm) in order of oldest to youngest leaf)						
PSAM plant #2	6.5*		4.0*	#	#	#	#
	21.5		23.0	#	#	#	#
	32.5		35.5	33.0	#	#	#
	21.0		32.0	31.8	32.0	31.5*	32.5*
			19.0	31.8	32.0	32.5	29.0*
				25.8	30.5	30.5	30.5*
				14.1	32.7	32.6	32.5*
					29.9	35.5	34.5
					15.0	36.0	37.0
						24.0	32.0
							18.5
SAM plant #1				33.0*	34.0*	#	#
				38.0	37.0*	29.0*	#
				24.0	24.5	24.0*	24.0*
				38.5	39.0	38.5	38.0*
				28.0	39.1	39.0	38.5
						33.0	32.0
						24.5	25.7
							15.0
SAT plant #1				20.0*	#	#	#
				26.0	27.0*	#	#
				27.0	28.0	27.5*	28.0*
				28.0	28.0	28.0	28.5*
				19.5	33.0	34.0	33.5
					19.0	34.0	34.0
						28.0	27.0

* Leaf blade completely dead
\# Leaf blade no longer attached to plant

Hofstra (1976), Kirby and Gosselink (1976), and Turner (1976) determination of aboveground primary production without taking into consideration vegetation death and disappearance can lead to significant underestimation of primary production. Table 17 presents the percentage of leaf losses during the growing season of plants at study sites PSAS and PSAM as well as percentages obtained from other researchers. The values obtained in this study are quite similar to those from other studies. While biomass losses due to vegetation death and disappearance during the growing season were not determined, it is apparent from this study that such losses should be taken into consideration in order to more accurately determine net aboveground primary production of salt marsh grasses.

At the end of the growing season, new leaf development stops, but the same dieback and decay pattern occurs throughout the fall and by early December there is only dead brown tissue present. For the first 3 months after the end of the growing season the major causes of plant breakdown were rotting (from being

Table 17. Comparison of percent leaf loss of *Spartina alterniflora* during the growing season for several salt marsh studies.

Marsh location	% Leaf loss	Author
New Jersey		This study
PSAS	27.3	
PSAM	31.5	
Canada		
Tall	23.3	Hatcher and Mann 1975
Medium	27.1	
Short	35.1	
North Carolina		
Marsh average	19.3	Williams and Murdock 1972
Georgia		
Streamside	22.4	Odum and Fanning 1973
Medium and low marsh	8.9	
Average all studies	21.6	

constantly wet) and wind breakage. Wind breaks off the brittle tips of the higher leaves which are infrequently wetted by tidal water. This breakage is usually only 1 to 15 cm of the higher leaves and represents less than one percent of the total plant. Rotting of the lower leaves is responsible for the loss of 20% to 40% of the plant. In addition to leaf decay, the culm of the plant also begins to decay near the marsh surface by early December. By January and February many of the culms have rotted through. At the sites where there is heavy to moderate tidal flooding (SAT, SAM, PSAM), much of this material is washed from the marsh. Thus most of the plant material (60-80%) is not broken or decayed from off the plants while they are still standing, rather than most of the plant is removed as a whole. At the less flooded sites (SAS, PSAS), decaying plant material tends to remain on the marsh surface.

There are also differences in the breakdown of the different height forms of *Spartina alterniflora* which are caused by the placement of the leaves relative to the marsh surface. Since it is the lower leaves which are rotted off while the plant is still standing, those height forms which have leaves near the base of the stem (SAS, SAM, PSAS) will lose a greater biomass before the stem is broken off. As the taller forms (SAT, PSAM) have their larger leaves up higher, these forms will tend to lose less material before the stem breaks.

DECOMPOSITION OF END OF THE SEASON PLANT MATERIAL

Methods

The in situ decomposition of *Spartina alterniflora* and *Spartina patens* was conducted at 10 stations during 1975-1976. The stations, shown on Figure 3, were established in two general areas, Mud Cove and Popular Point. Table 18 lists the 10 stations, their location, and type of plant material used. Study sites 1-6 were considered major stations while study sites 7-10 were considered minor stations. Study sites 1-8 used aboveground material while study sites 9-10 used below ground material.

Table 18. Study sites, locations, and vegetation used for the decomposition of end of season material study.

Study sites and vegetation used		Designation
Popular Point		
1. *Spartina alterniflora*	(short)	(1) PSAS
2. " "	(medium)	(2) PSAM
Mud Cove		
3. *Spartina alterniflora*	(short)	(3) SAS
4. " "	(medium)	(4) SAM
5. " "	(tall)	(5) SAT
6. *Spartina patens*		(6) *S. patens*
7. *Spartina alterniflora* (placed belowground)	(short)	(7) SAS
8. *Spartina alterniflora* (placed in ditch)	(tall)	(8) SAT
9. *S. alterniflora* belowground material washed and placed on surface	(short)	(9) SAS
10. *S. alterniflora* belowground material cut in half and replaced belowground	(short)	(10) SAS

Plant material, consisting of aboveground standing dead culms (marsh cores for sites 9 and 10), was collected on 28 October 1975 and returned to the laboratory. Aboveground material was air dried with belowground material washed free from mud and debris before being air dried.

The decomposition of plant material was determined by the use of plastic net litter bags in the form of tubes approximately 50 cm long by 15 cm diameter filled with 100 g of air dried aboveground plant material. This arrangement allowed for a mesh size of 5 mm. Approximately 30-40 g of belowground material was used for sites 9 and 10. The bags were set out on 2 November 1975 and collections were made at 4 week intervals between 2 December 1975 and 10 October 1976. Three bags were retrieved on each sample date at study sites 1-5, two bags at study site 6, and one bag at study sites 7-10.

After the bags were collected they were returned to the lab, washed of mud, air dried, and weighed. Weight loss was interpreted as the field decomposition rate. Ash content was measured in a Temco model F-1635 muffle furnace. Percent fat was determined by petroleum ether extraction for 3 hours in a Goldfisch Fat Extractor (Assoc. Offic. Agr. Chem. 1965). Crude fiber was determined according to the method in Cusmano and Scotton (1951). Percent Kjeldahl nitrogen of decomposition samples was determined using a modification of the macro-Kjeldahl method described by Skoog and West (1969) to a semimicro method. Percent crude protein was determined by multiplying Kjeldahl nitrogen content by 6.25 (Assoc. Offic. Agr. Chem. 1965).

Results and Discussion

PERCENT DECOMPOSITION - Percent weight loss of decomposition bags versus time (2 November 1975-10 October 1976) at all stations is listed in Table 19 and graphed on Figures 4-12. Linear regression analysis and calculation of correlation coefficients of percent weight loss of decomposition bags vs. time (2 November 1975-10 October 1976) are presented in Table 20. Of the six major study sites, four - (1)PSAS, (2)PSAM, (4)SAM, and (5)SAT - had a very high positive linear correlation ($r>.950$) between percent weight loss and time. For study site (3)SAS this correlation was high ($r=.918$), but low ($r=.584$) for study site (6)*S. patens*. The linear correlation between percent weight loss and time at the minor study sites was high for (8) Sat ($r=.953$) and moderate for (7)SAS ($r=.821$) and (9)SAS ($r=.776$).

The "very high" or "high" correlation coefficients found in six of the nine study sites indicate that a constant (linear) decompositional rate is statistically significant. The results from this study differ with results obtained by other workers (Odum et al. 1973; Kirby and Gosselink 1976). Most decomposition curves for aboveground plant material of salt marsh species have three more or less distinct sections with differing slopes; an initial steep slope (high decomposition rate) section representing the rapid loss of soluble compounds; a second section with a more moderate slope (moderate decomposition rate) representing the microbial breakdown of moderately labile compounds and the mechanical reduction of material by larger organisms such as amphipods; and a final gradual slope state (low decomposition rate) representing the slow breakdown of resistant material (Odum et al. 1973).

To determine if a three step decomposition rate pattern existed in this study (despite strong statistical evidence for a constant decomposition rate) a calculation of the percent weight loss increment of decomposition bags for each sampling date at all study sites was made (Table 21). The percent weight loss increment was determined by subtracting the percent weight loss of decomposition bags at a study site on a given sampling date from the percent weight loss at that study site on previous sampling date. A negative increment value would indicate that the percent weight loss of a sample was greater on the earlier

Table 19. Percent weight loss (± 1 SD) for decomposition samples at all Popular Point and Mud Cove study sites from 2 December 1975 to 10 October 1976.

Date	(1) PSAS	(2) PSAM	(3) SAS	(4) SAM	(5) SAT	(6) *S. patens*	(7) SAS	(8) SAT	(9) SAS
12-2-75	14.4± 4.0	11.6±8.1	23.6± 6.8	7.8±10.4	14.7±6.0	21.3±10.1	11.3	6.0	-
12-30-75	15.6±11.0	18.7±2.0	27.5± 6.7	28.6± 4.8	17.2±1.0	24.7± 5.6	14.6	12.9	2.8
1-26-76	30.6± 2.5	29.2±6.2	32.1± 5.1	29.4±11.4	20.6±5.1	13.7± 0.6	-	15.8	17.2
2-23-76	27.2± 2.2	18.2±6.2	36.5± 9.2	39.8± 5.5	21.9±7.8	11.6± 2.7	4.2	24.9	2.9
3-25-76	35.3± 7.4	24.7±4.9	33.9± 0.3	41.8± 0.5	23.9±9.3	23.3± 2.3	8.9	23.8	12.0
4-26-76	34.3± 3.7	36.9±3.1	27.3± 1.9	43.3± 8.8	30.8±6.5	26.0±15.6	18.3	21.3	1.1
5-20-76	43.0± 3.4	56.9±3.1	42.1± 5.3	53.8± 9.3	39.8±3.0	36.2±18.0	21.2	48.6	10.2
6-23-76	48.0±11.0	50.2±5.6	39.8± 6.8	55.1± 7.5	47.7±3.2	26.6± 9.1	29.4	46.5	7.9
7-20-76	51.3± 1.8	63.7±4.7	46.7±11.5	74.7± 3.1	58.7±8.4	12.7± 0.1	26.0	-	11.2
8-17-76	59.0±10.2	79.1±1.9	53.6± 7.8	89.7± 3.5	65.5±5.5	23.1± 1.1	-	71.9	38.1
9-14-76	55.9	77.2±2.6	72.1±15.6	82.6± 6.4	69.4±4.6	36.7±15.1	-	-	32.1
10-10-76	56.3± 9.7	81.0±0.2	70.0± 0.7	91.9± 1.4	76.3	28.0	-	-	44.0

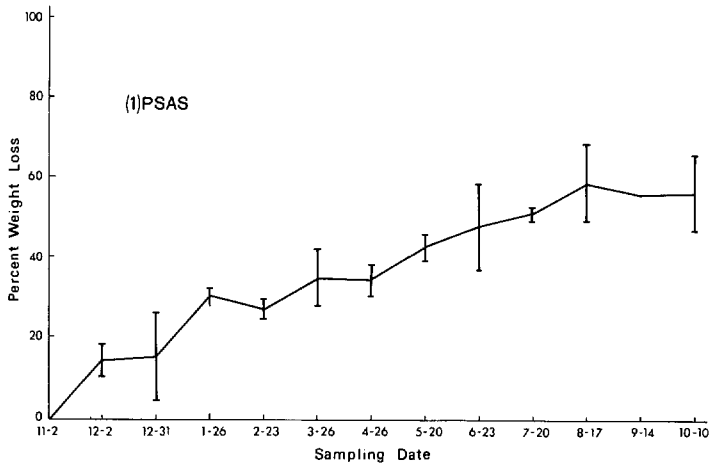

Fig. 4. % wt. loss vs. time for (1)PSAS. Vertical lines = 1 SD.

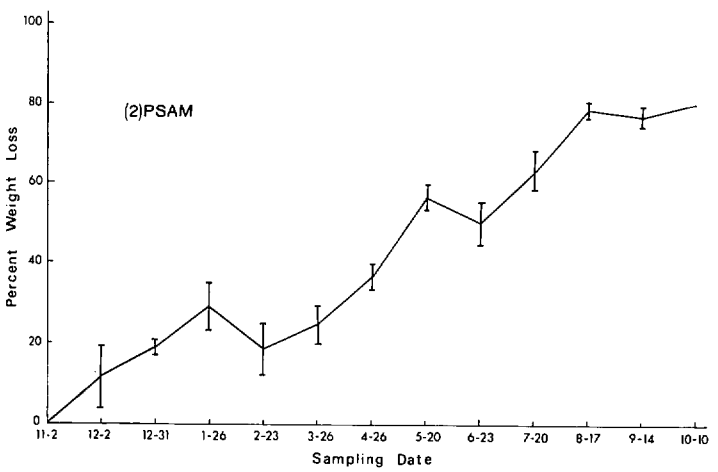

Fig. 5. % wt. loss vs. time for (2)PSAM. Vertical lines = 1 SD.

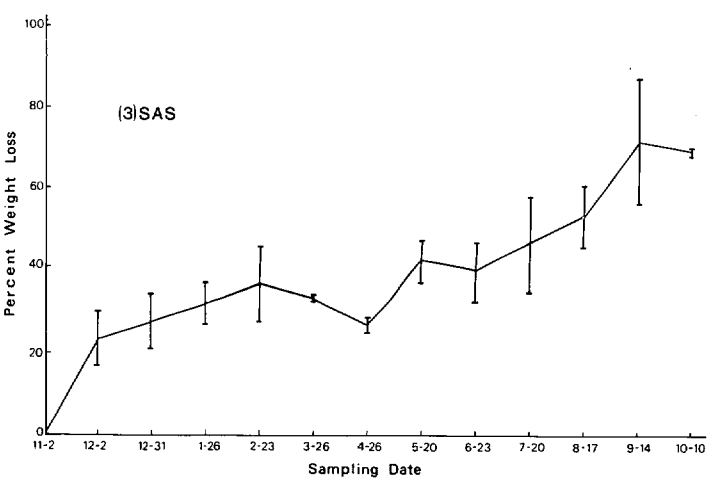

Fig. 6. % wt. loss vs. time for (3)SAS. Vertical lines = 1 SD.

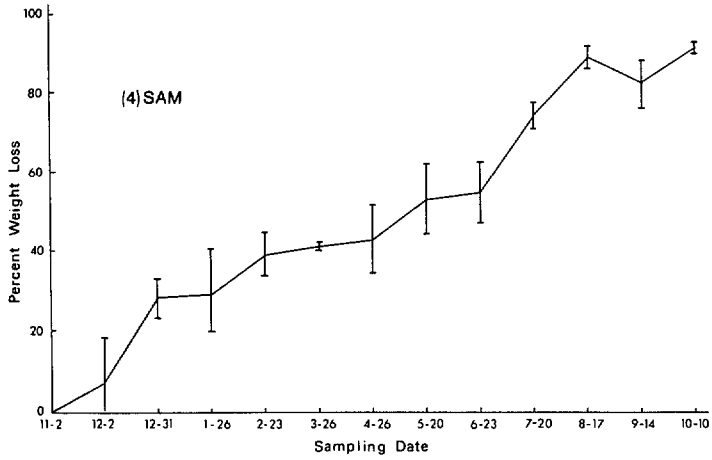

Fig. 7. % wt. loss vs. time for (4)SAM. Vertical lines = 1 SD.

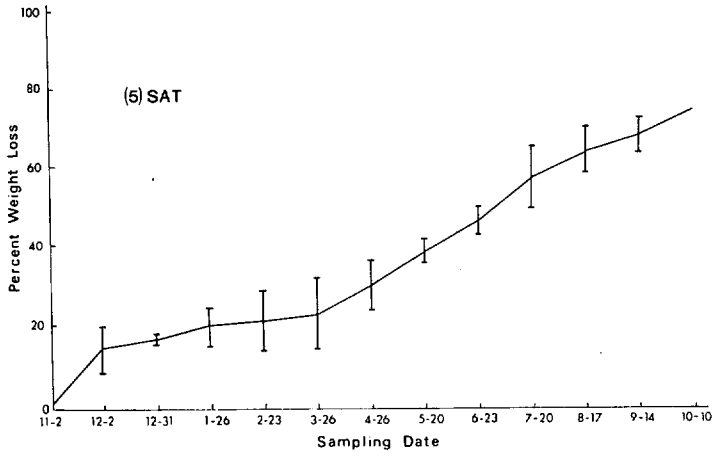

Fig. 8. % wt. loss vs. time for (5)SAT. Vertical lines = 1 SD.

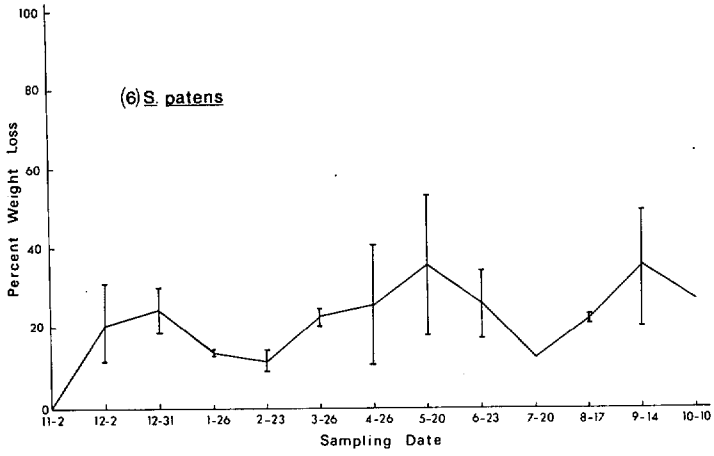

Fig. 9. % wt. loss vs. time for (6)*S. patens*. Vertical lines = 1 SD.

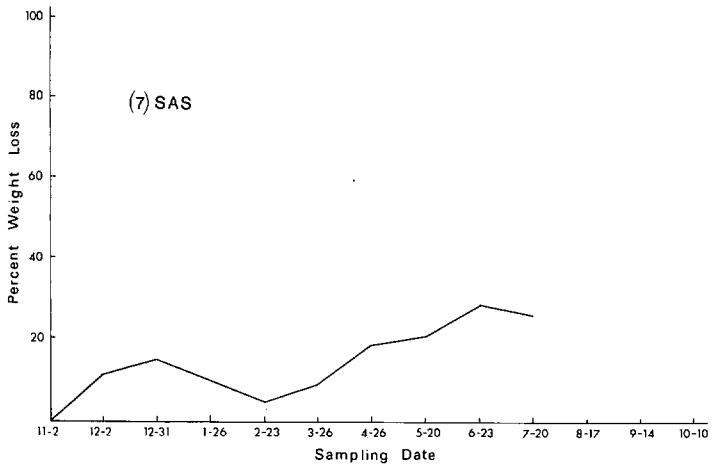

Fig. 10. % wt. loss vs. time for (7)SAS.

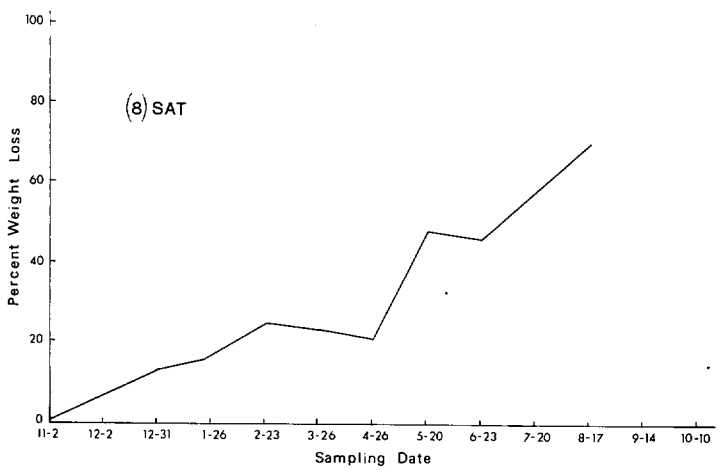

Fig. 11. % wt. loss vs. time for (8)SAT.

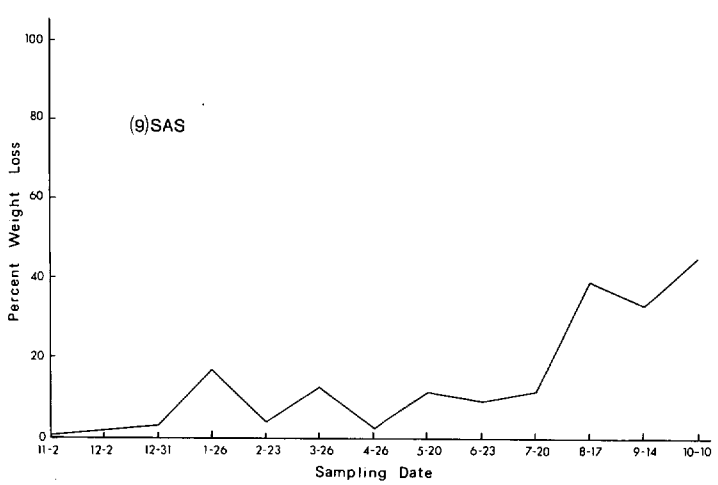

Fig. 12. % wt. loss vs. time for (9)SAS.

Table 20. Linear regression line equations and correlation coefficients (r) for percent weight loss of decomposition samples for the study period 2 November 1975 to 10 October 1976 at Popular Point and Mud Cove.

Study site	Linear regression line equation	Correlation coefficient (r)
(1)PSAS	y = 8.86 + 4.56x	.967
(2)PSAM	y = 0.71 + 6.90x	.971
(3)SAS	y = 11.62 + 4.54x	.918
(4)SAM	y = 4.46 + 7.41x	.979
(5)SAT	y = 0.94 + 6.08x	.983
(6)*S. patens*	y = 12.66 + 1.53x	.584
(7)SAS	y = 2.97 + 2.55x	.821
(8)SAT	y = -3.00 + 6.52x	.953
(9)SAS	y = -4.98 + 3.11x	.766

sampling date and would be an indication of the error involved in the method used to determine decompositional weight losses.

Of the six major study sites, the greatest percent weight loss increment occurred in the first sampling date at three sites ((3)SAS, (5)SAT, and (6)*S. patens*) (Table 21). This large percent weight loss could be attributed to the loss of highly soluble materials in the plant tissue (the initial step in the three step pattern). A decrease in the percent weight loss increment in the latter stages of this study appears to occur at four of the six major study sites ((1)PSAS, (2)PSAM, (3)SAS, and (6)*S. patens*) (Table 21). This could be attributed to the slow breakdown of remaining resistant material (the last step in the three step pattern). While individual steps of the three step decomposition rate pattern exist at some study sites, only site (3)SAS appears to fit the three step decomposition pattern described by Odum et al. (1973). The minor study sites, (7) SAS and (8)SAT appear to fit a linear decomposition pattern while (9)SAS appears to follow neither pattern. It should be noted that site (9)SAS is a study of root material decomposition and may not fit patterns observed for aboveground material.

Differences between results of this study and that of other workers appear to be related to several factors. First, the condition of the plant material used plays a major role. The use of live, fresh cut material will result in a large initial percent weight loss due to leaching of soluble materials (as discussed in the decomposition study of live "harvested" aboveground material section). The plant material used in the present study was harvested on 28 October 1975, a time when much of the soluble component of the plant had either been translocated to the roots or already been leached from the plant. Thus, initial percent weight losses due to leaching of such components would be small. It appears, therefore, that initial percent weight losses are strongly influenced by the soluble component content of the plant tissue. It was also

Table 21. Percent weight loss increments of decomposition samples at all Popular Point and Mud Cove study sites for the period 2 December 1975 to 10 October 1976.

Study site	12/2	12/31	1/26	2/23	3/26	4/26	5/20	6/23	7/20	8/17	9/14	10/10
(1)PSAS	14.4	1.2	15.0	-3.4*	8.1	-1.0	8.7	5.0	3.3	7.7	-3.1	0.4
(2)PSAM	11.6	7.1	10.5	-11.0	6.5	12.2	20.0	-6.7	13.5	15.4	-1.9	3.8
(3)SAS	23.6	3.9	4.6	4.4	-2.6	-6.6	14.8	-2.3	5.9	6.9	18.5	-2.1
(4)SAM	7.8	20.8	0.8	10.4	2.0	1.5	10.5	1.3	19.6	15.0	-7.1	9.3
(5)SAT	14.7	2.5	3.4	1.3	2.0	6.9	9.0	7.9	11.0	6.8	3.9	6.9
(6)*S. patens*	21.3	3.4	-11.0	-2.1	11.7	2.7	10.2	-9.6	-13.9	10.4	13.6	-8.7
(7)SAS	11.3	3.3		-10.4	4.7	9.4	2.9	8.2	-3.4			
(8)SAT	6.0	6.9	2.9	9.1	-1.1	-2.5	25.5	-0.3		35.4		
(9)SAS		2.8	14.4	-14.3	9.1	-10.9	9.1	-2.3	3.3	16.9	-3.0	

* A negative value indicates that the percent weight loss was lower than the percent weight loss on the previous sampling date at that site.

noted that the percent weight loss increment decreased toward the end of the study period at four of the six major study sites. This trend indicates it is likely that the rate of decomposition does decrease in the later stages due to an increasing percentage of more refractory material. If this study could have been extended for a longer period of time, the decrease in the decomposition rate could have been more apparent. A decrease in the decomposition rate was not observed at any of the minor study sites, however, sampling at both (7)SAS and (8)SAT were completed earlier than at the major study sites and study site (9)SAS involving root material.

While temperature did not appear to strongly influence decomposition in this study, other workers (Kirby and Gosselink 1976; Waits 1967) felt that temperature strongly influenced decomposition rates. Higher summer temperatures increased the rate of decomposition in those studies.

A general pattern of decomposition of aboveground plant material at Manahawkin can be described under these special conditions. Because of the initial condition of the plant material used, percent weight losses due to leaching of soluble material are kept to a minimum. The only notable exception to this is at study site (3)SAS where the initial percent weight loss was quite high. Because initial percent weight losses are not extremely high, decomposition rates are more or less constant from the start (representing the second step of the three step pattern). While this rate is constant at a particular site, rates vary from site to site depending upon the environmental conditions at each site and, to some extent, on the nature of the plant material itself.

Results from this study indicate that, in general, the rate of decomposition is affected by moisture content and exposure to air. The highest decomposition rates are shown by (2)PSAM and (4)SAM, both intermediate height forms of *Spartina alterniflora*. These sites appear to have the best balance of exposure to air and moisture content (primarily due to flooding). Sites with less exposure to air due to more flooding ((5)SAT and (8)SAT, tall height forms of *S. alterniflora*) have slightly lower decomposition rates. It was noted that decomposition bags at these sites tended to be covered by mud and silt. This most likely created anaerobic conditions in some parts of the decomposition bags which may have slightly slowed down the decomposition process. This seems to indicate that aerobic decomposers are more efficient or plentiful than anaerobic decomposers. Sites with longer air exposure time (thus allowing for the drying out of the material) such as (1)PSAS and (3)SAS have even lower decomposition rates. The anaerobic site, (7)SAS, has a low decomposition rate. At some point the rate of decomposition decreases because of a relative increase in the amount of refractory material left in the sample. This occurrence is most likely a function of the original decomposition rate, controlled by environmental conditions at that site, and the nature of the decomposing material itself.

It appears that this stage was just beginning at most of the major study sites at the end of the study period. This stage was not evident at some of the major study sites and all of the minor study sites; thus correlation coefficients for linear decomposition rates remained quite high. If this study was longer, it is likely that a leveling off of the decomposition would have been evident, changing the decomposition process from a one step (linear) pattern to a two step pattern or even a three step pattern at site (3)SAS. The only exception to this general description is study site (6)*S. patens* which has a fluctuating pattern of percent weight loss with time. This site pattern could possibly be due to differences in washing the samples free from mud on the different sampling

dates. Study (9)SAS measured percent weight loss of root material placed on the marsh surface. Percent weight loss was low and fluctuated from the start of the study to 20 July 1976 followed by a sharp increase in percent weight loss for the remainder of the study period. Reasons for this pattern are not evident.

Another factor which plays a role in the decomposition process is that of small organisms such as amphipods, snails, and crabs which accelerate the fragmentation of plant material into smaller particles so they can be flushed out of litter bags by tidal action (Odum et al. 1973). While this factor was not investigated in the study, it was noted that small organisms (primarily amphipods and the snail *Melampus*) were found at study sites (1)PSAS, (2)PSAM, (3)SAS, (4)SAM, and (5)SAT. Such organisms at study sites (4)SAM, (2)PSAM, and (5)SAT no doubt help contribute to the high decomposition rates found at those sites. Anaerobic conditions at study site (8)SAT most likely limited association with these organisms, but apparently had little effect on the decomposition rate. While amphipods and *Melampus* were found at sites (1)PSAS and (3)SAS, reduced flooding conditions resulted in lower decomposition rates. Sites with little flooding and/or anaerobic conditions ((6)*S. patens*, (7)SAS, (9)SAS) which had few associated small organisms, had the lowest decomposition rates.

Because of differences in the mesh size of decomposition bags used, duration of the experiments, and environmental conditions, direct comparisons of decomposition rates obtained by other workers must be made with caution (Williams and Murdoch 1972). Burkholder and Bornside (1957) reported a ≈90% weight loss of *S. alterniflora* put in a shallow stream in Georgia after 300 days. At site (8)SAT in this study there was a 72.1% weight loss after approximately 300 days. Burkholder and Bornside, however, used wooden crates rather than decomposition bags. Odum and de la Cruz (1967) reported a 42% weight loss after 300 days for *S. alterniflora* placed at a stream side in Georgia. At a comparable site in this study ((5)SAT), there was a 65.5% weight loss after approximately 300 days. The mesh size of the decomposition bags used by Odum and de la Cruz was 2.5 cm compared to 5.0 cm in this study. Kirby and Gosselink (1976) working in Louisiana, found decomposition losses of 78% for short form *S. alterniflora* and 89% for tall form *S. alterniflora* after 11 months and 95% for tall form *S. alterniflora* placed in a stream after 10 months. Results from comparable stations in this study were 72.1%, 69.4% and 71.9% respectively. Mesh size of decomposition bags in the Kirby and Gosselink study was 2 mm. Seneca et al. (1976) working in North Carolina, found decomposition to be related to the leaf:stem ratio. *S. alterniflora* short form had the highest leaf:stem ratio and also the highest weight loss (≈93% after 11 months) followed by *S. alterniflora* medium (≈90% after 11 months) and *S. alterniflora* tall (≈72% after 11 months). With the exception of *S. alterniflora* short, similar results were obtained in this study (70%, 91.9%, and 76.3% respectively). Seneca et al. (1976) also reported that litter bags placed in creeks had slightly slower decomposition rates when compared to litter bags containing the same type of material which were placed on the marsh surface. This agrees with the results from this study, but differs from that of Kirby and Gosselink (1976).

In addition to differences in the decomposition bags used, environmental factors in these studies, such as tidal amplitude, varied greatly (from ≈50 cm in Louisiana to 1.8 m in Georgia).

PERCENT ASH - Percent ash analysis for all samples in this study is presented in Table 22. At four of the six major study sites, there is a sharp decrease in

percent ash between the 2 November 1975 (initial plant material) and 3 December 1975 samples. It is thought that the high initial percent ash content of three of these sites ((1)PSAS, (4)PSAM, (6)*S. patens*) was in part a result of mud covering the plant material that was not completely removed. True percent ash content is probably close to that found at the other sites (9-13%). Minimum percent ash values occur between 3 December 1975 and 26 January 1976 at all of the major sites. It is felt that leaching of the mineral content of the plant material accounts for this minimum. All major sites show a general increase in percent ash from this minimum until 23 June 1976. Percent ash content at study sites (2)PSAM, (3)SAS, and (5)SAT then decreases until 17 August 1976; then increases for the remainder of the study period. At study site (1)PSAS, percent ash increases until 17 August 1976 then decreases for the rest of the study period, while at study site (6)*S. patens*, percent ash increases to 20 July 1976 then shows a slight general decrease for the rest of the study period. Percent ash at study site (4)SAM shows a general increase until 14 September 1976 and then rises quite sharply on 10 October 1976. The high percent ash in this sample can be attributed to mud which was in the sample. The samples collected at this site on that sample date had undergone a large amount of decomposition (91.9% weight loss of the original sample) and was in small fragments. Treatment needed to effectively remove all mud trapped in the sample would have broken down the sample to a point where it would all be washed out of the decomposition bag. Table 22 presents data for the two minor sites at Mud Cove involving aboveground material. At study site (7)SAS there is a sharp drop in percent ash content from 2 November 1975 to 3 December 1975. The high initial ash content is most likely due to mud that was not completely washed off the plant material. Percent ash increased until 23 June 1976, then decreased on 20 July 1976. At study site (8)SAT there is a fluctuation in ash content (between 6 and 10%) throughout the entire study period. Table 22 shows percent ash values for the two minor sites at Mud Cove using belowground (root) material. Percent ash content is generally higher at these sites compared to aboveground material sites. At both (9)SAS and (10)SAS there is a general increase in percent ash to a maximum on 23 June 1976 followed by a decrease until 17 August 1976 with a subsequent increase for the remainder of the study.

At a majority of the study sites there is, in general, an increase in percent ash content from a minimum in December or January to a maximum on 23 June 1976. This increase seems logical since mud tends to become incorporated with the plant material in the decomposition bags with time. This in turn requires a more vigorous washing of the decomposition bags to remove such mud. With increasing time, however, decomposition material becomes more "fragile" and has been broken down to a point where excessive and vigorous washing removes such material as well as mud from the bags. In order to prevent excessive material loss, decomposition bags must be washed less vigorously resulting in an increase in mud (ash) in the sample. The sharp decrease in percent ash content found at many sites from 23 June 1976 to 17 August 1976 is somewhat difficult to explain. One possible explanation is the method by which decomposition bags were processed. Decomposition bags collected from 3 December 1975 to 23 June 1976 were processed by one worker while all bags collected since 20 July 1976 were processed by the present graduate assistant on this study. A more vigorous washing of decomposition bags collected on 20 July 1976 and 17 August 1976 to remove mud would result in lower percent ash values.

PERCENT CRUDE FAT - Table 23 presents crude fat values for all sites. Because of the backlog of samples, analysis at most study sites was made only to

Table 22. Percent ash content (± 1 SD) of samples at all study sites from 2 November 1975 to 10 October 1976.

Date	(1)PSAS	(2)PSAM	(3)SAS	(4)SAM	(5)SAT	(6) *S. patens*	(7)SAS	(8)SAT	(9)SAS	(10)SAS
11-2-75	20.07	11.91	17.88	13.45	9.07	18.99	17.88	9.07		
12-2-75	8.11± .38	10.69±2.03	6.71±1.37	9.11± .47	9.13± .55	5.52± .56	6.24	5.94		17.63
12-30-75	6.39± .66	7.97± .35	6.36± .28	11.11± .77	8.02±2.01	3.70± .98	5.46	9.05	11.21	15.65
1-26-76	6.56±1.15	8.06±2.68	5.94±1.29	10.04±3.46	7.29± .59	6.44± .50		9.75	10.33	
2-23-76	11.55±1.29	12.39± .51	7.66±1.21	11.16± .50	8.97±1.56	7.88± .13	8.89	6.78	12.00	22.32
3-25-76	9.61±1.15	9.07±2.39	8.39± .72	9.70±1.06	8.44± .69	6.27± .23	9.66	8.17	14.46	13.00
4-26-76	9.19± .08	9.93± .69	10.59±1.05	13.94±2.11	8.52±1.23	5.94± .32	10.17	9.67	15.99	13.79
5-20-76	9.02±1.70	8.56±1.38	9.04±1.54	12.96±2.49	9.02±1.28	5.21± .99	11.28	7.76	17.57	20.47
6-23-76	11.55±1.06	11.69±3.65	12.49±1.23	18.36±6.76	11.43± .38	7.08± .35	12.23	10.79	24.14	39.91
7-20-76	13.87±3.38	8.76±2.58	8.66±2.80	14.23±3.53	8.68±2.23	8.21± .75	8.39		20.42	18.59
8-17-76	15.60±2.84	5.70±1.05	6.90±1.59	19.10±3.04	6.64± .63	5.39± .90		7.33	15.30	13.20
9-14-76	12.52	8.11±4.33	6.80±1.51	13.33±2.18	9.72± .92	7.23±1.91			14.62	24.90
10-10-76	10.95±1.89	12.87±3.29	8.41±3.05	33.23±3.38	11.41	6.57			17.20	

23 June 1976. Of the six major study sites, all but (6)*S. patens* follow the same general pattern. For the first 20-24 weeks, percent crude fat at these sites in general remained fairly constant. Percent crude fat values at these sites ranged from ≈2.1% for (3)SAS to ≈1.5% for (5)SAT. After this period, percent crude fat values decrease reaching 1.07% at (3)SAS and 0.63% at (5) SAT by the end of the study. Except for a 26 January 1976 peak, percent crude fat values at (6)*S. patens* fluctuated between 0.74-1.25%. All of the minor study sites followed the same general pattern, but this pattern was shifted over an 8 week period between the four sites. All sites showed an increase in percent crude fat to a maximum between 2 December 1975 - 26 January 1976, fell to a minimum between 30 December 1976 - 24 March 1976, increased to a secondary maximum between 25 March 1976 - 26 April 1976, and decreased. It is not known why all minor sites followed this pattern and why this pattern was followed. Percent crude fat was generally higher at sites (7)SAS and (8)SAT (1.20-3.11%) which used aboveground material than at sites (9)SAS and (10)SAS (0.29-2.30%) which used belowground material. Odum and de la Cruz (1967) reported a decrease in fat from ≈4% to >1% in decomposing *S. alterniflora*. Teal (1962) working in the laboratory with finely ground inoculated *Spartina* material collected in midwinter found a gradual decrease in percent fat from ≈2.5% to ≈0.6% in 16 weeks.

PERCENT CRUDE FIBER - The percent crude fiber of all samples that have been analyzed is presented in Table 24. Because of a backlog of samples, only samples to 23 February 1976 were analyzed. For this period the percent crude fiber of all decomposition samples (except (9)SAS (10)SAS) show, in most cases, an increase with time. Since crude fiber is a measure of materials (e.g. lignins and cellulose) which are more resistant to microbial decomposition, an increase in the percent crude fiber can be explained due to a differential decomposition rate between the crude fiber and noncrude fiber components of plant material. Percent crude fiber increased between ≈8%-21% at these sites from ≈35-42% to 48-57% during a 16 week period. At sites (9)SAS and (10)SAS, using root and rhizome material, percent crude fiber remained fairly constant.

Extreme caution must be used in applying the results obtained for crude fiber beyond the time period studied. It is not known whether percent crude fiber will continue to increase, level off, or decrease through time. Odum and de la Cruz (1967) noted for *Spartina* an increase in percent crude fiber followed by a decrease then another increase. Teal (1962) using finely ground inoculated *Spartina* in the laboratory, found a decrease in percent fiber from ≈35% to ≈8% in 16 weeks.

PERCENT NITROGEN AND PERCENT CRUDE PROTEIN - Because of the backlog of samples to be processed, it was felt that analysis of samples from a single study site for the entire study period would be of more value than analysis of samples from all study sites on a single sampling date. Using this approach, all samples from study sites (3)SAS, (4)SAM, (5)SAT, and (6)*S. patens* were processed; results are presented in Table 25. Since crude protein is determined by multiplying Kjeldahl nitrogen content by 6.25 (Assoc. Offic. Agr. Chem. 1965), only nitrogen data will be discussed.

Percent nitrogen levels at site (3)SAS followed a similar pattern as that of site (5)SAT. After a slight initial drop during the first four week period, percent nitrogen levels remained more or less constant for 20 weeks followed by an increase in percent nitrogen for the remainder of the study. Final percent nitrogen was greater than initial percent nitrogen content at site (3)SAS (0.83% vs. 1.27%) but not at site (5)SAT (1.45% vs. 1.35%).

Table 23. Percent (%) crude fat ash-free dry weight of samples at all study sites.

Date	(1)PSAS	(2)PSAM	(3)SAS	(4)SAM	(5)SAT	(6) *S. patens*	(7)SAS	(8)SAT	(9)SAS	(10)SAS
11-2-75	1.71	1.82	1.61	1.73	1.20	1.37	1.61	1.20		
12-2-75	1.86	1.67	2.15	1.96	1.53	0.94	2.52	1.50		1.13
12-30-75	1.47	2.31	2.13	2.55	1.56	1.02	1.58	2.76	0.29	2.05
1-26-76	2.23	1.84	2.11	1.71	1.55	1.65		3.11	2.30	
2-23-76	1.82	1.83	2.00	1.77	1.52	0.85	1.98	1.81	1.24	0.95
3-25-76	2.02	1.87	2.12	1.76	1.57	1.19	1.76	1.75	0.89	1.38
4-26-76	1.96	1.85	2.09	1.66	1.30	1.25	2.23	2.87	1.32	0.92
5-20-76	1.79	1.35	1.75	1.29	1.30	1.19	1.83	1.60	0.76	0.99
6-23-76	1.75	1.61	1.72	1.13	0.85	0.99	1.85	1.27	0.83	1.28
7-20-76			1.53	1.14	0.84	0.88				
8-17-76			1.51	0.75	1.05	0.76				
9-14-76			1.45		1.04	0.74				
10-10-76			1.07		0.63	1.00				

Table 24. Percent (%) crude fiber ash-free dry weight of samples at all study sites from 2 November 1975 to 23 February 1976.

Study sites	11/2/75	12/2/75	12/30/75	1/26/76	2/23/76
(1)PSAS	34.40	43.81	54.45	50.41	48.35
(2)PSAM	36.92	44.45	48.50	51.24	51.72
(3)SAS	34.74	44.07	47.22	51.30	55.70
(4)SAM	41.97	48.88	46.65	50.33	50.45
(5)SAT	35.68	47.18	47.35	50.16	54.72
(6)*S. patens*	42.85	49.37	53.90	51.68	57.05
(7)SAS	34.74	45.43	53.64		55.17
(8)SAT	35.68	44.81	46.47	52.46	42.10
(9)SAS			53.90	55.27	49.88
(10)SAS		35.33	38.62		36.92

At site (4)SAM there was also an initial decrease in percent nitrogen during the first 4 week period (1.23% to 0.93%). Percent nitrogen, however, increased immediately and continued to do so for the remainder of the study reaching a final value of 2.94%. As with site (3)SAS, the final percent nitrogen level was greater than the initial value although (4)SAM values at the later stages of the study were about two times higher than (3)SAS levels.

Percent nitrogen values at site (6)*S. patens* showed no initial drop and fluctuated between 0.56% and 0.71% throughout the entire study period. Percent nitrogen at this site in general were the lowest of all the study sites analyzed.

The nitrogen and crude protein pattern observed at sites (3)SAS, (4)SAM, and (5)SAT is similar to that found by other workers using litterbags (Odum and de la Cruz 1967; Odum et al. 1973) or finely ground inoculated *Spartina* in the laboratory (Teal 1962; Gosselink and Kirby 1971). Work by Seneca et al. (1976) showed an increase in percent crude protein in all height forms of *S. alterniflora* at the end of a 13 month study period, but the monthly pattern observed fluctuated and differed between sites. The pattern did not follow that described by Odum et al. (1973).

The initial drop in percent nitrogen and protein has been attributed to a rapid breakdown of these components with the subsequent rise due to the enrichment of the plant material (detritus) by bacterial and fungal colonization as well as the loss of carbohydrate from the material (Odum et al. 1973).

DECOMPOSITION STUDY OF LIVE (HARVESTED) ABOVEGROUND MATERIAL

Methods

A study of the decomposition of aboveground material at different stages of the growing season was conducted during the summer and fall of 1976. The

Table 25. Percent Kjeldahl nitrogen ash-free dry wt (± 1 SD) and percent crude protein ash-free dry weight (± 1 SD) of samples at study sites (3)SAS, (4)SAM, (5)SAT, and (6) *S. patens* at Mud Cove from 2 November 1975 to 10 October 1976.

Sample date	(3)SAS		(4)SAM		(5)SAT		(6)*S. patens*	
	%C.P.*	%K.N.#	%C.P.	%K.N.	%C.P.	%K.N.	%C.P.	%K.N.
11-2-75	5.11	0.83	7.68	1.23	9.06	1.45	3.39	0.56
12-3-75	4.12± .27	0.66±.05	5.97± .30	0.96±.07	4.22±.76	0.68±.12	3.59±.22	0.58±.04
12-31-75	4.64± .41	0.75±.07	6.49± .31	1.04±.31	3.86±.43	0.63±.07	3.66±.06	0.59±.01
1-26-76	4.29± .64	0.69±.10	7.07± .64	1.13±.10	4.11±.39	0.66±.07	3.50±.11	0.57±.01
2-23-76	4.82± .22	0.78±.04	7.76± .38	1.25±.06	3.78±.53	0.62±.08	4.03±.01	0.65±.00
3-25-76	4.34± .34	0.70±.07	7.09± .34	1.14±.06	4.25±.47	0.68±.08	3.77±.14	0.61±.02
4-26-76	4.88± .11	0.78±.02	8.01±1.54	1.26±.25	4.53±.60	0.73±.10	3.55±.16	0.57±.03
5-20-76	5.23± .42	0.84±.07	8.21± .83	1.31±.13	4.87±.39	0.78±.06	3.69±.17	0.59±.03
6-23-76	5.42±1.00	0.87±.16	10.03±2.07	1.60±.33	4.69±.03	0.75±.01	4.02±.21	0.65±.03
7-20-76	5.44± .69	0.87±.11	12.57±1.09	2.01±.18	6.19±.74	1.01±.11	4.39±.54	0.71±.08
8-17-76	6.87± .42	1.10±.06	15.65± .23	2.51±.04	7.13±.38	1.15±.07	3.77±.42	0.61±.08
9-14-76	7.36± .51	1.18±.08	13.52±1.43	2.16±.23	7.21±.59	1.16±.09	4.29±.37	0.69±.06
10-10-76	7.89± .64	1.27±.11	18.33± .53	2.94±.06	8.52	1.35	4.16	0.66

* C.P. = crude protein # K.N. = Kjeldahl nitrogen

study sites selected were the same five major sites used in the 1975-76 Decomposition Study. The sites were (1)PSAS, (2)PSAM, (3)SAS, (4)SAM, and (5)SAT. This was done so that results from this experiment could be directly compared to the 1975-1976 study. Live aboveground material was collected at each site on 4 June 1976. This material was returned to the laboratory where it was air dried, bagged in nylon netting, weighed, and returned to the field on 16 June 1976. Six decomposition bags were set out at each site. These bags were collected on 23 June 1976 (one bag at each site), 20 July 1976 (two bags), 17 August 1976 (two bags), and 14 September 1976 (one bag). A second collection of live material was made on 20 July 1976 and returned to the laboratory where it was processed as the first collection. Four decomposition bags for each site were returned to the sites on 17 August 1976. Two bags at each site were retrieved on 14 September 1976 and two more on 10 October 1976. A third collection of live material was made on 17 August 1976, processed in the laboratory, and returned to the sites on 14 September 1976 (two bags at each site). These bags were collected on 10 October 1976.

Bags retrieved were washed of mud, air dried, and weighed. Weight loss through time was determined as the field decomposition rate.

Results and Discussion

Table 26 presents the weight loss of the live harvested decomposition bags at all sites for the entire study period. In looking at the first fresh clipped collection (material clipped 4 June 1976, set out 16 June 1976), the following patterns are noted. First, all sites showed a very high percent weight loss within one week. The percent weight loss was about the same for all sample sites (≈35%). After this high initial decomposition rate, the rate decreased at all sites but to varying degrees. Sites PSAM and SAT had the highest percent weight loss (≈80-85%) after 13 weeks (17 August 1976), while sites SAM, PSAS, and SAS had a lower percent weight loss (≈65%) after 13 weeks.

These results differ greatly from those obtained in the 1975-76 decomposition study in two major ways: (1) Percent weight loss through time in this study was not a linear relationship as it was in the 1975-76 study and (2) the rates of decomposition were much greater than in the 1975-76 study. Such differences can possibly be explained due to the type of material used in this study compared to the 1975-76 study. The initial material used in the 1975-76 study was standing dead material. Such material would contain very little soluble material such as sugars which would be lost rapidly in the first month of a decomposition study. Fresh clipped material (such as that used in this study) would have large amounts of soluble materials and could account for the large percent weight loss in the first week of a decomposition study. After this rapid initial loss, the breakdown of more resistant material would occur at a slower rate. This could account for the rapid, non-linear decomposition rate of fresh clipped material. Squires and Good (1974) reported that percent crude fiber of *S. alterniflora* increases during the growing season. Therefore, fresh material clipped in June has a lower percentage of crude fiber (high % crude fiber slows decomposition) than material clipped in November. This, too, could help account for the higher decomposition rate in this study compared to the 1975-76 study.

In looking at all three collection series, several trends are seen. At highly and moderately flooded sites (PSAM, SAM, SAT), the initial percent weight loss decreased with each succeeding live harvested collection series. It is thought than an increase in percent crude fiber and/or decrease in soluble components in the plant tissues during the growing season are factors influencing

Table 26. Percent weight loss (± 1 SD) of live harvested decomposition bags at Popular Point and Mud Cove. Except where noted bags were set in the field on 16 June 1976.

Study site	Date of collection				
	6/23/76	7/20/76	8/17/76	9/14/76	10/10/76
(1)PSAS	35.3	39.2±3.2	59.6±2.2	61.9 13.7±2.1*	 32.7±1.9* 24.1±1.7#
(2)PSAM	34.7	71.5±1.3	84.2±0.7	184.8 57.9±1.1*	 66.7+0.2* 34.9#
(3)SAS	42.3±8.1	57.1±6.5	69.4	 18.0±1.7*	 56.6±6.0* 36.1±2.6#
(4)SAM	32.5	50.8±0.4	66.1±2.6	80.7 35.4±2.8*	 60.5±3.0* 43.8±5.5#
(5)SAT		79.3±0.3	84.8±1.0	 58.7±0.2*	 68.0±0.4* 50.0±0.7#

* Bags set in field 8/17/76

\# Bags set in field 9/14/76

the decrease in initial percent weight loss of live harvested material collected throughout the growing season. Initial percent weight losses at all these sites for all three collection series, however, were greater than the initial percent weight losses obtained at those sites in the 1975-76 Decomposition Study.

At less flooded sites (SAS, PSAS), the initial percent weight loss of material in the third collection series was lower than the first collection series, but was about twice as great as that of the second live harvested collection series. It is not known why such a pattern would exist. Possible differences in flooding patterns at the less flooded sites at different times during the study period may effect initial percent weight losses.

The decomposition pattern for live harvested material at all sites appears to fit a three step pattern as described by Odum et al. (1973) rather than a linear pattern found in the 1975-76 Decomposition Study. Decomposition of live harvested material is quite rapid when compared to the 1975-76 Decomposition Study. Percent weight losses of live harvested material from the first collection series after 13 weeks (16 June 1976-14 September 1976) were nearly identical to percent weight losses of 1975-1976 Decomposition Study material after 48 weeks. It is felt that the difference in the soluble component and crude fiber content of the initial plant material used in the two studies accounts, to a large extent, such differences.

STUDY OF BELOWGROUND MATERIAL DECOMPOSITION

Methods

An attempt was made to measure the in situ decomposition of belowground (root and rhizome) material at two sites, SAS and *S. patens* (sites (3)SAS and (6)*S. patens* of the 1975-76 Decomposition Study). On 9 June 1976, 12 belowground cores were taken to a depth of 30 cm at each site. Each core was cut in half lengthwise and weighed on a solution balance in the field. One core half was tagged and placed in a nylon mesh bag and returned to the core hole. The other core half was returned to the laboratory where all core halves were washed over a screen of 0.5 mm mesh to separate root material from mud. These roots were then air dried and weighed.

At 4 week intervals between 23 June 1976 and 21 November 1976, 2 core halves from each site were removed from the marsh and returned to the laboratory where they were processed as the initial core halves.

Based on the assumption that root and rhizome material is evenly distributed throughout the two core halves, the dry root-rhizome weight (hereafter termed dry root weight) of the core half left in the core at the start of the study could be estimated using the following equation:

$$\text{dry weight core half left in core hole} = \left[\frac{\text{dry root weight core half returned to laboratory}}{\text{wet weight entire core half (root and mud) returned to laboratory}}\right] \times \text{wet weight entire core half (root and mud) left in core hole}$$

Core halves subsequently collected were processed and actual dry root weights were determined. Losses in dry root weight between calculated initial estimates and actual values when collected were considered as decompositional weight losses.

Results and Discussion

Estimated initial dry root weights for core halves left in the field as well as actual dry root weights for core halves collected from 23 June 1976 to 21 November 1976 are found in Table 27. This table also presents the difference in actual-initial dry root weights. As seen in Table 27, actual dry root weights for samples collected between 23 June 1976 and 14 September 1976 were greater than estimated initial dry root weights (with one exception). It appears that root growth rather than root decomposition was taking place in both short form *Spartina alterniflora* and *S. patens*. It also appears that root biomass at both sites increased from 23 June 1976 through 14 September 1976. The large increase in actual dry root weight compared to initial weight for the 23 June 1976 and one of the 14 September 1976 SAS cores is probably due to mud that was not washed from the cores during processing.

Table 27. Estimated initial dry root weight, actual dry root weight, and actual-initial dry root weight difference for belowground samples collected from 23 June 1976 to 21 November 1976 at Mud Cove.

Sample site	Collection date	Estimated initial dry root wt. (g)	Actual dry root wt. (g)	Difference in dry root wt. (actual-initial) (g)
SAS	23 June 76	31.3	53.3	+22.0*
SAS (a)	20 July 76	31.7		
(b)		32.0		
S. patens (a)		26.8		
(b)		23.4		
SAS (a)	17 August 76	34.9	32.9	- 2.0#
(b)		36.8	39.7	+ 2.9
S. patens (a)		23.3	26.8	+ 3.5
(b)		28.3	32.0	+ 3.7
SAS (a)	14 September 76	31.7	52.2	+20.5
(b)		29.9	37.0	+ 7.1
S. patens (a)		23.6	29.8	+ 6.2
(b)		24.5	35.0	+10.5
SAS (a)	10 October 76	31.0	39.0	+ 8.0
(b)		34.4	34.1	- 0.3
S. patens (a)		24.2	22.8	- 1.4
(b)		29.1	23.6	- 5.5
SAS	21 November 76	32.2	33.1	+ 0.9

* Positive value indicates increase in root biomass

\# Negative value indicates decomposition of root material

It appears that the increase in root biomass in the cores was not due to root growth into the cores from outside surrounding root material as this was not visibly noticed during core collection. It was also noticed that limited shoot regrowth occurred on some but not all of the cores left in the field.

On the 10 October 1976 collection there was a decrease in actual dry root weight compared to estimated initial weights for both *S. patens* and one SAS core sample. It appears that for at least *S. patens* there is some decomposition of root material. It is less apparent for SAS as one core sample gained weight and one lost weight, however, there was an overall decrease in dry root weight compared to September. The SAS core collected on 21 November 1976 showed a slight increase in dry root weight compared to the initial, but this increase was less than increases from previous sample dates. This seems to indicate that some belowground decomposition of SAS root material is taking place.

The pattern of belowground biomass changes observed in this experiment is quite similar to that found in the belowground production study (Table 10). Belowground biomass at all *S. patens* and the disturbed SAS sites increased during the growing season to a maximum in August or September followed by a decrease in belowground biomass. Coring and bagging of belowground material during the late spring apparently has little or no effect on normally occurring

biomass changes during the growing season. Belowground biomass dynamics, therefore, are quite stable and can respond to such stress quite readily.

CONCLUSIONS

Primary production in the Manahawkin marshes is derived from both the aquatic and terrestrial systems; both lower plants (algae) in the water and on the marsh surface as well as higher plants in the water and on the marsh. This study has been involved with the primary production resulting from the vascular plants of the marsh. The fate of the resulting biomass has also been followed through the decompositional process utilizing phenological studies as the link between production and decomposition. Furthermore, all phases of the production/decomposition process have been related to environmental parameters present.

In the 1974 progress report of this study (Good and Smith 1974) comparisons of aboveground production to other areas were made. Later, belowground production information was obtained and comparisons with similar vegetation data were also made. A comparison of above and belowground production showed that belowground production was about 5 times greater than aboveground.

Values for total production that are available in the literature are often in the form of energy units. Therefore conversion of the biomass figures for SAS (the most abundant vegetation type of this study) to the same energy units allows for comparison. This is done by multiplying the caloric value per gram times the annual production ($g \cdot m^{-2}$) which gives $kcal \cdot m^{-2}$. Using values of 4.4 $kcal \cdot g^{-1}$ (aboveground) and 4.7 $kcal \cdot g^{-1}$ (belowground) for energy equivalents on an ash-free dry weight basis, the 500 $g \cdot m^{-2}$ (aboveground) and 3,000 $g \cdot m^{-2}$ (belowground) production estimates yield an energy value for SAS of approximately 16,000 $kcal \cdot m^{-2}$ which represents annual net primary production. Therefore, 320 ha covered by SAS at Manahawkin would thus have an annual net production of 5.12×10^9 kcal.

This 16,000 $kcal \cdot m^{-2}$ value for SAS would fall into the 10-25 thousand $kcal \cdot m^{-2} \cdot y^{-1}$ range given by Odum (1971) for this type of system although downward adjustment must be made since his figures are for gross production. If we assume that net primary production is 60% of the gross primary production, the net primary production for Odum's range would be 6-15 thousand $kcal \cdot m^{-2} \cdot y^{-1}$; with SAS at the top of this range. Odum (1971) gives net primary production values of 15,200 $kcal \cdot m^{-2}$ for alfalfa and 13,000 for a mature rain forest; values which represent some of the highest presented. It therefore appears that the value of 16,000 $kcal \cdot m^{-2}$ is a good starting figure which can be used for net primary production of the SAS marsh types until further refinements can be made.

Chemical analyses performed in this investigation and related studies (Smith 1976) revealed that standing crops of crude fiber, nitrogen free extract, crude fat (aboveground material only), and crude protein (belowground material only) were a function of dry matter biomass. Accumulation of crude protein (containing nitrogen) in aboveground material during the beginning of the growing season was thought to be a storage mechanism for nitrogen which is potentially limiting later in the growing season. Since this early season accumulation of nitrogen is not evident for the belowground component and since crude protein standing crop is directly related to belowground biomass, it appears that nitrogen is not as limiting as it is in the aboveground component. Woodhouse et

al. (1974) and Valiela et al. (1976) showed that application of nitrogen improved the aboveground production, but had little impact on the root-rhizome system. Woodhouse et al. (1974) felt that nitrogen and other nutrients such as phosphorus limited aboveground production because they are tied up in the large amount of belowground biomass. There is a possibility that with the compact nature of the root-rhizome system of SAS, space for root growth is limiting rather than nutrients.

If indeed this form of *S. alterniflora* is limited by nitrogen and phosphorus it may very well serve to remove these nutrients from the tidal waters. There are reports of freshwater marshes acting to improve dissolved oxygen as well as lowering nutrient levels (Grant and Patrick 1970) although a study of wetlands in Chesapeake Bay showed that the marshes were not functioning in this manner (Bender and Correll 1974). The general findings for North Carolina (Woodhouse et al. 1974) are that the marshes may be important in the recycling of nutrients that might otherwise occur as pollutants in the estuary. Woodhouse et al. (1974) feel that using marshes for removal of excessive nutrients increases growth of *Spartina* which would provide an increased supply of food energy and nutrients to the detritus food chain rather than to other energy pathways.

That portion of the net primary production which is unharvested at the end of the growing season represents a large percentage of the yearly production (estimated for this study at 90%). While a majority of the study sites had the same general decomposition pattern, only those sites with similar environmental regimes had similar decomposition rates. In addition, the type of plant material in question may have an effect on the decomposition rate.

Based on the litterbag studies, SAS loses approximately 4.5% of the original material per month during the first year of decomposition. SAT loses about 6.0% per month while *S. patens* loses about 1.5% per month during the first year of decomposition. Using 1975 aboveground production values of 444 $g \cdot m^{-2}$ for SAS, 735 $g \cdot m^{-2}$ for SAT and 535 for *S. patens*, approximately 20 $g \cdot m^{-2} \cdot month^{-1}$ (SAS), 44 $g \cdot m^{-2} \cdot month^{-1}$ (SAT) and 8 $g \cdot m^{-2} \cdot month^{-1}$ (*S. patens*) of plant material enters the detrital food chain.

These values, however, do not account for all vascular plant material which enters the detrital food chain. Material lost during the growing season should also be included. It was shown for *S. alterniflora* in the phenological study section of this report that some aboveground plant material dies during the growing season and undergoes decomposition. The rate of decomposition of this material is much greater than material which undergoes decomposition at the end of the growing season. While biomass losses were not directly measured, it was estimated that about 10% of net aboveground production is lost in this manner.

Using the previously stated production figures and a 5 month growing season (May-September) approximately 9 $g \cdot m^{-2} \cdot month^{-1}$ (SAS) and 15 $g \cdot m^{-2} \cdot month^{-1}$ (SAT) are contributed during the growing season. The amount contributed by *S. patens* was not determined but would be quite small.

It was shown in this study that end of the season material doesn't decompose entirely in 1 year. Therefore, contributions to the detrital food chain made by this older material must be considered. It was shown in this study that

there appears to be a fairly large decrease in the decomposition rate of plant material by the end of the first year of decomposition at many of the major study sites. Also, it is this older material which becomes incorporated into the marsh itself. Once incorporated into the marsh, the amount of plant material which becomes part of the detrital food chain, is quite small. With these two factors taken into account, the contribution made by this older decaying plant material to the detrital food chain would be small.

While SAS contributes less than half the amount of plant material than does SAT to the detrital food chain on a meter square basis, the large coverage of SAS (320 ha) and small coverage of SAT (9 ha) make SAS the most important source of detritus in the Manahawkin marshes. *S. patens*, an abundant type (140 ha) represents a vast store of plant material in a temporarily nonusable form for the detrital food chain. It has a higher average production than the short form of *S. alterniflora* and it loses very little material over the year. Thus there is an accumulation of material espececially in the *S. patens* sites which only slowly and partially decomposes, becoming available to consumers.

Chemical analysis of decomposition material revealed that for nearly all study sites percent crude fat decreased and percent crude protein increased by the end of the study period. Percent crude fiber analysis of early samples showed an increase with time. The increase in percent crude protein was attributed to colonization of the plant material by bacteria and fungi. Odum and de la Cruz (1967) and Odum et al. (1973) have stated that it is the microbial enrichment of detritus which makes it a good food source for consumers; better than the grass tissue that forms the base of most detritus.

The Barnstable (Massachusetts) intertidal marsh with its high flooding frequency has been shown to have an average rate of vertical accretion of 1.83 $cm \cdot year^{-1}$ (Redfield 1972). This accretion is due to input of sediment from the flooding tide as well as any net accumulation of organic matter (from primary production of vascular plants). In the high marsh at Barnstable (vegetated by *S. alterniflora* short form and *S. patens*) the increase in elevation has been at a rate which exceeded the general rise in sea level during the several thousand years of its existence; exceeding it by 15.2 cm in 10^3 years (Redfield 1972). Since the opportunity for sediment input is reduced in the less frequently flooded high marsh, the contribution from incompletely decomposed plant material may be significant. Specifically, Redfield's findings at Barnstable should be considered in interpreting the low rate of decomposition for *S. patens* and its role in marsh accretion at Manahawkin. In interpreting the results for *S. alterniflora* short form, the contribution by the belowground biomass (Table 10) in marsh accretion should be considered as balancing out the greater rate of decomposition for the aboveground material of *S. alterniflora* compared to *S. patens*.

Since the Manahawkin marshes have probably existed for a similar period of time as the Barnstable marshes (Daddario 1961) and the marsh sediments are partially plant material in origin, a fine balance must exist, (now and in the past) among production, decomposition, detrital export, accumulation, and incorporation. For the marsh to remain stable these processes must also be in balance with tide levels and on a long term basis, sea level. Figure 13 is a model of these dynamic processes for a salt marsh plant community like *Spartina alterniflora*. The status of the marsh is then dependent on the rates of these processes.

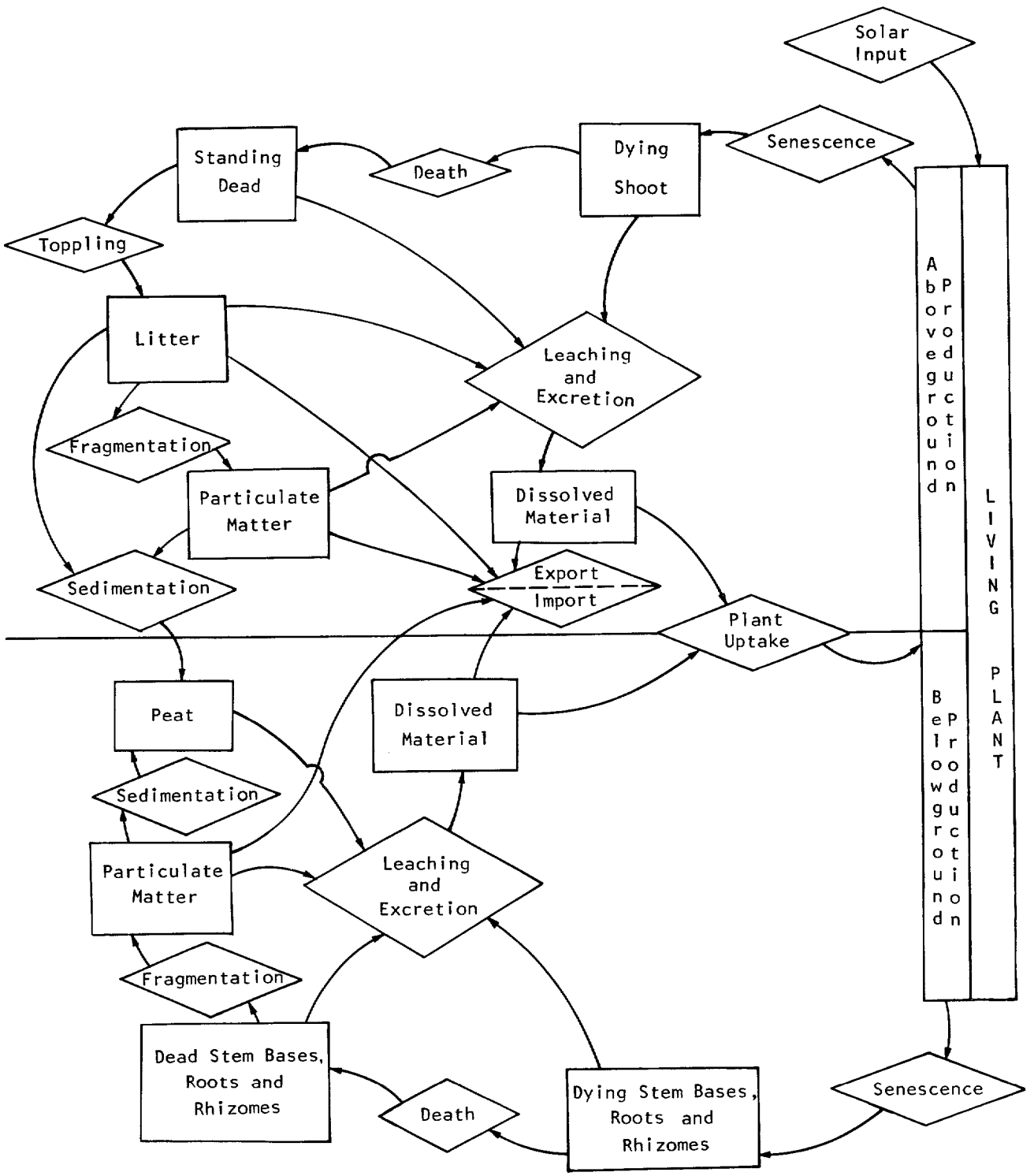

Fig. 13. A model of the dynamic processes of a *Spartina alterniflora* salt marsh community. Boxes represent components of the system with diamonds representing processes occurring within the system. Arrows show the possible inputs, exports, and transfers which can occur. (Modified from Gallagher 1977).

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APPENDIX A

Tables and Figures from the June 1974 Estuarine Evaluation Study Annual Report: Marsh Plant Productivity

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Table 2. Mean dry weight ± one standard deviation ($g \cdot m^{-2}$) of live and litter for *Spartina alterniflora* short form (SAS) for stations 2, 4, 7, 9, 11, and 14 throughout the 1973 growing season.

Month	Station no.											
	2		4		7		9		11		14	
	Live	Litter	Live	Litter	Live	Litter	Live	Litter	Live	Litter	Live	Litter
7A	380±60	184±53	389±40	142±39			405±86	265±38				
7B					393±89	146±56						
8A											306±126	168±144
8B									547±60	159±26		
9A	669±33	944±11	484±13	213±28	633±231	513±44	442±146	535±243	734±42	243±5		
9B							360±80	673±45			353±25	165±19
10A	473±117	395±5	295	381					422±32	467±13		
10B	348±11	574±100	232±36	364±134	234±0	689±4	273±4	494±11	349±30	434±98	369±83	353±117
11A					188±6	823±110						

A First to fifteenth of month

B Sixteenth to end of month

Table 3. Mean dry weight ± one standard deviation ($g \cdot m^{-2}$) of live and litter for *Spartina patens* for stations 1, 3, 6, 8, 10, 13, 16 throughout the 1973 growing season.

Month	Station no.													
	1		3		6		8		10		13		16	
	Live	Litter	Live	Litter	Live	Litter	Live	Litter	Live	Litter	Live	Litter	Live	Litter
7A													344±62	525±111
7B	440±118	525±0	390±81	902±134	458±66	1275±183	498±36	927±68	691±42	665±42				
8A											558±3	763±4		
8B	613±15	612±40	680±10	505±0					631±13	632±121	694±64	743±33	380±16	488±74
9A			684±11	308±26	519±202	1183±174	746±0	844±112						
9B	601±144	545±63			428±140	1528±139	425±35	688±180	548±247	464±93	559±64	887±111	365±124	529±66

A First to fifteenth of month

B Sixteenth to end of month

Table 4. Mean dry weight ± one standard deviation ($g \cdot m^{-2}$) of *Spartina alterniflora* tall (SAT) for stations 5, 12, and 15 throughout the 1973 growing season.

Month	Station no.					
	5		12		15	
	Live	Litter	Live	Litter	Live	Litter
8A					639±85	306±119
8B	1098±255	609±109	739±82	270±49		
9A						
9B						
10A			368±45	327±23		
10B	666±208	624±4	322±22	405±73	477±18	360±30
11A	358±108	771±146			491±47	256±2

A First to fifteenth of month

B Sixteenth to end of month

Table 5. Mean dry weight ± one standard deviation ($g \cdot m^{-2}$) of live and litter for *Distichlis* and *Distichlis-Juncus* for stations 17 and 18 throughout the 1973 growing season.

Month	Station no.				
	17			18	
	Live *Distichlis*	Live *Juncus*	Litter	Live	Litter
8A	189±59	325±120	278±49		
8B	364±102	150±28	557±211	644±77	937±113
9A					
9B					
10A	235 ± 57		636±69	565±60	561±86

A First to fifteenth of month

B Sixteenth to end of month

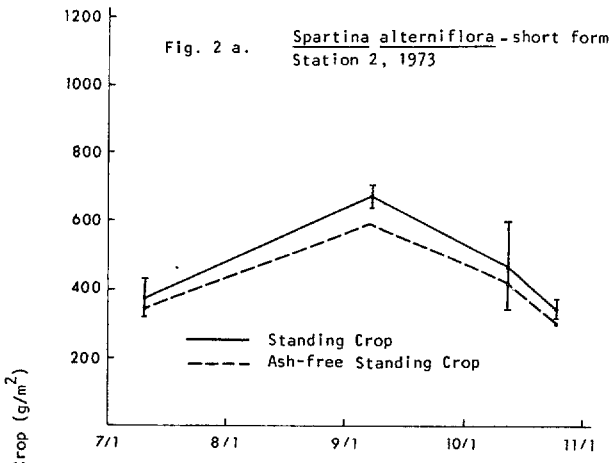
Table 6. Mean seasonal dry weight ($g \cdot m^{-2}$) for all stations by species throughout the 1973 growing season.

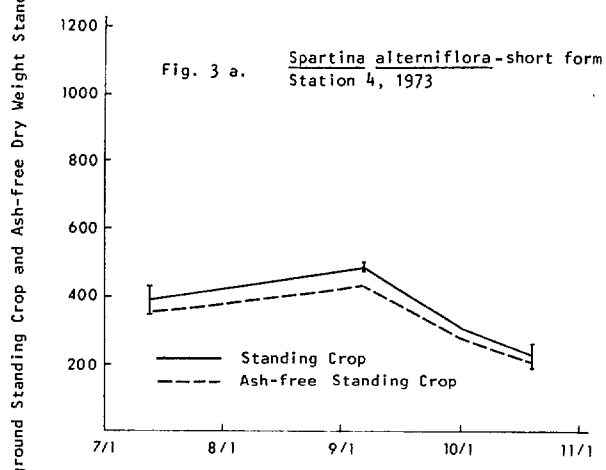
	S. alterniflora short		*S. patens*		*S. alterniflora* tall		*D. spicata*		*D. spicata-Juncus*	
Month	Live	Litter	Live	Litter	Live	Litter	Live	Litter	Live	Litter
7A	391	197	(344)	(525)						
7B	(393)	(146)	495	859						
8A	(306)	(168)	(558)	(763)	639	306			515	278
8B	515	178	600	596	919	440	644	937	514	557
9A	592	490	650	778						
9B	356	419	488	774						
10A	396	414			365	327	565	561	235	636
10B	300	485			488	463				
11A	(188)	(823)			425	514				

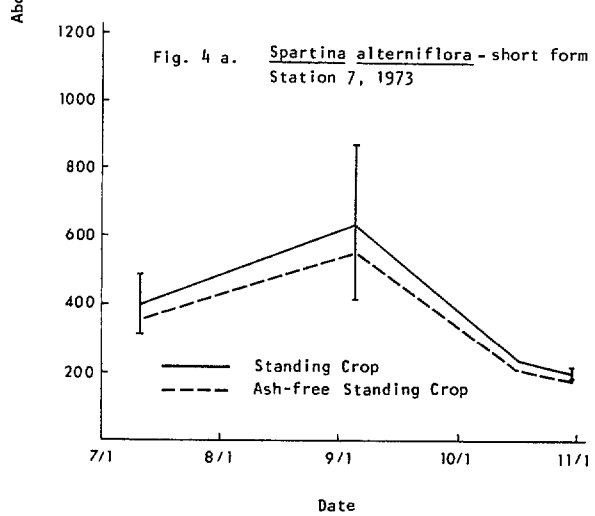
Parentheses indicate that figure represents one station.

A. First to fifteenth of month

B. Sixteenth to end of month

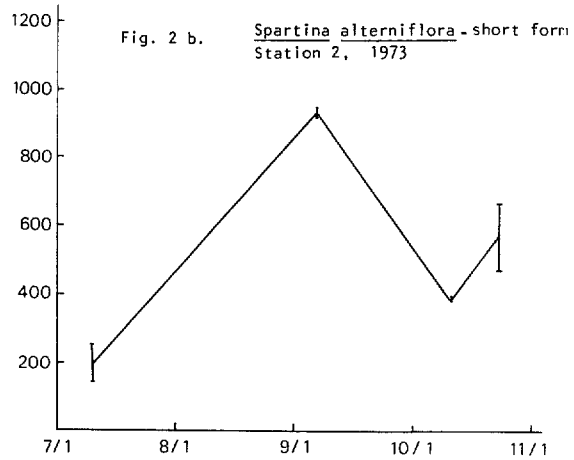


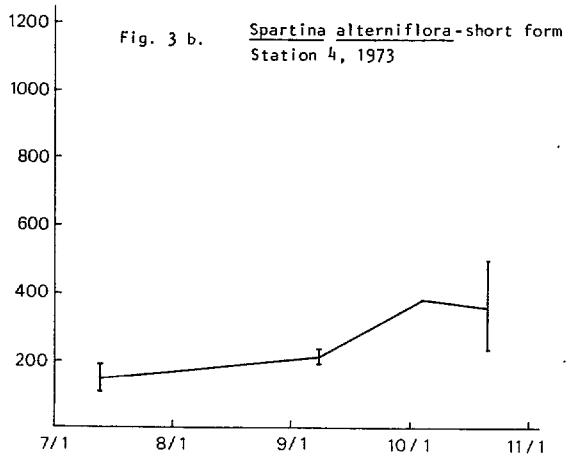


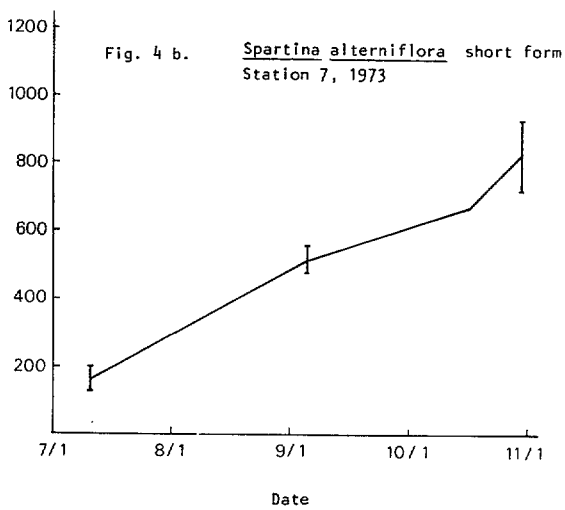


Aboveground Standing Crop and Ash-free Dry Weight Standing Crop (g/m^2)

Figs. 2 a, 3 a, and 4 a. Aboveground standing crop and ash-free dry weight standing crop ($g \cdot m^{-2}$).

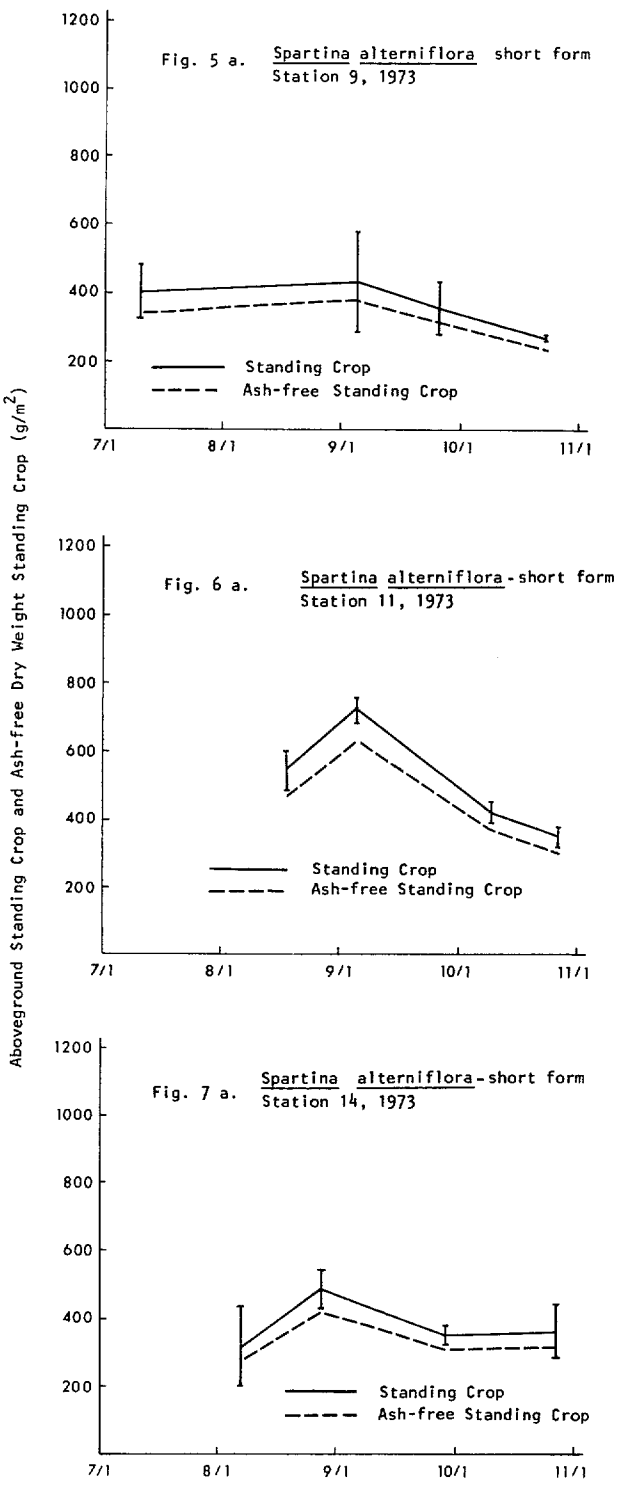




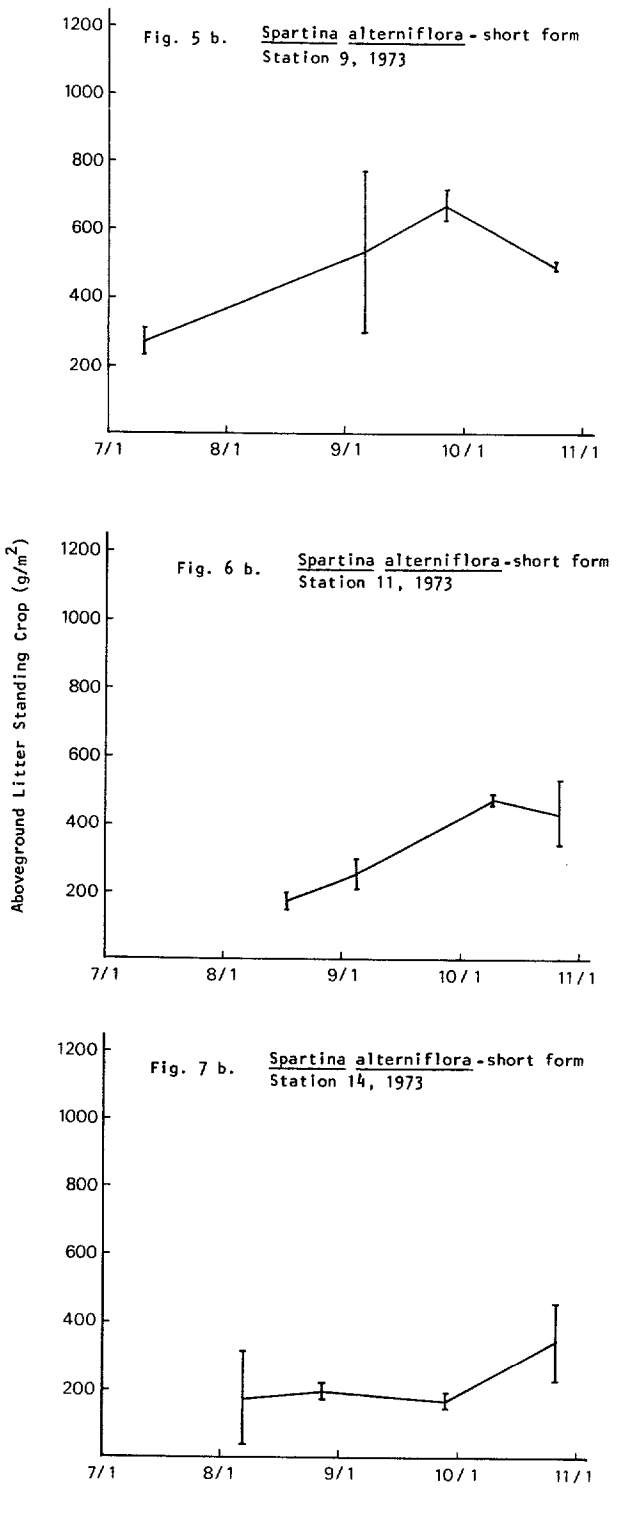


Aboveground Litter Standing Crop (g/m^2)

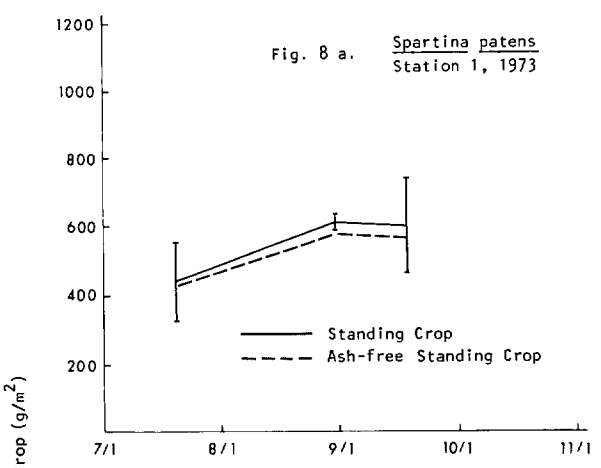
Figs. 2 b, 3 b, and 4 b. Aboveground litter standing crop ($g \cdot m^{-2}$).

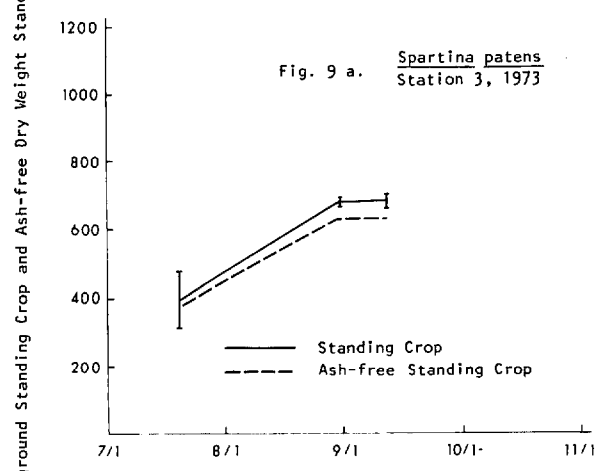


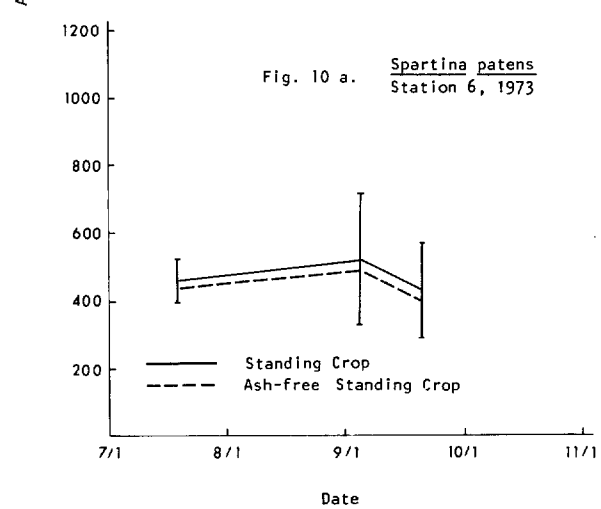
Figs. 5 a, 6 a, and 7 a. Aboveground standing crop and ash-free dry weight standing crop ($g \cdot m^{-2}$).



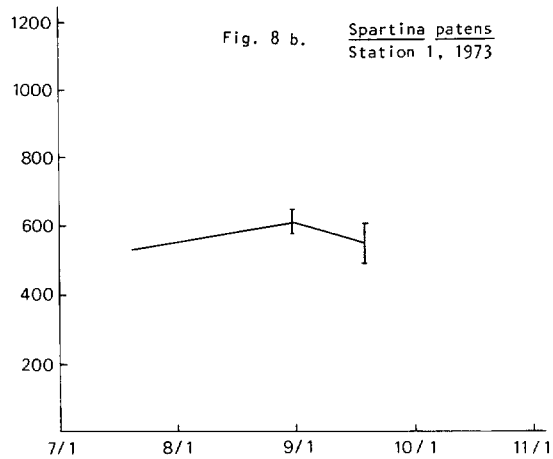
Figs. 5 b, 6 b, and 7 b. Aboveground litter standing crop ($g \cdot m^{-2}$).

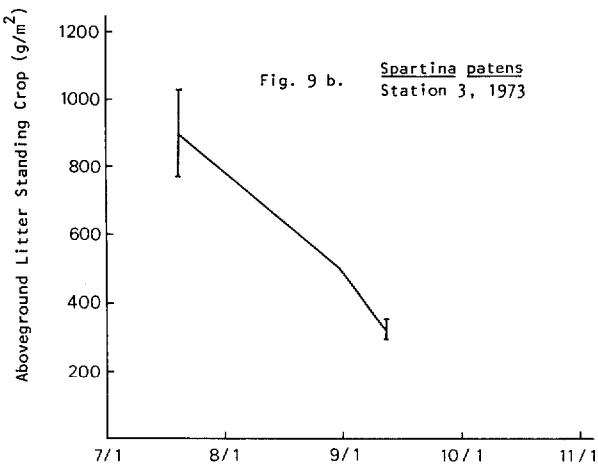


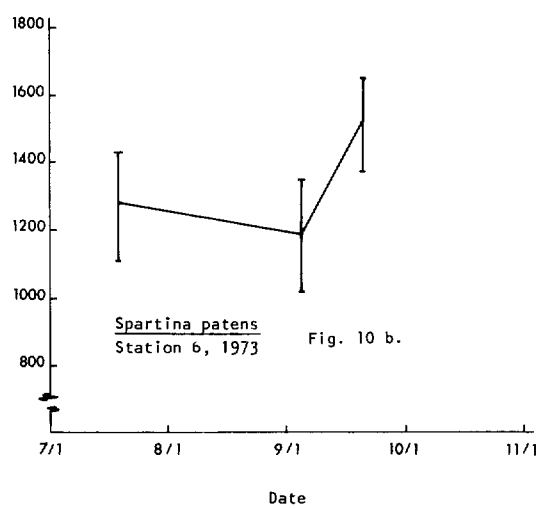




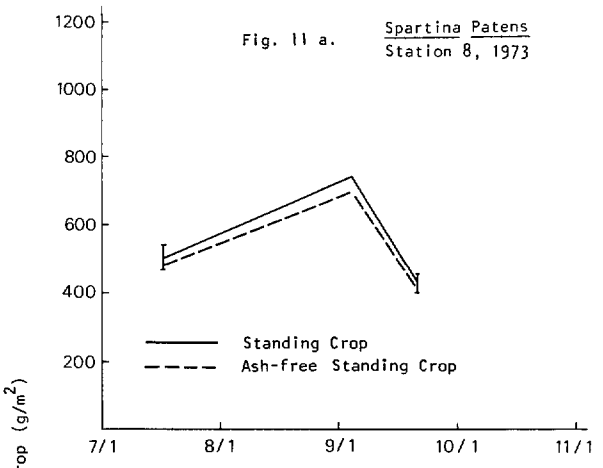
Figs. 8 a, 9 a, and 10 a. Aboveground standing crop and ash-free dry weight standing crop ($g \cdot m^{-2}$).

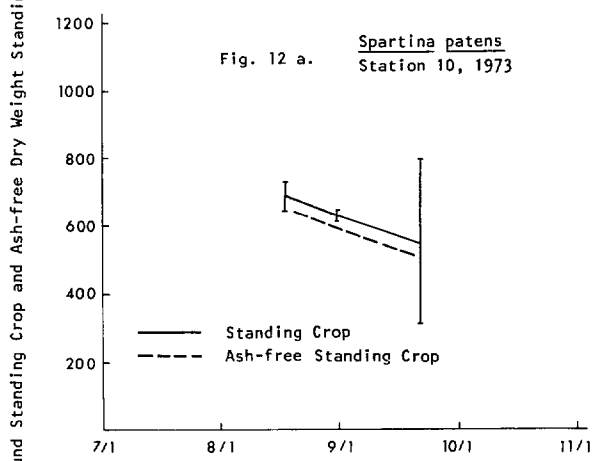


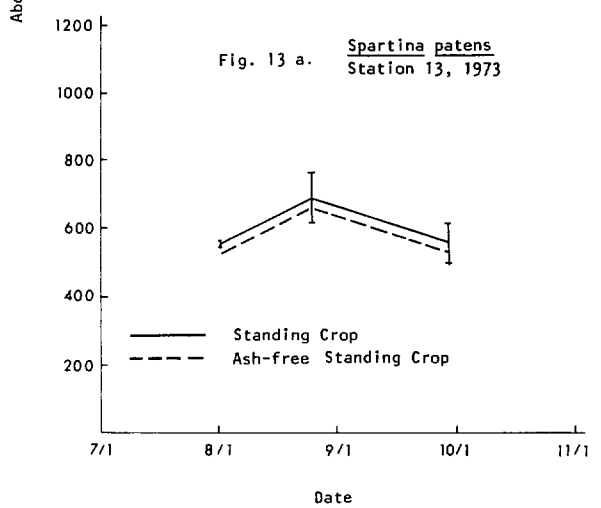




Figs. 8 b, 9 b, and 10 b. Aboveground litter standing crop ($g \cdot m^{-2}$).

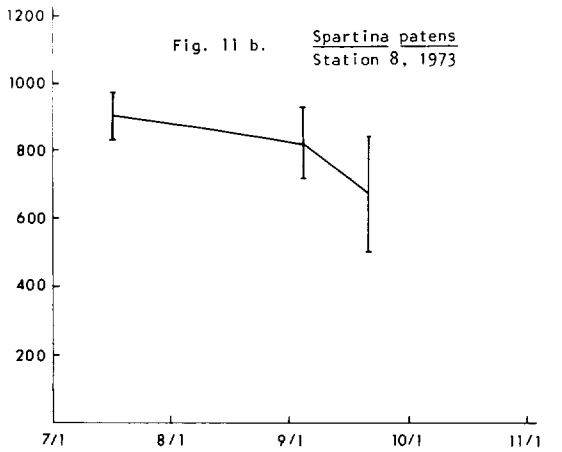


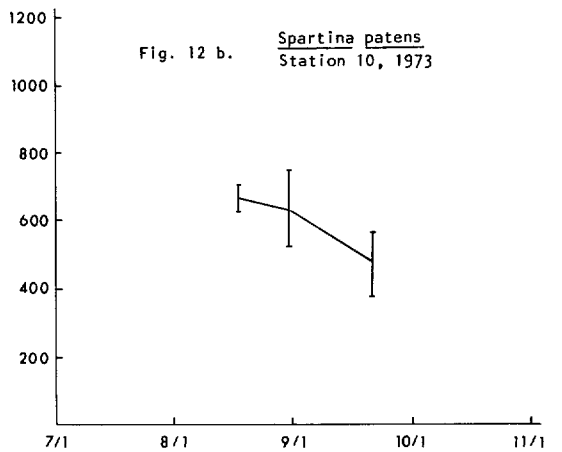


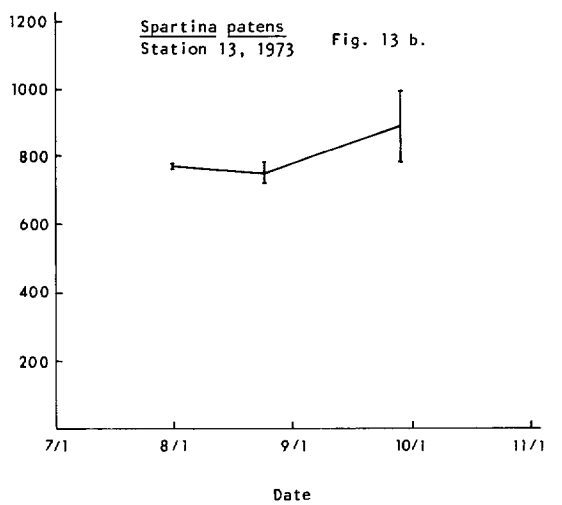


Aboveground Standing Crop and Ash-free Dry Weight Standing Crop (g/m^2)

Figs. 11 a, 12 a, and 13 a. Aboveground standing crop and ash-free dry weight standing crop ($g \cdot m^{-2}$).

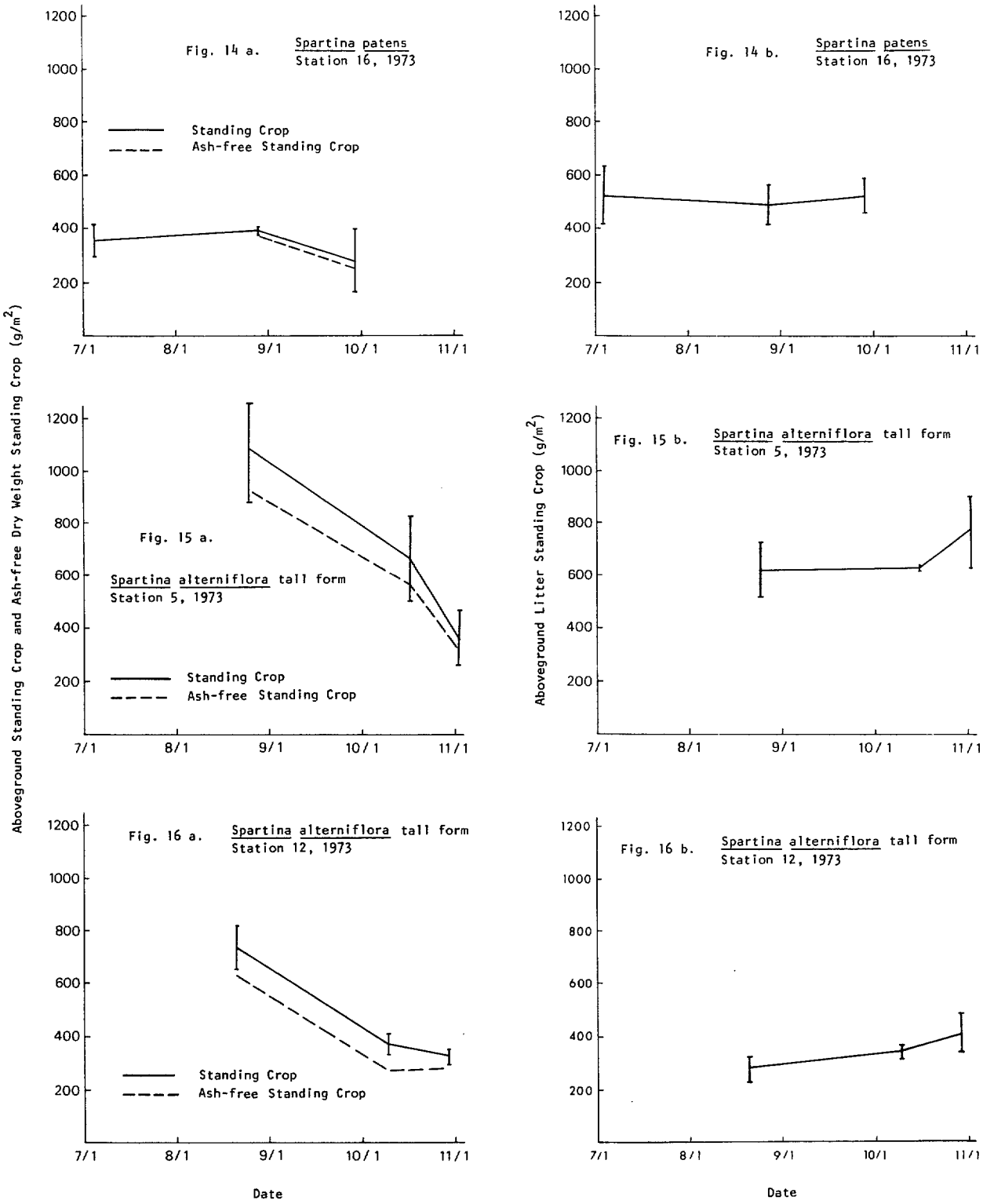






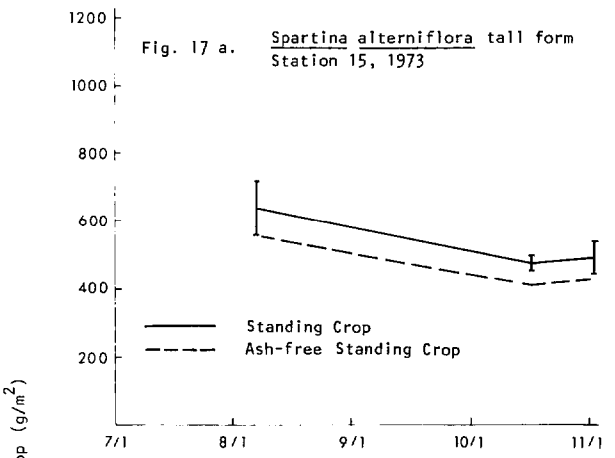
Aboveground Litter Standing Crop (g/m^2)

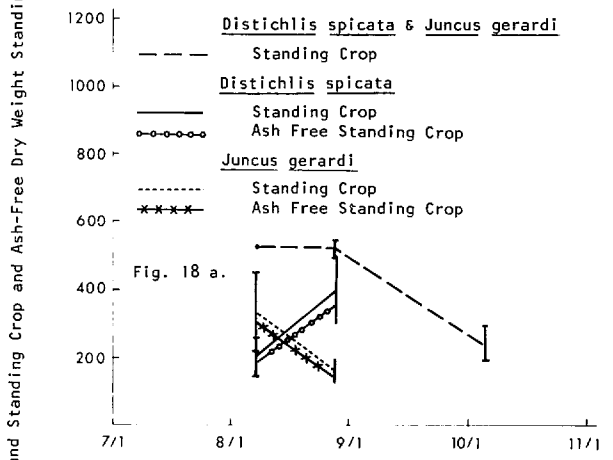
Figs. 11 b, 12 b, and 13 b. Aboveground litter standing crop ($g \cdot m^{-2}$).

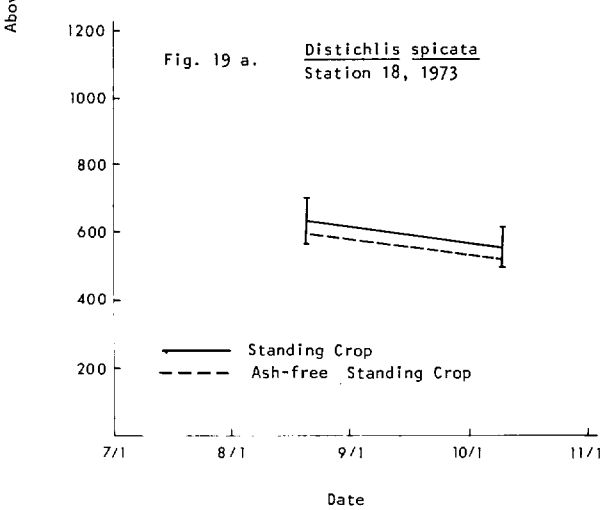


Figs. 14 a, 15 a, and 16 a. Aboveground standing crop and ash-free dry weight standing crop ($g \cdot m^{-2}$).

Figs. 14 b, 15 b, and 16 b. Aboveground standing crop ($g \cdot m^{-2}$).

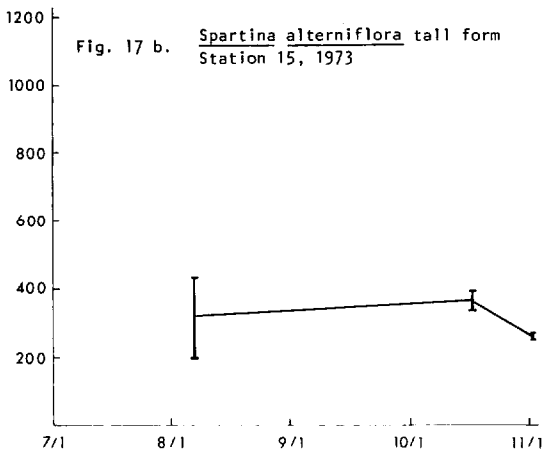


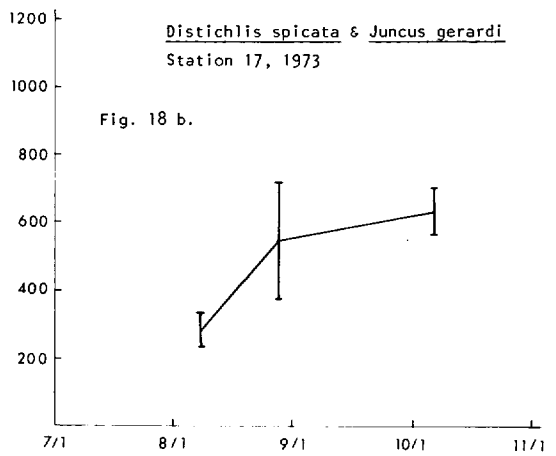


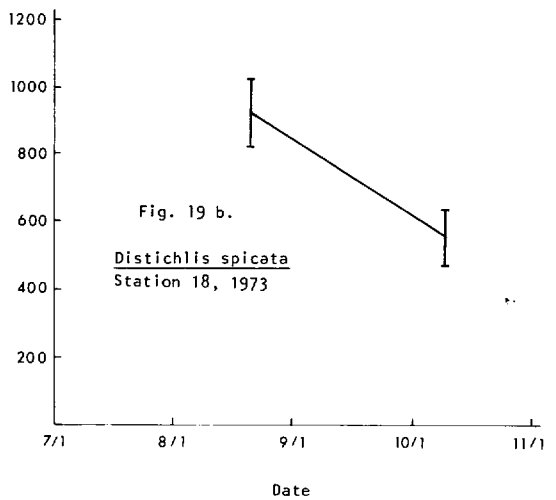


Aboveground Standing Crop and Ash-Free Dry Weight Standing Crop (g/m^2)

Figs. 17 a, 18 a, and 19 a. Aboveground standing crop and ash-free dry weight standing crop ($g \cdot m^{-2}$).







Aboveground Litter Standing Crop (g/m^2)

Figs. 17 b, 18 b, and 19 b. Aboveground litter standing crop ($g \cdot m^{-2}$).

Table 7. Peak live standing crop, peak litter standing crop, dates of peak live and litter standing crops, and ratios of live to dead on those dates.

Vegetation type	Station	Peak live standing crop ($g \cdot m^2$ $\pm$ S $\bar{x}$)	Date of peak live standing crop	Ratio live/ dead	Peak litter standing crop ($g \cdot m^2$ $\pm$ S $\bar{x}$)	Date of peak litter standing crop	Ratio Live/ Dead
Spartina alterniflora short form	2	669±33	9/7/73	0.71	944±11	9/7/73	0.71
	4	484±13	9/7/73	2.27	364±134	10/20/73	0.64
	7	633±231	9/5/73	1.23	689±4	10/17/73	0.33
	9	442±146	9/5/73	0.83	676±45	9/26/73	0.53
	11	735±42	9/5/73	3.03	467±13	10/10/73	0.90
	14	483±49	8/27/73	2.47	353±117	10/27/73	1.05
Spartina patens	1	613±15	8/31/73	1.00	612±40	8/31/73	1.00
	3	684±11	9/12/73	2.22	505±0	8/31/73	1.35
	6	519±202	9/4/73	0.44	1,528±139	9/19/73	0.28
	8	746±0	9/4/73	0.88	927±68	7/16/73	0.53
	10	691±42	8/17/73	1.04	665±42	8/17/73	1.04
	13	694±65	8/24/73	0.93	887±111	9/29/73	0.63
	16	380±16	8/27/73	0.78	529±66	9/29/73	0.69
Spartina alterniflora tall form	5	1,098±255	8/24/73	1.80	771±146	10/31/73	0.46
	12	739±82	8/20/73	2.74	405±76	10/31/73	0.80
	15	639±85	8/6/73	2.09	360±30	10/17/73	1.33
Distichlis spicata and *Juncus gerardi*	17	514±77	8/7/73 and 8/27/73	1.85 0.92	557±210	8/27/73	0.92
Distichlis spicata	18	644±77	8/20/73	0.69	937±113	8/20/73	0.69

Table 8. Change in litter standing crop ($g \cdot m^2$) for the five communities.

	SAS	*S. patens*	SAT	*D. spicata*	*D. spicata* with *Juncus*
Change in litter between harvest 1 & harvest 2	+264	-82	+42	+376	279
Change in litter between harvest 2 & harvest 3	+21	-8	+40		
Change in litter between harvest 3 & harvest 4	+45				
Total change	+330	-90	+82	+376	279

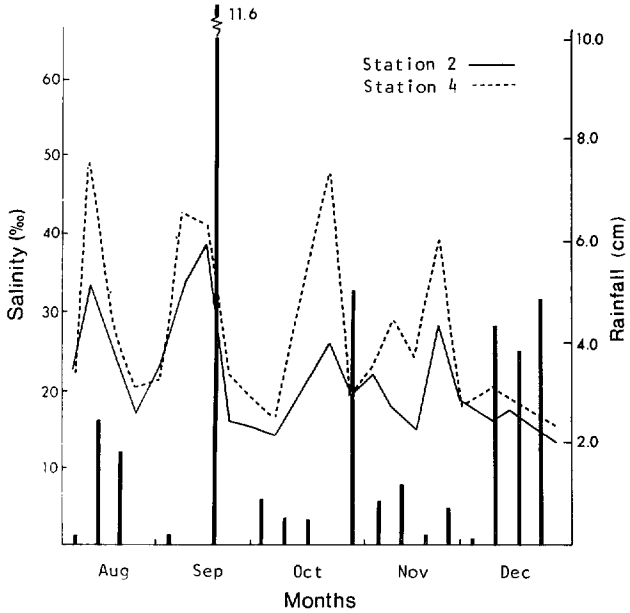


Fig. 20 a. Salinity and precipitation values for Stations 2 and 4 (*Spartina alterniflora* short form) from August through December 1973.

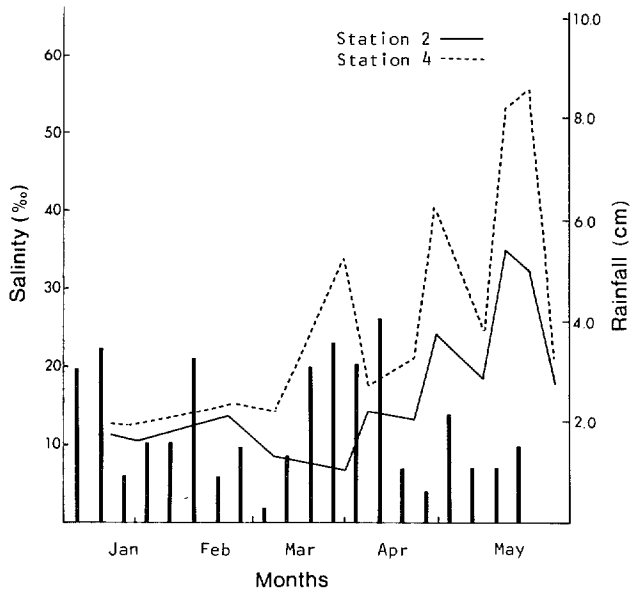


Fig. 20 b. Salinity and precipitation values for Stations 2 and 4 (*Spartina alterniflora* short form) from January through May 1974.

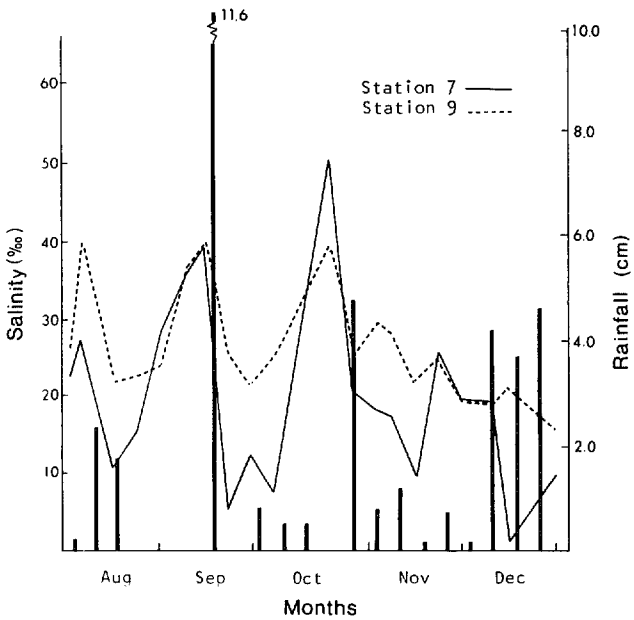


Fig. 21 a. Salinity and precipitation values for Stations 7 and 9 (*Spartina alterniflora* short form) from August through December 1973.

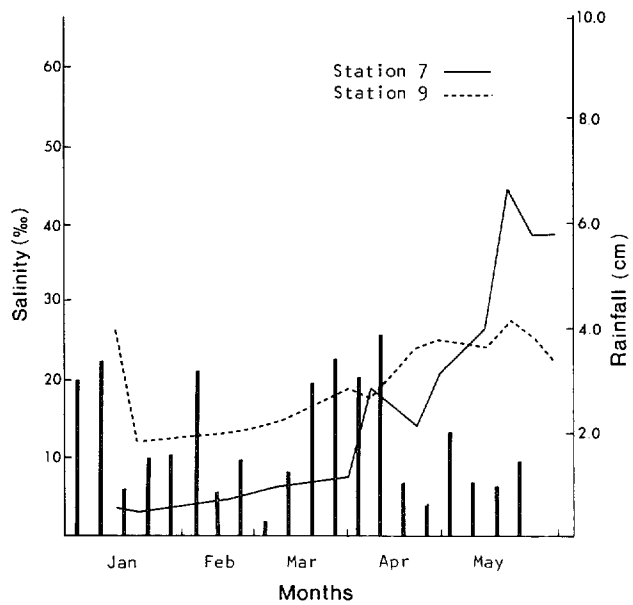


Fig. 21 b. Salinity and precipitation values for Stations 7 and 9 (*Spartina alterniflora* short form) from January through May 1974.

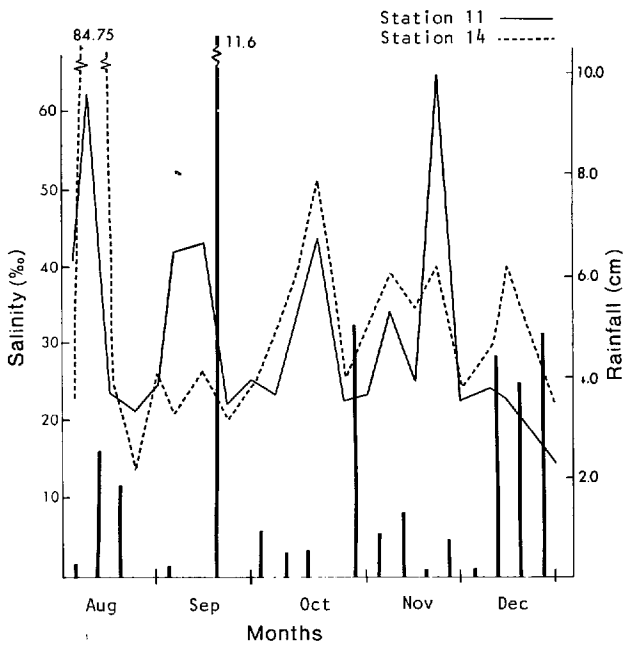


Fig. 22 a. Salinity and precipitation values for Stations 11 and 14 (*Spartina alterniflora* short form) from August through December 1973.

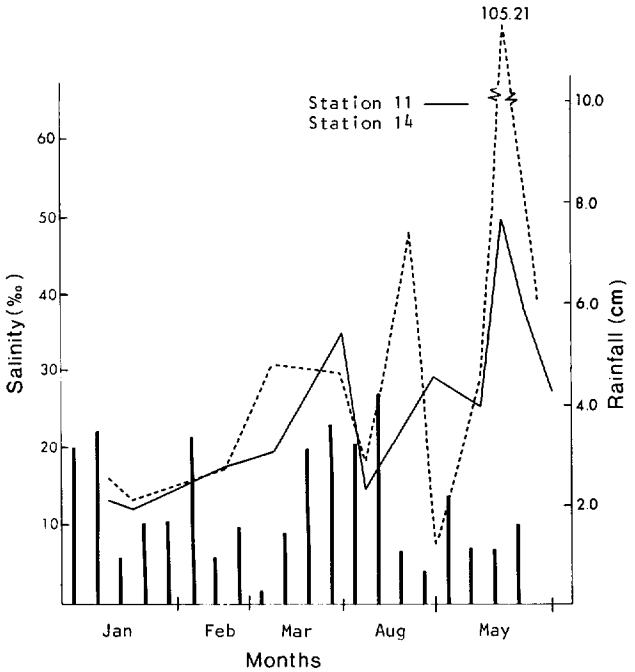


Fig. 22 b. Salinity and precipitation values for Stations 11 and 14 (*Spartina alterniflora* short form) from January through May 1974.

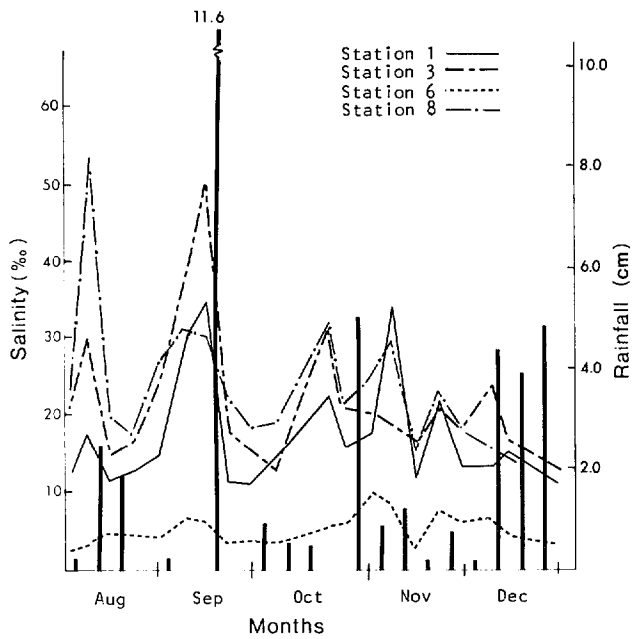


Fig. 23 a. Salinity and precipitation values for Stations 1, 3, 6, and 8 (*Spartina patens*) from August through December 1973.

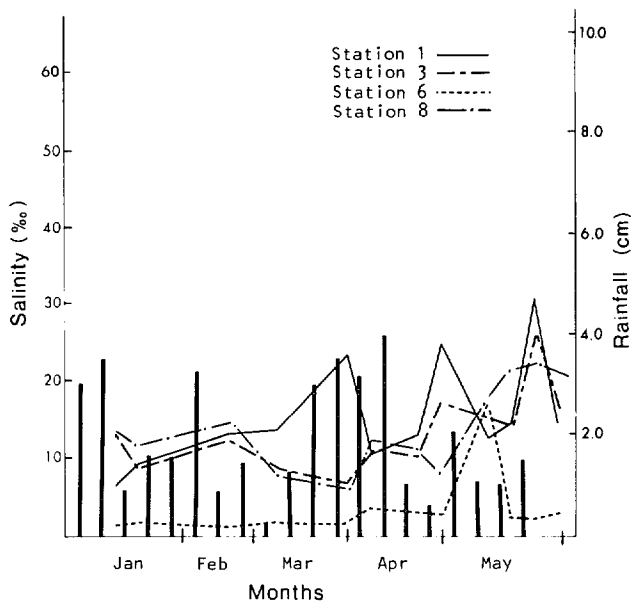


Fig. 23 b. Salinity and precipitation values for Stations 1, 3, 6, and 8 (*Spartina patens*) from January through May 1974.

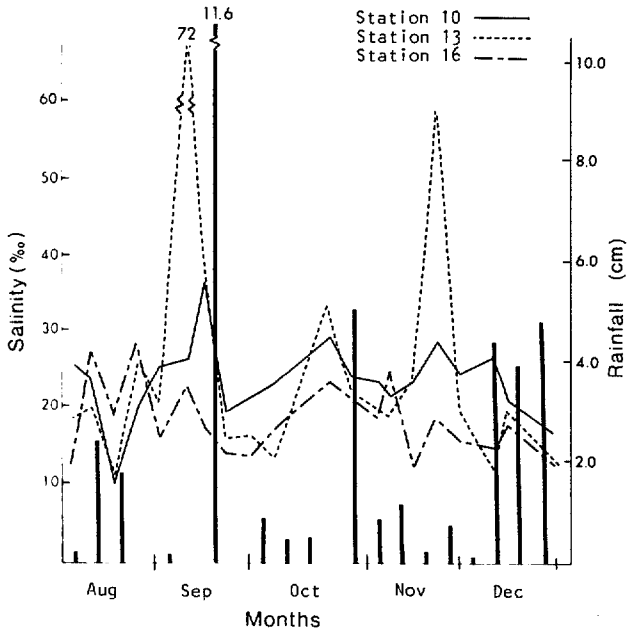


Fig. 24 a. Salinity and precipitation values for Stations 10, 13, and 16 (*Spartina patens*) from August through December 1973.

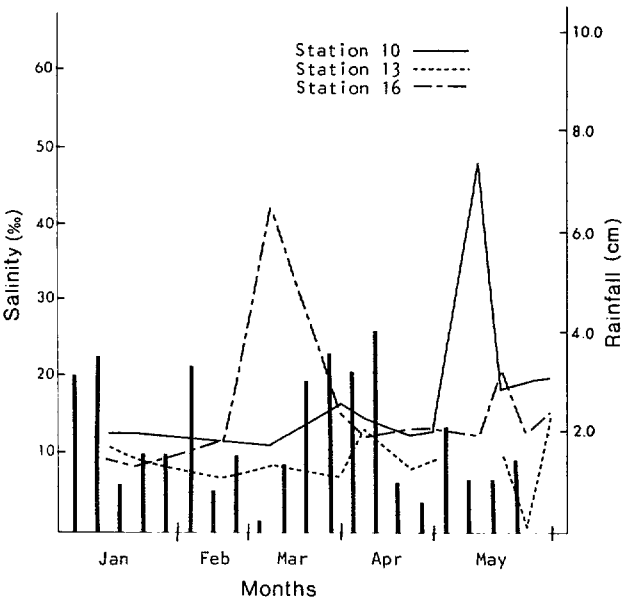


Fig. 24 b. Salinity and precipitation values for Stations 10, 13, and 16 (*Spartina patens*) from January through May 1974.

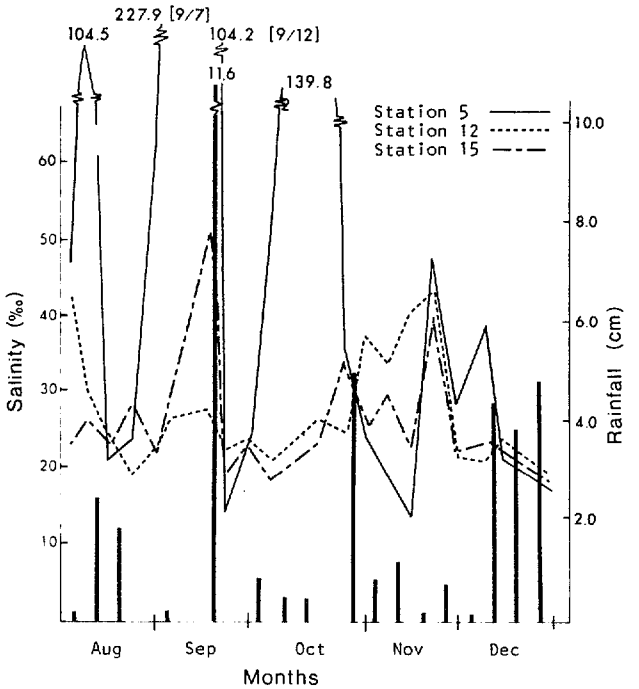


Fig. 25 a. Salinity and precipitation values for Stations 5, 12, and 15 (*Spartina alterniflora* tall form) from August through December 1973.

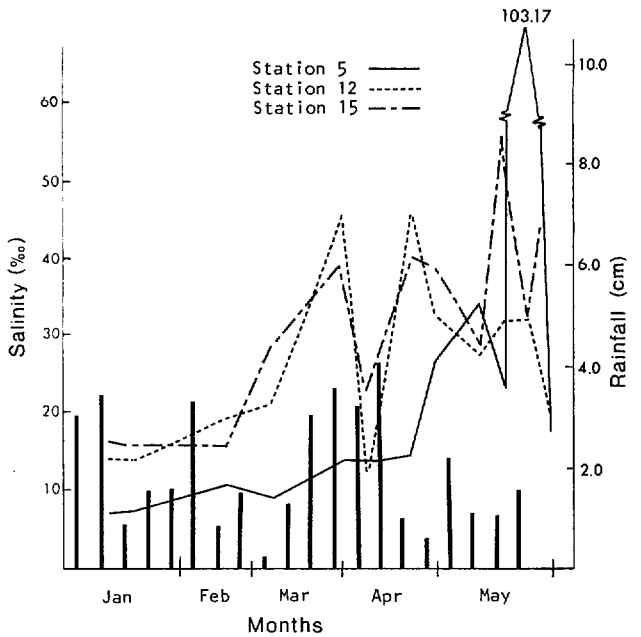


Fig. 25 b. Salinity and precipitation values for Stations 5, 12, and 15 (*Spartina alterniflora* tall form) from January through May 1974.

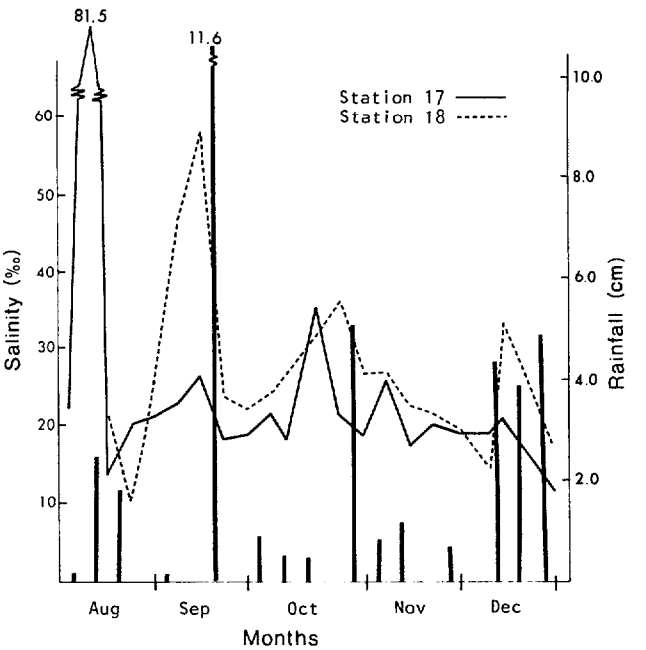


Fig. 26 a. Salinity and precipitation values for Station 17 (*Distichlis spicata* with *Juncus gerardi*) and Station 18 (*D. spicata*) from August through December 1973.

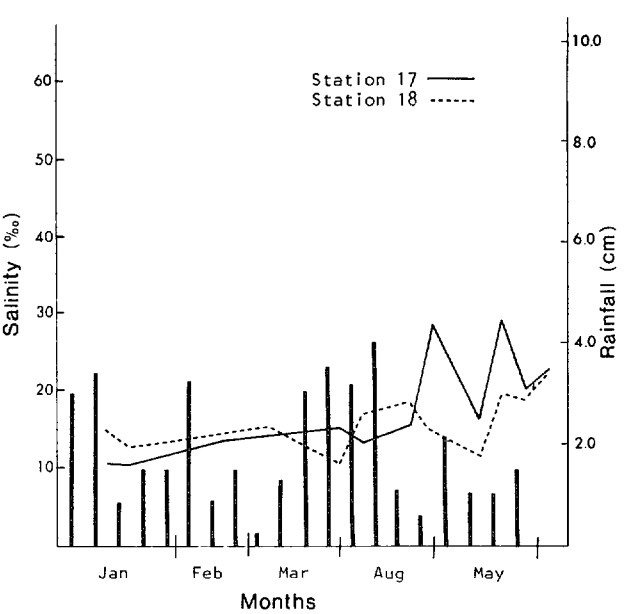


Fig. 26 b. Salinity and precipitation values for Station 17 (*Distichlis spicata* with *Juncus gerardi*) and Station 18 (*D. spicata*) from January through May 1974.

APPENDIX B

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Table 1. List of vascular species occurring in the Manahawkin marshes*.

Chenopodiaceae

Atriplex patula var. *hastata*

Salicornia europaea

Suaeda linearis#

Compositae

Iva frutescens#

Aster tenuifolius

Solidago sempervirens#

Pluchea purpurascens

Baccharis halimifolia#

Cirsium vulgare#

Cyperaceae

Scirpus olneyi

Scirpus robustus

Scirpus americanus

Gramineae

Spartina alterniflora

Spartina patens

Spartina cynosuroides

Distichlis spicata

Phragmites communis

Panicum virgatum

Juncaceae

Juncus gerardi

Onagraceae

Oenothera biennis#

Phytolaccaceae

Phytolacca americana#

Typhaceae

Typha angustifolia

* Nomenclature following Fernald (1950).

Found on spoilbank or fill areas at Popular Point.

Table 4. Individual salinity values (o/oo) for each station, with mean values for each vegetation type and monthly precipitation, during 1974-1975.

Vegetation types	Station no.	6/5	6/11	6/17	6/25	7/1	7/8	7/15	7/22	7/29
S. patens	1	11.9	16.5	35.4	19.0	13.6	18.2	23.8	13.4	24.3
	3	17.4	25.8	34.7	10.1	18.1	20.8	22.2	22.7	30.7
	6	3.0	2.2	4.7	5.7	4.5	4.6	6.3	5.4	11.5
	8	18.8	27.7	32.8	20.8	19.6	22.7	22.1	25.4	30.6
	10	19.8	23.2	38.6	24.7		24.3	26.3	40.6	44.1
Mean		14.2	19.1	29.2	16.1	15.2	18.1	20.1	22.3	28.3
SAS	2	17.2	26.9	43.2	14.3	21.8	20.8	27.9	20.7	33.0
	4	30.0	73.4	95.5	18.2	17.5	41.9	41.5	22.1	47.6
	7	13.4	33.1	52.9	19.4	18.2	31.3	16.9	52.2	57.8
	9	28.2	37.5	37.1	21.6	20.6	28.8	40.7	32.5	36.2
	11	23.3	39.8	42.4	24.1	21.3	31.0	41.0	30.9	53.7
	14	47.3	50.4	81.3	42.8	28.7	90.2	191.7	25.8	113.4
	19							27.4	39.4	37.7
	20					24.2		54.5	31.7	46.6
	21							70.5	58.9	46.3
Mean		26.6	43.5	58.7	23.4	19.0	40.7	56.9	54.9	52.5
SAT	5	21.4	25.1	100.9	33.4	35.9	59.8	114.1	151.0	122.0
	12	27.7	27.8	29.5	22.9	27.3	28.1	27.5	27.4	32.7
	15	21.1	31.3	34.9	20.6	23.0	12.0	27.2	26.5	30.3
Mean		23.4	28.1	55.1	25.7	28.7	33.3	56.3	68.3	61.7
D. spicata	18	21.7	13.8	31.8	18.0	23.3	58.7	22.7	27.4	29.7
Precipitation (cm)										
1974-1975		8.18					3.96			
1973-1974		16.28					9.73			

Table 4. Continued.

Vegetation types	Station no.	8/5	8/14	8/25	9/9	10/2	10/20	11/6	11/27
S. patens	1	36.1	13.9	14.0	10.4	14.2	19.0	14.3	15.2
	3	37.3	16.3	19.6	12.5	20.6	18.4	12.1	21.8
	6	12.2	3.9	4.1	2.1	2.9	2.7	3.0	3.3
	8	35.1	22.0	21.3	16.9	23.7	23.4	14.2	26.5
	10	50.7	22.5	20.7	16.4	21.4	20.0	13.0	26.7
Mean		34.3	78.6	15.9	11.7	16.6	16.7	11.3	18.7
SAS	2	38.6	23.1	20.9	15.5	25.8	14.3	22.9	24.8
	4	60.3	25.2	20.5	16.2	41.0	26.9	17.1	19.7
	7	45.3	28.9	7.6	5.8	10.4	9.1	8.3	15.0
	9	50.7	22.5	20.7	22.1	29.7	27.9	22.2	30.6
	11	52.0	28.6	25.3	19.6	30.5	24.8	27.2	25.8
	14	68.8	36.2	27.2	24.5	55.2	37.0	40.2	42.6
	19	56.8	26.3	23.8	19.5	27.7	24.9	27.3	27.8
	20	69.3	32.2	25.6	24.2	35.1	33.1	26.9	28.7
	21	83.3	42.7	21.2	19.7	35.9	25.5	37.0	32.6
Mean		58.3	29.5	21.4	18.6	32.3	24.9	25.5	27.5
SAT	5	140.4	25.5	31.1	14.3	43.1	42.2	29.5	34.7
	12	28.2	31.2	21.8	19.3	26.2	23.5	13.2	
	15	40.7	17.7	24.1	18.7	25.2	20.8	20.0	19.3
Mean		69.8	24.8	25.6	17.6	31.5	28.8	20.9	27.0
D. spicata	18	31.5	23.6	21.8	23.4	34.5	32.8	27.6	24.6
Precipitation (cm)									
1974-1975		20.57			9.50	4.37		3.43	
1973-1974		5.33			13.72	6.30		3.43	

Table 4. Continued.

Vegetation types	Station no.	12/30	1/28	3/5	4/21
S. patens	1	18.6	8.3	18.2	19.5
	3	19.4	7.3	9.1	16.1
	6	6.9	1.9	1.2	2.1
	8	21.0	10.4	10.0	15.7
	10	25.0	6.0	16.4	13.1
Mean		18.2	6.8	11.0	13.3
SAS	2	18.3	11.5	15.9	18.2
	4	21.3	9.3	15.2	20.5
	7	13.4	5.0	3.9	10.6
	9	19.5	9.8	21.5	24.7
	11	21.4	14.1	24.1	31.0
	14	25.2	20.0	23.1	26.4
	19	20.9	15.0	23.5	29.0
	20	27.4	18.0	36.1	27.9
	21	27.7	11.8	26.5	29.1
Mean		21.7	12.7	21.1	24.1
SAT	5	25.6	13.1		
	12	22.9	16.6	20.3	27.7
	15	20.7	14.8	24.2	
Mean		23.0	14.9	22.3	27.7
D. spicata	18	25.7	12.0		22.2
Precipitation (cm) 1974-1975		10.67	13.72	10.41	
1973-1974		14.99	10.41	11.43	5.84

Table 6. Dry weight ($g \cdot m^{-2}$) of *Spartina alterniflora* short form from Mud Cove stations 19, 20, and 21 for aboveground and washed belowground material. Each data point is based on six samples from the 1974-1975 period.

Sample	5 Jun	1 Jul	15 Jul	31 Jul	19 Aug	18 Sep	28 Oct
Aboveground material							
Live	312	395	459	440	361	357	295
	±37*	±146	±211	±107	±105	±114	±51
Litter	691	646	540	695	566	499	616
	±157	±139	±75	±221	±140	±100	±82
Belowground material							
Segment 1 (0-5cm)	2,210	2,335	2,310	2,275	2,489	2,285	2,730
	±191	±800	±316	±389	±331	±424	±215
2 (5-10cm)	2,609	2,351	2,455	2,558	2,459	2,738	2,621
	±412	±451	±259	±233	±413	±614	±296
3 (10-15cm)	1,974	2,071	2,154	2,164	2,034	2,099	2,101
	±364	±546	±432	±521	±226	±218	±353
4 (15-20cm)	1,225	1,765	1,255	1,517	1,526	1,699	1,947
	±233	±198	±652	±384	±248	±351	±679
5 (20-30cm)	2,367	2,511	2,528	2,587	2,577	2,269	2,687
	±255	±330	±532	±715	±498	±445	±467
6 (30-40cm)	2,116	1,961	1,905	2,995	2,283	2,663	2,534
	±472	±236	±987	±829	±476	±224	±526
7 (40-50cm)	2,394	1,529	1,796	2,268	1,337	1,641	2,148
	±193	±350	±1,012	±877	±408	±1,072	±820

Table 6. Continued.

Sample	27 Nov	30 Dec	28 Jan	5 Mar	30 Mar	30 Apr
Aboveground						
Live						
Litter						
Belowground						
Segment 1 (0-5cm)	2,359	2,559	2,319	2,102	2,593	2,760
	±433	±368	±305	±606	±494	±357
2 (5-10cm)	2,408	2,633	2,451	2,448	2,539	2,742
	±411	±481	±269	±125	±394	±285
3 (10-15cm)	2,263	2,067	1,672	1,871	1,943	2,043
	±365	±414	±147	±321	±125	±244
4 (15-20cm)	1,654	1,607	1,361	1,732	1,762	1,878
	±530	±381	±165	±368	±397	±409
5 (20-30cm)	2,388	2,400	2,167	2,068	2,636	2,949
	±187	±229	±527	±467	±333	±406
6 (30-40cm)	2,017	2,110	1,989	2,015	2,457	2,613
	±520	±533	±528	±696	±930	±353
7 (40-50cm)	1,782	2,051	1,191	1,041	1,751	1,608
	±667	±887	±265	±170	±491	±851

* This value equals 1 SD.

Table 9. Dry weight ($g \cdot m^{-2}$) of *Spartina alterniflora* short form from stations 2, 4, 7, 9, and 14 for aboveground and washed belowground material during the period 1974-1975.

Sample	8 Apr	16 May	3 Jul	8 Aug	9 Sep	27 Nov	28 Jan	21 Apr
Aboveground material								
Live		145 ±80*	320 ±108	353 ±111	256 ±39			
Litter		735 ±199	473 ±153	535 ±165	335 ±182			
Belowground material								
Segment 1 (0-5cm)	2,518 ±621	2,271 ±667	2,244 ±710	2,462 ±870	2,215 ±1,001	1,848 ±711	2,226 ±871	2,190 ±580
2 (5-10cm)	2,534 ±348	2,460 ±537	2,550 ±493	3,175 ±605	2,933 ±607	2,464 ±624	2,545 ±540	2,541 ±405
3 (10-15cm)	2,009 ±508	1,884 ±653	2,342 ±459	2,589 ±876	2,244 ±200	2,294 ±479	2,441 ±321	1,961 ±559
4 (15-20cm)	1,510 ±399	1,739 ±580	1,826 ±522	2,151 ±702	1,617 ±289	2,074 ±475	1,979 ±667	1,678 ±821
5 (20-30cm)	1,963 ±515	1,236 ±534	2,767 ±1,017	2,799 ±1,268	2,256 ±807	2,289 ±593	2,847 ±841	1,916 ±1,218
6 (30-40cm)	2,052 ±1,445	1,507 ±956	1,936 ±641	1,977 ±938	1,823 ±608	1,273 ±805	2,077 ±819	1,701 ±1,237
7 (40-50cm)	1,350 ±586	1,268 ±465	2,120 ±1,170	1,438 ±689	1,848 ±703	947 ±713	1,918 ±729	1,181 ±1,074
No. of samples								
Aboveground		10	12	11	10			
Belowground	10	10	12	11	9	10	10	10

* This value equals 1 SD.

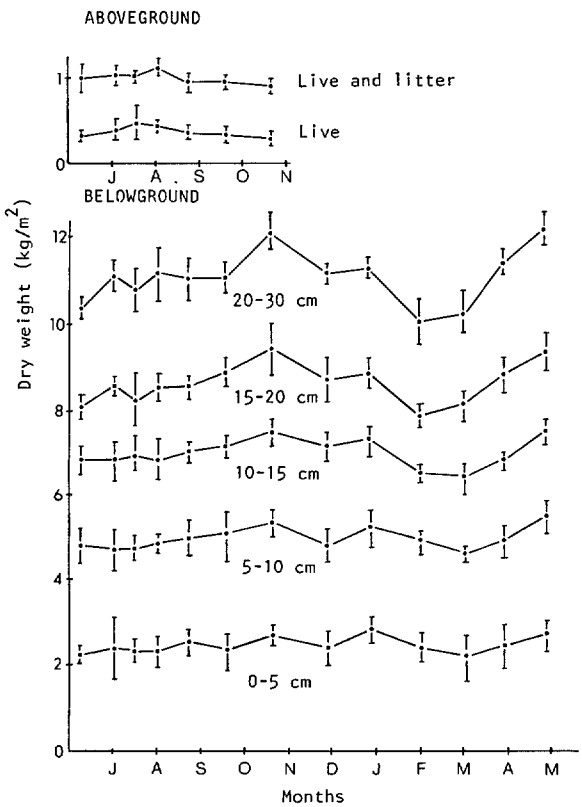


Fig. 2. Seasonal changes in above and belowground biomass ($kg \cdot m^{-2}$) for SAS at stations 19, 20, and 21. Vertical lines equal 1 SD.

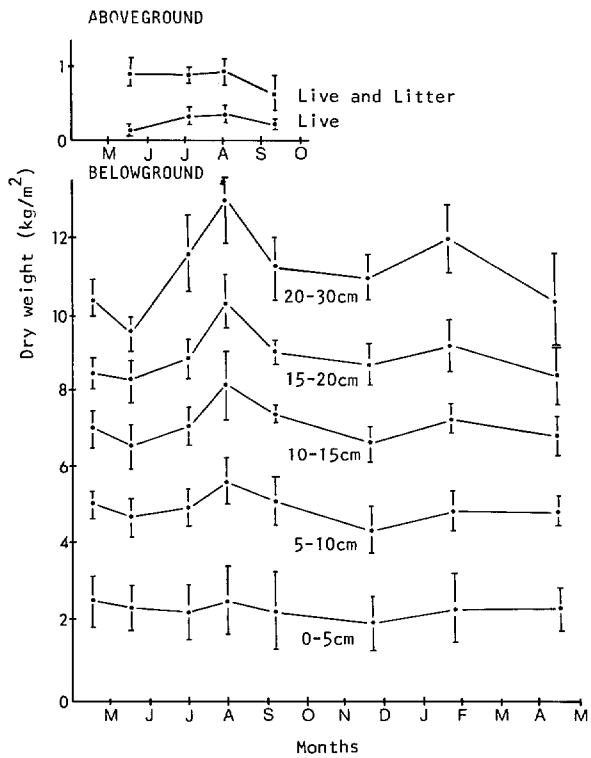


Fig. 4. Seasonal change in above and belowground biomass for SAS at stations 2, 4, 7, 9, and 14. Vertical lines equal 1 SD.

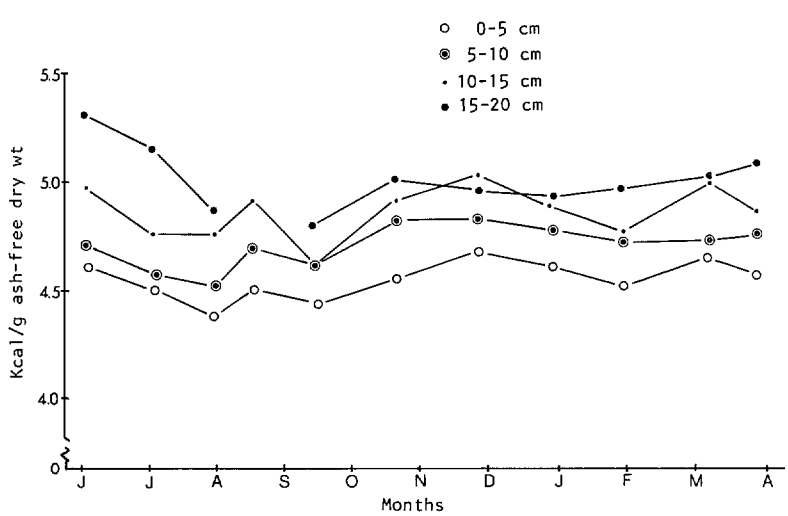


Fig. 3. Seasonal change in caloric content ($kcal \cdot g$ ash-free dry wt^{-1}) for four belowground segments of SAS for stations 19, 20, and 21.

Table 10. Dry weight ($g \cdot m^{-2}$) of *Spartina patens* from stations 1, 3 and 10 for aboveground and washed belowground material. Each data point is based on six samples from the 1974-1975 period.

	8 May	11 Jun	29 Jul	26 Aug	30 Oct	30 Dec	5 Mar
Aboveground material							
Live		372	587	424	85		
		±80*	±54	±77	±24		
Litter		705	651	720	979		
		±232	±276	±270	±634		
Belowground material							
Segment 1 (0-5cm)	1,827	2,174	2,842	2,718	2,591	2,142	2,448
	±539	±384	±724	±695	±990	±631	±334
2 (5-10cm)	1,751	1,671	2,500	2,056	2,133	1,857	1,889
	±405	±523	±170	±632	±689	±438	±384
3 (10-15cm)	1,511	1,665	2,192	1,617	1,834	1,624	1,633
	±456	±438	±534	±191	±658	±262	±169
4 (15-20cm)	1,416	1,477	2,138	1,533	1,327	1,315	1,239
	±207	±566	±1,067	±413	±508	±285	±333
5 (20-30cm)	1,683	1,773	1,814	1,941	2,239	2,215	2,176
	±419	±921	±334	±657	±700	±952	±904
6 (30-40cm)	1,393	1,569	1,785	1,404	1,772	1,578	1,787
	±660	±981	±381	±286	±197	±595	±1,180
7 (40-50cm)	1,402	1,477	1,827	1,812	1,384	1,490	1,640
	±352	±722	±514	±826	±582	±698	±639

* This value equals 1 SD.

Table 11. Dry weight ($g \cdot m^{-2}$) of *Spartina patens* from Popular Point stations 6 and 8 for aboveground and washed belowground material. Each data point is based on four samples from the period 1974-1975.

Sample	8 May	11 Jun	29 Jul	26 Aug	30 Oct	30 Dec	5 Mar
Aboveground material							
Live		301	399	391	134		
		±105*	±46	±105	±43		
Litter		1,039	947	1,137	868		
		±215	±158	±605	±735		
Belowground material							
Segment 1 (0-5cm)	998	1,221	1,932	2,077	1,415	1,907	1,384
	±114	±133	±621	±1,086	±402	±1,010	±427
2 (5-10cm)	1,200	1,223	1,495	1,490	1,642	1,651	1,198
	±360	±374	±425	±842	±441	±716	±323
3 (10-15cm)	1,089	1,116	1,402	1,458	1,225	1,411	1,159
	±144	±381	±190	±442	±332	±709	±213
4 (15-20cm)	1,058	1,094	1,277	1,286	958	1,123	1,141
	±166	±453	±232	±330	±294	±456	±213
5 (20-30cm)	1,710	2,135	1,718	1,925	1,891	1,753	1,646
	±487	±897	±638	±395	±355	±785	±153
6 (30-40cm)	1,067	1,130	1,072	1,474	1,227	1,114	1,085
	±82	±347	±382	±354	±639	±411	±304
7 (40-50cm)	1,187	901	713	1,162	505	1,298	1,042
	±339	±142	±323	±310	±218	±507	±114

* This value equals 1 SD.

Table 12. Dry weight ($g \cdot m^{-2}$) of *Spartina alterniflora* tall form from stations 5, 12, 15 and 22 for aboveground and washed belowground material during the 1974-1975 period.

Sample	5 Jun	15 Jul	12 Aug	26 Sep	4 Dec	3 Feb	30 Apr
Aboveground material							
Live	80*#	468±189#†	547±165#	735±110			
		575±125	638±56				
Litter	3,388*#	567±706#	658±480#	209±50			
		268±263	380±268				
Belowground material							
Segment 1 (0-5cm)	1,409	643	1,560	1,320	961	666	842
	±392	±299	±619	±711	±372	±432	±318
2 (5-10cm)	1,778	969	1,710	1,558	1,330	1,295	1,583
	±370	±411	±795	±490	±947	±755	±653
3 (10-15cm)	1,642	1,116	2,108	1,449	1,652	1,841	1,424
	±320	±630	±855	±565	±858	±980	±655
4 (15-20cm)	985	1,232	1,805	1,304	1,357	1,576	951
	±131	±670	±924	±706	±630	±991	±480
5 (20-30cm)	2,688	1,214	2,561	1,366	1,965	1,843	1,966
	±797	±446	±1,240	±773	±969	±784	±1,562
6 (30-40cm)	3,152	874	2,072	1,363	1,645	1,483	1,465
	±1,279	±660	±1,157	±1,103	±1,035	±755	±902
7 (40-50cm)	2,312	697	2,267	1,739	1,842	1,667	1,509
	±1,430	±432	±1,552	±1,195	±542	±1,090	±947
No. of samples							
Aboveground	2	6	6	6			
Belowground	2	6	6	6	5	6	6

* Based on one sample

\# This includes samples from SAT area undergoing change resulting from altered drainage pattern.

† This value equals 1 SD.

Table 13. Dry weight ($g \cdot m^{-2}$) of *Distichlis spicata* from Mud Cove station 18 for aboveground and washed belowground material. Each data point is based on two samples from the period 1974-1975.

Sample	5 Jun	15 Jul	12 Aug	26 Sep	6 Nov	4 Dec	3 Feb	30 Apr
Aboveground material								
Live	204	482	613	538				
	±102*	±7	±3	±68				
Litter	994	813	520	211				
	±59	±97	±17	±97				
Belowground material								
Segment 1 (0-5cm)	133	1,637	1,900	1,180	1,806	1,270	541	922
	±317	±86	±602	±205	±226	±680	±38	±74
2 (5-10cm)	1,291	1,803	2,145	1,474	2,534	1,696	1,078	1,463
	±897	±1,002	±45	±1,118	±532	±183	±144	±400
3 (10-15cm)	1,719	1,221	1,438	1,626	1,229	1,212	1,477	1,343
	±160	±528	±99	±138	±132	±311	±349	±231
4 (15-20cm)	1,990	1,492	1,678	1,166	1,150	985	1,449	1,157
	±330	±522	±967	±445	±221	±289	±61	±467
5 (20-30cm)	2,215	2,740	2,915	2,113	1,472	2,935	2,747	3,372
	±253	±128	±1,185	±69	±544	±240	±109	±211
6 (30-40cm)	2,276	1,991	1,597	1,769	1,169	2,348	2,163	2,276
	±110	±58	±813	±775	±263	±501	±179	±112
7 (40-50cm)	1,954	962	2,253	1,823	956	1,680	2,330	1,877
	±224	±596	±208	±314	±199	±985	±131	±330

* This value equals 1 SD.

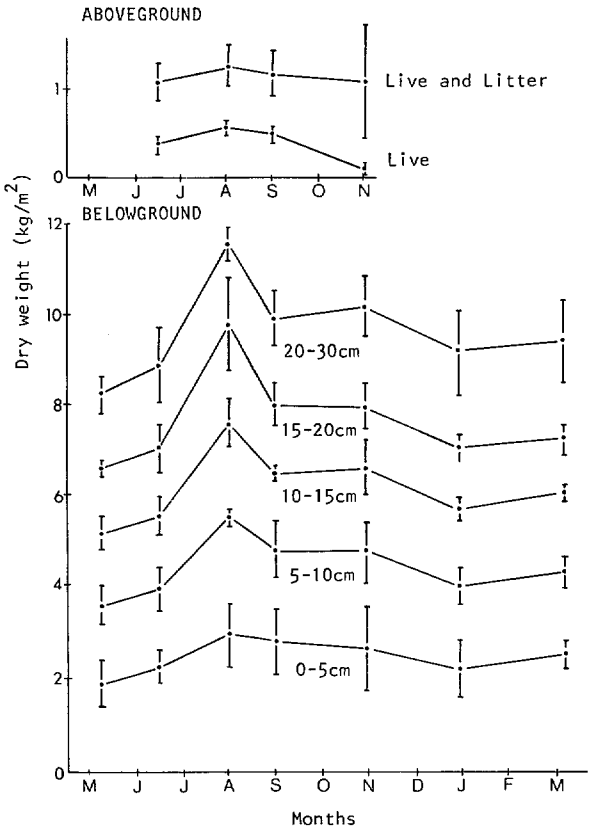


Fig. 5. Seasonal change in above and belowground biomass (kg·m^{-2}) for *S. patens* at stations 1, 3, and 10. Vertical lines equal 1 SD.

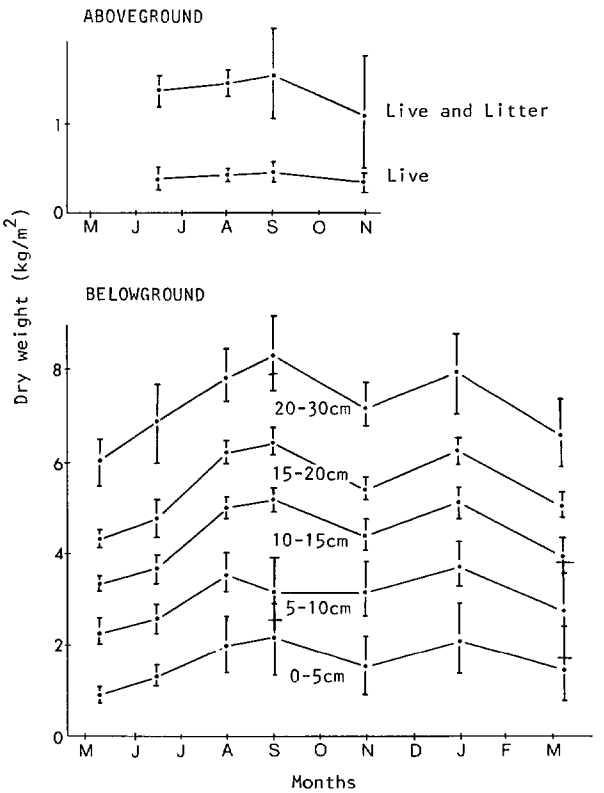


Fig. 6. Seasonal change in above and belowground biomass (kg·m^{-2}) for *S. patens* at stations 6 and 8. Vertical lines equal 1 SD.

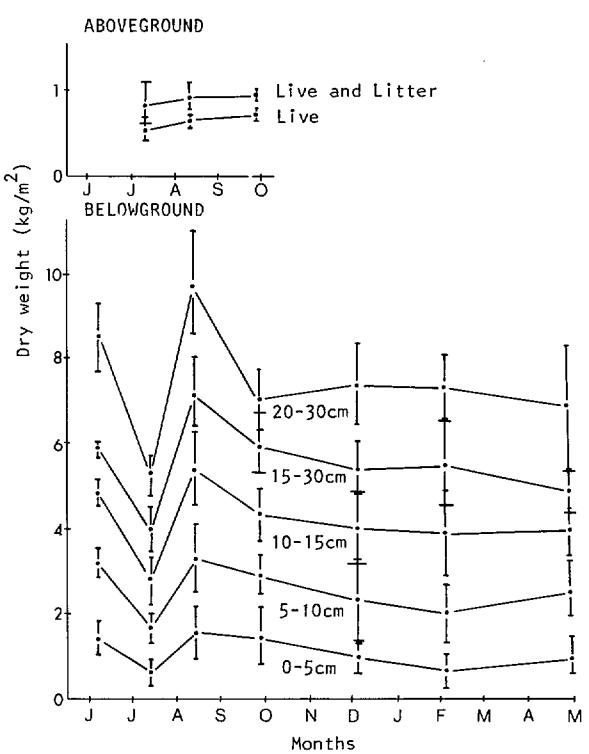


Fig. 7. Seasonal change in above and belowground biomass (kg·m^{-2}) for SAT stations 5, 12, 15, and 22. Vertical lines equal 1 SD.

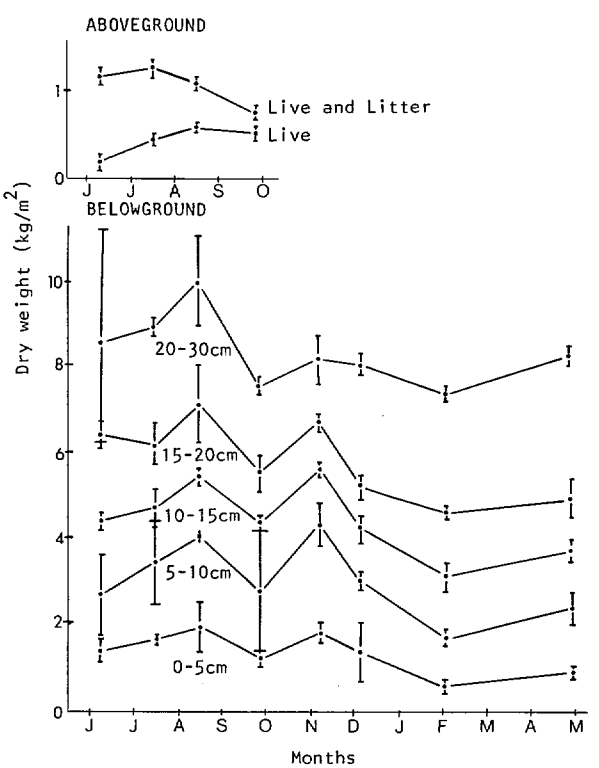


Fig. 8. Seasonal change in above and belowground biomass (kg·m^{-2}) for *Distichlis spicata* station 18. Vertical lines equal 1 SD.

Table 14. Seasonal change in belowground biomass and turnover rate of *S. alterniflora*, short form, stations 19, 20, and 21 and *S. alterniflora*, short form, stations 2, 4, 7, 9, and 14.

Segment (cm)	Period of greatest difference	Maximum biomass ($g \cdot m^{-2}$)	Increment ($g \cdot m^{-2}$)	Turnover rate (%)	Turnover rate (Years)
S. alterniflora short form, stations 19, 20 and 21:					
0-10	5 March-30 April*	5,502	952	17.30	5.78
0-20	23 October*-28 January	9,399	1,596	16.98	5.89
0-30	28 January-30 April*	12,372	2,402	19.41	5.15
10-20	23 October*-28 January	4,048	1,015	25.07	3.99
20-30	5 March-30 April*	2,949	882	29.91	3.34
S. alterniflora short form, stations 2, 4, 7, 9, 14:					
0-10	8 August*-27 November	5,637	1,325	23.51	4.25
0-20	16 May-8 August*	10,377	2,023	19.49	5.13
0-30	16 May-8 August*	13,176	3,585	27.21	3.67
10-20	8 April-8 August*	4,740	1,221	25.76	3.88
20-30	28 January*-21 April	2,847	931	32.70	3.06

* Date of greatest biomass.

Table 15. Seasonal change in belowground biomass and turnover rate of *S. patens*, stations 1, 3, and 10 and *S. patens*, stations 6 and 8.

Segment (cm)	Period of greatest difference	Maximum biomass ($g \cdot m^{-2}$)	Increment ($g \cdot m^{-2}$)	Turnover rate (%)	(Years)
S. patens, stations 1, 3 and 10:					
0-10	8 May-29 July*	5,342	1,764	33.02	3.03
0-20	8 May-29 July*	9,672	3,143	32.49	3.08
0-30	8 May-29 July*	11,486	3,274	28.50	3.51
10-20	29 July*-5 March	4,330	1,458	33.67	2.97
20-30	8 May-30 October*	2,239	556	24.83	4.03
S. patens, stations 6 and 8:					
0-10	8 May-26 August*	3,567	1,438	40.31	2.48
0-20	8 May-26 August*	6,311	2,035	32.25	3.10
0-30	8 May-26 August*	8,236	2,250	27.32	3.66
10-30	8 May-26 August*	2,744	597	21.76	4.60
20-30	11 June*-March 5	2,135	489	22.90	4.37

* Date of greatest biomass

Table 16. Seasonal change in belowground biomass and turnover rate of SAT stations 5, 12, 15, and 22 and *D. spicata*, station 18.

Segment (cm)	Period of greatest difference	Maximum biomass ($g \cdot m^{-2}$)	Increment ($g \cdot m^{-2}$)	Turnover rate (%)	Turnover rate (Years)
S. alterniflora tall form, stations 5, 12, 15, 22:					
0-10	15 July-12 August*	3,270	1,658	50.70	1.97
0-20	15 July-12 August*	7,183	3,223	44.87	2.23
0-30	5 June*-15 July	8,502	3,328	39.14	2.55
10-20	3 February*-30 April	3,417	1,042	30.49	3.28
20-30	5 June*-15 July	2,688	1,474	54.84	1.82
Distichlis spicata, station 18:					
0-10	6 November*-3 February	4,340	2,721	62.69	1.59
0-20	12 August*-3 February	7,161	2,616	36.53	2.74
0-30	12 August*-3 February	10,076	2,784	27.63	3.62
10-20	12 August*-4 December	3,116	919	29.49	3.39
20-30	6 November-30 April*	3,372	1,900	56.35	1.77

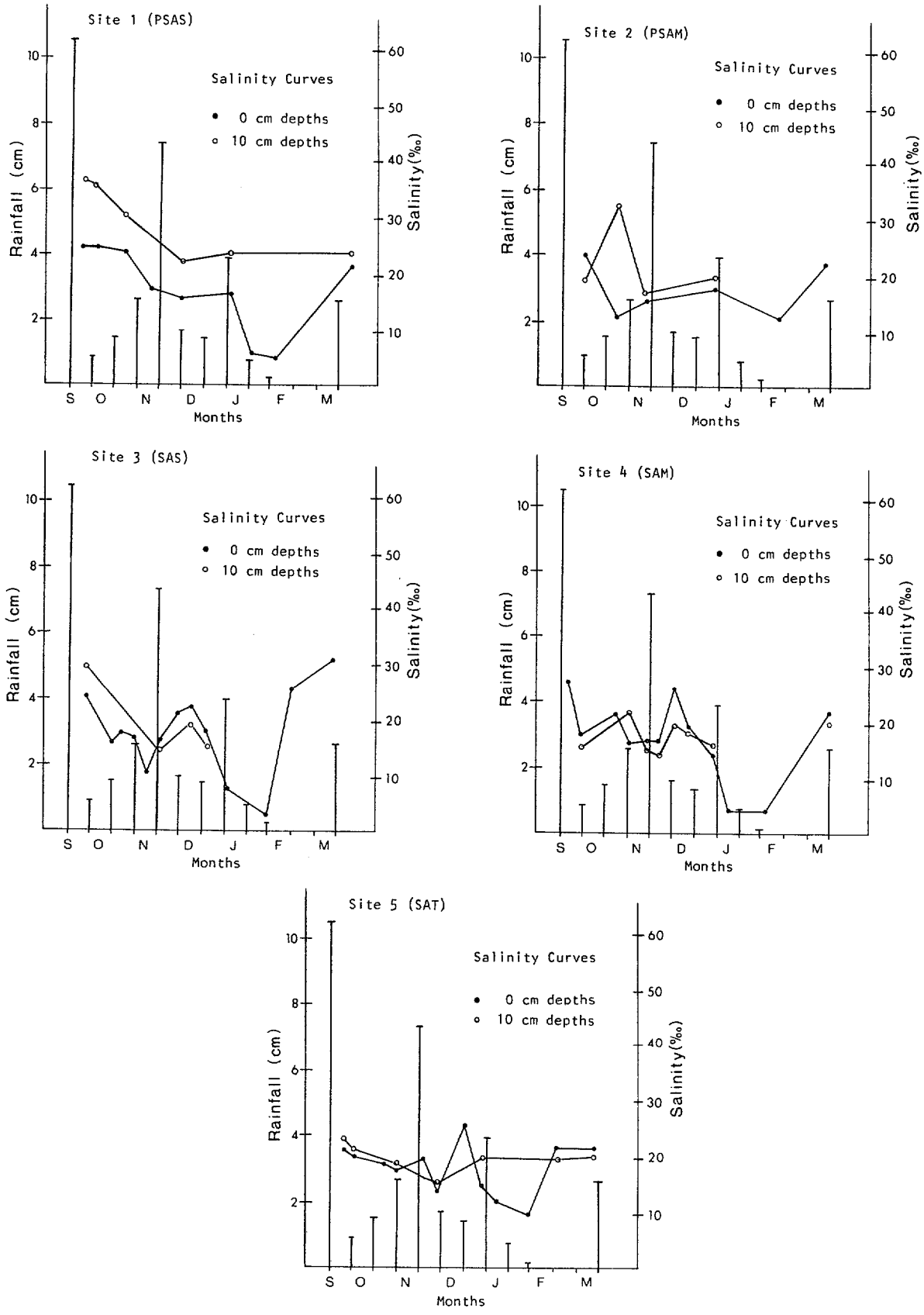
* Date of greatest biomass.

APPENDIX C

Tables and Figures from the July 1976 Estuarine Evaluation Study Annual Report: Marsh Plant Productivity Decomposition

LIST OF FIGURES

Figure		Page
2	Precipitation and mud salinity at 0 and 10 cm depths for site (1)PSAS from September 1975	2.105
3	Precipitation and mud salinity at 0 and 10 cm depths for site (2)PSAM from September 1975	2.105
4	Precipitation and mud salinity at 0 and 10 cm depths for site (3)SAS from September 1975	2.105
5	Precipitation and mud salinity at 0 and 10 cm depths for site (4)SAM from September 1975	2.105
6	Precipitation and mud salinity at 0 and 10 cm depths for site (5)SAT from September 1975	2.105



Figs. 2-6. Precipitation and mud salinity at 0 and 10 cm depths for sites (1)PSAS, (2)PSAM, (3)SAS, (4)SAM, and (5)SAT from September 1975.

3. MARSH PRODUCTIVITY: SUBMERGED SALT POND VEGETATION

Dennis Slate[1]

SUMMARY

Data collected from 24 permanent salt ponds (nine of which supported *Ruppia* growth) for the period 15 March to 1 November 1976 have been analyzed statistically. A step-wise discriminant procedure was employed to delineate which physical and chemical parameters measured may be used to predict the presence or absence of submerged vascular vegetation in these salt ponds. Three parameters, depth, salinity, and surface area predicted accurately 21 of 24 attempts.

Two replicate one half square meter ($m^2/2$) biomass samples were collected from a total of 26 *Ruppia* ponds. Mean peak standing crop biomass estimates ranged from 0.04 - 79.66 g dry wt/m^2; least significant interval (lsi) = 4.8; grand mean ($\bar{X}$) = 30.2 g dry wt/m^2.

BACKGROUND

Permanent salt ponds and their associated flora and fauna are an integral component of the salt marsh ecosystem. Ponds provide resting and feeding sites for waterfowl, as well as other avian species. Algal blooms frequently occur in many ponds which may in turn provide food and cover for invertebrates, especially amphipods. Some permanent ponds support higher vascular plant life, whereas others do not. Since the dynamics of permanent salt ponds are not well understood, information derived from this study will assist in drafting guidelines for future salt pond management.

OBJECTIVES

The primary objective of this project are:

1) To determine why some salt ponds produce submerged vascular spermatophytes and others do not, based on certain physical, chemical, or environmental parameters.

2) To estimate the standing crop biomass of submerged vascular plants in permanent salt ponds.

PROCEDURE

In March 1975, eight salt ponds were selected at each of three different locations that lie on a transect approximately parallel to Oyster Point Creek

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[1]The author is associated with Cook College, Rutgers University. This report was prepared for the N.J. Division of Fish, Game, and Shellfisheries with funds provided in part by the Federal Aid to Wildlife (Pittman-Robertson) Act for Project W-53-R-2, "Wetlands Ecology," during the period 15 August 1975 to 31 May 1976.

and perpendicular to the uplands and Little Egg Harbor. Such a design allows for a check on any environmental or production gradients that may exist.

The surface area of individual ponds was determined with the use of a Gurley table, alidade, compass, and steel tape. Depths were randomly taken within each pond. The apparatus consisted of a rule with an attached flattened base to prevent it from penetrating the soft bottom sediments. A marked stake delineating the initial depth was permanently driven into each pond. On subsequent sampling trips, the change in depth was taken from this mark to obtain estimates of mean depth.

Water samples were collected from each pond. From these samples, the salinity, pH, and dissolved oxygen concentration were determined.

1) Salinity - The Harvey method was employed. This involves a silver nitrate ($AgNO_3$) titration, with potassium chromate (K_2CrO_4) as an indicator of end point.

2) pH - The pH for each pond was determined in the field on a Photovolt 126A pH meter.

3) Dissolved oxygen - Water samples were collected in BOD bottles. Manganous sulfate ($MnSO_4$) and an alkali-azide ($NaOH$-NaN_3) reagent were added and then samples were acidified with concentrated sulfuric acid (H_2SO_4). Samples (200 ml) were titrated in the field with sodium thiosulfate ($Na_2S_2O_3$). Soluble starch indicator was used.

Other analyses were performed to determine nitrate concentrations (NO_3) and turbidity. Spectrophotometric methods were employed; however, experimental variation due to low turbidity and nitrate concentrations was too high to justify continuing these tests. Water temperature was obtained by suspending a stem Celsius thermometer at middepth in each pond.

Sediment samples were collected from each of the 24 ponds. These are still in the process of being analyzed for sediment texture, organic content, and cation exchange.

Two replicate ($m^2/7$) samples were collected biweekly from the nine ponds supporting *Ruppia* growth to monitor for the occurrence of peak biomass. Twelve transects were sampled in the interim such that the proportion of ponds supporting *Ruppia* to those which did not could be determined (Figure 1 and Table 1). All those ponds found that supported *Ruppia* were added to the nine in the original sample. At peak biomass, two replicate ($m^2/2$) samples were collected from a total of 26 ponds (9 from the original sample and 15 supplementary ponds). The larger sample size provided for a more precise estimate of peak standing crop biomass of *Ruppia*. Wet weights and dry weights were obtained for all plant samples.

In March 1976, a slightly modified sampling regime was implemented. A total of 30 ponds (15 *Ruppia* producers and 15 non-producers) were sampled on a weekly basis to obtain estimates of salinity, mean depth, and water temperature. The surface area of new ponds has been determined. These data will be used to test the predictability of the parameters mentioned (i.e., can they be used to predict the presence of *Ruppia* in a given pond). Triplicate ($m^2/2$) *Ruppia* samples were collected biweekly and returned to the lab for analysis.

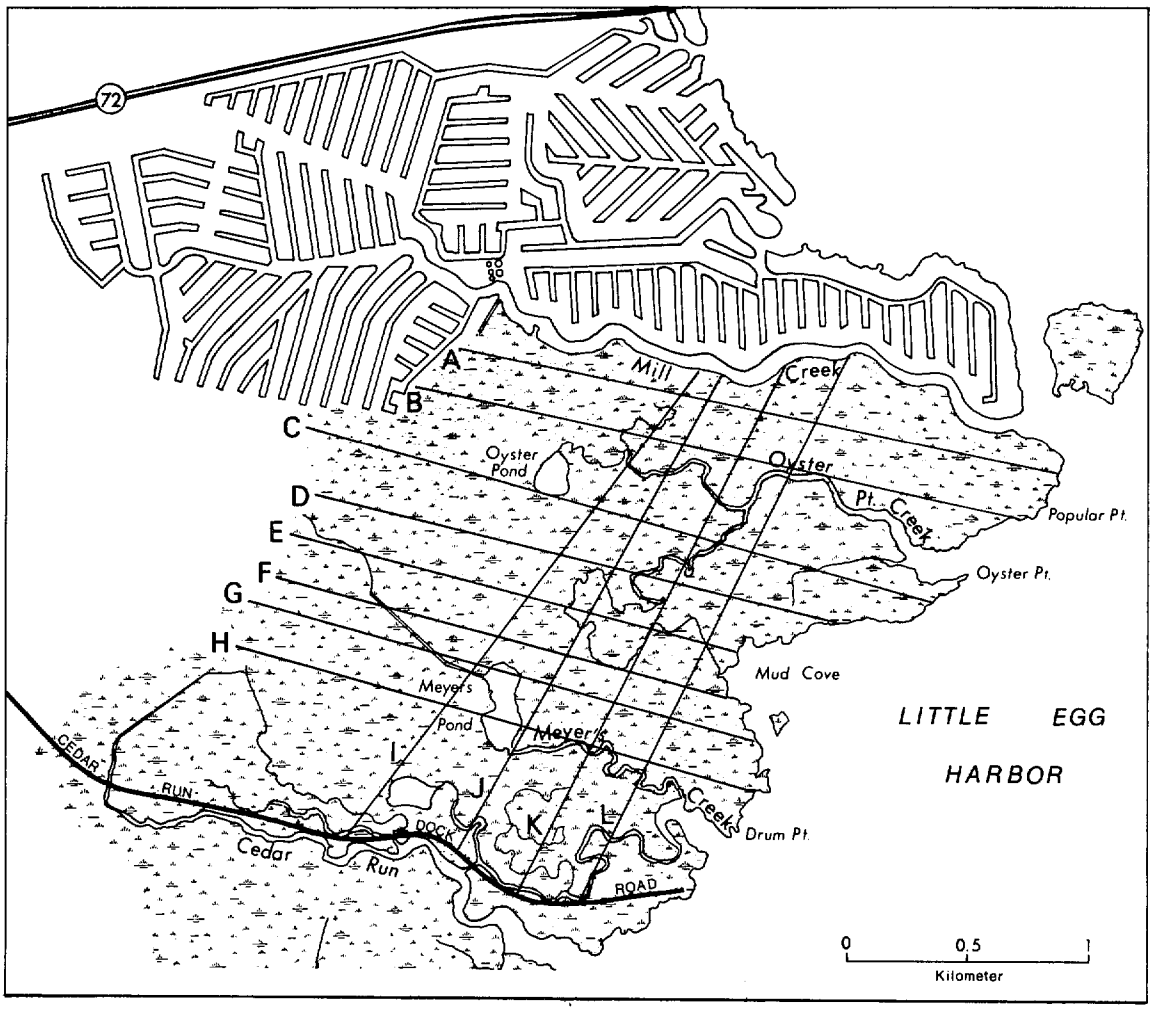

Figure 1. Schematic of sampling transects.

Table 1. Relative proportion of *Ruppia* ponds (Life=1) to non-*Ruppia* ponds (Life=0) found along the sampling transects.

Transect	Life=0	Life=1	
A	19	11	
B	9	3	
C	17	7	
D	6	0	
E	13	0	
F	11	1	
G	6	1	
H	7	0	
I	2	3	
J	3	2	
K	16	1	
L	18	3	
TOTAL	127	32	$\frac{32}{127} = 0.26$

FINDINGS

Since some ponds produced *Ruppia maritima* and others did not, ponds included in each group were treated as two separate populations. The simple statistics for these populations are presented in Table 2 (salinity in parts per thousand, temperature in degrees Celsius, oxygen in mg/l, depth in inches, surface area in square feet). As a first approximation, these data was subjected to discriminant analysis to ascertain the predictability of these parameters. Table 3 clearly indicates their predictive value, with 23 of 24 ponds properly classified.

Table 2. Simple statistics for Life=0 (*Ruppia* absent) and Life=1 (*Ruppia* present) populations.

Variable	n	Mean	Standard deviation
For Life=0:			
Salinity	135	22.2 °/oo	2.7
Temperature	120	25.4 °C	1.2
Dissolved oxygen	120	6.2 mg/l	1.2
Depth	135	9.1 in.	2.0
pH	45	7.7	0.4
Surface area	15	1,910.5 ft^2	5,284.4
For Life=1:			
Salinity	81	17.2 °/oo	3.7
Temperature	72	24.9 °C	0.9
Dissolved oxygen	72	7.7 mg/l	1.2
Depth	81	12.7 in.	1.5
pH	27	7.8	0.3
Surface area	9	3,111.8 ft^2	2,291.9

Table 3. Classification of salt ponds from the discriminant analysis.

	Life classification:	0	1
	Life:		
	0	14	1
	1	0	9

Data were then analyzed by a stepwise discriminant procedure to determine which of these six parameters were best suited to discriminate between the two populations of ponds. Depth, salinity, and surface area were all significant at $\alpha = 0.05$. Twenty-one of 24 ponds were correctly classified with these three parameters.

Ponds with lower salinities tend to support *Ruppia* growth. This may reflect the inability of *Ruppia* to tolerate higher salinities for long periods of time. A salinity-temperature interaction is also possible.

Ruppia is present consistently in the deeper ponds. Salinity is generally lower in the larger and deeper ponds. Larger ponds offer greater surface area for the interception of rainfall. Since larger ponds are generally deeper, the salt concentration remains diluted. Only under extreme evaporative conditions or frequent tidal inundation would the salinities of the larger ponds approximate those of small ponds. Under laboratory conditions, it should be possible to test the effects of various salinity levels on *Ruppia* to determine its tolerance limits.

Peak biomass occurred between the last week of July and early August (Figure 2). With the addition of 15 supplementary ponds, two replicate ($m^2/2$) samples were collected from a total of 26 ponds. Biomass estimates ranged from 0.04 - 79.66 g dry wt/m^2 with a grand mean ($\bar{\bar{X}}$) of 30.2 g dry wt/m^2 and a least significant interval of 9.6 (Table 4).

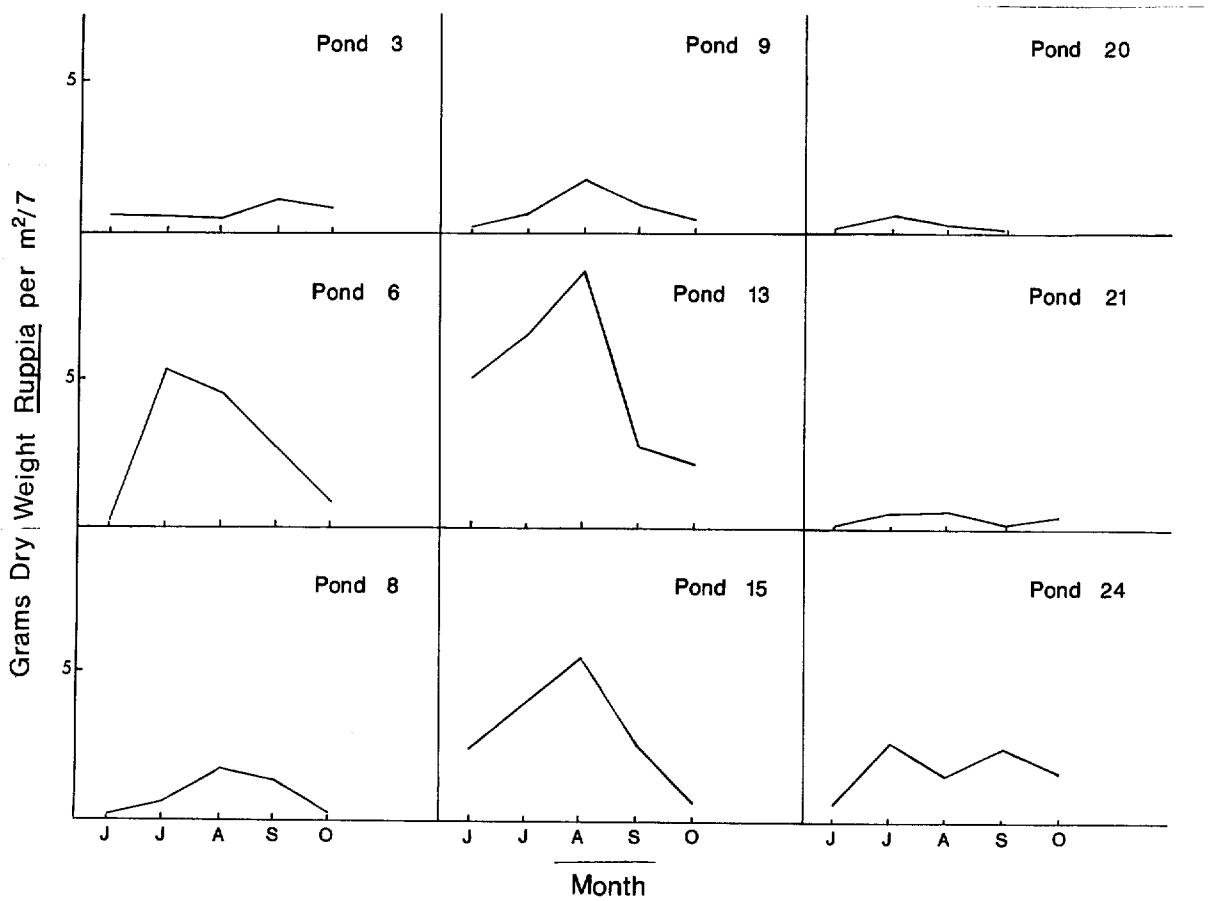

Figure 2. Peak biomass occurred between the last week of July and early August. Monthly means were generated by pooling the four one seventh meter squared samples collected within each month (i.e., two replicates were collected biweekly).

Sampling began in March 1976. *Ruppia* growth was observed on 31 March 1976 approximately one month earlier than 1975. The unreasonably warm spring suggests that temperature has a pronounced effect on the initiation of *Ruppia* growth. Salinity, pH, and mean depth were sampled weekly. Triplicate ($m^2/2$) plant samples were collected biweekly since early May.

Table 4. Mean peak biomass estimates generated from two replicates collected from each permanent salt pond.

Pond Number	X_i ranked (g dry wt/m^2)	Pond Number	X_i ranked (g dry wt/m^2)
13	79.66	21	2.30
301	66.08	207	1.20
206	58.18	20	.60
24	33.80	212	.58
6	30.20	200	.52
9	27.04	204	.46
15	22.98	208	.32
201	15.82	215	.26
210	12.62	203	.04
209	11.78	214	.04
8	11.72	202*	0.00
211	8.70	205*	0.00
3	7.68	213*	0.00

MS = 21.82 lsi = 9.6

* *Ruppia* was present in these ponds; however, growth was either sparse or clumped such that no stems occurred in the two (m^2/2) samples. A triplicate sampling regime has been employed this year.

4. ESTUARINE EVALUATION STUDY: BENTHIC INVERTEBRATES. FOUR YEAR REPORT, 1973-1977.

Harold H. Haskin and Gary Ray[1]

[1]The first author is a Professor with the Department of Zoology, Rutgers University. The second author is a graduate student associated with that department. This report was prepared for the New Jersey Division of Fish, Game, and Shellfisheries with funds provided in part by the New Jersey Division of Marine Services during the period 1973 to 1977 and by the Center for Coastal and Environmental Studies, Rutgers - The State University during the period 1978 to 1979.

ACKNOWLEDGEMENTS

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Boats, motors, and sampling gear were supplied by the New Jersey Oyster Research Laboratory, New Jersey Agricultural Experiment Station.

Messrs. Michael Hogan, Bruce Kiesel, Gary Ray, and William Ressler, graduate assistants in the Department of Zoology, Rutgers University collected all samples and drafted various reports.

Expert assistance in identification of specimens during the initial phases of the project was supplied by Ms. Cindy Van Dover. Numerous undergraduate assistants were involved throughout the project in the tedious activity of sorting specimens from the samples. The final report is largely the result of the hard work and dedication of Gary Ray, although the final responsibility rests with the principal investigator.

H. H. Haskin

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INTRODUCTION

The presence of a series of barrier beach islands along the east coast of New Jersey has created shallow bays and allowed the development of extensive salt marshes. The principal sources of primary production in these salt marshes are the marsh grasses *Spartina alterniflora* and *Spartina patens* (Teal 1969). In the salt marshes of Rhode Island (Nixon and Oviatt 1973), Georgia (Teal 1962), and Louisiana (Day et al. 1973), these species account for 95% of all plant biomass and primary production. Approximately 77% of gross primary production is consumed by the plants in respiration and maintenance (Teal 1962). The remaining 23% is available for consumption by other trophic levels. Teal (1962) has summarized the energy flow through the various trophic levels and found 7% of the net primary production is consumed by primary consumers (herbivores). A total of 47% of the net primary production is consumed by bacteria. This leaves 45% of the net primary production available for export to the surrounding tidal creeks and bays. The plants are generally not exported as entire plants, but as detritus. The plants are broken into progressively smaller pieces by the combined actions of weathering, wave action, marsh invertebrates feeding, and bacterial decomposition. The remains of the decomposed plants are washed off the marsh surface and into tidal creeks during high tides. Odum and de la Cruz (1967) found 90 - 99% of the total seston in tidal creeks of the Georgia salt marshes was composed of organic detritus. The load of detritus ranged from 2 $mg \cdot l^{-1}$ at mid flood tide to 20 $mg \cdot l^{-1}$ during mid ebb tide. When the detritus is suspended in the water column, it is available to planktonic organisms as a food source. Carlson (1978) reported zooplankton biomass in the waterways of Long Island salt marshes could not account for the available phytoplankton production. He suggests the zooplankton rely upon detritus as a food source. The production of the ctenophore *Mnemiopsis leidyi* also exceeded available phytoplankton and zooplankton resources suggesting these animals also rely upon detritus as a food source. The bulk of the suspended detritus eventually is deposited as sediment in the tidal creeks and surrounding bays. Richard (1978) reported from 9 - 47 mm of sediment per year deposited on mud flats in the vicinity of Long Island salt marshes. Upon deposition, the detritus is available for further bacterial decomposition and ingestion by benthic organisms. Adams and Angelovic (1970), Hargrave (1970), and Giere (1975) have reported benthic invertebrates utilize the bacterial and diatom populations of sediment particles as a major food source. In addition to feeding upon the bacterial populations, the benthic invertebrates affect sediment properties by tube-building, burrowing, grazing, and pelletization (Rhoads 1971). These activities in turn affect the bacterial community (Driscol 1975) and nutrient cycling (Dursma and Gross 1971). Quantitatively, the benthic invertebrate community is responsible for much of the reworking of the sediments. Gordon (1966) reported the benthic community of Barnstable Harbor, Massachusetts was capable of processing the surface sediments several times before the sediments were permanently deposited. This is a conservative estimate based primarily upon the reworking capabilities of a single species. In addition to their importance in sediment reworking, the benthic invertebrate community is the major food source for many estuarine fish and epibenthic invertebrate species (Odum and Heald 1972).

As a part of the Estuarine Evaluation Study, the structure, distribution, production, and food web relationships of the benthic invertebrate community of salt marsh waterways in the Manahawkin, New Jersey area were studied. The benthic invertebrate portion of the study was carried out in two phases. The first phase, July 1973 - February 1975, consisted of an inventory of the species found

in natural and undisturbed creeks, partially disturbed creeks, and fully lagooned waterways. During this phase, the first quantitative data on species' distributions within the various waterway types were collected. The second phase, July 1975 - March 1977, consisted of an intensive study of the dominant species of the benthic community to include their distribution, population structure, growth, production, and food web relationships. Information on the distribution of the marsh mussel *Modiolus demissus* was also obtained.

To determine the distribution and dynamics of the benthic invertebrate community, several community variables were measured. First of all, the types and numbers of species from each of the waterway types were tabulated. The numbers of individuals and biomass of each species were measured on a quantitative basis to monitor both waterway and seasonal differences in distributions. The numbers of species and their abundances required the use of several mathematical indices to summarize the characteristics of the community structure. An index of persistence based on percent occurrence was calculated to detect numerical changes in speciation. Species diversity indices have been calculated to summarize differences in the distributions of species' abundances. These indices are not species specific and rely upon nonbiological analogies (Hulbert 1971); however they remain the most convenient method of summarizing the relationships between species' numbers and species' abundances. Two such indices based on information theory, Shannon-Weaver's H' (Shannon and Weaver 1949) and Pielou's eveness index or J (Pielou 1966) were calculated. A third index, Simpson's D (Simpson 1949) was calculated. This index is less affected by numerical dominance by one or two species than are either H' or J. While all of these indices suffer from the same problems of nonspecies specificity and sample size dependence they are the preferred indices (Gray 1974). Two indices of numerical dominance were also calculated. The Berger-Parker index (Berger and Parker 1970) measures the degree of numerical dominance accounted for by the single most abundant species. The McNaughton index (McNaughton 1967) measures the degree of numerical dominance accounted for by the two most abundant species. These indices supplied information critical to the interpretation of the diversity indices. Further information on the similarity of speciation among sampling sites was obtained by calculation of the Czekandowski or Sorrenson index (Sorrenson 1948). These indices provide insight to structural differences within the communities of the waterway types, but may be difficult to relate to observed biological differences in the community. Data on individual species' ranges, numbers of individuals, biomass, and population structure are necessary to interpret the biological significance of changes or differences within the community.

The results of the biological analyses are related to the hydrographical differences among the waterway types. Data on temperature, salinity, depth, dissolved oxygen concentrations, and sediment characteristics were correlated to give as clear a picture as possible of the factors causing the difference in the structure and nature of the benthic community among the waterways.

METHODS

Sampling Sites and Dates

The sampling area for this study included portions of the mainland (western) side of Manahawkin Bay and Little Egg Harbor in Ocean County, New Jersey (Figure 1; note that all figures for the report are located in APPENDIX A). The waterways sampled between July 1973 and March 1975 (Figure 2) included Dinner Point

Creek, Meyers Creek, Cedar Run, Mill Creek, and two systems in Beach Haven West development which we designated Lagoon Systems A and B. Meyers Creek and Dinner Point Creek were categorized as natural creeks, Mill Creek and Cedar Run as partially disturbed waterways, and Lagoon Systems A and B as fully lagooned waterways. A bay reference station was also sampled. This station was located approximately 100 m directly east of the Cedar Run public dock. In each waterway, a total of three permanent stations were established. One station was located at the most bayward portion of the waterway (mouth), another at the midpoint of the waterway (mid), and one at the most landward point in the waterway that could be reached on a regular basis (upper). The location of all stations are indicated on Figure 2.

All stations were sampled on a quarterly basis (every 3 months). The sampling dates were as follows: (1) Summer 1973 - 11 and 13 July, 8, 14, and 21 August; (2) Fall 1973 - 4 and 18 October, 2 November; (3) Winter 1974 - 27 December (Dinner Point Creek mid, Lagoon System B mid, and reference station only); (4) Spring 1974 - 11 and 12 April; (5) Summer 1974 - 11 July, 9 and 12 August; (6) Fall 1974 - 17 September, 31 October, 7 November; and (7) Winter 1975 - 24 January.

During the first three quarterly samplings, a variable number of grab hauls were taken at each station. These data were used to determine a minimum sample size, sampling sites, qualitative species distributions, and establish a specimen reference collection. The fourth quarterly sampling (11 April 1974) was used to quantify species and community distributions. Four grab hauls were taken at each station. Starting with the fifth quarterly sampling,(11 July, 9 and 12 August 1974) the number of grab hauls per sample was increased to five to insure accurate quantitative data collection. The five grab haul sample size was arrived at by a series of collections where eight grab hauls were taken and the percent recovery of species was determined. Seven of these collections were made between 11 July 1974 and 4 October 1973. An additional collection was made on 13 July 1975 when a total of 10 grab hauls were taken. The results of these collections are summarized in Table 1 (note that all Tables for this report are in APPENDIX B unless otherwise specified). During the first series of samples, 90% of the total species collected in eight grab hauls were taken by the fifth haul. In the second series of samples, 96% of the total species found in ten hauls were collected by the fifth haul.

In July 1975, the second phase of the study was started. During this phase, only Meyers Creek and Lagoon System B were sampled. All original stations were maintained. Two new stations were added midway between the existing stations (Figure 2). All stations were sampled on a quarterly basis and five grab hauls were taken at each station. Unlike the first phase sampling where all grab hauls were pooled, the grab hauls in the second phase were kept separate to allow more detailed statistical analysis. Sampling dates during the second phase were: (1) Summer 1975 - 13 and 14 July; (2) Fall 1975 - 12 and 21 October; (3) Winter 1976 - 18 February; (4) Spring 1976 - 20 April; (5) Summer 1976 - 14 July; (6) Fall 1976 - 21 October; and (7) Winter 1977 - 9 March.

Samples for gut content analyses and size frequency determinations were taken from regular benthic samplings and from extra monthly samplings. These samples were taken at sites near Meyers Creek station 1 and 5, Dinner Point Creek mouth and upper stations, and at random sites in the bay. Samples for respiration

studies were taken at the same sites. The sampling dates for these additional samples were as follows: (1) 24 July 1975; (2) 17 September 1975; (3) 21 October 1975; (4) 18 November 1975; (5) 10 December 1975; (6) 18 February 1976; (7) 23 March 1976; (8) 20 April 1976; (9) 25 May 1976; (10) 16 June 1976; (11) 27 July 1976; (12) 25 August 1976; (13) 25 September 1976; (14) 21 October 1976; (15) 9 March 1977; and (16) 19 April 1977.

Biological Methods

All samples were taken with a ponar grab which sampled an area approximately 0.05 m^2. Samples were sieved with a nesting pair of screens with mesh openings of 1.0 cm^2 and 1.0 mm^2. Materials retained by the screens were preserved in sea water and formalin buffered with Methenamine (Hexamethylenamine, Laboratory Grade, Fisher Scientific Co.). In the lab, all samples were stained with a solution of Rose Bengal to facilitate separation of the specimens from the sediment and plant debris. After staining, the samples were reseived through a 1 mm mesh screen and placed in a white porcelain pan. The specimens were then picked from the sediment and stored in 70% buffered ethanol. The specimens were identified to species level and counted. Taxonomic keys used for identification included Abbott (1974), Abbott, et al. (1968), Bousfield (1973), Day (1973), Pettibone (1963), Schultz (1969), Smith (1964), and Williams (1965).

All specimens collected during the second phase of the study were dried to obtain estimates of biomass. Members of each species within a sample were separated, placed in porcelain crucibles, dried in an oven at 60°C for 12 hours, and then weighed. The dried samples were then ashed in a muffle furnace at 500°C to constant weight (approximately 90 minutes). Between all dryings, ashings, and weighings, the samples were kept in a desiccator with fresh desiccant. All samples were weighed to the nearest 0.1 mg on a Sartorius balance.

Samples used for size frequency analyses were usually returned to the lab for screening. A screen of 0.5 mm mesh was used to insure collection of smaller individuals. All specimens were stored in 70% buffered ethanol. Individual animals were measured under a dissecting microscope equipped with an ocular micrometer. Size measurements were made using the following criteria: (1) *Ampelisca abdita* - length from the tip of the head to the tip of the uropods; (2) *Leptocheirus plumulosus* - length from the tip of the head to the tip of the uropods; (3) *Cyathura polita* - length from the tip of the head to the tip of the uropods; (4) *Hypaniola grayi* - length from the tip of the prostomium to the tip of the tail; (5) *Streblospio benedicti* - length from the tip of the prostomium to the tip of the tail; (6) *Nereis succinea* - length from the tip of the prostomium to the tip of the tail; (7) *Heteromastus filiformis* - width of the prostomium; and (8) *Lumbrineris tenuis* - width of the prostomium.

Ampelisca abdita, Leptocheirus plumulosus, Hypaniola grayi, and *Streblospio benedicti* were measured to the nearest 0.01 mm. *Cyathura polita* and *Nereis succinea* were measured to the nearest 0.1 mm, and *Heteromastus filiformis* and *Lumbrineris tenuis* were measured to the nearest 0.0001 mm. Specimens with hard exoskeletons presented little problem in obtaining reproducible measurements. Length measurements of soft bodied forms such as polychaetes were made by application of slow gentle pressure until the specimen was in a straight line position. Curled or tightly wound specimens were excluded from the measurements. Some shrinkage undoubtedly occurred in the soft bodied forms due to preservation, but no corrections were made for this shrinkage.

Gut content determinations were made by examination of untreated gut contents and by a modification of the methods of Fenchel et al. (1975). Direct examination involved the dissection of the intestines and the smearing of the gut contents onto glass microscope slides. The gut contents were air dried on the slides and then mounted using a drop of Diaphane mounting media (Diaphane Colorless, Will Corporation) and a coverslip. These slides were examined under 100X and 400X magnifications, and the materials were identified when possible. The second method of examination involved the digestion of 0.5 g aliquots of wet preserved specimens in concentrated nitric acid. Aliquots were placed in 12 ml conical centrifuge tubes, digested in the acid for 3 hours, centrifuged for 5 minutes at high speed, and the acid pipetted off. The centrifuged pellet was resuspended in fresh nitric acid using a vortex mixer, digested for 12 hours, recentrifuged, and the nitric acid removed. The pellet was resuspended through two 95% ethanol changes, recentrifuged, and finally spread on a glass microscope slide and allowed to air dry. After application of a drop of Diaphane and a cover slip, the slides were examined at 400X magnification. Diameters of 200 particles found in randomly selected fields were measured and the number of diatoms per 200 particles was determined. After measurement of the particles, the entire slide was examined for diatom frustules and the diatoms were identified to genus level. Broken frustules were not measured or identified. Both diatom and sand particles were measured to the nearest 2.5 μm using an ocular micrometer. Estimation of the volumetric contribution of each size class of particle was made by calculating the volume of a spherical particle of a given diameter ($V = 1.33\pi r^3$) and multiplying this volume by the number of particles of that diameter. Qualitative examination of several epibenthic crustacean and fish species were also made. A total of 112 *Palaemonetes vulgaris*, 52 *Crangon septemspinosa*, 12 *Callinectes sapidus*, 10 *Neopanope texana*, and 41 *Fundulus heteroclitus* guts were examined. The intestinal tracts were dissected, the contents teased onto microscope slides or watch glasses, and the material examined under either a dissecting or compound microscope.

Statistical and Numerical Methods

The 10 ponar grab sample taken in July 1975 provided data both for the confirmation of the minimum sample size and for determination of the distribution of individuals among the samples. The distribution of animals among the individual ponar grabs did not fit a statistically Normal distribution, but fitted an aggregated or Poisson distribution. In order to analyze the data, a data transformation was used. Following the recommendations of Steel and Torrie (1960) and Zar (1974), a logarithmetic transformation was used. This transformation involved the conversion of all data to the form LOG (X + 1). After transformation, the data was analyzed by an Analysis of Variance (ANOVA) using a randomized block design with nesting and replication. The ANOVA for the spring 1974 data was as follows:

Source	Degrees of Freedom	Estimated Mean Squares
Waterway Type (WT)	2	$s^2_{st} + 3s^2_w + 6s^2_{wt}$
Waterway (W)	3	$s^2_{st} + 3s^2_w$
Station (ST)	12	s^2_{st}

Data from the summer 1974 to winter 1975 was analyzed using the following ANOVA:

Source	Degrees of Freedom	Estimated Mean Squares
Season (S)	2	$s^2_{st} + 3s^2_w + 6s^2_{sxwt} + 18s^2_s$
Waterway Type (WT)	2	$s^2_{st} + 3s^2_w + 6s^2_{sxwt} + 24s^2_{wt}$
Season X Waterway Type (SXWT)	4	$s^2_{st} + 3s^2_w + 6s^2_{sxwt}$
Waterway (W)	9	$s^2_{st} + 3s^2_w$
Station (ST)	36	s^2_{st}

The data from the summer 1975 to winter 1977 collections were analyzed using the following ANOVA:

Source	Degrees of Freedom	Estimated Mean Squares
Season (S)	6	$s^2_{sa} + 5s^2_{st} + 25s^2_{sxw} + 50s^2_s$
Waterway (W)	1	$s^2_{sa} + 5s^2_{st} + 25s^2_{sxw} + 175s^2_w$
Season X Waterway (SXW)	6	$s^2_{sa} + 5s^2_{st} + 25s^2_{sxw}$
Station (ST)	56	$s^2_{sa} + 5s^2_{st}$
Sample (SA)	280	s^2_{sa}

The 95% confidence intervals were calculated using the following formula:

$$95\%\ CI = (t_{a2})(v1 + v2)\sqrt{\frac{(Sp^2)}{n_i}}$$

where

t_{a2} = Student's t value for a two tailed test

v1 and v2 = degrees of freedom

Sp^2 = pooled variance = $\frac{(SS1 + SS2)}{(v1 + v2)}$

n_i = number of samples giving rise to Sp^2

SS1 and SS2 = Sums of Squares for samples

A F test was used to test the significance of differences between sources of variation. Mean squares used in the F test were determined from the estimated mean squares. All data analyses were performed on Rutgers University CCIS batch terminals using SAS-76 programming.

Shannon-Weaver's H' was calculated using the following equation:

$$H' = (- p_i \log p_i)$$

where

p_i = the percent abundance of the ith species

Pielou's eveness index, J, was calculated using the following equation:

$$J = \frac{(H')}{S}$$

where

H' = Shannon - Weaver's Index

S = Total number of species

Simpson's D diversity index was calculated using the following equation:

$$D = (1-C)$$

where

$$C = \frac{n_i\ (n_i - 1)}{N\ (N - 1)}$$

n_i = number of individuals in the ith species

N = total number of species

Berger - Parker's Dominance index was calculated from the following question:

$$B\text{-}P = \frac{(n_i)\ (100)}{(N)}$$

where

n_i = number of individuals in the most abundant species

N = total number of individuals

McNaughton's Dominance index was calculated from the following equation:

$$McN = \frac{(n1 + n2)\ (100)}{(N)}$$

where

n1 and n2 = the number of individuals in the two most abundant species

N = total number of individuals

Species richness was measured simply as the total number of species found in a particular collection. Species persistance was measured as the percent of the total species found over a given period of time.

The Sorrenson index (K) or Czekandowski index was calculated to compare the species composition of a pair of samples. It was calculated from the following equation:

$$K = \frac{(2w)}{(A + B)}$$

where

W = the number of common species

A = the total number of species in sample A

B = the total number of species in sample B

Analysis of species' size frequency distributions were performed using the method of Harding (1949) as modified by Cassie (1954). This method, the probability paper method of analysis, detects the presence of subpopulations within a population distribution.

Hydrographical Methods

During each quarterly sampling, hydrographic and sediment data were collected. Surface and bottom water temperatures were measured to the nearest 0.1^{o}C with a reversing thermometer or a standard laboratory thermometer. Samples of both surface and bottom waters were taken for salinity and dissolved oxygen determinations. Bottom water samples were taken with a Kemmerer bottle. The dissolved oxygen concentrations were measured by the Winkler method with the azide modification (American Waste Water Association 1965). Salinity was measured as chlorinity by the Knudsen method and salinity was calculated using the Knudsen tables (Oxner 1965). Depth was measured to the nearest 0.5 ft using a marked leaded line.

Sediment samples were analyzed by the Bouyoucos method and by mechanical sieving through a set of Wentworth screens. Sediment data were analyzed using the graphical method of Krumbein (1938). Mean particle diameter, sorting coefficient, and percentage silt/clays were determined from the graphs. The sorting coefficient of Sverdrup et al. (1942) was used to measure the degree of sorting.

RESULTS

Hydrographical Results 1973 - 1975

Table 2 is a summary of the hydrographic data. The raw hydrographic data are reported in APPENDIX C: Tables 1-7. (Note that all raw data tables are found in APPENDIX C.)

The depths of the waterway types and stations within the waterway types displayed distinct patterns of distribution. In the creeks, most depths were 1.2 - 5.5 ft. Creek mouth station depths were between 1.3 - 5.5 ft, mid stations between 2.5 - 7.3 ft, and upper stations between 1.8 - 3.8 ft. The partially disturbed waterways had greater depth ranges. The mouth stations were 4.0 - 12.0 ft in depth, the mid stations 8.0 - 14.8 ft, and the upper stations 4.3 - 9.0 ft. The range of depths in the lagoon systems was also large. The mouth station depths were between 3.3 - 11.0 ft, the mid stations 9.0 - 15.0 ft, and the upper stations 10.0 - 15.8 ft. Both the creeks and the partially disturbed waterways were deepest at the mid stations and shallowest at the upper stations. The lagoon systems were deepest at the upper stations and shallowest at the mouth stations. The reference station depth was 4.0 - 7.5 ft.

The creek temperature was generally 3.7 - 27.5°C for surface waters and 3.7 - 26.9°C for bottom waters. Among the creek stations, the warmest temperatures were found at the mouth station. The partially disturbed waterways were slightly warmer on the average for both surface waters (4.2 - 28.9°C) and bottom waters (5.3 - 28.0°C). Of these, the warmest stations were the mid stations. In the lagoons, the temperatures were usually 3.9 - 29.9°C at the surface and 4.3 - 26.8°C at the bottom. Again, the warmest stations were the mid stations. The temperature range at the reference station was 5.5 - 28.9°C for surface waters and 5.5 - 28.3°C for bottom waters.

A pattern of temperature differences for both surface and bottom waters was evident among the waterway types. The lagooned and partially disturbed waterways were deeper than the creeks and the minimum bottom water temperatures were higher. This pattern was particularly true for the deepest stations such as the upper and mid stations. The outer (mouth) stations of lagooned and partially disturbed waterways were deeper than those in the creeks; however, the temperatures at the low end of the temperature range were generally lower than those of the creeks. The surface waters of the lagoons and partially disturbed waterways also had slightly higher maximum temperatures than creek surface waters. The reference station had the warmest minimum temperature for bottom waters.

The results of the dissolved oxygen determinations related directly to the temperature and depth distributions. In the creeks, partially disturbed waterways, and reference station ranges of dissolved oxygen concentrations were usually 6 - 11 mg $O_2 \cdot l^{-1}$ for surface waters and 5 - 10 mg $O_2 \cdot l^{-1}$ for bottom waters. The highest concentrations were found at the surface and during the coldest times of the year. The lowest levels occurred during the warm months and in the bottom waters. Depth and dissolved oxygen concentrations were inversely related. This pattern was most pronounced in the lagoons. The deep upper stations were anaerobic for much of the year. The highest dissolved oxygen concentrations occurred at these stations only during the coldest months.

Differences in salinity occurred between the waterway types at the upper and mid stations. Dinner Point Creek, Cedar Run, Mill Creek, and to a lesser extent Meyers Creek upper stations, all had low salinities when compared to the other stations. The surface and bottom waters ranged from 6.0 to 9.0 °/oo salinity at the upper Dinner Point Creek station. The surface and bottom waters of the Cedar Run upper station had a greater range of salinities (0.3 - 22.0 °/oo). The Mill Creek upper station surface and bottom waters varied from 4 to 17 °/oo. The Meyers Creek upper station varied from 14 to 25 °/oo. The lowest salinities in the lagoons occurred in the surface waters of the upper stations. Mid and outer stations generally ranged between 14 and 25 °/oo. Only partially disturbed waterway mid stations had salinities below this range. The highest salinities encountered were at the reference station.

The measurement of turbidity by Secchi depth showed differences in turbidity between waterway types and stations within the waterway types. The highest turbidity was found in the creeks. Creek Secchi depths were 0.7 - 3.7 ft. Partially disturbed waterways had Secchi depths between 1.4 - 3.9 ft and the reference station between 1.5 - 5.0 ft. Lagoons had the deepest Secchi depths with average values between 2.3 and 6.3 ft. In all waterway types, the Secchi depth increased with proximity to the bay.

The average sediment characteristics also varied between waterway types and stations. Creek and partially disturbed waterways had mean particle diameters approximately 52 and 54 μm, respectively. Sorting coefficients averaged 2.1 in the creeks and 1.9 in the partially disturbed waterways. Lagoon system and reference station mean particle diameters averaged 34 and 31 μm, respectively. Sorting coefficients averaged 1.7 in the lagoons and 1.3 in the reference station. In all waterway types, the mean particle diameters were highest at the mid and upper stations. Dinner Point Creek and Cedar Run upper stations both had sandy sediments. The silt/clay proportions in all waterway types were highest at mid and mouth stations. Among the waterway types, the lowest average silt/clay percentages were found in the creeks (61%). The partially disturbed waterways, the lagoon systems, and the reference station had silt/clay percentages of 65 - 66%.

Hydrographical Results 1975 - 1977

The summary of hydrographic data collected during 1975 - 1977 is presented in Table 3, and the raw data are presented in APPENDIX C: Tables 8 and 9. All of Meyers Creek stations, except station 5, ranged from 2.5 - 7.0 ft deep while station 5 ranged from 2.0 - 3.0 ft. In Lagoon System B, the depth increased with progressive distance from the bay. The deepest stations were stations 4 and 5. These stations were 16.0 - 18.0 ft and 12.0 - 20.0 ft deep, respectively.

The range of temperatures differed between waterways and paralleled differences in depth. The temperature range for all of Meyers Creek was 8.1 - 21.1°C for both surface and bottom waters. There was little difference between surface and bottom water temperatures. In the lagoon, the temperature range on a system basis was 6.3 - 24.5°C for surface waters and 5.6 - 23.5°C for bottom waters. In general, the bottom water temperatures were lower than surface water temperatures. Seasonally, creek temperatures rose and fell more rapidly than lagoon temperatures. For instance, in the spring 1976, the average creek bottom water temperature was 21.5°C while the average lagoon bottom temperature was 17.3°C. In the fall 1975, the average creek bottom temperature was 14.5°C and the average lagoon bottom temperature was 17.1°C.

The creek dissolved oxygen concentrations generally exceeded those in the lagoon. In Meyers Creek, most concentrations were approximately 6.1 - 11.1 mg $O_2 \cdot l^{-1}$ for surface waters and 6.0 - 10.4 mg $O_2 \cdot l^{-1}$ for bottom waters. The lowest oxygen concentrations were found at station 5. In Lagoon System B, the range of dissolved oxygen concentrations on a system basis was 7.3 - 10.7 mg $O_2 \cdot l^{-1}$ for bottom waters. The lowest concentrations were found at the deepest stations. Station 5 was anoxic for much of the year. Station 4 (the next deepest station) had the next lowest oxygen concentrations.

Salinities in the creek were usually between 18.5 and 29.8 °/oo for surface waters and 18.7 - 29.8 °/oo for bottom waters. Among the creek stations, station 5 was the only one which had salinities outside a span of 19 - 30 °/oo. The salinity range at station 5 was between 17 and 30 °/oo. Lagoon salinities were usually 21 - 26 °/oo for the surface waters and 23 - 27 °/oo for the bottom waters. This range of values was found at all stations except station 1 which averaged 21 - 31 °/oo.

During 1975 - 1977, the average mean particle diameter of creek sediments was 20 µm. Among the Meyers Creek stations, the mean particle diameter ranged from 18 - 22 µm, but varied in no distinguishable pattern. In Lagoon System B, the mean particle diameter was 36 µm. The largest mean particle size was found at station 2. The sorting coefficients averaged 1.8 in the creek and varied from a low of 1.5 at station 1, increased to 2.0 at station 3, and decreased to 1.8 at stations 4 and 5. In the lagoon, the average sorting coefficient was 2.3. The highest sorting coefficient was found at station 4, the lowest at station 5, and the remainder were within 0.5 of each other. Silt/clay percentages averaged 86% in the creek and varied little among the stations. The total range of values varied by only 3%. In the lagoon system, the average silt/clay percentage was 72% and varied from a high of 93% at station 1 to a low of 63% at station 2. The remaining stations averaged between 66 and 68% silt/clays.

Species Composition

During the first phase of the benthic sampling (1973 - 1975), a total of 185 species and 231,135 organisms were collected. Of these 185 species, 22 accounted for over 93% of all the organisms. The percentage composition for these 22 species are listed in Table 4 for each of the waterway types and the total collection. Each of the waterways had a different total percent composition, but the range of values was within 6%. The lowest total percent composition by the 22 species was found in the lagoon systems, the next highest value was in the partially disturbed waterways, and the highest value was in the natural creeks (93%). The reference station had a value midway between the creeks and partially disturbed waterways. The differences in these values were determined by the relative contribution of the species among the waterway types. The amphipod *Ampelisca abdita* was the most abundant species in the collections. Overall, it comprised 56% of all specimens. *Ampelisca abdita* made up 62% of all organisms collected at the reference station, 60% of all creek organisms, 53% of all organisms in the partially disturbed waterways, and 48% of the organisms in the lagooned waterways. The polychaete *Streblospio benedicti* was the second most abundant species and accounted for 10% of all specimens in the collections. *Streblospio benedicti* made up 25% of the lagoon organisms, 9% of the creek organisms, 8% of the organisms in the partially disturbed waterways, and less than 0.2% of the reference station organisms. The third most abundant species, the polychaete *Hypaniola grayi*, accounted for nearly 8% of the total numbers of individuals during 1973 - 1975.

Its distribution was limited primarily to the natural creeks and partially disturbed waterways where it comprised 9% and 11% of the organisms, respectively. At the lagoon and reference stations, *Hypaniola grayi* made up less than 0.1% of all individuals. The fourth most abundant species, the polychaete *Nereis succinea*, made up 3% of the animals collected. *Nereis succinea* accounted for 3.2% of the creek animals, 2.6% of the partially disturbed waterway animals, 1.7% of the lagoon animals, and was practically absent from the reference station collections. The fifth most abundant species, the amphipod *Leptocheirus plumulosus*, comprised 2.6% of the total collections, but was found in substantial amounts only in the partially disturbed waterways. *Leptocheirus plumulosus* made up 5.3% of the partially disturbed waterway collections, but elsewhere accounted for less than 1% of the collections. The sixth most abundant species, the isopod *Cyathura polita*, comprised 1.5% of the total collections and was most abundant in the partially disturbed waterways. In the partially disturbed waterways, it made up 2.4% of all animals, in the creeks and reference station, it accounted for 1.3 - 1.4% of the animals; and in the lagoons, it accounted for only 0.5% of the animals. The seventh most abundant species, the polychaete *Heteromastus filiformis*, constituted nearly 1.5% of the total animals collected. It made up 1.9% of the creek organisms, 1.7% of the animals at the reference station, and less than 1% of the partially disturbed or the lagooned waterways. The Oligochaeta constituted 1.4% of all the specimens collected and was the eighth most abundant species. This group was equally important among the waterway types (1.4 - 1.6%), but was practically absent from the reference station collections. The ninth most abundant species, the polychaete *Scoloplos robustus*, made up 1.2% of all specimens collected. It comprised 2% of the lagoon collections, 2.5% of the reference station collections, and less than 1% of the creek and partially disturbed waterway collections. The tenth most abundant species, the gastropod *Ilyanassa obsoleta*, comprised 1% of all specimens collected. It was most abundant in the lagoon systems (1.5%) and made up approximately 1% of the animals in the other waterways. Two species, the polychaete *Eteone heteropoda* and the amphipod *Gammarus palustris*, made up less than 1% of the total collections, but were found in highest abundances in the creeks. *Eteone heteropoda* accounted for 1% of the creek animals and less than 0.4% of the animals in the other waterways. *Gammarus palustris* constituted nearly 1% of the creek animals and less than 0.2% in the other collections. *Glycera* spp., *Melita nitida*, *Lumbrineris tenuis*, *Maldanopsis elongata*, *Melinna cristata*, *Mulinia lateralis*, *Retusa canaliculata*, and *Neomysis americana* were all found in the highest abundance at the reference station. The polychaetes *Glycinde solitaria* and *Polydora ligni* were most abundant in the lagoons.

In Table 5, the percentage composition of the most abundant species collected during the second phase (1975 - 1977) are listed. As during the first phase, the two most abundant species were *Ampelisca abdita* and *Streblospio benedicti*. *Ampelisca abdita* was the most abundant species constituting 69% of the total collections. This species accounted for 74% of the creek animals and 49% of the lagoon animals. *Streblospio benedicti*, the second most abundant species, accounted for 8.5% of the total animals, 14% of the lagoon animals, and 7.2% of the creek animals. *Nereis succinea* was the third most abundant species in the second phase constituting 4.4% of all animals. It made up 5% of the creek collections and 1.7% of the lagoon collections. The fourth species was *Gemma gemma*, the gem clam, which made up 2.6% of the collections. In the creek, *Gemma gemma* accounted for 2.7% of the animals and in the lagoon it accounted for 1.9% of the animals. Fifth in the ranking of the species during the second phase was the tanaid *Leptochelia savignyi*. This species had no contribution to the collections prior to fall 1976 and very little contribution afterwards. It accounted for 1.6% of the total

animals collected. It was virtually absent from the creek collections, but made up 8.5% of the lagoon collections. A similar situation is found with the tenth most abundant species, an unidentified ostracod. The ostracod was found only between fall 1975 and winter 1976. It made up 1% of the total collections, but was found primarily at two stations in the lagoon. The sixth most abundant species, the polychaete *Heteromastus filiformis*, accounted for 1.6% of the total collections, 1.8% of the creek animals, and less than 1% of the lagoon animals. The seventh most abundant species, the Oligochaeta, made up 1.4% of the total collections, 1.4% of the creek collections, and 1.6% of the lagoon collections. The eighth species, *Lumbrineris tenuis*, comprised 1.4% of the total animals. It constituted 1.5% of the animals in the creek and 1% of the animals in the lagoon. The ninth most common species was *Leptocheirus plumulosus*. It made up 1.1% of the total collection, 3.5% of the lagoon collections, and 0.6% of the creek collections. The polychaete *Hypaniola grayi* was the third most common species during the first phase, but during the second phase it made up less than 1% of the total specimens. It was most abundant (0.9%) in the creek and practically absent in the lagoon (0.03%). *Scoloplos robustus* made up 1.2% of the collections in 1973 - 1975, but during 1975 - 1977, it accounted for only 0.7%. It was most abundant in the lagoon. *Cyathura polita* declined from 1.5% of the collections in the first phase to 0.6% in the second phase. Unlike the results of the first phase, the greatest abundance of this isopod was found in the creek. The snail, *Ilyanassa obsoleta*, dropped from 1% of the collections during the first phase to 0.4% of the collections in the second phase. Changes in the abundance of *Cyathura polita, Hypaniola grayi, Leptocheirus plumulosus,* and *Gammarus palustris* were due both to yearly changes in abundance and to changes in the sampling sites between the phase of sampling. These species had their distributions centered at the upper stations of Dinner Point Creek and Cedar Run. Since these sites were not sampled during the second phase, the contribution by these species was reduced.

In Table 6, the complete species list and relative contributions of each species to the collections are listed. As previously mentioned, approximately 20 species accounted for 94% of all the animals collected. The 10 most common species collected in both phases were (in order): *Ampelisca abdita, Streblospio benedicti, Hypaniola grayi, Leptocheirus plumulosus, Nereis succinea, Heteromastus filiformis,* Oligochaeta, *Nereis* spp., *Cyathura polita,* and *Scoloplos robustus*.

In Table 7, the percentage contributions of the three major taxonomic groups (Polychaeta, Crustacea, and Mollusca) for both phases of the study are listed. During the first phase, the average contribution of the three groups was nearly identical for both creeks and partially disturbed waterways. The crustaceans were the dominant group with over 60% of the total animals. The polychaetes accounted for approximately 29% of the animals. In the lagooned waterways, the crustaceans accounted for 48% of the animals and the polychaetes made up an additional 26%. The reference station had the most distinctive fauna. This station had the greatest abundance of molluscs (12%) and crustaceans (74%). The results from the second phase were similar to those of the first phase. Meyers Creek had 76% crustaceans, 12% polychaetes, and 3% molluscs. The lagoon had a higher percentage of crustaceans (69%) than previously, but the percentage of polychaetes and molluscs were similar to the lagoon averages of the first phase.

Statistical Distributions

The first quantitative samples were taken at the spring 1974 sampling. A total of four ponar grab hauls were taken at each station. Numbers of animals per square meter are listed in Tables 8-28 and the results of the statistical analyses are summarized in Table 29. All data are plotted in Figures 3-20 for waterway type distributions and in Figures 21-38 for seasonal distributions.

There are statistically significant differences in the waterway type distributions of total species and *Ampelisca abdita* ($P \leq 0.05$). The greatest numbers of individuals for total species were collected in the natural creeks. Fewer animals were collected in the partially disturbed waterways and the least numbers of animals in the lagooned waterways. The greatest numbers of *Ampelisca abdita* were in the partially disturbed waterways, fewer in the creeks, and the least in the lagoons. The remaining species and species combinations showed no statistically significant differences ($P \leq 0.05$) in waterway type distributions. Of these species and species combinations, a total of 13 had the greatest numbers of individuals in the natural creeks or partially disturbed waterways and the least numbers in the lagoon systems. Only *Scoloplos robustus*, *Ilyanassa obsoleta*, and *Glycera* spp. had greater numbers of individuals in the lagoons than in the other waterway types. In general, the reference station had numbers of individuals approximating those of the partially disturbed waterways. Unlike any of the waterway types, the reference station had large numbers of the molluscs *Retusa canaliculata* and *Mulinia lateralis*.

The numbers of individuals per square meter for the summer 1974 - winter 1975 collections are listed in Tables 8-28. The results of the statistical analyses are summarized in Table 29. The data are plotted for waterway distributions in Figures 3-20.

Numbers of individuals for total species, total polychaete species, total crustacean species, total molluscan species, and 10 of the individual species displayed statistically significant differences in their waterway type distributions. Total species, total crustacean species, and 8 of the 10 individual species were found in the greatest numbers in the natural creeks, fewer in the partially disturbed waterways, and the least in the lagooned waterways. Total molluscan species and *Ampelisca abdita* were collected in the greatest numbers in the partially disturbed waterways. Fewer animals were found in the creeks and the fewest in the lagoons. Total polychaete species were most abundant in the lagoon systems, less abundant in the partially disturbed waterways, and least abundant in the creeks. *Lumbrineris tenuis* was the only polychaete species that displayed both a significant waterway type and a significant waterway difference in distribution. This species was found in greater numbers in Lagoon System A of the lagooned waterway type and in Meyers Creek of the creek waterway type.

In Tables 8-28, the seasonal distribution of numbers of individuals are presented. The statistical analyses are summarized in Table 29. The data are plotted in Figures 21-38.

Total crustacean species, total molluscan species, *Ampelisca abdita*, *Nereis succinea*, and *Molgula manhattensis* all showed significant differences ($P \leq 0.05$) in their seasonal distributions. Total molluscan species, *Nereis succinea*, and *Molgula manhattensis* were all found in the greatest abundance in the winter 1975 samples, while total crustacean species and *Ampelisca abdita* were found in the

greatest numbers in the fall 1975 samples. All other species and species combinations showed no significant differences in seasonal distributions ($P \leqq 0.05$). There were also no signficant ($P \leqq 0.05$) differences in seasonal distributions between the waterway types (no season by waterway type effect).

Data on the distributions of numbers of individuals among the stations showed a variety of patterns. Numbers of individuals for total species were found in greatest abundance at the mid stations of both partially disturbed waterways and natural creeks. The mouth stations had fewer animals and the upper stations had the fewest. In the lagoon systems, the greatest numbers of individuals for total species were observed at the mouth stations, fewer were collected from the mid stations, and the least were collected from the upper stations. Total polychaete species were detected in the greatest abundance in the mid stations of all waterway types. In the lagooned and partially disturbed waterways, the next greatest numbers of individuals were found at the mouth stations and the least at the upper stations. In the creeks, the next highest numbers of individuals were observed at the upper stations and the least numbers at the mouth stations. Total crustacean species had the highest numbers of individuals at the mouth stations, fewer at mid stations, and least numbers at upper stations in both natural creeks and lagoon systems. In the partially disturbed waterways, the greatest numbers of individuals were collected at the mid stations, fewer were collected at the mouth stations, and the least at the upper stations. Total molluscan species were found in the greatest abundance at mouth stations, less at mid stations, and least at upper stations in all waterway types. Among the individual species, *Hypaniola grayi* and *Nereis succinea* were detected in highest abundance at upper stations, less at mid stations, and least at the mouth stations. In contrast, *Lumbrineris tenuis*, *Scoloplos robustus*, and *Glycera* spp. were collected in the highest abundance at mouth stations, less at mid stations, and least at upper stations. *Streblospio benedicti* and *Melinna cristata* were found in the greatest abundance at mid stations and least abundance at mouth and upper stations. The distribution of *Eteone heteropoda* was identical to *S. benedicti* and *M. cristata* in the lagooned and partially disturbed waterways, but was identical to *H. grayi* and *N. succinea* in the creeks. The crustaceans *Leptocheirus plumulosus* and *Cyathura polita* were observed in highest numbers at upper stations, less at mid stations, and least at mouth stations. *Ampelisca abdita* was found in greatest abundance at mouth stations, less at mid stations, and least at upper stations. The molluscs *Ilyanassa obsoleta* and *Mulinia lateralis* were distributed in a pattern identical to *A. abdita*. *Gemma gemma* was found almost entirely at mid stations. The tunicate *Molgula manhattensis* displayed no difference in its distributions among the stations in any waterway type.

Data for distribution of numbers of individuals per square meter collected during the second phase are presented in Tables 30-49. The results of the statistical analyses are summarized in Table 29. All data for waterway distributions are plotted in Figures 3-20 and for seasonal distributions in Figures 21-38. Biomass distributions are presented in Tables 50-69 and statistical analyses are again summarized in Table 29. All data are plotted for waterway distributions in Figures 39-57 and for seasonal distributions in Figures 58-75.

The results of the statistical analyses for waterway distributions of numbers of individuals per square meter indicate total species, total polychaete species, total crustacean species, and total molluscan species displayed significant differences ($P \leqq 0.05$). Overall, 9 times as many animals were collected from the

creek than the lagoon. Eleven of the individual species displayed significant differences in waterway distributions ($P \leq 0.05$). The greatest numbers of individuals were found in the creek for all 11 species. *Melinna cristata* was the only species exhibiting a significant difference in its waterway distribution ($P \leq 0.05$) and was found in the greatest abundance in the lagoons. *Lumbrineris tenuis*, *Glycera* spp., and *Mulinia lateralis* showed no significant differences ($P \leq 0.05$) in their waterway distributions.

Of the 20 species and species combinations analyzed statistically, only two displayed significant difference ($P \leq 0.05$) in their seasonal distributions. The two species, *Scoloplos robustus* and *Cyathura polita*, had seasonal peaks of abundance in fall 1975 and summer 1976. Neither species displayed a significant seasonal effect ($P \leq 0.05$) during the first phase of sampling. Total species, total crustacean species, and *Ampelisca abdita* had seasonal peaks of abundance for numbers of individuals during fall 1975 and summer 1976. *Ampelisca abdita* constituted 86 - 90% of all crustacean numbers of individuals and 60 - 62% of all total species numbers of individuals. The only other species to show peaks of numerical abundance in fall 1975 and summer 1976 was the polychaete *Lumbrineris tenuis*. This species contributed only 2 - 3% to the total species numbers of individuals. Total polychaete species numbers of individuals had a single peak of abundance in summer 1976. This peak was due to the high numbers of *Streblospio benedicti* which comprised 57% of the total polychaete numbers and 19% of total species numbers. *Heteromastus filiformis* and *Glycera* spp. also had peaks of abundance in summer 1976. *Nereis succinea* had maximum numbers of individuals during fall 1975 and winter 1976. As mentioned previously, both total crustacean species and *Ampelisca abdita* numbers of individuals had two seasons of peak abundance, fall 1975 and summer 1976. The other crustacean species, *Leptocheirus plumulosus* and *Cyathura polita*, had single seasonal peaks. *Leptocheirus plumulosus* had maximum numbers of individuals in fall 1975, while *Cyathura polita* had peak numbers of individuals in summer 1976. Total molluscan species numbers of individuals had no seasonal peak of abundance. Instead, there was a general decline in numbers of individuals following the spring 1976. This pattern is seen in the distribution of *Ilyanassa obsoleta*, but is the most pronounced in the distribution of *Gemma gemma*.

The analyses of season by waterway effects showed all but five species displayed no significant difference in the distribution of numbers of individuals ($P \leq 0.05$) between seasons and waterways. *Glycera* spp., *Mulinia lateralis*, and *Molgula manhattensis* displayed significant season by waterway effects ($P \leq 0.05$), but no seasonal or waterway effects. *Heteromastus filiformis* showed a significant season by waterway effect and a significant waterway effect ($P \leq 0.05$). This species was found in peak abundances during the fall 1975 and summer 1976, but only in the creeks. The lagoon populations of this species showed no seasonal peaks. *Eteone heteropoda* also had a significant interaction effect ($P \leq 0.05$) and significant waterway effect ($P \leq 0.05$). *Eteone heteropoda* had a single peak of abundance during winter 1976 in the creek and a single peak of abundance during summer 1976 in the lagoons.

The data for station numbers of individuals within the waterways are given in Tables 30-49 and are plotted in Figures 76-111. The results of the statistical analyses are summarized in Table 29.

All species and species combinations except *Mulinia lateralis* displayed significant differences ($P \leq 0.05$) in their distributions. In the creek, the highest numbers of individuals for total species were found at station 1. At the remaining stations, the numbers of individuals decreased in the following order: station 3, 5, 4, and 2. The total polychaete species numbers of individuals were highest at station 5 and decreased at the other stations in the order station 3, 1, 2, and 4. The high abundance of individuals at station 5 corresponds to the station distributions of *Nereis succinea*, *Hypaniola grayi*, *Eteone heteropoda*, and *Streblospio benedicti*. *Nereis succinea* and *Hypaniola grayi* were found primarily at station 5 and constituted 57% of the polychaete numbers at this station. *Eteone heteropoda* had peaks of abundance at stations 5 and 3. *Streblospio benedicti* was most numerous at station 1, but had lesser peaks of numbers at station 3 and 5. *Heteromastus filiformis* and *Glycera* spp. were in greatest abundance at station 1 and decreased in numbers in a stepwise fashion at station 2, 3, 4, and 5. *Lumbrineris tenuis* was found in high abundance at station 2 and *Scoloplos robustus* at station 3. Total crustacean species and *Ampelisca abdita* numbers of individuals were distributed in identical patterns. The greatest numbers of individuals were found at station 1, lesser amounts at stations 2 and 3, and the least numbers at stations 4 and 5. *Leptocheirus plumulosus* was distributed in a manner similar to *Ampelisca abdita* except the decrease in numbers of *Leptocheirus plumulosus* between stations 1 and 2 was not as precipitous as for *A. abdita*. *Cyathura polita* was found in a pattern of gradually increasing numbers of individuals starting at a minimum level at station 1 and increasing to a maximum at station 5. Total molluscan species numbers of individuals were most abundant at station 3 and least abundant at stations 4 and 5. This pattern of distribution was due to the high numbers of *Gemma gemma* at station 3. *Ilyanassa obsoleta* was found in the highest amounts at stations 1 and 3.

In the lagoon, total species numbers of individuals were highest at station 3. Numbers of animals decreased at the other stations in the order: station 2, 1, 4, and 5. The distribution of total polychaete species and total crustacean species numbers of individuals were identical to total species numbers. *Heteromastus filiformis*, *Eteone heteropoda*, *Nereis succinea*, and *Streblospio benedicti* also had the same pattern of distribution. *Melinna cristata*, *Scoloplos robustus*, and *Lumbrineris tenuis* were distributed in a pattern similar to total species except the greatest numbers of individuals were found at station 2 instead of 3. *Glycera* spp. had nearly equal numbers of individuals at stations 2 and 3. The crustacean *Ampelisca abdita* was found in the largest numbers at station 1, fewer at station 3, and even less at station 2. Specimens were only collected occasionally at stations 4 and 5. *Leptocheirus plumulosus* was found in the highest numbers at station 2. Lesser numbers of animals were found at station 3 and virtually none were found at stations 1, 4, and 5. *Cyathura polita* was found almost exclusively at station 2 although a few were collected at station 3. Total molluscan species numbers of individuals and *Gemma gemma* numbers were distributed in the same pattern. The highest numbers of individuals were collected at station 2, fewer were collected at stations 1 and 3, and no animals were collected at stations 4 and 5. *Mulinia lateralis* was found primarily at station 2. *Ilyanassa obsoleta* was absent from the lagoon stations. The tunicate *Molgula manhattenis* was found mostly at stations 2 and 3.

Biomass data for stations are presented in Tables 50-69 and plotted in Figures 112-147. The results of the statistical analyses are summarized in Table 29.

The results of the statistical analyses of the biomass (ash-free dry weight) distributions indicated significant differences ($P \leq .05$) between the waterways. Overall, there was 26 times more biomass in the creek than in the lagoon. Of all the species and species combinations tested, only one, *Melinna cristata*, had more biomass in the lagoon than in the creek. Three species, *Streblospio benedicti*, *Eteone heteropoda*, and *Glycera* spp., showed no significant differences in their waterway distributions of biomass. However, these three species were found in greater abundance in the creek than the lagoon during seasonal peaks. Among the crustaceans, only *Leptocheirus plumulosus* showed no waterway effect. Both *Ampelisca abdita* and *Cyathura polita* had significantly greater ($P \leq 0.05$) biomass in the creek than in the lagoon. Total molluscan biomass and *Ilyanassa obsoleta* biomass were higher in the creek than in the lagoon. Neither *Gemma gemma* nor *Mulinia lateralis* showed significant ($P \leq .05$) differences in waterway distributions. *Molgula manhattensis* also showed no waterway effect.

The statistical analyses indicated no overall seasonal effect. Biomass for total species increased from summer 1975 to winter 1976 and decreased for the remainder of the study. The most precipitous drops in biomass per square meter occurred after summer 1976 and again after fall 1976. Biomass abundance varied among the individual species and the species combinations; however, the decline in abundance after summer 1976 and fall 1976 was common to nearly all. The total polychaete biomass per square meter peaked in fall 1975 and summer 1976, then declined through winter 1977. Of the individual species, only *Heteromastus filiformis* and *Lumbrineris tenuis* had biomass distributions identical to total polychaete species. *Nereis succinea* and *Scoloplos robustus* had seasonal peaks of biomass during fall 1975 and spring 1976. *Streblospio benedicti* and *Glycera* spp. each had a single seasonal peak of biomass during summer 1976. *Eteone heteropoda* had a single peak of biomass in spring 1976. Seasonal biomass peaks for *Hypaniola grayi* and *Melinna cristata* were not apparent. Total crustacean biomass was highest during the fall 1975 and summer 1976. Unlike total polychaete biomass, which had the greatest biomass in summer 1976 and a lesser peak in fall 1975, total crustacean biomass was greatest in fall 1975 and the summer 1976 peak was less. Among the crustaceans *Ampelisca abdita* and *Cyathura polita*, seasonal peaks occurred during fall 1975 and summer 1976. *Ampelisca abdita* was found in maximal biomass during the summer 1976, and *Cyathura polita* was found in maximal biomass during fall 1975. *Leptocheirus plumulosus* did not have any seaonal peak in biomass. Total molluscan biomass was greatest during winter 1976. *Ilyanassa obsoleta* was found in greatest abundance during winter 1976 and again during summer 1976. Biomass of *Gemma gemma* was highest during summer 1975 and declined throughout the remainder of the collections.

Season by waterway interactions were detected in *Streblospio benedicti*, *Heteromastus filiformis*, *Glycera* spp., *Mulinia lateralis*, and *Molgula manhattensis*. Three of these species, *Glycera* spp., *Mulinia lateralis*, and *Streblospio benedicti*, had no significant seasonal or waterway effects ($P \leq 0.05$) for either numbers of individuals or biomass. All three had a single peak of biomass during summer 1976 which was restricted to the creek stations. *Heteromastus filiformis* had two peak seasons of biomass, fall 1975 and summer 1976, which were also restricted to the creek. *Molgula manhattensis* had a single peak of biomass during spring 1976 which was restricted to the lagoon.

The station distribution patterns of all species combinations and individual species biomass were similar to the station distribution patterns for numbers of individuals. *Melinna cristata* was the only species which did not display significant differences ($P \leqq 0.05$) in its station distributions. In the creek, total species biomass was distributed in an identical manner to numbers of individuals. The highest biomass was found at station 1 and elsewhere it decreased in the order: stations 3, 5, 2, and 4. Total polychaete biomass was greatest at station 5 and decreased at the other stations in the order: stations 2, 1, 3, and 4. The distribution of biomass for *Nereis succinea* and *Hypaniola grayi* parallel their numerical distributions with the greatest biomass present at station 5. *Lumbrineris tenuis* biomass, likewise, is most abundant at station 3. *Glycera* spp. and *Heteromastus filiformis* which both displayed stepwise decreases in numbers of individuals starting at station 1 have modified stepwise decreases in biomass. In the case of *Glycera* spp., the highest biomass was at station 2. Stations 1, 3, and 4 had equal biomass values and station 5 the lowest biomass. *Heteromastus filiformis* biomass was greatest at station 3. The patterns of biomass distribution for *Streblospio benedicti*, *Eteone heteropoda*, *Scoloplos robustus*, and *Melinna cristata* were considerably different from their distributions of numbers of individuals. Numbers of individuals of *Streblospio benedicti* decreased progressively at stations 1, 3, 5, 4, and 2. Biomass decreased progressively at stations 5, 1, 4, 3, and 2. *Eteone heteropoda* numbers of individuals were maximal at stations 3 and 5, but biomass was maximal only at station 3. *Scoloplos robustus* had greatest numbers of individuals at stations 2 and 3, but greatest biomass only at station 3. *Melinna cristata* displayed no significant ($P \leqq 0.05$) station effect. The highest biomass for this species was observed at station 2. The biomass distributions for total crustaceans, *Ampelisca abdita*, and *Cyathura polita* were identical to their distribution of numbers of individuals. *Leptocheirus plumulosus* biomass was considerable only at stations 1 and 3. Total molluscan biomass and *Ilyanassa obsoleta* biomass were distributed in patterns identical to their numbers of individuals.

In the lagooned waterways, the biomass distributions followed the overall pattern of distribution of individuals, but in a modified form. Total species numbers were highest at station 3. Next highest numbers of individuals were found at stations 2 and 1, respectively. Total species biomass was greatest at station 2 and next highest at stations 3 and 1, respectively. Total polychaete biomass followed the same pattern of distribution as total species biomass. Among the individual species of polychaetes, *Heteromastus filiformis*, *Lumbrineris tenuis*, *Scoloplos robustus*, *Melinna cristata*, and *Eteone heteropoda* had biomass distribution patterns identical to their numerical distributions. *Nereis succinea*, which had greater numbers of individuals at station 3 than at 2, had nearly equal biomass at both stations. *Glycera* spp. was found in roughly equal numbers at stations 2 and 3, and peak biomass was at station 2. *Hypaniola grayi* was essentially absent from the lagoon stations. Total crustacean species biomass was greater at station 2 than 3, although numbers of individuals were greater at station 3 than 2. This shift is also present in the biomass distribution of *Ampelisca abdita*. Highest numbers of *Ampelisca abdita* were found at stations 1, 3, and 2 (in that order) and biomass was found to be highest at stations 3, 2, 1 (in that order). Numbers of individuals of *Leptocheirus plumulosus* were greater at station 2 than 3; however, biomass was roughly equal at these two stations. The pattern of biomass distribution for total molluscan species and the individual mollusc species were identical to their distributions of numbers of individuals. The tunicate *Molgula manhattensis* also had identical patterns of numbers of individuals and biomass distributions.

Distributions of Species Not Statistically Analyzed

In the following section, the distributions of those species not handled statistically will be examined. All data can be found in APPENDIX C: Tables 10-42.

The polychaete *Glycinde solitaria* was found during the first phase of sampling in nearly equal numbers in each of the waterway types. This species constituted 1.5, 0.7, and 0.5% of the respective lagoon, partially disturbed waterway, and creek populations. During the second phase, it accounted for 0.2% of the creek animals and 0.7% of the lagoon animals. In 1973-1975, *G. solitaria* was most abundant in the spring and summer collections. During 1975-1977, it was most abundant during the fall seasons. In both phases, this species was collected primarily at mid to mouth stations.

The polychaete *Polydora ligni* formed a greater part of the lagoon populations than either creek or partially disturbed waterway populations throughout the study. Most abundant during the spring 1974, *Polydora ligni* displayed no other seasonal peaks of abundance. Within the waterways, it occurred mostly at mid to mouth stations. Polychaetes in the family Terebellidae were the most common in the lagoons during both the phases of the study. There were no distinguishable seasonal peaks and most animals were collected from mid and mouth stations. During the second phase, the Terebellidae were especially abundant at station 2 in Lagoon System B.

The amphipod *Corophium insidiosum* was observed during 1973 - 1975 almost entirely in the creeks and partially disturbed waterways. Between these two waterway types, *C. insidiosum* was most abundant in the creeks. During the second phase of sampling, it occurred in the greatest numbers at the creek stations. Seasonally, *C. insidiosum* had one peak of numbers of individuals during the spring 1974. Within the waterways, it was recorded in the greatest numbers at mouth stations.

The amphipod *Gammarus palustris* was collected in the highest numbers from the creeks and partially disturbed waterways during 1973 - 1975 and from Meyers Creek during 1975 - 1977. There were no detectable seasonal peaks. Within the waterways, *G. palustris* was found primarily at upper stations. In particular, the upper stations of Dinner Point Creek and Cedar Run had the largest populations of this species. During the second phase, *G. palustris* was observed only at the outer stations of Meyers Creek.

The amphipod *Lysianopsis alba* was collected throughout the study area in low numbers. During 1975 - 1977, it was abundant at stations 2 and 3 of the Lagoon System B. There were no seasonal peaks of abundance.

The amphipod *Cymadusa compta* had a limited distribution. During 1973 - 1975, it was found only at Dinner Point Creek upper station and not at all during the second phase.

The isopod *Edotea triloba* was observed in all waterways during the first phase, but was most common in the upper stations of the creeks and Cedar Run.

During the second phase, *E. triloba* was found primarily at the first three stations of Meyers Creek. This species displayed two seasonal peaks of abundance. One peak was during spring 1974 and the second was during summer 1974.

The blue crab, *Callinectes sapidus*, did not appear to show a difference in its distribution among the waterway types. It was found at mid and mouth stations.

The sand shrimp, *Crangon septemspinosa*, also showed no preference among the waterway types. It was collected in the highest numbers at mid and mouth stations.

The mysid shrimp, *Neomysis americana*, was collected during 1973 - 1975 mostly at mid stations of Cedar Run and Lagoon System B. The site of highest abundance was the reference station. During 1975 - 1977, *N. americana* was most abundant at creek stations 1 and 2 and lagoon station 3. There were three seasonal peaks. The first was during winter 1974, the second was during the fall 1976, and the third was in winter 1977.

Among the molluscs were the species *Tellina agilis* and *Retusa canaliculata*. *Tellina agilis* was most numerous during the first phase in the partially disturbed waterways and the reference station. Within the waterways, it occurred at mid and mouth stations. During the second phase, this species was not collected. *Retusa canaliculata* was most common at the reference station, the mid stations of Meyers Creek and Lagoon System B, and the mouth stations of Dinner Point Creek and Cedar Run. During the second phase, it was most common at lagoon stations 1, 2, and 3.

Species Richness

The total numbers of species collected during the first phase are reported in Table 70. The spring 1974 quantitative samples were based on a four ponar sample. All other samplings utilized a five ponar sample size. Since the number of species collected is dependent upon the sample size, the spring 1974 samples slightly underestimate the total numbers of species.

The highest number of species collected in the spring of 1974 was at Cedar Run (47 spp.). Mill Creek, Dinner Point Creek, and Meyers Creek all had between 30 and 31 species while the lagoons had between 16 and 20 species. The highest number of species during the summer of 1974 was observed at Dinner Point Creek (32 spp.). Cedar Run and the reference station had 29 and 28 species, respectively. Mill Creek and Meyers Creek had 21 - 23 species and the lagoon systems had 12 - 19 species. Considering the lower number of species collected by a four ponar sample, it would appear there was a decrease in the total numbers of species between spring and summer 1974. From summer to fall 1974, the numbers of species increased in all waterways except Cedar Run and Lagoon System B. Dinner Point Creek and Mill Creek had the highest numbers of species followed by Meyers Creek and Lagoon System A. During the winter 1975, the numbers of species increased in Meyers Creek, Cedar Run, and Lagoon System B. Species numbers declined in all other waterways. While there was a trend of decreasing numbers of species between spring and summer 1974 and a trend of increasing numbers of species from summer to fall 1974, there was no apparent trend between fall and winter. The creeks and partially disturbed waterways had the greatest numbers of species during the first phase (Table 70). Table 71 lists the net changes in species numbers and the average absolute changes in species numbers for the first phase. The net

changes in species indicated an increase in the numbers of species in both creeks and lagoons and a decrease in species in the partially disturbed waterways. The average absolute changes in species numbers showed species changes in the creeks were the least of any of the waterways. The natural creeks averaged a change of seven species per season while partially disturbed waterways averaged a change of 11 species and lagooned waterways nine species.

On a station basis, lagoons were the only waterways with the same distribution of species from one season to the next. In Lagoon System A, the highest numbers of species were always found at the mouth station and the least number of species at the upper station. In Lagoon System B, the highest numbers of species were collected at the mid station and the least number of species at the upper station. In Dinner Point Creek, the greatest number of species were collected at the upper station during spring 1974, but afterwards the greatest number of species were found at the mouth station, and the upper station had the least number of species. In the Meyers Creek system, the mid station had the greatest number of species, and the upper station had the least species between spring and fall 1974. During the winter 1975, the greatest number of species was found at the mouth station. The upper station still had the fewest species. In Cedar Run, the greatest number of species was collected at the mouth station during spring and fall 1974 and at the mid station during summer 1974 and winter 1975. The fewest species were generally found at the upper station. In Mill Creek, the highest numbers of species were collected at the mid station during spring and summer 1974 and at the mouth station during fall 1974 and winter 1975. The upper station always had the lowest number of species. Throughout this data, there was a pattern of lower species numbers at the upper stations. Of the 24 collections during the first phase of the study, there were only three instances where the upper stations had greater numbers of species than the mid or mouth stations.

The total numbers of species collected during the second phase are listed in Table 72. The same pattern of seasonal abundance was found in both Meyers Creek and Lagoon System B. Species numbers increased from summer to fall 1975 and then decreased between fall and spring 1976. Species numbers increased between spring and summer 1976 and decreased between summer 1976 and winter 1977. While the total numbers of species collected from the two waterways and the seasonal pattern of changes are similar, the degree of changes are not. In Table 71, the net and average absolute changes in species numbers are listed. Meyers Creek averaged a change of 6.3 species per season while the Lagoon System B averaged a change of 8.8 species per season. These values are identical to those found in the first phase.

The distribution of the species among the station varied with the waterway examined. Meyers Creek had a pattern of decreasing numbers of species starting at the mouth (Station 1) and extending to the uppermost station (station 5). In Lagoon System B, the highest numbers of species were found at stations 2 and 3. The fewest species were found at stations 4 and 5. In both waterways, there was the same pattern of fewer species at the upper stations as was found during the first phase.

Species Persistence

The species persistence data for 1973 - 1975 are listed in Table 73. The highest degree of species persistence was found in the creeks. An average of 26% of the total species were present during four of the six samplings. The partially disturbed waterways had a species persistence of 17% and the lagoons had a value of 11%. The reference station had 17% of its species occurring in four of the seasons. The stations of highest species persistence within the waterways varied with the waterway. In Dinner Point Creek, the highest persistence was found at the mouth station (29% species persistence). In Meyers Creek, the upper station had the highest persistence. In Cedar Run, Mill Creek, and Lagoon System B, the mid stations were the sites of highest persistence. In Lagoon System A, the mouth station had the highest value.

The species persistence data for the 1975 - 1977 samplings are listed in Table 74. Species persistence values for four of the seven seasons were identical at 51% for both waterways. For five of the seven seasons, Meyers Creek had 41% of the total species persisting and Lagoon System B had only 33% persistence. For six of the seven seasons, Meyers Creek had a value of 32% and Lagoon System B had a value of 23%. For all seven seasons, Meyers Creek had a value of 20% and the lagoons 11%. Among the stations within the waterways, the mouth station of the Meyers Creek and stations 2 and 3 of the Lagoon System B each had the highest value for their respective waterway. In the creek, the pattern of persistence values indicated a trend of lower persistence of species at stations 2 and 4. In the lagoons, persistence values were lowest at stations 4 and 5.

Diversity Indices

Three indices of diversity were calculated for the data: Shannon - Weaver's H', Pielou's J, and Simpson's D. Each index measures the distribution of individuals among the species in a sample. Recorded in Table 75 are the index values for waterways sampled from spring 1974 to winter 1975 and in Table 76 the index values for individual stations sampled during this period.

During spring 1974, the highest H' values were at Dinner Point Creek and Cedar Run. The lagoon systems had slightly lower values and Meyers Creek and Mill Creek the lowest values. The eveness index (Pielou's J) followed the same pattern except the Dinner Point Creek values were closer to the lagoon values than to Cedar Run. The Simpson's D index which is less affected by numerical dominance indicated the highest diversity to be in Meyers Creek and Cedar Run. During the summer 1974, all indices indicated the highest diversity was in the natural creeks. The values for the partially disturbed waterways were less and the lagooned waterway values were the least. During fall 1974 and winter 1975, a single pattern was present. The highest diversity values were in Dinner Point Creek and Cedar Run. Next in order of diversity were Lagoon System B, Meyers Creek, and Mill Creek. Lagoon System A was the fourth most diverse during winter 1975 and last during fall 1974.

Station patterns of diversity were the same for Dinner Point Creek, Mill Creek, and the lagoons. The diversity at the mouth stations was the highest and at the upper stations was the lowest. In Cedar Run, this pattern was reversed with the mouth station having the lowest diversity and the upper station having

the highest diversity. In Meyers Creek, the mid station had the highest diversity values and the upper station had the lowest values.

Seasonally, the indices increased between summer 1974 and fall 1974 only in Dinner Point Creek. All other waterways experienced a decrease or no change in values. Between fall 1974 and winter 1975, diversity values for Lagoon System A and Cedar Run increased, decreased in Mill Creek, and remained constant elsewhere. The increase in diversity values between summer 1974 and fall 1974 occurred primarily at the mouth and mid stations. While there was little overall changes in values between fall and winter, there was a general decrease in diversity and eveness values at each station. The increase in diversity values in Cedar Run and Lagoon System A between fall and winter were centered at the mid station of Cedar Run and the mid and mouth stations of Lagoon System A. In Meyers Creek, the values decreased at the mid and mouth stations between summer and fall and increased slightly between fall and winter. In Mill Creek, the mid and mouth station values decreased from summer to fall while the upper station increased slightly. From fall to winter, the same pattern of change in values was found. In Lagoon System B, the mouth station diversity values varied little between seasons. The mid station values increased between summer and fall but decreased between fall and winter. At the upper station, the values decreased between summer and fall and increased between fall and winter. Reference station values increased slightly between summer and fall and greatly between fall and winter.

In Table 77, the diversity index values for the 1975 - 1977 data are listed. In Meyers Creek, the diversity values decreased from summer 1975 to fall 1975, increased through winter and spring 1976, and decreased between spring and summer 1976. After summer 1976, the Meyers Creek values changed very little. In the lagoons, there was an increase in diversity values between summer and fall 1975. Otherwise, the Lagoon System B values exhibited the same pattern of seasonal change as the Meyers Creek values. While the pattern of changing diversity values is similar between the waterways, the degree of change is not. In Figure 148, the values are plotted. The lagoon values varied less than the creek values. In Table 78 and Figure 149, the values for station diversity are reported. In the creek, the values increased in a stepwise manner from the mouth (station 1) to the upper station (station 5). In the lagoons, the values are highest at stations in the center of the waterway (stations 2 - 4). The lagoon diversity values were generally higher than the comparable values in the creek. On the station to station basis, there also appears to be a different pattern of response between the waterways. In the creek, station 1 has a peak of diversity during spring 1976 while at stations 2 - 4, this peak is present in both winter and spring 1976. The upper station (station 5) had no spring 1976 peak but did have peaks in summer 1976 and winter 1977. Even among the stations with the winter - spring peak, there were station to station variations. Station 2 was the only station to display a fall 1976 peak in diversity values. Much the same was true in the lagoons. Station 1 had peaks in winter - spring 1976 and again in fall 1976. At station 2, the values reached a plateau at fall 1975 and remained constant until winter 1977. In station 3, there were peaks in spring 1976 and winter 1977. At stations 4 and 5, there was a peak of diversity values in fall 1975, a decline through fall 1976, and an increase in winter 1977.

Dominance Indices

Two measures of numerical dominance, the McNaughton Index and the Berger - Parker Index, have been calculated for the data. The values of these indices are listed in Tables 79 and 80 for the 1974 - 1975 data and in Table 81 for the 1975 - 1977 data.

During the spring 1974, there was a low level of both single and double species dominance in all waterways. The highest single species dominance value was 46% and the highest double species dominance was 84%. Other single and double species values ranged between 18 to 38% and 23 to 68%, respectively. The predominate species were *Streblospio benedicti* and *Ampelisca abdita*. During the summer 1974 there was a general increase in both single and double species dominance values. This increase was due to *Hypaniola grayi* and *Ampelisca abdita*. During the fall 1974 and winter 1975, there was another general increase in dominance values. The single species dominant in most of the waterways was *Ampelisca abdita*.

In Dinner Point Creek, the mouth station was dominated by *Ampelisca abdita* and *Ilyanassa obsoleta*. The mid station was dominated by *Hypaniola grayi* and *Nereis succinea*. The upper station was dominated by *Hypaniola grayi*. In Meyers Creek, the mouth station was dominated by *Heteromastus filiformis* during spring and summer 1974 and by *Ampelisca abdita* during fall and winter. At the mid station, the same pattern of seasonal domination was present except the spring - summer dominant was *Streblospio benedicti*. The Meyers Creek upper station was dominated by *Streblospio benedicti* during spring and summer and by *Nereis succinea* during the fall and winter. The Cedar Run mouth and mid stations were dominated by *Ampelisca abdita*. The upper station was dominated by *Leptocheirus plumulosus* and *Nereis succinea*. Mill Creek was dominated at all stations by *Ampelisca abdita*, but less at the upper station than either the mid or mouth stations. In general, the upper stations of Mill Creek and the lagoons have high one and two species dominance values due to the paucity of species at these stations. The dominant species were *Ampelisca abdita* and *Streblospio benedicti*. At the reference station, *Mulinia lateralis* and *Retusa canaliculata* were the dominants during spring 1974. The summer and fall dominant was *Ampelisca abdita* and the winter dominant was *Glycera americana*.

In Table 81, the dominance indices for 1975 - 1977 are listed. *Ampelisca abdita* was the overall dominant in both waterways. It averaged 74% of the animals in Meyers Creek and 49% of the animals in Lagoon System B. Among the stations in the creek, station 5 was the only one where *A. abdita* was not dominant. It was replaced by *Nereis succinea*. In the lagoon, high dominance values are found at stations 2 - 5. At stations 2 and 3, *A. abdita* and *Streblospio benedicti* dominated. Stations 4 and 5 generally had only one to four species and few individuals. The result was high dominance values at times and virtually no values at other times. Seasonally, the influx of large numbers of *S. benedicti* was seen during the summer and fall 1976. Also, an increase in *Neomysis americana* during winter 1977 was reflected in the values for both Meyers Creek and Lagoon System B mouth stations.

Similarity Indices 1974 - 1975

Sorrenson's K, a measure of similarity of species composition between two samples, was calculated for several sample combinations. In Table 82, the K values are listed for comparison of waterways sampled during 1974 - 1975.

During the spring 1974, each waterway was most like the other waterway in its waterway type classification. That is, Dinner Point Creek was most like Meyers Creek, Cedar Run was most like Mill Creek, and Lagoon System A was most like Lagoon System B. Cedar Run was very similar to Dinner Point Creek and Meyers Creek as was Mill Creek. In general, the partially disturbed waterways had a species composition closer to the creeks than the lagoons. The reference station was relatively unlike any of the waterways. Comparison of the species lists of the waterways previously showed the species found in the waterways were generally the same, but were present in different amounts. The reference station had large numbers of mollusc and isopod species not found in the waterways. In the succeeding seasons (summer 1974 - winter 1975), the same pattern of waterway similarities was found.

In Tables 83-86, the K values for sample combinations of the second phase of sampling are presented. Table 87 lists the data on comparison of seasonal samples. A seasonal sample consisted of all species collected during a given season irregardless of waterway. The highest degree of similarity was between the first four seasons of the second phase. There was a greater similarity between consecutive seasons than between the same seasons of different years. In Table 84, the seasonal comparisons between waterways are listed. Each sample consisted of the total species collected in a waterway during a given season. In the lagoons, there was a low degree of similarity between summer 1975 and the remaining seasons. The greatest similarity was between seasons, beginning with fall 1975 and ending with summer 1976. This pattern suggested a change in speciation between summer 1975, fall 1975 to summer 1976, and fall 1976 to winter 1977. The change between summer 1975 and fall 1975 to summer 1976 represented the reestablishment of populations or species lost between winter 1975 and summer 1976. The change between summer 1976 and fall 1975 to winter 1977 represented the loss of many of these same species. In other words, no "new" species were gained or "old" species permanently lost. In the creek, no pattern was detected. The greatest similarity values were between successive seasons.

In Table 85, the data on station comparisons are listed. Each sample consisted of the complete species list for a given station during the second phase. In Lagoon System B, there were three sets of similar stations. Station 1 was most like the first three creek stations and lagoon stations 2 and 3. Lagoon stations 2 and 3 were most like one another. Stations 4 and 5 were similar to each other. In Meyers Creek, station 1 was more similar to station 3 than any other station; stations 2 and 3 were alike one another. Station 3 was in turn similar to station 4 and station 4 was similar to station 5. The pattern of station similarity in the creek was of gradually decreasing similarity between stations further apart. The mouth station was more like the mid stations than the upper stations. The upper stations were more like the mid stations than the mouth station. This same pattern existed in the lagoons, but the changes in similarity were less gradual.

In Table 86, the data on station by season comparisons are listed. Each sample consisted of the species list for a given station during a given season. In

Lagoon System B, station 1 showed no seasonal pattern of similarity. Only two comparisons had a K value of 50% or greater. Winter 1976 and winter 1977 had the greatest value (67%) and winter 1976 and summer 1976 had the second greatest value (57%). As shown by the persistence data, a third or less of the species collected at lagoon station 1 remained for four or more of the seven seasons. At station 2, the highest degree of similarity was between consecutive seasons. In particular, comparisons of winter 1976, spring 1976, and summer 1976 resulted in the highest K values. At station 3, the highest degree of similarity was between fall 1975, winter 1976, and spring 1976. Stations 4 and 5 had the most variable K values. These stations had few species and often had virtually no species. In Meyers Creek, station 1 had a pattern of greatest similarity between consecutive seasons. Fall 1975, winter 1976, and spring 1976 had high degrees of similarity. The highest values were for the fall 1975 and fall 1976 comparison. At stations 2 and 3, there was a high degree of similarity between nearly all the seasons. The exception was winter 1977. This season was unlike all previous seasons. This season was the period of the least numbers of species and individuals. Station 4 had a pattern of greatest similarity between consecutive seasons. This pattern does not hold for all comparisons, most notably those comparisons involving winter collections of either 1976 or 1977. These two seasons were periods of low species numbers. At station 5, the pattern of similarity between consecutive seasons was apparent for all seasonal comparisons except those involving fall 1976. This season was the period of lowest numbers of species during the second sampling phase.

If all K values for station by season comparisons are considered, these values exhibit the same pattern as the persistence values. Of the 105 comparisons made using the lagoon system data, only 32 had a value of 50% or greater. In the creek, 86 of the 105 values were 50% or greater. The overall species composition of the lagoon and the creek were nearly identical, but the lagoon systems were gaining and losing species at a more rapid rate from one season to the next. These gains and losses involved the same species, so there was no permanent change in species composition. Species merely disappeared and reappeared in the lagoon collections more rapidly than in the creek collections.

Individual Species Data

Ampelisca abdita -- In Figure 150, the size frequency histograms for *Ampelisca abdita* collected between spring 1974 and winter 1977 are presented. In Table 87, the results of the probability paper analyses for these collections are listed, and in Table 88 the population structure of the collections are reported.

The first collection of *Ampelisca abdita* (11 April 1974) consisted mostly of large individuals (5 mm or greater). The probability paper analyses showed the presence of three separate populations. The smallest sized population had a mean length of 2 mm and constituted 2% of the collection. The next largest population had a mean length of 4 mm and made up 19% of the collection. The largest sized individuals had a mean length of nearly 6 mm and made up 79% of the collection. In the next sampling, only a single population of individuals with a mean length of 3.5 mm was present. This population was still present in the 31 October 1974 sampling and had increased in mean length to 3.7 mm. By January 1975, the single

population had divided to form two populations. The mean lengths of the populations were 2.5 and 4.1 mm and constituted 43% and 57% of the collection, respectively. In the July 1975 collections, two populations were present, but the mean lengths were 2.6 and 3.9 mm. The larger sized individuals made up the bulk (88%) of the collection. Likewise, in the 27 September 1975 sampling, two populations with mean lengths of 2.1 and 3.4 mm were found. Most of the collection (56%) consisted of the smaller sized population. The 21 October 1975 collection consisted of a single population with a mean length of 3.1 mm. This population remained the only population present and increased in length to 3.7 mm in the 20 April 1976 sampling. In the next collection (25 May 1976), three populations with mean lengths of 1.9, 3.3, and 4.1 mm were found. The bulk of the animals were found in the smallest size class (73%). By 16 June 1976, 70% of the individuals were found to have a mean length of 3.7 mm. Of the collection, 5% had a mean length of 5 mm and an additional 25% had a mean length of 2.4 mm. In the 14 July 1976 collections, all of the largest sized individuals had disappeared. By 25 August 1976, four populations were detected, 63% of which were less than 3 mm mean length. A population of large individuals (6.3 mm mean length) had appeared. This size class was gone by the September 1976 collection. In this collection, 40% of the individuals had a mean length of 0.5 mm. The next collection (18 November 1976) had two populations. Of this sampling, 85% had a mean length of 3.9 mm. The March 1977 collections had three populations with mean lengths of 2.1, 4.4, and 5.5 mm. The mid sized individuals made up 77% of the collection. In the April 1977 sampling, only two populations with mean lengths of 4 and 5.6 mm were present.

The population structure data (Table 88) showed ovigerous females were present only from April to October. The greatest numbers of ovigerous females were found during June and September. These months were the same periods when the maximal numbers of juveniles and mature males were found. Decreases in large sized individuals (and concurrent increases in small sized individuals) occurred after the times of highest numbers of ovigerous females. These patterns indicated once the adults bred they died (postbreeding mortality). The two maxima for numbers of ovigerous females indicated the presence of two breeding year classes.

Leptocheirus plumulosus -- The size frequency histograms for *Leptocheirus plumulosus* are presented in Figure 151. The results of the probability paper analyses are reported in Table 89 and the population structure data are reported in Table 90.

In most cases, the collections of *L. plumulosus* consisted of a single population. The 24 July 1976 collection was the only one with more than one population present. The initial sampling (11 April 1974) was comprised mostly of large individuals (average length 6.6 mm). The majority of the large individuals disappeared by July 1974. The mean length of the July collection was 4.4 mm. This mean length increased to 5.7 mm in October 1974 and 6.2 mm in January 1975. As mentioned previously, there were two populations present in July 1975. One population (84%) had a mean length of 3.8 mm and the second had a mean length of 5.7 mm. By 21 October 1975, both populations had disappeared and were replaced by a single population with an average length of 3 mm. This population remained in the samplings and increased in length up to the April 1976 collections. In this collection, the mean length was 5 mm. This population by July 1976 was replaced by a population with an average length of 3.3 mm. This population was

still present in March 1977 and had increased in length to 4.1 mm. The population structure data indicated ovigerous females were present from April to October. During 1974, the greatest numbers of ovigerous females were found in April. During 1975, nearly equal amounts of ovigerous females were found in July and October while during 1976 ovigerous females were present primarily during April. Adult males were most abundant during or prior to maximum numbers of ovigerous females. The February 1976 collections were composed exclusively of mature males. Juveniles were found only in the March 1977 samples.

The loss of large sized individuals after breeding periods indicated post-breeding mortality. The absence of juveniles from most of the collections was not readily explainable. Two possible explainations are either the juveniles move out of the breeding area after release or that they grow rapidly enough to enter the general population before they can be detected as a separate population.

Cyathura polita -- The size frequency histograms for *Cyathura polita* are presented in Figure 152. The results of the probability paper analyses are listed in Table 91 and the population structure data are listed in Table 92.

From the probability paper analyses and histograms, the following population changes were detected. During April 1974, three populations were present. The smallest sized individuals had an average length of 6 mm and made up 11% of the collection. Most of the collection (76%) was comprised by individuals with a mean length of 11.5 mm. The largest sized animals (16 mm) made up the remaining 13%. By July 1974, only two populations were observed. The smallest sized individuals (7 mm) made up 70% of the animals while the largest individuals (16 mm) made up 30%. In October 1974, all individuals had an average length of 14 mm. By January 1975, three populations were present once more. The smallest sized individuals (5 mm) made up 37% of the animals while 11.5 and 16 mm individuals made up 23 and 40%, respectively. In July 1975, only a single population with a mean length of 12 mm was found. This population remained the only population present through April 1976 and increased in length to 17 mm. The final collection (July 1976) was structured like the July 1974 collection. Most of the animals belonged to a small sized population (6.5 mm).

The population structure data (Table 111) showed ovigerious females were found in April to July samples and juveniles primarily in July samples. Males were most abundant in October to April samples.

Nereis succinea -- The size frequency histograms for *Nereis succinea* are reported in Figure 153 and the results of the probability paper analyses are listed in Table 93.

The collections of *N. succinea* were generally composed of two or three populations. During July 1974, the collections contained two populations with mean lengths of 11 and 33 mm. By October 1974, there was an increase in mean length of one population to 17 mm and a decrease to 31 mm in the other. In January 1975, there was a loss of large individuals resulting in two populations with mean lengths of 9 and 23 mm. There was a further loss of large individuals reducing the mean lengths to 9 and 19 mm by July 1975. These lengths increased to 10 and

30 mm by October 1975. In February 1976, there was still a small sized population (9 mm), but the larger sized individuals had divided into two populations with average lengths of 25 and 41 mm. By April, all three populations had increased in length. In July 1976, the smallest size class (7 mm) increased in abundance and the larger size classes increased in mean length to 38 and 67 mm. In September 1976, the smallest sized individuals (6 mm) made up 80% of the collection. Individuals larger than 40 mm disappeared from the collections. By March 1977, the same three populations were present, but the numbers of animals were more evenly divided between the two smallest sized populations of animals.

Streblospio benedicti -- The size frequency histograms for *Streblospio benedicti* are reported in Figure 154 and the results of the probability paper analyses are listed in Table 94.

In the initial collection (11 April 1974), there were two populations with mean lengths of 9.2 and 14.5 mm. By July 1974, both populations had disappeared and had been replaced by a single population with an average length of 5.2 mm. This population increased in average length to 9.8 mm by October 1974. In January 1975, there were two populations once more. One population had a mean length of 9.8 mm and the other had a mean length of 18.2 mm. By July 1975, only a single population averaging 4.4 mm in length remained. This population increased in length to 4.8 mm by October 1975 and then decreased in length to 4.3 mm by February 1976. In April 1976, there were three populations with lengths of 4.5, 8.0, and 12 mm. By July 1976, the largest size class was gone and the remaining classes averaged 7 and 10.8 mm in length. In September 1976, the lengths had increased to 7.7 and 11.2 mm. The final sample (March 1977) had a single population with an average length of 8 mm.

Hypaniola grayi -- The size frequency histograms for *Hypaniola grayi* are reported in Figure 155 and the probability paper analyses are listed in Table 95.

During 1974 and 1975, there were three populations present. In April 1974, these populations had average lengths of 4.6, 7.5, and 12.8 mm. Most of the animals (86%) were found in the mid sized class. By July 1974, the two largest sized classes had disappeared and been replaced by two classes with lengths of 3 and 4 mm. The original small class increased in length to 6 mm. The mean length of the populations increased to 3.7, 7.1, and 10.8 mm by October 1974 and to 5.5, 9.1, and 12.5 mm by January 1975. In July 1975, there was only a single class with a mean length of 3.9 mm. The length of this class increased to 4.5 mm by October 1975 and to 6.5 mm by February 1976. No new classes were added during this time.

Heteromastus filiformis -- The size frequency histograms for *Heteromastus filiformis* are reported in Figure 156 and the probability paper analyses are listed in Table 96.

In July 1975, there was a single population with a mean prostomium width of 0.7 mm. By October 1975, there were two populations with mean widths of 0.98

and 1.04 mm constituting 69% and 31% of the collection, respectively. In February 1976, there were two new populations with mean widths of 0.70 and 0.86 mm making up a total of 21% of the collection. The remaining parts of the collection was made up of two populations with mean widths of 1.09 and 1.27 mm. By April 1976, the smaller populations had combined to form a single population with a mean prostomium width of 0.96 mm, the two larger sized populations had combined to form a single population with a mean width of 1.30 mm, and a new population with a mean width of 0.29 mm had been added. By July 1976, the largest sized individuals had disappeared and been replaced by populations with mean widths of 0.41 and 0.67 mm. The final collection had three populations with mean widths of 0.18, 0.65, and 1.11 mm.

Lumbrineris tenuis -- The size frequency histograms for *Lumbrineris tenuis* are reported in Figure 157 and the probability paper analyses are listed in Table 97.

During October 1974, there were two populations with mean widths of 0.36 and 0.60 mm present. By January 1975, there was only a single population present with a mean prostomium width of 0.39 mm. In July 1975, there was still only a single population and the mean width had increased to 0.57 mm. In October 1975, there were two populations found. The mean prostomium widths were 0.34 and 0.60 mm and constituted 8 and 92% of the collection, respectively. These results are nearly identical to those of the previous October. In February 1976, there was once again only one population and its mean width was 0.54 mm. There was no change in the mean width of this population until after April 1976. In July 1976, there were three populations and they had mean widths of 0.23, 0.44, and 0.60 mm. The largest sized class made up 57% of the collection. By the final collection (September 1976), the smallest sized class had increased its mean width of 0.34 mm and the largest sized class had increased its width to 0.88 mm. The largest sized class had also increased its share of the collection to 64%.

Growth Data

Growth rates as a percentage of the instantaneous relative growth are reported for selected dominant benthic invertebrates in Tables 98-102. *Ampelisca abdita* winter generations had the highest rates of growth between November and December of 1975, May and June 1976, September and November 1976, and March and April 1977. The summer generation had its highest growth rate between June and mid July 1976. These patterns of growth suggested high summer temperatures and low winter temperatures limited growth. The periods of growth were highest when temperatures were intermediate to the yearly temperature extremes. The same pattern was seen in the growth rates of *Leptocheirus plumulosus*, *Nereis succinea*, *Hypaniola grayi*, and *Streblospio benedicti*. In some cases, the pattern was obscured by the long periods of time between measurements; however, the periods of time included were consistent with periods of intermediate temperatures. The growth rates of *Hypaniola grayi* also suggested there were differences in growth rates of different sized individuals. In the case of *H. grayi*, smaller individuals (less than 0.68 mg ash-free dry weight) grew most rapidly during the colder periods of the year. The higher growth rates of the larger individuals may have reflected reproductive growth, since the time periods involved corresponded to the reproductive periods of this species.

Respiration Data

In Table 103, the results of analyses of oxygen consumption rates of selected benthic invertebrates are reported. In Table 104, these values are compared with equivalent values obtained from the literature. *Ampelisca abdita* showed no great change in respiration rate between 10 and 15° at 25 °/oo but did show an increased respiratory rate at lower salinity. Both *Nereis succinea* and *Cyathura polita* had roughly the same oxygen consumption at 15 or 25 °/oo when measured at 10°C. *Ilyanassa obsoleta* displayed no great changes in oxygen consumption below 15°C at 22 - 25 °/oo, but had an increased respiratory rate at 25°C. Comparison of the oxygen consumption values between this study and values obtained from the literature were difficult due to the diversity of methods employed by various authors and the manner in which such data were reported. However, there is generally a close correlation between all values.

Production Data

In Tables 105-108, the respiration and production estimates for 1975 to 1977 are reported. In order to obtain the respiration estimates, the following equation was used:

$$R = (B)\ (Rr)\ (365\ \text{days}\cdot\text{year}^{-1})\ (4.86\ \text{kcal}\cdot 1\ O_2^{-1})\ (1\cdot \text{ml}^{-1}\cdot 10^{-3})$$

where

R = Respiration in ($\text{kcal}\cdot\text{m}^{-2}\cdot\text{year}^{-1}$)
Rr = Respiration rate in ($\text{ml}\ O_2\cdot\text{g}^{-1}\cdot\text{day}^{-1}$)
B = Biomass in (g ash-free dry weight)

In order to obtain the production estimates, the respiration estimate was multiplied by the percent efficiency of production assimilation. This factor represents the percentage of respiration that is converted to production. The total respiration for the creek was 15.6 $\text{kcal}\cdot\text{m}^{-2}\cdot\text{year}^{-1}$ and for the lagoon it was 1.8 $\text{kcal}\cdot\text{m}^{-2}\cdot\text{year}^{-1}$. These values represented production values of 2.8 and 0.3 $\text{kcal}\cdot\text{m}^{-2}\cdot\text{year}^{-1}$ for the creek and lagoons, respectively.

In Tables 105-107, the distribution of respiration and production among the dominant species and the taxonomic groups are also presented. Polychaetes accounted for 46% of the total production in Meyers Creek and 33% of the production in Lagoon System B. Crustaceans accounted for 54% of the production in Meyers Creek and 66% in Lagoon System B, and the molluscs accounted for 6% of the production in the creek and 1% in the lagoons. The dominant species contributed approximately 46% of the production in the creek and 69% in the lagoon. Within the taxonomic groups, the dominant species were responsible for 59% of the crustacean production, 22% of the polychaete production, and 67% of the molluscan production in the creek. In the lagoon, the dominant species accounted for 73% of the crustacean production, 63% of the polychaete production, and 25% of the molluscan production. In both waterways, the most important species contribution to production was provided by *Ampelisca abdita*. This species comprised 32 - 48% of total production in both waterways and was responsible for 59 - 73% of all crustacean production.

In addition to production estimates from respiration and biomass data, production was estimated by using P/B ratios and Allen Curves. The P/B ratio is

simply the ratio between the mean annual biomass for a particular species and its average annual production. Using these ratios, an estimate of production could be obtained using the ratio in conjunction with the mean annual biomass. The Allen Curve method for calculating production consists of plotting the average numbers of individuals surviving in a cohort over time versus the average weight of the individuals. The production is measured as grams per unit time by estimating the area under the curve. The estimates of production based on the P/B ratios were generally low, but the same proportions of importance as calculated from respiration were maintained. The value for production based on the Allen Curves were generally 20% higher than those based on the P/B ratios. The difference between the P/B ratio and Allen Curve estimates are probably because the Allen Curves are based on the production of a particular population while the P/B ratios are based on results from several populations. That is, the Allen Curve method estimates the production of the specific population under study while the P/B estimates the production of an average population. For the purposes of calculating the production of a specific area, the Allen Curve is a more accurate method. The limitation of the Allen Curve method is that it requires detailed information on the abundance of a species over time.

Gut Contents

The results of the qualitative examinations of the gut contents of 10 species of benthic invertebrates are listed in Table 109. This table includes the general types of material found and the maximum size of the matter found.

Each of the species injested the same sort of material; sand, detritus, diatoms, plant and algal filaments. In all cases, the sand/detritus materials formed the bulk of the gut contents. *Nereis succinea* also had a gastropod larvae in its gut contents.

In Table 110, the volumetric contribution of different size ranges of sand and detrital particles of total sand/detrital material are tabulated. These data are reported as cumulative percentages of total volume. In order to obtain a per particle volume, the formula for the volume of a spherical particle was used ($1.333\ \pi\ r^3$). The contribution of each particle size to volume was calculated by multiplying the number of particles in each size range by the particle volume. The diameter of particles at the 50% cumulative volume point was used to compare the particle distributions between the species. These values are listed in Table 111. The lowest values (25 - 32 μm) were found for *Ampelisca abdita* and *Streblospio benedicti*. The remaining species had values in 47 - 60 μm except for *Hypaniola grayi* and *Eteone heteropoda* which both had 50% cumulative percent values of 75 μm.

In Table 112, the percentage of diatoms found in the gut contents of the 10 species are listed along with the mean diameter of diatom frustules found in the gut contents. The highest percentage occurrence of diatoms was found in *Hypaniola grayi* (4.2%). *Nereis succinea* and *Ilyanassa obsoleta* had 3 - 4% occurrences of diatoms in the gut contents and the remaining species had less than 2%. The largest mean diameters of diatom frustules were found in *Scoloplos robustus* and *Hypaniola grayi* (57.5 - 37.5 μm). The remaining species injested relatively small mean frustule diameters (20 - 28 μm). In Table 113, the generic composition of the diatoms found in the benthic invertebrate gut contents are listed. In all cases, *Coscinodiscus*, *Navicula*, and *Cocconeis* accounted for 70% or more of the

diatoms present. *Amphora* constituted 3 - 10% of the diatoms in the contents of all species of invertebrates except for *Cyathura polita* and *Eteone heteropoda*. *Amphiprora* made up 3 - 11% of the diatoms in the gut contents of all species except *Cyathura polita* and *Lumbrineris tenuis*. *Melosira* was found to make up 1 - 8% of the diatoms in all species except *Eteone heteropoda*. *Biddulphia* was found to make up 1% or more of the diatoms in only *Streblospio benedicti*, *Scoloplos robustus*, *Ilyanassa obsoleta*, and *Heteromastus filiformis*. *Surirella* was found to compose greater than 1% of the diatoms in only *Nereis succinea*. The same was true for *Actinophycus*. *Gyrosigma* made up greater than 1% of the diatoms in *Streblospio benedicti*, *Scoloplos robustus*, and *Nereis succinea*. *Achanthes* made up greater than 1% of the diatoms in the guts of *Ampelisca abdita*, *Streblospio benedicti*, *Heteromastus filiformis*, and *Lumbrineris tenuis*. *Pinnularia* made up more than 1% of the diatoms in *Streblospio benedicti*, *Scoloplos robustus*, *Nereis succinea*, and *Hypaniola grayi*.

In Table 114, the feeding habit classifications of the dominant benthic invertebrate species are listed. Most species were either nonspecific deposit feeders or omnivores. Almost all of the larger forms such as the shrimp and crabs were omnivores. In Table 115, the results of the examinations of shrimp, crab, and fish gut contents are listed. The fish species all contained plant remains and crustacean remains. *Opsanus tau* and *Gobiosoma* sp. contained the remains of *Ampelisca abdita* and *Leptocheirus plumulosus* as well as the shrimp *Crangon septemspinosa*. The shrimp *Crangon septemspinosa* and *Palaemonetes vulgaris* both contained the remains of gammarid amphipods. *C. septemspinosa* also contained the remains of an unidentified polychaete. The gut contents of the crabs were too macerated to permit identification of anything other than vascular plant remains.

DISCUSSION

The distribution and abundance of benthic invertebrates are determined by the interaction of numerous physical, chemical, and biological factors. In the waterways of the Manahawkin salt marsh, the most important factors appear to be depth, flushing rate, temperature, salinity, dissolved oxygen concentrations, sediment characteristics, interspecific competition, and predation. The relative importance of the individual factors varies between waterways and waterway types. The primary source of this variation is the extent to which the individual waterways have been disturbed by the construction of waterfront housing developments.

In the upper portions of the lagoon systems and Mill Creek, the most important factor affecting the distribution and abundance of the benthic community was the concentration of dissolved oxygen. In these areas, the depth, low flushing rates, and lack of mixing facilitated formation of a thermocline in the summer. In Mill Creek, stratification was further strengthened by freshwater entering the waterway. In both cases, the exchange of oxygen between upper and lower layers was limited, and eventually oxygen was depleted in the bottom layer. While low oxygen conditions were most pronounced during the summer, portions of these areas remained anoxic for periods of time up to 9 months. Replenishment of the bottom oxygen supply was dependent upon the overturn of the water column during seasonal changes in water temperature.

While the effects of low oxygen concentrations were most severe and most obvious in the upper portions of these waterways, they were not limited to these areas. The dissolved oxygen concentrations of bottom waters in the lagoons and

deep sections of the partially disturbed waterways were generally lower than those of the creeks and shallow portions of the partially disturbed waterways. These conditions may be responsible for the lower dominance, lower persistence, and changes in the relative abundance of individual species found in the collections from the lagoons. Heck (1976) and Livingston (1975) reported the epibenthic invertebrate and fish communities in Florida estuaries exposed to low oxygen conditions or pollutants displayed decreased abundances and lower dominance values than unexposed communities. These responses can be correlated with the tolerances of individual species to low oxygen conditions and to the accompanying increased hydrogen sulfide concentrations of anaerobic sediments (Theede et al. 1969). It is not impossible to interpret the distribution of species in the lagoons purely on the basis of the low oxygen conditions because of the lack of knowledge of the tolerances of the individual species and because other factors such as temperature and sediment characteristics also affect the distributions. In fact, the sediment characteristics of the mid and outer stations appear to be largely responsible for species distributions and abundances. Sediments of the mid and outer stations of the lagoons were not uniformly distributed. For instance, at Lagoon System B station 3 (mid) replicate sediment samples showed both silty and sandy sediments side by side. The variability of the sediment at this station was reflected in its fauna. This station supported not only species common to mud bottoms, but also species, such as *Gemma gemma*, which prefer sandy sediment (Sellmer 1967). Likewise, the sand-gravel-peat sediment of Lagoon System B station 2 supported a fauna unlike that of any other station. This station had high abundances of gravel associated species, such as *Melinna cristata* (Buchanan 1963) and sand associated species, such as *Cyathura polita* (Burbanck 1962) and *Leptocheirus plumulosus* (Bousfield 1973). This station was also unique because it supported populations of the tanaid *Leptochelia savignyi* and an unidentified benthic ostracod for short periods of time.

At the upper ends of Dinner Point Creek and Cedar Run, the primary factors affecting the distribution and abundance of the species were salinity and sediment characteristics. Appreciable amounts of freshwater entering the waterways and sandy sediments were present at these locations. The reduction in the number of species was attributable to low salinity (Wells 1961) and changes in the relative abundance of individual species were attributable to low salinity and sandy sediments. The dominant species at these stations were *Hypaniola grayi*, *Cyathura polita*, *Nereis succinea*, *Leptocheirus plumulosus*, and *Gammarus palustris*.

Hypaniola grayi is a tube-building polychaete. It has been reported in oligohaline portions of the Mullica River estuary (Durand and Nadeau 1967) and the Hudson River estuary (Ristich et al. 1977).

The amphipod *Leptocheirus plumulosus* was found at sites throughout the study area, but was most abundant at the low salinity stations. Ristich et al. (1977) found *L. plumulosus* primarily in oligohaline portions of the Hudson River. Boesch et al. (1976) reported *L. plumulosus* at sandy, low salinity sites in Chesapeake Bay.

The polychaete *Nereis succinea* was also found throughout the study area, but was most abundant at the upper stations of Dinner Point Creek and Cedar Run. Tenore (1972) reported a similar distribution of *N. succinea* in the Pamlico River estuary of North Carolina.

Cyathura polita has a tolerance range of salinity from 0-28 °/oo (Frankenburg and Burbanck 1963). Ristich et al. (1977) collected *C. polita* mostly in the oligohaline and mesohaline portions of the Hudson River, and Kruczynski and Subrahmanyam (1978) reported a similar distribution of *C. polita* in Florida *Juncus* marshes.

While there was a change in the relative abundance of species at the low salinity stations, these "low salinity" species were not found exclusively at these locations, but were found throughout the study area. For instance, *Hypaniola grayi* accounted for between 28 - 76% of the total numbers of individuals at the Dinner Point Creek upper station between 5 - 49% at the mid station, and at the mouth station 0.1 - 1.3%. At the same stations, *Streblospio benedicti* accounted for between 0.1 - 0.8% (upper), 5 - 83% (mid), and 0.2 - 16% (mouth) of the total numbers of individuals. With the exception of *Ilyanassa obsoleta*, none of the species dominant at the "higher salinity" stations were excluded from the low salinity stations. The exclusion of *I. obsoleta* from the upper stations is consistant with Scheltema's observation (Scheltema 1964) that *Ilyanassa* is restricted to salinities of 15 °/oo or greater.

The abundance of the dominant species at the mid and mouth stations may or may not be related to salinity. *Streblospio benedicti* was prevalent at the mid station of Dinner Point Creek but not at the upper or mouth stations. This same pattern of distribution was found for *S. benedicti* in Meyers Creek which had no appreciable amount of freshwater entering it. The amphipod *Ampelisca abdita* was found in the greatest abundance at mouth stations, intermediate abundance at mid stations, and least abundance at upper stations in both Dinner Point Creek and Meyers Creek. Like the *S. benedicti* distribution pattern, the distribution pattern of *A. abdita* does not seem to correlate with the salinity regime of the waterway.

The factors controlling the distribution and abundance of the benthic species in Meyers Creek and the mid and mouth stations of Dinner Point Creek and Cedar Run appear to be depth and interspecific competition. Depth was of concern primarily at the shallow stations of Meyers Creek. During the thawing of ice cover during late winter, these stations were subject to scouring by ice flowing out of the creek. This effect was seen in the reduction of species at stations 2, 3, and 4 in the winter 1977 collections. Depth may also be a factor in controlling the relative abundance of species at Meyers Creek station 5. This station was periodically exposed during low tides and the benthic fauna subject to desiccation and/or freezing. The predominant species at this station was a burrowing polychaete, *Nereis succinea*, which could avoid severe conditions by burrowing deeper into the sediment. The abundance of a burrowing species at this station could also be due to interspecific interactions. Woodin (1976) has shown abundance of different life-habit types (tube-building species versus burrowing or browsing species) affects the settlement of other species. A mat of tube-builders will prevent burrowing species from settling while burrowing species destabilize sediments and prevent successful settling of tube-building species. This type of interaction may be illustrated by the fauna of the mouth and upper stations of Meyers Creek. The mouth station was dominated by tube-building species such as *Ampelisca abdita* and *Streblospio benedicti* while the upper station was dominated by burrowing species. Changes in the abundance of tube-builders at the upper station generally did not occur unless there was a change in the abundance of the burrowing species. Another type of life-habit interaction can

be seen in the relationship between the browsing activity of the snail *Ilyanassa obsoleta* and the abundance of the tube-building species. Browsing *Ilyanassa obsoleta* destroy tube-mats, and the numbers of individuals of *Ampelisca abdita*, *Streblospio benedicti*, and *Heteromastus filiformis* was reduced after *I. obsoleta* was found in high numbers. Competition for food may also control the abundance of particular species. For example, the gut content analyses for *Ampelisca abdita* and *Streblospio benedicti* suggested these species were ingesting nearly identical fractions of the sediment and its accompanying diatom flora. The observation that these species are not found in high abundance at the same station simultaneously supports the hypothesis suggested by Mills (1967) that there is competition between them. Similarly, the gut content analyses and distribution patterns of *Eteone heteropoda* and *Scoloplos robustus* suggested competition for food.

The reproductive biology of a benthic species also influences its distribution. The high degree of dominance in the salt marsh waterways led to a primary interest in the biology of the dominant species as a means of understanding the seasonal distribution and abundance of the community. In the following sections, information from this study and literature pertinant to the biology of the dominant species is summarized.

Population data for *Ampelisca abdita* indicate there are two generations produced each year. The first or summer generation is produced by overwintering adults which breed in mid April. The first ovigerous females appeared in May and reached maximum numbers by June. The summer generation matured between June and August producing the overwintering generation in late August and September. The absence of adults with a mean length greater than 5 mm after April, June, and August suggested postbreeding mortality. Growth for the summer generation was most rapid from June to July and for the overwintering generation from March to April. These population characteristics are identical to those of *A. abdita* found in New England (Mills 1967). A significant difference between the New England and New Jersey populations is the minimum length of mature females. Mills (1967) has reported a minimum length of 5.5 mm for ovigerous females, in contrast to 2 mm for our New Jersey populations. Mean length of ovigerous females in New England is 5.5 - 6.0 mm and in New Jersey is 3.5 - 4.0 mm. An adaptation to reach maturity at smaller size is not inconsistent with the temperature dependence for growth and the opportunistic nature of this species. *Ampelisca abdita* produces large numbers of young, matures rapidly, and is able to invade and colonize uninhabited areas quickly. Ovigerous females leave the mat area to release the juveniles (Mills 1967), a behavioral adaptation which increases the range of colonization. Loss of postbreeding adults decreases intraspecific competition for food and space. Similar characteristics have been reported for other amphipod species including *Ampelisca brevicornis* (Klein et al. 1975), *Gammarus palustris* (Rees 1975) and *Corophium insidiosum* (Sheader 1978).

Leptocheirus plumulosus is distributed from Cape Cod to Florida and has ovigerous females present from May to September (Bousfield 1973). Each female is capable of producing several broods. The maximum length is 10 - 17 mm. Specimens in our collections attained a maximum size of 13.5 mm and bred from April to October. The greatest numbers of ovigerous females were present in April and again in July. Maximum numbers of males occurred simultaneously with maximum numbers of ovigerous females. Data from the summers of 1975 and 1976 indicated a mean length of 3 mm for juveniles. The spring and summer 1974 data indicate postbreeding mortality occurs between summer and fall and again between winter and spring.

The life span of *Cyathura polita* has been reported to be 3 years (Burbanck 1962). Gravid females are present from May to August. Subrahmanyam (1976) found the greatest numbers of juveniles in the fall. In our collections, mature females with juveniles in the marsupia were collected in April and July samples. Juveniles (less than 12 mm) were present year round, but were most abundant in winter and spring samples. Probability paper analyses indicated postbreeding mortality in the largest adults.

Dean (1965) reported New England populations *Streblospio benedicti* spawn from May to October and each female can produce several broods. The larvae are planktonic after release and may remain in the plankton from 2 - 21 days. When a suitable substrate is found, the larvae settle and undergo metamorphosis. Maximum growth occurs between May and June. Boesch (1973) and Watling (1975) report maximum numbers of individuals in Chesapeake Bay and Rehoboth Bay, Delaware are present in fall and winter. Whitlach (1977) reports maximum numbers in Massachusetts occur in spring and summer. Our data indicated settling of new individuals between April and July and postbreeding mortality of the largest adults. Between spring and summer 1974 and again between winter and summer 1975, there was a complete loss of the largest animals. Watling (1975) also reported postbreeding mortality in Rehoboth Bay populations. Most growth takes place between February and June. Little or no growth occurs from July to February.

Nereis succinea breeds from June to September when it swarms near the surface of the water in a modified heteronerid form and releases its gametes (Pettibone 1963). Fertilization is external and the larvae may remain in the plankton for up to 4 months. Sexual maturity is reached after about a year (Grassle and Grassle 1974). In our samples, the presence of up to three populations or year classes was detected.

Our data indicated the presence of up to three populations (presumably year classes) of *Hypaniola grayi*. The greatest number of small individuals was found in summer samples. The mean length of this class was 3 mm. The absence of animals larger than 6 mm after spring and winter months suggests postbreeding mortality. The disappearance of large numbers of this species after February 1976 and the paucity of literature limit our understanding of *H. grayi's* breeding habits, growth, and seasonal fluctuations.

Heteromastus filiformis spawns between January and April (Buchanan and Warwich 1974). The greatest numbers of individuals are reported to appear from May to July in Rehoboth Bay populations (Watling 1975). After breeding and settlement of larvae, numbers of individuals remain constant. Only 2 year old worms can breed and postbreeding mortality removes the breeding year class by September (Buchanan and Warwick 1974). The data collected in this study differs from the literature in that three age classes (presumably year classes) were present and postbreeding mortality was not detected. The largest numbers of small worms were found in the spring and the loss of large worms occurred during the summer.

As with *Hypaniola grayi*, there is little literature available on the biology of *Lumbrineris tenuis*. The probability paper analyses of the specimens in our collections indicated the presence of up to three populations, but since the size ranges for these populations are very close to one another it is questionable if they represent year classes. A related species, *Lumbrineris fragilis* has been

reported to have a 3 year life span (Buchanan and Warwick 1974). The smallest individuals were present in the spring and no animals with a mean prostomium width greater than 6 mm collected after fall. Whitlach (1977) has reported maximum numbers of *L. tenuis* in Massachusetts in collections taken from May to June. In New Jersey, maximum numbers were found in fall 1975 and summer 1976.

In Massachusetts, *Ilyanassa obsoleta* breeds and deposits its egg capsules in the spring (Scheltema 1964). Larvae hatch from the capsules at water temperatures of 16 - 17°C. Larvae are pelagic until they reach a length of 1.5 - 2.0 mm when they undergo metamorphosis and settle out of the plankton (Scheltema 1964). Growth is most rapid during the summer and stops between fall and spring. Mean lengths of year classes are 5 mm for first year, 9 mm for second year, and 12 mm for third year. Growth beyond the third year is irregular and aging the snails is difficult. The total life span is approximately 5 years (Scheltema 1964).

Pettibone (1963) has reported *Scoloplos robustus* breeds from May to September, but most heavily in July. The larvae are planktonic and settle out of the plankton about 3 weeks after release.

Glycera dibranchiata breeds in April and May in the New England region (Pettibone 1963). Sexual maturity is not reached until the third year. This species produces planktonic larvae. Postbreeding mortality eliminates the breeding year class after the larvae are released.

Whitlach (1977) reports *Eteone heteropoda* populations in Massachusetts have a 3 year life span and are found in the greatest abundance in the summer. In New Jersey, the highest numbers of *E. heteropoda* were collected in late winter and early spring.

Gemma gemma is an oviparous bivalve which releases juveniles in early spring and late summer. The juveniles are relatively immobile and rely upon water currents and wave action for dispersal. The average life span is 2 years and breeding can occur at the end of the first year or during the second year. Second year adults die after the second winter. Maximum growth is during the summer months and maximum mortality is found in juveniles and second year adults. These data are reported from the work of Sellmer (1967) on New Jersey populations.

Gammarus palustris populations in the Patuxent River, Maryland breed from February to October and produces two generations per year (Rees 1975). Up to three broods may be produced per generation in New Hampshire populations (Gable and Croker 1978). Juveniles appear in March and mature by June. The overwintering generation dies off by April (postbreeding mortality). Growth is most rapid during the summer (Rees 1975).

Seasonally, the patterns of distribution of the benthic invertebrate community in all waterway types were keyed to the reproductive periods of the dominant species. The major peaks of abundance were particularly dependent on the reproductive periods of *Streblospio benedicti* and *Ampelisca abdita*. These two species accounted for 81 - 87% of all individuals during the peak seasons of fall 1974, fall 1975, winter 1975, and summer 1976. *Ampelisca abdita* alone accounted for 75 - 82% of the total numbers of individuals during these seasons. The reproductive periods for *Ampelisca abdita* are late spring and early fall and the reproductive period for *Streblospio benedicti* is May - October. There were generally no differences in the timing of seasonal peaks of abundance between the waterway types.

Another factor that may have affected the seasonal distribution and abundances of the benthic invertebrate community is predation. Festa (1975) reported fish species of the Manahawkin marsh area rely heavily on the dominant species of the benthic invertebrate community for food. Polychaetes such as *Nereis* spp. and *Polydora* spp. comprised 4 - 16% of fish gut contents by volume and the amphipods *Ampelisca abdita* and *Cymadusa compta* comprised an additional 18% of the gut volumes. *Ampelisca abdita* accounted for 68% of the total amphipods found in fish gut contents. Festa (1976) studied the feeding habits of *Pseudopleuronectes americanus* from the Manahawkin area. Fish in the 3 - 11 mm size range fed mostly on *Nereis* spp., *Maldanopsis elongata*, and capitellids, but *Ampelisca abdita* made up 14% of the diet. Fish in the 12 - 21 mm range fed primarily on *Glycera americana* and *Nereis succinea*. *Cyathura polita* made up 1% of the diet and *Ampelisca abdita* made up 6.5% of the diet. Large and medium sized flounder fed heavily on *Neomysis americana*, *Palaemonetes vulgaris*, *Crangon septemspinosa*, and xanthid crabs. Richards (1963) and Pearcy (1962) found adult and juvenile fish of the Long Island Sound area also fed on many of the same benthic invertebrate species found in the Manahawkin area.

Epibenthic invertebrates such as shrimp and crabs also ingest many of the dominant benthic invertebrate species. Odum and Heald (1972) and Nixon and Oviatt (1973) have reported that palaemonitid shrimp feed upon crustaceans, polychaetes, and molluscs. The same is true for sand shrimp (Price 1962) and blue claw crabs (Tagatz 1968).

Ctenophores may also significantly affect the abundance of benthic invertebrate species by predation. They feed primarily on copepods and detritus, but may also ingest planktonic larvae of crustaceans, polychaetes, and molluscs and may even eat adult benthic invertebrate species which swarm or swim near the surface during some portion of their life cycles (Burrell and Van Engel 1976).

SUMMARY

The total numbers of species collected are not clearly different among the waterway types. The total species lists for each of the waterway types are in fact nearly identical. The differences in speciation among the waterway types are in the degree of persistence and the rate of change of species. Species in the lagooned and partially disturbed waterways were lost and replaced at a greater rate than species in the natural creeks.

The benthic invertebrate community of the salt marsh waterways was dominated by a group of approximately 20 species. These species included *Ampelisca abdita*, *Streblospio benedicti*, *Hypaniola grayi*, *Nereis succinea*, *Leptocheirus plumulosus*, *Cyathura polita*, *Heteromastus filiformis*, *Scoloplos robustus*, *Ilyanassa obsoleta*, *Eteone heteropoda*, *Gammarus palustris*, *Glycera* spp., *Lumbrineris tenuis*, *Melinna cristata*, *Gemma gemma*, *Mulinia lateralis*, and *Retusa canaliculata*. The creeks were more heavily dominated by combinations of one or two species than either the lagoons or partially disturbed waterways.

Distributions of numbers of individuals and biomass were distinctly different between the waterway types. The creeks had 9 times more individuals and 25 times more biomass than the lagoons. Partially disturbed waterways had numbers of individuals intermediate between those of the creeks and lagoons. The range of numbers of individuals and biomass in the salt marsh waterways were similar to those reported by other authors working in similar habitats. Creek numbers varied from

400 - 6,500 animals$\cdot m^{-2}$ and biomass varied from 0.2 - 3.2 g ash-free dry weight$\cdot m^{-2}$. Sanders (1958) reported mud bottom areas of Buzzards Bay, Massachusetts had between 1,000 - 8,000 animals$\cdot m^{-2}$ and O'Connor (1972) reported mud bottom habitats of Moriches Bay, Long Island had between 1,400 - 3,000 animals$\cdot m^{-2}$ and 4 - 6 g ash-free dry weight$\cdot m^{-2}$. Lagoons of the Manahawkin area had between 80 - 340 animals$\cdot m^{-2}$ and 0.02 to 0.20 g ash-free dry weight$\cdot m^{-2}$. O'Connor (1972) reported dredged areas near Long Island, subject to anaerobic conditions, supported 400 animals$\cdot m^{-2}$ meter and 0.66 g ash-free dry weight$\cdot m^{-2}$. Holland (1977) reported mud bottom areas in Chesapeake Bay subject to anoxic conditions supported 50 - 1,000 animals$\cdot m^{-2}$ and 2.1 g ash-free dry weight$\cdot m^{-2}$.

While the distributions of numbers of individuals and biomass were different between waterway types, the patterns of distribution within the waterways were similar. The number of species, numbers of individuals, and biomass declined with distance from the bay in all waterways. In the lagoons and the upper end of Mill Creek, the decline in species and abundances were attributable to the anoxic conditions present at the upper ends of these waterways. Changes in speciation and species abundances elsewhere in the lagoons were partially affected by the sediment characteristics. In Dinner Point Creek and Cedar Run, these changes at the upper stations appear to be related to both salinity and sediment. In Meyers Creek and portions of other waterways not affected by salinity, sediment, or dissolved oxygen levels, biological interactions between benthic invertebrate species seemed to be controlling speciation and abundances. Distributions in these areas may also be related to the distance from the bay. Most of the species inhabiting the salt marsh waterways have planktonic larvae or spend some time near the surface, thus the distribution patterns may partially reflect distance from "parent" populations in the bay.

Seasonal fluctuations in species, numbers of individuals, and biomass seemed related to the reproductive patterns of the dominant benthic species. Peaks of abundance generally occurred during peak reproductive periods for the dominant species. Of particular importance were *Ampelisca abdita* and *Streblospio benedicti* which accounted for 81 - 87% of all individuals and 20 - 24% of all biomass during the peak seasons of fall 1974, winter 1975, fall 1975, and summer 1976. Woodin (1974), Holland et al. (1977), Eagle (1975), and Tenore (1972) have all reported the dependence of fluctuations in soft bottom communities on the reproductive periods and success of individual species.

The abundances of the benthic invertebrate community also fluctuated in a pattern consistent with the presence and abundance of predator species. Invertebrate and fish species common to the Manahawkin area rely on benthic invertebrates as a major food source. These predatory species are most common during the late spring to early fall months. Hoff and Ibara (1977) and Cain and Dean (1976) have reported that the highest numbers of fish species and numbers of individuals are present in the tidal creeks and estuaries of Massachusetts and South Carolina (respectively) during the spring and summer. Likewise, the shrimp populations of Delaware Bay (Price 1962) and Rhode Island (Welsh 1975) are present in the greatest abundance from spring to fall. Ctenophores which may prey upon planktonic larvae are also most abundant during the summer (Burrell and Van Engel 1976). These patterns of abundance seem to correlate with the predominance of peak numbers of benthic species during fall periods. While it is possible to estimate when predation may be the most intense, it is not feasible to estimate which of the dominant species will be most affected. Predators such as shrimp feed on whatever species is the most

abundant at a particular locality and a particular time (Bell and Coull 1978). Also, predation may not be equal on all size classes of a particular species. Vince et al. (1976) have shown that *Fundulus heteroclitus* feeds primarily on the smaller size ranges of the marsh amphipod *Orchestia grillus* and the snail *Melampus bidentatus*.

In addition to the distributions of species, numbers of individuals, and biomass, the distribution of production of the benthic invertebrate community is of importance. The creek benthic invertebrate community respired an approximate 16 $kcal \cdot m^{-2} \cdot year^{-1}$ and produced an approximately 3 $kcal \cdot m^{-2} \cdot year^{-1}$. The lagoon benthic community respired an approximate 2 $kcal \cdot m^{-2} \cdot year^{-1}$ and produced an approximate 0.3 $kcal \cdot m^{-2} \cdot year^{-1}$. Edwards (1973) reported a 5 fold difference in production and respiration between two tropical sand bottom communities where one of the communities was exposed to chronic oxygen depletion.

There was also a partial redistribution of production and respiration among the dominant species and taxonomic groups between the waterway types. This redistribution is proportional to the differences in distribution of the dominant species and taxonomic groups. The polychaete and crustacean species were proportionally more important to the lagoon than to the creek community production.

The contribution of the benthic macrofaunal community to the quantitative energy flow of the salt marsh ecosystem is relatively small. Teal (1962) reported marsh surface annelid and marsh mussel populations accounted for annual respirations of 26 and 39 $kcal \cdot m^{-2} \cdot year^{-1}$, respectively. The creek macrofaunal respiration is only about half of these amounts. The total sediment respiration reported by Durand et al. (Estuarine Evaluation Study) appears to be 500 - 600 ml $O_2 \cdot m^{-2} \cdot day^{-1}$ which represents an annual respiration of 900 - 1,000 $kcal \cdot m^{-2} \cdot year^{-1}$. The creek macrofaunal respiration comprises only 1.6 - 1.8% of the total sediment respiration. The important role of the benthic macrofaunal invertebrates is in nutrient recycling and in the conversion of bacterial biomass to biomass that can be harvested by fish and invertebrate species.

The majority of species found in this study are classified as opportunistic (Grassle and Grassle 1974). The dominance of the community by a few opportunistic species, the resulting low diversity values, and the wide fluctuations in numbers of individuals are typical of soft bottom estuarine communities (Boesch et al. 1976). The decreased abundance and lower dominance values of the lagoons and partially disturbed waterways are also typical of estuarine communities that have been exposed to low oxygen concentrations or pollutants (Heck 1976; Livingston 1975). That the partially disturbed waterways display characteristics intermediate between those of the undisturbed creeks and fully developed lagoons suggests that the disturbance of the benthic invertebrate community is proportional to the degree of development.

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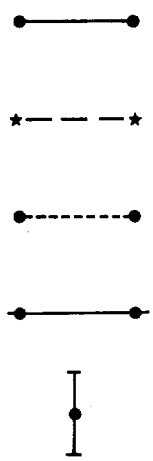
APPENDIX A

Figures for the Estuarine Evaluation Study:
Benthic Invertebrate Report

The following symbols were used in APPENDIX A:



Data from the natural creeks

Data from the partially disturbed waterways

Data from the lagooned waterways

Data from the entire study area

95% confidence interval

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151	Size frequency distributions for *Leptocheirus plumulosus*	4.99
152	Size frequency distributions for *Cyathura polita*	4.101
153	Size frequency distributions for *Nereis succinea*	4.103
154	Size frequency distributions for *Streblospio benedicti*	4.105
155	Size frequency distributions for *Hypaniola grayi*	4.107
156	Size frequency distributions for *Heteromastus filiformis*	4.109
157	Size frequency distributions for *Lumbrineris tenuis*	4.110

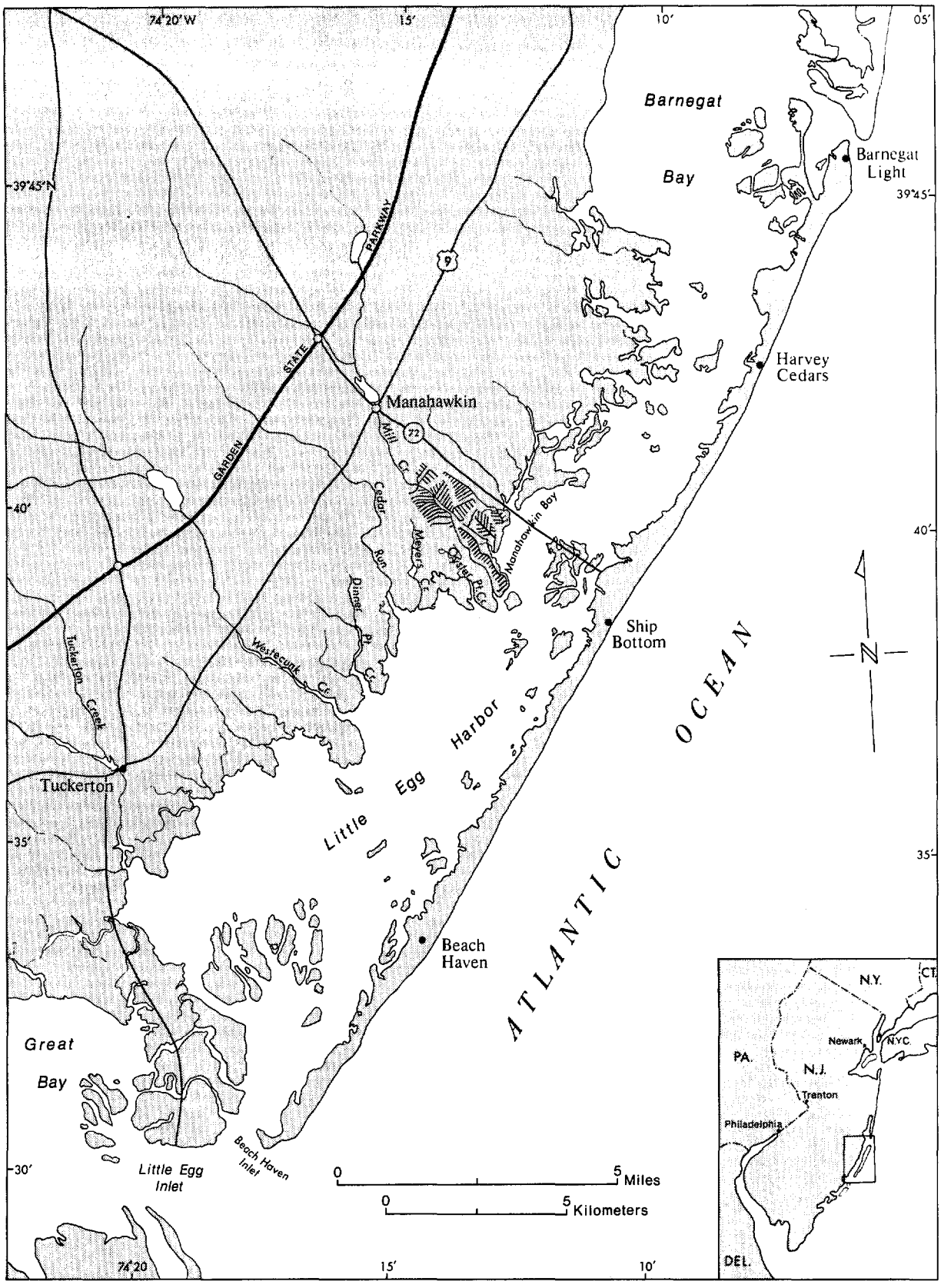


Fig. 1. The study area.

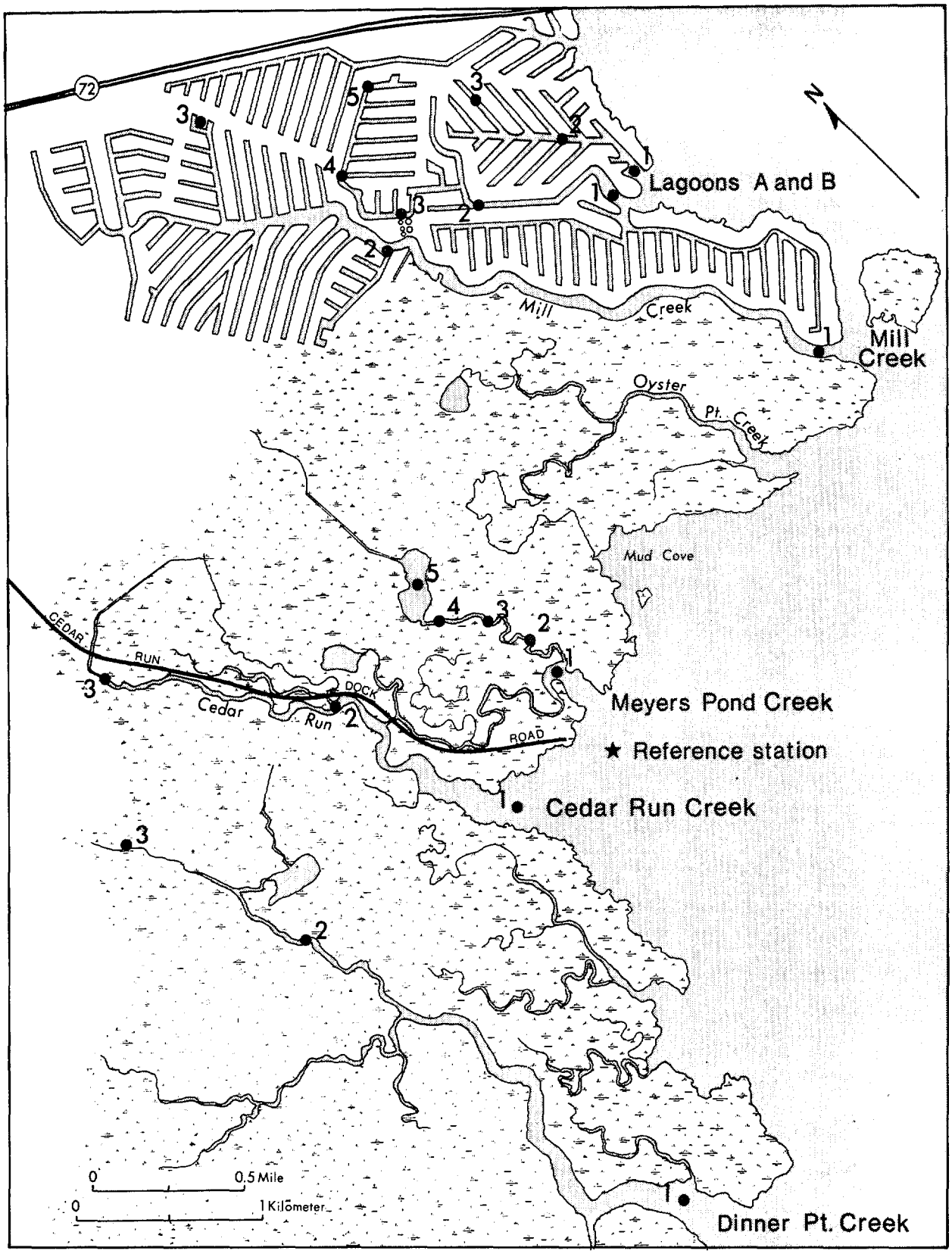
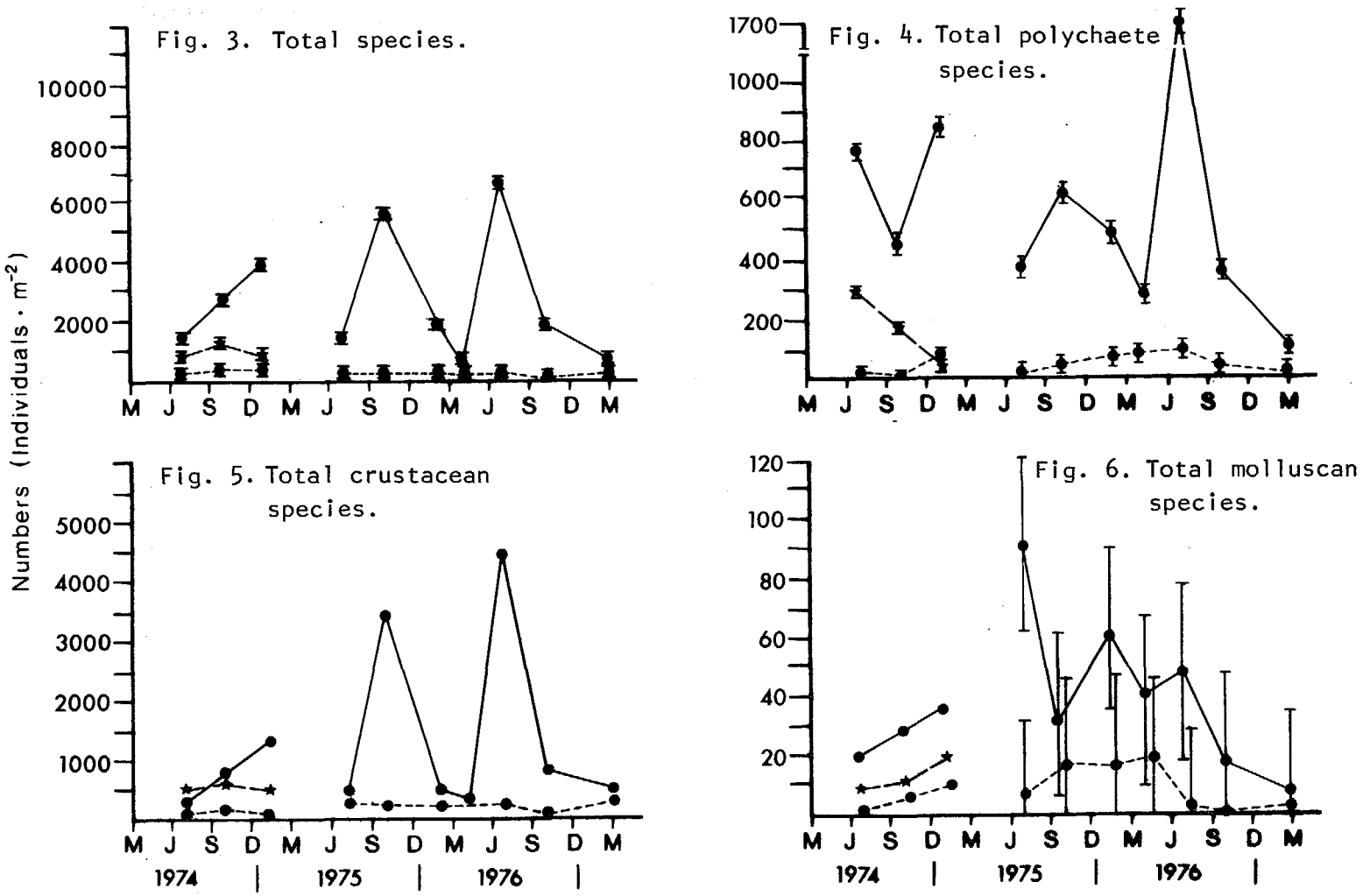
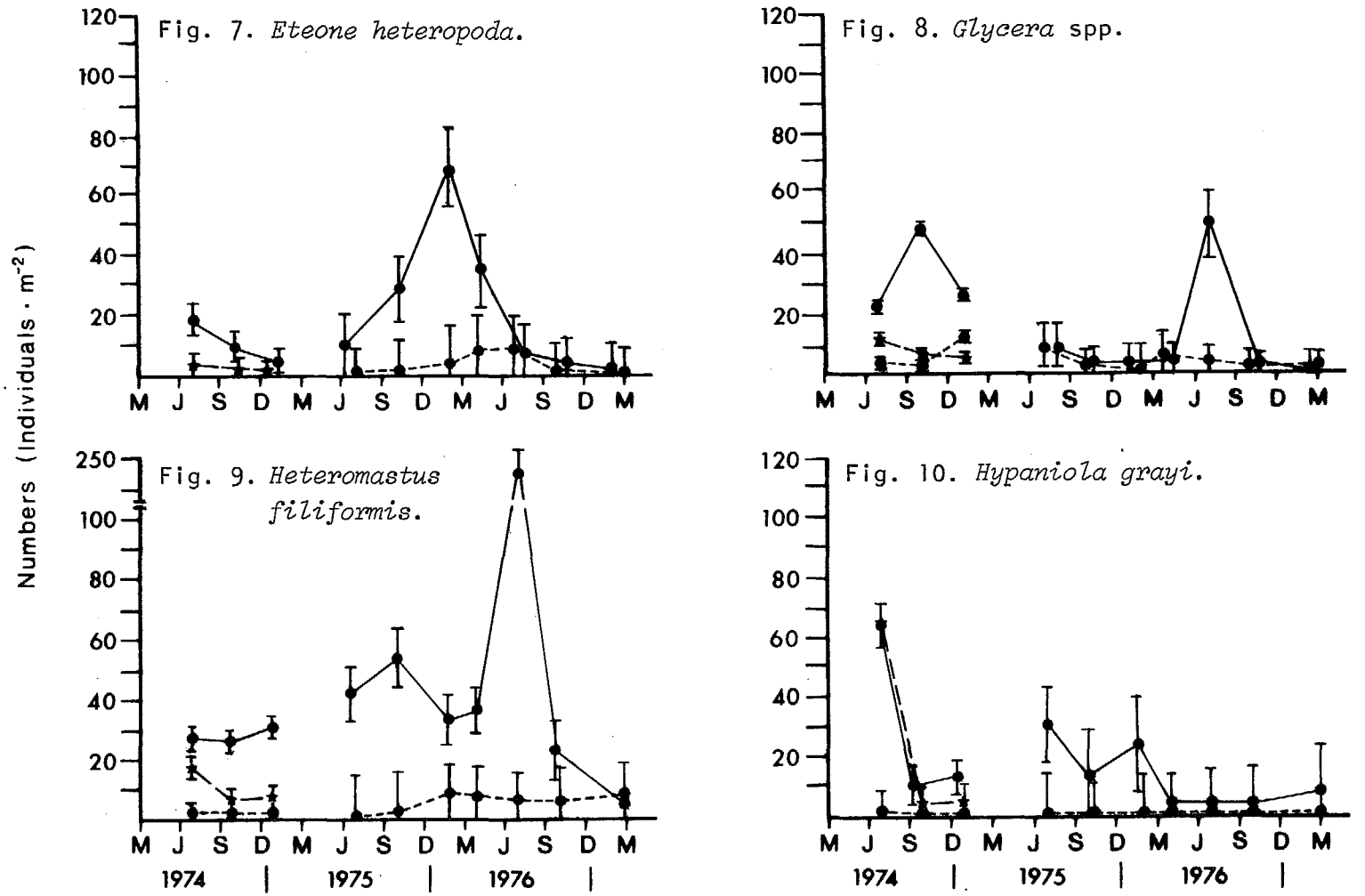


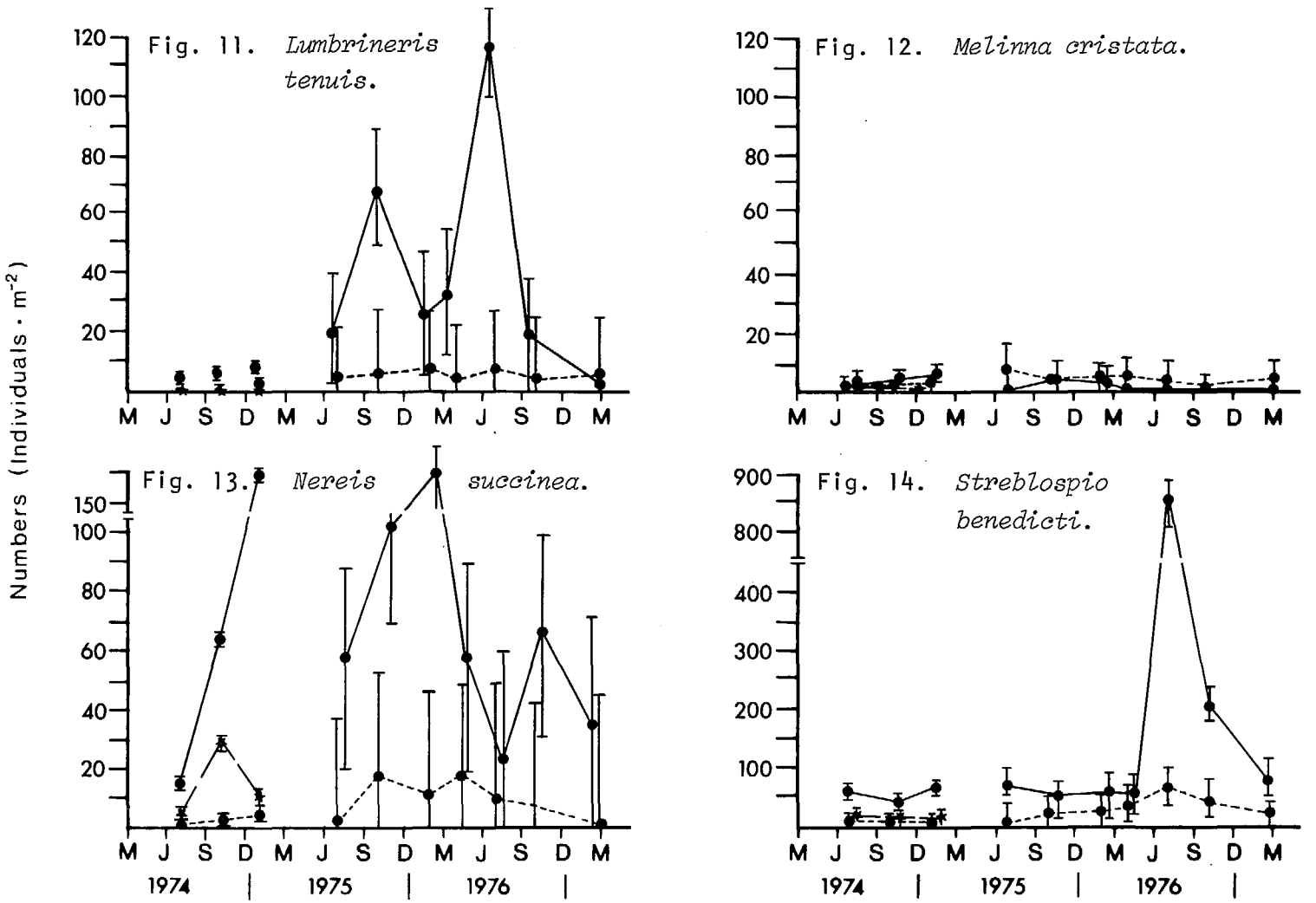
Fig. 2. The sampling sites.



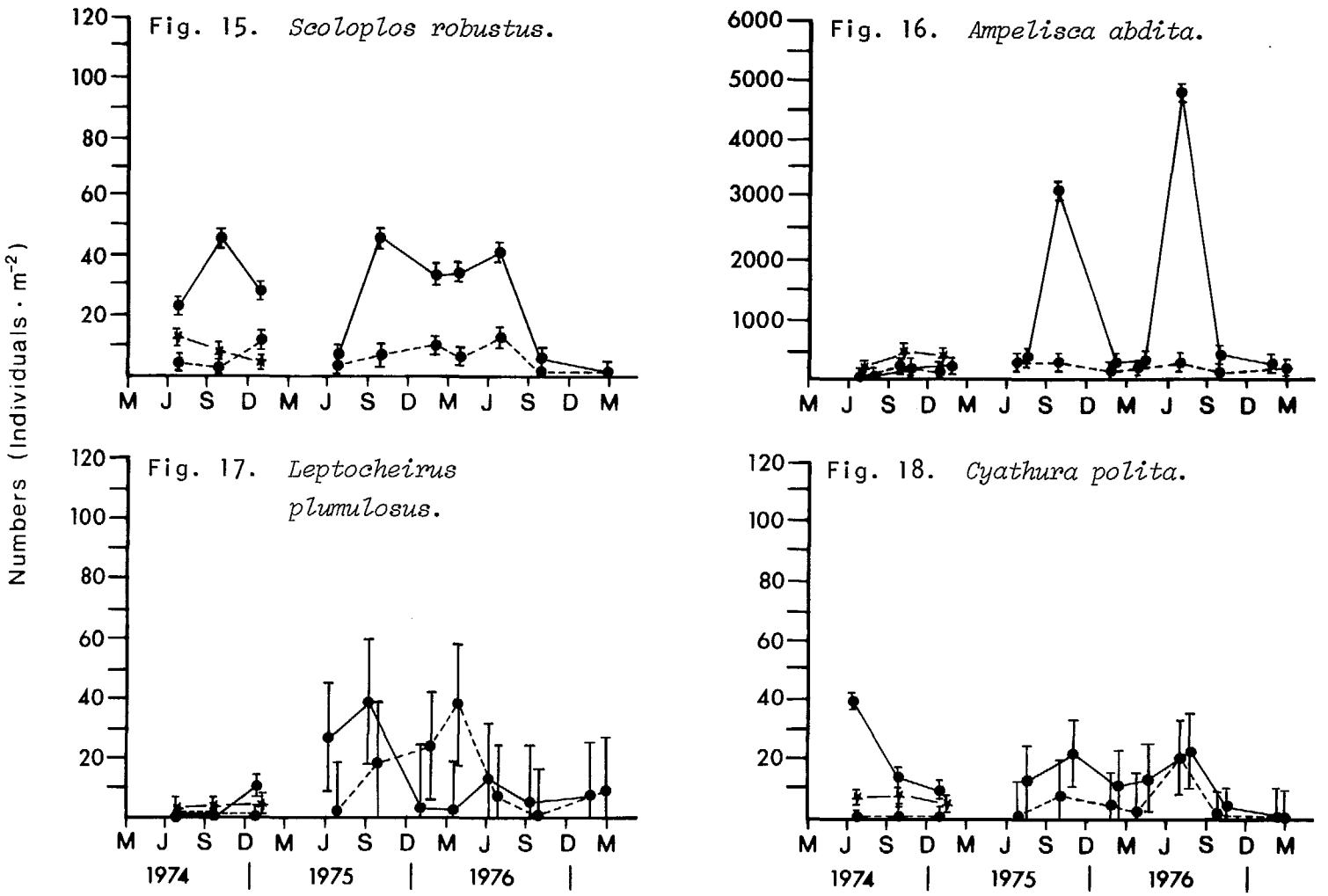
Figs. 3-6. Waterway totals of individuals·m^{-2} for the overall categories.



Figs. 7-10. Waterway totals of individuals·m^{-2} for *Eteone*, *Glycera*, *Heteromastus*, and *Hypaniola*.



Figs. 11-14. Waterway totals of individuals·m^{-2} for *Lumbrineris*, *Melinna*, *Nereis*, and *Streblospio*.



Figs. 15-18. Waterway totals of individuals·m^{-2} for *Scoloplos*, *Ampelisca*, *Leptocheirus*, and *Cyathura*.

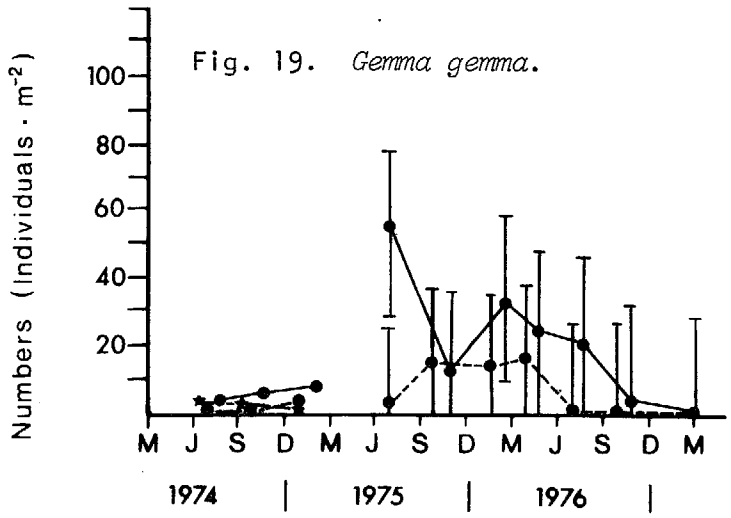


Fig. 19. *Gemma gemma.*

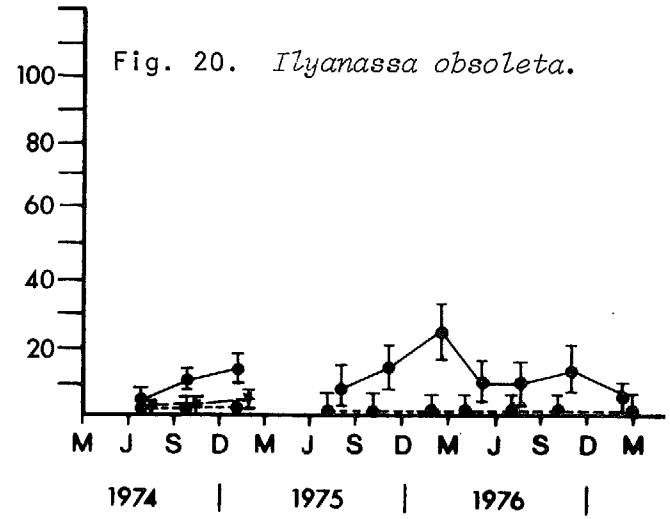
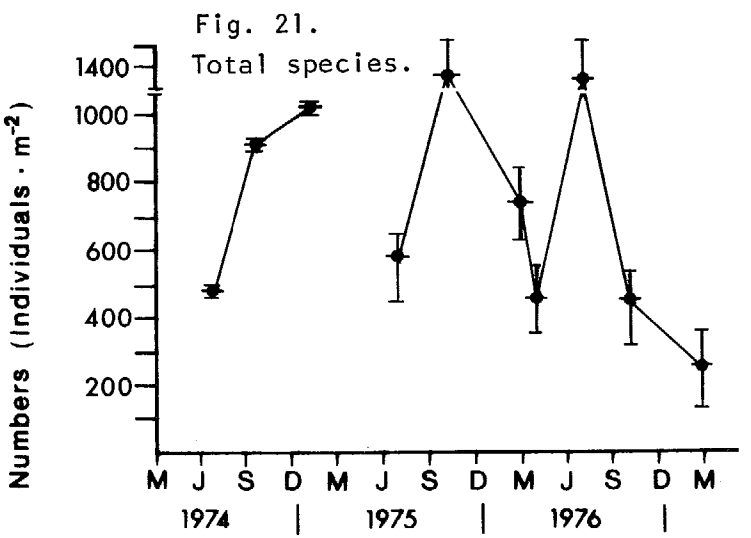
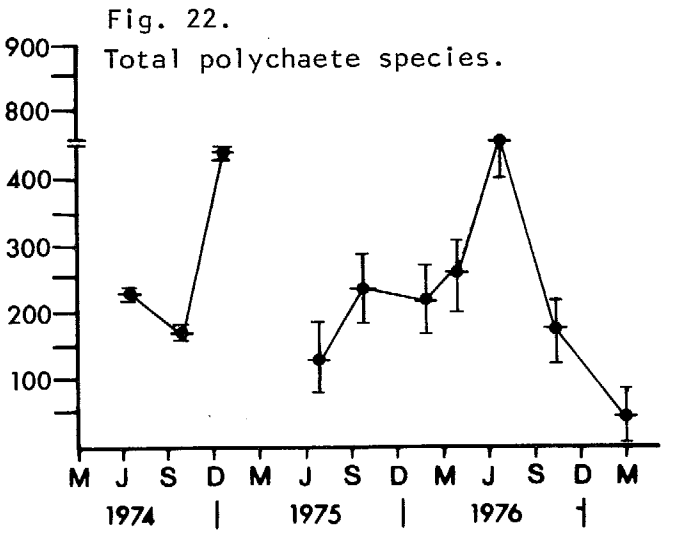


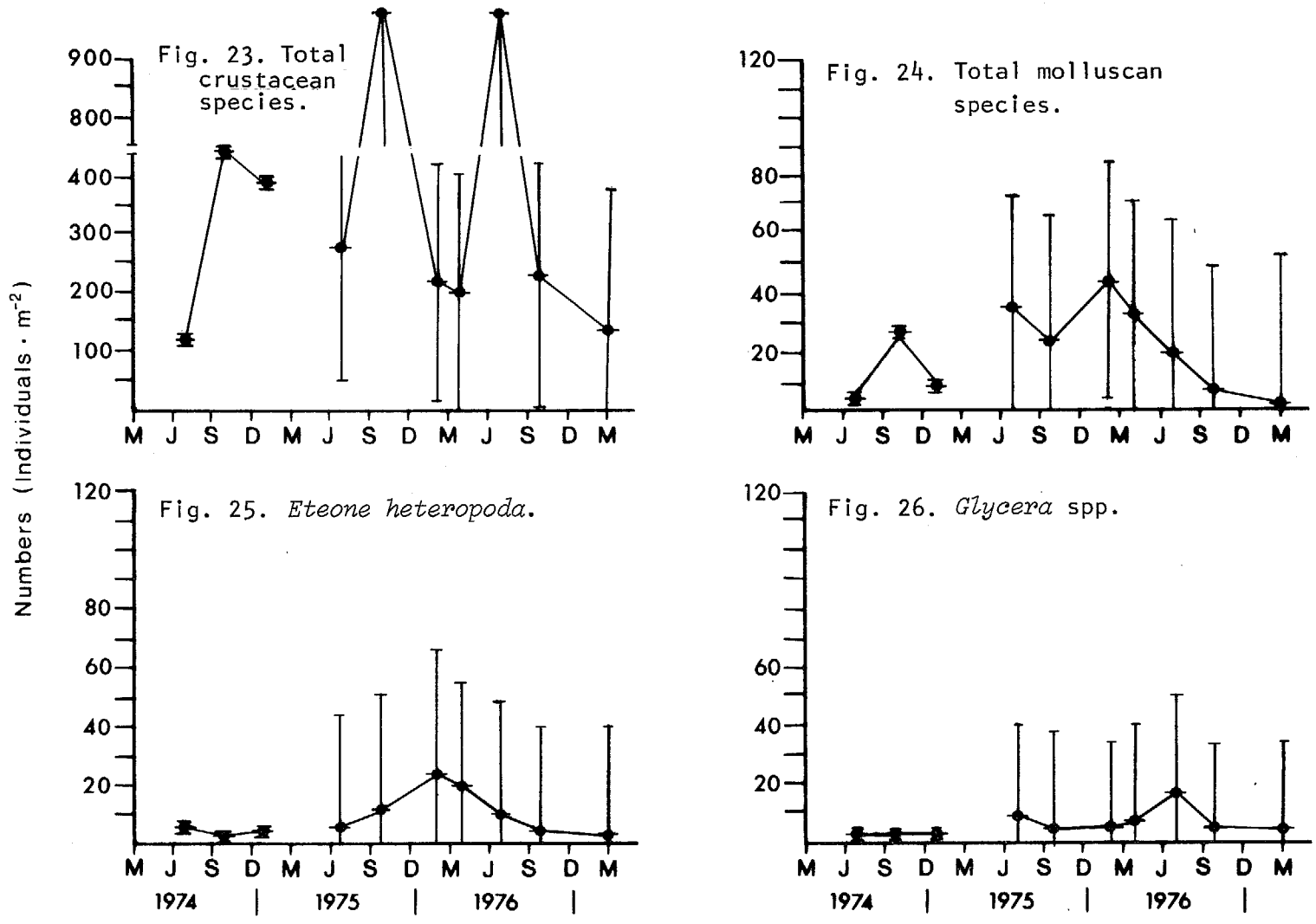
Fig. 20. *Ilyanassa obsoleta.*

Figs. 19-20. Waterway totals of individuals·m^{-2} for *Gemma* and *Ilyanassa*.

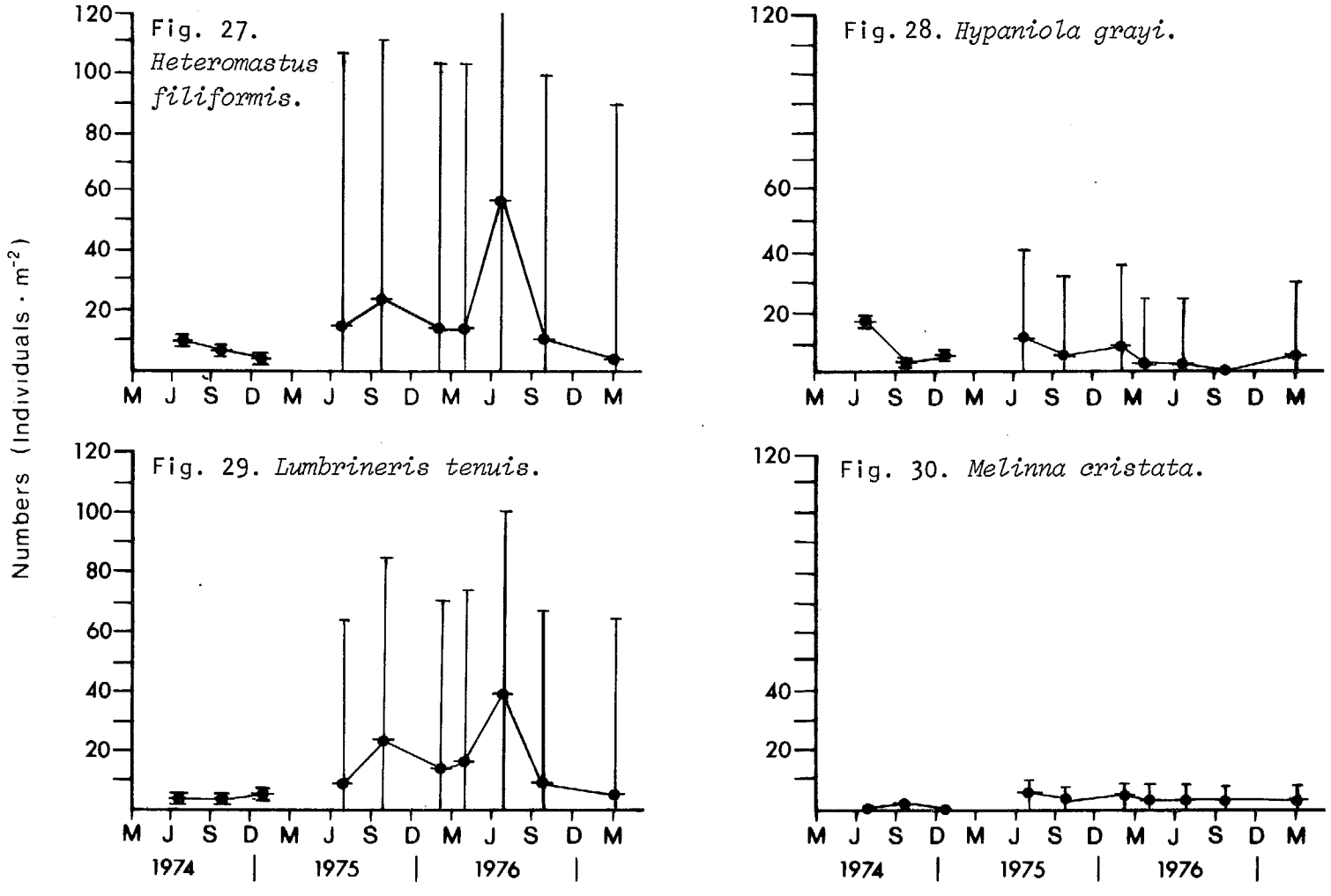




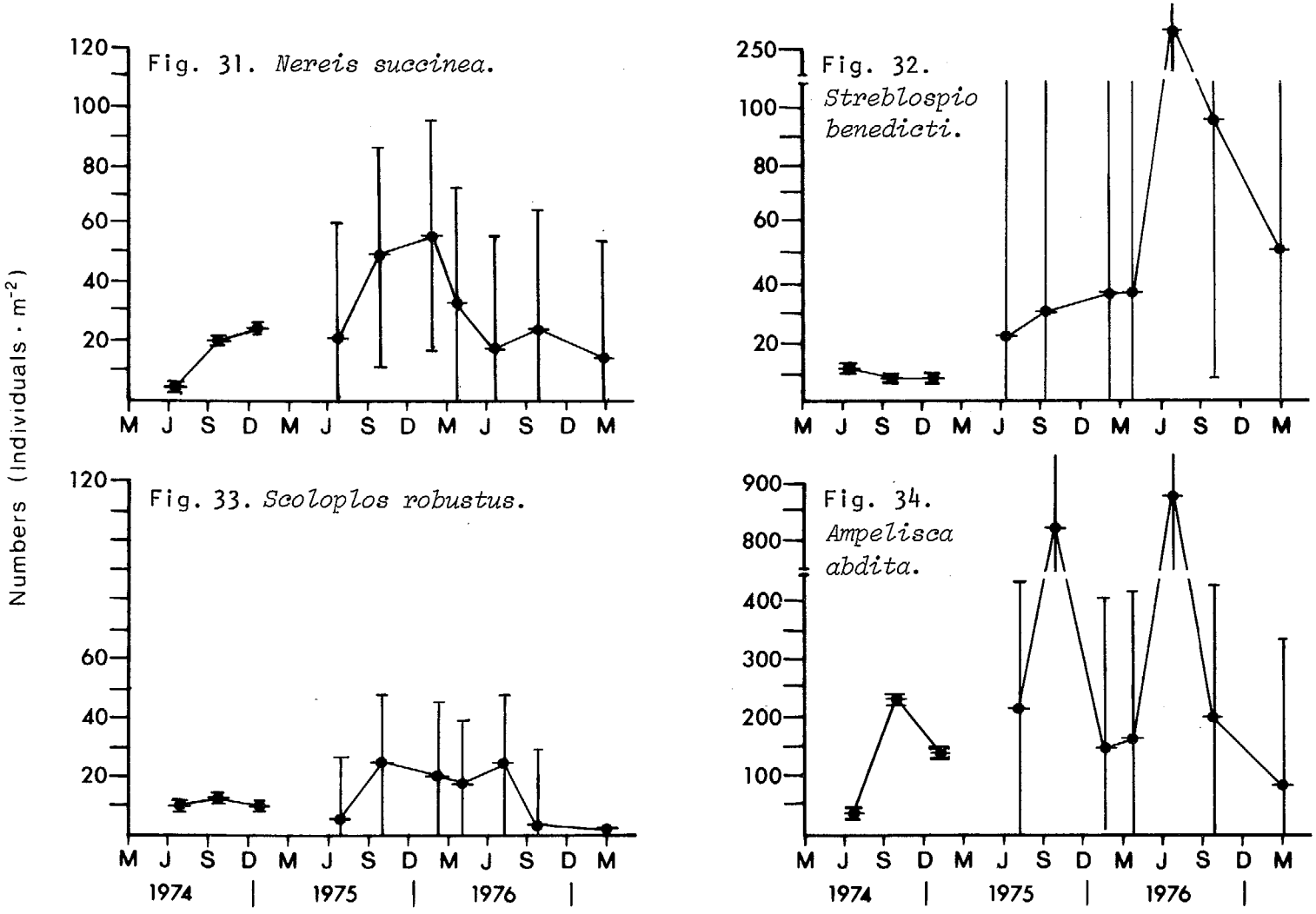
Figs. 21-22. Seasonal totals of individuals·m^{-2} for total species and total polychaete species throughout the study area.



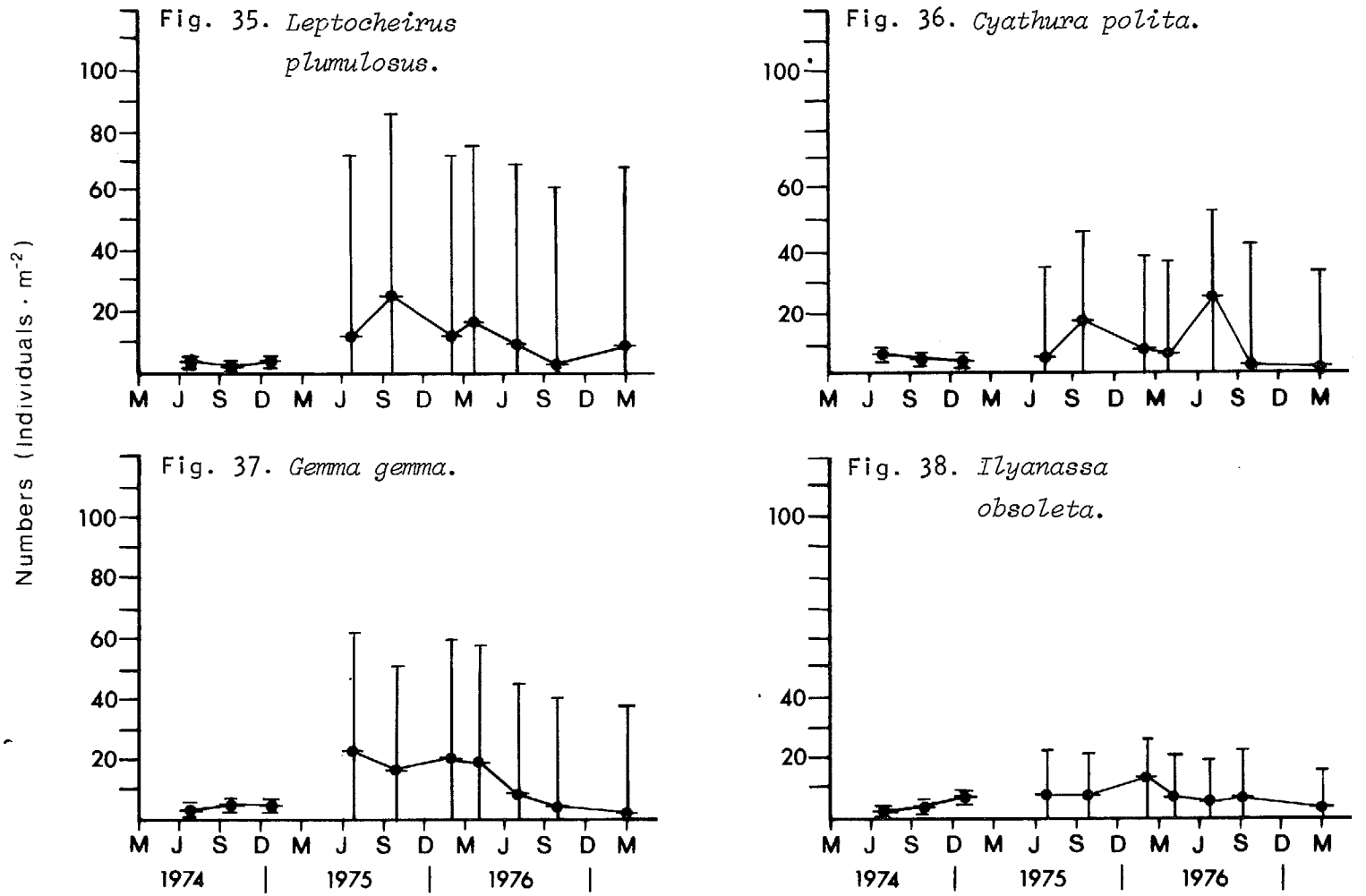
Figs. 23-26. Seasonal totals of individuals·m^{-2} for total crustacean species, total molluscan species, *Eteone*, and *Glycera* throughout the study area.



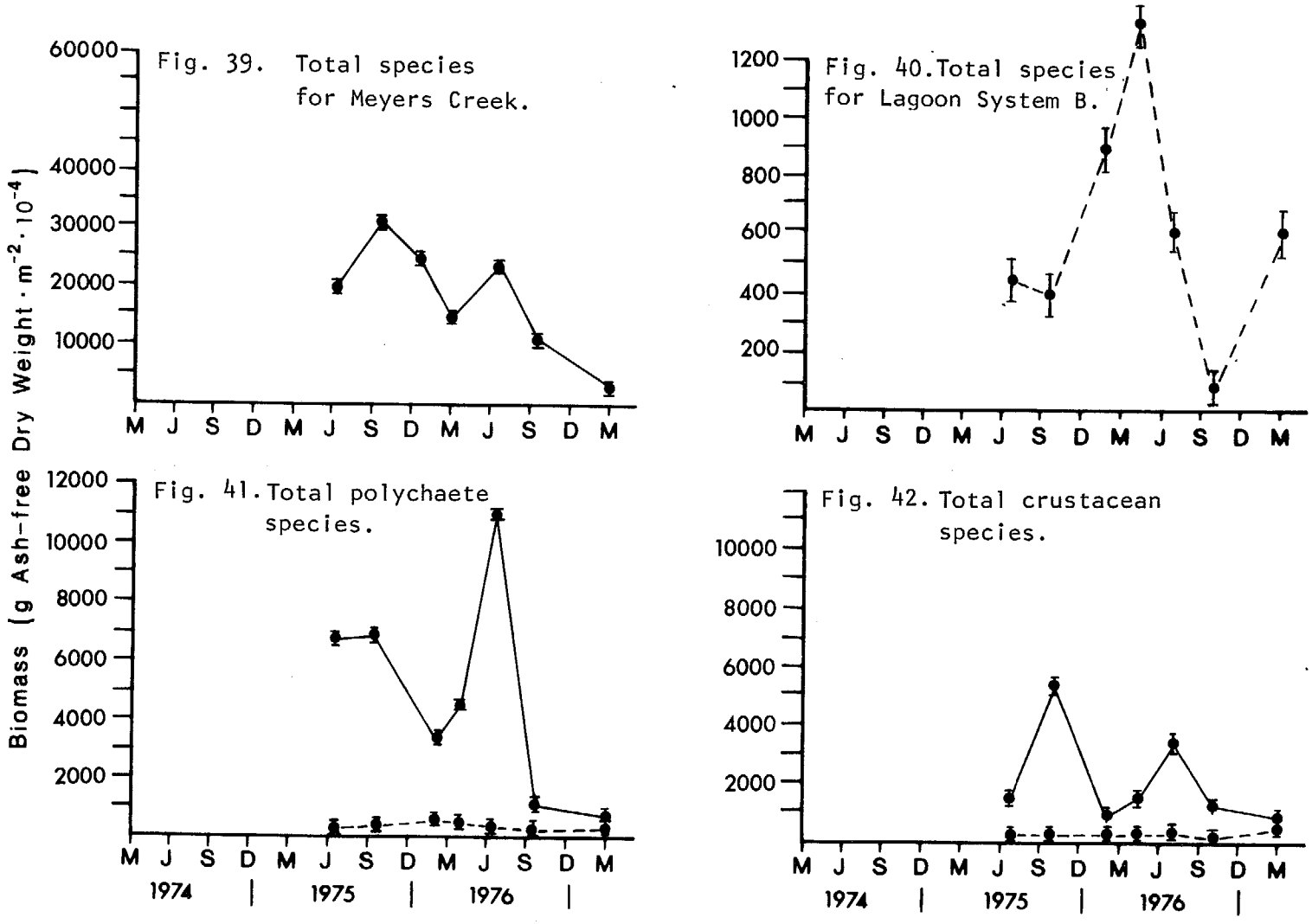
Figs. 27-30. Seasonal totals of individuals·m^{-2} for *Heteromastus*, *Hypaniola*, *Lumbrineris*, and *Melinna* throughout the study area.



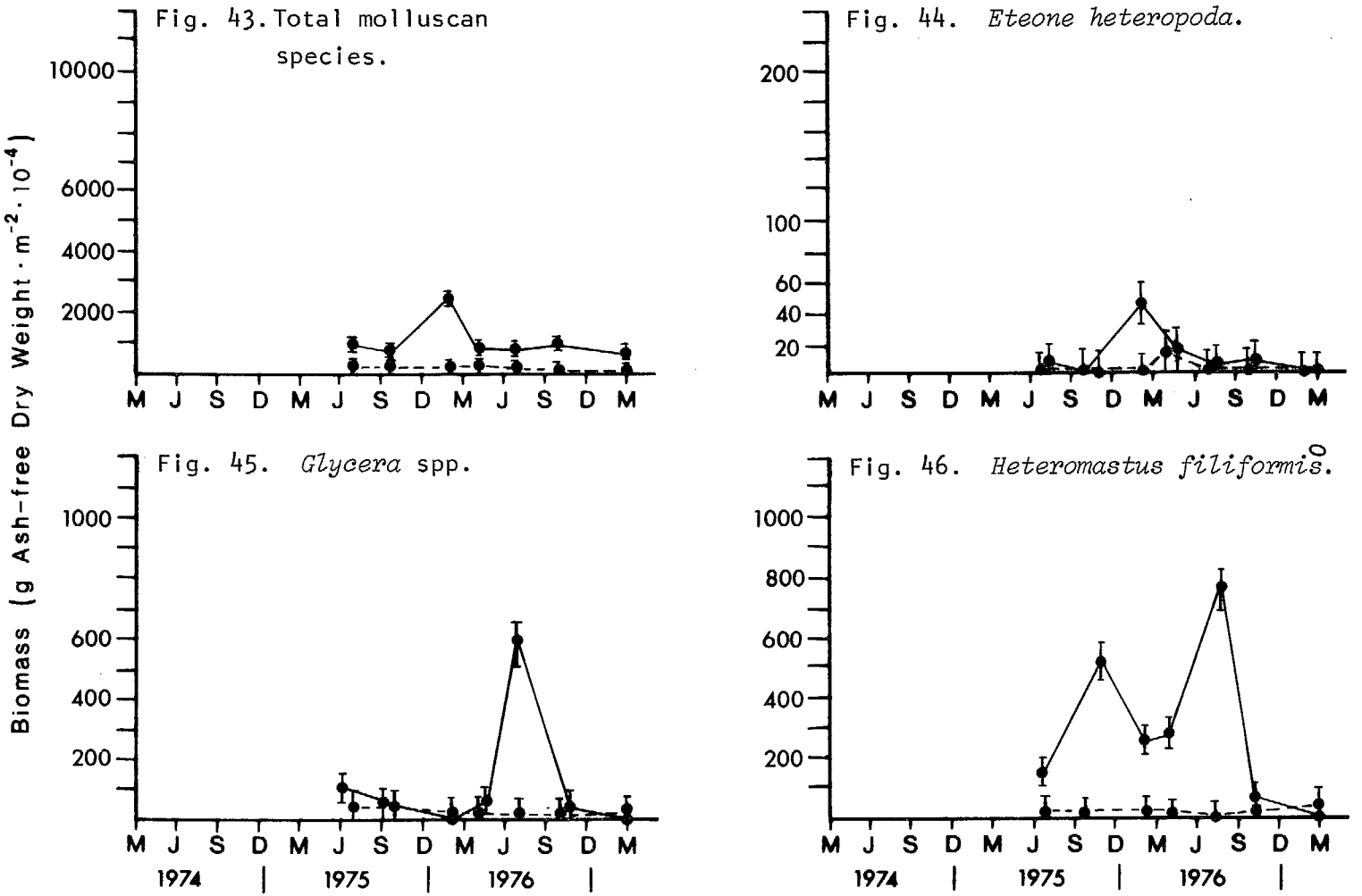
Figs. 31-34. Seasonal totals of individuals·m^{-2} for *Nereis*, *Streblospio*, *Scoloplos*, and *Ampelisca* throughout the study area.



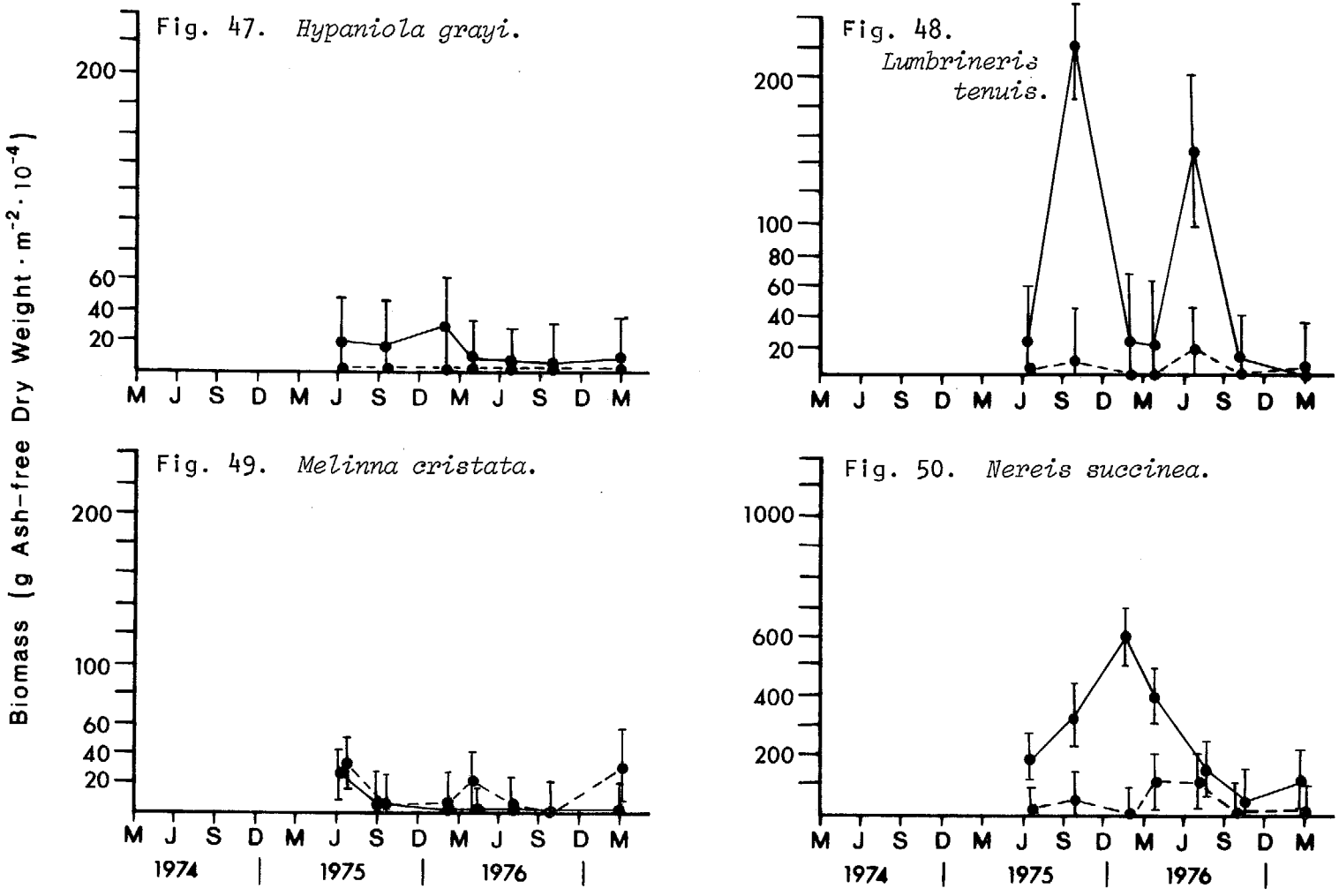
Figs. 35-38. Seasonal totals of individuals·m^{-2} for *Leptocheirus*, *Cyathura*, *Gemma*, and *Ilyanassa* throughout the study area.



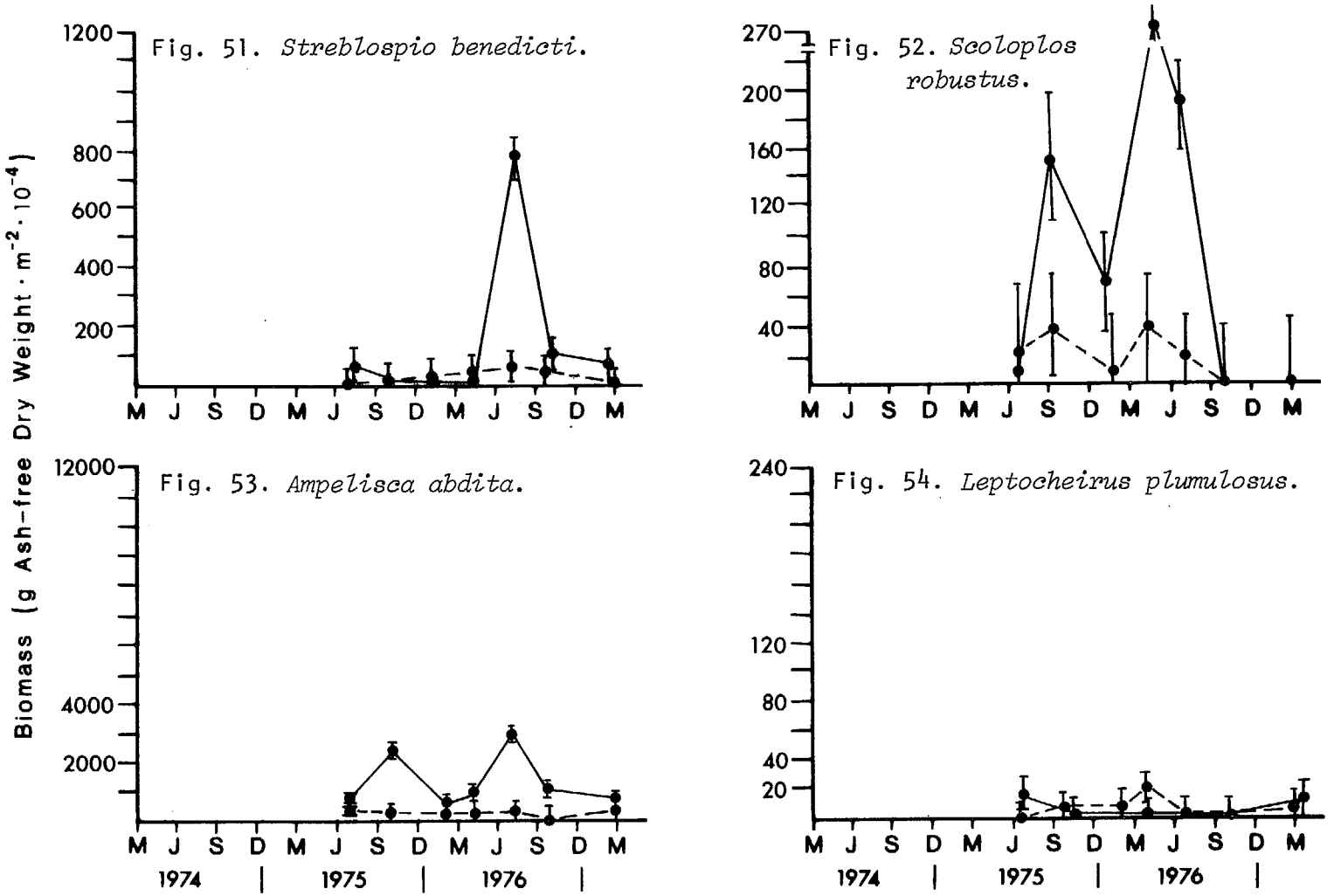
Figs. 39-42. Waterway biomass totals (1975 - 1977) for the overall categories.



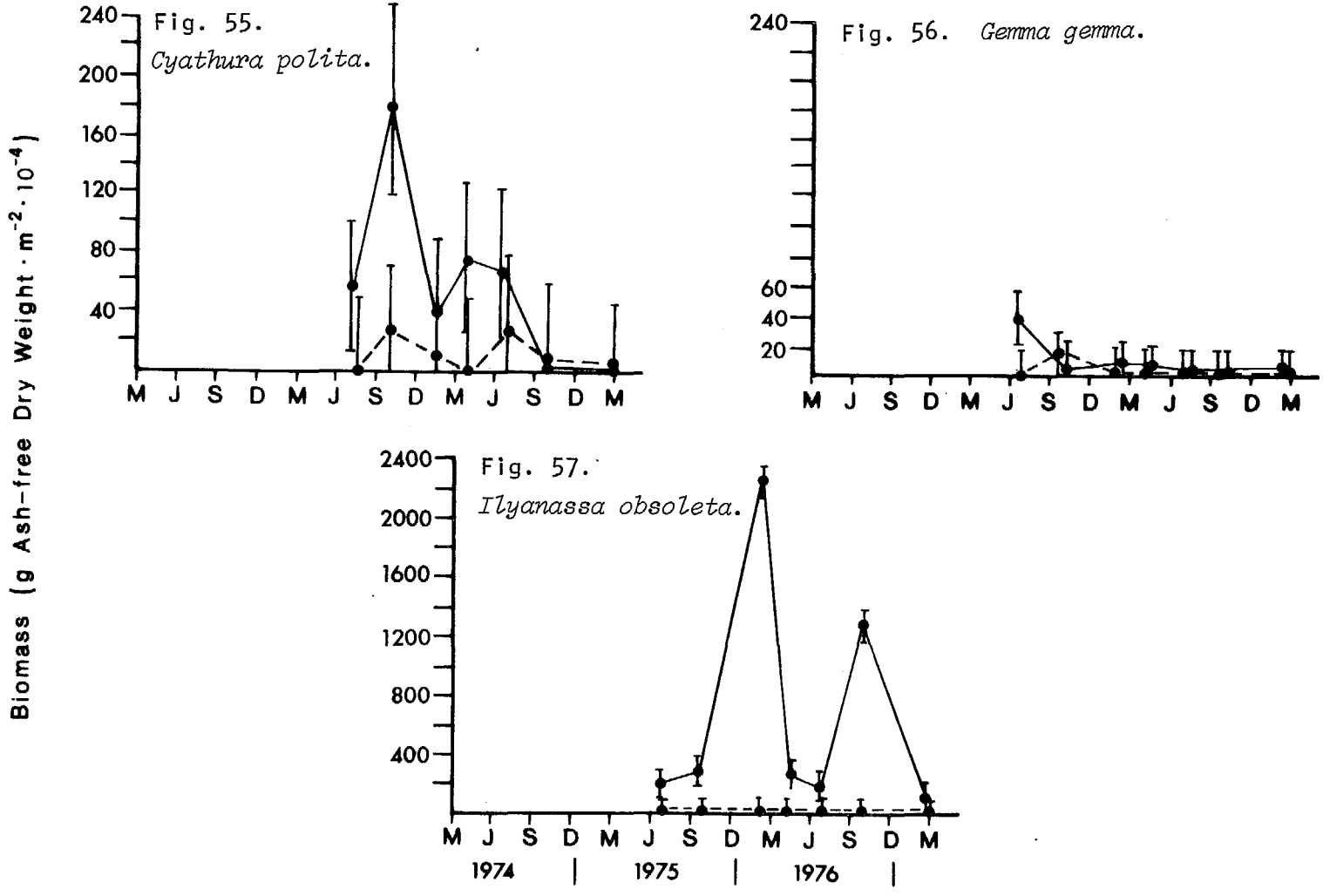
Figs. 43-46. Waterway biomass totals (1975 - 1977) for total molluscan species, *Eteone*, *Glycera*, and *Heteromastus*.



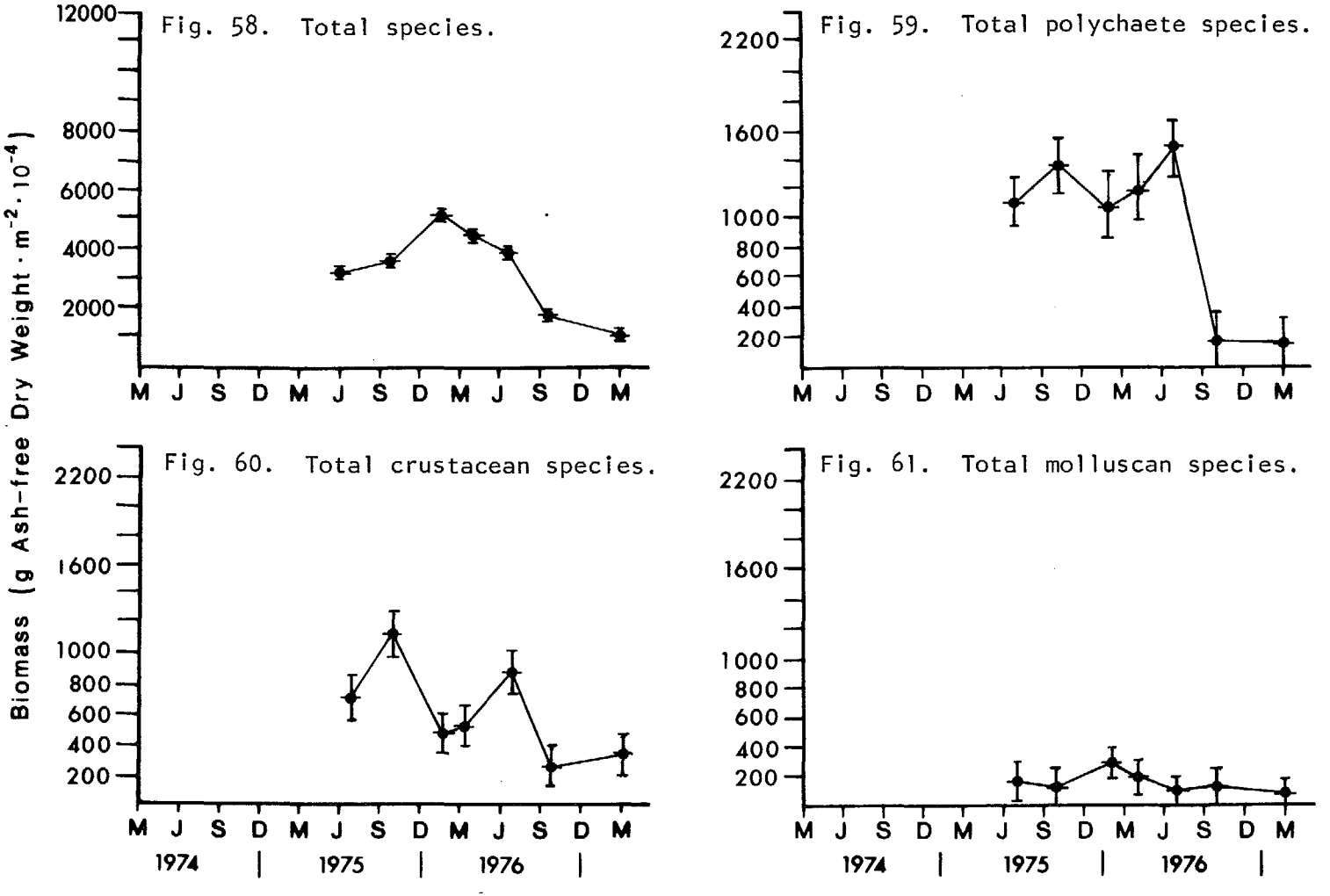
Figs. 47-50. Waterway biomass totals (1975 - 1977) for *Hypaniola*, *Lumbrineris*, *Melinna*, and *Nereis*.



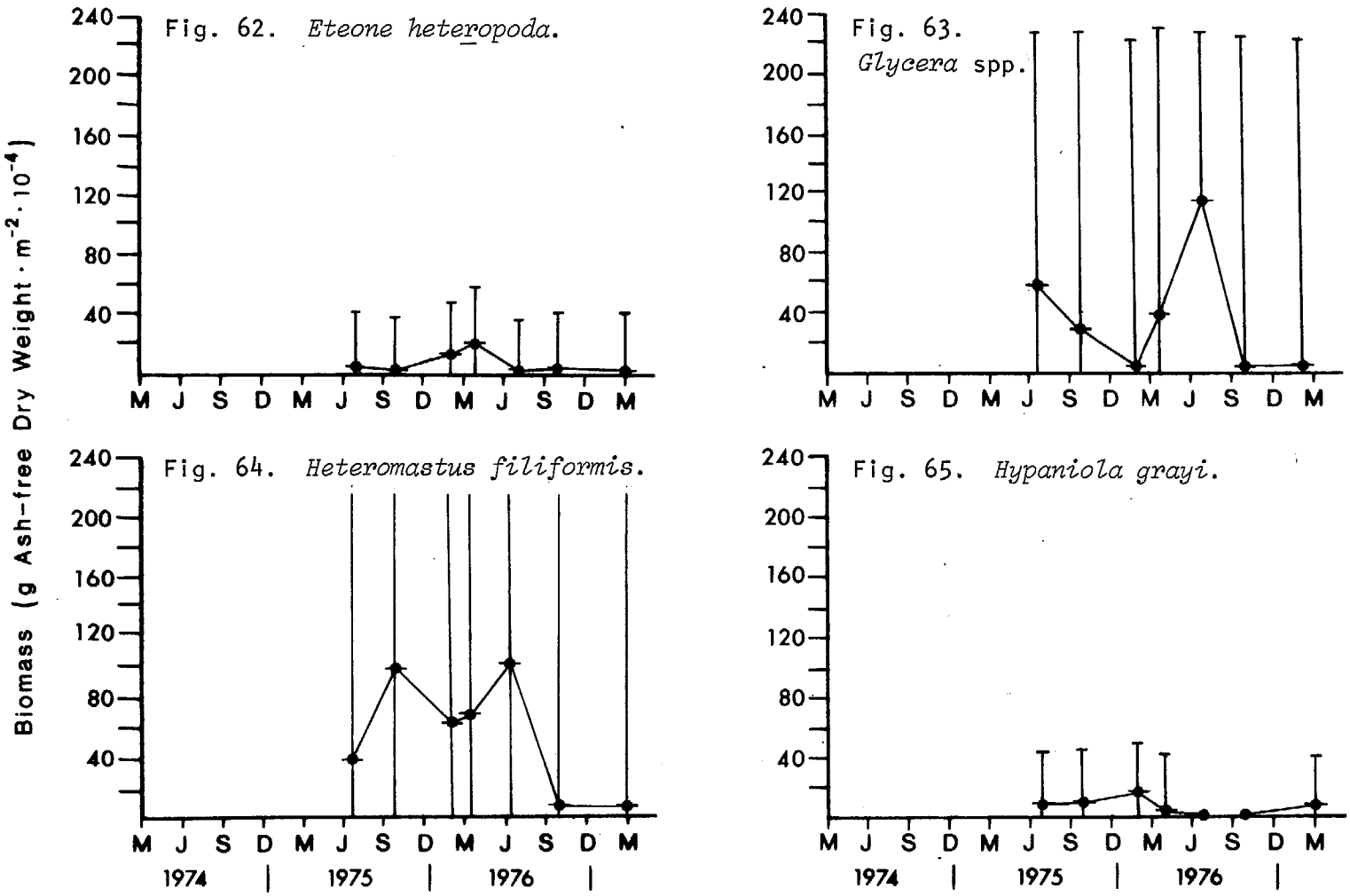
Figs. 51-54. Waterway biomass totals (1975 - 1977) for *Streblospio*, *Scoloplos*, *Ampelisca*, and *Leptocheirus*.



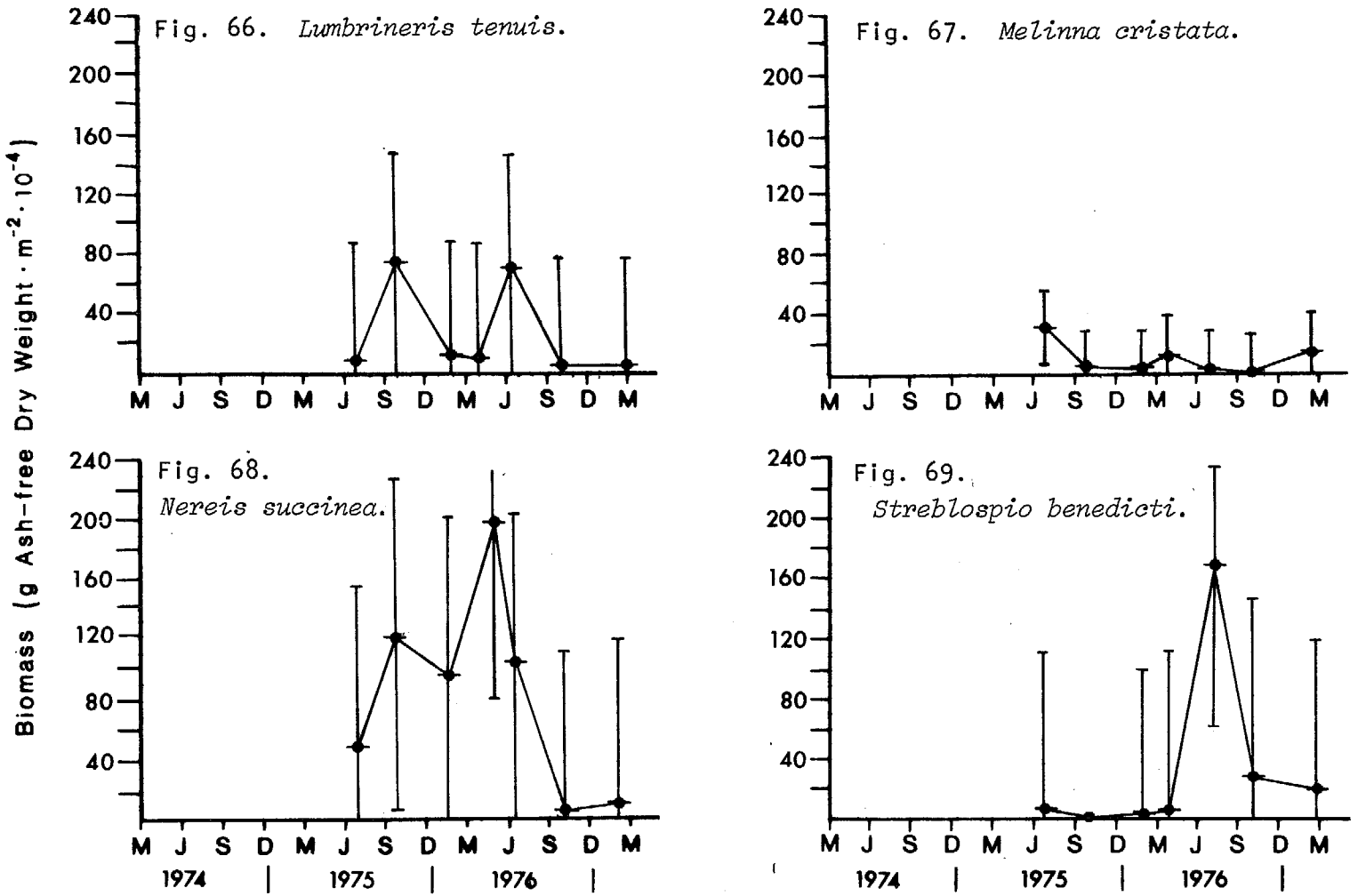
Figs. 55-57. Waterway biomass totals (1975-1977) for *Cyathura*, *Gemma*, and *Ilyanassa*.



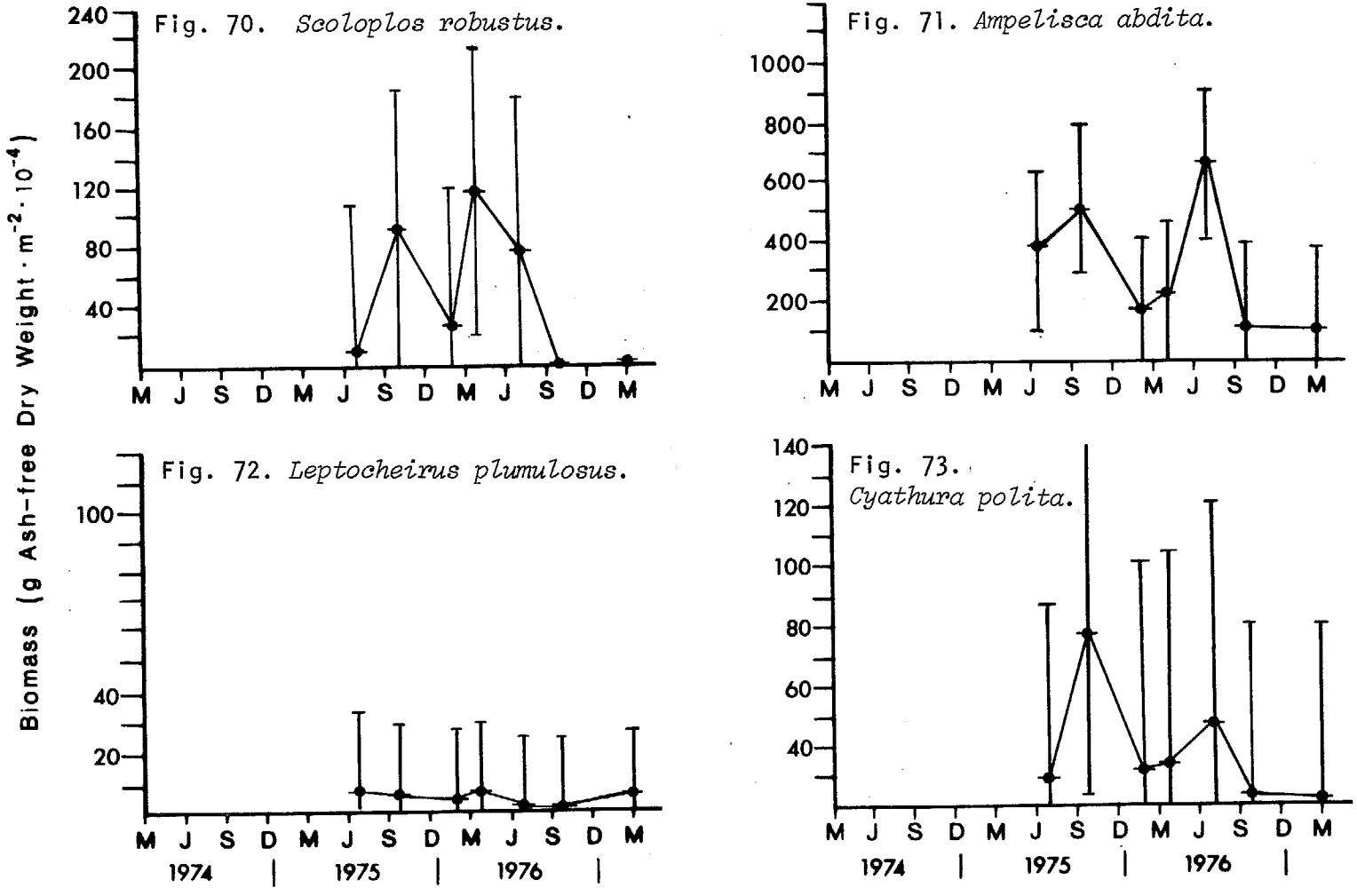
Figs. 58-61. Seasonal biomass totals (1975-1977) for the overall categories throughout the study area.



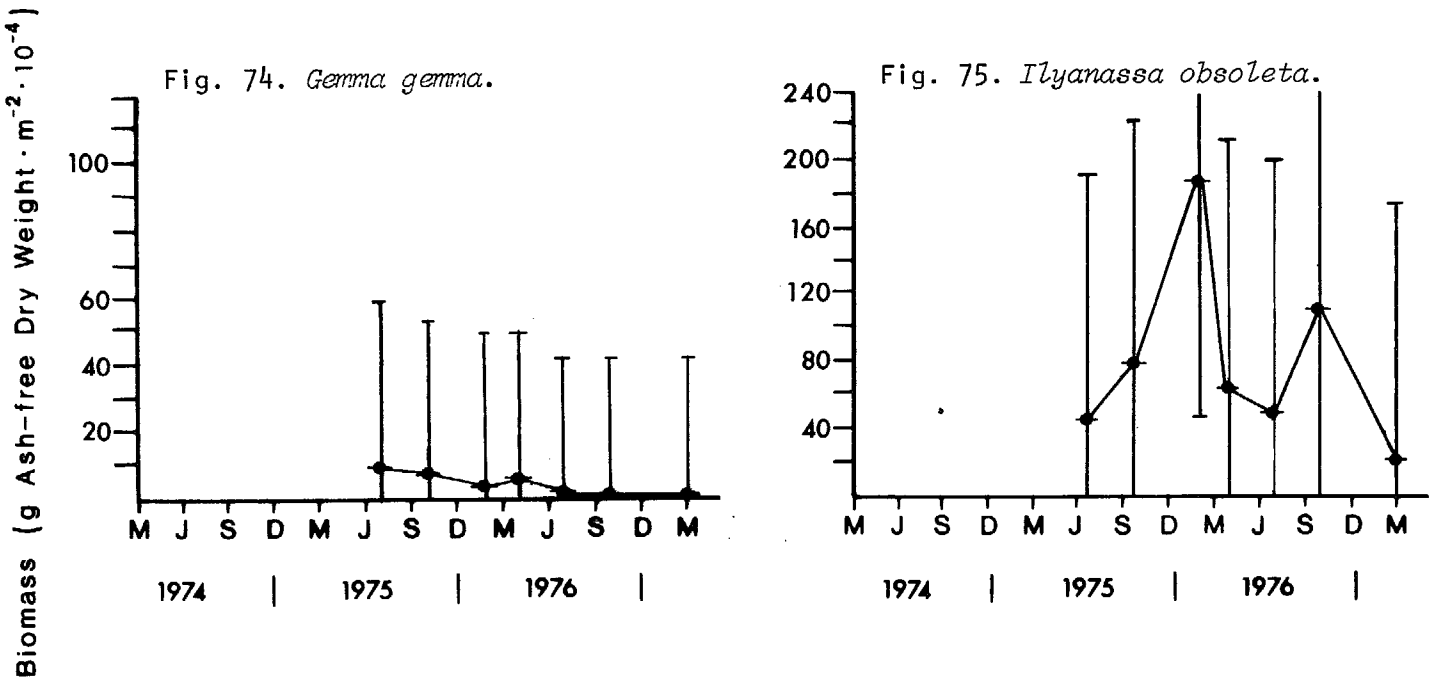
Figs. 62-65. Seasonal biomass totals (1975-1977) for *Eteone*, *Glycera*, *Heteromastus*, and *Hypaniola*.



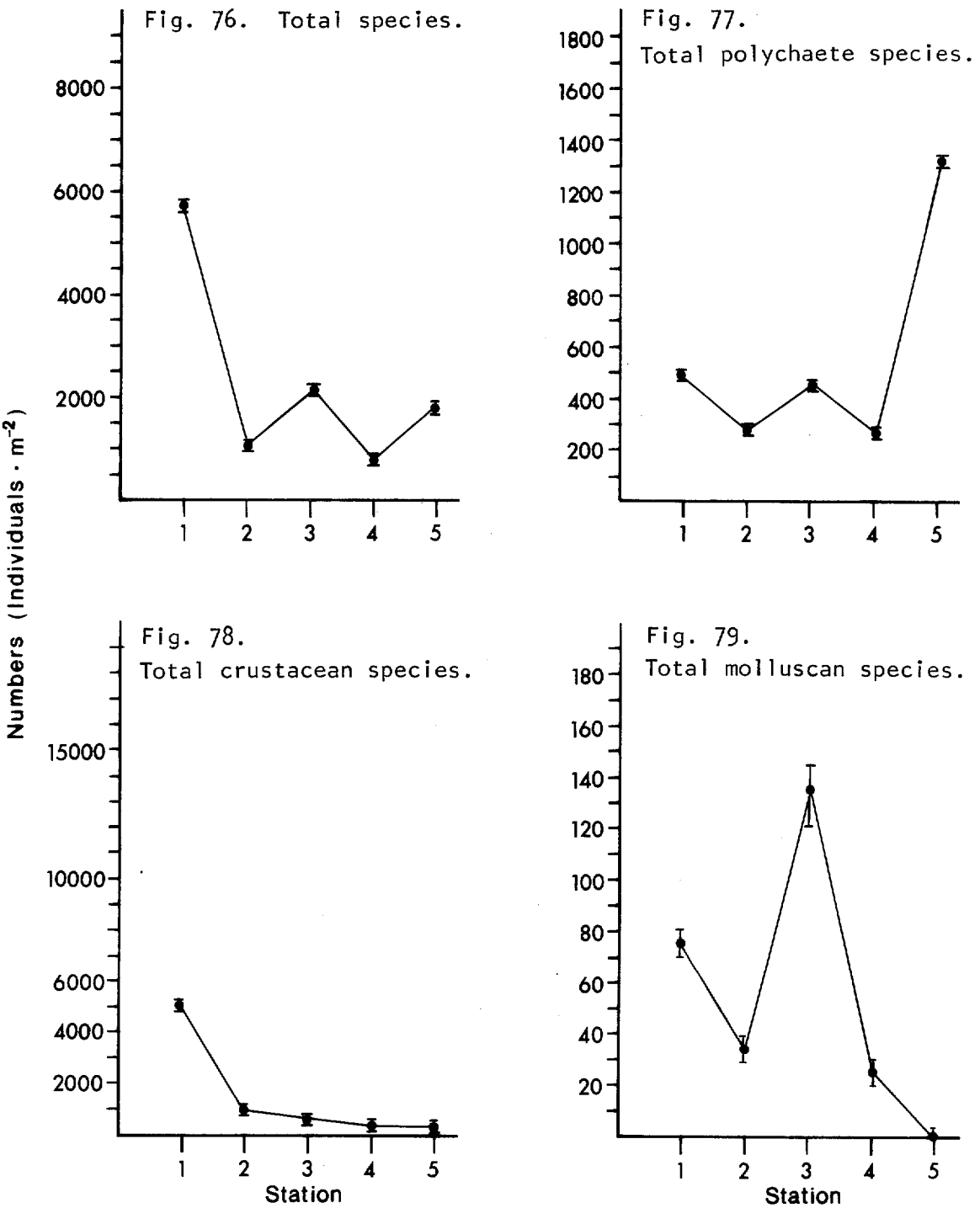
Figs. 66-69. Seasonal biomass totals (1975-1977) for *Lumbrineris*, *Melinna*, *Nereis*, and *Streblospio*.



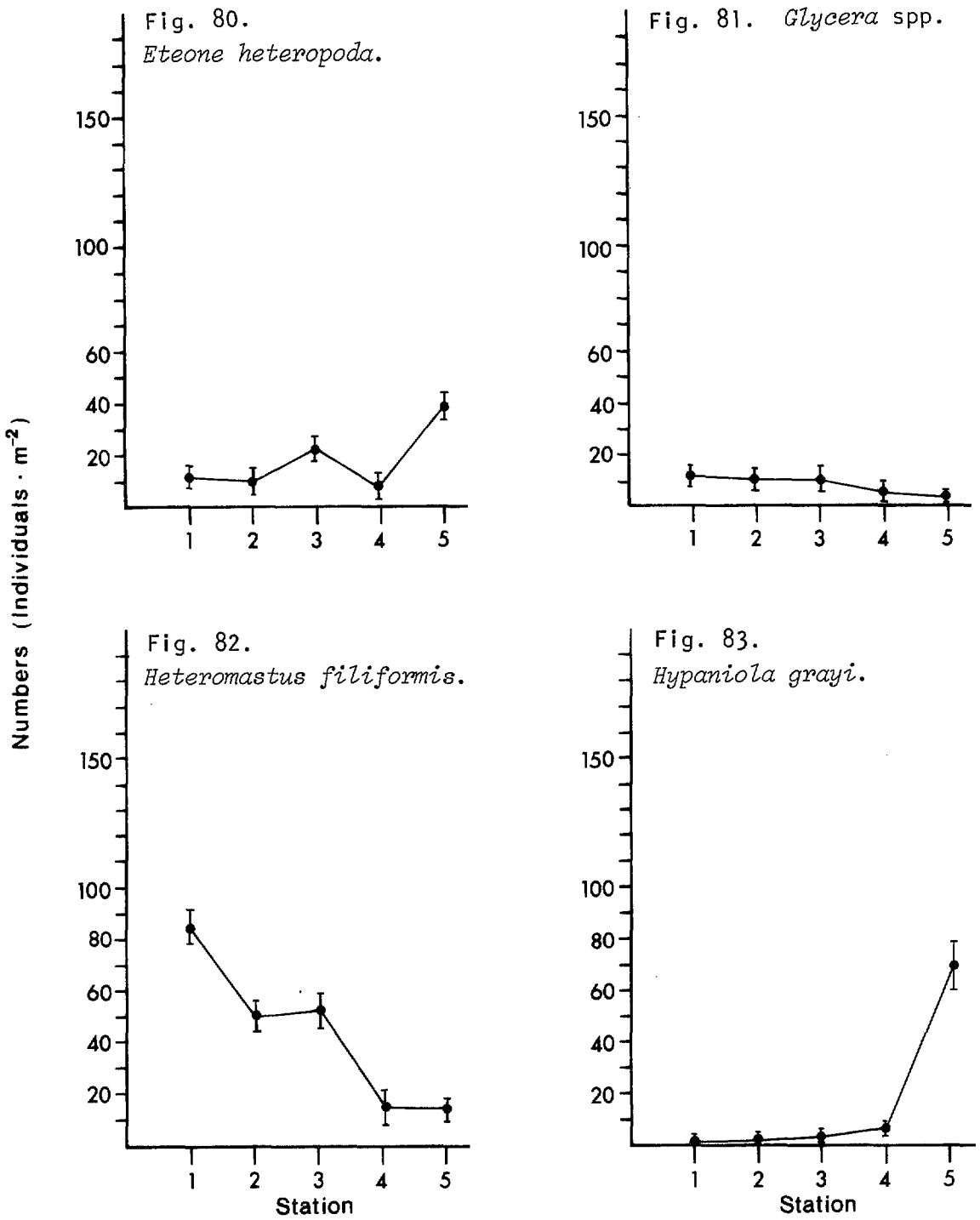
Figs. 70-73. Seasonal biomass totals (1975-1977) *Scoloplos*, *Ampelisca*, *Leptocheirus*, and *Cyathura*.



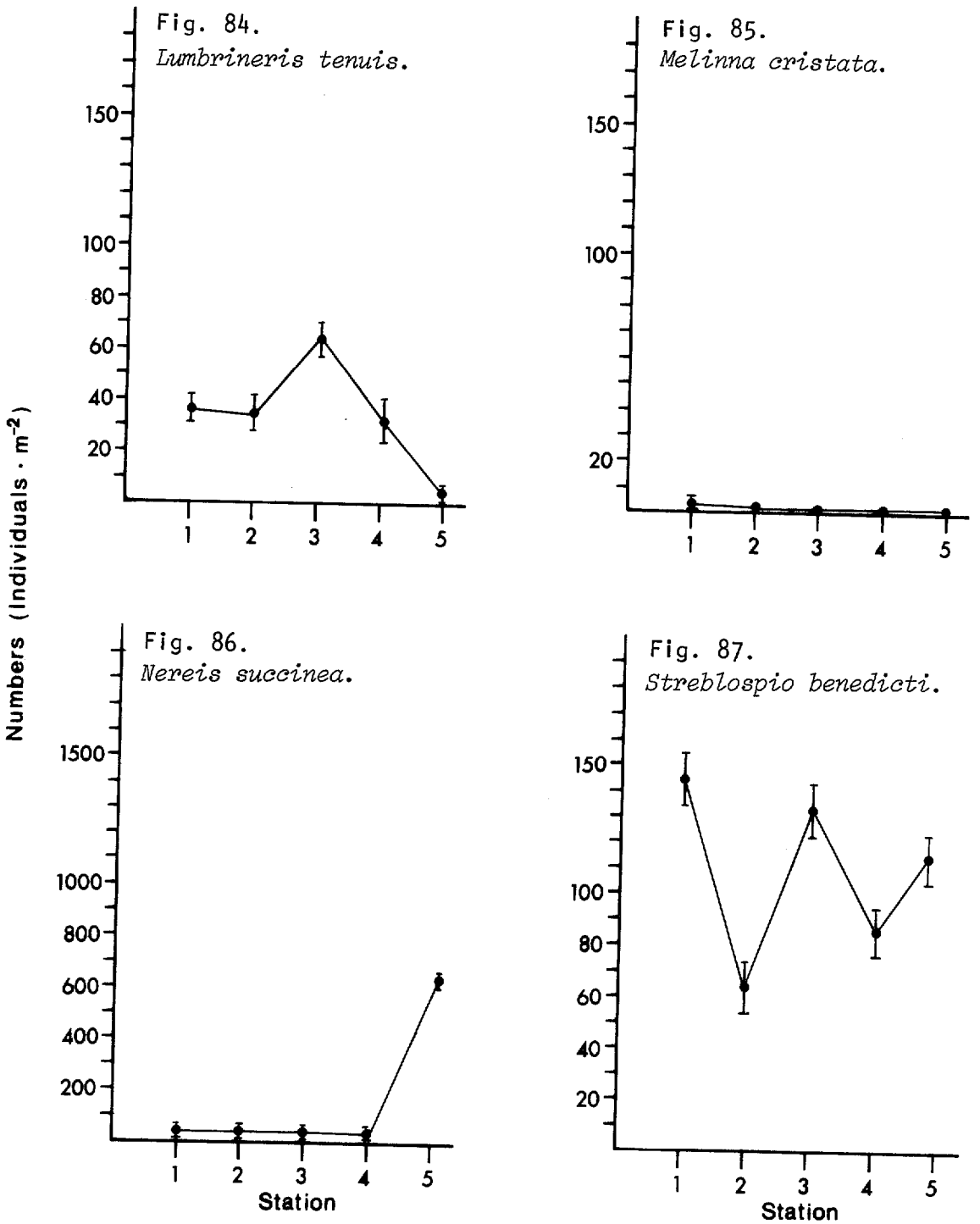
Figs. 74-75. Seasonal biomass totals (1975-1977) for *Gemma* and *Ilyanassa*.



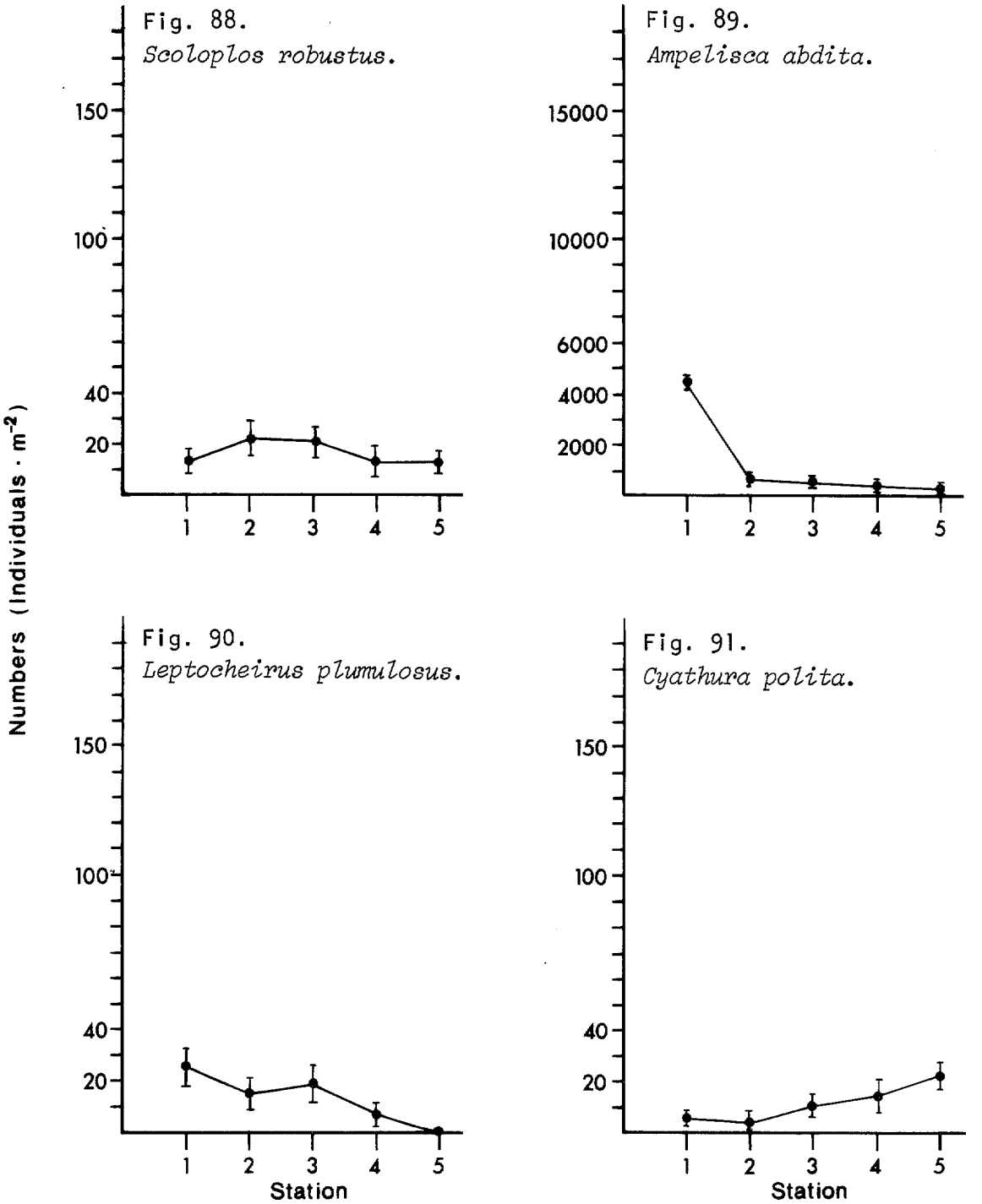
Figs. 76-79. Meyers Creek station totals for numbers of individuals·m^{-2} for the overall categories (1975 - 1977).



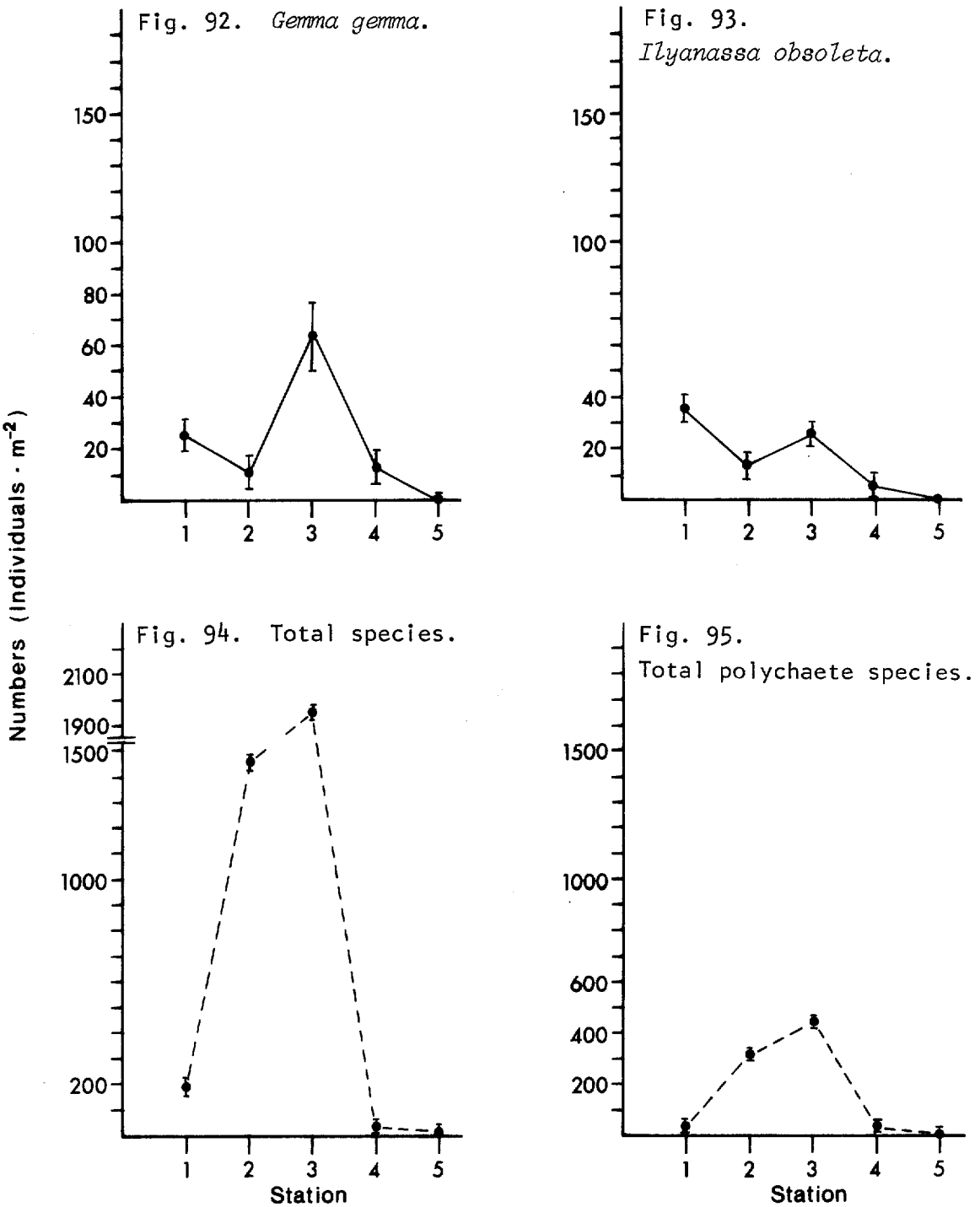
Figs. 80-83. Meyers Creek station totals for numbers of individuals·m^{-2} for *Eteone*, *Glycera*, *Heteromastus*, and *Hypaniola* (1975 - 1977).



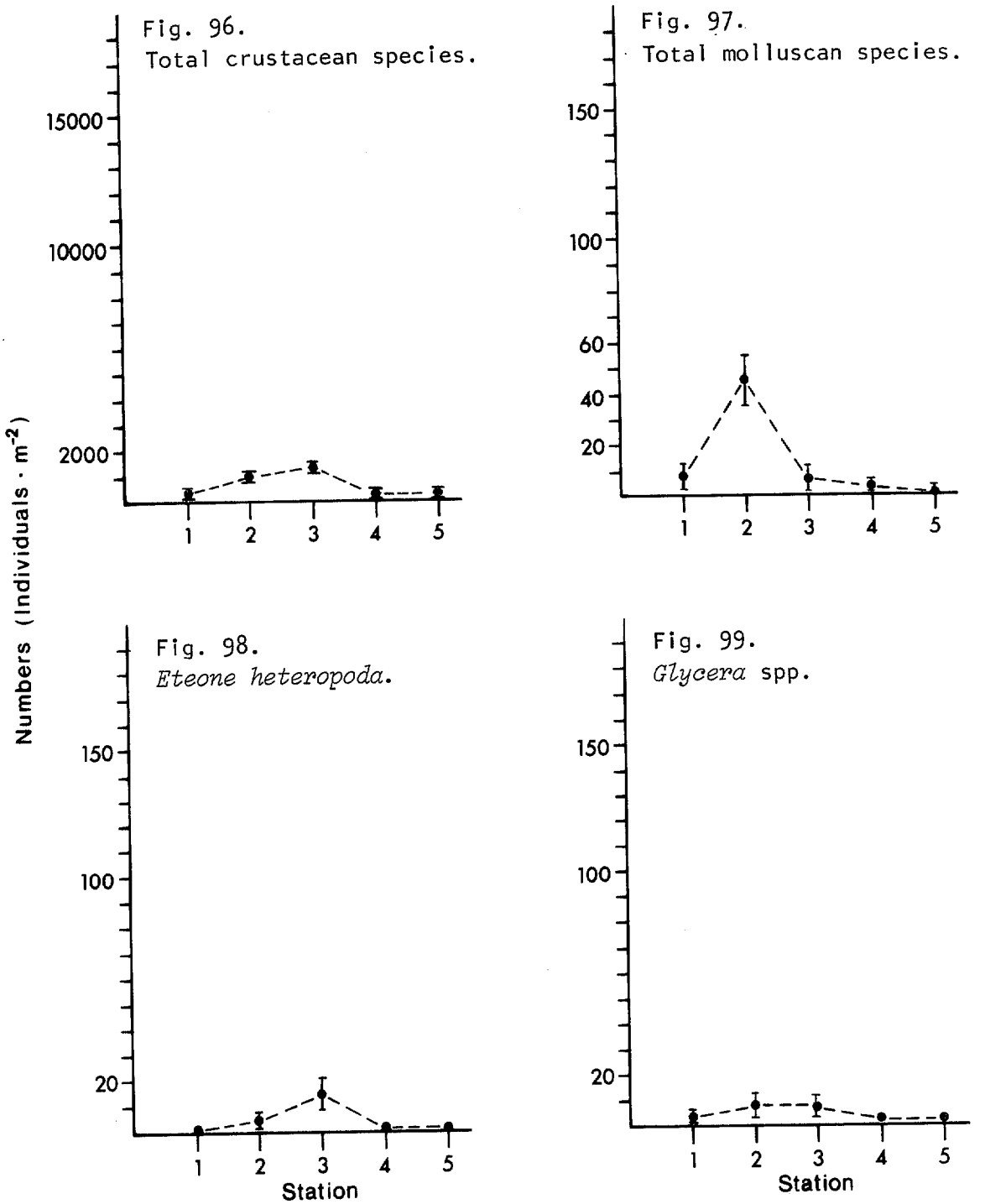
Figs. 84-87. Meyers Creek station totals for numbers of individuals·m^{-2} for *Lumbrineris*, *Melinna*, *Nereis*, and *Streblospio* (1975 - 1977).



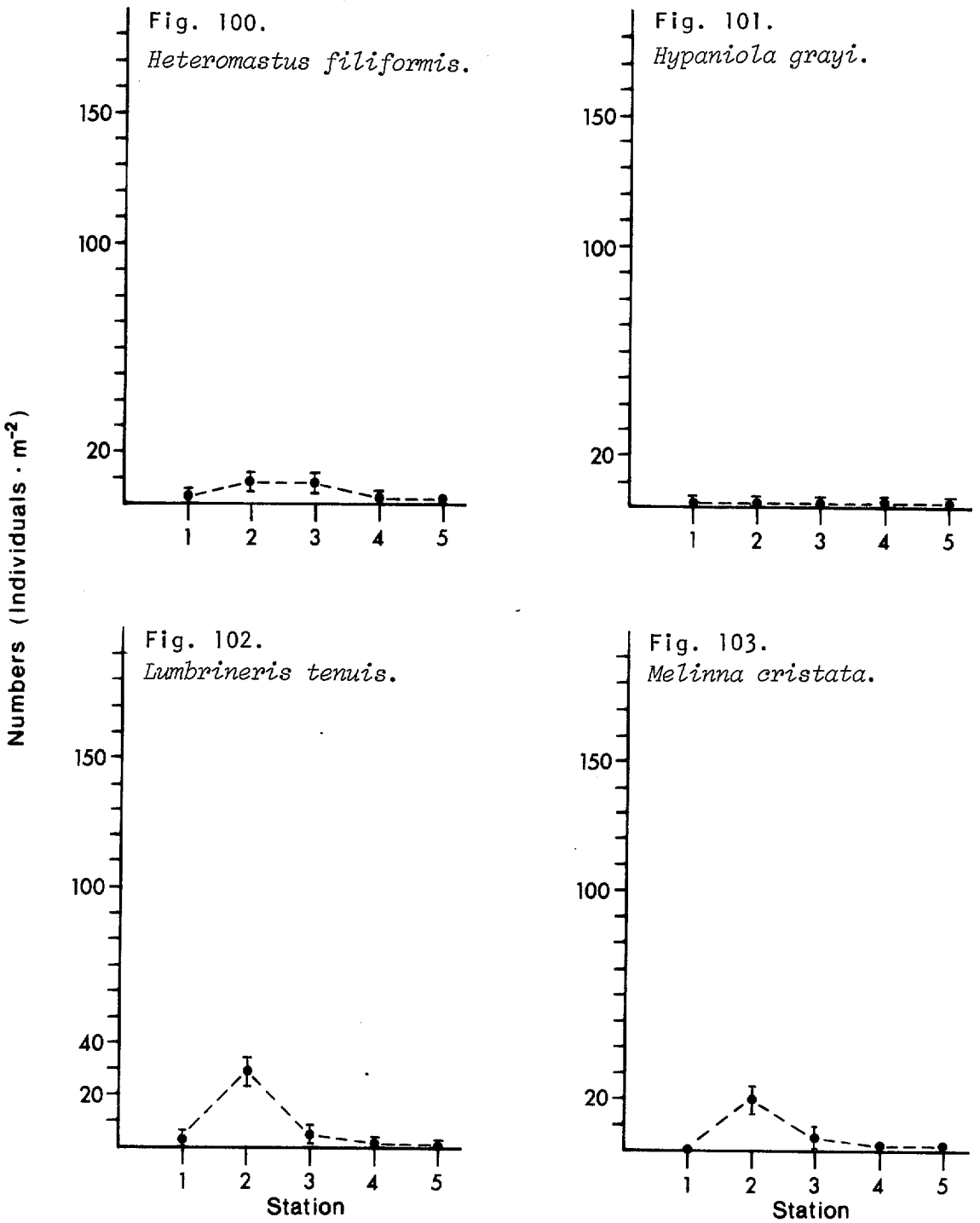
Figs. 88-91. Meyers Creek station totals for numbers of individuals· m^{-2} for *Scoloplos*, *Ampelisca*, *Leptocheirus*, and *Cyathura* (1975 - 1977).



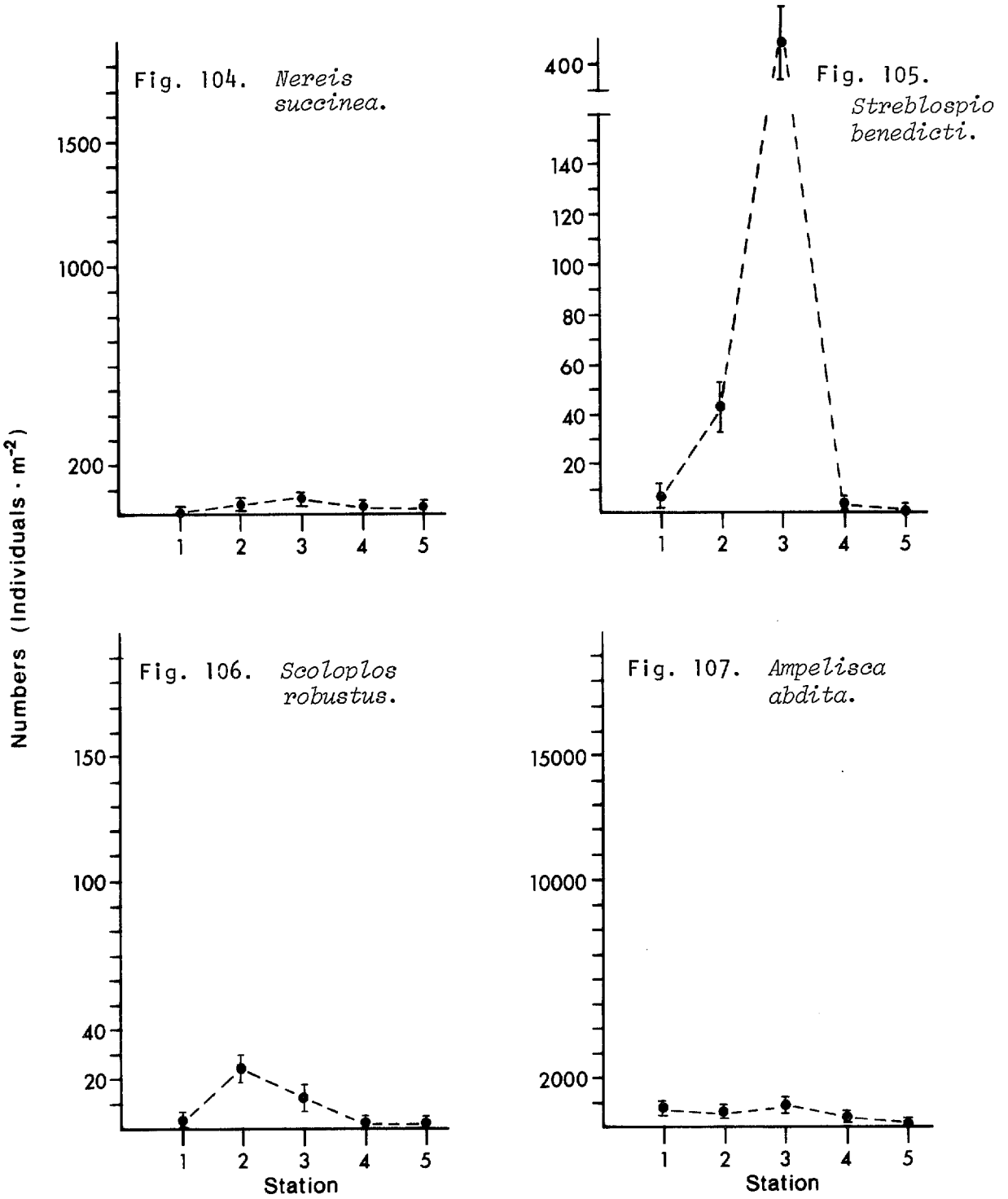
Figs. 92-95. Station totals for numbers of individuals·m^{-2} for *Gemma* and *Ilyanassa* in Meyers Creek and for total species and total polychaete species in Lagoon System B (1975 - 1977).



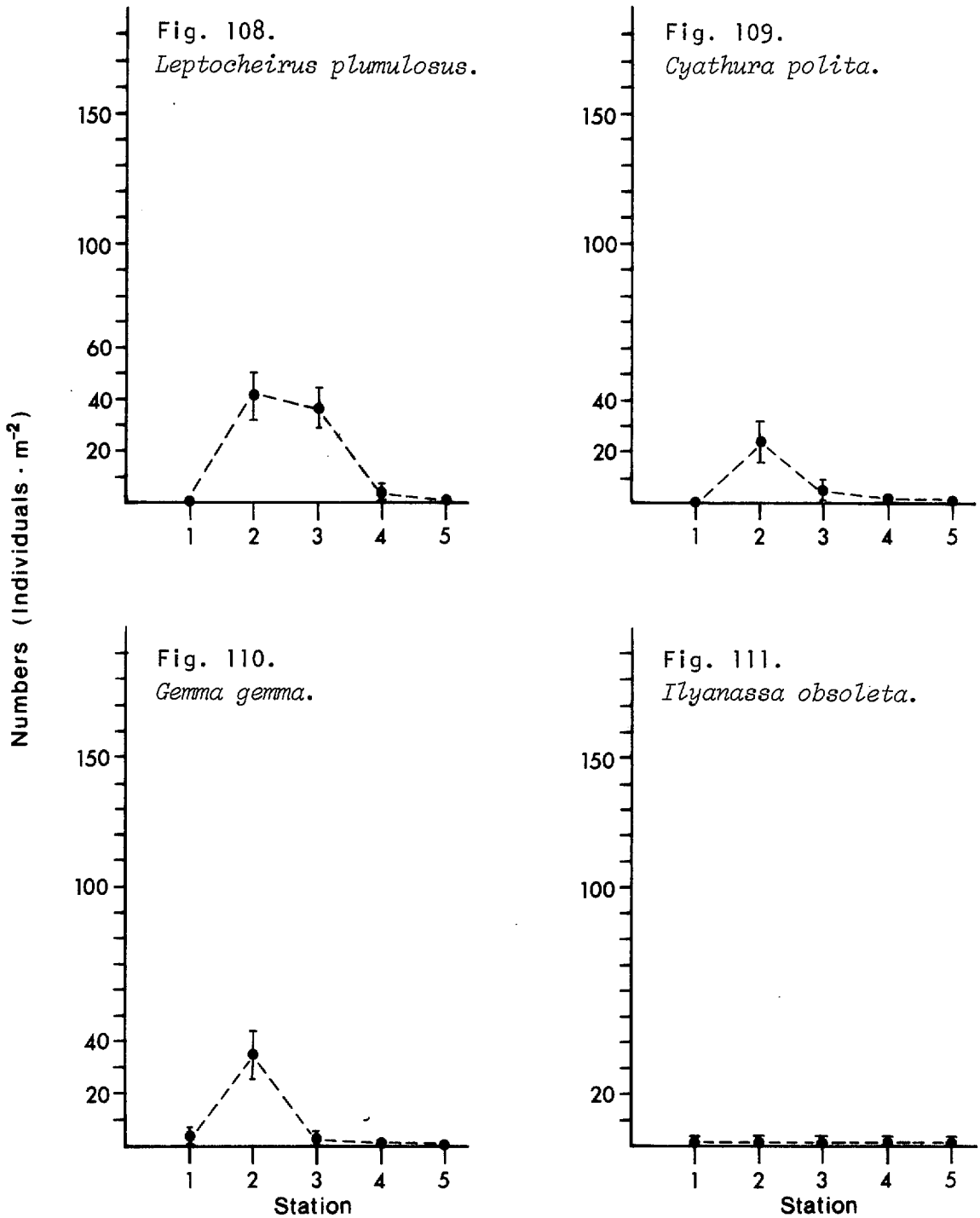
Figs. 96-99. Lagoon System B station totals for numbers of individuals· m^{-2} for total crustacean species, total molluscan species, *Eteone*, and *Glycera* (1975 - 1977).



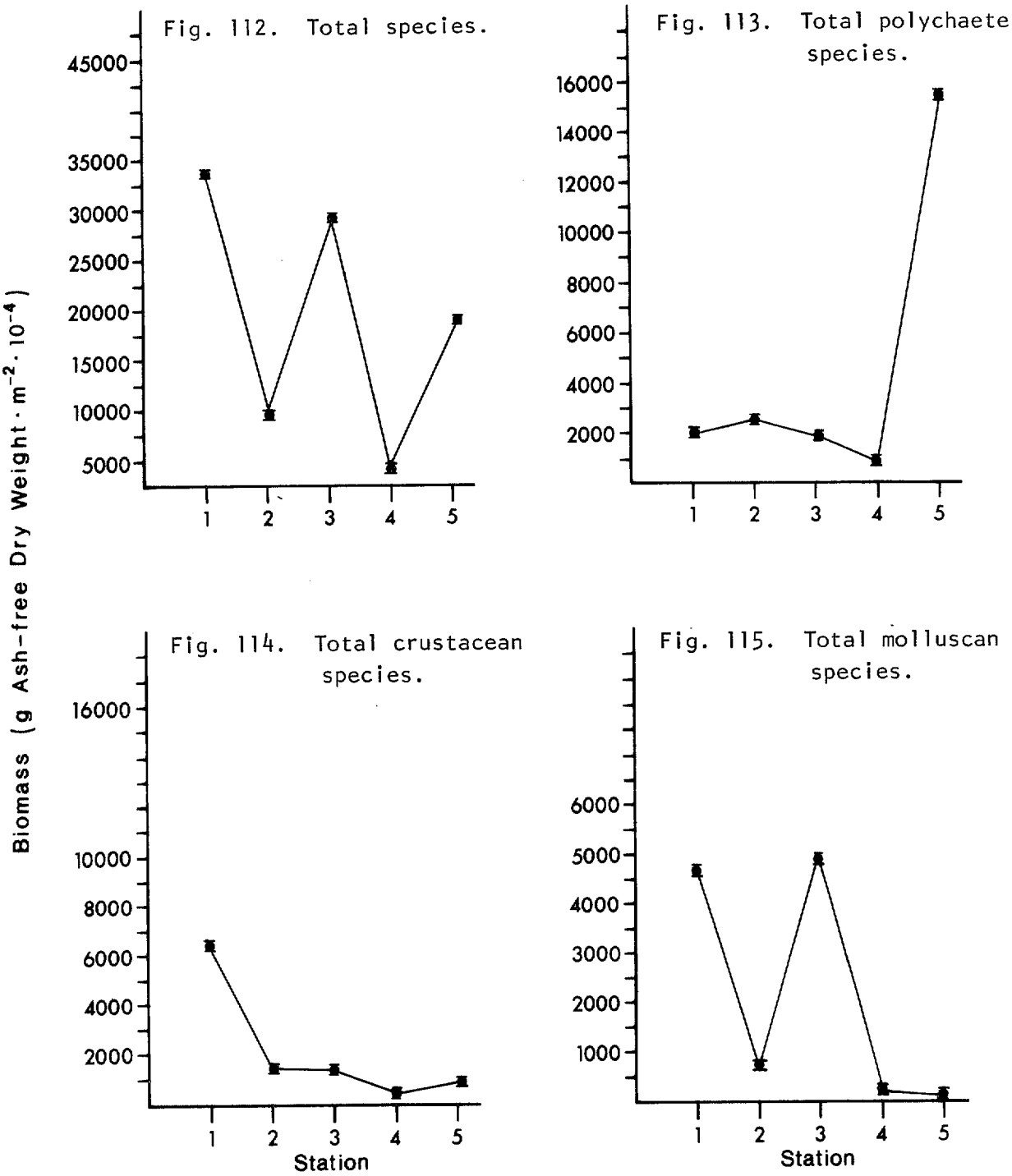
Figs. 100-103. Lagoon System B station totals for numbers of individuals· m^{-2} for *Heteromastus*, *Hypaniola*, *Lumbrineris*, and *Melinna* (1975 - 1977).



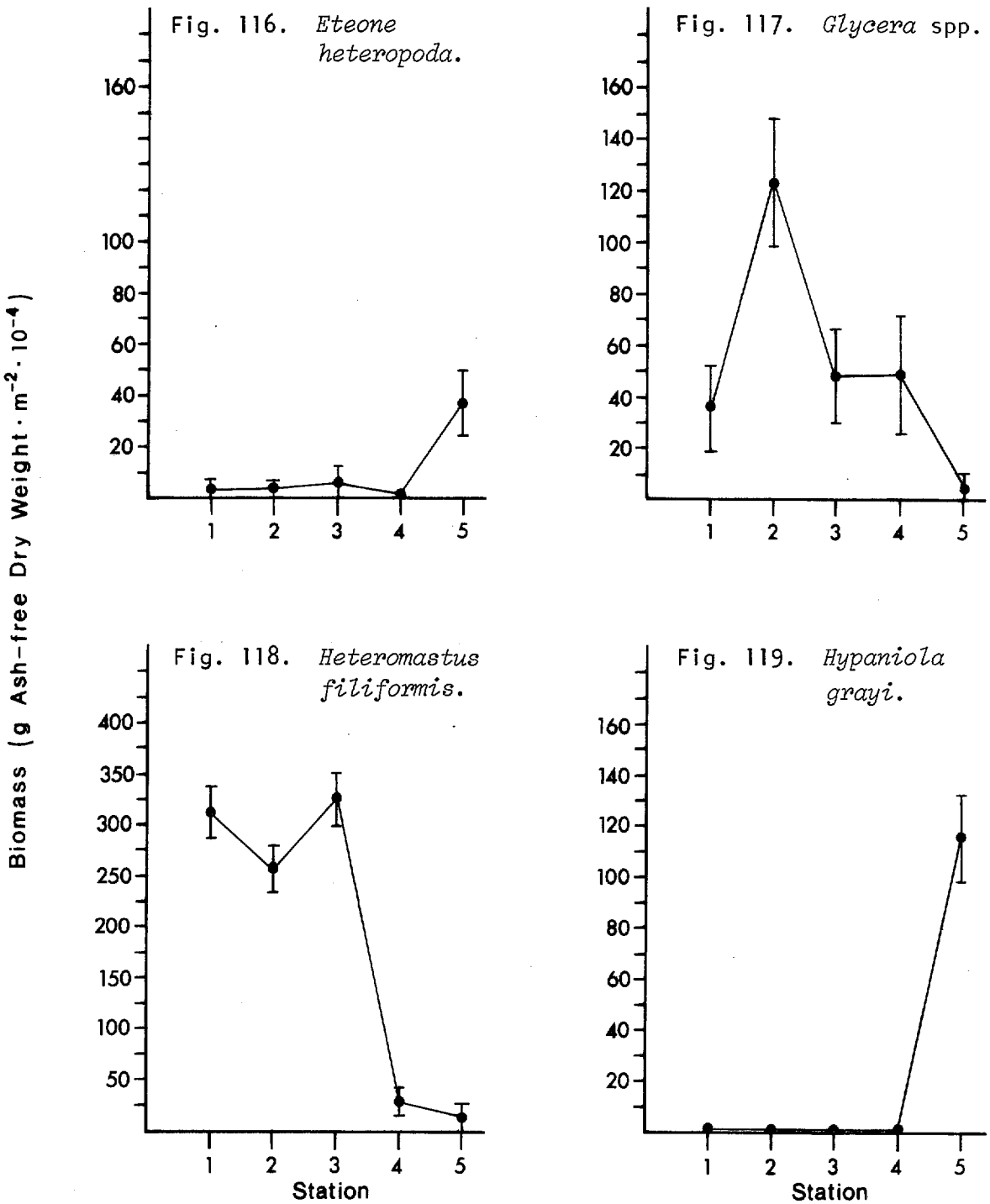
Figs. 104-107. Lagoon System B station totals for numbers of individuals· m^{-2} for *Nereis*, *Streblospio*, *Scoloplos*, and *Ampelisca* (1975 - 1977).



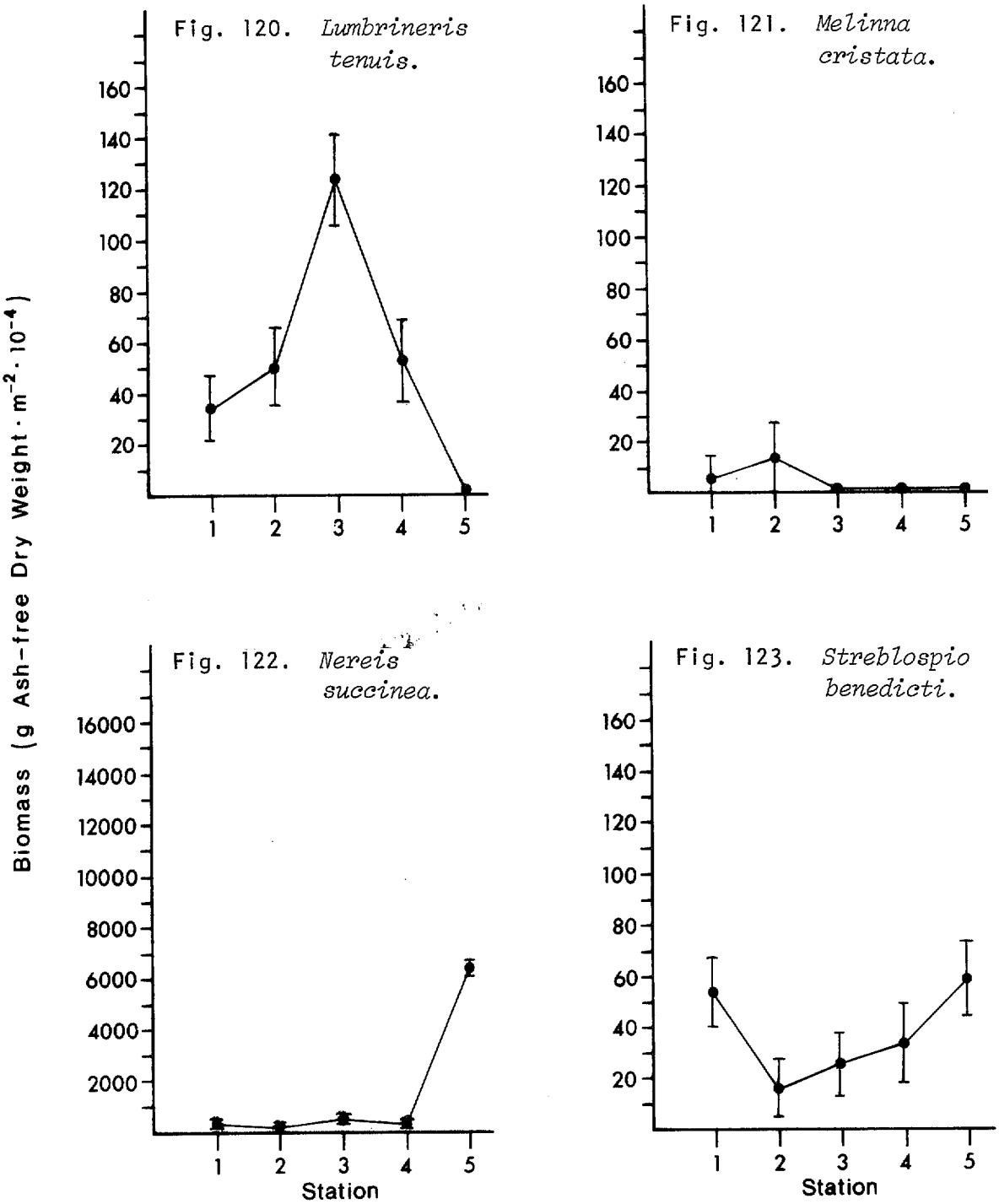
Figs. 108-111. Lagoon System B station totals for numbers of individuals· m^{-2} for *Leptocheirus*, *Cyathura*, *Gemma*, and *Ilyanassa* (1975 - 1977).



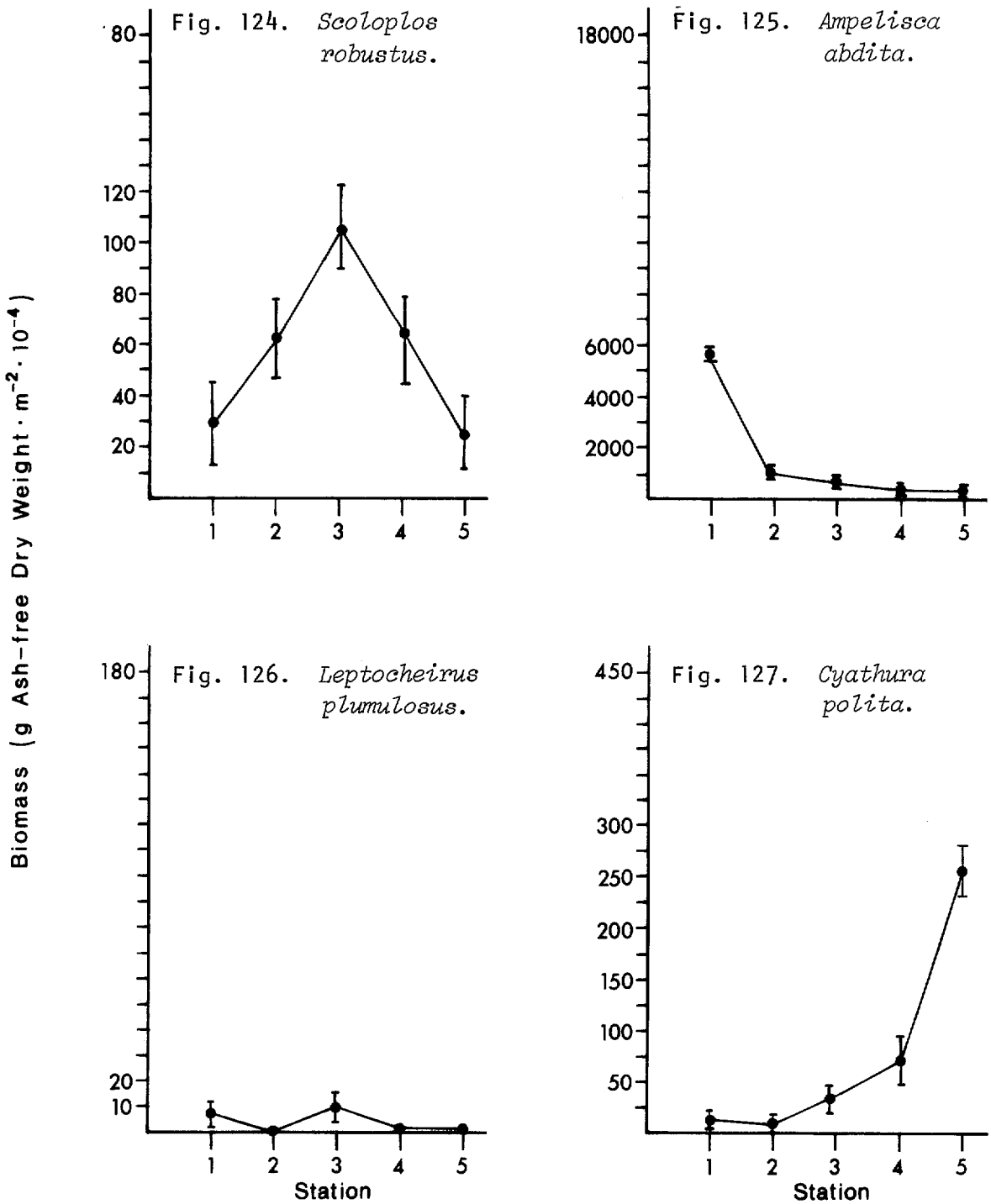
Figs. 112-115. Meyers Creek station biomass totals (1975 - 1977) for the overall categories.



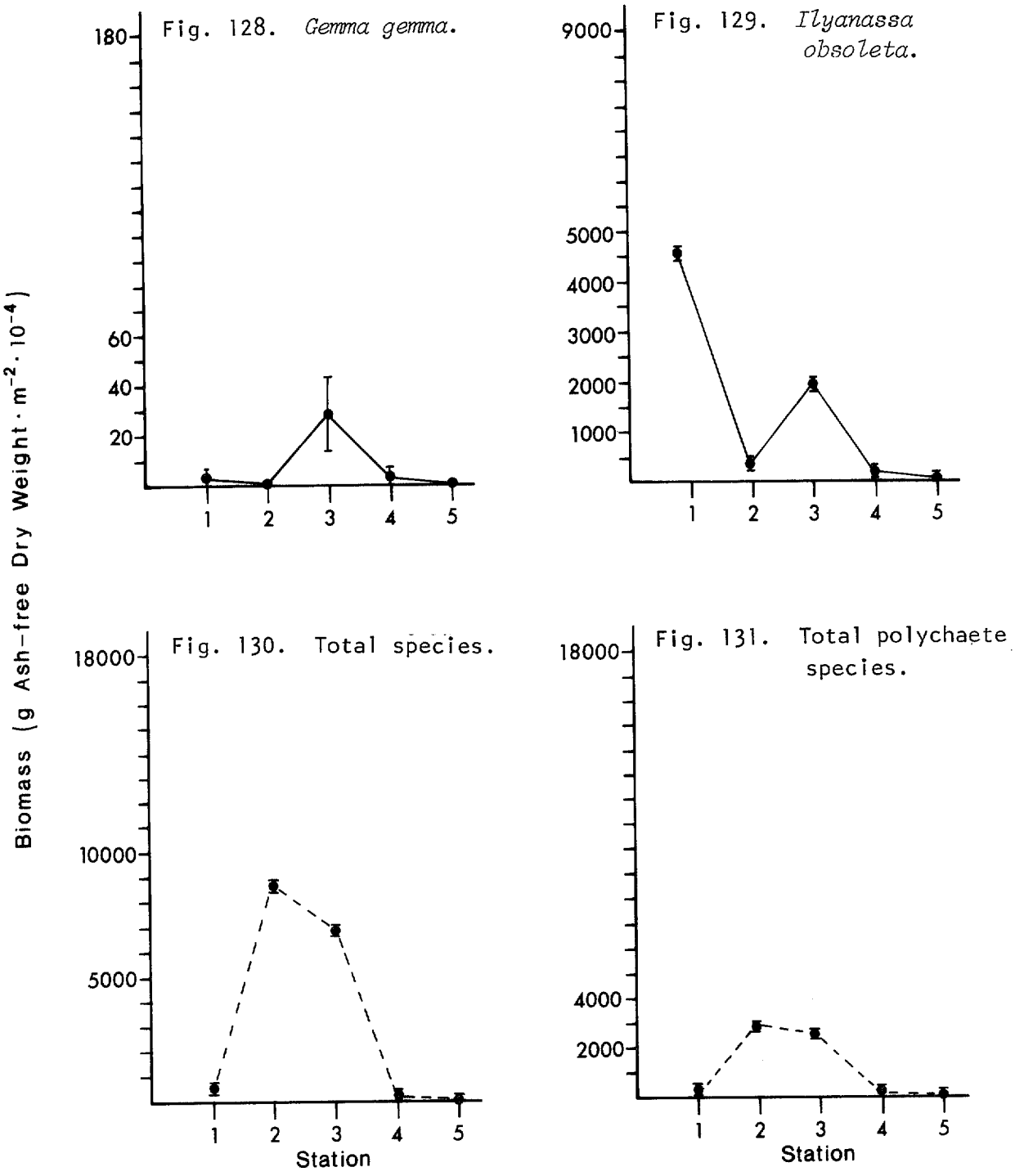
Figs. 116-119. Meyers Creek station biomass totals (1975 - 1977) for *Eteone*, *Glycera*, *Heteromastus*, and *Hypaniola*.



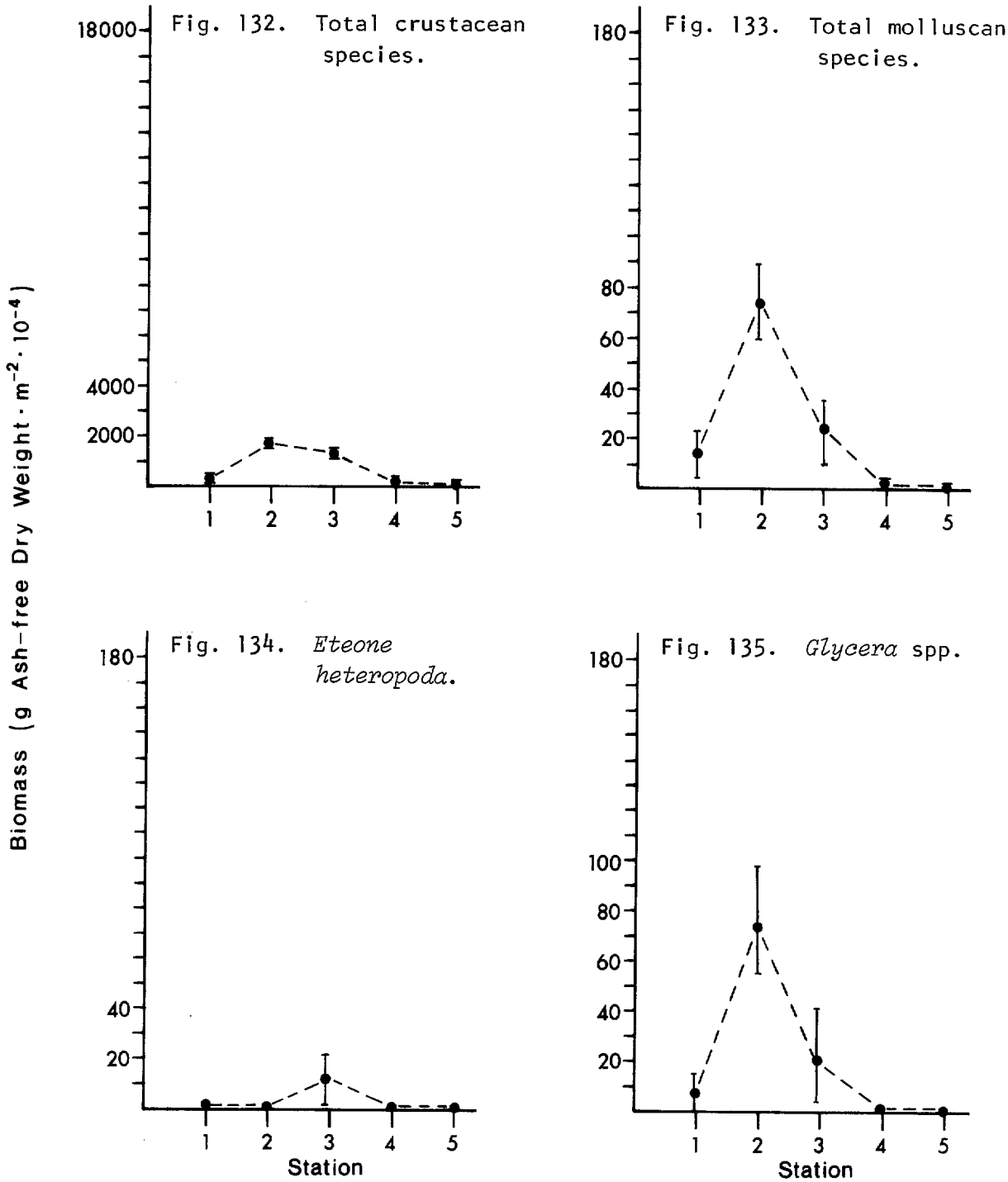
Figs. 120-123. Meyers Creek station biomass totals (1975 - 1977) for *Lumbrineris*, *Melinna*, *Nereis*, and *Streblospio*.



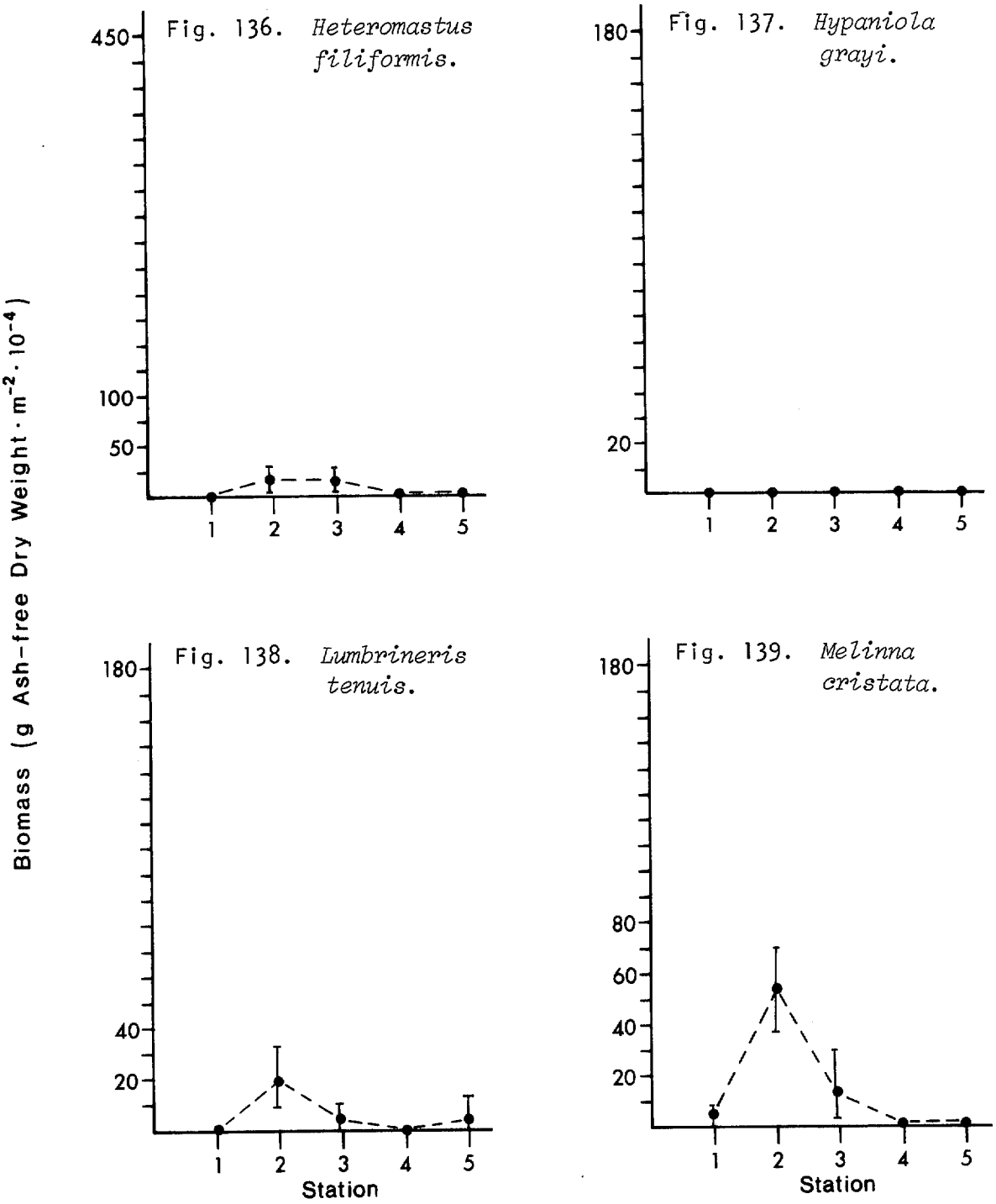
Figs. 124-127. Meyers Creek station biomass totals (1975 - 1977) for *Scoloplos*, *Ampelisca*, *Leptocheirus*, and *Cyathura*.



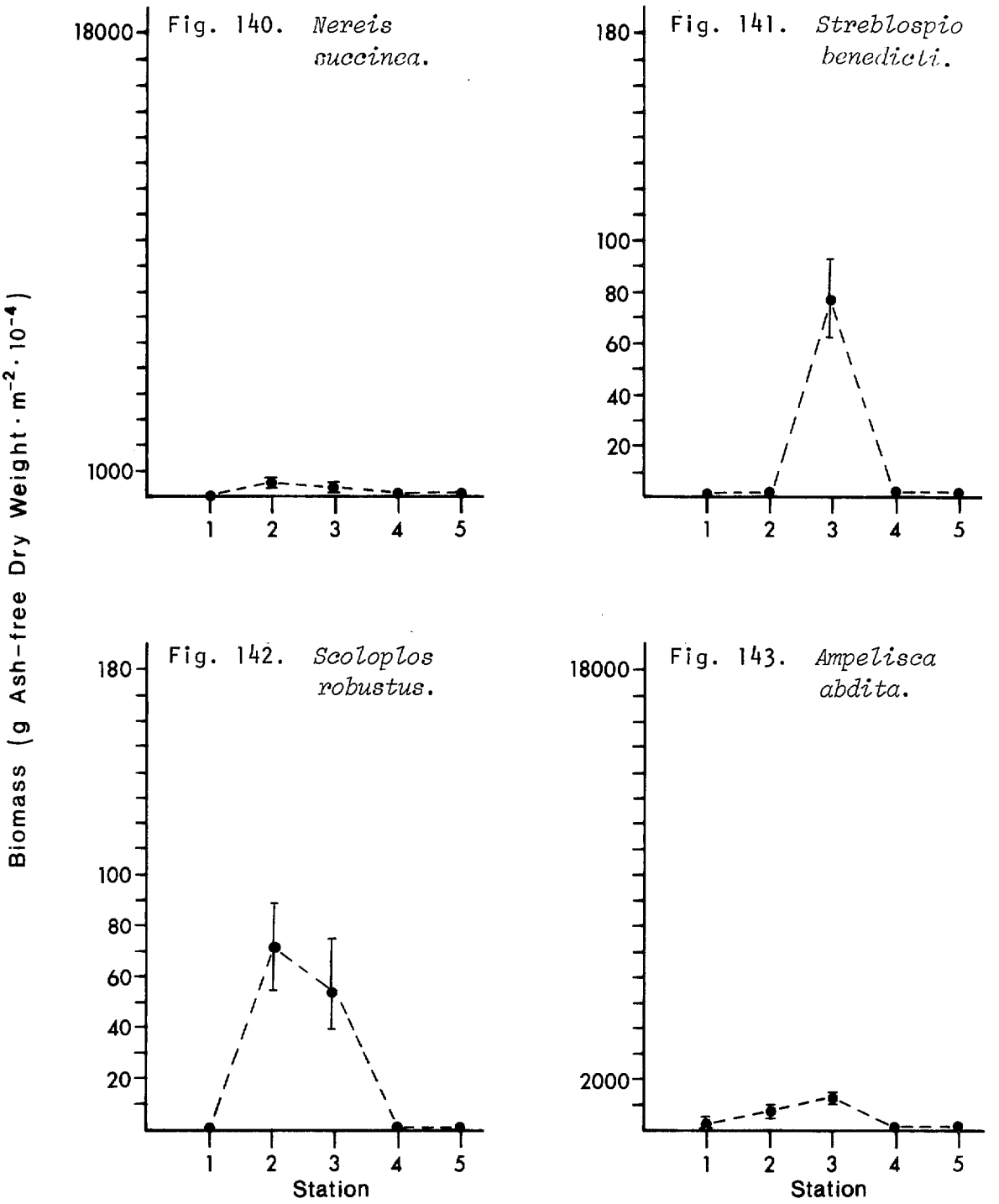
Figs. 128-131. Station biomass totals (1975 - 1977) for *Gemma* and *Ilyanassa* in Meyers Creek and total species and total polychaete species in Lagoon System B.



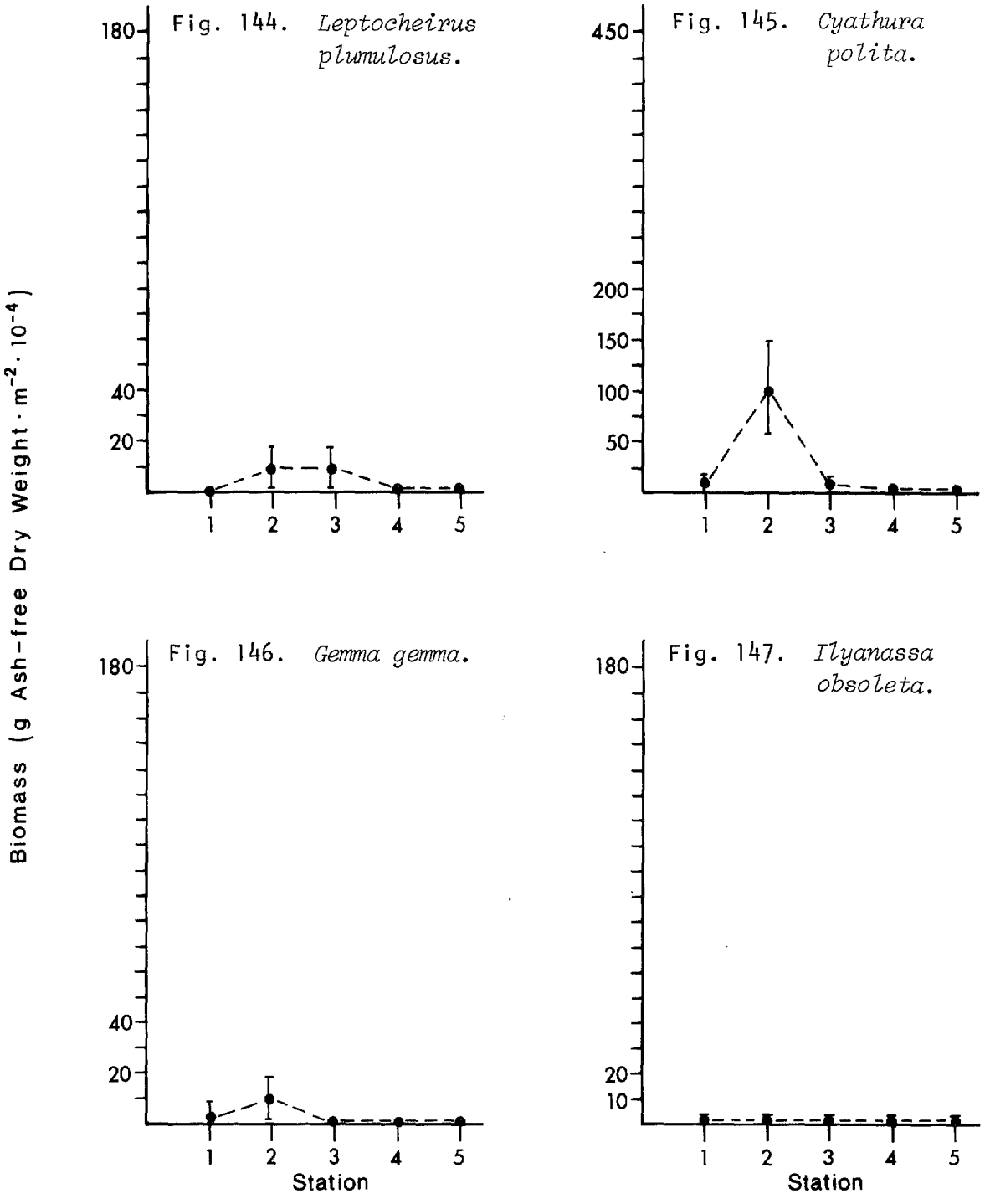
Figs. 132-135. Lagoon System B station biomass totals (1975 - 1977) for total crustacean species, total molluscan species, *Eteone*, and *Glycera*.



Figs. 136-139. Lagoon System B station biomass totals (1975 - 1977) for *Heteromastus*, *Hypaniola*, *Lumbrineris*, and *Melinna*.



Figs. 140-143. Lagoon System B station biomass totals (1975 - 1977) for *Nereis*, *Streblospio*, *Scoloplos*, and *Ampelisca*.



Figs. 144-147. Lagoon System B station biomass totals (1975 - 1977) for *Leptocheirus*, *Cyathura*, *Gemma*, and *Ilyanassa*.

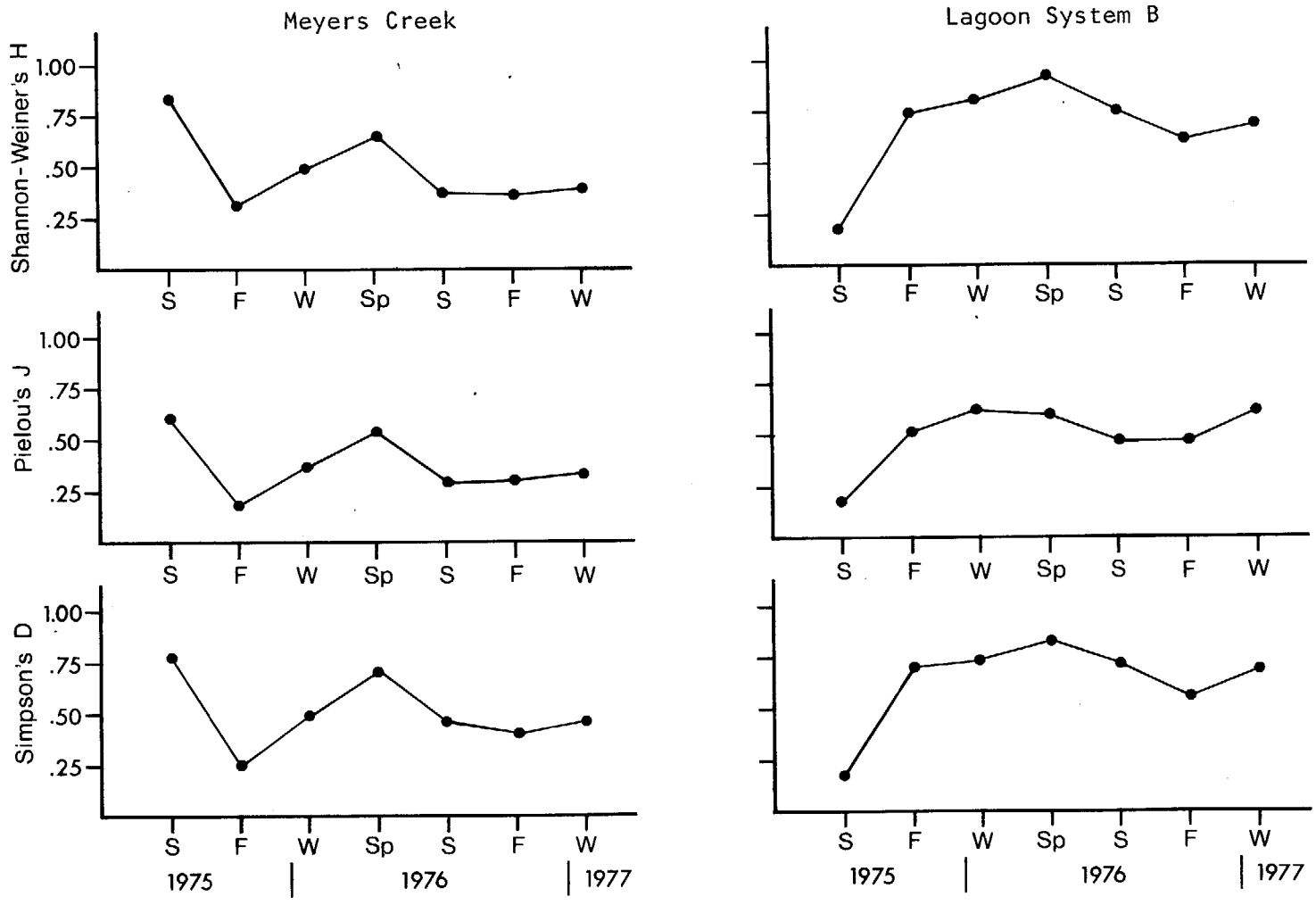


Fig. 148. Diversity indices for the seasons at Meyers Creek and Lagoon System B.

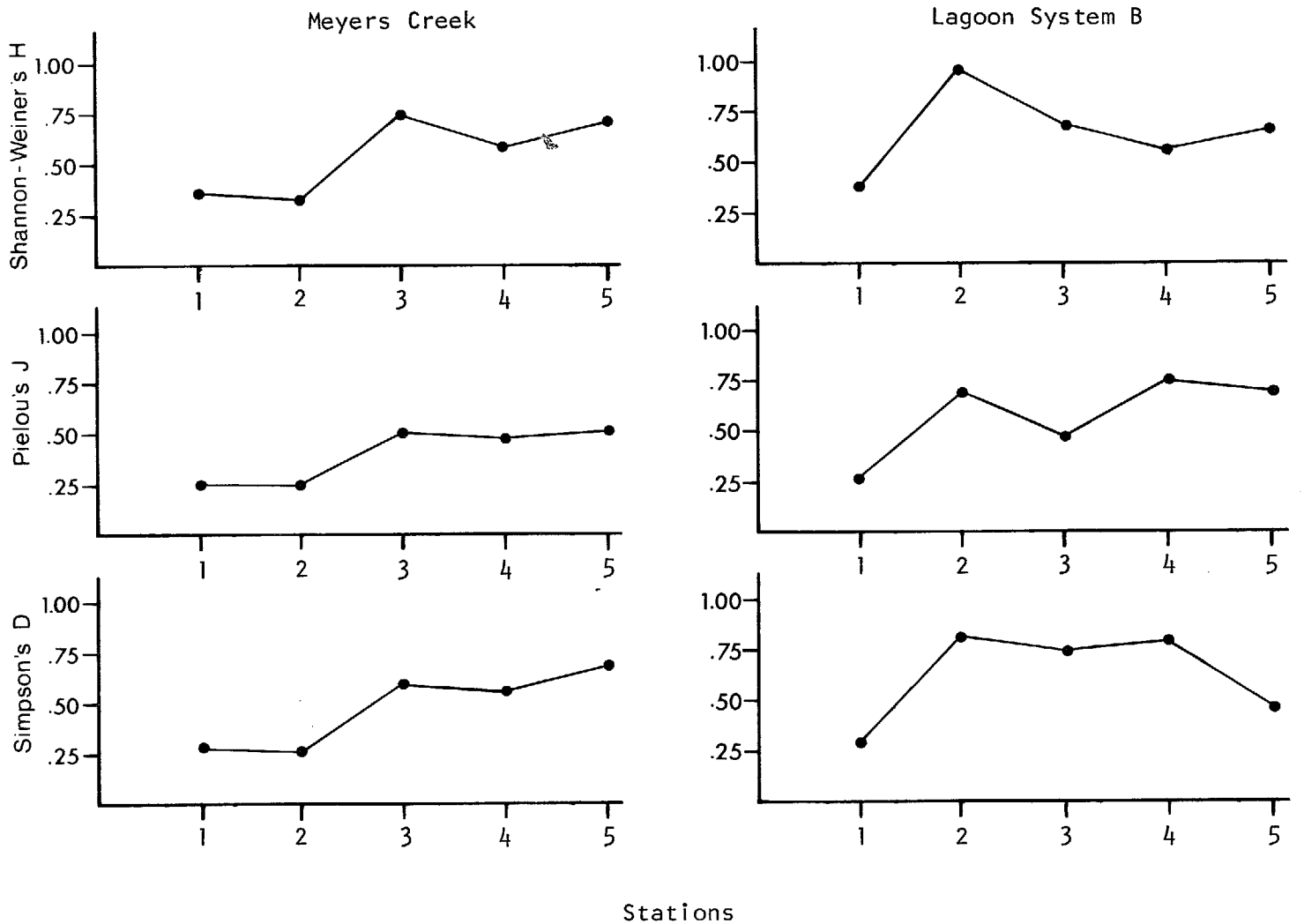


Fig. 149. Diversity indices for the Meyers Creek and Lagoon System B stations.

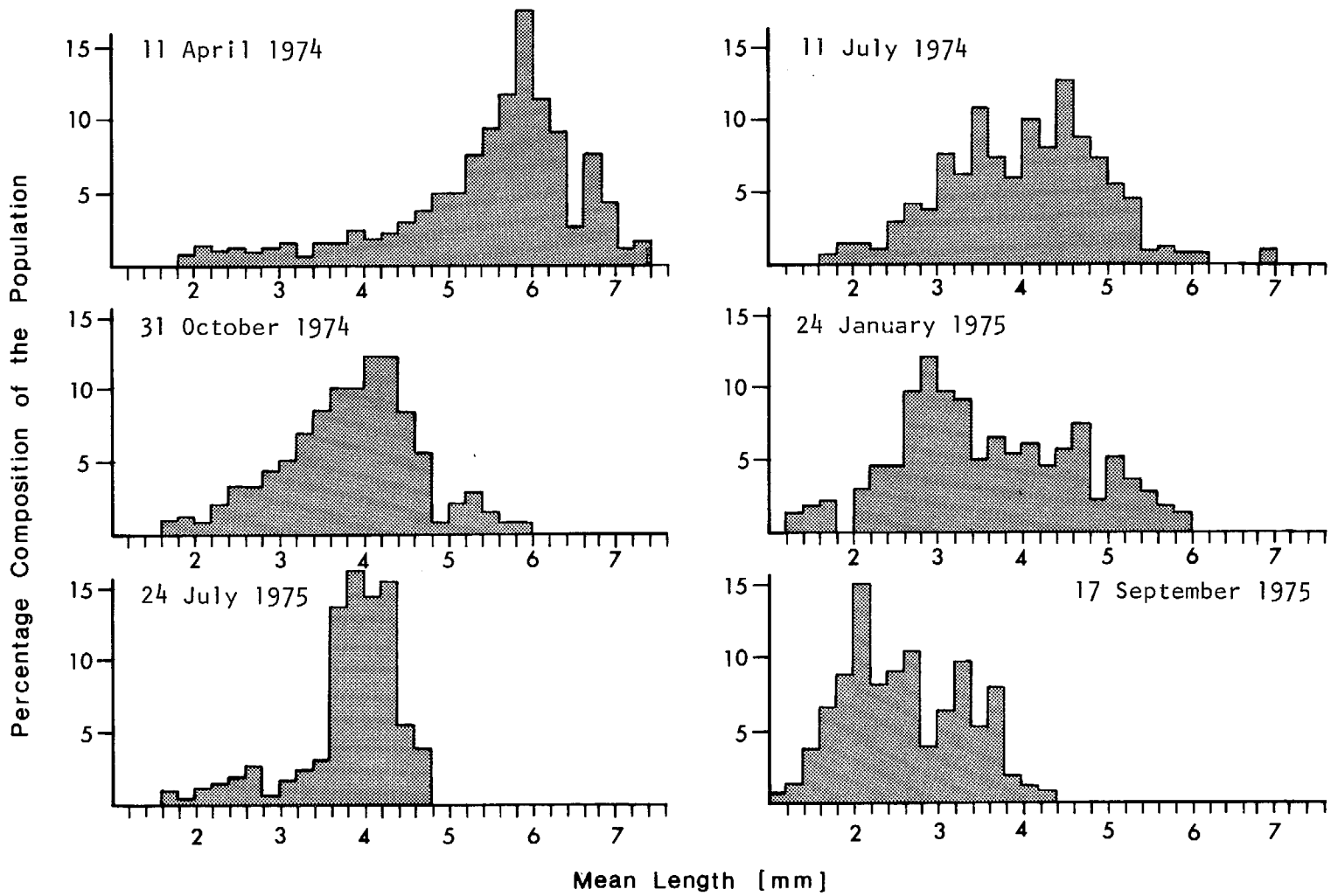


Fig. 150. Size frequency distributions for *Ampelisca abdita*.

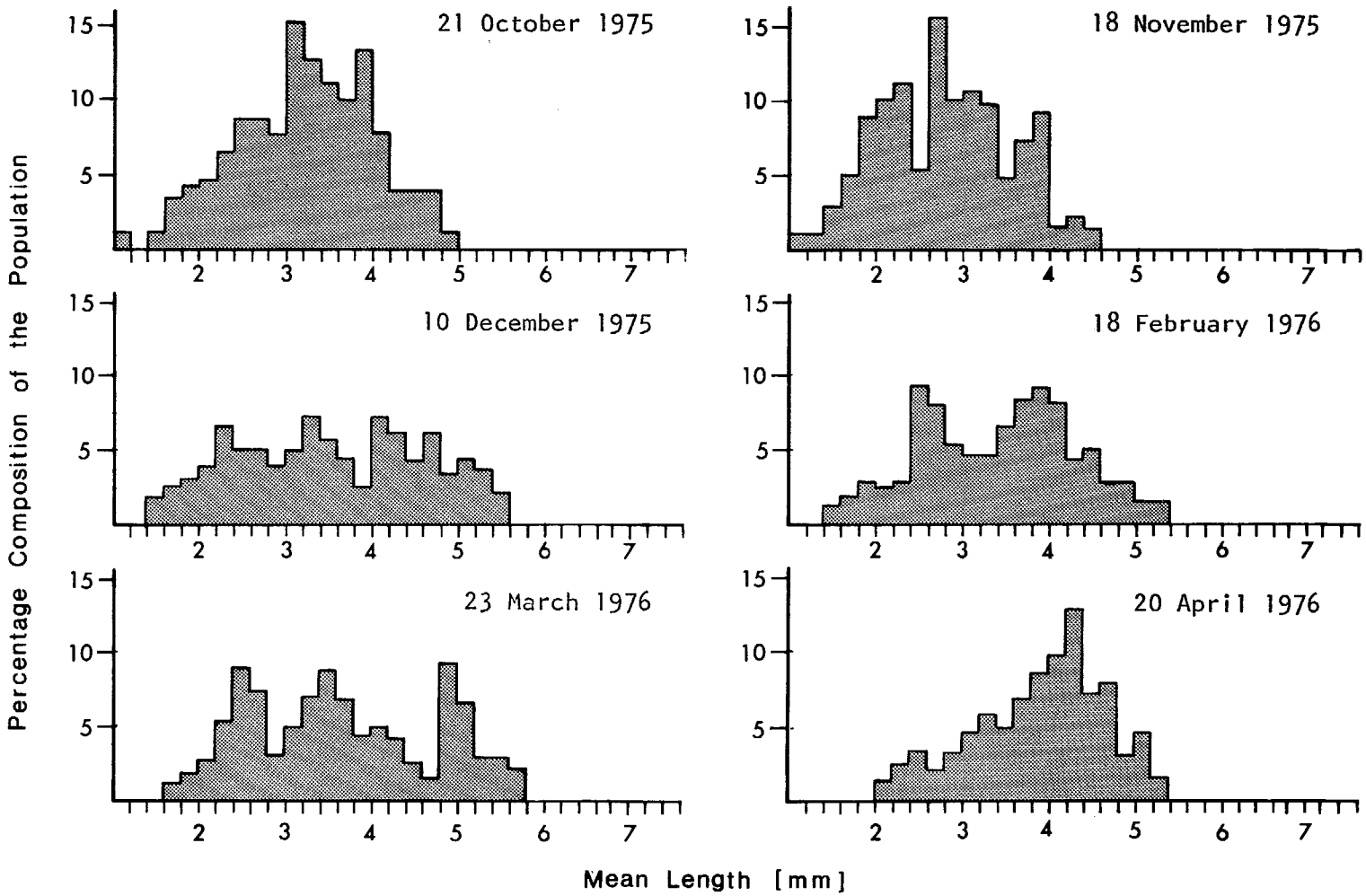


Fig. 150. Continued.

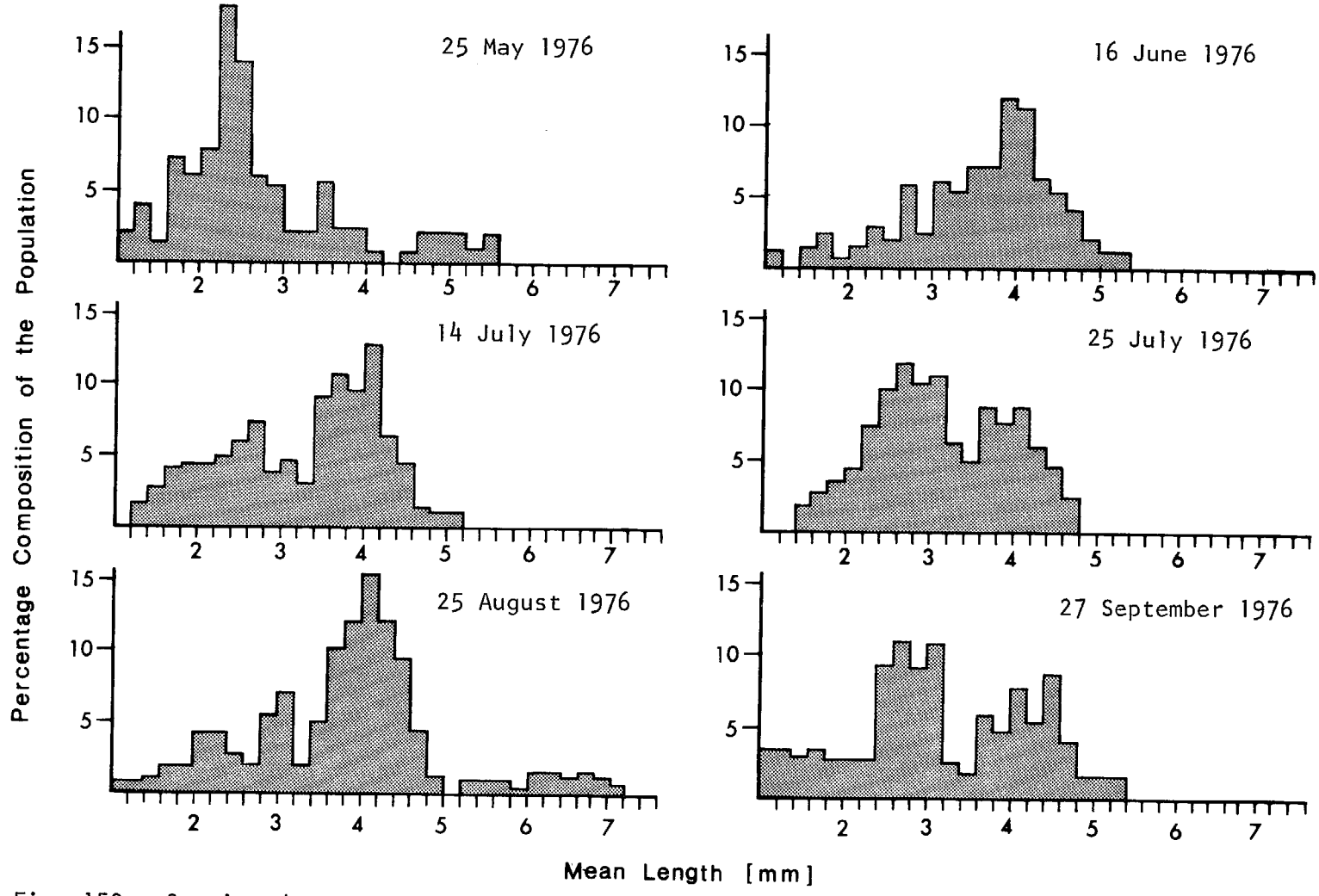


Fig. 150. Continued.

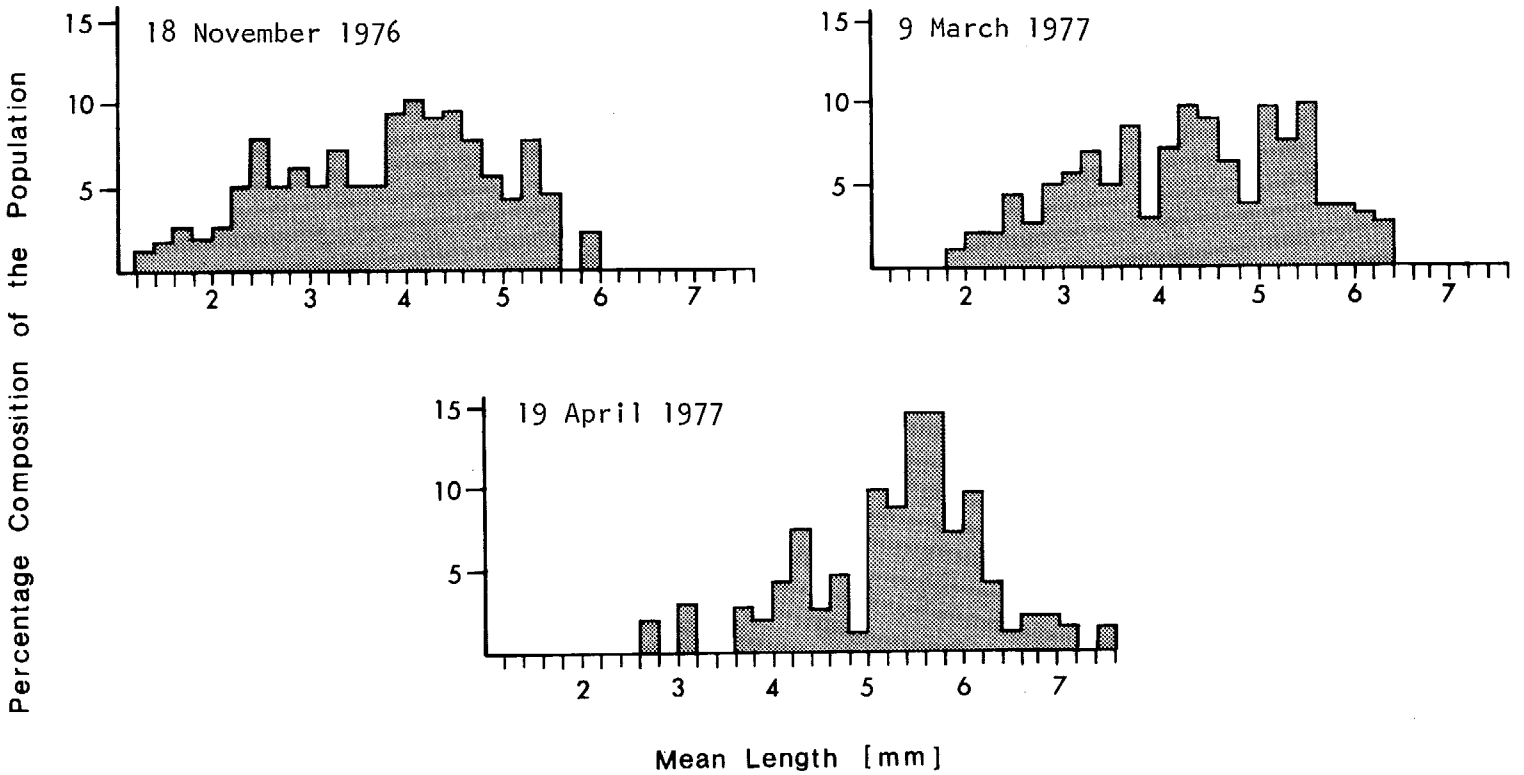
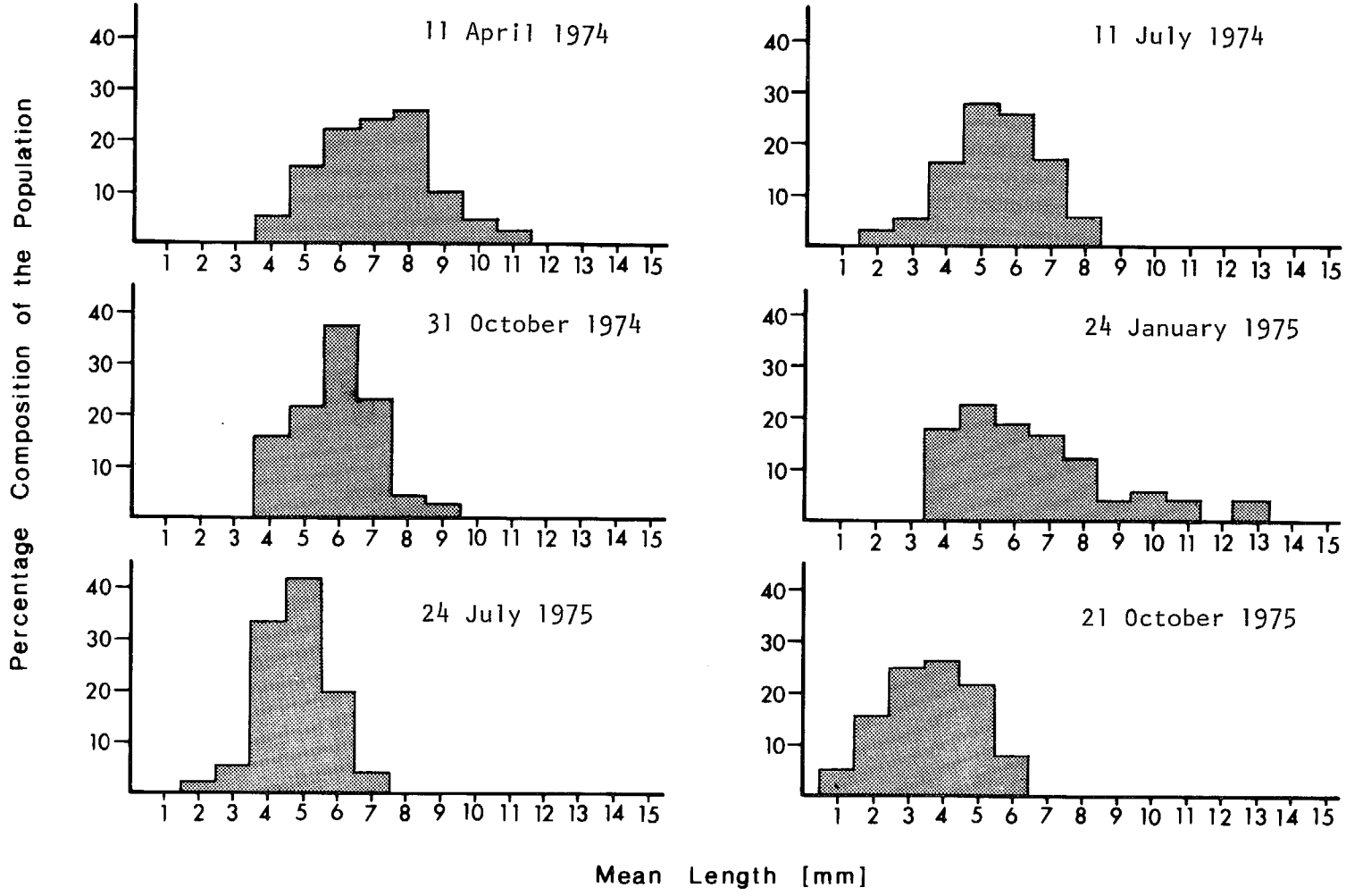


Fig. 150. Continued.



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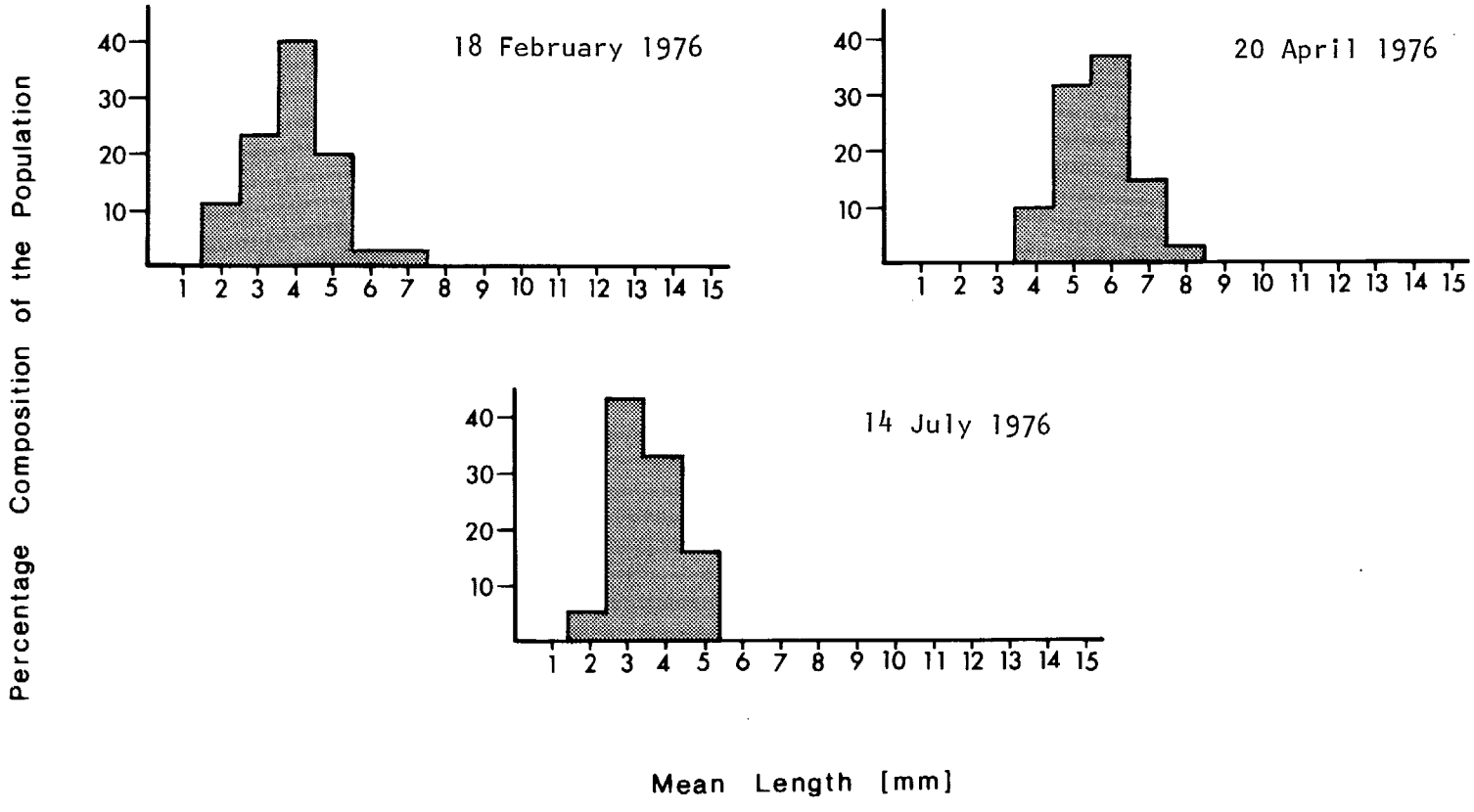
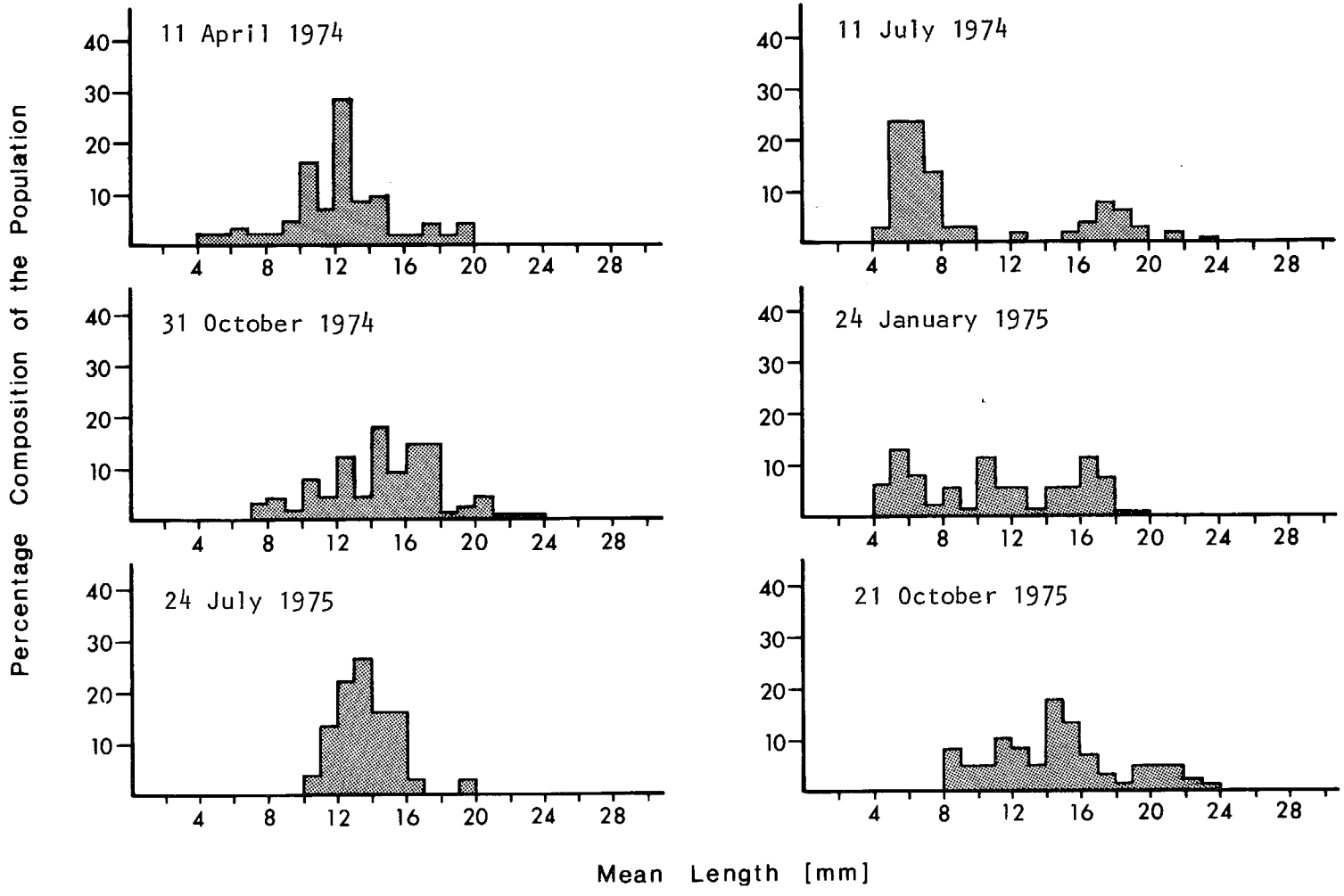


Fig. 151. Continued.



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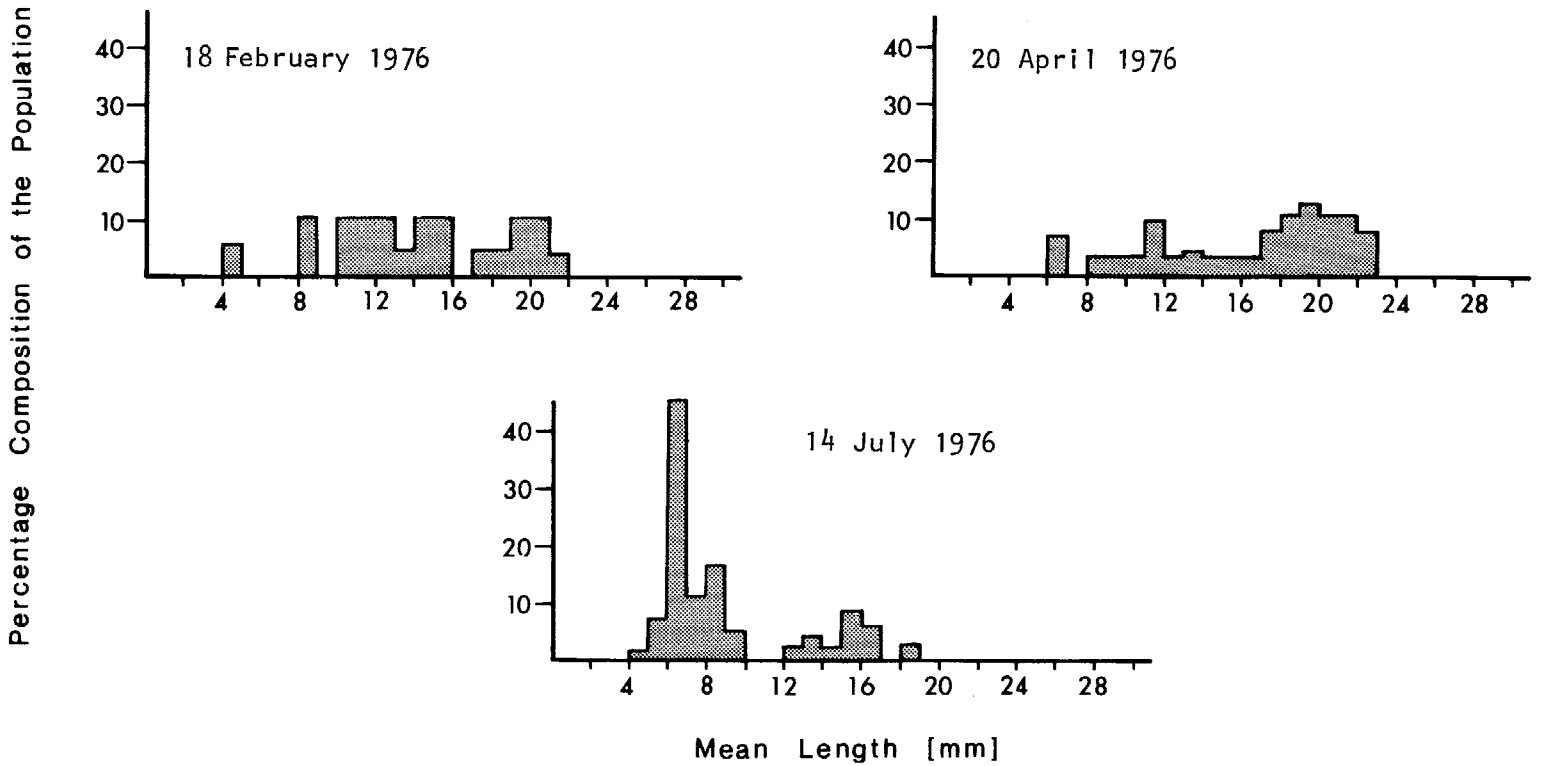
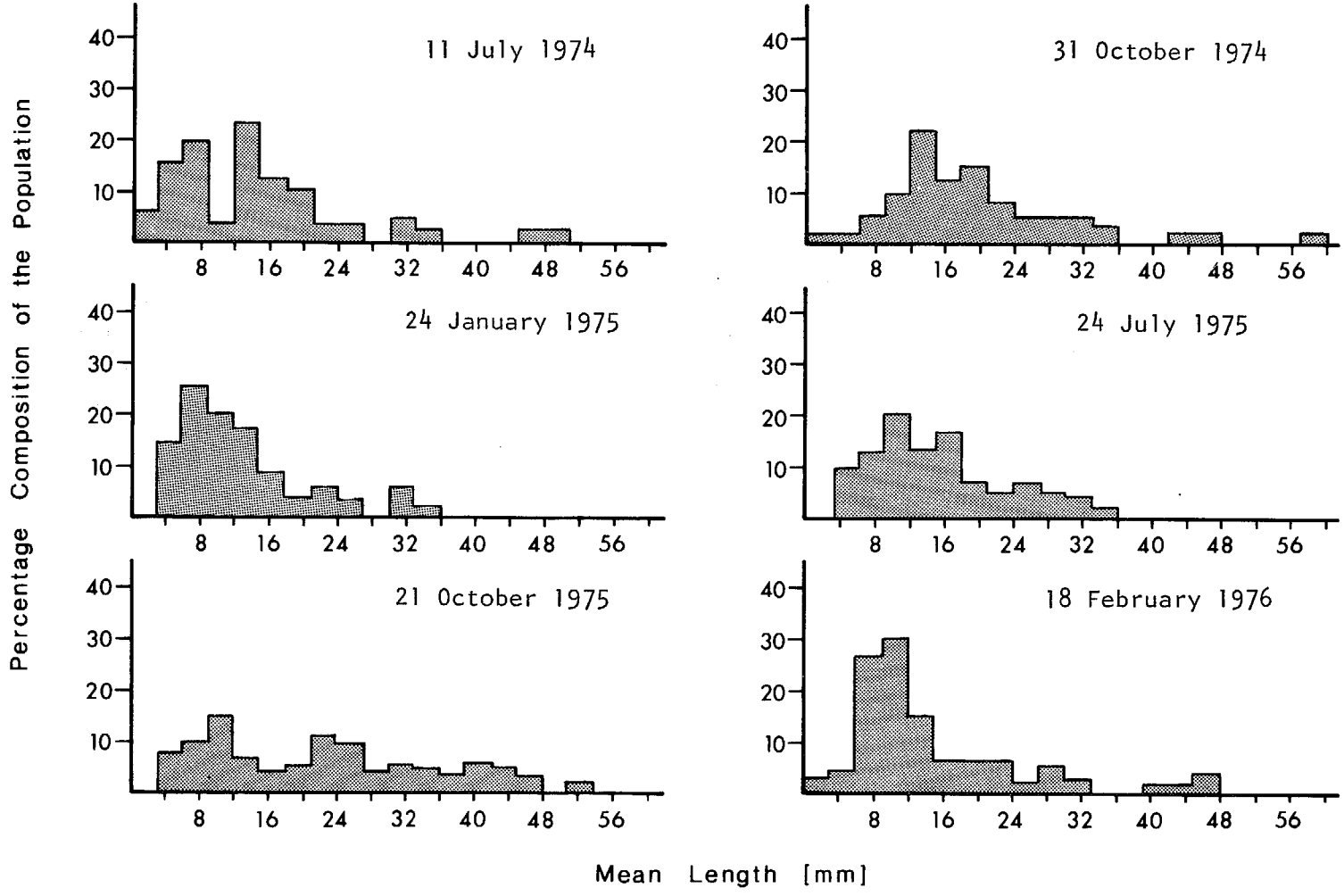


Fig. 152. Continued.



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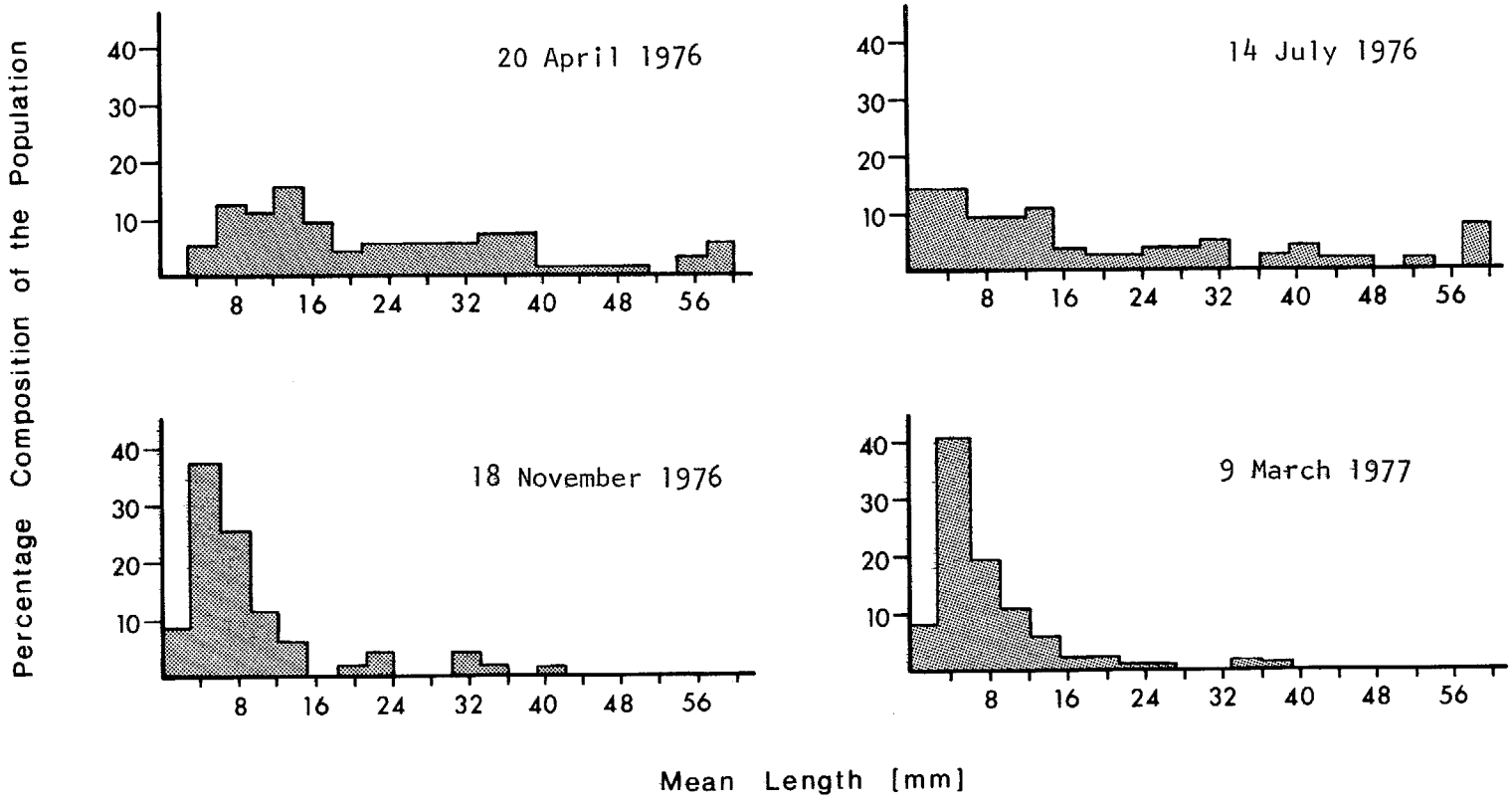

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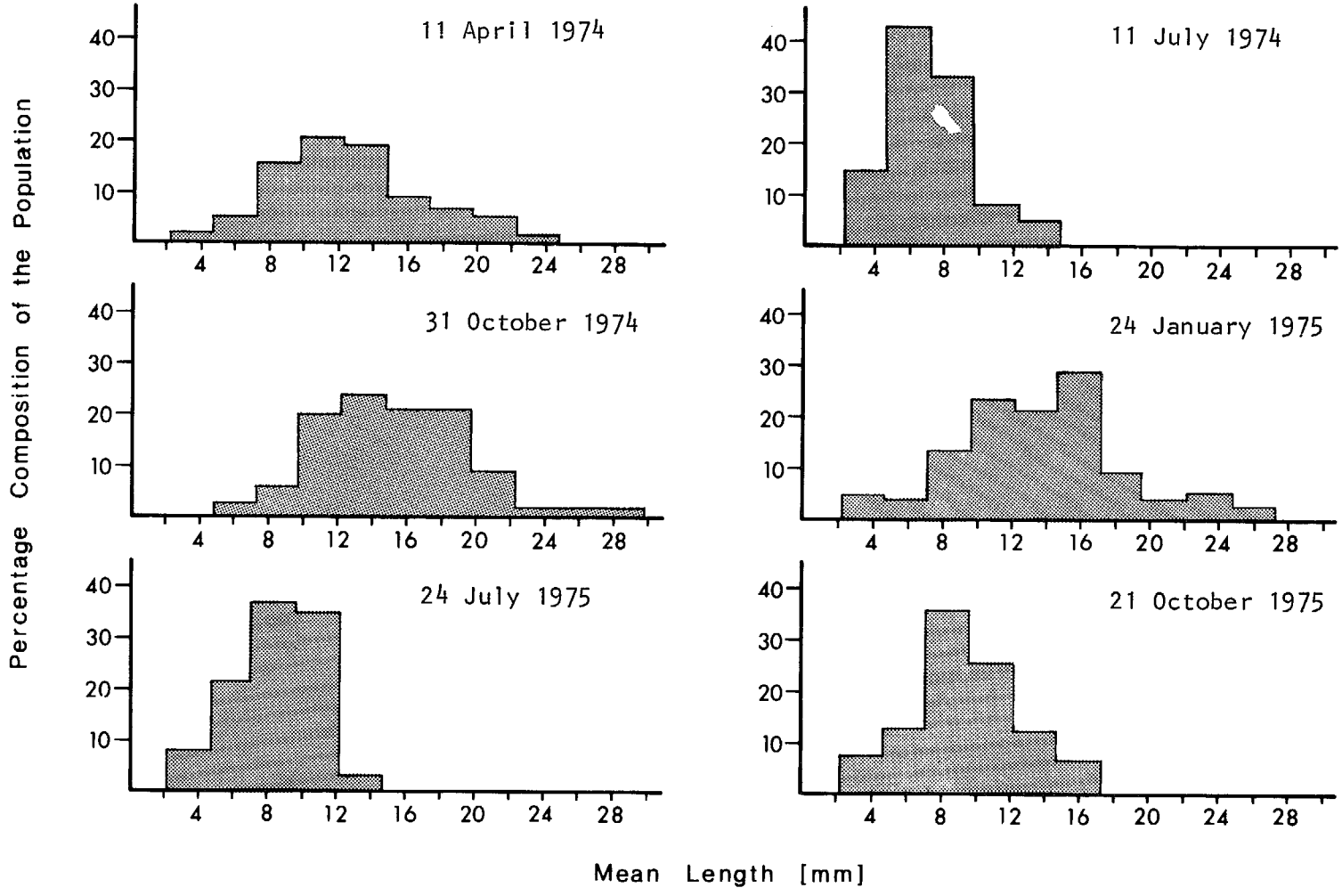

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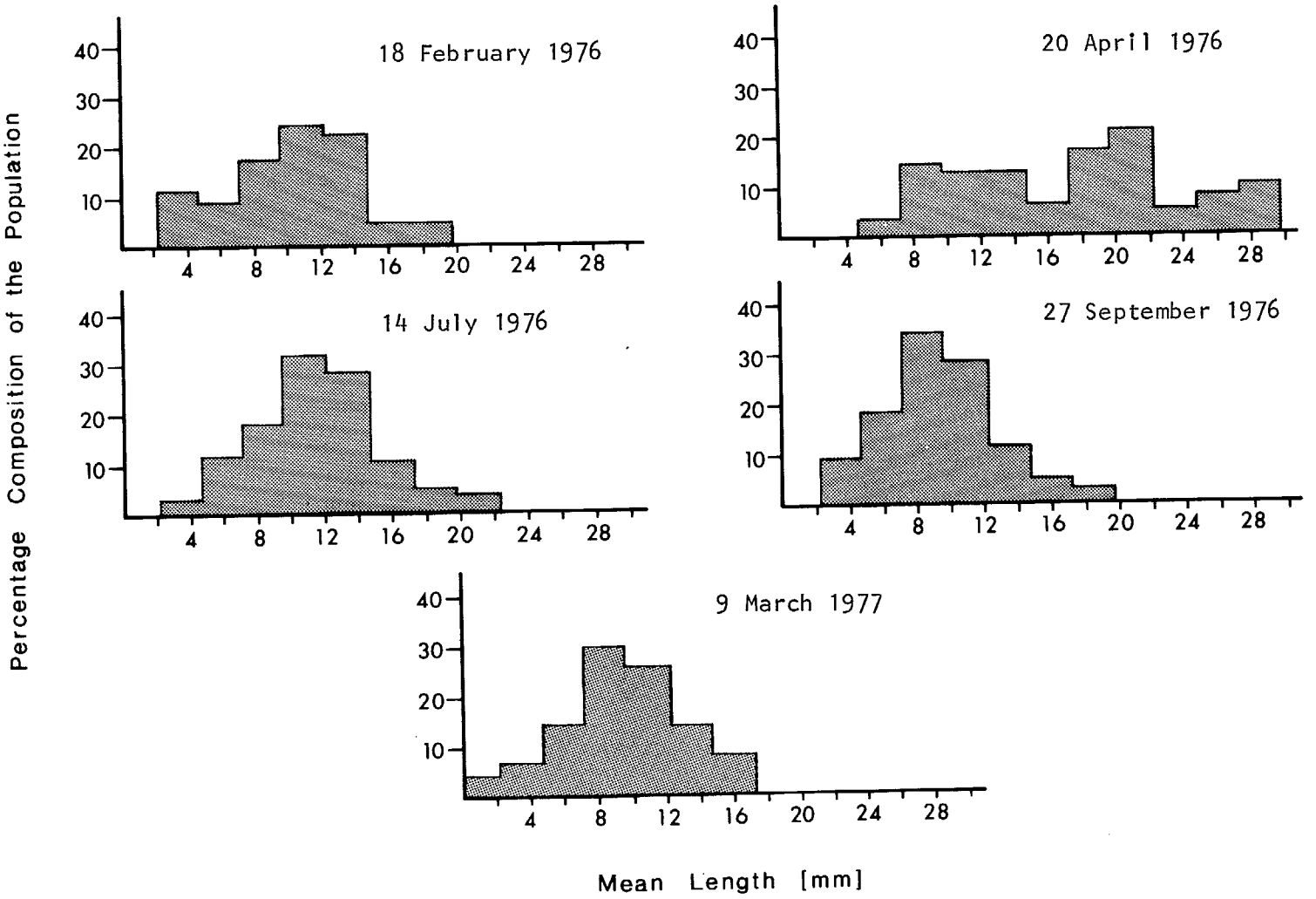

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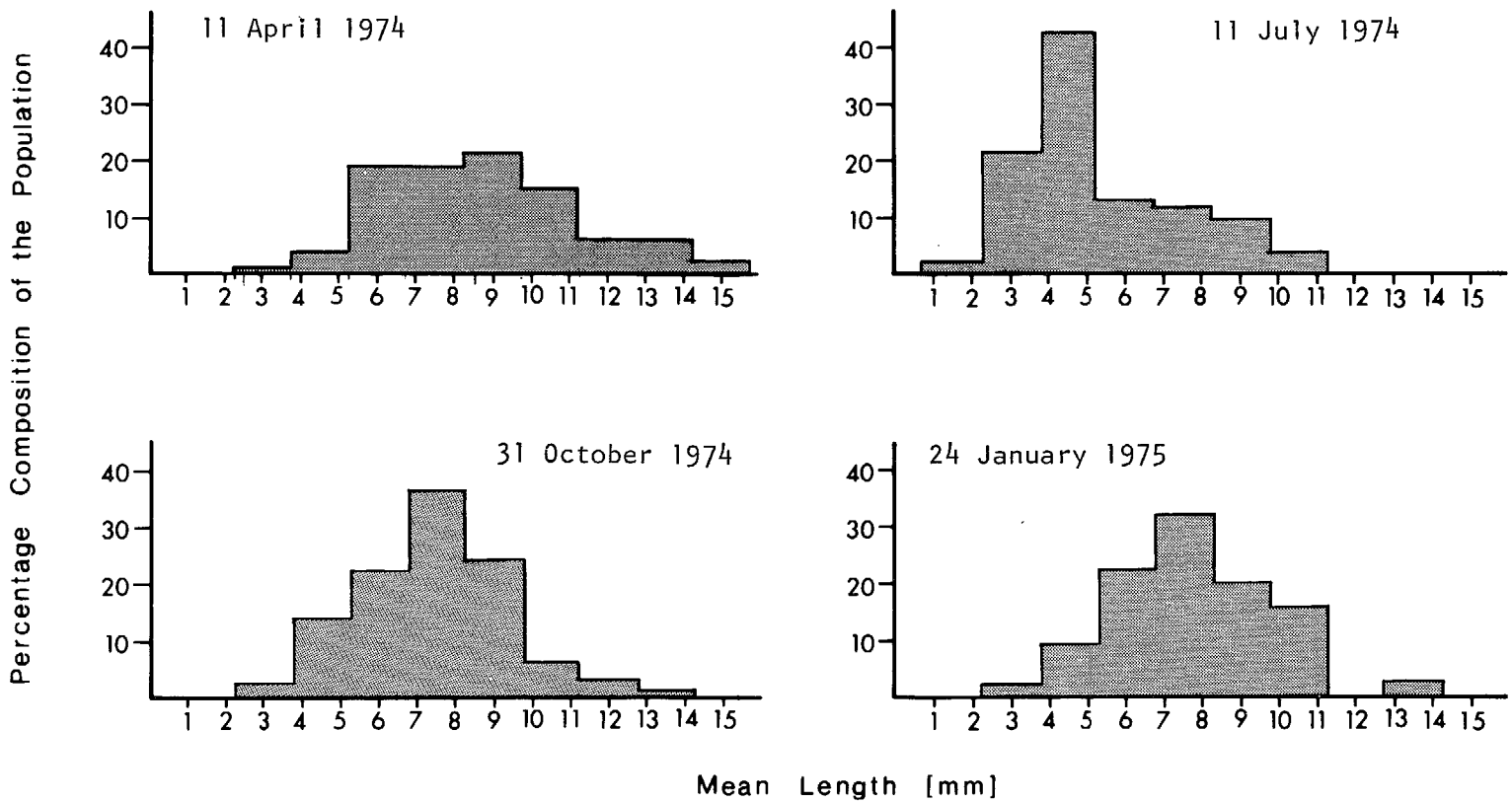

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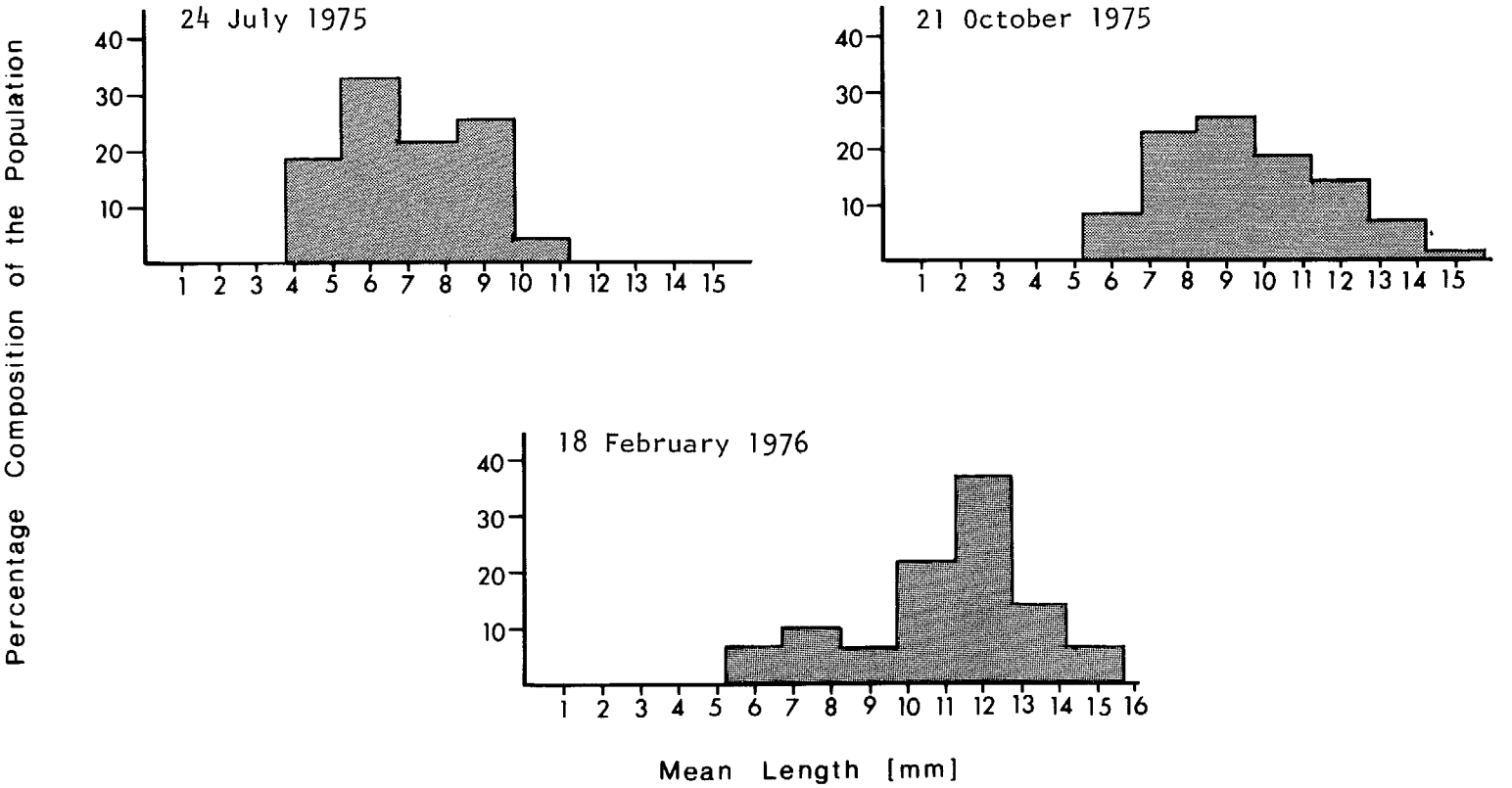
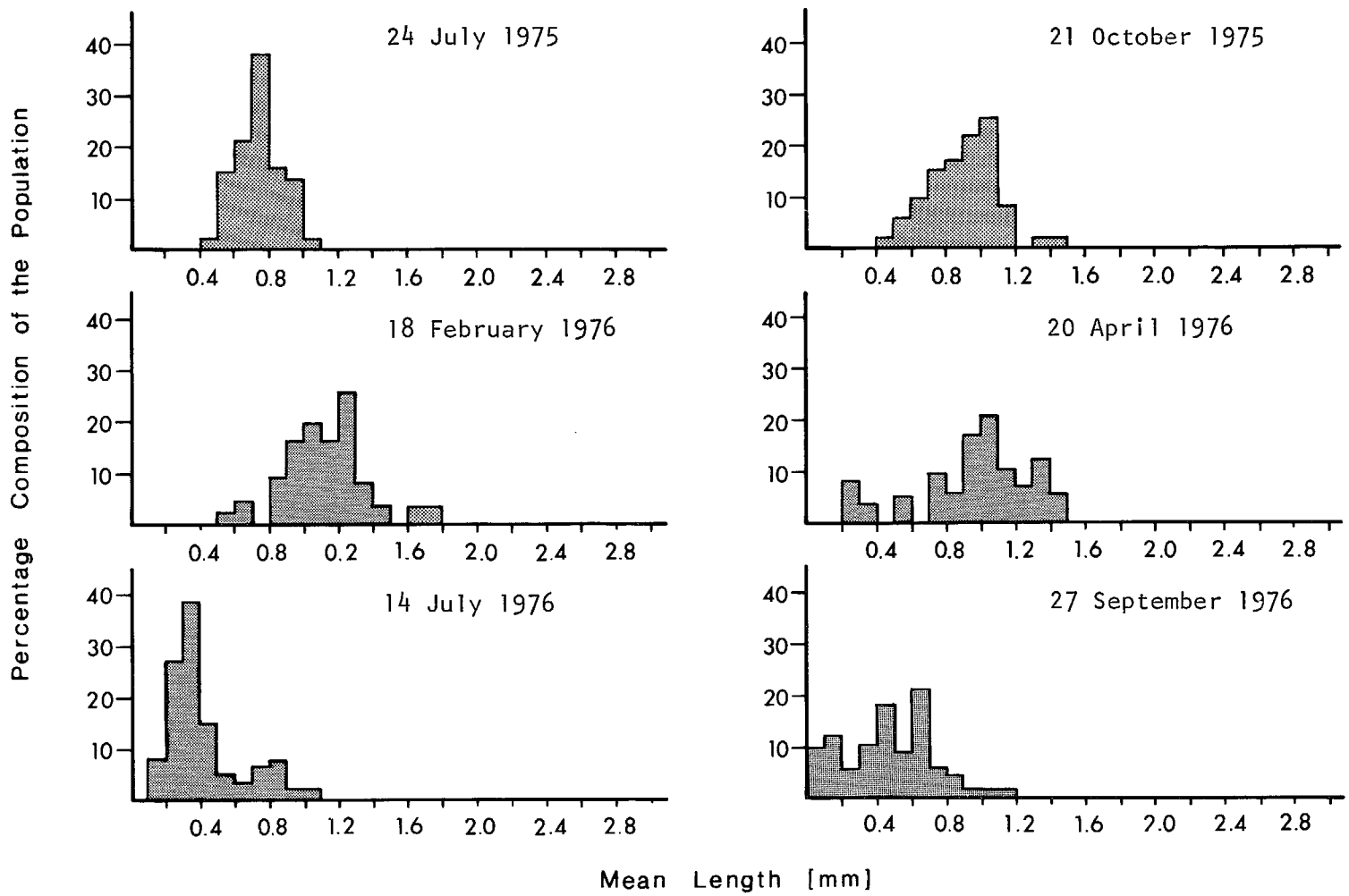


Fig. 155. Continued.



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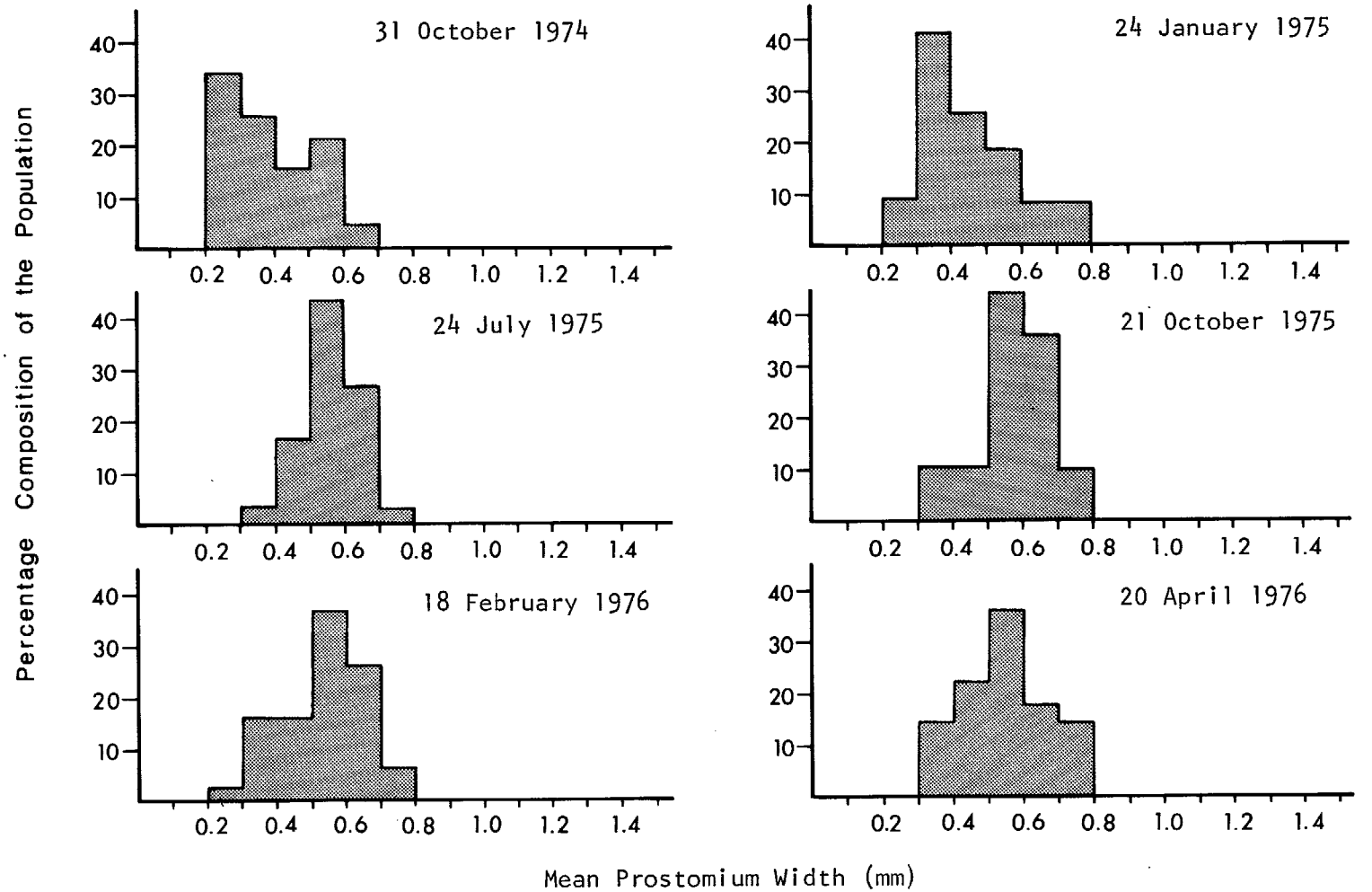

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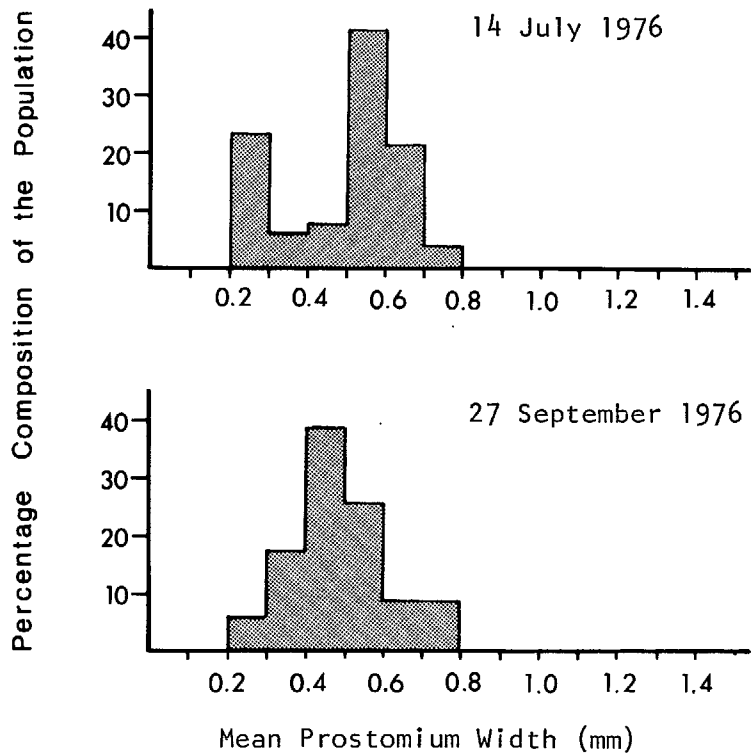

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APPENDIX B

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Table 1. Numbers of species and cumulative percent of new species collected in eight to ten ponar grab haul samples.

Site	Date	Parameter	Ponar 1	2	3	4	5	6	7	8	9	10
Dinner Point Creek Mid Station	13 July 1973	No. new species	8	5	7	1	1	0	1	0		
		Cumulative percent	35	57	87	91	96	96	100	100		
Meyers Creek Mid Station	4 October 1973	No. new species	16	3	5	1	2	4	1	0		
		Cumulative percent	50	59	75	78	84	97	100	100		
Meyers Creek Mid Station	13 July 1975	No. new species	16	5	2	1	3	0	0	0	0	1
		Cumulative percent	57	75	82	86	96	96	96	96	96	100
Cedar Run Mid Station	8 August 1973	No. new species	11	5	18	1	2	3	0	0		
		Cumulative percent	28	40	85	88	93	100	100	100		
Mill Creek Mid Station	14 August 1973	No. new species	9	1	3	1	1	0	1	2		
		Cumulative percent	50	56	72	78	83	83	89	100		
Lagoon System B Mid Station	11 July 1973	No. new species	0	2	3	1	3	0	0	0		
		Cumulative percent	0	22	56	67	100	100	100	100		
Lagoon System B Mouth Station	8 August 1973	No. new species	4	1	1	3	1	0	0	0		
		Cumulative percent	40	50	60	90	100	100	100	100		
Lagoon System A Mid Station	21 August 1973	No. new species	0	0	0	2	0	0	0	5		
		Cumulative percent	0	0	0	29	29	29	29	100		

Table 2. Summary of the hydrographic data for 1973-1975.

Parameter	Type		Station			
			Upper	Mid	Mouth	Average
Depth (ft)	Creeks		1.8- 3.8	2.5- 7.3	1.3- 5.5	1.2- 5.5
	Partially disturbed		4.3- 9.0	8.0-14.8	4.0-12.0	5.4-11.9
	Lagoons		10.0-15.8	9.0-15.0	3.3-11.0	7.5-13.9
	Reference station					4.0- 7.5
Temperature (^{o}C)	Creeks	S*	3.5-27.6	3.0-27.0	4.5-27.8	3.7-27.5
		B#	3.5-26.2	3.0-26.8	4.5-27.7	3.7-26.9
	Partially disturbed	S	4.0-27.8	4.5-28.9	4.0-29.0	4.2-28.9
		B	4.0-27.5	5.0-28.2	4.0-28.3	5.3-28.0
	Lagoons	S	3.8-30.2	4.5-29.8	3.5-29.6	3.9-29.9
		B	4.5-23.6	4.8-27.7	3.5-28.9	4.3-26.8
	Reference station	S				5.5-28.9
		B				5.5-28.3
Dissolved oxygen (mg $O_2 \cdot l^{-1}$)	Creeks	S	4.3- 7.9	6.2-11.1	6.8-11.6	5.8-10.2
		B	5.4- 6.5	6.3- 8.7	8.4- 8.8	6.7- 8.0
	Partially disturbed	S	5.8-11.2	4.9-10.6	7.1-11.5	5.9-11.1
		B	3.0- 9.8	4.0- 9.1	6.7- 9.6	4.6- 9.5
	Lagoons	S	7.5-12.0	6.9-11.8	7.5-12.3	7.3-12.0
		B	0.0- 7.3	0.4- 9.9	6.0-10.9	2.2- 9.3
	Reference station	S				6.3-10.6
		B				6.0-10.5
Salinity ($^{o}/oo$)	Creeks	S	10.6-23.0	14.3-26.1	18.0-26.3	14.3-25.1
		B	16.6-22.9	14.0-26.0	20.7-26.6	17.1-25.2
	Partially disturbed	S	2.5-18.9	6.5-19.6	12.5-24.2	6.6-20.9
		B	10.3-18.9	7.1-23.5	18.4-24.2	10.6-22.2
	Lagoons	S	16.5-24.9	20.2-24.8	20.6-25.0	19.1-24.9

Table 2. Continued.

Parameter	Type		Station			
			Upper	Mid	Mouth	Average
		B	21.0-25.2	20.3-25.0	20.6-24.8	20.6-25.0
	Reference station	S				21.2-27.1
		B				21.0-27.2
Secchi depth	Creeks		0.5- 3.0	1.0- 4.0	0.5- 4.0	0.7- 3.7
(ft)	Partially disturbed		1.5- 3.5	1.5- 4.0	1.2- 4.2	1.4- 3.9
	Lagoons		2.5- 5.5	2.0- 6.0	2.2- 7.3	2.3- 6.3
	Reference station					1.5- 5.0
Sediment characteristics	Creeks	MPD†	74	59.1	21.8	51.6
		SC**	1.505	3.075	1.845	2.142
		S/c##	51.4	55.4	75.9	60.9
	Partially disturbed	MPD	109.1	21.8	30.1	53.5
		SC	2.095	1.960	1.575	1.877
		S/c	38.7	80.3	78.2	65.7
	Lagoons	MPD	37.3	38.0	30.0	34.4
		SC	1.790	1.250	1.965	1.668
		S/c	60.9	68.6	69.9	66.4
	Reference station	MPD				30.8
		SC				1.250
		S/c				65.5

* S = Surface sample
\# B = Bottom sample
† MPD = Mean particle diameter (μm)
** SC = Sorting coefficient
S/c = Percent silts and clays

Table 3. Summary of the hydrographic data for 1975-1977.

Parameter	Waterway		Station 1	Station 2	Station 3
Depth (ft)	Meyers Creek		2.5- 5.0	3.5- 5.0	3.5- 5.0
	Lagoon System B		6.0-16.0	5.0- 9.0	8.0-11.0
Temperature (^{o}C)	Meyers Creek	S*	7.4-20.4	8.6-21.1	8.6-21.1
		B#	7.3-20.4	8.6-20.6	8.6-21.1
	Lagoon System B	S	6.8-25.0	6.8-24.6	6.8-24.4
		B	6.5-25.0	7.1-24.5	6.6-24.4
Dissolved oxygen (mg $O_2 \cdot l^{-1}$)	Meyers Creek	S	7.3-11.1	7.1-11.2	6.8-11.9
		B	7.0- 9.8	6.9-11.2	6.8-11.9
	Lagoon System B	S	7.9-10.2	8.0.10.2	7.3-11.0
		S		5.5-10.2	3.0-10.0
Salinity ($^{o}/oo$)	Meyers Creek	S	18.8-29.4	19.0-30.2	19.0-29.6
		B	18.9-30.1	19.0-29.3	19.0-30.1
	Lagoon System B	S	20.6-31.0	20.8-25.1	20.7-24.7
		B	20.6-31.2	20.8-25.3	20.8-25.2
Sediment characteristics	Meyers Creek	MPD†	19.7	18.3	20.1
		SC**	1.805	1.796	2.020
		S/c##	85.3	86.7	84.9
	Lagoon System B	MPD	25.3	43.5	40.3
		SC	1.251	2.973	2.070
		S/c	93.4	63.3	66.3

Table 3. Continued.

Parameter	Waterway		Station 4	Station 5	Waterway average
Depth (ft)	Meyers Creek		3.0- 7.0	2.0- 3.0	2.9- 5.0
	Lagoon System B		16.0-18.0	12.0-20.0	9.0-12.0
Temperature (^{o}C)	Meyers Creek	S	8.5-21.3	7.9-21.8	8.1-21.1
		B	8.5-21.3	7.9-21.8	8.1-21.0
	Lagoon System B	S	6.1-24.4	5.2-24.0	6.3-24.5
		B	5.9-24.5	1.8-19.0	5.6-23.5
Dissolved oxygen (mg $O_2 \cdot l^{-1}$)	Meyers Creek	S	5.7-10.3	3.8-11.0	6.1-11.1
		B	5.7-10.3	3.6- 9.0	6.0-10.4

Table 3. Continued.

Parameter	Waterway		Station 4	Station 5	Waterway average
	Lagoon System B	S	6.7-11.2	6.4-11.1	7.3-10.7
		B	5.8- 8.5	0.0- 3.3	4.1- 8.5
Salinity (°/oo)	Meyers Creek	S	19.2-30.0	16.7-29.8	18.5-29.8
		B	19.2-29.6	17.2-29.8	18.7-29.8
	Lagoon System B	S	20.7-24.8	20.3-24.9	20.6-26.1
		B	20.8-24.9	22.6-26.4	22.7-26.6
Sediment characteristics	Meyers Creek	MPD	19.1	22.0	19.8
		SC	1.745	1.499	1.835
		S/c	88.4	87.3	85.5
	Lagoon System B	MPD	35.4	36.7	35.7
		SC	2.540	2.363	2.312
		S/c	66.1	68.3	71.6

S* = Surface sample
B# = Bottom sample
MPD = Mean particle diameter (μm)
SC** = Sorting coefficient
S/c## = Percent silts and clays

Table 4. Percentage numerical composition of most abundant species for 1973-1975.

Species	Creeks	Partially disturbed	Lagoons	Reference station	Total
Polychaetes:					
Eteone heteropoda	0.93	0.37	0.27	0.07	0.66
Glycera spp.	0.10	0.07	0.09	1.32	0.13
Glycinde solitaria	0.51	0.71	1.46	1.261	0.72
Heteromastus filiformis	1.92	0.95	0.63	1.69	1.47
Hypaniola grayi	8.99	10.90	0.10	0.08	7.99
Lumbrineris tenuis	0.60	0.16	0.36	1.23	0.47
Maldanopsis elongata		0.06	0.05	1.18	0.07
Melinna cristata	0.06	0.08	0.03	0.26	0.07
Nereis succinea	3.21	2.58	1.68	0.02	2.71
Polydora ligni	0.31	1.08	1.67	0.07	0.70
Scoloplos robustus	1.02	0.93	2.46	2.09	1.23
Streblospio benedicti	9.07	7.81	25.09	0.19	10.57
Terebellidae	0.02	0.02	0.04		0.02

Table 4. Continued.

Species	Creeks	Partially disturbed	Lagoons	Reference station	Total
Crustaceans:					
Ampelisca abdita	59.77	52.76	48.29	62.45	56.37
Gammarus palustris	0.72	0.20		0.06	0.68
Leptocheirus plumulosus	0.82	5.29	0.22	0.02	2.63
Lysianopsis alba		0.02	0.03		0.01
Melita nitida	0.03	0.06		1.04	0.07
Cyathura polita	1.31	2.41	0.48	1.38	1.50
Edotea triloba	0.59	0.66	0.05	0.07	0.57
Leptochelia savigni		0.04			0.01
Ostracod	0.01	0.02	0.01		0.01
Neomysis americana	0.14	0.30	0.98	7.25	0.56
Molluscs:					
Gemma gemma	0.82	0.44	1.08	0.68	0.75
Mulinia lateralis	0.04	0.02	0.14	3.85	0.19
Ilyanassa obsoleta	0.95	1.03	1.46		1.01
Retusa canaliculata	0.27	0.40	0.67	5.67	0.73
Miscellaneous Oligochaeta:	1.50	1.41	1.61	0.06	1.44
Molgula manhattensis	0.02	0.09	0.09		0.05
Number of species	120	121	95	82	190
Percent of population contributed by the 22 most abundant species	93.06	89.10	87.74	91.92	93.86

Table 5. Percentage numerical abundance of the most abundant species for 1975-1977.

Species	Meyers Creek	Lagoon System B	Total
Polychaetes:			
Eteone heteropoda	0.73	0.72	0.73
Glycera spp.	0.41	0.59	0.33
Glycinde solitaria	0.16	0.67	0.21
Heteromastus filiformis	1.79	0.59	1.56
Hypaniola grayi	0.85	0.03	0.70
Lumbrineris tenuis	1.53	0.97	1.43
Maldanopsis elongata	0.01	0.08	0.02
Melinna cristata	0.01	0.81	0.17
Nereis succinea	5.08	1.65	4.43
Polydora ligni	0.20	1.00	0.36

Table 5. Continued.

Species	Meyers Creek	Lagoon System B	Total
Scoloplos robustus	0.63	1.09	0.72
Streblospio benedicti	7.20	14.15	8.54
Terebellidae	0.12	2.35	0.55
Crustaceans:			
Ampelisca abdita	73.77	49.13	69.07
Gammarus palustris	0.02		0.02
Leptocheirus plumulosus	0.62	3.37	1.15
Lysianopsis alba	0.03	1.17	0.18
Melita nitida	0.10	0.26	0.13
Cyathura polita	0.39	1.32	0.57
Edotea triloba	0.16	0.04	0.14
Leptochelia savigni	0.02	8.47	1.65
Ostracod	0.12	4.18	0.90
Neomysis americana	0.67	0.90	0.72
Molluscs:			
Gemma gemma	2.71	1.86	2.55
Mulinia lateralis	0.03	0.07	0.03
Ilyanassa obsoleta	0.51		0.41
Retusa canaliculata	0.02	0.15	0.05
Miscellaneous Oligochaeta:	1.39	1.58	1.43
Molgula manhattensis	0.01	0.64	0.13
Numbers of species	57	56	70
Percent of population contributed by the 22 most abundant species	98.85	82.79	94.03

Table 6. Numbers of individuals and percent composition by species for 1973-1977.

	1973 - 1975		1975 - 1977		Total	
Species	No.	%	No.	%	No.	%
Polychaetes:						
Ampharetidae	72	0.03			72	0.03
Autolytus prolifera	28	0.01	2	0.01	30	0.01
Autolytus sp. 1						
Autolytus sp. 2	3	0.00			3	0.00
Axiothella catenata	10	0.00			10	0.00
Capitella capitata	360	0.16	38	0.07	398	0.14

Table 6. Continued.

Species	1973 - 1975 No.	1973 - 1975 %	1975 - 1977 No.	1975 - 1977 %	Total No.	Total %
Capitellidae	542	0.23			542	0.19
Cirratulidae	12	0.00	5	0.01	17	0.01
Dodecaceria sp.	36	0.02	3	0.01	39	0.01
Drilonereis longa	7	0.00			7	0.00
Eupomatus dianthus	65	0.03	1	0.00	66	0.02
Eteone flava	7	0.00			7	0.00
Eteone heteropoda	1,516	0.66	376	0.73	1,892	0.67
Eteone sp.	10	0.00			10	0.00
Exogene dispar	1,690	0.73	40	0.08	1,730	0.61
Exogene sp.	15	0.01			15	0.01
Fabricia sabella	23	0.01			23	0.08
Glycera americana	280	0.12	39	0.08	319	0.11
Glycera capitata	26	0.01	17	0.03	43	0.02
Glycera dibranchiata	5	0.00	116	0.23	121	0.04
Glycinda solitaria	1,666	0.72	107	0.21	1,773	0.63
Gyptis vittata	177	0.08			177	0.06
Heteromastus filiformis	3,388	1.47	804	1.56	4,192	1.48
Hypaniola grayi	8,458	7.99	359	0.70	18,817	6.66
Lumbrineris tenuis	1,088	0.47	735	1.43	1,823	0.65
Maldanopsis elongata	157	0.07	9	0.02	166	0.06
Melinna cristata	160	0.07	85	0.17	245	0.09
Microphthalmus aberrans	22	0.01			22	0.01
Nereis diversicolor	686	0.30			686	0.24
Nereis sp.	3,827	1.66			3,827	1.35
Nereis succinea	2,439	1.06	2,282	4.43	4,721	1.67
Nereis virens	150	0.07	2	0.00	152	0.05
Notomastus latericeus	2	0.00			2	0.00
Pectinaria gouldii	92	0.04	12	0.02	104	0.04
Pereplanosyllus ingiorata	238	0.10			238	0.08
Polydora ligni	1,617	0.70	184	0.36	1,801	0.64
Potamilla neglecta	17	0.01	1	0.00	18	0.01
Prionospio malmgreni	3	0.01			3	0.00
Sabella microphthalmus	127	0.06	4	0.01	131	0.01
Sabellidae	9	0.00			9	0.00
Scolepidis virides	1,974	0.85	4	0.01	1,978	0.70
Scoloplos acutus	8	0.00			8	0.00
Scoloplos fragalis	58	0.03	1	0.00	59	0.02
Scoloplos robustus	2,839	1.23	369	0.72	3,208	1.14
Scoloplos sp.	52	0.02			52	0.02
Serpulidae	20	0.01			20	0.01
Spio filicornis	2	0.00			2	0.00
Spio setosa	3	0.00			3	0.00
Spionidae	33	0.01			33	0.01
Spiochaetopterus oculatus	424	0.18			424	0.15
Stenolais boa	7	0.00			7	0.00
Streblospio benedicti	24,433	10.57	4,403	8.54	28,836	10.20

Table 6. Continued.

Species	1973 - 1975 No.	1973 - 1975 %	1975 - 1977 No.	1975 - 1977 %	Total No.	Total %
Syllidae	47	0.02	26	0.05	73	0.03
Terebellidae	50	0.02	283	0.55	333	0.12
Tharyx acutus	71	0.03			71	0.03
Other polychaetes:						
Brania clavata	16	0.01			16	0.01
Diopatra cuprea	8	0.00	1	0.00	9	0.00
Eteone lactea	4	0.00			4	0.00
Eumida sanguinea	4	0.00			4	0.00
Petaloproctus tenuis			1	0.00	1	0.00
Unidentified polychaete			3	0.01	3	0.00
Nemertea:						
Amphiporus bioculatus	22	0.01			22	0.01
Amphiporus ochraceus	81	0.04			81	0.03
Amphiporus sp.	19	0.01			19	0.01
Euplana gracilis	12	0.00			12	0.00
Paleonemertea A	43	0.02			43	0.02
Paleonemertea B	248	0.11			248	0.09
Nemerteans unidentified	1,032	0.45	178	0.35	1,110	0.39
Nematoda:						
Tetrastemmatidae	3	0.00			3	0.00
Unidentified nematodes	33	0.01			33	0.01
Crustaceans:						
Ampelisca abdita	130,281	56.4	35,619	69.1	165,900	58.7
Ampelisca agassizi	3	0.00			3	0.00
Ampelsica vadorum	7	0.00	5	0.01	12	0.00
Amphithoe longimana	35	0.02			35	0.01
Batea catharinensis	34	0.02			34	0.01
Caprellidae	82	0.04	2	0.00	84	0.00
Cerapus tubularis	9	0.00			9	0.00
Corophium insidiosum	856	0.37	71	0.14	927	0.34
Corophium simile	140	0.06			140	0.05
Corophium sp.	15	0.01			15	0.00
Corophium tuberculatum	4	0.00			4	0.00
Cymadusa compta	784	0.34			784	0.28
Gammarus daiberi	5	0.00			5	0.00
Gammarus mucronatus	18	0.01	28	0.05	46	0.02
Gammarus palustris	1,577	0.68	10	0.02	1,587	0.56
Gammarus sp.	56	0.02			56	0.02
Leptocheirus pinguis	28	0.01			28	0.01
Leptocheirus plumulosus	6,080	2.63	592	1.15	6,672	2.36
Lysianopsis alba	19	0.01	94	0.18	113	0.04

Table 6. Continued.

Species	1973 - 1975 No.	1973 - 1975 %	1975 - 1977 No.	1975 - 1977 %	Total No.	Total %
Melita nitida	75	0.03	68	0.13	143	0.05
Microdeutopus gryllotalpa	88	0.04	1	0.00	89	0.03
Mellitidae	98	0.04			98	0.04
Podoceridae	13	0.01			13	0.00
Unidentified amphipod	1,422	0.61			1,422	0.51
Isopoda:						
Cyathura polita	3,474	1.50	298	0.57	3,767	1.33
Edotea triloba	1,186	0.51	70	0.14	1,256	0.44
Erichsonella attenuata	28	0.01			28	0.01
Idotea baltica	10	0.00			10	0.00
Leptochelia savigni	35	0.02	850	1.65	885	0.31
Chirodotea sp.	3	0.00			3	0.00
Sphaeromidae	6	0.00			6	0.00
Unidentified isopod	17	0.01			17	0.01
Other Crustaceans:						
Balanus balanoides	1,088	0.47			1,088	0.39
Balanus sp.	54	0.02			54	0.02
Callinectes sapidus	28	0.01	6	0.01	34	0.01
Campanularidae	14	0.01			14	0.00
Brachyuran crabs	24	0.01			24	0.01
Copepoda	119	0.05			119	0.04
Collembolla	4	0.00			4	0.00
Crangon septemspinosa	83	0.04	11	0.02	94	0.03
Cumacea	25	0.01			25	0.01
Cyclaspis varians	16	0.01			16	0.01
Mysidopsis bigelowi	83	0.04	8	0.02	91	0.02
Neomysis americana	1,286	0.56	369	0.72	1,655	0.59
Palaemonetes pugio	16	0.01			16	0.01
Palaemonetes vulgaris	11	0.01	4	0.01	15	0.01
Neopanope texana	111	0.05			111	0.04
Nymphon longitarse	96	0.04			96	0.03
Ostracod	26	0.01	465	0.90	491	0.17
Oxyurostylis smithi	148	0.06	13	0.03	161	0.06
Xanthid crabs	50	0.02			50	0.02
Molluscs:						
Bivalvia:						
Anadara ovalis						
Acteon punctostriatus	160	0.07	44	0.08	204	0.07
Ensis directus	8	0.00	2	0.00	10	0.00
Gemma gemma	1,728	0.75	1,315	2.55	3,043	1.08
Lyonsia hyalina	44	0.02			44	0.02
Macoma balthica	5	0.00	9	0.02	14	0.00
Mercenaria mercenaria	23	0.01	1	0.00	24	0.01

Table 6. Continued.

Species	1973 - 1975 No.	1973 - 1975 %	1975 - 1977 No.	1975 - 1977 %	Total No.	Total %
Modiolus demissus	23	0.01			23	0.01
Mulinia lateralis	435	0.19	17	0.03	452	0.16
Mya arenaria	13	0.01	2	0.00	15	0.00
Mytilus edulis	15	0.01			15	0.00
Solemya velum	9	0.00			9	0.00
Spisula solidissima	38	0.02			38	0.01
Tagelus plebeius			4	0.01	4	0.00
Tellina agilis	231	0.10	1	0.00	232	0.08
Unidentified bivalves	73	0.03			73	0.03
Gastropoda:						
Anachis avara	8	0.00			8	0.00
Bittium alternatum	9	0.00			9	0.00
Cerithiopos sp.	7	0.00			7	0.00
Corambella	17	0.01			17	0.01
Crepidula fornicata	110	0.05	13	0.03	123	0.04
Crepidula convexa	569	0.25			569	0.20
Crepidula sp.	163	0.07			163	0.06
Eupleura caudata	8	0.00	1	0.00	9	0.00
Melampus bidentatus	7	0.00			7	0.00
Mitrella lunata	60	0.03			60	0.02
Ilyanassa obsoleta	2,323	1.00	213	0.43	2,536	0.90
Nassarius vibex	169	0.07	1	0.00	170	0.06
Polinices duplicatus	4	0.00			4	0.00
Odostomia	391	0.17			391	0.14
Retusa canaliculata	1,679	0.73	25	0.05	1,704	0.60
Turbonilla	161	0.07			161	0.06
Unidentified gastropods	213	0.09			213	0.08
Urosalpinx cinereus	23	0.01			23	0.01
Miscellaneous:						
Anthozoans	261	0.11			261	0.09
Anguilla rostrata	158	0.07			158	0.06
Asterias forbesii	36	0.02			36	0.01
Ascidian	5	0.00			5	0.00
Botryllus sp.	289	0.12			280	0.10
Mnemiopsis leidyi	59	0.03			59	0.02
Amathia sp.	X		X		X	
Hirudinea	5	0.00			5	0.00
Hydrozoan	4	0.00			4	0.00
Holothurian	5	0.00			5	0.00
Hydractinia			1	0.00	1	0.00
Insect larvae	118	0.05			118	0.04
Lysidice sp.	4	0.00			4	0.00
Medusa						
Membranipora sp.	X		X		X	
Metridium sp.	8	0.00	22	0.04	30	0.01

Table 6. Continued.

Species	1973 - 1975 No.	1973 - 1975 %	1975 - 1977 No.	1975 - 1977 %	Total No.	Total %
Microciona prolifera	X		X		X	
Microporella sp.	X		X		X	
Molgula manhattensis	120	0.05	65	0.13	185	0.07
Nematostella vectensis	43	0.02			43	0.02
Notella sp.	4	0.00			4	0.00
Platyhelminthes			2	0.00	2	0.00
Pycnogonid	1	0.00			1	0.00
Oligochaeta	3,323	1.44	738	1.43	4.061	1.44
Vorticella	X		X		X	
Clione sp.	X		X		X	

Table 7. Taxonomic composition of the 1973-1975 and 1975-1977 collections.

Collection date	Taxonomic group	Percent composition by waterway and waterway type			
		Creeks	Partially disturbed	Lagoons	Reference station
1973-1975	Crustacea	65.54	63.67	48.54	74.35
	Mollusca	2.46	2.92	4.38	13.36
	Polychaeta	29.16	29.60	26.48	12.06

		Dinner Point Creek	Meyers Creek	Cedar Run	Mill Creek	Lagoon System A	Lagoon System B
1973-1975	Crustacea	37.03	78.38	53.78	71.16	78.37	32.70
	Mollusca	3.00	2.21	4.89	2.88	4.93	4.03
	Polychaeta	54.28	16.64	37.45	23.34	10.29	57.85

		Meyers Creek	Lagoon System B
1975-1977	Crustacea	76.17	69.07
	Mollusca	3.38	2.34
	Polychaeta	11.78	25.70

Table 8. Numbers of individuals per square meter for total species.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	373 ± 0	485 ± 1	901 ± 1	1,010 ± 1
Creeks	1,091 ± 3	1,404 ± 2	2,391 ± 2	4,042 ± 2
Partially disturbed	695 ± 3	815 ± 2	1,174 ± 2	796 ± 2
Lagoons	66 ± 3	99 ± 2	260 ± 2	320 ± 2
Dinner Point Creek	1,826 ± 6	2,556 ± 4	992 ± 4	2,281 ± 4
Meyers Creek	652 ± 6	771 ± 4	5,759 ± 4	7,160 ± 4
Cedar Run	1,250 ± 6	2,472 ± 4	851 ± 4	600 ± 4
Mill Creek	386 ± 6	268 ± 4	1,620 ± 4	1,054 ± 4
Lagoon System A	41 ± 6	86 ± 4	246 ± 4	259 ± 4
Lagoon System B	111 ± 6	114 ± 4	274 ± 4	393 ± 4

Table 9. Numbers of individuals per square meter for total polychaete species.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	145 ± 0	223 ± 2	157 ± 2	422 ± 2
Creeks	776 ± 6	787 ± 1	469 ± 1	874 ± 1
Partially disturbed	201 ± 6	306 ± 1	196 ± 1	70 ± 1
Lagoons	18 ± 6	451 ± 1	42 ± 1	97 ± 1
Dinner Point Creek	1,291 ± 12	926 ± 3	466 ± 3	699 ± 3
Meyers Creek	466 ± 12	668 ± 3	472 ± 3	1,093 ± 3
Cedar Run	455 ± 12	578 ± 3	244 ± 3	167 ± 3
Mill Creek	88 ± 12	162 ± 3	158 ± 3	29 ± 3
Lagoon System A	6 ± 12	73 ± 3	50 ± 3	105 ± 3
Lagoon System B	55 ± 12	28 ± 3	34 ± 3	90 ± 3

Table 10. Numbers of individuals per square meter for total crustacean species.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	71 ± 0	104 ± 1	476 ± 1	380 ± 1
Creeks	130 ± 4	152 ± 3	769 ± 3	1,300 ± 3
Partially disturbed	299 ± 4	295 ± 3	751 ± 3	510 ± 3
Lagoons	8 ± 4	25 ± 3	186 ± 3	82 ± 3
Dinner Point Creek	272 ± 5	642 ± 6	314 ± 6	757 ± 6
Meyers Creek	62 ± 5	36 ± 6	1,876 ± 6	2,230 ± 6
Cedar Run	629 ± 5	911 ± 6	424 ± 6	350 ± 6
Mill Creek	142 ± 5	95 ± 6	1,329 ± 6	741 ± 6
Lagoon System A	7 ± 5	27 ± 6	189 ± 6	172 ± 6
Lagoon System B	9 ± 5	23 ± 6	184 ± 6	39 ± 6

Table 11. Numbers of individuals per square meter for total molluscan species.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	10 ± 0	7 ± 1	10 ± 1	16 ± 1
Creeks	16 ± 2	20 ± 3	25 ± 3	33 ± 3
Partially disturbed	10 ± 2	7 ± 3	9 ± 3	14 ± 3
Lagoons	4 ± 2	2 ± 3	5 ± 3	9 ± 3
Dinner Point Creek	8 ± 9	37 ± 10	10 ± 10	9 ± 10
Meyers Creek	31 ± 9	11 ± 10	63 ± 10	113 ± 10
Cedar Run	15 ± 9	4 ± 10	9 ± 10	7 ± 10
Mill Creek	6 ± 9	13 ± 10	10 ± 10	26 ± 10
Lagoon System A	6 ± 9	1 ± 10	6 ± 10	19 ± 10
Lagoon System B	3 ± 9	2 ± 10	3 ± 10	4 ± 10

Table 12. Numbers of individuals per square meter for *Eteone heteropoda*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	3 ± 0	4 ± 1	1 ± 1	2 ± 1
Creeks	9 ± 2	21 ± 3	3 ± 3	9 ± 3
Partially disturbed	2 ± 2	3 ± 3	1 ± 3	1 ± 3
Lagoons	0 ± 2	0 ± 3	0 ± 3	1 ± 3
Dinner Point Creek	4 ± 3	18 ± 3	2 ± 3	1 ± 3
Meyers Creek	20 ± 3	24 ± 3	6 ± 3	54 ± 3
Cedar Run	1 ± 3	2 ± 3	0 ± 3	2 ± 3
Mill Creek	2 ± 3	3 ± 3	2 ± 3	1 ± 3
Lagoon System A	0 ± 3	1 ± 3	0 ± 3	0 ± 3
Lagoon System B	0 ± 3	0 ± 3	0 ± 3	2 ± 3

Table 13. Numbers of individuals per square meter for *Glycera* spp.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	2 ± 0	1 ± 1	1 ± 1	1 ± 1
Creeks	1 ± 4	2 ± 1	3 ± 1	1 ± 1
Partially disturbed	0 ± 4	1 ± 1	1 ± 1	1 ± 1
Lagoons	2 ± 4	1 ± 1	0 ± 1	0 ± 1
Dinner Point Creek	0 ± 2	1 ± 2	1 ± 2	0 ± 2
Meyers Creek	2 ± 2	2 ± 2	5 ± 2	4 ± 2
Cedar Run	1 ± 2	2 ± 2	2 ± 2	1 ± 2
Mill Creek	0 ± 2	0 ± 2	1 ± 2	1 ± 2
Lagoon System A	0 ± 2	1 ± 2	0 ± 2	0 ± 2
Lagoon System B	7 ± 2	1 ± 2	0 ± 2	1 ± 2

Table 14. Numbers of individuals per square meter for *Heteromastus filiformis*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	8 ± 0	9 ± 1	5 ± 1	6 ± 1
Creeks	30 ± 3	27 ± 2	25 ± 2	29 ± 2
Partially disturbed	5 ± 3	17 ± 2	4 ± 2	5 ± 2
Lagoons	2 ± 3	1 ± 2	1 ± 2	1 ± 2
Dinner Point Creek	12 ± 6	15 ± 3	15 ± 3	10 ± 3
Meyers Creek	73 ± 6	48 ± 3	40 ± 3	78 ± 3
Cedar Run	7 ± 6	16 ± 3	8 ± 3	5 ± 3
Mill Creek	3 ± 6	17 ± 3	2 ± 3	4 ± 3
Lagoon System A	2 ± 6	3 ± 3	1 ± 3	0 ± 3
Lagoon System B	1 ± 6	0 ± 3	1 ± 3	2 ± 3

Table 15. Numbers of individuals per square meter for *Hypaniola grayi*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	3 ± 0	18 ± 3	2 ± 3	3 ± 3
Creeks	10 ± 11	64 ± 6	10 ± 6	12 ± 6
Partially disturbed	2 ± 11	64 ± 6	2 ± 6	3 ± 6
Lagoons	0 ± 11	1 ± 6	0 ± 6	0 ± 6
Dinner Point Creek	64 ± 6	203 ± 5	60 ± 5	157 ± 5
Meyers Creek	1 ± 6	20 ± 5	1 ± 5	0 ± 5
Cedar Run	0 ± 6	119 ± 5	3 ± 5	9 ± 5
Mill Creek	10 ± 6	35 ± 5	1 ± 5	1 ± 5
Lagoon System A	0 ± 6	1 ± 5	1 ± 5	1 ± 5
Lagoon System B	0 ± 6	1 ± 5	0 ± 5	0 ± 5

Table 16. Numbers of individuals per square meter for *Lumbrineris tenuis*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	3 ± 0	1 ± 1	1 ± 1	2 ± 1
Creeks	4 ± 7	2 ± 4	4 ± 4	8 ± 4
Partially disturbed	2 ± 7	0 ± 4	0 ± 4	0 ± 4
Lagoons	0 ± 7	0 ± 4	0 ± 4	2 ± 4
Dinner Point Creek	0 ± 2	0 ± 2	0 ± 2	1 ± 2
Meyers Creek	26 ± 2	11 ± 2	25 ± 2	42 ± 2
Cedar Run	4 ± 2	1 ± 2	0 ± 2	0 ± 2
Mill Creek	1 ± 2	0 ± 2	0 ± 2	0 ± 2
Lagoon System A	0 ± 2	0 ± 2	0 ± 2	1 ± 2
Lagoon System B	0 ± 2	0 ± 2	0 ± 2	4 ± 2

Table 17. Numbers of individuals per square meter for *Melinna cristata*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	1 ± 0	0 ± 1	1 ± 1	0 ± 1
Creeks	0 ± 1	1 ± 1	0 ± 1	0 ± 1
Partially disturbed	1 ± 1	0 ± 1	0 ± 1	0 ± 1
Lagoons	0 ± 1	1 ± 1	1 ± 1	1 ± 1
Dinner Point Creek	1 ± 2	0 ± 2	1 ± 2	0 ± 2
Meyers Creek	0 ± 2	0 ± 2	1 ± 2	1 ± 2
Cedar Run	2 ± 2	1 ± 2	1 ± 2	0 ± 2
Mill Creek	1 ± 2	0 ± 2	0 ± 2	0 ± 2
Lagoon System A	0 ± 2	1 ± 2	1 ± 2	0 ± 2
Lagoon System B	0 ± 2	2 ± 2	1 ± 2	3 ± 2

Table 18. Numbers of individuals per square meter for *Nereis succinea*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	10 ± 0	4 ± 2	18 ± 2	21 ± 2
Creeks	19 ± 9	15 ± 2	64 ± 2	157 ± 2
Partially disturbed	17 ± 9	4 ± 2	32 ± 2	12 ± 2
Lagoons	2 ± 9	0 ± 2	2 ± 2	4 ± 2
Dinner Point Creek	45 ± 7	20 ± 4	46 ± 4	86 ± 4
Meyers Creek	8 ± 7	11 ± 4	89 ± 4	286 ± 4
Cedar Run	68 ± 7	11 ± 4	28 ± 4	33 ± 4
Mill Creek	4 ± 7	1 ± 4	36 ± 4	4 ± 4
Lagoon System A	0 ± 7	0 ± 4	3 ± 4	7 ± 4
Lagoon System B	9 ± 7	1 ± 4	1 ± 4	3 ± 4

Table 19. Numbers of individuals per square meter for *Scoloplos robustus*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	5 ± 0	11 ± 2	10 ± 2	12 ± 2
Creeks	3 ± 7	23 ± 2	47 ± 2	28 ± 2
Partially disturbed	4 ± 7	11 ± 2	7 ± 2	5 ± 2
Lagoons	6 ± 7	5 ± 2	3 ± 2	12 ± 2
Dinner Point Creek	0 ± 7	15 ± 4	27 ± 4	8 ± 4
Meyers Creek	17 ± 7	36 ± 4	81 ± 4	98 ± 4
Cedar Run	11 ± 7	17 ± 4	8 ± 4	6 ± 4
Mill Creek	1 ± 7	7 ± 4	5 ± 4	4 ± 4
Lagoon System A	4 ± 7	3 ± 4	1 ± 4	6 ± 4
Lagoon System B	9 ± 7	8 ± 4	5 ± 4	24 ± 4

Table 20. Numbers of individuals per square meter for *Streblospio benedicti*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	34 ± 0	12 ± 1	8 ± 1	8 ± 1
Creeks	142 ± 3	56 ± 3	21 ± 3	51 ± 3
Partially disturbed	22 ± 3	7 ± 3	5 ± 3	2 ± 3
Lagoons	11 ± 3	4 ± 3	5 ± 3	3 ± 3
Dinner Point Creek	108 ± 14	30 ± 6	19 ± 6	11 ± 6
Meyers Creek	187 ± 14	105 ± 6	23 ± 6	227 ± 6
Cedar Run	18 ± 14	3 ± 6	3 ± 6	4 ± 6
Mill Creek	26 ± 14	14 ± 6	9 ± 6	1 ± 6
Lagoon System A	4 ± 14	2 ± 6	1 ± 6	1 ± 6
Lagoon System B	27 ± 14	8 ± 6	17 ± 6	5 ± 6

Table 21. Numbers of individuals per square meter for *Ampelisca abdita*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	14 ± 0	41 ± 1	224 ± 1	137 ± 1
Creeks	32 ± 2	44 ± 6	206 ± 6	107 ± 6
Partially disturbed	51 ± 2	76 ± 6	326 ± 6	356 ± 6
Lagoons	0 ± 2	20 ± 6	168 ± 6	68 ± 6
Dinner Point Creek	35 ± 8	126 ± 12	31 ± 12	16 ± 12
Meyers Creek	29 ± 8	15 ± 12	1,362 ± 12	666 ± 12
Cedar Run	88 ± 8	63 ± 12	86 ± 12	174 ± 12
Mill Creek	30 ± 8	92 ± 12	1,221 ± 12	727 ± 12
Lagoon System A	2 ± 8	51 ± 12	162 ± 12	37 ± 12
Lagoon System B	0 ± 8	7 ± 12	175 ± 12	123 ± 12

Table 22. Numbers of individuals per square meter for *Leptocheirus plumulosus*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	4 ± 0	3 ± 2	1 ± 2	3 ± 2
Creeks	3 ± 8	2 ± 4	1 ± 4	10 ± 4
Partially disturbed	12 ± 8	3 ± 4	4 ± 4	5 ± 4
Lagoons	0 ± 8	2 ± 4	1 ± 4	0 ± 4
Dinner Point Creek	8 ± 5	10 ± 4	2 ± 4	22 ± 4
Meyers Creek	1 ± 5	0 ± 4	0 ± 4	4 ± 4
Cedar Run	61 ± 5	18 ± 4	5 ± 4	15 ± 4
Mill Creek	2 ± 5	0 ± 4	3 ± 4	1 ± 4
Lagoon System A	0 ± 5	0 ± 4	1 ± 4	0 ± 4
Lagoon System B	0 ± 5	9 ± 4	1 ± 4	0 ± 4

Table 23. Numbers of individuals per square meter for *Cyathura polita*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	5 ± 0	6 ± 1	4 ± 1	3 ± 1
Creeks	7 ± 5	38 ± 2	14 ± 2	7 ± 2
Partially disturbed	13 ± 5	7 ± 2	6 ± 2	3 ± 2
Lagoons	0 ± 5	0 ± 2	0 ± 2	0 ± 2
Dinner Point Creek	17 ± 4	103 ± 4	17 ± 4	11 ± 4
Meyers Creek	2 ± 4	14 ± 4	11 ± 4	5 ± 4
Cedar Run	43 ± 4	13 ± 4	6 ± 4	5 ± 4
Mill Creek	3 ± 4	3 ± 4	6 ± 4	2 ± 4
Lagoon System A	0 ± 4	0 ± 4	0 ± 4	0 ± 4
Lagoon System B	0 ± 4	0 ± 4	0 ± 4	1 ± 4

Table 24. Numbers of individuals per square meter for *Gemma gemma*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	2 ± 0	1 ± 2	1 ± 2	2 ± 2
Creeks	1 ± 1	1 ± 2	3 ± 2	6 ± 2
Partially disturbed	3 ± 1	1 ± 2	1 ± 2	0 ± 2
Lagoons	0 ± 1	0 ± 2	0 ± 2	2 ± 2
Dinner Point Creek	0 ± 3	1 ± 3	1 ± 3	1 ± 3
Meyers Creek	1 ± 3	1 ± 3	5 ± 3	20 ± 3
Cedar Run	3 ± 3	1 ± 3	1 ± 3	1 ± 3
Mill Creek	2 ± 3	1 ± 3	1 ± 3	0 ± 3
Lagoon System A	0 ± 3	1 ± 3	0 ± 3	2 ± 3
Lagoon System B	0 ± 3	0 ± 3	0 ± 3	1 ± 3

Table 25. Numbers of individuals per square meter for *Ilyanassa obsoleta*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	4 ± 0	1 ± 1	2 ± 1	5 ± 1
Creeks	3 ± 2	3 ± 3	13 ± 3	16 ± 3
Partially disturbed	2 ± 2	1 ± 3	1 ± 3	4 ± 3
Lagoons	5 ± 2	1 ± 3	1 ± 3	2 ± 3
Dinner Point Creek	4 ± 9	4 ± 4	4 ± 4	4 ± 4
Meyers Creek	2 ± 9	2 ± 4	41 ± 4	60 ± 4
Cedar Run	4 ± 9	0 ± 4	0 ± 4	2 ± 4
Mill Creek	1 ± 9	4 ± 4	1 ± 4	6 ± 4
Lagoon System A	5 ± 9	2 ± 4	2 ± 4	3 ± 4
Lagoon System B	4 ± 9	0 ± 4	0 ± 4	1 ± 4

Table 26. Numbers of individuals per square meter for *Mulinia lateralis*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	1 ± 0	1 ± 1	0 ± 1	1 ± 1
Creeks	0 ± 1	1 ± 1	0 ± 1	1 ± 1
Partially disturbed	0 ± 1	0 ± 1	0 ± 1	0 ± 1
Lagoons	0 ± 1	0 ± 1	1 ± 1	2 ± 1
Dinner Point Creek	0 ± 1	4 ± 1	0 ± 1	2 ± 1
Meyers Creek	0 ± 1	0 ± 1	1 ± 1	1 ± 1
Cedar Run	0 ± 1	0 ± 1	0 ± 1	1 ± 1
Mill Creek	1 ± 1	1 ± 1	0 ± 1	0 ± 1
Lagoon System A	0 ± 1	1 ± 1	3 ± 1	3 ± 1
Lagoon System B	0 ± 1	0 ± 1	0 ± 1	1 ± 1

Table 27. Numbers of individuals per square meter for *Molgula manhattensis*.

Site	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Total	1 ± 0	0 ± 0	0 ± 0	0 ± 0
Creeks	0 ± 3	0 ± 1	0 ± 1	0 ± 1
Partially disturbed	1 ± 3	0 ± 1	0 ± 1	0 ± 1
Lagoons	1 ± 3	0 ± 1	0 ± 1	1 ± 1
Dinner Point Creek	0 ± 3	0 ± 1	0 ± 1	0 ± 1
Meyers Creek	0 ± 3	0 ± 1	0 ± 1	0 ± 1
Cedar Run	3 ± 3	1 ± 1	0 ± 1	2 ± 1
Mill Creek	0 ± 3	0 ± 1	0 ± 1	0 ± 1
Lagoon System A	0 ± 3	0 ± 1	0 ± 1	0 ± 1
Lagoon System B	2 ± 3	0 ± 1	0 ± 1	1 ± 1

Table 28. Numbers of individuals per square meter at the reference station for 1974-1975.

Taxonomic group	Average	95% Confidence interval
Total species	694	3
Total crustacean species	277	5
Total polychaete species	41	3
Total molluscan species	94	2
Heteromastus filiformis	5	3
Hypaniola grayi	0	0
Eteone heteropoda	0	0
Lumbrineris tenuis	2	2
Melinna cristata	3	2
Nereis succinea	0	0
Scoloplos robustus	6	4
Streblospio benedicti	0	0
Ampelisca abdita	112	2
Leptocheirus plumulosus	0	0
Cyathura polita	4	2
Gemma gemma	0	0
Mulinia lateralis	29	1
Ilyanassa obsoleta	0	0
Molgula manhattensis	0	0

Table 29. Summary of statistical analyses probability of a greater F value.

Taxonomic group	Spring 1974		Summer 1974 - Winter 1975			
	WT*	W	S	WT	SXWT	W
Total species	.0650	.6907	.1202	.0026	.8184	.6931
Total Polychaeta	.1093	.6355	.8003	.0213	.1304	.8450
Total Crustacea	.0529	.5127	.0358	.0122	.8139	.6699
Total Mollusca	.3068	.8698	.0379	.0033	.9608	.7742
Eteone heteropoda	.0814	.4751	.1130	.0077	.8405	.3735
Glycera spp.	.7847	.0541	.7573	.1604	.6449	.6911
Heteromastus filiformis	.0924	.7059	.3396	.0021	.7233	.6085
Hypaniola grayi	.4899	.1007	.1044	.0359	.7519	.0937
Lumbrineris tenuis	.5588	.0022	.2791	.0106	.9620	.0001
Melinna cristata	.1564	.8145	.3735	.1757	.8158	.1898
Nereis succinea	.5092	.1661	.0472	.0065	.4655	.8682
Scoloplos robustus	.9495	.2793	.9381	.0504	.4583	.7655
Streblospio benedicti	.0934	.8902	.4944	.0061	.8698	.6962
Ampelisca abdita	.0170	.8900	.0047	.0172	.9906	.6453
Cyathura polita	.2005	.1800	.3630	.0052	.3852	.9550
Leptocheirus plumulosus	.3375	.1263	.6967	.3139	.6258	.1942
Gemma gemma	.0651	.8507	.4648	.2369	.2847	.7240
Mulinia lateralis	.4648	.4262	.3735	.1757	.8158	.1898
Ilyanassa obsoleta	.4515	.9496	.1489	.0251	.8202	.4704
Molgula manhattensis	.6464	.4262	.0178	.1111	.9617	.1131

Table 29. Continued.

Taxonomic group	Summer 1975 - Winter 1977							
	SN	SB	WN	WB	SXWN	SXWB	STN	STB
Total species	.2391	.5427	.0007	.0002	.7077	.6936	.0001	.0001
Total Polychaeta	.0811	.1553	.0002	.0012	.8498	.6191	.0001	.0001
Total Crustacea	.3671	.5880	.0195	.0042	.3565	.5863	.0001	.0001
Total Mollusca	.1707	.2162	.0043	.0002	.7006	.8252	.0001	.0001
Eteone heteropoda	.2392	.2278	.0309	.2685	.0500	.3670	.0001	.0001
Glycera spp.	.3899	.5079	.3633	.2548	.0002	.0035	.0001	.0007
Heteromastus filiformis	.5561	.6510	.0173	.0181	.0001	.0078	.0001	.0001
Hypaniola grayi	.5599	.5000	.0264	.0467	.4794	.7509	.0001	.0001
Lumbrineris tenuis	.3897	.1925	.0223	.0242	.0574	.2856	.0001	.0001
Melinna cristata	.5508	.0907	.0008	.1042	.9473	.7545	.0001	.0001
Nereis succinea	.1825	.2274	.0008	.0061	.8482	.6272	.0001	.0001
Scoloplos robustus	.0443	.0902	.0250	.0728	.2801	.2170	.0001	.0001
Streblospio benedicti	.1067	.1764	.0119	.1345	.3329	.0464	.0001	.0001
Ampelisca abdita	.3059	.4920	.0283	.0210	.3019	.4117	.0001	.0001
Cyathura polita	.0171	.1303	.0354	.0294	.8504	.7020	.0001	.0001
Leptocheirus plumulosus	.7761	.8159	.9983	.7196	.0838	.0878	.0001	.0001
Gemma gemma	.2555	.6320	.0427	.5613	.5798	.3165	.0001	.0001
Mulinia lateralis	.4795	.3692	.7928	.6380	.0102	.0038	.2327	.3233
Ilyanassa obsoleta	.5000	.5000	.0003	.0003	.7907	.6885	.0001	.0001
Molgula manhattensis	.5014	.4906	.3051	.2958	.0362	.0427	.0001	.0001

* Abbreviations used in the above table:
WT = Waterway type numbers of individuals
W = Waterway numbers of individuals
S = Seasonal numbers of individuals
SXWT = Season by waterway interaction numbers of individuals
SN = Seasonal numbers of individuals
SB = Seasonal biomass
WN = Waterway numbers of individuals
WB = Waterway biomass
SXWN = Season by waterway interaction numbers of individuals
SXWB = Season by waterway interaction biomass
STN = Station numbers of individuals
STB = Station biomass

Table 30. Numbers of individuals per square meter for total species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	1,474± 76	5,286± 76	1,660± 76	850± 76	6,586± 76	2,236± 76	408± 76	1,830± 10
Station 1	1,914± 4	5,110± 4	15,078± 4	2,346± 4	11,070± 4	10,186± 4	4,742± 4	5,700± 8
Station 2	1,278± 4	25,472± 4	1,114± 4	830± 4	8,710± 4	1,778± 4	10± 4	1,146± 17
Station 3	5,764± 4	3,792± 4	1,502± 4	710± 4	11,856± 4	2,962± 4	268± 4	2,180± 10
Station 4	140± 4	2,830± 4	150± 4	176± 4	9,992± 4	3,982± 4	204± 4	660± 14
Station 5	3,196± 4	2,940± 4	2,918± 4	1,712± 4	1,074± 4	512± 4	1,542± 4	1,698± 5
Lagoon System B	234± 76	338± 76	240± 76	230± 76	274± 76	78± 76	146± 76	204± 76
Station 1	936± 4	302± 4	60± 4	146± 4	590± 4	36± 4	68± 4	180± 10
Station 2	2,288± 4	4,994± 4	3,864± 4	2,452± 4	1,078± 4	282± 4	468± 4	1,462± 8
Station 3	1,170± 4	3,304± 4	1,132± 4	2,598± 4	4,728± 4	1,274± 4	1,524± 4	1,946± 8
Station 4	0± 4	22± 4	108± 4	10± 4	10± 4	0± 4	54± 4	20± 6
Station 5	0± 4	6± 4	10± 4	10± 4	2± 4	0± 4	6± 4	4± 3
Total	596±112	1,358±112	770±112	446±112	1,374±112	448±112	248±112	

Table 31. Numbers of individuals per square meter for total polychaete species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	382±48	630±48	506±48	296±48	1,710±48	404±48	134±48	448± 6
Station 1	268± 4	202± 4	598± 4	394± 4	2,218± 4	402± 4	500± 4	482± 8
Station 2	154± 4	170± 4	460± 4	170± 4	1,548± 4	450± 4	6± 4	270±10
Station 3	508± 4	862± 4	658± 4	196± 4	2,210± 4	280± 4	96± 4	460± 8
Station 4	108± 4	690± 4	54± 4	56± 4	2,638± 4	422± 4	54± 4	222±12
Station 5	3,104± 4	2,124± 4	2,676± 4	1,110± 4	674± 4	496± 4	762± 4	1,262± 6
Lagoon System B	24±48	64±48	80±48	88±48	106±48	58±48	30±48	6± 6
Station 1	14± 4	28± 4	12± 4	38± 4	90± 4	16± 4	4± 4	24± 5
Station 2	180± 4	810± 4	590± 4	676± 4	216± 4	194± 4	34± 4	302± 3
Station 3	38± 4	246± 4	336± 4	766± 4	3,068± 4	922± 4	330± 4	440±10
Station 4	0± 4	0± 4	54± 4	4± 4	0± 4	0± 4	0± 4	4± 5
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Total	112±54	214±54	210±54	164±54	446±54	162±54	68±54	

Table 32. Numbers of individuals per square meter for total crustacean species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	300± 80	3,282± 80	342± 80	168± 80	4,376± 80	1,038± 80	202± 80	712±16
Station 1	1,178± 4	4,712± 4	13,668± 4	1,600± 4	8,550± 4	9,680± 4	4,180± 4	4,592± 9
Station 2	864± 4	24,898± 4	444± 4	276± 4	7,038± 4	1,218± 4	4± 4	950±18
Station 3	1,648± 4	2,508± 4	170± 4	242± 4	9,322± 4	2,544± 4	56± 4	850±14
Station 4	6± 4	1,756± 4	22± 4	44± 4	7,014± 4	1,484± 4	132± 4	276±18
Station 5	52± 4	722± 4	106± 4	164± 4	388± 4	8± 4	456± 4	162± 9
Lagoon System B	224± 80	170± 80	146± 80	148± 80	198± 80	34± 80	122± 80	144±80
Station 1	898± 4	244± 4	28± 4	70± 4	480± 4	18± 4	58± 4	128±10
Station 2	2,046± 4	3,596± 4	2,328± 4	1,232± 4	842± 4	82± 4	258± 4	934±10
Station 3	1,126± 4	2,940± 4	708± 4	1,482± 4	1,604± 4	304± 4	972± 4	1,080± 8
Station 4	0± 4	16± 4	30± 4	6± 4	10± 4	0± 4	54± 4	14± 5
Station 5	0± 4	0± 4	10± 4	10± 4	4± 4	0± 4	6± 4	4± 2
Total	260±210	958±210	224±210	200±210	958±210	220±210	158±210	

Table 33. Numbers of individuals per square meter for total molluscan species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	94±28	34±28	64±28	40±28	48±28	22±28	6±28	40± 5
Station 1	146± 4	58± 4	130± 4	196± 4	96± 4	48± 4	6± 4	74± 7
Station 2	40± 4	78± 4	44± 4	78± 4	40± 4	10± 4	4± 4	34± 5
Station 3	3,556± 4	32± 4	218± 4	34± 4	140± 4	68± 4	46± 4	134±12
Station 4	6± 4	64± 4	64± 4	14± 4	48± 4	18± 4	0± 4	24± 7
Station 5	0± 4	0± 4	4± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Lagoon System B	6±28	18±28	18±28	20±28	2±28	0±28	2±28	8± 5
Station 1	4± 4	12± 4	2± 4	10± 4	6± 4	0± 4	6± 4	8± 4
Station 2	36± 4	114± 4	158± 4	206± 4	0± 4	0± 4	0± 4	42±10
Station 3	4± 4	20± 4	0± 4	16± 4	4± 4	0± 4	0± 4	6± 3
Station 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Total	34±40	26±40	38±40	28±40	18±40	8±40	4±40	

Table 34. Numbers of individuals per square meter for *Eteone heteropoda*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	8±12	26±12	68±12	36±12	10±12	4±12	2±12	18± 1
Station 1	4± 2	8± 2	34± 2	54± 2	0± 2	4± 2	6± 2	12± 5
Station 2	0± 2	4± 2	142± 2	10± 2	10± 2	0± 2	0± 2	10± 6
Station 3	8± 2	48± 2	146± 2	28± 2	12± 2	8± 2	0± 2	24± 6
Station 4	0± 2	38± 2	0± 2	14± 2	28 +2	6± 2	4± 2	10± 5
Station 5	44± 2	56± 2	152± 2	122± 2	8± 2	6± 2	4± 2	36± 6
Lagoon System B	0±12	2±12	6±12	8±12	10±12	2±12	0±12	4±12
Station 1	0± 2	4± 2	0± 2	0± 2	4± 2	0± 2	0± 2	0± 1
Station 2	0± 2	0± 2	14± 2	6± 2	6± 2	0± 2	0± 2	4± 3
Station 3	0± 2	4± 2	22± 2	64± 2	88± 2	6± 2	0± 2	16± 6
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Total	40±40	12±40	28±40	20±40	10±40	2±40	2±40	

Table 35. Numbers of individuals per square meter for *Glycera* spp.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	8± 8	2± 8	4± 8	4± 8	48± 8	2± 8	0± 8	8±5
Station 1	8± 2	6± 2	16± 2	6± 2	86± 2	0± 2	0± 2	12±5
Station 2	16± 2	0± 2	0± 2	10± 2	72± 2	10± 2	0± 2	10±4
Station 3	14± 2	6± 2	6± 2	6± 2	58± 2	0± 2	0± 2	10±5
Station 4	6± 2	4± 2	0± 2	0± 2	40± 2	0± 2	0± 2	4±3
Station 5	0± 2	0± 2	0± 2	0± 2	10± 2	0± 2	0± 2	2±1
Lagoon System B	8± 8	2± 8	0± 8	6± 8	4± 8	2± 8	2± 8	4±5
Station 1	6± 2	0± 2	0± 2	4± 2	12± 2	0± 2	0± 2	2±2
Station 2	52± 2	6± 2	0± 2	0± 2	0± 2	6± 2	8± 2	8±4
Station 3	6± 2	10± 2	0± 2	36± 2	10± 2	0± 2	6± 2	8±4
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Total	8±34	2±34	2±34	4±34	20±34	2±34	2±34	

Table 36. Numbers of individuals per square meter for *Heteromastus filiformis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	40±12	54±12	28±12	32±12	288±12	20±12	4±12	40±9
Station 1	96± 4	62± 4	108± 4	74± 4	490± 4	34± 4	22± 4	84±4
Station 2	82± 4	86± 4	14± 4	14± 4	258± 4	80± 4	4± 4	50±7
Station 3	60± 4	114± 4	28± 4	64± 4	382± 4	12± 4	0± 4	52±8
Station 4	8± 4	48± 4	0± 4	0± 4	174± 4	12± 4	0± 4	18±7
Station 5	6± 4	8± 4	36± 4	44± 4	64± 4	0± 4	0± 4	18±5
Lagoon System B	0±12	2±12	6±12	4±12	4±12	4±12	6±12	4±9
Station 1	0± 4	0± 4	0± 4	8± 4	0± 4	0± 4	0± 4	1±2
Station 2	0± 4	18± 4	24± 4	10± 4	0± 4	18± 4	10± 4	10±4
Station 3	0± 4	0± 4	12± 4	6± 4	28± 4	4± 4	26± 4	10±4
Station 4	0± 4	0± 4	4± 4	0± 4	0± 4	0± 4	0± 4	0±1
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0±0
Total	14±84	22±84	16±84	16±84	56±84	10±84	4±84	

Table 37. Numbers of individuals per square meter for *Hypaniola grayi*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	28±16	16±16	22±16	2±16	2±16	2±16	6±16	10± 5
Station 1	4± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 3	28± 2	0± 2	6± 2	0± 2	0± 2	0± 2	0± 2	4± 3
Station 4	10± 2	8± 2	16± 2	0± 2	0± 2	6± 2	8± 2	6± 3
Station 5	372± 2	240± 2	338± 2	10± 2	12± 2	8± 2	42± 2	70±10
Lagoon System B	0±16	0±16	0±16	0±16	0±16	0±16	0±16	0± 5
Station 1	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 2	0± 2	0± 2	0± 2	0± 2	4± 2	0± 2	0± 2	0± 1
Station 3	0± 2	0± 2	0± 2	4± 2	0± 2	0± 2	0± 2	0± 1
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Total	12±30	6± 30	10±30	2±30	2±30	0±30	4±30	

Table 38. Numbers of individuals per square meter for *Lumbrineris tenuis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	20±20	60±20	22±20	32±20	120±20	18±20	2±20	30±5
Station 1	22± 2	44± 2	120± 2	74± 2	80± 2	6± 2	6± 2	38±7
Station 2	14± 2	38± 2	6± 2	28± 2	154± 2	148± 2	0± 2	37±7
Station 3	114± 2	172± 2	64± 2	64± 2	318± 2	6± 2	0± 2	64±9
Station 4	6± 2	298± 2	0± 2	22± 2	212± 2	12± 2	0± 2	32±9
Station 5	0± 2	0± 2	0± 2	6± 2	20± 2	0± 2	4± 2	4±3
Lagoon System B	4±20	6±20	8±20	4±20	10±20	4±20	6±20	6±5
Station 1	0± 2	4± 2	8± 2	0± 2	6± 2	0± 2	0± 2	2±2
Station 2	12± 2	48± 2	38± 2	20± 2	44± 2	22± 2	26± 2	28±5
Station 3	12± 2	0± 2	6± 2	6± 2	12± 2	0± 2	16± 2	6±4
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Total	10±58	28±58	16±58	16±58	44±58	10±58	4±58	

Table 39. Numbers of individuals per square meter for *Melinna cristata*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	0±8	2±8	2±8	0±8	0±8	0±8	0±8	0±5
Station 1	0±2	8±2	4±2	0±2	0±2	0±2	0±2	2±2
Station 2	0±2	0±2	0±2	0±2	0±2	0±2	0±2	0±0
Station 3	0±2	0±2	4±2	0±2	0±2	0±2	0±2	0±1
Station 4	0±2	0±2	0±2	0±2	0±2	0±2	0±2	0±0
Station 5	0±2	0±2	0±2	0±2	0±2	0±2	0±2	0±0
Lagoon System B	8±8	4±8	6±8	6±8	4±8	2±8	4±8	4±5
Station 1	4±2	0±2	0±2	0±2	4±2	0±2	0±2	0±1
Station 2	48±2	20±2	22±2	38±2	4±2	12±2	12±2	20±5
Station 3	6±2	4±2	10±2	6±2	14±2	0±2	18±2	4±4
Staiton 4	0±2	0±2	4±2	0±2	0±2	0±2	0±2	0±1
Station 5	0±2	0±2	0±2	0±2	0±2	0±2	0±2	0±0
Total	4±4	2±4	4±4	2±4	2±4	2±4	2±4	

Table 40. Numbers of individuals per square meter for *Nereis succinea*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	56±36	106±36	150±36	50±36	20±36	62±36	34±36	60±6
Station 1	10± 2	6± 2	82± 2	20± 2	4± 2	94± 2	104± 2	32±7
Station 2	6± 2	54± 2	92± 2	36± 2	4± 2	8± 2	0± 2	20±5
Station 3	48± 2	106± 2	130± 2	8± 2	6± 2	46± 2	0± 2	32±7
Station 4	8± 2	60± 2	20± 2	12± 2	0± 2	70± 2	20± 2	22±6
Station 5	1,518± 2	1,620± 2	2,088± 2	812± 2	322± 2	180± 2	206± 2	662±7
Lagoon System B	2±36	20±36	12±36	16±36	10±36	6±36	0±36	8±6
Station 1	0± 2	4± 2	0± 2	0± 2	4± 2	0± 2	0± 2	0±1
Station 2	6± 2	102± 2	6± 2	26± 2	4± 2	26± 2	0± 2	24±6
Station 3	6± 2	4± 2	24± 2	74± 2	86± 2	10± 2	4± 2	78±6
Station 4	0± 2	0± 2	6± 2	4± 2	0± 2	0± 2	0± 2	2±1
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Total	20±40	50±40	54±40	30±40	14±40	26±40	14±40	

Table 41. Numbers of individuals per square meter for *Scoloplos robustus*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	6± 2	48± 2	28± 2	30± 2	36± 2	4± 2	0± 2	18±6
Station 1	10± 2	10± 2	60± 2	14± 2	12± 2	6± 2	0± 2	14±4
Station 2	4± 2	78± 2	42± 2	64± 2	50± 2	18± 2	0± 2	28±6
Station 3	8± 2	64± 2	68± 2	32± 2	36± 2	0± 2	0± 2	22±5
Station 4	6± 2	106± 2	4± 2	8± 2	36± 2	4± 2	0± 2	14±5
Station 5	0± 2	26± 2	8± 2	48± 2	64± 2	0± 2	0± 2	14±5
Lagoon System B	4± 2	8± 2	12± 2	8± 2	16± 2	2± 2	0± 2	6±6
Station 1	0± 2	6± 2	0± 2	6± 2	4± 2	4± 2	0± 2	2±2
Station 2	38± 2	42± 2	56± 2	18± 2	36± 2	6± 2	0± 2	24±4
Station 3	0± 2	10± 2	24± 2	28± 2	86± 2	0± 2	0± 2	14±5
Station 4	0± 2	0± 2	4± 2	0± 2	0± 2	0± 2	0± 2	0±1
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±1
Total	6±24	24±24	20±24	18±24	24±24	4±24	0±24	

Table 42. Numbers of individuals per square meter for *Streblospio benedicti*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	74±36	46±36	50±36	36±36	884±36	186±36	92±36	104± 2
Station 1	48± 4	16± 4	108± 4	74± 4	1,314± 4	236± 4	278± 4	144±10
Station 2	4± 4	54± 4	126± 4	38± 4	904± 4	68± 4	4± 4	62±10
Station 3	62± 4	194± 4	58± 4	58± 4	1,106± 4	166± 4	94± 4	138± 9
Station 4	40± 4	30± 4	28± 4	16± 4	2,164± 4	278± 4	26± 4	86±12
Station 5	876± 4	22± 4	4± 4	18± 4	138± 4	284± 4	476± 4	114±12
Lagoon System B	2±36	16±36	28±36	34±36	68±36	42±36	16±36	26± 2
Station 1	0± 4	0± 4	0± 4	6± 4	54± 4	10± 4	4± 4	8± 4
Station 2	4± 4	70± 4	74± 4	106± 4	52± 4	62± 4	10± 4	44± 8
Station 3	6± 4	66± 4	170± 4	354± 4	2,526± 4	842± 4	186± 4	236±12
Station 4	0± 4	0± 4	12± 4	0± 4	0± 4	0± 4	0± 4	2± 2
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Total	24±84	28±84	36±84	36±84	256±84	9±84	44±84	

Table 43. Numbers of individuals per square meter for *Ampelisca abdita*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	198± 84	3,076± 84	200± 84	206± 84	4,280± 84	776± 84	118± 84	534± 2
Station 1	1,032± 4	4,640± 4	13,576± 4	1,490± 4	8,514± 4	9,578± 4	4,004± 4	4,400±10
Station 2	836± 4	24,694± 4	348± 4	376± 4	7,004± 4	426± 4	0± 4	770±19
Station 3	1,334± 4	2,280± 4	104± 4	228± 4	9,276± 4	2,516± 4	8± 4	656±16
Station 4	0± 4	1,524± 4	12± 4	38± 4	6,920± 4	1,444± 4	38± 4	210±19
Station 5	0± 4	676± 4	6± 4	48± 4	360± 4	0± 4	360± 4	76±12
Lagoon System B	224± 84	208± 84	92± 84	114± 84	160± 84	28± 84	60± 84	108± 2
Station 1	896± 4	186± 4	24± 4	68± 4	466± 4	6± 4	12± 4	960±12
Station 2	2,028± 4	956± 4	1,042± 4	946± 4	420± 4	66± 4	272± 4	562± 8
Station 3	1,120± 4	2,810± 4	594± 4	1,078± 4	1,394± 4	292± 4	732± 4	934± 8
Station 4	0± 4	22± 4	0± 4	0± 4	6± 4	0± 4	0± 4	4± 3
Station 5	0± 4	6± 4	10± 4	4± 4	4± 4	0± 4	4± 4	0± 2
Total	210±244	822±244	136±244	154±244	858±244	176±244	86±244	

Table 44. Numbers of individuals per square meter for *Leptocheirus plumulosus*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	28±20	36±20	4±20	2±20	12±20	6±20	8±20	12±7
Station 1	98± 4	8± 4	18± 4	8± 4	46± 4	12± 4	46± 4	26±4
Station 2	24± 4	78± 4	4± 4	0± 4	10± 4	16± 4	0± 4	14±6
Station 3	96± 4	118± 4	0± 4	4± 4	10± 4	0± 4	0± 4	16±7
Station 4	0± 4	50± 4	0± 4	0± 4	6± 4	6± 4	0± 4	6±4
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	8± 4	0±2
Lagoon System B	2±20	18±20	22±20	36±20	6±20	0±20	10±20	12±7
Station 1	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0±0
Station 2	16± 4	148± 4	126± 4	170± 4	16± 4	0± 4	6± 4	42±8
Station 3	0± 4	32± 4	28± 4	266± 4	26± 4	0± 4	84± 4	34±8
Station 4	0± 4	0± 4	28± 4	0± 4	0± 4	0± 4	0± 4	2±3
Station 5	0± 4	0± 4	0± 4	6± 4	0± 4	0± 4	0± 4	0±1
Total	12±58	26±58	12±58	16±58	8±58	2±58	8±58	

Table 45. Numbers of individuals per square meter for *Cyathura polita*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	10±12	22±12	10±12	12±12	24±12	2±12	0±12	10± 2
Station 1	4± 2	0± 2	10± 2	4± 2	10± 2	0± 2	0± 2	4± 2
Station 2	0± 2	8± 2	6± 2	0± 2	6± 2	0± 2	0± 2	2± 3
Station 3	10± 2	6± 2	10± 2	10± 2	42± 2	6± 2	0± 2	10± 4
Station 4	6± 2	96± 2	6± 2	8± 2	62± 2	0± 2	0± 2	16± 6
Station 5	48± 2	52± 2	18± 2	72± 2	24± 2	0± 2	0± 2	24± 5
Lagoon System B	0±12	8±12	4±12	2±12	22±12	2±12	0±12	4±12
Station 1	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 1
Station 2	0± 2	64± 2	36± 2	8± 2	232± 2	8± 2	0± 2	26± 8
Station 3	0± 2	0± 2	0± 2	0± 2	40± 2	0± 2	0± 2	4± 3
Station 4	0± 2	0± 2	0± 2	0± 2	4± 2	0± 2	0± 2	0± 1
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 1
Total	4±14	14±14	8±14	6±14	24±14	2±14	0±14	

Table 46. Numbers of individuals per square meter for *Gemma gemma*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	52±24	14±24	34±24	28±24	26±24	4±24	0±24	20± 5
Station 1	52± 4	8± 4	60± 4	88± 4	14± 4	22± 4	0± 4	28± 7
Station 2	12± 4	8± 4	12± 4	64± 4	20± 4	0± 4	0± 4	12± 5
Station 3	2,924± 4	22± 4	116± 4	18± 4	108± 4	6± 4	0± 4	68±14
Station 4	0± 4	46± 4	42± 4	14± 4	36± 4	0± 4	0± 4	14± 6
Station 5	0± 4	0± 4	4± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Lagoon System B	2±24	14±24	12±24	14±24	0±24	0±24	0±24	6± 5
Station 1	0± 4	6± 4	0± 4	0± 4	4± 4	0± 4	4± 4	2± 2
Station 2	16± 4	108± 4	212± 4	192± 4	0± 4	0± 4	0± 4	36± 9
Station 3	0± 4	10± 4	0± 4	6± 4	0± 4	0± 4	0± 4	2± 2
Station 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Total	22±40	14±40	22±40	20±40	10±40	2±40	0±40	

Table 47. Numbers of individuals per square meter for *Mulinia lateralis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	0±2	2±2	0±2	0±2	4±2	0±2	0±2	0±5
Station 1	0±1	0±1	0±1	0±1	6±1	0±1	0±1	0±1
Station 2	0±1	4±1	0±1	0±1	8±1	0±1	0±1	2±2
Station 3	0±1	4±1	0±1	0±1	6±1	0±1	0±1	2±1
Station 4	0±1	0±1	0±1	0±1	0±1	0±1	0±1	0±0
Station 5	0±1	0±1	0±1	0±1	0±1	0±1	0±1	0±0
Lagoon System B	0±2	0±2	0±2	34±2	0±2	0±2	0±2	0±5
Station 1	0±1	0±1	0±1	6±1	4±1	0±1	0±1	1±1
Station 2	0±1	0±1	4±1	0±1	0±1	0±1	0±1	0±1
Station 3	0±1	4±1	0±1	6±1	0±1	0±1	0±1	0±2
Station 4	0±1	0±1	0±1	0±1	0±1	0±1	0±1	0±0
Station 5	0±1	0±1	0±1	0±1	0±1	0±1	0±1	0±0
Total	0±4	0±4	0±4	2±4	2±4	0±4	0±4	

Table 48. Numbers of individuals per square meter for *Iluanassa obsoleta*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	12±12	16±12	26±12	12±12	10±12	16±12	6±12	14±2
Station 1	60± 2	48± 2	42± 2	68± 2	66± 2	18± 2	0± 2	36±6
Station 2	4± 2	56± 2	28± 2	8± 2	4± 2	4± 2	4± 2	12±5
Station 3	10± 2	4± 2	80± 2	16± 2	6± 2	62± 2	46± 2	24±6
Station 4	6± 2	6± 2	20± 2	0± 2	4± 2	18± 2	0± 2	6±4
Station 5	4± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Lagoon System B	0±12	0±12	0±12	0±12	0±12	0±12	0±12	0±2
Station 1	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Station 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Station 3	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0±0
Total	6±14	6±14	10±14	6±14	4±14	6±14	2±14	

Table 49. Numbers of individuals per square meter for *Molgula manhattensis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0±1
Station 1	0± 1	0± 1	4± 1	0± 1	0± 1	0± 1	0± 1	0±0
Station 2	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0±0
Station 3	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0±0
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0±0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0±0
Lagoon System B	0± 8	0± 8	2± 8	18± 8	0± 8	0± 8	0± 8	2±1
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0±0
Station 2	0± 1	0± 1	0± 1	62± 1	0± 1	0± 1	0± 1	4±4
Station 3	0± 1	0± 1	6± 1	116± 1	0± 1	0± 1	0± 1	8±5
Station 4	0± 1	0± 1	6± 1	0± 1	0± 1	0± 1	0± 1	0±1
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0±0
Total	0±20	0±20	2±20	8±20	0±20	0±20	0±20	

Table 50. Biomass (g ash-free dry weight·m^{-2}·10^{-4}) for total species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	19,058±104	31,904±104	24,834±104	14,184±104	24,148±104	13,562±104	2,386±104	14,966± 13
Station 1	49,872± 8	33,820± 8	46,498± 8	58,402± 8	36,970± 8	25,750± 8	10,364± 8	33,278± 7
Station 2	15,420± 8	58,192± 8	23,734± 8	19,130± 8	22,182± 8	12,238± 8	60± 8	9,830± 20
Station 3	21,410± 8	15,214± 8	65,860± 8	22,478± 8	28,570± 8	44,360± 8	27,460± 8	28,888± 8
Station 4	5,054± 8	25,384± 8	3,134± 8	494± 8	20,706± 8	11,686± 8	594± 8	4,364± 20
Station 5	30,154± 8	43,478± 8	41,284± 8	44,652± 8	16,752± 8	2,796± 8	5,742± 8	18,170± 8
Lagoon System B	468±104	408±104	974±104	1,312±104	634±104	176±104	656±104	566±104
Station 1	1,812± 8	192± 8	180± 8	1,618± 8	1,726± 8	108± 8	296± 8	490± 8
Station 2	13,454± 8	17,092± 8	14,786± 8	31,556± 8	4,204± 8	2,018± 8	4,202± 8	8,726± 8
Station 3	2,756± 8	9,914± 8	8,284± 8	23,380± 8	10,082± 8	2,546± 8	5,628± 8	6,930± 8
Station 4	0± 8	0± 8	692± 8	60± 8	50± 8	0± 8	398± 8	56± 8
Station 5	0± 8	0± 8	36± 8	24± 8	4± 8	0± 8	24± 8	10± 8
Total	3,028±162	3,678±162	4,952±162	4,328±162	3,956±162	1,600±162	1,254±162	

Table 51. Biomass (g ash-free dry weight·m^{-2}·10^{-4}) for total polychaete species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	6,822±112	6,874±112	3,210±112	4,780±112	11,012±112	470±112	206±112	2,620± 15
Station 1	3,720± 8	1,086± 8	9,236± 8	4,898± 8	7,450± 8	160± 8	816± 8	2,130± 16
Station 2	6,340± 8	3,868± 8	1,322± 8	10,430± 8	10,998± 8	4,356± 8	0± 8	2,464± 19
Station 3	6,184± 8	8,052± 8	6,886± 8	6,260± 8	11,960± 8	16± 8	72± 8	1,866± 21
Station 4	3,788± 8	11,504± 8	36± 8	196± 8	10,404± 8	340± 8	102± 8	796± 24
Station 5	26,676± 8	38,914± 8	41,660± 8	36,610± 8	15,884± 8	2,784± 8	3,138± 8	15,566± 9
Lagoon System B	152±112	222±112	324±112	280± 8	178±112	50±112	116±112	168± 15
Station 1	150± 8	20± 8	0± 8	58± 8	4± 8	8± 8	0± 8	24± 12
Station 2	7,714± 8	9,150± 8	9,142± 8	6,076± 8	1,886± 8	110± 8	2,576± 8	3,044± 15
Station 3	802± 8	5,696± 8	3,942± 8	6,076± 8	6,864± 8	1,230± 8	2,304± 8	2,578± 13
Station 4	0± 8	0± 8	180± 8	22± 8	0± 8	0± 8	0± 8	10± 10
Station 5	0± 8	0± 8	14± 8	0± 8	0± 8	0± 8	0± 8	2± 3
Total	1,066±196	1,272±196	1,034±196	1,180±196	1,460±196	166±196	156±196	

Table 52. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for total crustacean species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	1,744± 92	5,392± 92	890± 92	1,104± 92	3,396± 92	1,100± 92	310± 92	1,412± 14
Station 1	2,090± 4	5,250± 4	21,460± 4	2,438± 4	5,316± 4	12,774± 4	8,924± 4	6,196± 10
Station 2	1,146± 4	19,990± 4	2,170± 4	1,294± 4	5,002± 4	1,622± 4	0± 4	1,520± 18
Station 3	4,108± 4	2,122± 4	492± 4	1,094± 4	8,026± 4	2,100± 4	90± 4	1,358± 13
Station 4	460± 4	5,442± 4	6± 4	88± 4	5,276± 4	1,410± 4	110± 4	476± 19
Station 5	1,868± 4	3,742± 4	954± 4	4,582± 4	388± 4	8± 4	1,512± 4	898± 15
Lagoon System B	234± 92	196± 92	206± 92	236± 92	246± 92	44± 92	250± 92	194± 14
Station 1	1,358± 4	92± 4	0± 4	60± 4	206± 4	6± 4	78± 4	86± 15
Station 2	936± 4	3,872± 4	4,786± 4	3,844± 4	2,016± 4	784± 4	1,296± 4	2,024± 10
Station 3	2,024± 4	2,750± 4	3,506± 4	3,728± 4	1,766± 4	100± 4	2,848± 4	1,708± 12
Station 4	0± 4	0± 4	32± 4	18± 4	50± 4	0± 4	398± 4	26± 12
Station 5	0± 4	0± 4	14± 4	6± 4	4± 4	0± 4	24± 4	6± 4
Total	650±156	1,064±156	434±156	516±156	932±156	246±156	328±156	

Table 53. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for total molluscan species.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	994±104	634±104	2,554±104	618±104	418±104	862±104	74±104	610± 11
Station 1	11,866± 12	8,940± 12	7,444± 12	40,872± 12	19,016± 12	404± 12	0± 12	4,674± 29
Station 2	862± 12	26,038± 12	4,350± 12	370± 12	602± 12	82± 12	44± 12	750± 31
Station 3	8,482± 12	48± 12	56,114± 12	4,090± 12	854± 12	40,376± 12	13,576± 12	4,844± 29
Station 4	148± 12	354± 12	3,064± 12	0± 12	60± 12	1,574± 12	0± 12	160± 29
Station 5	52± 12	0± 12	0± 12	58± 12	0± 12	0± 12	0± 12	10± 12
Lagoon System B	24±104	34±104	18±104	50±104	8±104	0±104	0±104	16± 11
Station 1	18± 12	16± 12	0± 12	128± 12	24± 12	0± 12	0± 12	16± 12
Station 2	238± 12	360± 12	480± 12	162± 12	0± 12	0± 12	0± 12	76± 17
Station 3	22± 12	74± 12	0± 12	140± 12	22± 12	0± 12	0± 12	22± 13
Station 4	0± 12	0± 12	0± 12	0± 12	0± 12	0± 12	0± 12	0± 0
Station 5	0± 12	0± 12	0± 12	0± 12	0± 12	0± 12	0± 12	0± 0
Total	192±118	170±118	292±118	192±118	88±118	112±118	24±118	

Table 54. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Eteone heteropoda*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	2±20	0±20	48±20	20±20	0±20	2±20	0±20	8± 5
Station 1	0± 2	0± 2	0± 2	20± 2	0± 2	0± 2	0± 2	2± 4
Station 2	0± 2	0± 2	14± 2	0± 2	0± 2	0± 2	0± 2	2± 3
Station 3	0± 2	0± 2	138± 2	0± 2	0± 2	0± 2	0± 2	6± 7
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 5	20± 2	0± 2	630± 2	312± 2	0± 2	14± 2	0± 2	38±12
Lagoon System B	0±20	0±20	0±20	20±20	0±20	0±20	0±20	2± 5
Station 1	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 3	0± 2	0± 2	0± 2	646± 2	0± 2	0± 2	0± 2	12±10
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Total	2±40	0±40	16±40	20±40	0±40	2±40	0±40	

Table 55. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Glycera* spp.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	88± 36	22± 36	0± 36	66± 36	584± 36	12± 36	0± 36	40± 16
Station 1	50± 8	0± 8	0± 8	144± 8	686± 8	0± 8	0± 8	34± 17
Station 2	326± 8	0± 8	0± 8	990± 8	1,878± 8	188± 8	0± 8	122± 26
Station 3	62± 8	158± 8	0± 8	50± 8	564± 8	0± 8	0± 8	44± 17
Station 4	330± 8	70± 8	0± 8	0± 8	1,158± 8	0± 8	0± 8	46± 22
Station 5	0± 8	0± 8	0± 8	0± 8	66± 8	0± 8	0± 8	4± 6
Lagoon System B	32± 36	28± 36	4± 36	6± 36	8± 36	4± 36	22± 36	14± 16
Station 1	20± 8	0± 8	36± 8	0± 8	0± 8	0± 8	0± 8	6± 8
Station 2	1,248± 8	196± 8	0± 8	52± 8	0± 8	34± 8	98± 8	76± 23
Station 3	0± 8	76± 8	0± 8	0± 8	92± 8	0± 8	104± 8	22± 15
Station 4	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Station 5	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Total	56±216	24±216	2±216	28±216	110±216	8±216	8±216	

Table 56. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Heteromastus filiformis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	118± 44	518± 44	212± 44	220± 44	760± 44	18± 44	0± 44	138± 19
Station 1	474± 1	284± 1	4,464± 1	908± 44	1,862± 1	0± 1	0± 1	314± 22
Station 2	910± 1	1,410± 1	0± 1	136± 1	2,722± 1	286± 1	0± 1	254± 21
Station 3	282± 1	2,920± 1	380± 1	910± 1	4,704± 1	0± 1	0± 1	324± 21
Station 4	0± 1	748± 1	0± 1	0± 1	270± 1	0± 1	0± 1	30± 15
Station 5	0± 1	26± 1	902± 1	274± 1	20± 1	0± 1	0± 1	12± 16
Lagoon System B	4± 44	8± 44	10± 44	10± 44	0± 44	4± 44	18± 44	6± 19
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 2	0± 1	80± 1	0± 1	30± 1	0± 1	26± 1	86± 1	20± 13
Station 3	26± 1	0± 1	118± 1	32± 1	0± 1	0± 1	74± 1	22± 13
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Total	38±294	102±294	62±294	64±294	104±294	10±294	8±294	

Table 57. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Hypaniola grayi*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	22± 28	18± 28	34± 28	4± 28	0± 28	0± 28	2± 28	10± 5
Station 1	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 3	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 5	878± 2	490± 2	2,952± 2	20± 2	0± 2	2± 2	16± 2	116± 18
Lagoon System B	0± 28	0± 28	0± 28	0± 28	0± 28	0± 28	0± 28	0± 5
Station 1	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 3	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Total	10± 34	8± 34	14± 34	2± 34	0± 34	0± 34	2± 34	

Table 58. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Lumbrineris tenuis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	24± 36	224± 36	34± 36	28± 36	146± 36	8± 36	0± 36	40± 9
Station 1	24± 1	34± 1	428± 1	108± 1	0± 1	0± 1	0± 1	32± 15
Station 2	0± 1	280± 1	0± 1	0± 1	1,306± 1	96± 1	0± 1	48± 16
Station 3	420± 1	614± 1	98± 1	82± 1	872± 1	0± 1	0± 1	122± 19
Station 4	0± 1	4,230± 1	0± 1	24± 1	246± 1	0± 1	0± 1	50± 18
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Lagoon System B	2± 36	12± 36	0± 36	0± 36	20± 36	2± 36	6± 36	6± 9
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 2	0± 1	158± 1	0± 1	0± 1	94± 1	8± 1	20± 1	20± 12
Station 3	16± 1	0± 1	0± 1	0± 1	0± 1	0± 1	20± 1	4± 5
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	90± 1	0± 1	0± 1	6± 8
Total	12± 84	66± 84	12± 84	10± 84	62± 84	21± 84	2± 84	

Table 59. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Melinna cristata*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	26± 24	8± 24	0± 24	0± 24	0± 24	0± 24	0± 24	4± 4
Station 1	50± 4	22± 4	0± 4	0± 4	0± 4	0± 4	0± 4	6± 9
Station 2	326± 4	24± 4	0± 4	0± 4	0± 4	0± 4	0± 4	14± 14
Station 3	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Lagoon System B	0± 24	2± 24	4± 24	18± 24	4± 24	0± 24	24± 24	10± 4
Station 1	24± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	2± 4
Station 2	826± 4	8± 4	0± 4	426± 4	0± 4	0± 4	164± 4	56± 16
Station 3	22± 4	0± 4	30± 4	0± 4	32± 4	0± 4	100± 4	18± 12
Station 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Total	32± 30	4± 30	2± 30	8± 30	2± 30	0± 30	10± 30	

Table 60. Biomass (g ash-free dry weight·m^{-2}·10^{-4}) for *Nereis succinea*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	196± 84	310± 84	568± 84	422± 84	110± 84	10± 84	72± 84	162± 13
Station 1	0± 1	0± 1	428± 1	194± 1	28± 1	0± 1	150± 1	48± 15
Station 2	0± 1	64± 1	30± 1	392± 1	28± 1	0± 1	0± 1	28± 15
Station 3	1,120± 1	82± 1	1,748± 1	214± 1	36± 1	0± 1	0± 1	120± 20
Station 4	22± 1	596± 1	36± 1	36± 1	0± 1	46± 1	20± 1	44± 16
Station 5	24,404± 1	36,652± 1	31,992± 1	14,242± 1	14,242± 1	20± 1	2,364± 1	6,610± 20
Lagoon System B	4± 84	38± 84	0± 84	64± 84	64± 84	0± 84	0± 1	16± 13
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 2	24± 1	174± 1	0± 1	1,318± 1	1,318± 1	0± 1	0± 1	90± 20
Station 3	0± 1	240± 1	0± 1	362± 1	362± 1	0± 1	0± 1	48± 17
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Total	52±146	118±146	88±146	192±146	84±146	4±146	22±146	

Table 61. Biomass (g ash-free dry weight·m^{-2}·10^{-4}) for *Scoloplos robustus*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	8± 40	158± 40	70± 40	268± 40	184± 40	0± 40	0± 40	52± 10
Station 1	28± 1	20± 1	494± 1	26± 1	26± 1	0± 1	0± 1	30± 14
Station 2	0± 1	542± 1	4± 1	1,640± 1	128± 1	0± 1	0± 1	62± 19
Station 3	22± 1	164± 1	680± 1	860± 1	196± 1	0± 1	0± 1	102± 18
Station 4	0± 1	1,074± 1	16± 1	32± 1	1,382± 1	0± 1	0± 1	62± 16
Station 5	0± 1	20± 1	0± 1	604± 1	150± 1	0± 1	0± 1	28± 13
Lagoon System B	26± 40	38± 40	10± 40	38± 40	20± 40	0± 40	0± 40	16± 10
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 2	410± 1	660± 1	0± 1	212± 1	86± 1	0± 1	0± 1	72± 16
Station 3	0± 1	102± 1	110± 1	344± 1	116± 1	0± 1	0± 1	58± 19
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Total	16±108	82±108	32±108	110±108	72±108	0±108	0±108	

Table 62. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Streblospio benedicti*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	20± 36	0± 36	0± 36	0± 36	744± 36	70± 36	52± 36	36± 13
Station 1	0± 1	0± 1	0± 1	0± 1	2,058± 1	116± 1	246± 1	54± 15
Station 2	0± 1	0± 1	0± 1	0± 1	1,486± 1	0± 1	0± 1	18± 12
Station 3	0± 1	0± 1	0± 1	0± 1	1,588± 1	6± 1	30± 1	24± 13
Station 4	0± 1	0± 1	0± 1	0± 1	2,556± 1	144± 1	0± 1	34± 15
Station 5	590± 1	0± 1	0± 1	0± 1	0± 1	510± 1	358± 1	60± 15
Lagoon System B	0± 36	0± 36	4± 36	10± 36	28± 36	18± 36	2± 36	8± 36
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 2	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 3	0± 1	0± 1	22± 1	138± 1	1,708± 1	468± 1	18± 1	78± 1
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Total	8±156	0±156	2±156	4±156	174±156	38±156	20±156	

Table 63. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Ampelisca abdita*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	702±100	2,594±100	182±100	336±100	3,016±100	592±100	112±100	594± 17
Station 1	1,738± 1	3,398± 1	20,620± 1	2,224± 1	5,090± 1	12,774± 1	8,546± 1	5,474± 11
Station 2	2,080± 1	19,490± 1	524± 1	1,294± 1	5,002± 1	252± 1	0± 1	948± 19
Station 3	2,006± 1	1,680± 1	54± 1	1,094± 1	6,584± 1	2,058± 1	0± 1	674± 18
Station 4	410± 1	1,462± 1	0± 1	26± 1	4,688± 1	580± 1	18± 1	232± 19
Station 5	42± 1	728± 1	0± 1	18± 1	304± 1	0± 1	284± 1	74± 14
Lagoon System B	226±100	102±100	140±100	152±100	136±100	14±100	100±100	106± 17
Station 1	1,260± 1	12± 1	0± 1	20± 1	206± 1	6± 1	0± 1	42± 14
Station 2	844± 1	786± 1	2,808± 1	3,116± 1	410± 1	12± 1	902± 1	674± 13
Station 3	2,024± 1	2,526± 1	1,624± 1	2,490± 1	870± 1	100± 1	2,196± 1	1,242± 12
Station 4	0± 1	0± 1	0± 1	0± 1	24± 1	0± 1	0± 1	2± 3
Station 5	0± 1	0± 1	36± 1	6± 1	6± 1	0± 1	10± 1	6± 5
Total	402±250	542±250	160±250	228±250	670±250	122±250	106±250	

Table 64. Biomass (g ash-free dry weight·m^{-2}·10^{-4}) for *Leptocheirus plumulosus*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	18± 12	2± 12	0± 12	0± 12	0± 12	0± 12	6± 12	4± 1
Station 1	24± 1	0± 1	0± 1	0± 1	0± 1	0± 1	46± 1	6± 7
Station 2	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 3	186± 1	8± 1	0± 1	0± 1	0± 1	0± 1	0± 1	10± 7
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Lagoon System B	0± 12	6± 12	6± 12	20± 12	0± 12	0± 12	2± 12	2± 1
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 2	0± 1	68± 1	12± 1	54± 1	0± 1	0± 1	0± 1	12± 8
Station 3	0± 1	0± 1	20± 1	166± 1	0± 1	0± 1	12± 1	12± 9
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Total	8± 34	4± 34	2± 34	8± 34	0± 34	0± 34	4± 34	

Table 65. Biomass (g ash-free dry weight·m^{-2}·10^{-4}) for *Cyathura polita*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	58± 48	178± 48	40± 48	78± 48	74± 48	2± 48	0± 48	42± 8
Station 1	20± 4	0± 4	102± 4	26± 4	0± 4	0± 4	0± 4	12± 11
Station 2	0± 4	58± 4	0± 4	0± 4	0± 4	0± 4	0± 4	4± 6
Station 3	98± 4	24± 4	0± 4	6± 4	506± 4	14± 4	0± 4	32± 14
Station 4	18± 4	3,106± 4	0± 4	68± 4	526± 4	0± 4	0± 4	70± 18
Station 5	834± 4	1,442± 4	808± 4	4,418± 4	42± 4	0± 4	0± 4	254± 22
Lagoon System B	0± 48	30± 48	14± 48	4± 48	32± 48	8± 48	0± 48	10± 8
Station 1	0± 4	18± 4	0± 4	0± 4	0± 4	0± 4	0± 4	2± 4
Station 2	0± 4	1,012± 4	248± 4	22± 4	1,152± 4	80± 4	0± 4	108± 54
Station 3	0± 4	0± 4	0± 4	0± 4	20± 4	0± 4	0± 4	2± 4
Station 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Total	20± 74	80± 74	26± 74	28± 74	50± 74	4± 74	0± 74	

Table 66. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Gemma gemma*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	38± 20	2± 20	4± 20	4± 20	0± 20	0± 20	0± 20	4± 6
Station 1	0± 2	0± 2	6± 2	14± 2	0± 2	0± 2	0± 2	2± 3
Station 2	0± 2	0± 2	0± 2	6± 2	0± 2	0± 2	0± 2	0± 0
Station 3	4,282± 2	0± 2	24± 2	0± 2	0± 2	0± 2	0± 2	28± 16
Station 4	0± 2	10± 2	0± 2	0± 2	0± 2	0± 2	0± 2	2± 2
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Lagoon System B	0± 20	20± 20	0± 20	0± 20	0± 20	0± 20	0± 20	2± 6
Station 1	0± 2	28± 2	0± 2	0± 2	0± 2	0± 2	0± 2	2± 5
Station 2	0± 2	266± 2	0± 2	0± 2	0± 2	0± 2	0± 2	10± 8
Station 3	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 4	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Station 5	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 2	0± 0
Total	14± 48	10± 48	2± 48	2± 48	0± 48	0± 48	0± 48	

Table 67. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Mulinia lateralis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	0± 8	0± 8	0± 8	0± 8	36± 8	0± 8	0± 8	4± 5
Station 1	0± 4	0± 4	0± 4	0± 4	146± 4	0± 4	0± 4	8± 4
Station 2	0± 4	0± 4	0± 4	0± 4	46± 4	0± 4	0± 4	4± 8
Station 3	0± 4	0± 4	0± 4	0± 4	168± 4	0± 4	0± 4	8± 10
Station 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Lagoon System B	0± 8	2± 8	0± 8	8± 8	4± 8	0± 8	0± 8	2± 5
Station 1	0± 4	0± 4	0± 4	22± 4	24± 4	0± 4	0± 4	4± 7
Station 2	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 3	0± 4	16± 4	0± 4	24± 4	0± 4	0± 4	0± 4	4± 6
Station 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Station 5	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 4	0± 0
Total	0± 34	2± 34	0± 34	4± 34	18± 34	0± 34	0± 34	

Table 68. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Ilyanassa obsoleta*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1976	Total
Meyers Creek	208± 96	278± 96	2,270± 96	354± 96	188± 96	1,276± 96	74± 96	380± 13
Station 1	11,822± 8	8,940± 8	7,302± 8	40,580± 8	17,810± 8	4,040± 8	0± 8	4,610± 29
Station 2	60± 8	26,038± 8	4,350± 8	194± 8	48± 8	78± 8	44± 8	364± 33
Station 3	174± 8	48± 8	53,244± 8	1,430± 8	232± 8	40,376± 8	13,576± 8	2,010± 36
Station 4	148± 8	76± 8	1,826± 8	0± 8	46± 8	1,574± 8	0± 8	124± 29
Station 5	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Lagoon System B	0± 96	0± 96	0± 96	0± 96	0± 96	0± 96	0± 96	0± 13
Station 1	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Station 2	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Station 3	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Station 4	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Station 5	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 8	0± 0
Total	48±146	80±146	190±146	66±146	44±146	112±146	24±146	

Table 69. Biomass (g ash-free dry weight$\cdot m^{-2} \cdot 10^{-4}$) for *Molgula manhattensis*.

Site	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Total
Meyers Creek	0± 28	0± 28	4± 28	0± 28	0± 28	0± 28	0± 28	0± 41
Station 1	0± 1	0± 1	38± 1	0± 1	0± 1	0± 1	0± 1	7± 7
Station 2	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 3	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 4	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Lagoon System B	0± 28	0± 28	14± 28	192± 28	0± 28	0± 28	0± 28	10± 41
Station 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Station 2	0± 1	0± 1	0± 1	13,464± 1	0± 1	0± 1	0± 1	30± 20
Station 3	0± 1	0± 1	110± 1	3,996± 1	0± 1	0± 1	0± 1	36± 20
Station 4	0± 1	0± 1	22± 1	0± 1	0± 1	0± 1	0± 1	2± 4
Station 5	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 1	0± 0
Total	0±112	0±112	10±112	46±112	0±112	0±112	0±112	

Table 70. Numbers of species collected, spring 1974-winter 1975.

Waterway	Season			
	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek	31	32	43	40
Meyers Creek	30	21	33	38
Cedar Run	47	29	28	38
Mill Creek	31	23	40	30
Lagoon System A	16	12	30	20
Lagoon System B	20	19	16	34
Reference station	17	28	11	13
Dinner Point Creek:				
Mouth	15	24	29	32
Mid	16	15	18	15
Upper	20	12	16	14
Meyers Creek:				
Mouth	13	9	17	33
Mid	30	18	21	29
Upper	13	16	18	16
Cedar Run:				
Mouth	42	12	16	17
Mid	20	17	13	28
Upper	10	13	9	15
Mill Creek:				
Mouth	11	11	31	19
Mid	24	18	29	18
Upper	3	3	4	2
Lagoon System A:				
Mouth	12	13	25	18
Mid	2	2	4	9
Upper	2	2	4	4
Lagoon System B:				
Mouth	6	8	11	8
Mid	23	15	12	35
Upper	1	4	5	5

Table 71. Changes in species numbers.

Time period	Waterway or station	Net change*	Average absolute change#
1974-1975	Dinner Point Creek	+13	5.0
	Meyers Creek	+ 8	8.7
	Cedar Run	- 9	9.7
	Mill Creek	- 1	11.7
	Lagoon System A	+ 4	10.7
	Lagoon System B	+14	7.3
	Reference station	- 4	10.0
1975-1977	Meyers Creek	-10	6.3
	Lagoon System B	- 5	8.8

* Total number of species lost or gained

\# Average number of species lost or gained per season

Table 72. Numbers of species collected, summer 1975-winter 1977.

		Season							
Waterway	Station	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977	Station totals
Meyers Creek	1	21	23	28	21	24	19	17	44
	2	17	25	19	15	20	22	4	40
	3	27	25	23	13	20	14	6	36
	4	11	23	10	9	19	18	8	30
	5	9	12	16	16	11	7	13	26
Total		32	38	35	24	32	29	20	
Lagoon System B	1	8	13	7	12	14	8	5	30
	2	20	34	21	28	20	13	13	50
	3	12	23	19	27	20	12	15	39
	4	0	1	11	3	2	0	1	14
	5	0	1	1	2	1	0	2	3
Total		24	41	31	24	31	21	19	

Table 73. Species persistence data, 1973-1975.

Organism or category	Dinner Point Creek			Meyers Creek			Cedar Run			Mill Creek			Lagoon System A			Lagoon System B			Ref.*
	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	
Capitellidae sp.				x													x		
Eteone heteropoda		x		x		x					x						x		
Exogene dispar			x		x	x									x				
Glycera americana					x	x			x		x								x
Glycinde solitaria			x	x	x	x		x	x		x	x			x		x		x
Hetermostus filiformis		x	x	x	x	x	x	x	x		x	x					x		x
Hypaniola grayi	x	x	x	x			x	x											
Lumbrineris tenuis				x	x	x			x										x
Maldanopsis elongata									x								x		x
Melinna cristata									x										x
Nereis sp.	x	x		x			x	x											
Nereis succinea		x	x	x	x	x		x			x				x		x		
Polydora ligni		x	x		x			x			x						x		
Scolecolepides virdis	x	x					x												
Scoloplos robustus		x	x	x	x	x		x	x		x	x			x		x	x	x
Spiochaetopterus oculatus			x														x		x
Streblospio benedicti		x	x	x	x	x		x			x	x			x		x	x	
Nemertea sp.		x	x			x					x								
Ampelisca abdita		x	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x
Corophium insidiosum			x			x													
Corophium simile	x																		
Leptocheirus plumulosus	x		x				x	x											

Table 73. Continued.

Organism or category	Dinner Point Creek			Meyers Creek			Cedar Run			Mill Creek			Lagoon System A			Lagoon System B			Ref.
	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	
Cyathura polita	x	x	x	x	x	x	x	x	x		x								x
Edotea triloba	x		x	x		x	x	x											
Crangon septemspinosa																			x
Neomysis americana			x			x		x			x						x		x
Gemma gemma					x			x			x						x		
Mulinia lateralis																		x	x
Tellina sp.											x								
Gastropoda sp.																			x
Ilyanassa obsoleta			x	x	x	x						x			x				
Odostomia sp.			x		x														
Retusa canaliculata			x		x						x						x		x
Anthozoa sp.											x						x		
Oligochaeta sp.	x	x	x	x			x	x			x	x					x		
Number of species present at least four of the six (or seven seasonal samplings (A)	8	13	20	15	15	16	9	15	9	1	17	7		1	7		16	4	15
Total number of species (B)	41	51	68	44	55	77	44	65	77	15	51	63	15	21	52	13	76	33	87
Percent relative appearance= $\frac{(A)}{(B)}(100)$																			
Station	20	26	29	34	27	21	21	23	12	7	33	11	0	5	13	0	21	12	17

Table 73. Continued.

Organism or category	Dinner Point Creek			Meyers Creek			Cedar Run			Mill Creek			Lagoon System A			Lagoon System B			Ref.*
	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	upper	mid	mouth	
Waterway	25			27			17			17			6			11			
Waterway type	26						17						8.5						

*Reference Station

Table 74. Species persistence data, 1975-1977.

Species or category	Meyers Creek station					Lagoon System B station				
	1	2	3	4	5	1	2	3	4	5
Eteone heteropoda	6*	4	6	5	7			5		
Glycera americana			4				4	4		
Glycinde solitaria	4		5				5	5		
Heteromastus filiformis	7	7	6	4	6		5	5		
Hypaniola grayi				5	7					
Lumbrineris tenuis	7	6	6	5			7	5		
Melinna cristata							7	6		
Nereis succinea	7	6	7	6	7		6	7		
Polydora ligni	5	4	4	4			4	4		
Scoloplos robustus	6	5	4	6	4	4	6	4		
Streblospio benedicti	7	7	7	7	7	5	7	7		
Terebellidae	5						4			
Nemertea	6	5			4		4	4		
Ampelisca abdita	7	6	7	6	5	7	7	7		5

Table 74. Continued.

Species or category	Meyers Creek station 1	2	3	4	5	Lagoon System B station 1	2	3	4	5
Corophium insidiosum	6	4					4			
Leptocheirus plumulosus	7	5	4				6	5		
Lysianopsis alba							5	6		
Melita nitida	5						4	4		
Cyathura polita	4		6	5	5		5			
Edotea triloba	4	4	5							
Leptochelia savignyi							4			
Ostracod							4			
Neomysis americana	4					6				
Acteon punctostriatus	4									
Gemma gemma	5	5	6				4			
Ilyanassa obsoleta	6	7	7	5						
Oligochaeta	7	5	5	7	7		5	5		
Percent of total species present for:										
4 of 7 seasons	52	38	44	40	38	13	42	41	0	33
5 of 7 seasons	41	28	33	33	31	10	24	28	0	33
6 of 7 seasons	32	15	25	17	23	7	14	13	0	0
7 of 7 seasons	20	8	11	6	19	3	8	8	0	0
Percent of total species present for:										
4 of 7 seasons			51					51		
5 of 7 seasons			41					33		
6 of 7 seasons			32					23		
7 of 7 seasons			20					11		

*Number of seasons present.

Table 75. Diversity indices, 1974-1975.

Season	Diversity index	Dinner Point Creek	Meyers Creek	Cedar Run	Mill Creek	Lagoon System A	Lagoon System B	Reference station
Spring 1974	H'*	0.9088	0.6997	1.2194	0.6255	0.8288	0.8553	0.8000
	J#	0.6094	0.4737	0.7293	0.4194	0.6883	0.6574	0.6502
	D†	0.7594	0.9565	0.8899	0.6428	0.7873	0.8331	
Summer 1974	H'	0.8610	0.9890	0.7105	0.6822	0.4651	0.6022	0.3283
	J	0.5720	0.7480	0.4859	0.5010	0.4310	0.4709	0.2269
	D	0.7769	0.8267	0.7160	0.6683	0.4301	0.5147	0.5147
Fall 1974	H'	1.0940	0.2879	0.7444	0.4000	0.1475	0.5993	0.4000
	J	0.6697	0.1896	0.5144	0.2497	0.0999	0.4977	0.3841
	D	0.8561	0.2169	0.6250	0.2096	0.0979	0.5561	
Winter 1974	H'	1.0695	0.3044	1.2042	0.2097	0.6506	0.5983	0.9320
	J	0.6676	0.1927	0.7622	0.1420	0.5000	0.3907	0.8367
	D	0.6089	0.2270	0.9018	0.1630	0.5652	0.4677	

* Shannon-Weaver's H'

\# Pielou's J

† Simpson's D

Table 76. Station diversity indices, 1974-1975.

Station	Diversity index	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek:					
Upper	H'*	0.8660	0.5038	1.2456	0.3023
	J#	0.7363	0.3650	0.8518	0.2008
Mid	H'	0.3635	0.6892	0.9211	0.8382
	J	0.3019	0.5724	0.7338	0.7127
Mouth	H'	0.4152	0.6571	0.6723	0.5099
	J	0.3191	0.6089	0.5583	0.4449
Meyers Creek:					
Upper	H'	0.8299	0.7743	0.8273	0.8981
	J	0.7450	0.6430	0.6591	0.7459
Mid	H'	0.9264	1.0154	0.2085	0.3227
	J	0.6272	0.8089	0.1577	0.2207
Mouth	H'	0.8499	0.5885	0.0955	0.1950
	J	0.7630	0.6167	0.0776	0.1284
Cedar Run:					
Upper	H'	1.2473	0.0869	0.9715	0.9059
	J	0.7684	0.0805	0.8068	0.7362
Mid	H'	0.6944	1.0466	0.2927	1.1691
	J	0.5337	0.8506	0.2628	0.8079
Mouth	H'	0.6163	0.5125	0.6992	0.8942
	J	0.6163	0.4601	0.7327	0.7603
Mill Creek:					
Upper	H'	0.4686	0.4517	0.5081	0.0517
	J	0.9821	0.9467	0.8439	0.1717
Mid	H'	0.5720	0.5989	0.3110	0.0677
	J	0.4144	0.4771	0.2127	0.0539
Mouth	H'	0.6936	0.8186	0.2732	0.6554
	J	0.6660	0.7861	0.1832	0.5125
Lagoon System A:					
Upper	H'	0.3010	0.2171	0.4582	0.4586
	J	0.9999	0.7212	0.7610	0.7617
Mid	H'	0.3010	0.2875	0.5268	0.6879
	J	0.9999	0.9550	0.8750	0.7209
Mouth	H'	0.7839	0.5403	0.1312	0.4460
	J	0.7264	0.4850	0.0939	0.3553
Lagoon System B:					
Upper	H'	0.0000	0.5012	0.4052	0.4126
	J	0.0000	0.8325	0.5797	0.5903
Mid	H'	0.3123	0.1863	0.2688	0.1372
	J	0.2293	0.1584	0.2491	0.0889
Mouth	H'	0.7661	0.5281	0.3835	0.5323
	J	0.9845	0.5848	0.3683	0.5894

* Shannon-Weaver's H'

\# Pielou's J

Table 77. Seasonal diversity indices, 1975-1977.

System	Season	Shannon-Weaver's H'	Pielou's J	Simpson's D
Meyers Creek	Summer 1975	0.8451	0.5615	0.7848
	Fall 1975	0.3209	0.2031	0.2414
	Winter 1976	0.5516	0.3602	0.4826
	Spring 1976	0.7295	0.5357	0.7467
	Summer 1976	0.4191	0.2810	0.4167
	Fall 1976	0.4108	0.2809	0.3519
	Winter 1977	0.4512	0.3528	0.4515
Lagoon System B	Summer 1975	0.2076	0.1504	0.1445
	Fall 1975	0.8102	0.5024	0.7265
	Winter 1976	0.8851	0.5880	0.7328
	Spring 1976	0.9857	0.6384	0.7959
	Summer 1976	0.6948	0.4658	0.6894
	Fall 1976	0.6239	0.4719	0.6007
	Winter 1977	0.7489	0.5856	0.7063

Table 78. Station seasonal diversity indices, 1975-1977.

Station	Diversity index	Period	Station 1	2	3	4	5
Meyers Creek	H'	Summer 1975	0.5468	0.3083	0.8096	0.9277	0.5140
		Fall 1975	0.1957	0.0880	0.5048	0.5828	0.5336
		Winter 1976	0.2061	0.9818	0.9941	0.8617	0.4915
		Spring 1976	0.6798	0.7901	0.8855	0.9075	0.6879
		Summer 1976	0.3964	0.3363	0.3875	0.4049	0.7419
		Fall 1976	0.1534	0.8731	0.3035	0.4565	0.4025
		Winter 1977	0.3025	0.6020	0.5939	0.7004	0.7017
		1975-1977	0.3204	0.3063	0.6994	0.5629	0.6646
	J	Summer 1975	0.4135	0.2506	0.5656	0.8908	0.5140
		Fall 1975	0.1437	0.0629	0.3611	0.4280	0.4944
		Winter 1976	0.1424	0.7678	0.8150	0.8617	0.4082
		Spring 1976	0.5141	0.6718	0.7949	0.9075	0.5713
		Summer 1976	0.2872	0.2585	0.2978	0.3226	0.7124
		Fall 1976	0.1200	0.6504	0.2648	0.3637	0.4763
		Winter 1977	0.2458	1.0000	0.7632	0.7756	0.6299
		1975-1977	0.1950	0.1912	0.4494	0.3811	0.4697
	D	Summer 1975	0.4971	0.2577	0.5927	0.8610	0.6342
		Fall 1975	0.1387	0.0574	0.4370	0.4994	0.5734
		Winter 1976	0.1483	0.8530	0.8987	0.8474	0.5086
		Spring 1976	0.5033	0.7246	0.8062	0.8661	0.7067
		Summer 1976	0.3838	0.3351	0.3951	0.4734	0.7618
		Fall 1976	0.1171	0.7298	0.2757	0.4420	0.5076
		Winter 1977	0.2502		0.7123	0.7691	0.7429
		1975-1977	0.2455	0.2309	0.5851	0.5249	0.6675

Table 78. Continued.

Station	Diversity index	Period	Station 1	2	3	4	5
Lagoon System B	H'	Summer 1975	0.0765	0.2745	0.1530	0.0000	0.0000
		Fall 1975	0.4178	0.9054	0.3584	1.0000	1.0000
		Winter 1976	0.6762	0.9068	0.5146	0.6734	1.0000
		Spring 1976	0.6797	0.9453	0.9160	0.4770	0.2764
		Summer 1976	0.3892	0.9377	0.5902	0.2764	0.0000
		Fall 1976	0.8567	0.9201	0.4229	0.0000	0.0000
		Winter 1977	0.4853	0.6562	0.7162	1.0000	0.3010
		1975-1977	0.3888	0.9681	0.6813	0.8510	0.3133
	J	Summer 1975	0.0847	0.2110	0.1418	0.0000	0.0000
		Fall 1975	0.3751	0.5912	0.2632	0.0000	0.0000
		Winter 1976	0.8001	0.6659	0.3892	0.6466	0.0000
		Spring 1976	0.6484	0.6532	0.6330	0.9997	0.9182
		Summer 1976	0.3396	0.7207	0.4536	0.9182	0.0000
		Fall 1976	0.9486	0.8260	0.3919	0.0000	0.0000
		Winter 1977	0.6236	0.5891	0.6090	0.0000	1.0000
		1975-1977	0.2632	0.5698	0.4282	0.7425	0.6944
	D	Summer 1975	0.0538	0.2111	0.1127	0.0000	0.0000
		Fall 1975	0.3438	0.7396	0.2856	0.0000	0.0000
		Winter 1976	0.6917	0.8004	0.4298	0.6770	0.0000
		Spring 1976	0.6384	0.7937	0.7849	0.0000	0.6667
		Summer 1976	0.7085	0.7728	0.6060	0.6767	0.0000
		Fall 1976	0.9273	0.8476	0.4779	0.0000	0.0000
		Winter 1977	0.6013	0.6304	0.6935	0.0000	0.0000
		1975-1977	0.2910	0.8018	0.6781	0.8044	0.4394

Table 79. Dominance indices, 1974-1975.

Season	Index	Dinner Point Creek	Meyers Creek	Cedar Run	Mill Creek	Lagoon System A	Lagoon System B
Spring 1974	Berger- Parker	37	18	24	46	38	28
	Mc Naughton	68	23	42	84	56	50
	Species*	Hg/Sb#	Sb/Hf	Lp/Aa	Sb/Aa	Io/Sb	Sb/Pl
Summer 1974	Berger- Parker	37	37	39	50	75	69
	Mc Naughton	62	48	72	77	83	75
	Species	Aa/Hg	Sb/Hg	Aa/Hg	Hg/Aa	Aa/Cc	Sb/Aa
Fall 1974	Berger- Parker	28	88	60	89	95	65
	Mc Naughton	49	91	70	90	96	80
	Species	Hg/Cc	Aa/Ol	Aa/Ns	Aa/Ns	Aa/Ns	Aa/Sb
Winter 1975	Berger- Parker	59	88	20	91	65	73
	Mc Naughton	78	90	38	96	72	77
	Species	Aa/Hg	Aa/Sb	Ns/Aa	Aa/Io	Aa/Cc	Aa/Sb

* Species initials.

Aa = *Ampelisca abdita*

Cc = *Capitella capitata*

Hf = *Heteromastus filiformis*

Hg = *Hypaniola grayi*

Ns = *Nereis succinea*

Pl = *Polydora ligni*

Ol = Oligochaeta

Io = *Ilyanassa obsoleta*

Sb = *Streblospio benedicti*

\# Most abundant species/ second most abundant species.

Table 80. Station dominance indices, 1974-1975.

Station	Index	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek:					
Mouth	Berger - Parker	30	76	19	88
	Mc Naughton	47	81	32	90
	Species*	Hf/Io	Aa/Hf	Io/Aa	Aa/Io
Mid	Berger - Parker	83	36	35	36
	Mc Naughton	88	68	48	59
	Species	Sb/Hg	Aa/Hg	Hg/Ns	Hg/Ns
Upper	Berger - Parker	64	40	43	70
	Mc Naughton	96	75	75	79
	Species	Hg/Cs	Hg/Gp	Lp/Hg	Hg/Lp
Meyers Creek:					
Mouth	Berger - Parker	23	58	97	93
	Mc Naughton	45	75	97	94
	Species	Hf/Sb	Hf/Lt	Aa/Io	Aa/Sb
Mid	Berger - Parker	42	33	94	87
	Mc Naughton	56	47	95	90
	Species	Sb/Aa	Sb/Aa	Aa/Lt	Aa/Sb
Upper	Berger - Parker	35	44	35	23
	Mc Naughton	56	62	64	44
	Species	Sb/Rc	Sb/Ns	Io/Eh	Io/Eh
Cedar Run:					
Mouth	Berger - Parker	28	97	26	37
	Mc Naughton	38	98	45	49
	Species	Aa/Pl	Aa/Sb	Pp/Aa	Aa/Sr
Mid	Berger - Parker	24	16	87	24
	Mc Naughton	42	32	90	33
	Species	Aa/Sb	Hg/Gs	Aa/Ns	Aa/Ns
Upper	Berger - Parker	53	59	36	27
	Mc Naughton	73	85	60	50
	Species	Lp/Sv	Hg/Lp	Ns/Lp	Aa/Ns
Mill Creek:					
Mouth	Berger - Parker	60	30	83	45
	Mc Naughton	72	52	85	80
	Species	Pl/Aa	Aa/Cc	Aa/Sb	/Aa
Mid	Berger - Parker	48	55	38	97
	Mc Naughton	87	81	40	98
	Species	Sb/Aa	Hg/Aa	Aa/Ns	Aa/Ns

Table 80. Continued.

Station	Index	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Upper	Berger - Parker	43	67	57	97
	Mc Naughton	71	100	90	100
	Species	Lp/Aa	Aa/Ns	Aa/Pl	Aa/Cc
Lagoon System A:					
Mouth	Berger - Parker	39	67	96	78
	Mc Naughton	58	82	97	84
	Species	Io/Sb	Aa/Sr	Aa/Ns	Aa/ Io
Mid	Berger - Parker	50	63	61	28
	Mc Naughton	100	100	94	47
	Species	Cr/An	Cc/Aa	Aa/Cc	Cc/Aa
Upper	Berger - Parker	50	80	54	63
	Mc Naughton	100	100	83	79
	Species	Aa/As	Aa/Hg	Aa/Cc	Cc/Ns
Lagoon System B:					
Mouth	Berger - Parker	39	20	81	21
	Mc Naughton	65	40	85	34
	Species	Sb/Sr	Na/Aa	Aa/Sr	Na/Aa
Mid	Berger - Parker	24	74	46	74
	Mc Naughton	46	79	79	79
	Species	Sb/Pl	Sb/Aa	Aa/Sb	Aa/Sb
Upper	Berger - Parker	100	57	73	79
	Mc Naughton	100	71	90	86
	Species	Cs	Ta/Hg	Aa/Cc	Cc/Sr
Reference Station:	Berger - Parker	39	87	77	31
	Mc Naughton	67	89	86	54
	Species	Ml/Rc	Aa/Na	Aa/Rc	Ga/Aa

* Species initials.

Aa = *Ampelisca abdita*

An = Anthozoan

As = *Asterias forbesii*

Cc= *Capitella capitata*

Cr= Caprellidae

Cs = *Callinectes sapidus*

Eh = *Eteone heteropoda*

Ga = *Glycera americana*

Gp = *Gammarus palustris*

Gs = *Glycinde solitaria*

Table 80. Continued.

Hf = *Heteromastus filiformis*

Hg = *Hypaniola grayi*

Lp = *Leptocheirus plumulosus*

Lt = *Lumbrineris tenuis*

Ml = *Mulinia lateralis*

Na = *Neomysis americana*

Io = *Ilyanassa obsoleta*

Ns = *Nereis succinea*

Pl = *Polydora ligni*

Rc = *Retusa canaliculata*

Sb = *Streblospio benedicti*

Sr = *Scoloplos robustus*

Sv = *Scolepides virides*

Ta = *Tharyx acutus*

Table 81. Dominance indices, 1975-1977.

Period	Station 1	Station 2	Station 3	Station 4	Station 5	Total
Meyers Creek Berger - Parker indices:						
Summer 1975	71 Aa*	86 Aa	54 Gg	33 Sb	42 Ns	36 Aa
Fall 1975	93 Aa	97 Aa	75 Aa	70 Aa	59 Ns	87 Aa
Winter 1976	92 Aa	30 Aa	19 Gg	26 Gg	70 Ns	70 Aa
Spring 1976	70 Aa	50 Aa	39 Aa	26 Ol	48 Ns	47 Aa
Summer 1976	78 Aa	81 Aa	76 Aa	69 Aa	35 Aa	75 Aa
Fall 1976	94 Aa	32 Na	85 Aa	73 Aa	62 Sb	80 Aa
Winter 1977	86 Aa	25 #	42 Sb	37 Na	36 Sb	73 Aa
Total	87 Aa	88 Aa	62 Aa	67 Aa	52 Ns	74 Aa
Meyers Creek Mc Naughton indices:						
Summer 1975	79 Aa†	91 Aa	82 Gg	46 Sb	84 Ns	59 Aa
	Lp	Hf	Aa	Ol	Sb	Gg
Fall 1975	94 Aa	98 Aa	81 Aa	78 Aa	80 Ns	91 Aa
	No	Os	Sb	Lt	Aa	Ns
Winter 1976	94 Aa	42 Aa	34 Gg	47 Gg	83 Ns	81 Aa
	Ol	Ol	Ol	Sb	Hg	Ns
Spring 1976	75 Aa	59 Aa	49 Aa	42 Ol	71 Ns	59 Aa
	Gg	Sr	Lt	Aa	Ol	Ns
Summer 1976	89 Aa	92 Aa	90 Aa	92 Aa	65 Aa	90 Aa
	Sb	Sb	Sb	Sb	Ns	Sb
Fall 1976	97 Aa	61 Na	92 Aa	88 Aa	95 Sb	87 Aa
	Sb	Aa	Sb	Sb	Ns	Sb
Winter 1977	91 Aa	50 #	66 Sb	61 Na	68 Sb	85 Aa
	Sb		Na	Aa	Aa	Sb
Total	91 Aa	91 Aa	75 Aa	84 Aa	72 Ns	81 Aa
	Sb	Sb	Gg	Sb	Sb	Sb

Table 81. Continued.

Period	Station 1	Station 2	Station 3	Station 4	Station 5	Total
Lagoon System B Berger - Parker indices:						
Summer 1975	97 Aa	89 Aa	94 Aa	0	0	93 Aa
Fall 1975	82 Aa	47 Ls	84 Aa	100 Aa	100 Aa	43 Aa
Winter 1976	35 Ap	33 Aa	74 Aa	54 Cc	100 Aa	48 Aa
Spring 1976	60 Aa	40 Aa	41 Aa	33 Lp	67 Lp	41 Aa
Summer 1976	80 Aa	39 Aa	55 Sb	100 Aa	100 Aa	42 Sb
Fall 1976	27 Sb	27 Aa	69 Sb	0	0	59 Sb
Winter 1977	61 Na	58 Aa	51 Aa	100 Na	50 Aa	51 Aa
Total	84 Aa	38 Aa	55 Aa	36 Cc	75 Aa	49 Aa
Lagoon System B Mc Naughton indices:						
Summer 1975	98 Aa	91 Aa	95 Aa	0	0	94 Aa
Fall 1975	87 Gg/Aa	63 Mc/Ls	89 Lt/Aa	100 —/Aa	100 —/Aa	72 Mc/Aa
Winter 1976	69 Ls/Ap	61 Aa/Aa	83 Sb/Aa	70 —/Cc	100 —/Aa	64 Ls/Aa
Spring 1976	66 Aa/Aa	55 Os/Aa	56 Sb/Aa	67 Lp/Lp	100 —/Lp	52 Os/Aa
Summer 1976	89 Hf/Aa	64 T/Aa	85 Sb/Sb	100 Aa/Aa	100 —/Aa	80 Lp/Sb
Fall 1976	45 Sb/Sb	51 Cp/Aa	91 Aa/Sb	0 —/—	0 —/—	82 Aa/Sb
Winter 1977	83 Aa/Na	74 Sb/Aa	65 Aa/Aa	100 —/Na	100 —/Aa	62 Aa/Aa
Total	87 Aa/Na	57 Na/Aa/Ls	81 Na/Aa/Sb	57 —/Cc/Na	92 —/Aa/Lp	63 Na/Aa/Sb

* Species initials.

Aa = *Ampelisca abdita*

Ap = *Aceteon punctostriatus*

Cp = *Cyathura polita*

Cc = *Capitella capitata*

Gg = *Gemma gemma*

Hf = *Heteromastus filiformis*

Hg = *Hypaniola grayi*

Lp = *Leptocheirus plumulosus*

Ls = *Leptochelia savignyi*

Lt = *Lumbrineris tenuis*

Mc = *Melinna cristata*

Na = *Neomysis americana*

Ns = *Nereis succinea*

Ol = Oligochaeta

Table 81. Continued.

Os = Ostracod

Sb = *Streblospio benedicti*

Sr = *Scoloplos robustus*

T = Terebellidae

Equal dominance value contributed by four species.

† The two most abundant species which were used in the calculation.

Table 82. Similarity index values, 1974-1975.

Season	System	Dinner Point Creek	Meyers Creek	Cedar Run	Mill Creek	Lagoon System A	Lagoon System B	Reference station
Spring 1974	Dinner Point Creek	1	.66	.62	.61	.30	.35	.25
	Meyers Creek		1	.68	.66	.35	.44	.30
	Cedar Run			1	.64	.35	.45	.34
	Mill Creek				1	.47	.51	.29
	Lagoon System A					1	.56	.18
	Lagoon System B						1	.22
	Reference station							1
Summer 1974	Dinner Point Creek	1	.68	.62	.65	.37	.63	.40
	Meyers Creek		1	.64	.59	.42	.50	.37
	Cedar Run			1	.50	.34	.58	.39
	Mill Creek				1	.40	.67	.43
	Lagoon System A					1	.45	.30
	Lagoon System B						1	.38
	Reference station							1

Table 82. Continued.

Season	System	Dinner Point Creek	Meyers Creek	Cedar Run	Mill Creek	Lagoon System A	Lagoon System B	Reference station
Fall 1974	Dinner Point Creek	1	.56	.59	.70	.66	.58	.20
	Meyers Creek		1	.46	.60	.57	.45	.34
	Cedar Run			1	.56	.45	.45	.17
	Mill Creek				1	.60	.39	.13
	Lagoon System A					1	.56	.21
	Lagoon System B						1	.42
	Reference station							1
Winter 1975	Dinner Point Creek	1	.72	.67	.54	.57	.54	.34
	Meyers Creek		1	.66	.62	.59	.67	.39
	Cedar Run			1	.50	.48	.44	.24
	Mill Creek				1	.60	.59	.23
	Lagoon System A					1	.63	.30
	Lagoon System B						1	.38
	Reference station							1

Table 83. Similarity index values for seasons, 1975-1977.

Seasons	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Summer 1975	1	.75	.67	.71	.72	.71	.61
Fall 1975		1	.78	.78	.79	.71	.58
Winter 1976			1	.77	.73	.64	.65
Spring 1976				1	.74	.71	.63
Summer 1976					1	.72	.65
Fall 1976						1	.70
Winter 1977							1

Table 84. Season by waterway similarity index values, 1975-1977.

Code*	BS1	BF1	BW2	BSp2	BS2	BF2	BW3	MS1	MF1	MW2	MSp2	MS2	MF2	MW3
BS1	1	.58	.41	.47	.55	.53	.47	.54	.53	.45	.42	.42	.45	.33
BF1		1	.76	.79	.75	.55	.51	.69	.81	.69	.62	.68	.60	.57
BW2			1	.77	.79	.55	.65	.61	.74	.81	.70	.70	.68	.61
BSp2				1	.76	.61	.56	.72	.77	.74	.71	.68	.63	.52
BS2					1	.57	.60	.67	.81	.74	.66	.78	.70	.60
BF2						1	.60	.62	.55	.52	.46	.60	.61	.56
BW3							1	.56	.57	.62	.57	.55	.68	.70
MS1								1	.74	.67	.68	.68	.72	.59
MF1									1	.75	.71	.73	.75	.56
MW2										1	.72	.63	.73	.64
MSp2											1	.63	.72	.65
MS2												1	.75	.65
MF2													1	.62
MW3														1

Table 84. Continued.

* Datum is identified by a two part code using the following abbreviations. The parts of the code define location and season.

M = Meyers Creek	F = Fall	1 = 1975
B = Lagoon System B	Sp = Spring	2 = 1976
S = Summer	W = Winter	3 = 1977

Table 85. Station similarity index values, 1975-1977.

Stations		Lagoon System B stations					Meyers Creek stations				
		1	2	3	4	5	1	2	3	4	5
Lagoon System B:	1	1	.65	.64	.50	.12	.68	.71	.73	.60	.54
	2		1	.79	.44	.11	.70	.69	.67	.63	.53
	3			1	.49	.14	.70	.73	.69	.67	.65
	4				1	.35	.41	.37	.44	.46	.50
	5					1	.13	.14	.15	.18	.14
Meyers Creek:	1						1	.74	.80	.70	.66
	2							1	.76	.77	.73
	3								1	.78	.74
	4									1	.75
	5										1

Table 86. Season to season comparisons for similarity indices.

Station	Season	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek:								
Station 1	Summer 1975	1	.66	.67	.68	.67	.65	.58
	Fall 1975		1	.67	.64	.60	.81	.55
	Winter 1976			1	.74	.65	.72	.67
	Spring 1976				1	.67	.75	.63
	Summer 1976					1	.65	.68
	Fall 1976						1	.77
	Winter 1977							1
Station 2	Summer 1975	1	.52	.56	.69	.70	.67	.29
	Fall 1975		1	.68	.50	.71	.55	.21
	Winter 1976			1	.77	.72	.54	.35
	Spring 1976				1	.74	.54	.32
	Summer 1976					1	.57	.25
	Fall 1976						1	.31
	Winter 1977							1
Station 3	Summer 1975	1	.69	.69	.65	.68	.54	.30
	Fall 1975		1	.72	.68	.80	.67	.24
	Winter 1976			1	.69	.60	.65	.34
	Spring 1976				1	.67	.67	.54
	Summer 1976					1	.65	.31
	Fall 1976						1	.50
	Winter 1977							1

Table 86. Continued.

Station	Season	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek:								
Station 4	Summer 1975	1	.47	.67	.57	.53	.55	.42
	Fall 1975		1	.55	.67	.62	.73	.39
	Winter 1976			1	.70	.41	.57	.67
	Spring 1976				1	.57	.59	.59
	Summer 1976					1	.65	.36
	Fall 1976						1	1
	Winter 1977							1
Station 5	Summer 1975	1	.64	.54	.54	.70	.63	.55
	Fall 1975		1	.79	.79	.78	.54	.64
	Winter 1976			1	.75	.67	.43	.62
	Spring 1976				1	.74	.52	.62
	Summer 1976					1	.55	.65
	Fall 1976						1	.70
	Winter 1977							1
Lagoon System B:								
Station 1	Summer 1975	1	.29	.27	.30	.27	.38	.31
	Fall 1975		1	.30	.32	.44	.29	.33
	Winter 1976			1	.21	.57	.40	.67
	Spring 1976				1	.38	.50	.24
	Summer 1976					1	.36	.42
	Fall 1976						1	.46
	Winter 1977							1

Table 86. Continued.

Station	Season	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B:								
Station 2	Summer 1975	1	.44	.42	.42	.35	.42	.36
	Fall 1975		1	.63	.65	.63	.51	.43
	Winter 1976			1	.78	.78	.59	.53
	Spring 1976				1	.75	.55	.44
	Summer 1976					1	.61	.48
	Fall 1976						1	.53
	Winter 1977							1
Station 3	Summer 1975	1	.57	.30	.35	.50	.33	.44
	Fall 1975		1	.68	.87	.65	.40	.58
	Winter 1976			1	.61	.62	.52	.77
	Spring 1976				1	.60	.46	.89
	Summer 1976					1	.43	.57
	Fall 1976						1	.59
	Winter 1977							1
Station 4	Summer 1975	1	0	0	0	0	0	0
	Fall 1975		1	0	.50	.67	0	0
	Winter 1976			1	.14	0	0	0
	Spring 1976				1	0	0	.50
	Summer 1976					1	0	0
	Fall 1976						1	0
	Winter 1977							1

Table 86. Continued.

Station	Season	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B: Station 5	Summer 1975	1	0	0	0	0	0	0
	Fall 1975		1	1	.67	1	0	.67
	Winter 1976			1	.67	1	0	.67
	Spring 1976				1	.67	0	.50
	Summer 1976					1	0	.33
	Fall 1976						1	0
	Winter 1977							1

Table 87. Mean lengths of *Ampelisca abdita* populations.

Date	Mean length (mm)	SD (mm)	Percent of the population
11 April 1974	1.96	0.10	2
	4.13	0.83	19
	5.89	0.52	79
11 July 1974	3.51	0.80	100
31 October 1974	3.72	0.72	100
24 January 1975	2.53	0.52	43
	4.08	0.67	57
24 July 1975	2.55	0.45	12
	3.90	0.30	88
17 September 1975	2.10	0.40	56
	3.35	0.45	44
21 October 1975	3.10	0.80	100
18 November 1975	2.80	1.00	100
10 December 1975	3.50	1.30	100
18 February 1976	3.30	1.00	100
23 March 1976	3.50	1.60	100
20 April 1976	3.70	0.60	100
25 May 1976	1.90	0.50	73
	3.30	0.30	18
	4.10	0.40	9
16 June 1976	2.40	0.70	25
	3.70	0.50	70
	5.00	0.30	5
14 July 1976	1.65	0.46	10
	2.07	0.41	6
	3.62	1.09	84
25 July 1976	2.43	0.88	41
	3.77	0.72	59
25 August 1976	2.12	0.33	52
	2.95	0.16	11
	4.03	0.36	29
	6.30	0.44	8
27 September 1976	0.46	0.36	40
	2.64	0.31	21
	3.98	0.46	39
18 November 1976	2.07	0.26	15
	3.88	0.98	85
9 March 1977	2.12	0.16	6
	4.39	0.83	77

Table 87. Continued.

Date	Mean length (mm)	SD (mm)	Percent of the population
	5.48	0.31	17
19 April 1977	4.03	0.36	20
	5.63	0.46	80

Table 88. Population structure of *Ampelisca abdita*.

Date	Percentage composition			
	Juveniles	Nonovigerous females	Ovigerous females	Males
11 April 1974		9	1	1
11 July 1974	0	92	7	1
31 October 1974	0	99	1	0
24 January 1975	0	99	0	1
24 July 1975	1	75	23	1
17 September 1975	28	59	12	1
21 October 1975	8	92	0	0
18 November 1975	14	85	0	1
10 December 1975	4	96	0	0
18 February 1976	6	94	0	0
23 March 1976	3	96	<1	<1
20 April 1976	0	84	12	4
25 May 1976	42	52	3	2
16 June 1976	4	75	16	5
14 July 1976	10	80	9	1
25 July 1976	40	55	5	0
25 August 1976	50	31	14	5
27 September 1976	40	48	8	4
18 November 1976	15	84	1	0
9 March 1977	6	94	0	<1
19 April 1977	0	83	9	8

Table 89. Mean lengths of *Leptocheirus plumulosus* populations.

Date	Mean length (mm)	SD (mm)	Percent of the population
11 April 1974	6.61	1.65	100
11 July 1974	4.44	1.24	100
31 October 1974	5.68	1.24	100
24 January 1975	6.20	1.86	100
24 July 1975	3.80	0.70	84
	5.70	0.20	16
21 October 1975	3.00	1.20	100
18 February 1976	3.20	1.10	100
20 April 1976	5.00	1.00	100
14 July 1976	3.31	0.62	100
9 March 1977	4.13	0.83	100

Table 90. Population structure of *Leptocheirus plumulosus*.

	Percentage composition			
Date	Juveniles	Nonovigerous females	Ovigerous females	Males
11 April 1974		54	11	35
11 July 1974		59	22	19
31 October 1974		81		19
24 January 1975		65		35
24 July 1975			76	24
21 October 1975			75	25
18 February 1976				100
20 April 1976			95	5
14 July 1976		56	28	16
27 September 1976		90		10
9 March 1977	4	90		6

Table 91. Mean lengths of *Cyathura polita* populations.

Date	Mean length (mm)	SD (mm)	Percent of the population
11 April 1974	6.0	1.5	11
	11.5	1.5	76
	16.0	1.0	13
11 July 1974	7.0	1.0	70
	16.0	2.0	30
31 October 1974	14.0	3.5	100
24 January 1975	6.0	1.5	37
	11.5	1.5	23
	16.0	2.0	40
24 July 1975	12.0	3.0	100
21 October 1975	14.0	5.0	100
18 February 1976	13.0	5.0	100
20 April 1976	17.0	7.0	100
14 July 1976	6.5	0.5	83
	15.0	1.5	17

Table 92. Population structure of *Cyathura polita*.

	Percentage composition			
Date	Juveniles	Nonovigerous females	Ovigerous females	Males
11 April 1974	50	50	0	0
11 July 1974	70	24	6	0
31 October 1974	24	71	0	5
24 January 1975	59	38	0	3
24 July 1975	39	61	0	0
21 October 1975	24	70	0	6
18 February 1976	43	43	0	14
20 April 1976	29	41	20	10
14 July 1976	81	15	3	1

Table 93. Mean lengths of *Nereis succinea* populations.

Date	Mean length (mm)	SD (mm)	Percent of the population
11 July 1974	11.0	3.5	42
	33.0	12.0	58
31 October 1974	17.0	5.0	35
	31.0	5.5	65
24 January 1975	9.0	3.5	39
	23.0	7.5	61
24 July 1975	9.0	3.0	44
	19.0	7.0	56
21 October 1975	10.0	3.0	44
	30.0	9.5	56
18 February 1976	9.0	3.0	31
	25.0	5.5	56
	41.0	2.5	13
20 April 1976	11.0	2.5	26
	26.0	8.0	38
	53.0	20.0	26
14 July 1976	7.0	5.0	37
	38.0	12.0	44
	67.0	6.5	19
27 September 1976	6.0	2.0	80
	18.0	12.0	14
	33.0	6.0	6
9 March 1977	5.0	1.5	40
	12.0	3.5	42
	31.0	3.0	18

Table 94. Mean lengths of *Streblospio benedicti* populations.

Date	Mean length (mm)	SD (mm)	Percent of the population
11 April 1974	9.23	1.85	45
	14.46	0.90	55
11 July 1974	5.23	1.23	100
31 October 1974	9.84	2.46	100
24 January 1975	9.84	2.46	48
	18.15	2.45	52
24 July 1975	4.40	1.10	100
21 October 1975	4.81	1.60	100
18 February 1976	4.30	1.43	100

Table 94. Continued.

Date	Mean length (mm)	SD (mm)	Percent of the population
20 April 1976	4.50	1.00	30
	8.00	2.20	50
	12.00	1.85	20
14 July 1976	7.07	1.84	40
	10.77	1.54	60
27 September 1976	7.69	1.54	45
	11.22	0.76	55
9 March 1977	8.00	1.85	100

Table 95. Mean lengths of *Hypaniola grayi* populations.

Date	Mean length (mm)	SD (mm)	Percent of the population
11 April 1974	4.61	0.62	4
	7.54	0.62	86
	12.77	0.62	10
11 July 1974	3.08	0.50	9
	4.00	0.20	18
	6.00	1.85	73
31 October 1974	3.69	0.20	2
	7.07	0.70	41
	10.77	0.70	57
24 January 1975	5.54	0.62	4
	9.07	2.30	48
	12.46	1.39	48
24 July 1975	3.90	1.20	100
21 October 1975	4.50	1.20	100
18 February 1976	6.50	1.20	100

Table 96. Mean prostomium widths of *Heteromastus filiformis* populations.

Date	Mean width (mm)	SD (mm)	Percent of the popluation
24 July 1975	0.7001	0.1301	100
21 October 1975	0.9853	0.2074	69
	1.0372	0.0778	31
18 February 1976	0.7001	0.1297	5
	0.8557	0.0259	16
	1.0891	0.0778	45
	1.2706	0.1297	34
20 April 1976	0.2852	0.1556	7
	0.9594	0.1556	34
	1.2965	0.0778	59
14 July 1976	0.2852	0.0259	9
	0.4149	0.0778	38
	0.6742	0.1037	53
27 September 1976	0.1815	0.0778	10
	0.6483	0.1556	50
	1.1150	0.1037	40

Table 97. Mean prostomium widths of *Lumbrineris tenuis* populations.

Date	Mean width (mm)	SD (mm)	Percent of the population
31 October 1974	0.3630	0.0259	10
	0.5964	0.0519	90
24 January 1975	0.3890	0.1037	100
24 July 1975	0.5705	0.0519	100
21 October 1975	0.3371	0.0259	8
	0.5964	0.0778	92
18 February 1976	0.5445	0.1297	100
20 April 1976	0.5445	0.1297	100
14 July 1976	0.2334	0.0259	21
	0.4408	0.1297	22
	0.5964	0.0517	57
27 September 1976	0.3371	0.0778	19
	0.4408	0.0519	17
	0.8816	0.0778	64

Table 98. Instantaneous relative percentage growth for *Hypaniola grayi*.

Collection date	Days	Percent k (per day)
11 July 1974*		
31 October 1974	81	0.0973
24 January 1975	85	0.2554
11 July 1974#		
31 October 1974	81	0.3948
24 January 1975	85	0.1937
11 July 1974†		
31 October 1974	81	0.4813
24 January 1975	85	0.1230
24 July 1975**		
21 October 1975	89	0.0950
18 February 1976	120	0.1723

* Initial weight 0.61 mg.

\# Initial weight 0.69 mg.

† Initial weight 0.86 mg.

** Initial weight 0.68 mg.

Table 99. Instantaneous relative percentage growth for *Nereis succinea*.

Collection date	Days	Percent k (per day)
11 July 1974		
31 October 1974	81	0.2720
24 January 1975	85	0.2135
18 February 1976*		
20 April 1976	61	0.1396
18 February 1976#		
20 April 1976	61	0.0419
14 July 1976	86	0.0310
18 February 1976†		
20 April 1976	61	0.3278
14 July 1976	86	0.2222

* Initial weight 5.85 mg.

\# Initial weight 10.04 mg.

† Initial weight 14.23 mg.

Table 100. Instantaneous relative percentage growth for *Streblospio benedicti*.

Collection date	Days	Percent k (per day)
11 July 1974		
31 October 1974	81	0.4787
24 January 1975	85	0.0000
20 April 1976*		
14 July 1976	85	0.3556
27 September 1976	75	0.0567
9 March 1977	163	0.0250
20 April 1976#		
14 July 1976	85	0.2145
27 September 1976	75	0.0437

* Initial weight 0.17 mg.

\# Initial weight 0.25 mg.

Table 101. Instantaneous relative percentage growth for *Ampelisca abdita*.

Collection date	Days	Percent k (per day)
31 October 1974		
24 January 1975	85	0.1006
17 September 1975		
21 October 1975	34	0.1401
18 November 1975	29	-0.1642
10 December 1975	22	0.5230
18 February 1976	70	-0.0319
23 March 1976	33	0.0666
20 April 1976	28	0.1520
25 May 1976	36	0.2332
16 June 1976	22	0.5846
25 May 1976		
16 June 1976	22	0.3844
14 July 1976	28	0.8544
25 July 1976	11	0.1914
25 August 1976	31	0.1317
27 September 1976	33	0.0000
27 September 1976		
18 November 1976	52	0.8074
9 March 1977	111	0.0254
19 April 1977	41	0.8012

Table 102. Instantaneous relative percentage growth for *Leptocheirus plumulosus*.

Collection date	Days	Percent k (per day)
11 July 1974	81	0.1903
31 October 1974	85	0.0623
24 January 1975		
21 October 1975	120	0.0239
18 February 1976	61	0.4086
20 April 1976		

Table 103. Respiratory rates.

Species	Temperature (^{o}C)	Salinity ($^{o}/oo$)	Rate ± SD ($ml\ O_2 \cdot g\ dry\ weight^{-1} \cdot day^{-1}$)
Ampelisca abdita	15	25	50.7 ± 11.2
	15	22	30.6 ± 4.5
	15	15	191.4 ± 12.8
	10	25	48.6 ± 10.8
Ilyanassa obsoleta	25	25	25.6 ± 10.5
	15	22	2.3 ± 3.6
	10	25	11.3 ± 2.6
Nereis succinea	10	25	15.0 ± 3.3
	10	15	13.5 ± 1.9
Cyathura polita	10	25	6.7 ± 2.7
	10	15	5.4 ± 1.4

Table 104. Respiration rates used for production estimates.

Species	Respiration rate	Reference
Nereis succinea	15 $ml\ O_2 \cdot g\ dry\ wt^{-1} \cdot day^{-1}$	This study
Clymenella torquata	7.1 $ml\ O_2 \cdot g\ wet\ wt^{-1} \cdot day^{-1}$	Mangum (1963)
Clymenella mucosa	6.4 $ml\ O_2 \cdot g\ wet\ wt^{-1} \cdot day^{-1}$	Mangum (1963)
Clymenella zonalis	7.8 $ml\ O_2 \cdot g\ wet\ wt^{-1} \cdot day^{-1}$	Mangum (1963)
Pectinaria gouldii	6.0 $ml\ O_2 \cdot g\ ash\text{-}free\ dry\ wt^{-1} \cdot day^{-1}$	Nicholls (1975)
Average	8.7 $ml\ O_2 \cdot g^{-1} \cdot day^{-1}$	

Table 104. Continued.

Species	Respiration rate	Reference
Corophium volutator	48 ml $O_2 \cdot g$ dry $wt^{-1} \cdot day^{-1}$	McLusky (1969)
Gammarus oceanicus	14 ml $O_2 \cdot g$ wet $wt^{-1} \cdot day^{-1}$	Halcrow and Boyd (1967)
Cyathura polita	23 ml $O_2 \cdot g$ ash-free dry $wt^{-1} \cdot day^{-1}$	Frankenburg and Burbanck (1963)
Cyathura polita	6 ml $O_2 \cdot g$ dry $wt^{-1} \cdot day^{-1}$	This study
Ampelisca abdita	55 ml $O_2 \cdot g$ dry $wt^{-1} \cdot day^{-1}$	This study
Average	29 ml $O_2 \cdot g^{-1} \cdot day^{-1}$	
Ilyanassa obsoleta	15 ml $O_2 \cdot g$ dry $wt^{-1} \cdot day^{-1}$	This study
Ilyanassa obsoleta	9.6 ml $O_2 \cdot g$ dry $wt^{-1} \cdot day^{-1}$	Vernberg (1969)
Average	13 ml $O_2 \cdot g^{-1} \cdot day^{-1}$	

Table 105. Respiration values for 1975-1977.

Taxonomic group	Meyers Creek		Lagoon System B	
	Respiration ($kcal \cdot m^{-2} \cdot year^{-1}$)	% of waterway production	Respiration ($kcal \cdot m^{-2} \cdot year^{-1}$)	% of waterway production
Total polychaetes	4.224	27.05	0.277	15.65
Nondominant species	3.287	21.05	0.136	7.68
Dominant species	0.937	6.00	0.141	7.97
Nereis succinea	0.431	2.76	0.042	2.37
Total crustaceans	9.853	63.09	1.456	82.86
Nondominant species	3.992	25.56	0.401	22.66
Dominant species	5.861	37.53	1.055	59.60
Ampelisca abdita	5.795	37.10	1.034	58.42
Cyathura polita	0.045	0.29	0.011	0.56
Total molluscs	1.541	9.87	0.037	2.09
Nondominant species	0.512	3.28	0.028	1.58
Dominant species	1.029	6.59	0.009	0.51
Ilyanassa obsoleta	1.011	6.47		
Total for waterway	15.541		1.770	

Table 106. Production estimates from respiration data for 1975 - 1977.

Taxonomic group	Meyers Creek Production (kcal·m^{-2}·year^{-1})	Meyers Creek % of waterway production	Meyers Creek % of taxonomic group production	Lagoon System B Production (kcal·m^{-2}·year^{-1})	Lagoon System B % of waterway production	Lagoon System B % of taxonomic group production
Total polychaetes	1.267	46.16		0.110	33.03	
Nondominant species	0.986	35.92	77.82	0.041	12.31	37.27
Dominant species	0.281	12.24	22.18	0.069	20.72	62.73
Nereis succinea	0.129	4.70	10.18	0.039	11.71	35.45
Total crustaceans	1.478	53.84		0.219	65.77	
Nondominant species	0.599	21.82	40.53	0.060	18.02	27.40
Dominant species	0.879	32.02	59.47	0.159	47.75	72.60
Ampelisca abdita	0.869	31.66	58.80	0.155	46.55	70.78
Cyathura polita	0.007	0.26	0.47	0.002	0.60	0.91
Total molluscs	0.154	5.61		0.004	1.20	
Nondominant species	0.051	1.86	33.12	0.003	0.90	75.00
Dominant species	0.103	3.75	66.88	0.001	0.30	25.00
Ilyanassa obsoleta	0.101	3.68	65.58			
Total for waterway	2.899			0.333		

Table 107. Production estimates based on P/B ratios and Allen curves in ($g \cdot m^{-2} \cdot year^{-1}$).

Species	Meyers Creek	Lagoon System B
Glycera spp.	0.001	0.001
Heteromastus filiformis	0.014	0.001
Lumbrineris tenuis	0.005	0.001
Nereis succinea	0.034	0.003
Ampelisca abdita	0.239	0.044
Ilyanassa obsoleta	0.152	0.000
Ampelisca abdita (P/B ratio production estimate for July 1975 - April 1976)	0.361	0.046
Ampelisca abdita (Allen curve estimate for production for July 1975-April 1976)	0.445	0.058
Ampelisca abdita (Allen curve estimate of production per year for 1975 - 1977)	0.898	0.117

Table 108. Respiration to production efficiencies and P/B ratios from literature.

Taxonomic group	Efficiency (%)	P/B ratio	Source
Crustacea	15		Hargrave (1970)
Polychaeta	30		Teal (1962)
Mollusca	10		Teal (1962)
Glycera spp.		0.37	Buchanan and Warwick (1974)
Heteromastus filiformis		1.01	Buchanan and Warwick (1974)
Nereis succinea		1.60	Kay and Brafield (1973)*
Ampelisca abdita		3.48	Klein et al. (1975)*
Ilyanassa obsoleta		4.00	Borowski (1974)*

* P/B ratio based on similar species values.

Table 109. Qualitative analysis of benthic invertebrate gut contents.

Species	Contents
Ampelisca abdita	Sand, detritus, diatoms, algal filaments
Streblospio benedicti	Sand, detritus, diatoms, algal filaments
Lumbrineris tenuis	Sand, detritus, diatoms
Eteone heteropoda	Sand, detritus, diatoms
Scoloplos robustus	Sand, detritus, diatoms, algal filaments
Hypaniola grayi	Sand, detritus, diatoms
Cyathura polita	Sand, detritus, diatoms
Ilyanassa obsoleta	Sand, detritus, diatoms, plant fragments
Nereis succinea	Sand, detritus, diatoms, plant fragments, gastropod leaves
Heteromastus filiformis	Sand, detritus, diatoms, algal filaments

Table 110. Average percent volume for size classes of sand grains found in benthic invertebrates.

Mean diameter (μm)	Percent volume									
	E. heteropoda	*L. tenuis*	*I. obsoleta*	*C. polita*	*H. grayi*	*N. succinea*	*H. filiformis*	*S. robustus*	*S. benedicti*	*A. abdita*
2.5	0.08	0.12	0.07	0.16	0.05	0.07	0.06	0.04	0.42	0.35
5.0	0.09	0.32	0.18	0.60	0.17	0.24	0.25	0.12	1.26	1.07
7.5	0.16	0.73	0.42	1.01	0.32	0.47	0.47	0.32	2.19	2.58
10.0	0.39	1.34	0.87	1.80	0.56	0.83	0.73	0.47	3.08	4.19
12.5	0.46	2.39	1.38	3.38	1.07	1.54	2.01	1.11	4.90	6.49
15.0	0.65	2.95	1.50	3.60	1.49	1.99	1.73	1.25	4.63	6.26
17.5	1.03	2.19	1.90	3.27	1.95	2.79	1.98	1.90	4.72	7.65
20.0	0.86	2.33	1.77	3.09	1.54	2.48	2.51	1.39	3.23	6.10
22.5	0.24	4.32	2.05	2.38	2.02	3.57	2.33	2.12	5.57	5.53
25.0	2.35	5.01	2.51	2.67	2.00	5.16	4.84	2.25	7.80	9.40
27.5	2.23	1.21	2.45	0.50	1.14	4.37	3.05	2.38	4.45	4.67
30.0	1.74	1.51	4.90	2.48	1.98	4.66	3.97	2.04	3.29	6.61
32.5	2.95	4.00	2.66	1.67	3.17	3.51	1.81	1.99	2.94	4.55
35.0		5.00	2.20	1.85	1.38	2.63	2.80	1.22	2.41	2.48
37.5	5.66	3.07	3.05	3.90	1.21	3.69	5.56	2.60	2.60	6.32
40.0	1.13	1.87	3.59	0.78	1.17	2.60	2.13	3.92	10.03	3.16
42.5	2.75	2.24	1.83	2.21	2.82	2.02	3.18	3.46	2.93	2.23
45.0	1.65	2.66	1.85	4.62	2.09	0.67	1.26	1.55	2.07	3.53
47.5			4.11	3.52	0.95	5.64	3.57	1.33	2.64	0.68
50.0	8.05		4.57	1.76	3.98	5.12	0.87	5.09	3.95	1.45
52.5			2.46	5.15	1.34	4.23	3.84	3.02	3.56	3.65
55.0	3.57		2.11	2.30	3.64	2.92	2.29	3.39	3.12	1.06
57.5			2.06	9.30	1.76	3.35	3.93	1.62		6.24

Table 110. continued.

Mean diameter (μm)	Percent volume									
	E. heteropoda	*L. tenuis*	*I. obsoleta*	*C. polita*	*H. grayi*	*N. succinea*	*H. filiformis*	*S. robustus*	*S. benedicti*	*A. abdita*
60.0	5.24		4.68	2.97	2.00	3.80	2.98	1.74		
62.5			1.59		1.09	2.15	4.75	4.56		1.55
65.0		8.01	2.98				3.45	2.48	3.53	
67.5			2.00		1.37	2.70				
70.0					3.18				2.01	1.79
72.5						6.70		7.77		1.99
75.0			10.69	10.24	3.91	13.55		7.00	2.48	
77.5				24.39		6.55				
80.0		14.93	4.43		7.02			2.18		
82.5								4.79		
85.0			9.13		2.73		8.41			
87.5								5.72		
90.0			6.08							
92.5			3.42		3.51			6.38		
95.0				10.40						
97.5					8.59			3.95		
100.0	21.46							4.27		
102.5			4.66		4.78		13.52	4.60		
105.0		33.75			15.40					
107.5										
110.0										
112.5										
115.0										

Table 110. Continued.

Mean diameter (µm)	Percent volume									
	E. heteropoda	*L. tenuis*	*I. obsoleta*	*C. polita*	*H. grayi*	*N. succinea*	*H. filiformis*	*S. robustus*	*S. benedicti*	*A. abdita*
117.5										
120.0	37.08								10.16	
122.5										
125.0					8.67					

Table 111. Summary data for quantitative gut contents.

Species	Diameter of particles at 50% cumulative volume point (μm)
Ampelisca abdita	25.0
Streblospio benedicti	32.5
Nereis succinea	47.5
Heteromastus filiformis	52.5
Cyathura polita	52.5
Lumbrineris tenuis	55.0
Ilyanassa obsoleta	57.5
Scoloplos robustus	60.0
Eteone heteropoda	75.0
Hypaniola grayi	75.0

Table 112. Summary data for diatoms in benthic invertebrate gut contents.

Species	Percentage occurrence of diatoms	Mean frustule diameter (μm)
Ampelisca abdita	0.8	22.5
Streblospio benedicti	0.5	25.0
Nereis succinea	3.3	27.5
Heteromastus filiformis	0.1	25.0
Cyathura polita	0.4	22.5
Lumbrineris tenuis	1.7	20.0
Ilyanassa obsoleta	2.7	27.5
Scoloplos robustus	0.2	57.5
Eteone heteropoda	0.3	
Hypaniola grayi	4.2	37.5

Table 113. Generic composition of benthic invertebrate gut contents.

Diatom genera	Benthic invertebrate species									
	A. abdita	*S. benedicti*	*S. robustus*	*I. obsoleta*	*H. filiformis*	*N. succinea*	*H. grayi*	*C. polita*	*E. heteropoda*	*L. tenuis*
Cocconeis	29.77	27.22	18.42	18.86	24.86	22.48	4.69	32.00	33.33	53.60
Coscinodiscus	31.21	21.11	15.79	19.62	31.35	12.97	19.14	24.00	33.33	15.10
Navicula	17.05	28.89	51.32	35.09	20.81	33.43	56.39	36.00	16.67	18.90
Amphora	4.34	3.89	3.29	9.81	4.59	8.36	4.69			3.80
Amphiprora	5.20	7.22	2.63	11.32	5.41	4.03	5.47		16.67	
Melosira	6.36	1.67	1.97	0.75	3.24	4.32	7.81	8.00		1.90
Biddulphia	0.58	1.67	1.32	1.13	3.51	0.58				
Surirella	0.58			1.13	1.08	3.46	1.17			
Gyrosigma	0.87	3.33	2.63	0.38	1.08	6.34	0.78			
Actinophychus	0.29	0.56			1.62	2.02	0.39			
Achanthes	2.60	2.22		1.13	1.89	0.86	0.39			3.80
Pinnularia	0.87	2.22	2.63	0.75	0.54	1.15	5.08			

Table 114. Feeding habits of the dominant marsh invertebrates.

Species	Feeding habit	Reference
Polychaeta		
Eteone heteropoda	NSDF*	Sanders (1962)
Glycera americana	Scavenger, DF#	Sanders (1962)
Glycera dibranchiata	Scavenger, DF	Pettibone (1963)
Heteromastus filiformis	NSDF	Sanders (1962)
Lumbrineris tenuis	NSDF	Sanders (1960)
Melinna cristata	SDF†	Sanders (1960)
Nereis succinea	Omnivore	Sanders (1962)
Polydora ligni	SDF	Sanders (1962)
Scolplos robustus	NSDF	Sanders (1962)
Streblospio benedicti	SDF	Sanders (1962)
Crustacea		
Ampelisca abdita	SDF	Mills (1967)
Leptocheirus plumulosus	SDF	
Cyathura polita	Omnivore	Burbanck (1962)
Edotea triloba	Omnivore	Sanders (1960)
Leptochelia savignyi	NSDF	Odum and Heald (1972)
Palaemonetes spp.	Omnivore	Nixon and Oviatt (1973) and Odum and Heald (1972)
Callinectes sapidus		
Callinectes sapidus	Omnivore	Odum and Heald (1972)
Xanthid crabs	Omnivore	Odum and Heald (1972)
Mollusca		
Gemma gemma	SF**	Sellmer (1967)
Mulinia lateralis	SF	Sanders (1960)
Ilyanassa obsoleta	Omnivore	Scheltema (1964)

* NSDF = Nonspecific deposit feeder.

\# DF = Detritus feeder.

† SDF = Selective deposit feeder.

** SF = Surface feeder.

Table 115. Gut content analyses.

Species		Gut Contents
Opsanus tau	1)	All *Ampelisca abdita* (5 animals)
	2)	3 *A. abdita*, 6 *Leptocheirus plumulosus*, some plant material
	3)	1 *Crangon septemspinosa*, some plant material
	4)	*A. abdita* leg parts and plant material
	5)	Unidentified gammarid parts and plant material
Fundulus heteroclitus	1)	Unidentified rotifer, decapod parts, and plant material
	2)	1 *Palaemonetes vulgaris*
	3)	1 *Palaemonetes vulgaris*
	4)	Plant material
	5)	1 *Palaemonetes vulgaris* and plant material
Gobiosoma sp.	1)	1 *A. abdita*
	2)	1 *A. abdita* and 1 *Leptocheirus plumulosus*
	3)	1 *A. abdita* and 1 *L. plumulosus*
Palaemonetes vulgaris	1)	Plant material
	2)	Plant material
	3)	Plant material
	4)	Plant material
	5)	Plant material and gammarid parts
Crangon septemspinosa	1)	Plant material
	2)	Plant material and gammarid parts
	3)	Plant material
	4)	Plant material and polychaete (unidentified)
	5)	Plant material and *A. abdita*
Neopanope texana	1)	Plant material
	2)	Plant material
	3)	Plant material
	4)	Plant material
	5)	Plant material
Panopeus herbsti	1)	Plant material
	2)	Plant material
	3)	Plant material
	4)	Plant material
	5)	Plant material
Callinectes sapidus	1)	Plant material
	2)	Plant material

APPENDIX C

Tables of Raw Data for the Estuarine
Evaluation Study: Benthic Invertebrate Report

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Table 1. Hydrographic and sediment data for Dinner Point Creek.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek mouth	Total depth (ft)	3.0	3.5	1.8	3.0	1.0	4.0
	Secchi depth (ft)	1.0	2.5	1.8	2.0	1.0	2.0
	Temperature (^{o}C)						
	Surface	28.5	20.6	9.4	27.3	16.6	4.0
	Bottom	28.4	21.7				
	Salinity ($^{o}/oo$)						
	Surface	17.5	24.2	22.5	26.8	23.5	23.2
	Bottom	23.5	24.1				
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		8.0	10.0	5.7	9.3	12.2
	Bottom		7.9				
	Median grain size (μm)	22			19	18.5	
	Sorting coefficient	1.34			1.34	1.43	
	% Silt-clay	78.9			82.7	78.6	

Table 1. Continued.

Station	Variable	Summer 1973	Fall 1973	Winter 1974	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek mid	Total depth (ft)	3.5	7.0	5.0	4.0	5.0	4.0	5.0
	Secchi depth (ft)	2.0	3.0	1.5	2.5	1.5	4.0	2.0
	Temperature (^{o}C)							
	Surface	26.6	20.0	7.8	14.3	26.1	13.5	3.0
	Bottom	26.3	20.5	7.8	14.3	26.2	12.6	

Table 1. Continued.

Station	Variable	Summer 1973	Fall 1973	Winter 1974	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek mid	Salinity (°/oo)							
	Surface	14.6	23.5	17.0	21.1	14.4		20.7
	Bottom	14.4	23.4	17.3	21.4	15.1	22.9	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		6.9		8.2	6.5	6.5	11.8
	Bottom		7.0		8.2	5.7		
	Median grain size (μm)		23			22		26.5
	Sorting coefficient		6.41			2.77		1.58
	% Silt-clay		62.9			72.7		76.0

Table 1. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek upper	Total depth (ft)	3.5	3.0	2.0	2.0	3.0	2.0
	Secchi depth (ft)	1.5	2.0	1.0	1.0	3.0	0.5
	Temperature (°C)						
	Surface	26.8	18.5	14.43	24.60	13.0	4.0
	Bottom	24.8	19.2			12.4	
	Salinity (°/oo)						
	Surface	16.37	18.87	17.51	7.35		8.15
	Bottom	21.65	20.87			16.13	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		3.96	7.34	3.04		6.0
	Bottom		3.89			4.3	

Table 1. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Dinner Point Creek upper	Median grain size (μm)	140		100	64		
	Sorting coefficient	1.47		1.81	1.99		
	% Silt-clay	26.4		38.4	48.8		

Table 2. Hydrographic and sediment data for Meyers Creek.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Meyers Creek mouth	Total depth (ft)	3.5	3.0	1.5	2.0	3.5	2.5
	Secchi depth (ft)	3.5	3.0	0.5	1.5	3.5	1.0
	Temperature (^{o}C)						
	Surface	27.0	22.6	13.1	27.2	14.0	5.0
	Bottom	26.7	22.5			14.2	
	Salinity ($^{o}/oo$)						
	Surface	18.9	22.7	18.4	21.2	24.0	18.4
	Bottom	18.9	23.6			24.0	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		8.9	8.8	7.9		11.0
	Bottom		8.8			9.0	
	Median grain size (μm)	16.5			33	32	
	Sorting coefficient	2.19			2.56	2.18	
	% Silt-clay	79.4			62.5	72.9	

Table 2. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Meyers Creek mid	Total depth (ft)	6.0	4.5	2.5	4.0	4.0	3.0
	Secchi depth (ft)	4.0	4.0	1.0	1.5	4.0	1.0
	Temperature (^{o}C)						
	Surface	26.5	22.8	13.0	27.3	13.9	3.0
	Bottom	26.2	22.9	12.8	27.4	14.1	
	Salinity ($^{o}/oo$)						
	Surface	20.4	22.2	18.0	21.3	23.9	18.4
	Bottom	20.5	22.7	18.0	21.3	23.7	
	Dissolved Oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		5.9	9.7	7.9		10.4
	Bottom	8.9	8.8	6.8	9.1	9.0	
	Median grain size (μm)		33		165	85	
	Sorting coefficient		4.80		1.08	1.79	
	% Silt-clay		52.5		24.3	43.8	

Table 2. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Meyers Creek upper	Total depth (ft)	3.0	3.0	1.5	2.0	2.5	1.5
	Secchi depth (ft)	2.0	2.0	0.5	1.5	2.5	0.5
	Temperature (^{o}C)						
	Surface	26.8	23.3	15.5	27.3		3.0
	Bottom	26.5	23.8			14.1	

Table 2. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Meyers Creek upper	Salinity (°/oo)						
	Surface	16.9	21.1	13.7	22.5		15.6
	Bottom	17.1	22.2			22.9	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		7.0			8.7	8.2
	Bottom		6.9	8.0	8.5		
	Median grain size (μm)	49.0		50.0			42.0
	Sorting coefficient	1.29		1.27			1.19
	% Silt-clay	66.3		59.2			69.1

Table 3. Hydrographic and sediment data for Cedar Run.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Cedar Run mouth	Total depth (ft)	4.5	5.5	2.0	3.0	4.0	4.5
	Secchi depth (ft)	3.0	3.5	1.5	3.0	4.0	1.0
	Temperature (°C)						
	Surface	26.3	19.5	10.0	25.7	14.1	4.0
	Bottom	27.2	19.7	9.6	25.3	13.8	
	Salinity (°/oo)						
	Surface	14.0	21.9	17.8	21.8	24.4	11.24
	Bottom	21.3	22.7	19.1	23.5	23.4	

Table 3. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Cedar Run mouth	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		7.9	9.2	7.1	8.7	10.5
	Bottom		7.6	9.1	7.1	8.5	
	Median grain size (μm)	18.5			22.0	42.0	
	Sorting coefficient	1.16			0.77	1.13	
	% Silt-clay	94.9			87.7	83.5	

Table 3. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Cedar Run mid	Total depth (ft)	4.0	7.0	3.0	3.5	5.0	6.0
	Secchi depth (ft)	3.0	3.0	2.0	3.0	3.5	2.0
	Temperature (°C)						
	Surface	25.0	20.0	11.8	22.1	13.7	5.0
	Bottom	27.5	19.8	10.8	26.5	14.4	6.0
	Salinity (°/oo)						
	Surface	9.6	19.8	2.8	6.1	23.6	3.91
	Bottom	21.7	22.0	3.6	25.0	23.5	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		7.7	7.9	3.5	8.4	8.8
	Bottom		7.6	7.0	4.0	7.7	9.2
	Median grain size (μm)			13.0	20.0	12.5	
	Sorting coefficient			3.48	1.93	3.2	
	% Silt-clay			77.4	77.3	89.9	

Table 3. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Cedar Run upper	Total depth (ft)	3.5	5.0	2.0	2.0	3.0	1.5
	Secchi depth (ft)	3.0	3.0	2.0	2.0	3.0	1.5
	Temperature (^{o}C)						
	Surface	18.3	19.6	14.2	19.4	14.1	3.0
	Bottom	18.3	19.5	14.8		14.1	
	Salinity ($^{o}/oo$)						
	Surface	1.47	17.59	0.3	1.96	20.5	0.6
	Bottom	1.47	19.31	0.9		21.7	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		5.9	9.1	5.7		10.2
	Bottom		5.9	9.0		7.9	
	Median grain size (μm)	190		210			187
	Sorting coefficient	0.82		0.98			0.88
	% Silt-clay	7.4		6.6			7.3

Table 4. Hydrographic and sediment data for Mill Creek.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Mill Creek mouth	Total depth (ft)	7.0	13.5	9.5	15.0	15.0	18.0
	Secchi depth (ft)	4.0	3.5	2.0	2.0	3.0	3.0
	Temperature (^{o}C)						
	Surface	27.2	20.9	9.5	26.9	14.8	4.0
	Bottom	26.6	20.8	9.1	26.3	14.6	4.0

Table 4. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Mill Creek mouth	Salinity (°/oo)						
	Surface	23.0	15.4	21.6	13.8	19.7	20.4
	Bottom	24.0	22.6	22.0	22.3	23.0	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		8.6	10.8	7.1		12.5
	Bottom		6.4	10.6	6.3	8.9	
	Median grain size (µm)	24		43		31	
	Sorting coefficient	1.17		3.32		1.90	
	% Silt-clay	76.4		52.5		73.8	

Table 4. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Mill Creek mid	Total depth (ft)	17.0	17.0	16.0	16.5	14.0	13.0
	Secchi depth (ft)	4.0	3.0	3.0	2.0	3.0	3.0
	Temperature (°C)						
	Surface	27.0	21.2	10.8	26.9	14.6	4.0
	Bottom	27.2	20.2	9.0	28.2	14.0	4.0
	Salinity (°/oo)						
	Surface	9.9	10.3	9.1	9.6	15.6	11.3
	Bottom	21.3	19.9	17.7	18.9	22.0	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		8.8	10.4	6.2		12.3
	Bottom		6.2	7.9	4.0	9.0	

Table 4. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Mill Creek mid	Median grain size (μm)	25		32	28		
	Sorting coefficient	0.88		1.33	0.84		
	% Silt-clay	73.9		79.5	83.5		

Table 4. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Mill Creek upper	Total depth (ft)	12.5	10.5	9.0	9.5	10.0	10.0
	Secchi depth (ft)	3.5	2.0	2.5	2.0	2.0	2.0
	Temperature (°C)						
	Surface	21.0	20.8	12.2	27.5	15.5	5.0
	Bottom	24.0	21.1	9.8	24.6	16.7	5.0
	Salinity (°/oo)						
	Surface	7.0	4.3	4.7	11.0	14.7	4.1
	Bottom	14.9	12.3	12.6	13.2	14.1	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		12.0	10.1	5.9		12.2
	Bottom			10.5	0.0	5.4	
	Median grain size (μm)	25.0	22.0			20.5	
	Sorting coefficient	2.64	3.16			4.11	
	% Silt-clay	69.0	73.0			68.9	

Table 5. Hydrographic and sediment data for Lagoon System A.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System A mouth	Total depth (ft)	5.0	5.0	3.0	2.5	4.5	4.5
	Secchi depth (ft)	4.0	5.0	2.5	2.5	4.5	3.0
	Temperature (°C)						
	Surface	26.5	22.5	8.5	28.8	14.0	4.0
	Bottom	26.0	23.6	8.4	28.6	13.8	4.0
	Salinity (°/oo)						
	Surface	20.6	24.0	22.0	24.2	24.2	20.5
	Bottom	20.5	25.7	22.0	24.8	24.4	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		8.4	10.1	7.2		12.6
	Bottom		8.4	10.1	6.0	9.0	
	Median grain size (μm)	37.0		51.0		25.0	25.0
	Sorting coefficient	2.24		3.18		2.12	3.17
	% Silt-clay	54.7		44.8		71.4	59.8

Table 5. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System A mid	Total depth (ft)	19.0	15.0	15.0	12.0	17.0	14.0
	Secchi depth (ft)	4.0	6.5	3.5	2.0	3.5	3.0
	Temperature (°C)						
	Surface	27.0	22.1	8.4	29.1	13.8	4.0
	Bottom	22.0	20.9	7.5	27.8	11.3	4.0

Table 5. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System A mid	Salinity (°/oo)						
	Surface	20.5	23.3	22.2	24.8	24.5	20.5
	Bottom	23.6	25.2	23.9	19.2	24.8	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		8.1	10.1	7.3		12.4
	Bottom		5.1	4.1	.6	5.6	
	Median grain size (μm)	27.0			27.0		27.0
	Sorting coefficient	2.02			0.78		1.73
	% Silt-clay	70.9			83.5		61.9

Table 5. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System A upper	Total depth (ft)	11.0	11.5	11.8	11.0	12.0	11.0
	Secchi depth (ft)	3.5	5.0	3.5	2.5	3.5	3.0
	Temperature (°C)						
	Surface	27.7	22.0	8.6	30.4	14.0	1.0
	Bottom	22.4	21.2	8.5	19.5	11.6	2.0
	Salinity (°/oo)						
	Surface	20.2	23.8	22.4	24.9	24.9	20.4
	Bottom	21.1	24.7	23.7	25.8	24.8	
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		8.1	13.4	9.0		12.9
	Bottom		2.3	0.0	0.0	7.0	

Table 5. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System A upper	Median Grain size (μm)	27.0	27.0				
	Sorting coefficient	2.41	1.35				
	% Silt-clay	70.8	67.7				

Table 6. Hydrographic and sediment data for Lagoon System B.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System B mouth	Total depth (ft)	12.0	11.0	8.8	9.0	16.0	12.0
	Secchi depth (ft)	3.5	5.5	3.5	2.0	2.0	3.0
	Temperature (°C)						
	Surface	28.4	20.0	9.0	30.3	15.0	3.0
	Bottom	27.3	20.3	8.2	29.2	12.1	3.0
	Salinity (°/oo)						
	Surface	20.7	23.2	21.6	25.0	24.4	20.7
	Bottom	20.7	23.1	22.0	24.9	24.6	20.9
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		7.9	10.2	8.6		12.0
	Bottom		8.0	9.6	7.3	6.1	11.7
	Median grain size (μm)	25.0				25.0	
	Sorting coefficient	1.10				1.40	
	% Silt-clay	85.0				79.1	

Table 6. Continued.

Station	Variable	Summer 1973	Fall 1973	Winter 1974	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System B mid	Total depth (ft)	9.5	10.5	8.0	7.0	10.0	11.0	6.0
	Secchi depth (ft)	3.0	4.5	5.5	4.0	2.0	3.0	3.0
	Temperature (°C)							
	Surface	28.3	15.3	6.3	9.9	30.5	13.3	5.0
	Bottom	26.6	15.3	4.9	9.8	24.6	13.1	5.5
	Salinity (°/oo)							
	Surface	19.8	25.9	21.6	21.2	24.8	24.2	20.7
	Bottom	21.4	26.8	22.3	21.3	24.8	24.3	21.3
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		7.7		10.6	8.7		11.1
	Bottom		7.6		10.5	0.2	8.4	10.1
	Median grain size (μm)	40.0	50.0		26.0	37.0	45.0	43.0
	Sorting coefficient	1.03	0.28		1.43	1.16	1.39	0.63
	% Silt-clay	64.0	75.7		83.0	73.1	57.5	36.4

Table 6. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System B upper	Total depth (ft)	10.0	16.0	17.0	18.5	18.0	15.0
	Secchi depth (ft)	3.5	4.5	3.5	2.5	3.0	2.5
	Temperature (°C)						
	Surface	24.0	20.5	9.6	30.6	15.6	6.5
	Bottom	20.0	23.4	7.9	17.0	12.0	7.0

Table 6. Continued.

Station	Variable	Summer 1973	Fall 1973	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Lagoon System B upper	Salinity (°/oo)						
	Surface	20.0	22.9	20.6	24.6	23.7	12.7
	Bottom	21.0	23.9	21.9	24.5	24.3	20.9
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)						
	Surface		7.7	10.5	8.0		10.6
	Bottom		0.5	0.5	0.0	5.7	4.0
	Median grain size (μm)	21.0		70.0		52.0	
	Sorting coefficient	1.95		1.71		1.44	
	% Silt-clay	73.6		41.0		42.6	

Table 7. Hydrographic and sediment data for reference station.

Station	Variable	Summer 1973	Fall 1973	Winter 1974	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Reference station	Total depth (ft)	6.0	6.0	5.0	4.0	4.0	5.5	5.0
	Secchi depth (ft)	4.0	4.0	1.5	2.5	3.0	4.0	3.0
	Temperature (°C)							
	Surface	25.8	20.4	5.90	10.3	28.3	14.4	5.5
	Bottom	25.5	20.6	5.23	9.9	28.2	13.7	
	Salinity (°/oo)							
	Surface	27.0	24.8	21.9	21.3	25.6	21.2	21.6
	Bottom	28.3	24.8	24.5	21.6	25.6	25.9	21.1
	Dissolved Oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		8.6		10.6	6.3	9.3	9.0
	Bottom		6.5		10.5	6.1	9.0	

Table 7. Continued.

Station	Variable	Summer 1973	Fall 1973	Winter 1974	Spring 1974	Summer 1974	Fall 1974	Winter 1975
Reference station	Median grain size (μm)		18.0			49.0		28.0
	Sorting coefficient		1.96			0.73		1.10
	% Silt-clay		78.6			34.3		74.6

Table 8. Hydrographic and sediment data for Meyers Creek.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 1	Total depth (ft)	3.0	5.0	4.0	2.5	3.0		5.0
	Secchi depth (ft)							
	Temperature (°C)							
	Surface	20.0	16.0	9.3	20.0	20.4		7.4
	Bottom	20.0	16.0	9.3	19.9	20.4		7.3
	Salinity (°/oo)							
	Surface	23.0	18.8	24.6	23.8	29.4		26.1
	Bottom	23.0	18.9		23.5	30.1		25.2
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		7.3	9.3	8.8	7.7		11.1
	Bottom		7.6	9.3	9.2	7.7		9.8
	Median grain size (μm)	25.0	13.0	14.0	10.0	11.0	10.0	56.0
		26.0	16.0		16.0			

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 1	Sorting coefficient	1.39	2.07	1.38	2.10	3.16	1.91	2.01
		4.74	4.02	3.68	3.32	2.86	3.63	5.91
		1.20	1.35		1.48			
		4.92	4.06		4.06			
	% Silt-clay	91.0	78.0	92.0	92.0	85.0	91.0	48.0
		95.0	89.0		92.0			

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 2	Total depth (ft)	5.0	5.0	4.0	3.5	5.0		5.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	20.7	15.7	8.6	21.1	20.7		9.7
	Bottom	20.5	15.5	8.6	20.6	20.6		9.7
	Salinity ($^{o}/oo$)							
	Surface	22.9	19.0		24.9	30.2		24.0
	Bottom	22.8	19.0		24.7	29.3		
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		7.1	9.5	10.0	7.6		11.2
	Bottom		6.9	9.5	9.6	6.7		
	Median grain size (μm)	31.0	16.0	9.0	12.0	12.0	11.0	14.0
		41.0	18.0					

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 2	Sorting coefficient	1.69	1.64	2.93	1.45	2.38	1.20	1.60
		5.75	4.11	4.89	3.77	4.12	3.26	3.84
		1.51	1.76					
		5.18	4.97					
	% Silt-clay	81.0	90.0	85.0	89.0	84.0	88.0	91.0
		93.0	79.0					

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 3	Total depth (ft)	4.0	5.0	4.0	4.5	3.5		3.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	21.0	15.0	8.6	20.6	21.1		9.0
	Bottom	21.0	15.1	8.6	20.6	21.1		9.0
	Salinity ($^{o}/oo$)							
	Surface	23.2	19.0		23.8	29.6		24.7
	Bottom	23.3	19.0		23.6	30.1		
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		6.8	9.2	9.0	7.2		11.9
	Bottom		6.8	9.3	9.1	7.8		
	Median grain size (μm)	40.0	13.0	17.0	12.0	290.0	13.0	12.0
		40.0	18.0	18.0				
		39.0						

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 3	Sorting coefficient	1.25	1.49	1.54	1.96	5.26	2.35	1.58
		6.32	3.72	4.10	2.98	4.02	3.90	6.39
		1.54	5.77	1.54				
		5.35	1.85	4.32				
		1.18						
		6.24						
	% Silt-clay	89.0	82.0	92.0	88.0	35.0	88.0	82.0
		90.0	64.0	88.0				
		86.0						

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 4	Total depth (ft)	3.0	4.0	5.0	7.0	3.0		2.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	21.3	14.1	8.4	20.5	21.3		8.4
	Bottom	21.2	13.9	8.5	20.7	21.3		8.4
	Salinity ($^{o}/oo$)							
	Surface	23.2	19.2	24.3	23.5	30.0		24.0
	Bottom	23.2	19.2	24.5	24.7	29.6		
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		5.7	9.7	8.8	7.6		10.3
	Bottom		5.7	9.8	8.9	7.8		
	Median grain size (μm)	27.0	12.0	11.0	11.0	15.0	11.0	25.0
		39.0	21.0					

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 4	Sorting coefficient	1.41 5.17 1.52 4.86	1.93 3.89 3.72 10.56	1.32 3.19	1.41 3.41	1.20 4.32	1.50 3.62	1.69 4.73
	% Silt-clay	91.0 94.0	90.0 67.0	95.0	91.0	85.0	91.0	92.0

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 5	Total depth (ft)	2.0	3.0	2.0	2.0	2.0		2.5
	Secchi depth (ft)							
	Temperature (°C)							
	Surface	21.8	11.6	7.9	21.8	21.7		8.4
	Bottom	21.8	11.8	1.9	21.8	21.7		8.4
	Salinity (°/oo)							
	Surface	23.3	16.7	25.0	23.6	29.8		24.0
	Bottom		17.2					
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface		3.8	9.0	8.8	7.6		11.0
	Bottom		3.6					
	Median grain size (μm)	38.0 30.0	16.0 7.0	15.0	24.0	18.0	4.3	18.0

Table 8. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Meyers Creek Station 5	Sorting coefficient	1.19	1.28	1.33	2.56	1.49	1.58	1.57
		6.16	3.52	4.46	5.74	4.58	2.44	4.06
		1.27	1.22					
		5.33	2.78					
	% Silt-clay	87.0	86.0	86.0	71.0	91.0	92.0	97.0
		92.0	84.0					

Table 9. Hydrographic and sediment data for Lagoon System B.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 1	Total depth (ft)	6.0	7.0	10.0	8.5	10.0	12.0	16.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	25.0	16.7	7.5	20.0	23.0	13.2	6.8
	Bottom	25.0	16.6	7.1	19.9	22.6	13.2	6.5
	Salinity ($^{o}/oo$)							
	Surface	24.0	20.6		23.8	31.0		25.8
	Bottom	24.1	20.6		23.5	31.2		25.8
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface	8.3	7.9	8.3	8.8	8.3		10.2
	Bottom	6.0	7.3	6.0	9.2	6.6		10.3
	Median grain size (μm)	35.0	29.0		11.0	13.0	9.6	3.2
		39.0	40.0					

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 1	Sorting coefficient	1.22 5.55 1.04 6.32	1.23 5.72 1.37 4.97		1.48 3.47	1.69 3.94	1.63 3.37	1.35 1.82
	% Silt-clay	99.0 96.0	88.0 95.0		91.0	90.0	94.0	94.0

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 2	Total depth (ft)	7.0	6.0	9.0	8.5	9.0	5.0	8.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	24.6	16.9	6.8	19.7	24.2	15.1	6.8
	Bottom	24.5	16.8	7.1	18.0	23.9	15.1	7.1
	Salinity ($^{o}/oo$)							
	Surface	24.3	20.8		24.6			25.1
	Bottom	24.3	20.8		24.7			25.3
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface	9.0	8.0	9.0	8.3	8.4		10.2
	Bottom	5.5	7.7	5.5	8.1	8.0		10.2
	Median grain size (μm)	52.0 48.0	112.0 58.0	7.4	33.0 280.0	37.0		33.0

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 2	Sorting coefficient	1.37	1.79	1.32	5.21	2.58		2.70
		5.68	13.19	2.72	6.35	8.49		6.12
		2.44	3.54		15.81			
		7.40	9.28		5.98			
	% Silt-clay	83.0	18.0	95.0	58.0	65.0		63.0
		58.0	52.0		28.0			

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 3	Total depth (ft)	11.0	10.0	10.0	8.0	11.0	10.0	10.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	24.4	17.3	6.8	19.6	24.2	15.2	6.8
	Bottom	24.4	17.1	6.6	16.0	24.2	15.2	7.1
	Salinity ($^{o}/oo$)							
	Surface	24.2	20.7					24.7
	Bottom	24.3	20.8					25.2
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface	7.5	8.2	7.5	8.2	7.3		11.0
	Bottom	3.0	6.8	3.0	7.6	7.5		10.0
	Median grain size (μm)	260.0	56.0	220.0		21.0	28.0	33.0
		130.0	68.0	36.0				

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 3	Sorting coefficient	6.09	2.45	5.04		2.36	2.25	1.63
		26.48	4.91	4.42		4.63	6.38	4.81
		4.08	1.98	1.75				
		21.43	5.52	6.11				
	% Silt-clay	22.0	45.0	38.0		78.0	69.0	88.0
		26.0	47.0	71.0				

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 4	Total depth (ft)	16.0	16.0	16.0	16.0	16.0	18.0	16.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	24.4	17.3	6.5	20.0	24.3	15.7	6.1
	Bottom	24.4	17.2	5.9	12.0	24.5	15.7	6.0
	Salinity ($^{o}/oo$)							
	Surface	24.2	20.7		24.8			23.8
	Bottom	24.3	20.8		24.9			24.9
	Dissolved oxygen ($mg\ O_2 \cdot l^{-1}$)							
	Surface	8.8	8.5	8.5	7.8	6.7		11.2
	Bottom	8.4	6.4	8.5	5.8			7.8
	Median grain size (μm)	43.0	35.0	36.0		17.0	80.0	17.0
		240.0	20.0					

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 4	Sorting coefficient	1.73	2.10	3.29		1.62	3.29	3.82
		6.87	6.75	6.58		5.10	8.83	12.05
		2.98	1.93					
		8.46	6.48					
	% Silt-clay	70.0	69.0	60.0		82.0	42.0	64.0
		26.0	76.0					

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 5	Total depth (ft)	20.0	20.0	19.0	19.0	20.0	12.0	19.0
	Secchi depth (ft)							
	Temperature (^{o}C)							
	Surface	23.0	17.2	5.2	20.0	24.0	16.5	6.1
	Bottom	19.0	17.6	1.8	12.0	18.8	16.4	6.0
	Salinity ($^{o}/oo$)							
	Surface	24.9	20.3					23.4
	Bottom	23.7	22.6					26.4
	Dissolved oxygen (mg $O_2 \cdot l^{-1}$)							
	Surface	7.8	9.0	7.8	7.8	6.4	11.1	
	Bottom	0	0	0	3.3	0		0.7
	Median grain size (μm)	100.0	170.0	13.0		21.0	39.0	36.0
		43.0	68.0					

Table 9. Continued.

Station	Variable	Summer 1975	Fall 1975	Winter 1976	Spring 1976	Summer 1976	Fall 1976	Winter 1977
Lagoon System B Station 5	Sorting coefficient	3.07	1.79	1.77		2.61	2.93	1.71
		10.43	12.88	3.92		5.01	6.56	4.28
		2.80	2.36					
		6.82	9.75					
	% Silt-clay	44.0	19.0	80.0		77.0	62.0	89.0
		59.0	43.0					

Table 10. Dinner Point Creek mouth station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana			3	0.21			12	0.52	8	1.64		
Glycinde solitaria	63	3.52	7	0.50			88	3.81	16	3.29	12	0.20
Heteromastus filiformis	33	1.85	150	10.66	215	30.28	116	5.03	28	5.75	44	0.74
Hypaniola sp.	23	1.29	7	0.50			8	0.35			8	0.13
Lumbrineris tenuis	17	0.95	30	2.13							4	0.07
Maldanopsis elongata												
Nereis sp.												
Nereis succinea	17	0.95	47	3.34	5	0.70	4	0.17	20	4.11	94	1.59
Scolecolepides viridis												
Scoloplos robustus	20	1.12	7	0.50			76	3.29	52	10.68	12	0.20
Streblospio benedicti	3	0.17	96	6.82	110	15.49	48	2.08	24	4.93	12	0.20
Crustacea:												
Ampelisca abdita	396	22.15	103	7.32	115	16.20	1756	76.08	64	13.14	5244	88.43
Cyathura polita	23	1.29			5	0.70	8	0.35			12	0.20
Leptocheirus plumulosus	20	1.12	103	7.32			4	0.17	20	4.11		
Mellitidae sp.												
Neomysis americana	7	0.39							16	3.29	8	0.13

Table 10. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Mollusca:												
Mulinia lateralis							8	0.35			16	0.27
Ilyanassa obsoleta	7	0.39	107	7.60	120	16.90	24	1.04	92	18.89	100	1.69
Retusa canaliculata			13	0.92			32	1.39	4	0.82	44	0.74
Miscellaneous:												
Oligochaeta sp.			30	2.11	15	2.11			8	1.64	48	0.81
Polychaeta:												
Autolytus prolifer			7	0.50								
Capitellidae			157	11.16	5	0.70			12	2.46		
Eteone heteropoda					5	0.70	4	0.17			4	0.07
Exogene dispar	3	0.17	313	22.25			24	1.04	8	1.64	64	1.08
Fabricia sabella			3	0.21								
Gyptis vittata							4	0.17				
Lysidice sp.											4	0.07
Melinna cristata	10	0.56							4	0.82		
Pectinaria gouldii	3	0.17									8	0.13
Pista palmata									12	2.46		
Polydora ligni	17	0.95	33	2.34	10	1.41	8	0.35	4	0.82	28	0.47
Sabella microphthalmus							4	0.17				
Scoloplos sp.			3	0.21								
Spionidae			3	0.21								
Spiochaetopterus oculatus			17	1.21			4	0.17	4	0.82	20	0.34
Tharyx acustus							4	0.17	4	0.82		
Nemertea:												
Amphiporus sp.			10	0.71								
Nemertean			13	0.92			20	0.87	4	0.82	16	0.27

Table 10. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Nematoda:												
Tetrastemmatidae			33	2.35								
Crustacea:												
Amphipod 1					10	1.41						
Caprellidae			3	0.21							4	0.07
Corophium insidiosum	10	0.56	17	1.21	40	5.63	4	0.17			4	0.07
Corophium sp.	13	0.73										
Microdeutopus sp.									4	0.82		
Edotea triloba	17	0.95	27	1.92	45	6.34	28	1.21	4	0.82	12	0.20
Erichsonella attenuata			3	0.21								
Idotea baltica	7	0.39										
Balanus balanoides	683	38.20										
Callinectes sapidus			3	0.21								
Crangon septemspinosa	3	0.17	3	0.21							4	0.07
Mysidopsis bigelowi			3	0.21					8	1.64		
Neopanope texana									4	0.82		
Nymphon longitarse											4	0.07
Ostracod			7	0.50								
Oxyurostylis smithi											36	0.61
Palaemonetes pugio									12	2.46		
Mollusca:												
Gemma gemma	360	20.13							8	1.64	12	0.20
Mercenaria mercenaria											4	0.07
Spisula solidissima											4	0.07
Tellina sp.					5	0.70						
Bittium alternatum			3	0.21								
Crepidula convexa	7	0.39										
Crepidula sp.			13	0.92								
Eupleura caudata									4	0.82		
Gastropod	10	0.56					20	0.87	8	1.64		
Melampus sp.	3	0.17									4	0.07
Odostomia sp.			27	1.92	5	0.70			24	4.93	40	0.67

Table 10. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Miscellaneous:												
Ectoproct												
Amathia sp.	Present		Present									
Platyhelminth	13	0.73	13	0.92								
Membranipora sp.			Present									
Microciona prolifera			Present									
Ponar grabs taken	6		6		4		5		5		5	
Species collected	28		40		15		24		29		32	

Table 11. Dinner Point Creek mid station species data.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Winter 1974 No.	Winter 1974 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1974 No.	Winter 1974 % of total
Polychaeta:														
Glycera americana														
Glycinde solitaria	13	0.49			33	0.71			16	0.49				
Heteromastus filiformis	14	0.53	47	2.04	113	3.43	10	0.43	36	1.11	140	11.51	36	3.27
Hypaniola sp.	1303	48.95	400	17.37	500	10.74	115	4.93	1044	32.18	420	34.54	346	36.00
Lumbrineris tenuis														
Maldanopsis elongata														
Nereis sp.	7	0.26	7	0.30	7	0.15	30	1.28	28	0.86	160	13.16	252	22.91
Nereis succinea	5	0.19	7	0.30	73	1.57	20	0.16			4	0.33	24	2.18
Scolecolepides viridis	18	0.68	7	0.30			20	0.86	8	0.25			8	0.73
Scoloplos robustus					40	0.86			52	1.60	84	6.91	48	4.36
Streblospio benedicti	675	25.36	827	35.91	2908	62.46	1940	23.08	608	18.74	64	5.26	120	10.91

Table 11. Continued.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	& of total
Crustacea:														
Ampelisca abdita	182	6.84	687	29.85	313	6.72	65	2.78	1160	35.76	36	2.96		
Cyathura polita	164	6.16	127	5.51	200	4.30	45	1.93	124	3.82	152	12.50	78	2.55
Leptocheirus plumulosus							5	0.21					72	6.55
Mellitidae sp.														
Neomysis americana							25	1.07					84	7.64
Mollusca:														
Mulinia lateralis														
Ilyanassa obsoleta	2	0.08							4	0.12				
Retusa canaliculata									20	0.62				
Miscellaneous:														
Oligochaeta sp.	23	0.86	113	4.84	140	3.01	10	0.43			32	2.63	4	0.36
Polychaeta:														
Ampharetidae			13	0.56										
Capitella capitata	2	0.08												
Capitellidae	14	0.53												
Eteone heteropoda	16	0.60	33	1.43	53	1.14	15	0.64	104	3.21	16	1.32		
Eteone sp.	2	0.08												
Exogene dispar					7	0.15								
Melinna cristata	31	1.16					5	0.21						
Nereis diversicolor			7	0.30										
Nereis virens	2	0.08												
Polydora ligni	25	0.95	7	0.30	14	0.30					8	0.66	8	0.73
Spionidae	5	0.19												
Terebellidae					20	0.43								

Table 11. Continued.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1974	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Nemertea:														
Amphiporus bioculatus			7	0.30										
Amphiporus sp.	2	0.08	7	0.30										
Paleonemertea B							20	0.86						
Nemertea sp.	4	0.16	7	0.30	7	0.15			24	0.74	44	3.62	12	1.09
Crustacea:														
Amphipoda	11	0.41												
Ampelisca vadorum	4	0.16												
Corophium insidiosum					47	1.01	5	0.21						
Gammarus mucronatus							5	0.21						
Gammarus palustris											16	1.32		
Edotea triloba	94	3.53									24	1.97	4	0.36
Callinectes sapidus	2	0.08												
Mysidopsis bigelowi											4	0.33		
Mollusca:														
Acteon punctostriatus											4	0.33		
Bivalvia sp.													4	0.36
Gemma gemma					7	0.15			4	0.12				
Modiolus demissus					7	0.15								
Mya arenaria	2	0.08												
Tellina sp.									8	0.24	4	0.33		
Gastropod											4	0.33		
Miscellaneous:														
Anthozoan	7	0.26							4	0.12				
Campanularidae					7	0.15								
Ctenophora	29	1.09												
Microciona prolifera	Present													
Brachyura					7	0.15								

Table 11. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Winter 1974 No.	Winter 1974 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Ponar grabs taken	11		3		3		4		5		5		5	
Species collected	29		16		21		16		16		18		15	

Table 12. Dinner Point Creek upper species data.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Polychaeta:												
Glycera americana												
Glycinde solitaria												
Heteromastus filiformis	3	0.25										
Hypaniola sp.	343	28.14	640	76.01	2375	64.17	908	40.25	540	32.14	1260	69.84
Lumbrineris tenuis												
Maldanopsis elongata												
Nereis sp.	33	2.70	87	10.33	230	6.27	60	2.66	28	1.67	20	1.11
Nereis succinea	27	2.21			95	2.59					4	0.22
Scolecolepides viridis	146	11.98	14	1.66	45	1.26	48	2.13			8	0.44
Scoloplos robustus									4	0.24		
Streblospio benedicti			7	0.83	5	0.14			4	0.24		
Crustacea:												
Ampelisca abdita	7	0.58			5	0.14			12	0.71		
Cyathura polita	133	9.27	40	4.15	20	0.54	108	4.79	156	9.29	120	6.65
Leptocheirus plumulosus	140	11.48			110	3.00	252	11.17			160	8.87
Mellitidae sp.												
Neomysis americana					5	0.14					4	0.22
Mollusca:												

Table 12. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Mulinia lateralis							16	0.71				
Ilyanassa obsoleta												
Retusa canaliculata	3	0.25										
Miscellaneous:												
Oligochaeta sp.	113	9.27	27	0.83	30	0.82			44	2.62	80	4.43
Polychaeta:												
Capitella capitata			13	1.54			8	0.35				
Eteone heteropoda			7	0.83			12	0.53				
Exogene dispar					5	0.14						
Nereis diversicolor	76	6.23										
Polydora ligni					90	2.45						
Nemertea:												
Nemertean	3	0.25							8	0.48		
Crustacea:												
Amphipoda	123	10.09							8	0.48		
Corophium insidiosum	3	0.25										
Corophium simile					260	31.48	24	1.06	60	3.57	32	1.77
Cymudusa compta									724	43.10		
Gammarus palustris							784	34.75	24	1.43	96	5.32
Gammarus daiberi					5	0.14						
Melita nitida	20	1.64					4	0.18			8	0.44
Edotea	33	2.71			245	6.68	8	0.35	28	1.67	8	0.44
Cumacean					5	0.14						
Mysidopsis bigelowi											4	0.22
Mollusca:												
Bivalvia	3	0.25										

Table 12. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Tellina			7	0.83								
Gastropod					5	0.14						
Miscellaneous:												
Anthozoan									24	1.06	16	0.95
Anguilla rostrata					20	0.54			4	0.24		
Ectoprocta					Present							
Hirudinea					5	0.14						
Insect larva					110	3.00						
Nematostella vectensis	30	2.46										
Vorticella	Present											
Euplana gracilis									4	0.24		
Ponar grabs taken	6		3		4		5		5		5	
Species collected	19		9		20		12		16		14	

Table 13. Meyers Creek mouth station species data.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Polychaeta:												
Glycera americana	3	0.12			5	1.15			8	0.11	8	0.04
Glycinde solitaria	77	2.99	3	0.13	15	3.45	32	11.59	12	0.16	4	0.40
Heteromastus filiformis	336	13.06	37	1.61	75	17.24	160	57.97	12	0.16	88	0.40
Hypaniola sp.	3	0.12										
Lubrineris tenuis	83	3.23	7	0.31	45	10.34	48	17.39	20	0.27	56	0.25
Maldanopsis elongata												

Table 13. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Nereis sp.	3	0.12							24	0.33	24	0.11
Nereis succinea	13	0.51	7	0.31							292	1.32
Scolecolepides viridis												
Scoloplos robustus	30	1.27	43	1.80	65	14.94	12	4.35	40	0.55	64	0.29
Streblospio benedicti	13	0.55	140	6.11	70	16.09	4	1.45			328	1.48
Crustacea:												
Ampelisca abdita	1409	59.83	1662	72.48	5	1.15			7104	96.68	20516	92.82
Cyathura polita	20	0.78	3	0.13			4	1.45	4	1.10		
Leptocheirus plumulosus	93	3.61	20	0.87							24	0.11
Mellitidae sp.												
Neomysis americana	3	0.12	7	0.31	5	1.15					8	0.04
Mollusca:												
Mulinia lateralis	3	0.12									4	0.02
Nassarius obsoletus	93	3.61	63	2.75	25	5.75			52	0.71	56	0.25
Retusa canaliculata	3	0.12	17	0.74							16	0.07
Miscellaneous:												
Oligochaeta sp.	17	0.66			90	20.69					120	0.54
Polychaeta:												
Autolytus sp. 2			3	0.13								
Axiothella catenata												
Capitella capitata	3	0.12	10	0.44							4	0.02
Capitellidae sp.	3	0.12	50	2.18							24	0.11
Diopatra cuprea									4	0.05		
Eteone heteropoda	10	0.39	7	0.31	10	2.30	4	1.45			32	0.14
Eteone lactea									4	0.05		
Exogene dispar	40	1.55	20	0.87	20	4.60			4	0.05	160	0.72

Table 13. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Exogene sp.	3	0.12										
Gyptis vittata	3	0.12										
Melinna cristata	3	0.12	3	0.13								
Microphthalmus aberrans	3	0.12										
Nereis diversicolor			3	0.13								
Pectinaria gouldii	3	0.12										
Polydora ligni	3	0.12	23	1.00							28	0.13
Sabellaria vulgaris	3	0.12										
Spio setosa			3	0.13								
Spiochaetopterus oculatus											8	0.04
Tharyx acustus			7	0.31			8	2.90				
Nemertea:												
Amphiporus bioculatus	3	0.12										
Amphiporus ochraceus	3	0.12										
Paleonemertea sp. 1	3	0.12										
Nemertea sp.	3	0.12					4	1.45	36	0.49	40	0.18
Nematoda:												
Tetrastemmatidae sp.			3	0.13								
Crustacea:												
Amphipoda sp. 1	13	0.51										
Caprellidae sp.	40	1.55	10	0.44								
Corophium insidiosum	10	0.39	13	0.57					4	1.10	4	0.02
Corophium simile											8	0.04
Gammarus sp.	27	1.05	3	0.13							4	0.02
Edotea triloba	7	0.27	7	0.31	5	1.15					4	0.02
Idotea baltica	3	0.12										
Balanus balanoides	97	3.77	10	0.44								
Brachyura sp.	17	0.66										
Crangon septemspinosa	3	0.12	7	0.31								

Table 13. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Cumacea sp.	3	0.12										
Oxyurostylis smithi											80	0.36
Palaemonetes vulgaris			3	0.13								
Neopanope texana											4	0.02
Nymphon longitarse	3	0.12									4	0.02
Ostracoda sp.			3	0.13								
Mollusca:												
Bivalvia sp.	10	0.42							12	0.16		
Gemma gemma	7	0.30	40	1.74							64	0.29
Modiolus demissus	3	0.12										
Spisula solidissima	3	0.12										
Tellina sp.	3	0.12	3	0.13								
Corambella sp.			7	0.31								
Crepidula sp.	20	0.85										
Eupleura caudata			3	0.13								
Gastropoda sp.	14	0.60							4	0.05		
Odostomia	3	0.12	23	1.00							20	0.09
Polinices duplicata									4	0.05		
Miscellaneous:												
Anthozoa sp.	3	0.12										
Ectoprocta sp.			Present									
Amathia sp.	Present											
Holothuroidea sp.			Present								4	0.02
Membranipora sp.	Present											
Metridium sp.			Present									
Microciona prolifera	Present											
Molgula manhattensis			30	1.31							4	0.02
Camparularidae	3	0.12										

Table 13. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Ponar grabs taken	6		6		4		5		5		5	
Species collected	56		40		13		9		17		33	

Table 14. Meyers Creek mid station species data

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Polychaeta:												
Glycera americana	7	0.12	5	0.41	5	0.43	24	2.75	24	0.16	12	0.07
Glycinde solitaria	53	0.93	10	0.82	50	4.26	48	5.51	52	0.33	24	0.14
Heteromastus filiformis	47	0.82	13	1.07	70	5.96	28	3.21	80	0.53	72	0.43
Hypaniola sp.	7	0.12	3	0.25			28	3.21				
Lumbrineris tenuis	20	0.35	10	0.82	40	3.40	32	3.67	176	1.16	152	0.91
Maldanopsis elongata												
Nereis sp.			3	0.25	10	0.85					40	0.24
Nereis succinea	7	0.12	3	0.25			4	0.46	80	0.53	224	1.46
Scolecolepides viridis					50	4.26	52	5.96				
Scoloplos robustus	14	2.55			90	7.66	60	6.88	160	1.06	96	0.57
Streblospio benedicti	7	0.12	73	6.00	490	41.70	284	32.57	148	0.97	524	3.13
Crustacea:												
Ampelisca abdita	5096	89.37	828	68.04	165	14.04	124	14.22	14264	94.19	14472	86.47
Cyathura polita	40	0.70	10	0.82	40	3.40	16	1.83	12	0.08	12	0.07
Leptocheirus plumulosus					10	0.85						
Mellitidae sp.					5	0.43						
Neomysis americana					10	0.85					4	0.02

Table 14. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Mollusca:												
Mulinia lateralis									4	0.04		
Ilyanassa obsoleta	14	0.25	8	0.66			28	3.21	64	0.42	228	1.36
Retusa canaliculata	14	0.25	15	1.23					20	0.13	24	0.14
Miscellaneous:												
Oligochaeta sp.	7	0.12							8	0.06	100	0.60
Polychaeta:												
Eteone heteropoda					20	1.70	24	2.75			24	0.14
Exogene dispar	67	1.18			55	4.68	56	6.42	124	0.82	240	1.43
Melinna cristata	7	0.12							8	0.05	4	0.02
Pectinaria gouldii											8	0.05
Polydora ligni	7	0.12	5	0.41					32	0.21	32	0.19
Potamilla neglecta	7	0.12										
Scoloplos fragilis			13	1.07								
Scoloplos sp.			3	0.25								
Spiochaetopterus oculatus									8	0.05	4	0.02
Terebellidae sp.					5	0.43						
Tharyx acutus							12	1.38				
Nemertea:												
Amphiporus bioculatus	7	0.12										
Paleonemertea sp. 1			48	3.94	5	0.43						
Nemertea sp.							44	5.05	140	0.91	192	1.15
Crustacea:												
Caprellidae sp.			3	0.25								
Corophium insidiosum					5	0.43						
Podoceridae sp.	7	0.12										

Table 14. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Edotea triloba			5	0.41	25	2.13					24	0.14
Tanaidacea sp.									4	0.03		
Balanus balanoides			32	2.63								
Copepoda sp.					15	1.28						
Crangon septemspinosa			3	0.25								
Mysidopsis bigelowi	7	0.12	7	0.58								
Neopanope texana			3	0.25								
Nymphon longitarse			10	0.82					16	0.11		
Oxyurostylis smithi											20	0.12
Mollusca:												
Gemma gemma	253	4.44	83	6.82	10	0.85	4	0.46	48	0.32	144	0.86
Modiolus demissus											4	0.02
Spisula solidissima	7	0.12	3	0.25								
Crepidula convexa			3	0.25								
Gastropoda sp.							4	0.46			8	0.05
Odostomia sp.	7	0.12	5	0.41					4	0.03	24	0.14
Miscellaneous:												
Anthozoa sp.											4	0.02
Membranipora sp.	Present		Present									
Metridium sp.			3	0.25								
Microciona prolifera			Present									
Ponar grabs taken	3		8		4		5		5		5	
Species collected	24		30		30		18		21		29	

Table 15. Meyers Creek upper station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana												
Glycinde solitaria	3	0.13					4	0.21	4	0.24	8	0.81
Heteromastus filiformis	57	2.42	143	7.73	75	13.81	24	1.26	64	3.85	76	7.66
Hypaniola sp.	510	21.66	276	14.93	5	0.92	304	16.00	8	0.48		
Lumbrineris tenuis	3	0.13	3	0.16	10	1.84			4	0.24	8	0.81
Maldanopsis elongata												
Nereis sp.	619	26.28	223	12.06	45	8.29	316	16.63	340	20.43	232	23.39
Nereis succinea	30	1.27	17	0.92	10	1.84	32	1.68	20	1.20	48	4.84
Scolecolepides viridis			3	0.16								
Scoloplos robustus	7	0.30	17	0.92			64	3.37	84	5.05	152	5.24
Streblospio benedicti	250	10.62	579	31.31	190	34.99	828	43.58	92	5.53	68	6.85
Crustacea:												
Ampelisca abdita	100	4.24	37	2.00	25	4.60	32	1.68	24	1.44		
Cyathura polita	150	6.37	30	1.62			36	1.89	24	1.44	16	1.61
Leptocheirus plumulosus	7	0.30									4	0.40
Mellitidae sp.												
Neomysis americana			3	0.16								
Mollusca:												
Mulinia lateralis												
Ilyanassa obsoleta	93	3.95	17	0.92					20	1.20	16	1.61
Retusa canaliculata			3	0.16	113	20.81						
Miscellaneous:												
Oligochaeta sp.	17	0.72	140	7.57			628	37.74	228	22.98		
Polychaeta:												
Ampharetidae sp.			10	0.54								

Table 15. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Brania clavata									16	0.96		
Capitella capitata	3	0.13	63	3.41	5	0.92	4	0.21				
Capitellidae sp.			17	0.92			4	0.21			4	0.40
Eteone heteropoda	83	3.52	77	4.16	35	6.45	124	6.53	284	17.07	204	20.56
Exogene dispar	7	0.30	3	0.16								
Microphthalmus aberrans	3	0.13	7	0.38								
Nereis diversicolor	280	11.89										
Nereis virens	3	0.13	143	7.73								
Polydora ligni	13	0.55	13	0.70								
Scoloplos sp.			3	0.16								
Spionidae sp.			3	0.16								
Nemertea:												
Amphiporus bioculatus	3	0.13	3	0.16								
Amphiporus ochraceus	37	1.57										
Amphiporus sp.	3	0.13										
Nemertea sp.							88	4.62	32	1.92	8	0.81
Crustacea:												
Amphipoda sp. 1			3	0.16								
Gammarus sp.	3	0.13										
Melita nitida	7	0.30										
Edotea triloba	20	0.85	17	0.92	25	4.60			16	0.96	16	1.61
Cumacea sp.					5	0.92						
Mollusca:												
Gemma gemma									4	0.24		
Lyonsia hyalina							4	0.21				
Macoma balthica											4	0.40
Gastropoda sp.	7	0.30	3	0.16			36	1.89				

Table 15. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Miscellaneous:												
Anthozoa sp.	7	0.30										
Ctenophora sp.	30	1.27										
Tellina spp.							4	0.21				
Ponar grabs taken	6		6		4		5		5		5	
Species collected	29		28		13		16		18		16	

Table 16. Cedar Run mouth station species data.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Polychaeta:												
Glycera americana					5	0.35	4	0.09	16	4.40	4	1.96
Glycinde solitaria	40	7.26	23	1.46	15	1.04	20	0.47				
Heteromastus filiformis	13	2.36	3	0.19	45	3.13	4	0.09	4	1.10	8	3.92
Hypaniola sp.			7	0.45			4	0.09				
Lumbrineris tenuis	17	3.09	13	0.83	20	1.39	4	0.09				
Maldanopsis elongata	3	0.54	7	0.45	20	1.39			8	2.20		
Nereis sp.											Present	
Nereis succinea			10	0.64	55	3.82						
Scolecolepides viridis			7	0.45								
Scoloplos robustus	3	0.54	87	5.53	90	6.25	76	1.80	24	6.59	24	11.76
Streblospio benedicti					30	2.08						

Table 16. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Crustacea:												
Ampelisca abdita	363	65.88	80	5.09	400	27.78	4088	96.69	68	18.68	76	37.25
Cyathura polita			20	1.27	35	2.43	8	0.19	4	1.10		
Leptocheirus plumulosus			27	1.72	15	1.04					4	1.96
Mellitidae sp.					6	0.35						
Neomysis americana			3	0.19							20	9.80
Mollusca:												
Mulinia lateralis											4	1.96
Ilyanassa obsoleta	10	1.81	100	6.36	100	6.95					32	15.68
Retusa canaliculata	60	10.89	23	1.46	40	2.78						
Miscellaneous:												
Oligochaeta sp.			7	0.45								
Polychaeta:												
Ampharetidae sp.	3	0.54	37	2.35								
Capitellidae sp.					5	0.35						
Diopatra cuprea											4	1.96
Eteone heteropoda					10	0.69						
Exogene dispar			17	1.08	45	3.13						
Gyptis vittata			10	0.64								
Melinna cristata	3	0.54	10	0.64	25	1.74			4	1.10		
Nereis diversicolor			3	0.19								
Pectinaria gouldii	3	0.54	7	0.45								
Pista palmata			90	5.73					96	26.37		
Polydora ligni			13	0.83	145	10.07					4	1.96
Sabella microphthalmus			27	1.72	50	3.47						
Sabellidae					5	0.35						
Scoloplos fragilis	17	3.09										

Table 16. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Spiochaetopterus oculatus			3	0.19	5	0.35						
Syllidae			3	0.19								
Nemertea:												
Amphiporus bioculatus			3	0.19								
Amphiporus ochraceus			7	0.45								
Nemertea	3	0.54										
Crustacea:												
Amphipod 1			3	0.19								
Amphithoidae sp.											8	3.92
Caprellidae sp.					5	0.35						
Corophium insidiosum					55	3.82	8	0.19				
Cymadusa compta									48	13.19		
Lysianopsis alba			7	0.45								
Melita nitida									4	1.10		
Edotea triloba					10	0.69	4	0.09				
Erichsonella attenuata			3	0.19	25	1.74						
Isopod 1			7	0.45								
Isopod 2			7	0.45								
Balanus balanoides			7	0.45								
Callinectes sapidus			7	0.45								
Crangon septemspinosa	3	0.54			5	0.35						
Palaemonetes pugio									4	1.10		
Palaemonetes vulgaris			3	0.19							4	1.96
Neopanope texana									12	3.30	4	1.96
Xanthidae sp.					50	3.47						
Nymphon longitarse	7	1.27			15	1.04						
Ostracoda sp.							4	0.09				
Mollusca:												
Gemma gemma			7	0.45	5	0.35						
Mercenaria mercenaria							4	0.09				

Table 16. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Mytilus edulis					5	0.35						
Tellina sp.					10	0.69			28	7.89		
Anachis avara									8	2.20		
Corambella	3	0.54										
Crepidula convexa			33	2.10								
Crepidula fornicata			486	30.92					4	1.10		
Crepidula sp.			93	5.92								
Gastropod					5	0.35						
Mitrella lunata			3	0.19	5	0.35			32	8.74		
Nassarius vibex					15	1.04						
Nudibranch			7	0.45								
Odostomia sp.			13	0.83	5	0.35						
Urosalpinx cinereus					5	0.35						
Miscellaneous:												
Anthozoan			3	0.19	5	0.35						
Ascidian			236	15.01								
Ectoproct					Present							
Amathia sp.												
Hydrozoan			Present									
Medusa					5	0.35						
Membranipora sp.	Present		Present		Present							
Nolella sp.											4	1.96
Microciona prolifera			Present									
Molgula manhattensis					45	3.13					4	1.96
Ponar grabs taken	6		6		4		5		5		5	
Species collected	17		48		42		12		16		17	

Table 17. Cedar Run mid station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana							4	0.63				
Glycinde solitaria	27	2.01	33	2.81	25	3.21	100	15.72	20	0.90		
Heteromastus filiformis	34	2.60	47	4.00	10		48	7.55	16	0.72	4	0.63
Hypaniola sp.	43	3.29	360	30.64			104	16.35			8	1.26
Lumbrineris tenuis	7	0.54			5	0.64						
Maldanopsis elongata												
Nereis sp.	5	0.38	7	0.60	15	1.92					40	6.29
Nereis succinea	36	2.76	25	2.13	20	2.56	40	6.29	84	3.77	60	9.43
Scolecolepides viridis			47	4.00							8	1.26
Scoloplos robustus			7	0.60	20	2.56	72	11.32	28	1.26	12	1.89
Streblospio benedicti	11	0.84	347	29.53	220	28.21	80	12.58	44	1.97	16	2.52
Crustacea:												
Ampelisca abdita	553	42.34	73	6.21	290	37.18	64	10.06	1928	86.54	152	23.90
Cyathura polita	72	5.51	60	5.11	30	3.85	20	3.14				
Leptocheirus plumulosus	2	0.15	27	2.30	15	1.92	4	0.63			4	0.63
Mellitidae sp.												
Neomysis americana	2	0.15			25	3.21			44	1.97	28	4.40
Mollusca:												
Mulinia lateralis												
Ilyanassa obsoleta												
Retusa canaliculata	5	0.38										
Miscellaneous:												
Oligochaeta sp.			33	2.81	35	4.49	32	5.03	40	1.80	40	6.29
Polychaeta:												
Capitella capitata	2	0.15										

Table 17. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Capitellidae			7	0.60								
Eteone heteropoda			7	0.60			36	5.67			16	2.52
Gyptis vittata	2	0.15	7	0.60								
Melinna cristata							4	0.63				
Nereis diversicolor			27	2.30								
Nereis virens	2	0.15										
Pectinaria gouldii									4	0.18		
Polydora ligni	4	0.31	20	1.70	10	1.28					20	3.14
Scoloplos fragilis	7	0.54										
Scoloplos sp.	4	0.31										
Nemertea:												
Amphiporus ochraceus	13	1.00										
Paleonemertea sp. 1	4	0.31										
Paleonemertea sp. 2	4	0.31			5	0.64						
Nemertean							4	0.63			92	14.47
Crustacea:												
Amphipod 1	2	0.15										
Amphithoe longimana	14	1.07										
Caprellidae					5	0.64						
Corophium insidiosum					5	0.64						
Corophium insidiosum			7	0.60								
Leptocheirus pinguis											28	4.40
Melita nitida											16	2.52
Edotea triloba	4	0.31			20	2.56			4	0.18	24	3.77
Leptochelia sp.	7	0.54										
Sphaeromidae	2	0.15										
Tanaidae sp.											4	0.63
Balanus balanoides	301	23.05										
Callinectes sapidus	2	0.15										
Crangon septemspinosa	7	0.54			5	0.64					8	1.26
Cyclaspis varians	2	0.15										

Table 17. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Neopanope texana									4	0.18	4	0.63
Oxyurostylis smithi											4	0.63
Mollusca:												
Bivalve			7	0.60							4	0.63
Gemma gemma	101	7.73	13	1.11	10	1.28	4	0.63	4	0.18	4	0.63
Lyonsia hyalinia							4	0.63				
Mya arenaria					10	1.28						
Spisula solidissima	16	1.23										
Tellina sp.			7	0.60					8	0.36		
Crepidula convexa	7	0.54										
Gastropod							16	2.52			4	0.63
Miscellaneous:												
Anthozoan			7	0.60							24	3.77
Anguilla rostrata												
Campanularidae sp.	2	0.15										
Insect											4	0.63
Membranipora sp.	Present											
Microciona prolifera	Present											
Molgula manhattensis											4	0.63
Nolella sp.											4	0.63
Ponar grabs taken	11		3		4		5		5		5	
Species collected	36		22		20		17		13		28	

Table 18. Cedar Run upper station species data

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana			3	0.14								
Glycinde solitaria			10	0.48								
Heteromastus filiformis	37	2.76	10	0.48			20	0.36	8	1.05	4	0.24
Hypaniola sp.	279	20.82	679	32.71			3312	58.97	80	10.53	100	6.01
Lumbrineris tenuis			23	1.11								
Maldanopsis elongata			3	0.14								
Nereis sp.	7	0.52	27	1.30	165	9.48	44	0.78			372	22.34
Nereis succinea	2	0.15							276	36.32		
Scolecolepides viridis	497	37.09	313	15.08	340	19.54	128	2.28	124	13.68	76	4.56
Scoloplos robustus			13	0.63								
Streblospio benedicti			10	0.48							8	0.48
Crustacea:												
Ampelisca abdita	2	0.15	50	2.41	5	0.29			4	0.53	456	27.39
Cyathura polita	114	8.51	220	10.60	75	4.31	336	5.98	80	10.58	192	11.53
Leptocheirus plumulosus	266	19.85	290	13.97	925	53.16	1460	26.00	180	23.68	172	10.33
Mellitidae sp.												
Neomysis americana									4	0.53		
Mollusca:												
Mulinia lateralis												
Ilyanassa obsoleta												
Retusa canaliculata			50	2.41								
Miscellaneous:												
Oligochaeta sp.	7	0.52	240	1.56	140	8.05	36	0.64			64	3.84
Polychaeta:												
Capitella capitata	11	0.82										

Table 18. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Capitellidae					5	0.29						
Eteone heteropoda	2	0.15										
Exogene dispar											4	0.24
Nereis diversicolor	51	3.81	67	3.23								
Polydora ligni			13	0.63								
Scoloplos sp.			Present									
Nemertea:												
Nemertea	2	0.15									Present	
Crustacea:												
Amphithoe longimana			13	0.63								
Corophium insidiosum	4	0.30	17	0.82								
Corophium simile							64	1.14	4	0.53	44	2.64
Corophium tuberculatum	4	0.30										
Gammarus palustris							80	1.42			48	1.42
Chirodotea sp.			3	0.14								
Edotea triloba	53	3.96	13	0.63	5	0.29	124	2.21			124	7.45
Sphaeromidae sp.							4	0.07				
Callinectes sapidus			3	0.14								
Crangon septemspinosa					5	0.29						
Neopanope texana							4	0.07				
Mollusca:												
Bivalve			3	0.14								
Spisula solidissima	2	0.15										
Crepidula sp.			3	0.14								
Miscellaneous:												
Anguilla rostrata					75	4.31						
Microciona prolifera	Present											
Molgula manhattensis							4	0.07				

Table 18. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Fish											1	0.06
Ponar grabs taken	9		6		4		5		5		5	
Species collected	18		25		10		13		9		15	

Table 19. Mill Creek mouth station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana									4	0.06	4	0.44
Glycinde solitaria	13	9.42					12	3.41	44	0.43	12	1.33
Heteromastus filiformis	13	9.42					60	17.05	4	0.06	16	1.78
Hypaniola sp.	3	2.17	7	3.68	15	6.38	24	6.82				
Lumbrineris tenuis					5	2.13						
Maldanopsis elongata												
Nereis sp.												
Nereis succinea			10	5.26					66	0.97	4	0.44
Scolecolepides viridis												
Scoloplos robustus	13	9.42					24	6.82	48	0.71	12	1.33
Streblospio benedicti					5	2.13	16	4.55	112	1.65	8	0.89
Crustacea:												
Ampelisca abdita	47	36.36	10	5.26			104	29.55	6008	88.33	308	34.22
Cyathura polita									4	0.06		
Leptocheirus plumulosus												
Mellitidae sp.												

Table 19. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Neomysis americana	7	5.07							4	0.06	4	0.44
Mollusca:												
Mulinia lateralis							4	0.44				
Ilyanassa obsoleta	10	7.25	37	19.47	5	2.13	20	5.68	12	0.18	408	45.33
Retusa canaliculata	7	5.07							12	0.18		
Miscellaneous:												
Oligochaeta sp.	3	2.17	7	3.68					28	0.36		
Polychaeta:												
Capitella capitata			3	1.58								
Capitellidae sp.							30	22.73				
Eupomatus dianthus			3	1.58								
Eteone heteropoda					10	4.26						
Eteone sp.									8	0.12		
Exogene dispar			3	1.58	10	4.26			44	0.65		
Parapionosyllis longicirrata					5	2.13						
Pista palmata									40	0.59		
Polydora ligni					140	59.57			12	0.18		
Spiochaetopterus oculatus	3	2.17										
Nemertea:												
Amphiporus ochraceus	3	2.17										
Nemertea	7	5.07							24	0.35		
Crustacea:												
Amphipod 1					30	12.77						
Amphipod 2									72	1.06		

Table 19. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Corophium insidiosum					10	4.26			12	0.18		
Melita nitida									8	0.12		
Edotea triloba									4	0.06		
Isopod 2			3	1.58								
Tanaidae sp.									8	0.12		
Callinectes sapidus											4	0.44
Cumacea sp.	3	2.17										
Neopanope texana									8	0.12	8	0.89
Ostracod									8	0.12		
Lysianopsis alba									4	0.06		
Mollusca:												
Aceteon punctostriatus							4	1.14	4	0.06		
Gemma gemma	3	2.17	27	14.21								
Modiolus demissus											4	0.44
Tangelus plebius											4	0.44
Anachis avara									Present			
Cerithiopsis sp.			7	3.68								
Crepidula convexa											4	0.44
Crepidula fornicata									4	0.06		
Gastropod			13	6.84					12	0.18	20	2.22
Nassarius vibex											40	4.44
Odostomia sp.									8	0.12	24	2.67
Miscellaneous:												
Anthozoan			7	3.68								
Ascidian			53	27.89								
Ctenophora	Present											
Ectoproct			Present									
Amathia sp.	Present		Present									
Hydractinia sp.	Present						Present					
Euplana gracilis									4	0.06		
Membranipora sp.	Present		Present									

Table 19. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Clione sp.			Present									
Fish					4	2.13						
Tharyx acutus											4	0.44
Terebellidae sp.											4	0.44
Ponar grabs taken	6		6		4		5		5		5	
Species collected	18		18		11		11		31		19	

Table 20. Mill Creek mid station species distribution.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Polychaeta:												
Glycera americana			3	0.26								
Glycinde solitaria	8	1.54	7	0.60	15	0.23	12	0.37	12	0.18	4	0.05
Heteromastus filiformis	1	0.19	13	1.12	65	0.98	100	3.07	4	0.06	8	0.10
Hypaniola sp.	36	6.94	30	2.58	90	1.35	1800	55.28	4	0.06	4	0.05
Lumbrineris tenuis												
Maldanopsis elongata												
Nereis sp.	1	0.19										
Nereis succinea	4	0.77	27	2.33	110	1.65	8	0.25	152	2.32	24	0.29
Scolecolepides viridis	1	0.19			10	0.15					4	0.05
Scoloplos robustus	1	0.19			10	0.15	20	0.61	4	0.06	8	0.10
Streblospio benedicti	66	12.72	639	54.99	3195	47.97	212	6.51	8	0.12		
Crustacea:												
Ampelisca abdita	277	53.37	183	15.75	2590	38.89	848	26.04	5720	87.35	8160	97.42

Table 20. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Cyathura polita	21	4.05	20	1.72	85	1.28	64	1.97	56	0.86	28	0.33
Leptocheirus plumulosus									8	0.12	8	0.10
Mellitidae sp.												
Neomysis americana	1	0.19			10	0.15	8	0.25	8	0.12	24	0.29
Mollusca:												
Mulinia lateralis					5	0.08						
Ilyanassa obsoleta			30	2.58			4	0.12				
Retusa canaliculata	7	1.35					44	1.35	4	0.06	16	0.19
Miscellaneous:												
Oligochaeta sp.	7	1.35	17	1.46	40	0.60	4	0.12	108	1.65	12	0.14
Polychaeta:												
Capitella capitata	1	0.19										
Capitellidae sp.	1	0.19							4	0.06		
Eteone heteropoda	1	0.19	13	1.12	30	0.45	76	2.33	32	0.49	4	0.05
Exogene dispar									8	0.12		
Gyptis vittata	1	0.19	7	0.60					28	0.43		
Melinna cristata	6	1.16	3	0.26	5	0.08						
Polydora ligni	1	0.19	7	0.60	185	2.78			60	0.92	24	0.29
Terebellidae sp.					10	0.15						
Nemertea:												
Amphiporus ochraceus	1	0.19										
Paleonemertea sp. 1	28	5.39										
Paleonemertea sp. 2					110	1.65						
Nemertea sp.	20	3.85	60	5.16			4	0.12	112	1.71	Present	
Crustacea:												
Caprellidae sp.					5	0.08						

Table 20. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Corophium insidiosum			3	0.26	20	0.30						
Corophium simile									28	0.43		
Cymadusa compta									8	0.12		
Gammarus mucronatus							8	0.25				
Melita nitida									8	0.12		
Edotea triloba									12	0.18	20	0.24
Tanaidae sp.									8	0.12		
Callinectes sapidus			3	0.26	5	0.08						
Crangon septemspinosa			7	0.60								
Cyclaspis varians	1	0.19										
Neopanope texana									36	0.55	4	0.05
Mollusca:												
Gemma gemma	18	3.47	30	2.58	35	0.53	12	0.37	12	0.18		
Modiolus demissus									4	0.06		
Mya arenaria	1	0.19										
Spisula solidissima	3	0.58										
Tellina sp.	3	0.58	23	1.98	15	0.23	24	0.74			24	0.29
Gastropod					5	0.08			4	0.06		
Anthozoan	1	0.19	37	3.18	10	0.15	8	0.25	92	1.41		
Euplana gracilis									4	0.06		
Hydractinia			Present									
Metridium sp.	1	0.19										
Ponar grabs taken	14		6		4		5		5		5	
Species collected	29		22		25		20		30		18	

Table 21. Mill Creek upper station species distribution.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana												
Glycinde solitaria			3	10.34								
Heteromastus filiformis												
Hypaniola sp.												
Lubrineris tenuis	2	25.00	7	24.14								
Maldanopsis elongata												
Nereis sp.							4	25.00				
Nereis succinea												
Scolecolepides viridis												
Scoloplos robustus												
Streblospio benedicti			10	34.48								
Crustacea:												
Ampelisca abdita	2	25.00			10	28.57	8	50.00	52	54.17	152	97.44
Cyathura polita			3	10.34								
Leptocheirus plumulosus					15	42.86			4	4.17		
Mellitidae sp.												
Neomysis americana												
Mollusca:												
Mulinia lateralis												
Ilyanassa obsoleta												
Retusa canaliculata												
Miscellaneous:												
Oligochaeta sp.	2	25.00										
Polychaeta:												
Axiothella catenata			3	10.34								

Table 21. Continued.

Taxanomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Capitellidae sp.											4	2.56
Polydora ligni			3	10.34					32	33.33		
Sabellidae sp.							4	25.00				
Crustacea:												
Edotea triloba	2	25.00										
Mollusca:												
Mytilus edulis					10	28.57						
Miscellaneous:												
Insect larva									8	8.33		
Ponar grabs taken	9		6		4		5		5		5	
Species collected	4		6		3		3		4		2	

Table 22. Lagoon System A mouth station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana							12	2.46				
Glycinde solitaria	20	4.11			45	7.38	4	0.82	16	0.20	8	0.60
Heteromastus filiformis	7	1.44	14	1.81	20	3.28						
Hypaniola sp.									4	0.05		
Lumbrineris tenuis							4	0.82			4	0.30

Table 22. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Maldanopsis elongata												
Nereis sp.												
Nereis succinea	33	6.78	20	2.58					72	0.90	36	2.72
Scolecolepides viridis												
Scoloplos robustus	33	6.78	33	4.26	95	15.57	72	14.75	12	0.15	40	3.00
Streblospio benedicti			147	18.99	115	18.85	16	3.28	4	0.05	8	0.60
Crustacea:												
Ampelisca abdita	213	43.74	247	31.91	15	2.46	328	67.21	7648	95.55	1032	77.95
Cyathura polita												
Leptocheirus plumulosus			7	0.90								
Mellitidae sp.												
Neomysis americana							4	0.82			8	0.60
Mollusca:												
Mulinia lateralis											4	0.30
Ilyanassa obsoleta	13	2.67	27	3.49	240	39.34	24	4.92	40	0.50	80	6.00
Retusa canaliculata									16	0.20	32	2.42
Miscellaneous:												
Oligochaeta sp.	40	8.31	140	18.09	5	0.82			60	0.75	36	2.72
Polychaeta:												
Ampharetidae	7	1.44										
Capitella capitata			14	1.81							4	0.30
Capitellidae			7	0.90								
Eumida sanguinea									4	0.05		
Eupomatus dianthus			14	1.81								
Eteone flava	7	1.44										
Eteone heteropoda							4	0.82				

Table 22. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Exogene dispar	33	6.78	14	1.81					68	0.85	4	0.30
Gyptis vittata	7	1.44										
Melinna cristata							4	0.82	4	0.05		
Pectinaria gouldii	7	1.44			5	0.82						
Polydora ligni			73	9.43	10	1.64					4	0.30
Spionidae	13	2.67							8	0.10		
Spiochaetopterus oculatus							8	1.64	4	0.05	8	0.60
Sthenelais boa	7	1.44										
Syllidae	7	1.44										
Nemertean									4	0.05	Present	
Crustacea:												
Amphipoda 2												
Lysianopsis alba			3	0.39								
Edotea triloba									8	0.10		
Crangon septemspinosa	7	1.44										
Mysidopsis bigelowi	7	1.44							4	0.05		
Neopanope texana									4	0.05		
Nymphon longitarse									12	0.15		
Ostracoda sp.									4	0.05		
Tanaidacea sp.									4	0.05		
Mollusca:												
Bivalve					5	0.82	4	0.82				
Gemma gemma	13	2.67									12	0.90
Mercenaria mercenaria			7	0.90								
Tellina sp.											4	0.30
Crepidula convexa					45	7.38			4	0.05		
Crepidula sp.	20	4.11										
Gastropod sp.					10	1.64						
Odostomia sp.									4	0.05		

Table 22. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Miscellaneous:												
Anthozoan,									4	0.05		
Ectoprocta	Present											
Vorticella sp.							4	0.82				
Ponar grabs taken	6		6		4		5		5		5	
Species collected	20		14		12		13		25		18	

Table 23. Lagoon System A mid station species data.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Polychaeta:												
Glycinde solitaria	2	7.40										
Hypaniola sp.											4	1.47
Lumbrineris tenuis												
Nereis succinea												
Streblospio benedicti											20	7.35
Crustacea:												
Ampelisca abdita	7	25.93					24	37.50	16	50.00	52	19.12
Cyathura polita												
Leptocheirus plumulosus			7	100.00					4	12.50		
Mellitidae sp.												
Neomysis americana									4	12.50	8	2.84

Table 23. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Mollusca:												
Mulinia lateralis												
Ilyanassa obsoleta												
Retusa canaliculata												
Miscellaneous:												
Oligochaeta sp.												
Polychaeta:												
Capitella capitata									8	25.00	76	27.94
Capitellidae							40	62.50				
Exogene dispar											4	1.47
Melinna cristata	1	3.70										
Polydora ligni											4	1.47
Scolplos sp.	2	7.40										
Spiochaetopterus oculatus	4	14.81										
Crustacea:												
Caprellidae					5	50.00						
Copepoda											100	36.76
Mollusca:												
Gemma gemma	7	25.93										
Mya arenaria	2	7.40										
Miscellaneous:												
Anthozoan					5	50.00						
Ascidian	2	7.40										

Table 23. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Membranipora sp.	Present											
Molgula sp.											4	1.47
Ponar grabs taken	11		3		4		5		5		5	
Species collected	9		1		2		2		4		9	

Table 24. Lagoon System A upper station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana												
Glycinde solitaria												
Heteromastus filiformis									4	7.14		
Hypaniola sp.							4	20.00			8	10.53
Lumbrineris tenuis									4	7.14		
Maldanopsis elongata												
Nereis sp.	2	50.00										
Nereis succinea											12	15.79
Scolecolpides viridis												
Scoloplos robustus											8	10.53
Streblospio benedicti												
Crustacea:												
Ampelisca abdita			126	88.73			16	80.00	32	54.17		
Cyathura polita												
Leptocheirus plumulosus												

Table 24. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Mellitidae sp.												
Neomysis americana												
Mollusca:												
Mulinia lateralis												
Ilyanassa obsoleta												
Retusa canaliculata												
Miscellaneous:												
Oligochaeta sp.												
Polychaeta:												
Capitella capitata									16	28.57	48	63.16
Capitellidae	2	50.00										
Eupomatus dianthus			3	2.11								
Exogene dispar			3	2.11								
Polydora ligni			7	4.93								
Nemertea:												
Amphiporus bioculatus			3	2.11								
Crustacea:												
Amphipoda sp. 1					5	50.00						
Miscellaneous:												
Asterias forbesi					5	50.00						
Ponar grabs taken	9		6		4		5		5		5	
Species collected	2		5		2		2		4		4	

Table 25. Lagoon System B mouth station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana												
Glycinde solitaria	13	9.22	7	3.03	20	8.70						
Heteromastus filiformis			10	4.33					4	0.98		
Hypaniola sp.												
Lumbrineris tenuis			3	1.30							4	2.04
Maldanopsis elongata			3	1.30								
Nereis sp.					5	2.17	4	6.67				
Nereis succinea			10	4.33			4	6.67				
Scolecolepides viridis												
Scoloplos robustus			13	5.63	60	26.09	16	26.68	16	3.92	24	22.40
Streblospio benedicti	3	2.13	53	22.94	90	39.13			8	1.96		
Crustacea:												
Ampelisca abdita	48	34.04	3	1.30			12	13.34	332	81.37	100	51.02
Cyathura polita												
Leptocheirus plumulosus							4	6.67				
Mellitidae sp.												
Neomysis americana							12	20.00	12	2.94	40	20.80
Mollusca:												
Mulinia lateralis	5	3.55					4	6.67	8	1.96	4	2.00
Ilyanassa obsoleta			7	3.03	10	4.35						
Retusa canaliculata	40	2.84							4	0.98	16	8.16
Miscellaneous:												
Oligochaeta sp.			7	3.03			4	6.67	12	2.94		
Polychaeta:												
Autolytus prolifer	3	2.31										

Table 25. Continued.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Capitellidae	3	2.31										
Exogene dispar											4	2.04
Gyptis vittata			87	37.66								
Pista palmata	3	2.31										
Polydora ligni	10	7.10	3	1.30	45	19.57						
Prionospio malmgreni			3	1.30								
Scoloplos fragilis	5	3.55										
Scoloplos sp.			3	1.30								
Spiochaetopterus oculatus			3	1.30								
Crustacea:												
Copepoda											4	2.04
Mysidopsis bigelowi									4	0.98		
Mollusca:												
Gemma gemma			3	1.30								
Tellina sp.									4	0.98		
Odostomia sp.	3	2.31										
Miscellaneous:												
Anthozoan			13	5.63					4	0.98		
Amathia sp.			Present									
Metridium sp.	5	3.55										
Ponar grabs taken	8		6		4		5		5		5	
Species collected	12		18		6		8		11		8	

Table 26. Lagoon System B mid station species data.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:														
Glycera americana									8	0.93			4	0.08
Glycinde solitaria	33	0.13	13	0.57	227	4.73	25	2.46	20	2.34			40	0.77
Heteromastus filiformis	27	0.93	3	0.13	80	1.67	10	0.99	8	0.93			16	0.31
Hypaniola sp.					7	0.15			4	0.47				
Lumbrineris tenuis	27	0.93			47	0.98							20	0.58
Maldanopsis elongata					13	0.27							Present	
Nereis sp.			3	0.13			160	15.76						
Nereis succinea	40	1.37	53	2.32	193	4.02					12	3.00	40	0.77
Scolecolepides viridis														
Scoloplos robustus			40	1.75	153	3.19	15	1.48	40	4.67	12	3.00	120	2.31
Streblospio benedicti	2101	72.15	1928	84.56	2261	47.06	245	24.14	636	74.30	132	33.00	244	4.71
Crustacea:														
Ampelisca abdita	167	5.73	33	1.45	607	12.64	135	13.30	44	5.14	184	46.00	3844	74.15
Cyathura polita	80	2.75			67	1.39								
Leptocheirus plumulosus									36	4.21	8	2.00		
Mellitidae sp.														
Neomysis americana	26	0.89	3	0.13	147	3.06	10	0.99			4	1.00	28	0.54
Mollusca:														
Mulinia lateralis	7	0.24									4	1.00	8	0.15
Ilyanassa obsoleta			7	0.31			5	0.49					4	0.08
Retusa canaliculata	33	7.41	10	0.44	40	0.83							20	0.38
Miscellaneous:														
Oligochaeta sp.			17	0.75	140	2.91					24	6.00	120	2.31

Table 26. Continued.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:														
Autolytus prolifer			3	0.13										
Capitella capitata			10	0.44			35	3.45			8	2.00	8	0.15
Capitellidae			10	0.44	Present									
Cirratulidae					7	0.15	5	0.49						
Dodecaceria sp.			3	0.13	33	0.69								
Drilonereis longa	7	0.24												
Eupomatus dianthus	20	0.69					25	2.46						
Eteone heteropoda	33	1.13	3	0.13	20	0.42	10	0.99					16	0.31
Exogene dispar					127	2.63	15	1.48					20	0.58
Exogene sp.	7	0.24	3	0.13										
Glycera dibranchiata													4	0.08
Gyptis vittata			13	1.56	7	0.15								
Melinna cristata	7	0.24			147	3.06	15	1.48	32	3.74	4	1.00	56	1.08
Nereis diversicolor	7	0.24												
Pectinaria gouldii			3	0.13	20	0.42	5	0.49						
Polydora ligni			17	0.70	107	2.23	225	22.17			12	3.00	80	1.54
Potamilla neglecta							5	0.49					4	0.08
Sabella microphthalmus			20	0.88	14	0.29	5	0.49						
Scoloplos acutus	7	0.24												
Scoloplos fragilis	7	0.24												
Scoloplos sp.	14	0.48												
Serpulid							10	0.99						
Spiochaetopterus oculatus			3	0.13	193	4.02			12	1.40	4	1.00	36	0.69
Terrebellidae					7	0.15							4	0.08
Tharyx acutus			17	0.70					4	0.47			16	0.32
Nemertean:														
Nemertean	14	0.48	3	0.13									Present	
Crustacea:														
Amphipod 1					40	0.84								
Caprellidae							5	0.49						

Table 26. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Winter 1974 No.	Winter 1974 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Lysianopsis alba							5	0.49						
Microdeutopus sp.													84	1.62
Edotea triloba	7	0.24												
Cyclaspis varians					13	0.27								
Mysidopsis bigelowi													12	0.24
Oxyurostylis smithi													8	0.16
Mollusca:														
Aceteon punctostriatus													148	2.85
Bivalve					7	0.15								
Gemma gemma	207	7.11	20	0.88	40	0.84			4	0.47			32	0.62
Mercenaria mercenaria			3	0.13										
Tellina sp.			3	0.13					4	0.47				
Corambella sp.	7	0.24												
Crepidula fornicata	7	0.24												
Crepidula sp.					7	0.15								
Gastropod					13	0.27								
Turbonilla													136	2.62
Miscellaneous:														
Anthozoan			33	1.97			20	1.97	4	0.47			8	0.16
Ascidian			3	0.13										
Botryllus sp.					Present									
Amathia sp.			Present										Present	
Membranipora sp.	Present		Present		Present									
Nematostella vectensis					13	0.27								
Molgula sp.							25	2.46						
Vorticella									Present		Present			
Fish													4	0.08
Campanularidae					7	0.15								
Ponar grabs taken	3		6		3		4		5		5		5	
Species collected	26		31		35		23		15		12		35	

Table 27. Lagoon System B upper station species data.

Taxonomic group	Summer 1973		Fall 1973		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Polychaeta:												
Glycera americana												
Glycinde solitaria												
Heteromastus filiformis							4	14.29				2.56
Hypaniola sp.												
Lumbrineris tenuis												
Maldanopsis elongata												
Nereis sp.												
Nereis succinea												
Scolecolepides viridis												
Scoloplos robustus											4	7.14
Streblospio benedicti									4	3.33		
Crustacea:												
Ampelisca abdita									88	73.33	4	7.14
Cyathura polita											4	7.14
Leptocheirus plumulosus							4	14.29				
Mellitidae sp.												
Neomysis americana												
Mollusca:												
Mulinia lateralis												
Ilyanassa obsoleta												
Retusa canaliculata												
Miscellaneous:												
Oligochaeta sp.												
Polychaeta:												
Capitella capitata			13	68.42					20	16.67	44	77.33

Table 27. Continued.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Tharyx acutus							16	57.14				
Crustacea:												
Amphipod 1			3	15.79								
Corophium insidiosum							4	14.29				
Callinectes sapidus					5	100.00						
Mysidopsis bigelowi									8	6.67		
Mollusca:												
Gastropod			3	15.79					4	3.33	4	7.14
Ponar grabs taken		3		6		4		5		5		5
Species collected		0		3		1		4		5		5

Table 28. Reference station species data.

Taxonomic group	Summer 1973 No.	Summer 1973 % of total	Fall 1973 No.	Fall 1973 % of total	Winter 1974 No.	Winter 1974 % of total	Spring 1974 No.	Spring 1974 % of total	Summer 1974 No.	Summer 1974 % of total	Fall 1974 No.	Fall 1974 % of total	Winter 1975 No.	Winter 1975 % of total
Polychaeta:														
Glycera americana	13	1.74	11	2.13			5	0.88	8	0.17			48	30.77
Glycinde solitaria	34	4.56	15	2.90	33	2.54	5	0.88	20	0.42				
Heteromastus filiformis	36	4.83	24	4.64	40	3.08	15	2.63	24	0.50			4	2.56
Hypaniola sp.			7	1.35										
Lumbrineris tenuis	30	4.02	13	2.51	47	3.62	10	1.75					4	2.56
Maldanopsis elongata	16	2.14	22	4.26	27	2.08	15	2.63					20	12.82
Nereis sp.														

Table 28. Continued.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Nereis succinea	2	0.27												
Scolecolepides viridis														
Scoloplos robustus	21	2.81			87	6.71	45	7.89	12	0.25			12	7.69
Streblospio benedicti			2	0.39	14	1.08								
Crustacea:														
Ampelisca abdita	338	45.31	123	23.79	307	23.67	50	8.77	4140	86.83	340	77.27		
Cyathura polita	32	4.29	46	8.90	27	2.08			8	0.17			4	2.56
Leptocheirus plumulosus			2	0.39										
Mellitidae sp.									88	1.85				
Neomysis americana	18	2.14	4	0.77	467	36.01	10	1.75	116	2.43				
Mollusca:														
Mulinia lateralis	7	0.94	7	1.35			225	39.47	40	0.84	20	4.55	28	17.95
Ilyanassa obsoleta														
Retusa canaliculata	32	4.29	101	19.54	113	8.71	155	27.19	20	0.42	40	9.09	20	12.82
Miscellaneous:														
Oligochaeta sp.	5	0.67												
Polychaeta:														
Ampharetidae	2	0.27												
Autolytus prolifer			2	0.39										
Axiothella catenata	2	0.27	2	0.39										
Capitella capitata	1	0.13												
Capitellidae	7	0.94												
Eteone heteropoda	2	0.27							4	0.08				
Exogene dispar	10	1.34	24	4.64					12	0.25				
Exogene sp.	2	0.27												
Glycera dibranchiata	1	0.13												

Table 28. Continued.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Gyptis vittata	1	0.13												
Melinna cristata	2	0.27			7	0.54	5	0.88			4	0.91	4	2.56
Microphthalmus aberrans			2	0.39										
Pectinaria gouldii	3	0.40							4	0.08			4	2.56
Polydora ligni			2	0.39					4	0.08				
Potamilla neglecta	1	0.13												
Sabella microphthalmus			4	0.78										
Sabellidae									4	0.08				
Scoloplos acutus	1	0.13												
Scoloplos fragilis	3	0.40	2	0.39										
Scoloplos sp.	1	0.13	33	6.38										
Serpulid			10	1.93										
Spio filicornis			2	0.39										
Spiochaetoperus oculatus	7	0.91	10	1.93	46	3.62	5	0.88					4	0.56
Syllidae					7	0.54								
Nemertea:														
Nemertean	2	0.27	2	0.39										
Crustacea:														
Amphipod 1			2	0.39										
Ampelisca agassizi	1	0.13	2	0.39										
Ampelisca sp.	3	0.40												
Batea catharinensis	21	2.82							8	0.17				
Caprellidae	2	0.27												
Corophium insidiosum	6	0.80							40	0.84	8	1.82		
Corophium sp.	2	0.27												
Cymadusa compta													4	2.56
Gammarus palustris							5	0.88						
Gammarus sp.	4	0.54												
Podoceridae	6	0.80												
Edotea triloba	1	0.13					5	0.88						
Callinectes sapidus			4	0.77										

Table 28. Continued.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Crangon septemspinosa	8	1.07	2	0.39							4	0.91	4	2.56
Cumacean							5	0.88	4	0.08				
Neopanope texana									16	0.34				
Nymphon longitarse	2	0.27	2	0.37	7	0.39					16	3.64		
Mollusca:														
Anadara ovalis											4	0.91		
Bivalve	6	0.80							8	0.17				
Ensis directus									8	0.17				
Gemma gemma	11	1.47	4	0.77	47	2.59								
Lyonsia hyalina									40	0.84				
Macoma balthica	1	0.13												
Mercenaria mercenaria	5	0.67	4	0.77										
Modiolus demissus	1	0.13												
Solemya velum	9	1.21												
Tellina sp.									40	0.84				
Bittium alternatum	2	0.27							4	0.08				
Crepidula convexa									68	1.43				
Crepidula sp.	7	0.93	6	0.77										
Eupleura caudata	1	0.13												
Gastropod	1	0.13	2	0.37			5	0.88	8	0.17				
Mitrella lunata									16	0.34				
Nassarius vibex									4	0.08				
Turbonilla sp.	10	1.34	11	2.13										

Table 28. Continued.

Taxonomic group	Summer 1973		Fall 1973		Winter 1974		Spring 1974		Summer 1974		Fall 1974		Winter 1975	
	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total	No.	% of total
Miscellaneous:														
Anguilla rostrata	1	0.13												
Amathia sp.														
Holothuridia											Present			
Microciona prolifera							5	0.88						
Pycnogonid											Present			
Campanularidae	1	0.13												
	Present										Present			
Ponars grabs taken	21		9		3		4		5		5		5	
Species collected	56		37		16		17		28		11		13	

Table 29. Meyers Creek species data for the summer 1975.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Dodecaceria sp.					3	0.20				
Eteone heteropoda	1	0.16			5	0.34			12	1.33
Glycera americana			1	0.21	1	0.07				
Glycera capitata	2	0.32			3	0.20				
Glycera dibranchiata	1	0.16	4	0.82	2	0.14	2	5.13		
Glycinde solitaria			1	0.21	5	0.34				
Heteromastus filiformis	35	5.61	25	5.15	19	1.29	3	7.69	2	0.22
Hypaniola sp.	1	0.16			8	0.54	3	7.69	106	11.76
Lumbrineris tenuis	8	1.28	5	1.03	39	2.64	2	5.13		
Nereis succinea	4	0.64	2	0.41	17	1.15	3	7.69	382	42.40
Nereis virens							2	5.13		
Scolecolepides viridis					4	0.27				
Scoloplos robustus	3	0.48	1	0.21	3	0.20	2	5.13		
Streblospio benedicti	15	2.40	1	0.21	39	2.64	13	33.33	374	41.51
Terebellidae	2	0.32	1	0.21	1	0.07				
Nemertea:										
Crustacea:										
Ampelisca abdita	445	71.31	417	85.98	402	27.24				
Corophium insidiosum	12	1.92	6	1.24						
Gammarus mucronatus					24	1.63				
Leptocheirus plumulosus	45	7.21	9	1.86	33	2.24				
Lysianopsis alba	1	0.16								
Melita nitida	2	0.32			3	0.20				
Cyathura polita	1	0.16			4	0.27	2	5.13	16	1.78
Edotea triloba					2	0.14				
Leptochelia savignyi					1	0.07				
Crangon septemspinosa					2	0.14			1	0.11
Mysidopsis bigelowi	1	0.16								

Table 29. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Mollusca:										
Acteon punctostriatus					2	0.14			1	0.11
Gemma gemma	17	2.72	5	1.03	803	54.40				
Macoma balthica	1	0.16	4	0.82						
Ilyanassa obsoleta	19	3.04	1	0.21	4	0.27	2	5.13	1	0.11
Retusa canaliculata			1	0.21	3	0.20				
Miscellaneous:										
Oligochaeta	8	1.28	1	0.21	24	1.63	5	12.82	7	0.78

Table 30. Meyers Creek species data for the fall 1975.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Eteone heteropoda	3	0.18	1	0.01	13	0.98	18	1.89	17	2.18
Glycera americana					2	0.15	1	0.10		
Glycera dibranchiata	2	0.12								
Glycinde solitaria	6	0.36			7	0.53	4	0.42		
Heteromastus filiformis	16	0.97	22	0.30	34	2.56	16	1.68	3	0.38
Hypaniola sp.							3	0.31	99	12.68
Lumbrineris tenuis	19	1.15	12	0.16	52	3.92	80	8.39		
Maldanopsis elongata			1	0.01						
Melinna cristata	3	0.18								
Nereis succinea	3	0.18	17	0.23	29	2.19	25	2.62	457	58.51
Polydora ligni			3	0.04	1	0.08	7	0.73		
Scoloplos fragalis	1	0.06								
Scoloplos robustus	6	0.36	21	0.27	17	1.28	28	2.94	8	1.02
Streblospio benedicti	7	0.42	20	0.27	80	6.03	11	1.15	7	0.90

Table 30. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Syllidae			1	0.01					1	0.13
Terebellidae					1	0.08				
Nemertea:	4	0.24	21	0.29	13	0.98	18	1.89	1	0.13
Crustacea:										
Ampelisca abdita	1,530	92.78	7,128	97.09	995	74.98	667	69.99	168	21.51
Corophium insidiosum	5	0.30	1	0.01	8	0.60				
Gammarus mucronatus	1	0.06			1	0.08				
Leptocheirus plumulosus	5	0.30	29	0.39	42	3.17	21	2.20		
Lysianopsis alba			1	0.01						
Melita nitida	4	0.24	3	0.04	16	1.21	2	0.21		
Cyathura polita			3	0.04	2	0.15	25	2.62	15	1.92
Edotea triloba			2	0.03	2	0.15				
Leptochelia savignyi			2	0.03			1	0.10	1	0.13
Crangon septemspinosa	3	0.18								
Ostrocod			33	0.45	1	0.08	1	0.10		
Mollusca:										
Acteon punctostriatus	1	0.06								
Ensis directus							1	0.10		
Gemma gemma	3	0.18	1	0.01	6	0.45	16	1.68		
Mulina lateralis			1	0.01	1	0.08				
Crepidula fornicata	1	0.06								
Ilyanassa obsoleta	20	1.21	16	0.22	1	0.08	3	0.31		
Retusa canaliculata			1	0.01	1	0.08	1	0.10		
Miscellaneous:										
Metridium sp.			1	0.01	1	0.08	1	0.10		
Oligochaeta	5	0.30			1	0.08	3	0.31	4	0.51
Oxyurostylis smithi	1	0.06	1	0.01						

Table 31. Meyers Creek species data for the winter 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Eteone heteropoda	9	0.20	40	12.94	44	11.11			40	5.24
Exogene dispar					5	1.26				
Glycera americana	3	0.07			2	0.51				
Glycera capitata	2	0.04								
Glycinde solitaria	3	0.07			2	0.51				
Heteromastus filiformis	33	0.73	5	1.62	12	3.03			12	1.57
Hypaniola sp.					2	0.51	5	6.58	99	12.98
Lumbrineris tenuis	33	0.73	2	0.65	26	6.57				
Melinna cristata	1	0.02			1	0.25				
Nereis succinea	34	0.75	27	8.74	38	9.60	8	10.53	534	69.99
Polydora ligni	7	0.15	5	1.62	4	1.01				
Scoloplos robustus	15	0.33	15	4.85	20	5.05	1	1.32	3	0.39
Streblospio benedicti	41	0.91	33	10.68	18	4.55	16	21.05	1	0.13
Terebellidae	1	0.02								
Nemertea:	13	0.29	7	2.27	5	1.26			4	0.52
Crustacea:										
Ampelisca abdita	4,163	92.04	93	30.10	38	9.60	5	6.58	2	0.26
Corophium insidiosum	1	0.02								
Gammarus mucronatus									1	0.13
Gammarus palustris	1	0.02	1	0.32						
Leptocheirus plumulosus	6	0.13	1	0.32						
Cyathura polita	4	0.09	3	0.97	3	0.76	2	2.63	5	0.66
Edotea triloba	5	0.11	18	5.83	9	2.27			1	0.13
Leptochelia sp.					1	0.25			2	0.26
Callinectes sapidus			3	0.97						
Mysidopsis bigelowi	1	0.02								
Neomysis americana	1	0.02	3	0.97			1	1.32	18	2.36
Ostracod	3	0.07								

Table 31. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Mollusca:										
Acteon punctostriatus	4	0.09			5	1.26				
Gemma gemma	19	0.42	5	1.62	75	18.94	20	26.32	1	0.13
Ilyanassa obsoleta	11	0.24	9	2.91	23	5.81	7	9.21		
Miscellaneous:										
Metridium sp.			1	0.32	3	0.76				
Molgula sp.	1	0.02								
Oligochaeta	107	2.37	38	12.30	60	15.15	11	14.47	39	5.11
Oxyurostylis smithi	1	0.02							1	0.13

Table 32. Meyers Creek species data for the spring 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Eteone heteropoda	18	1.88	3	1.34	10	5.56	7	8.97	32	7.39
Exogene dispar	20	2.09	1	0.45						
Glycera americana	2	0.21	3	1.34	2	1.11				
Heteromastus filiformis	22	2.30	5	2.23	17	9.44			15	3.46
Hypaniola sp.									3	0.69
Lumbrineris tenuis	28	2.93	9	4.02	17	9.44	11	14.10	2	0.46
Nereis succinea	7	0.73	11	4.91	3	1.67	6	7.69	206	47.58
Polydora ligni	3	0.31	2	0.89			1	1.28	1	0.23
Scoloplos robustus	5	0.52	22	9.82	10	5.56	5	6.41	13	3.00
Streblospio benedicti	26	2.72	15	6.70	16	8.89	6	7.69	6	1.39
Terebellidae	16	1.67	1	0.45					1	0.23

Table 32. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Nemertea:	16	1.67	1	0.45					4	0.92
Crustacea:										
Ampelisca abdita	669	69.91	111	49.55	71	39.44	13	16.67	18	4.16
Leptocheirus plumulosus	3	0.31			1	0.56				
Melita nitida	4	0.42								
Cyathura polita	1	0.10			3	1.67	3	3.85	20	4.62
Edotea triloba	1	0.10							6	1.39
Leptochelia savignyi									1	0.23
Mollusca:										
Acteon punctostriatus	1	0.10								
Gemma gemma	47	4.91	20	8.93	11	6.11	6	7.69		
Ilyanassa obsoleta	24	2.51	3	1.34	6	3.33				
Retusa canaliculata	2	0.21								
Miscellaneous:										
Platyhelminth									2	0.46
Oligochaeta	42	4.39	17	7.59	13	7.22	20	25.64	103	23.79

Table 33. Meyers Creek species data for the summer 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Autolytus prolifer	1	0.04								
Eteone heteropoda			3	0.13	5	0.15	8	0.31	3	1.10
Glycera dibranchiata	23	0.81	19	0.81	18	0.56	12	0.47	3	1.10
Glycinde solitaria					1	0.03	1	0.04		
Heteromastus filiformis	123	4.35	85	3.63	107	3.31	53	2.08	17	6.23
Hypaniola grayi									4	1.47
Lumbrineris tenuis	24	0.85	41	1.75	101	3.12	64	2.51	7	2.56
Nereis succinea	1	0.04	1	0.04	2	0.06			83	30.40
Pista palmata	1	0.04								
Polydora ligni	25	0.88	4	0.17	7	0.22	6	0.24		
Scoloplos robustus	4	0.14	16	0.68	9	0.28	10	0.39	16	5.86
Streblospio benedicti	336	11.87	258	11.03	435	13.44	591	23.14	37	13.55
Terrebelidae	22	0.78	1	0.04	2	0.06				
Nemertea:	1	0.04	1	0.04			2	0.08		
Crustacea:										
Ampelisca abdita	2,192	77.46	1,889	80.69	2,475	76.46	1,754	68.70	95	34.80
Corophium insidiosum	7	0.25	1	0.04						
Leptocheirus plumulosus	12	0.42	4	0.17	4	0.12	2	0.08		
Lysianopsis alba	1	0.04								
Melita nitida	1	0.04								
Cyathura polita	3	0.11			17	0.53	21	0.82	7	2.56
Edotea triloba	2	0.07	2	0.09	2	0.06	1	0.04		
Crangon septemspinosa					1	0.03				
Neomysis americana	1	0.04								
Ostracoda	5	0.18	3	0.13	2	0.06	2	0.08		
Oxyurostylis smithi					2	0.06	1	0.04		

Table 33. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Mollusca:										
Gemma gemma			7	0.30	42	1.30				
Macoma balthica							2	0.08		
Mercenaria mercenaria	1	0.04								
Mulinia lateralis	2	0.07	3	0.13	2	0.06				
Eupleura caudata			1	0.04						
Ilyanassa obsoleta	20	0.71	1	0.04	2	0.60	1	0.40		
Miscellaneous:										
Oligochaeta	16	0.57	1	0.04			3	0.12	1	0.37

Table 34. Meyers Creek species data for the fall 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Eteone heteropoda	1	0.04			3	0.40	2	0.37	2	1.26
Glycera americana			1	0.21						
Glycera dibranchiata			1	0.43						
Glycinde solitaria	1	0.04	25	5.33	4	0.53	4	0.75		
Heteromastus filiformis	10	0.38	28	5.97	4	0.53	4	0.75		
Hypaniola grayi							2	0.37	1	0.62
Lumbrineris tenuis	2	0.08	45	9.59	2	0.26	5	0.94		
Nereis succinea	27	1.02	3	0.64	15	1.98	19	3.56	52	32.70
Polydora ligni	3	0.11			4	0.53	2	0.37		
Scoloplos robustus	2	0.08	5	1.07			1	0.19		
Streblospio benedicti	69	2.61	18	3.84	52	6.88	77	14.42	99	62.26

Table 34. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Nemertea:	3	0.11	4	0.85	3	0.40	4	0.75		
Crustacea:										
Ampelisca abdita	2,486	93.92	137	29.21	641	84.79	391	73.22		
Corophium insidiousum	12	0.45	1	0.21			1	0.19		
Gammarus mucronatus			1	0.21						
Leptocheirus plumulosus	4	0.15	7	1.49			3	0.56		
Lysianopsis alba			7	1.49						
Melita nitida	1	0.04	2	0.43	3	0.40	1	0.19		
Cyathura polita					2	0.26				
Edotea triloba			8	1.71			2	0.37	1	0.63
Neomysis americana	9	0.34	150	31.98	2	0.26	5	0.94		
Oxyurostylis smithi	1	0.04							2	1.26
Mollusca:										
Acteon punctostriatus	1	0.04								
Gemma gemma	8	0.30			2	0.26				
Mya arenaria			2	0.43						
Ilyanassa obsoleta	5	0.19	4	0.85	17	2.25	6	1.12		
Miscellaneous:										
Oligochaeta	2	0.08	17	3.62			3	0.56	4	2.52
Polychaeta:										
Diopatra cuprea			1	0.21						
Crustacea:										
Microdeutopus gryllotalpa			1	0.21						

Table 35. Meyers Creek species data for the winter 1977.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Eteone heteropoda	3	0.16					1	1.69	1	0.25
Glycinde solitaria	2	0.11							1	0.25
Heteromastus filiformis	6	0.32	1	25.00					1	0.25
Hypaniola grayi							3	5.08	17	4.32
Lumbrineris tenuis	2	0.11							1	0.25
Nereis succinea	37	1.99			1	1.56	6	10.17	58	14.43
Polydora ligni	27	1.45								
Streblospio benedicti	97	5.21	1	25.00	27	42.19	11	18.64	145	36.07
Terrebelidae	1	0.05								
Nemertea:	11	0.59							1	0.25
Crustacea:										
Ampelisca abdita	1,597	85.81			3	4.69	14	23.73	128	31.84
Ampelisca vadorum	5	0.27								
Corophium insidiosum	10	0.54								
Gammarus palustris							1	1.69	7	1.74
Leptocheirus plumulosus	23	1.24							3	0.75
Lysianopsis alba	1	0.05								
Edotea triloba	2	0.11								
Neomysis americana	34	1.83	1	25.00	15	23.44	22	37.29	18	4.48
Mollusca:										
Ilyanassa obsoleta			1	25.00	16	25.00				
Miscellaneous:										
Oligochaeta	3	0.16			2	3.13	1	1.69	20	4.98

Table 36. Lagoon System B species data for the summer 1975.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Cirratulidae			2	0.28	1	0.25				
Glycera americana			1	0.14	1	0.25				
Glycera capitata	3	0.74	6	0.85						
Glycera dibranchiata			9	1.28	2	0.51				
Lumbrineris tenuis			4	0.57	4	1.01				
Maldanopsis elongata	1	0.25	1	0.14	3	0.76				
Melinna cristata	1	0.25	15	2.13	2	0.51				
Nereis succinea			2	0.18	2	0.51				
Scoloplos robustsus			12	1.71						
Streblospio benedicti			1	0.14	3	0.76				
Syllidae					1	0.25				
Crustacea:										
Ampelisca abdita	392	97.27	624	88.76	373	94.43				
Caprellidae			2	0.28						
Leptocheirus plumulosus			5	0.71						
Lysianopsis alba	2	0.50								
Melita nitida					3	0.76				
Mysidopsis bigelowi	1	0.25	1	0.14						
Neomysis americana	2	0.50								
Mollusca:										
Gemma gemma			5	0.71						
Macoma balthica			1	0.14						
Tellina sp.			1	0.14						
Crepidula fornicata			9	1.28	1	0.25				
Retusa canaliculata	1	0.25	1	0.14						
Miscellaneous:										
Metridium sp.			1	0.14						

Table 37. Lagoon System B species data for the fall 1975.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Autolytus sp.	1	0.61								
Capitella capitata			1	0.06						
Eteone heteropoda	1	0.61			1	0.11				
Exogene dispar			2	0.12						
Glycera americana			1	0.06	1	0.11				
Glycera dibranchiata			1	0.06	2	0.23				
Glycinde solitaria			11	0.67	2	0.23				
Heteromastus filiformis			8	0.48						
Lumbrineris tenuis	1	0.61	16	0.97						
Maldanopsis elongata					2	0.23				
Melinna cristata			7	0.42	1	0.11				
Nereis succinea	1	0.61	31	1.88	19	2.17				
Polydora ligni	3	1.82	11	0.67	13	1.48				
Sabella microphthalmus			4	0.24						
Scoloplos robustus	2	1.21	11	0.67	3	0.34				
Streblospio benedicti			99	6.00	37	4.22				
Syllidae			14	0.85	5	0.57				
Terebellidae			55	3.33						
Nemertea:			9	0.55	3	0.34				
Crustacea:										
Ampelisca abdita	135	81.82	264	15.99	739	84.36	7	100.00	2	100.00
Corophium insidiosum			2	0.12						
Leptocheirus plumulosus			68	4.12	10	1.14				
Lysianopsis alba			19	1.15	2	0.23				
Melita nitida			3	0.18	3	0.34				
Cyathura polita	1	0.61	22	1.33						
Edotea triloba			1	0.06						
Leptochelia sp.	8	4.85	774	46.88	7	0.80				
Callinectes sapidus	1	0.61	1	0.06						
Crangon septemspinosa			1	0.06						
Mysidopsis bigelowi			2	0.12						

Table 37. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Ostracoda			141	8.54	11	1.26				
Mollusca:										
Ensis directus			1	0.06						
Gemma gemma	3	1.82	55	3.33	3	0.34				
Mulinia lateralis					1	0.11				
Crepidula fornicata					2	0.23				
Nassarius vibex			1	0.06						
Retusa canaliculata	2	1.21								
Miscellaneous:										
Metridium sp.			9	0.55						
Oligochaeta					8	0.91				
Petaloproctus tenuis			3	0.18						

Table 38. Lagoon System B species data for the winter 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Capitella capitata							33	54.10		
Eteone heteropoda			7	0.80	10	1.57				
Exogene dispar					2	0.31				
Glycinde solitaria			4	0.46	11	1.72				
Heteromastus filiformis			6	0.68	5	0.78	1	1.64		
Lumbrineris tenuis	3	11.54	12	1.37	2	0.31				
Melinna cristata			8	0.91	4	0.63	1	1.64		
Nereis succinea			18	2.05	6	0.94	2	3.28		

Table 38. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polydora ligni			10	1.14	18	2.82	1	1.64		
Potamilla neglecta					1	0.16				
Scoloplos robustus			15	1.71	6	0.94	1	1.64		
Streblospio benedicti	1	3.85	21	2.39	58	9.09	4	6.56		
Terebellidae	1	3.85	59	6.73						
Nemertea:			7	0.80	1	0.16				
Crustacea:										
Ampelisca abdita	9	34.62	287	32.73	470	73.67			4	100.00
Corophium insidiosum			1	0.11						
Leptocheirus plumulosus			37	4.22	17	2.66	10	16.39		
Lysianopsis alba			30	3.42	1	0.16				
Cyathura polita			13	1.48						
Edotea triloba					1	0.16				
Leptochelis sp.			18	2.05	6	0.94				
Callinectes sapidus							1	1.64		
Neomysis americana	2	7.69			4	0.63				
Ostracod			252	28.73	2	0.31				
Mollusca:										
Acteon punctostriatus	9	34.62								
Gemma gemma			60	6.84						
Mulina lateralis			1	0.11						
Retusa canaliculata			7	0.80						
Miscellaneous:										
Molgula sp.					5	0.78	2	3.28		
Oligochaeta			3	0.34	8	1.25	5	8.20		
Oxyurostylis smithi	1	3.85								
Polychaeta X			1	0.11						

Table 39. Lagoon System B species data for the spring 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Capitella capitata			1	0.16	2	0.30				
Eteone heteropoda			2	0.31	22	3.26				
Exogene dispar	2	4.00	7	1.10	1	0.15				
Glycera americana			2	0.31						
Glycera capitata	1	2.00								
Glycera dibranchiata					12	1.78				
Glycinde solitaria	1	2.00	4	0.63						
Heteromastus filiformis	3	6.00	3	0.47	2	0.30				
Lumbrineris tenuis			7	1.10	2	0.30				
Hypaniola sp.					2	0.30				
Melinna cristata			12	1.88	2	0.30				
Nereis succinea			14	2.20	23	3.41	1	33.33		
Pectinaria gouldii			1	0.16	1	0.15				
Polydora ligni	2	4.00	8	1.26	22	3.26				
Scoloplos robustus	2	4.00	6	0.94	11	1.63				
Streblospio benedicti	2	4.00	28	4.40	100	14.81				
Syllidae			4	0.63						
Terebellidae			96	15.07	7	1.04				
Nemertea:			10	1.57	6	0.89				
Crustacea:										
Ampelisca abdita	30	60.00	257	40.35	278	41.19			1	33.33
Leptocheirus plumulosus			61	9.58	76	11.26	1	33.33	2	66.67
Lysianopsis alba			3	0.47	3	0.44				
Melita nitida	1	2.00	1	0.16	1	0.15				
Cyathura polita			3	0.47						
Edotea triloba					1	0.15				
Leptochelia sp.			9	1.41	18	2.67				
Crangon septemspinosa					1	0.15				
Neomysis americana							1	33.33		
Ostracod			5	0.78	2	0.30				

Table 39. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Mollusca:										
Gemma gemma			55	8.63	2	0.30				
Mulinia lateralis	2	4.00			2	0.30				
Retusa canaliculata	2	4.00	2	0.31						
Miscellaneous:										
Molgula sp.			19	2.98	38	5.63				
Oligochaeta	2	4.00	16	2.51	35	5.19				
Tagelus plebelus			1	0.16	3	0.44				

Table 40. Lagoon System B species data for the summer 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Capitella capitata					1	0.08				
Eteone heteropoda	1	0.63	2	0.67	22	1.77				
Glycera americana	4	2.53			6	0.48				
Glycinde solitaria			2	0.67	4	0.32				
Heteromastus filiformis					12	0.97				
Hypaniola grayi			1	0.33						
Lumbrineris tenuis	2	1.27	14	4.68	5	0.40				
Maldonopsis elongata					1	0.08				
Melinna cristata	1	0.63	1	0.33	6	0.48				
Nereis succinea	1	0.63	1	0.33	30	2.42				
Polydora ligni			1	0.33	20	1.61				
Scoloplos robustus	1	0.63	10	3.34	25	2.01				
Streblospio benedicti	15	9.49	17	5.69	688	55.44				
Terrebellidae	1	0.63	14	4.68						

Table 40. Continued.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Nemertea:			4	1.34						
Crustacea:										
Ampelisca abdita	126	79.75	115	38.46	363	29.25	2	66.67	1	100.00
Corophium insidiosum			1	0.33						
Leptocheirus plumulosus			5	1.67	10	0.81				
Melita nitida			5	1.67	7	0.56				
Lysianopsis alba			26	8.70	22	1.77				
Cyathura polita			76	25.42	12	0.97	1	33.33		
Leptochelia savignyi			1	0.33						
Crangon septemspinosa					1	0.08				
Neomysis americana	2	1.27								
Ostracod			2	0.67						
Oxyurostylus smithi	1	0.63								
Mollusca:										
Gemma gemma	1	0.63								
Macoma balthica					1	0.08				
Mulinia lateralis	1	0.63								
Miscellaneous:										
Microciona prolifera					5	0.40				
Oligochaeta	1	0.63	1	0.33						

Table 41. Lagoon System B species data for the fall 1976.

Taxonomic group	Station 1 No.	Station 1 % of total	Station 2 No.	Station 2 % of total	Station 3 No.	Station 3 % of total	Station 4 No.	Station 4 % of total	Station 5 No.	Station 5 % of total
Polychaeta:										
Cirratulidae					2	0.55				
Eupomatus dianthus					1	0.28				
Eteone heteropoda					3	0.83				
Glycera dibranchiata			2	2.08						
Glycinde solitaria	1	9.09	6	6.25	3	0.83				
Heteromastus filiformis			7	7.29	1	0.28				
Lumbrineris tenuis			8	8.33						
Melinna cristata			4	4.17						
Nereis succinea			9	9.38	3	0.83				
Pectinaria gouldii					3	0.83				
Scoloplos robustus	1	9.09	2	2.08						
Streblospio benedicti	3	27.27	23	23.96	249	68.60				
Crustacea:										
Ampelisca abdita	2	18.18	26	27.08	82	22.59				
Corophium insidiosum	1	9.09								
Lysianopsis alba					1	0.28				
Melita nitida	1	9.09	1	1.04						
Cyathura polita			3	3.13						
Crangon septemspinosa					1	0.28				
Mysidopsis bigelowi	1	9.09								
Neomysis americana	1	9.09	1	1.04						
Miscellaneous:										
Oligochaeta			4	4.17	14	3.86				

Table 42. Lagoon System B species data for the winter 1977.

Taxonomic group	Station 1 No.	1 % of total	2 No.	2 % of total	3 No.	3 % of total	4 No.	4 % of total	5 No.	5 % of total
Polychaeta:										
Glycera americana			3	2.16	2	0.51				
Glycinde solitaria					1	0.25				
Heteromastus filiformis			3	2.16	8	2.04				
Lumbrineris tenuis			8	5.76	8	2.04				
Melinna cristata			4	2.88	11	2.80				
Nereis succinea					1	0.25				
Pectinaria gouldii			1	0.72	6	1.53				
Streblospio benedicti	1	5.56	3	2.16	52	13.23				
Nemertea:					1	0.25				
Crustacea:										
Ampelisca abdita	4	22.22	81	58.27	202	51.40			1	50.00
Corophium insidiosum			1	0.72						
Leptocheirus plumulosus			3	2.16	30	7.63				
Lysianopsis alba			1	0.72	4	1.02				
Edotea triloba					1	0.25				
Neomysis americana	11	61.11	22	15.83	14	3.56	18	100.00	1	50.00
Mollusca:										
Acteon punctostriatus	1	5.56								
Gemma gemma	1	5.56								
Miscellaneous:										
Hydractinia			1	0.72						
Oligochaeta			8	5.76	52	13.23				

5. MARSH PRODUCTIVITY: SURFACE INVERTEBRATE POPULATION INDICES

Fred Ferrigno, Lee Widjeskog, and Earl Tomlin[1]

SUMMARY

An experimental design for field study of invertebrate populations on the Cedar Run marshes was obtained from Dr. J. Richard Trout, statistician, Rutgers University. Stratification was necessary. Accordingly, the entire study area was cover-typed and the acreage of each type determined. Transects and 100 randomly selected sampling stations were established according to the proportion of each type. Major types within the 1,350.4 acre study area included 23.7 acres of tall salt marsh cordgrass, 809.4 acres of short salt marsh cordgrass, 347.3 acres of saltmeadow cordgrass, 22.7 acres of spike grass, 29.2 acres of marsh elder, 8.7 acres of reed, 3.0 acres of threesquare, 1.5 acres of switchgrass, 90.6 acres of salt marsh ponds, 7.5 acres of mosquito ditches, and 6.8 acres of fill.

BACKGROUND

The Division of Fish, Game, and Shellfisheries has utilized invertebrate population estimates to evaluate management practices (Ferrigno, MacNamara, and Jobbins 1969; Ferrigno, Kosinski, and Widjeskog 1970, 1971) and to determine the value of specific marshes for court cases, other aspects of protection, and environmental impact statements (Ferrigno 1971, 1972). During these investigations, statistical procedures were not used. There are many factors which affect the variability of data collected on salt marshes and obtaining the necessary significance is often difficult. Improving the quality of wetlands research and fulfilling federal aid requirements necessitates the use of proper sampling designs and analysis of data. During 1973-74, a statistician from Rutgers, Dr. R. Trout, was consulted. He provided the experimental sampling design for this invertebrate population study.

This job is part of a coordinated study by Rutgers University and the New Jersey Division of Fish, Game, and Shellfisheries to determine values of the Cedar Run salt marshes.

OBJECTIVES

The purpose of this study is to determine invertebrate population indexes and total yield from the major vegetational types of the Cedar Run marsh evaluation study area.

PROCEDURE

Dr. R. Trout provided the sampling design. It included the stratification of the marsh into major vegetational types. The number of sample stations was

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divided among these types according to the proportion of each type on each transect and the total marsh area. To accomplish this sampling procedure, it was first necessary to obtain wetlands maps from the Division of Marine Resources. Major types were clearly delineated by the aerial photography. However, cover-typing on these maps often combined major types into a mixed category. Field surveys were necessary to delineate these mixed types.

Once the acreages of each types was determined, 100 sampling stations were proportioned among the types according to their percent composition of the total marsh area. Seven transects were distributed across the marsh. Along these transects, squares approximately 0.05 acres in size were laid out and numbered. Using random numbers, squares were selected according to allocation of types and their proportion along transects. Cedar poles were established on the northeast corners of mil-acre plots situated in the middle of the randomly selected squares. Each pole had a metal tag designating the transect and plot number. Invertebrate counts, on a square meter basis, and measurements of vegetational data on species densities and occurrences were conducted on these mil-acre plots in August 1974. When indexes are established for each type, they will be projected to determine yield per acre over the entire marsh.

FINDINGS

Cover Types

Table 1 represents a summary of the vegetational and other types on the Cedar Run marsh evaluation study area. Overall, the area is a mixed short *Spartina alterniflora -Spartina patens* marsh. It is typical of short *S. alterniflora* marshes with a tidal range of approximately 3 to 3.5 feet. It is succeeding to *S. patens*. Such marshes will produce salt marsh mosquitoes (*Aedes sollicitans, Aedes cantator, Culex salinarius,* and *Anopheles bradleyi*). They are also considered as valuable contributors to the tidal flood web (Ferrigno, MacNamara, and Jobbins 1969).

Total acreage of types on the study area from Cedar Run Dock Road to Mill Creek amounted to 1,350.4 acres. The bulk of the 1,038 acre area just north of Mill Creek had been developed into a lagoon community. It is called Beach Haven West and is near Manahawkin, Ocean County, New Jersey.

Short salt marsh cordgrass (*Spartina alterniflora* Loisel) dominated other vegetation and comprised nearly 60 percent of the total composition (Table 1). It was followed by saltmeadow cordgrass (*Spartina patens* Ait.) with 26 percent. Together, these two types totaled 1,157 acres (86%). Other types in order of abundance included salt marsh ponds which usually supported widgeon grass (*Ruppia maritima* L.), marsh elder (*Iva frutescens* L.), tall salt marsh cordgrass (*S. alterniflora*), spike grass (*Distichlis spicata* L.), reed (*Phragmites australis* (Cav.) Trin. ex Steudel.), mosquito ditches, three square (*Scirpus olneyi* Gray), fill, and switchgrass (*Panicum virgatum* L.)

Sampling Stations

The location of each sampling station, transect, and designated type can be determined by consulting Table 2 and Figure 1.

Table 1. Vegetational types on the Cedar Run marsh evaluation study area.

Type	Acres		Number of sampling plots selected per type
	Total	Percent	
Tall, high vigor, salt marsh cordgrass (*Spartina alterniflora*)	23.7	1.8	15
Short, low vigor, salt marsh cordgrass (*Spartina alterniflora*)	809.4	59.9	35
Salt hay or saltmeadow cordgrass (*Spartina patens*)	347.3	25.7	24
Spike grass (*Distichlis spicata*)	22.7	1.7	10
Marsh elder (*Iva frutescens*)	29.2	2.2	4
Reed (*Phragmites australis*)	8.7	0.6	3
Threesquare (*Scirpus olneyi*)	3.0	0.2	2
Switchgrass (*Panicum virgatum*)	1.5	0.1	1
Permanent salt marsh ponds, Widgeon grass (*Ruppia maritima*)	90.6	6.7	0*
Mosquito ditches	7.5	0.6	4
Fill	6.8	0.5	2
Total	1,350.4	100.0	100

* Will be covered by other studies

Table 2. Sampling station numbers and types.

Type	Total number per type	Station numbers (Transect - Number)
Tall *S. alterniflora*	15	E-6, E-10, E-12, E-13, E-14, F-5, F-6, F-7, F-8, F-12, F-15, G-9, H-6, H-11, H-13
Short *S. alterniflora*	35	B-7, B-9, D-1, D-2, D-7, D-8, D-9, E-4, E-5, E-7, E-8, E-9, E-11, E-15, E-16, F-1, F-3, F-4, F-9, F-10, F-11, F-13, F-14, G-3, G-4, G-5, G-7, G-8, G-10, H-3, H-4, H-5, H-7, H-8, H-12
S. patens	24	B-1, B-3, B-10, B-11, B-12, B-13, C-1, C-5, D-5, D-6, D-10, E-1, E-2, E-3, F-2, G-1, G-2, G-6, G-11, G-12, H-1, H-2, H-9, H-10
D. spicata	10	A-4, A-5, A-6, A-7, B-4, C-3, C-4, C-6, D-3, D-4
I. frutescens	4	A-8, A-9, B-2, B-6
P. australis	3	A-10, A-11, A-12
S. olneyi	2	A-1, A-3
P. virgatum	1	A-2
Mosquito ditches	4	B-5, B-8, C-2, C-7
Fill	2	I-1, I-2
Total	100	

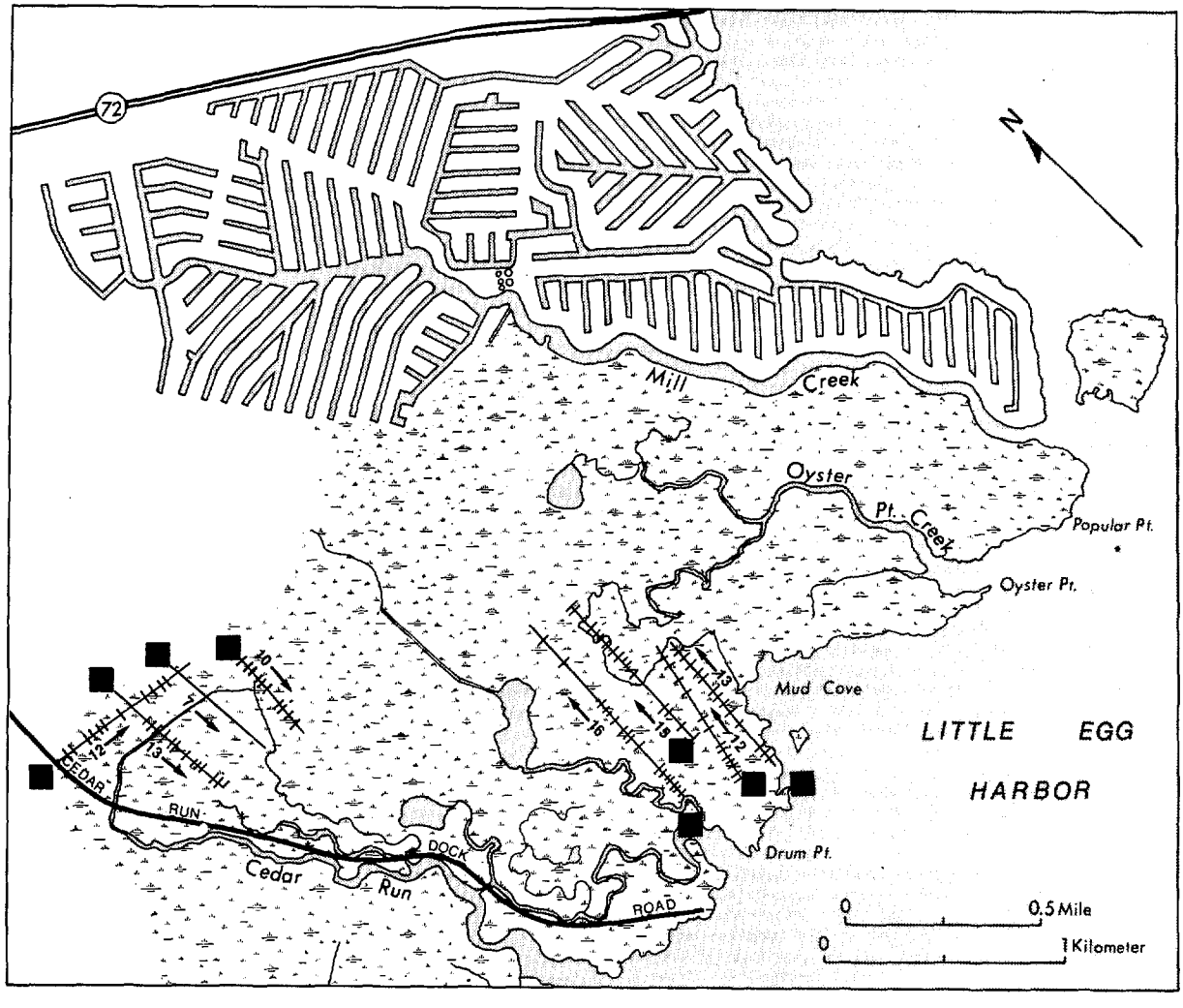

Fig. 1. Location: Marsh sampling plots.

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6. MARSH PRODUCTIVITY: SURFACE INVERTEBRATE POPULATION INDICES

J. Richard Trout[1]

SUMMARY

Due to the inherently high variability of the data collected, only that data collected in salt hay and short cordgrass have good precision. Means and standard deviations were prepared for each marsh organism in relation to the type of vegetation it was associated with.

BACKGROUND

During August 1974, an experiment was conducted by Ferrigno (1975) to study the invertebrate population on the Cedar Run marshes. Before the experiment was commenced, the number of acres of each vegetation type was established. Sampling stations (100) were allotted to the different vegetation types according to their presence in the marsh area. A summary of the vegetation types and sampling effort may be found in Appendix A. Further details of the experimental procedure may be found in Ferrigno (1974). The data collected from this experiment was transmitted by Ferrigno to Rutgers University in March 1975 for the purpose of statistical analysis. A summary of the invertebrate species found on the marsh study area and the data collected is displayed in Appendices B and C, respectively.

OBJECTIVES

The objective of the statistical analysis was to obtain point and interval estimates of the population size of the various invertebrate species in the different vegetation types on the Cedar Run marshes. Additionally, it was of interest to obtain population estimates of the total number of individuals within each of the cover types as well as an estimate of the population size of each of the invertebrate species on the study area.

PROCEDURES

Before an estimate of the population size could be made, it was of interest to obtain some information concerning the statistical distribution associated with the data. For example, if the data follow a normal distribution, then many well-known techniques exist to estimate the population size. If, however, the data is not normally distributed, these techniques may not be appropriate and it would be necessary to implement alternate procedures.

As will be shown in the "Results" section of this report, the indications are that the data collected in this study are not normally distributed. Under these conditions, an unbiased estimate of the mean of the distribution may be

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obtained using the sample mean, (Cochran 1963). That is if X_{ijk} is the count for the kth sample for invertebrate species i on vegetation type j then

$$\overline{X}_{ij} = \sum_{k=1}^{n_{ij}} \overline{X}_{ijk} \tag{1}$$

may be used to estimate μ_{ij} which is the mean number of individuals for species i on vegetation type j. The corresponding variance, σ_{ij}^2, may be estimated by S_{ij}^2 where

$$S_{ij}^2 = \frac{\sum_{k=1}^{n_{ij}} (X_{ijk} - \overline{X}_{ij})^2}{n_{ij} - 1} \tag{2}$$

A problem arises in the establishment of a confidence interval for μ_{ij} due to the lack of normality in the distribution of the counts. Attempts were made to classify the statistical distribution but, as will be discussed in a later section, no definite conclusions could be made. It is known, however, that, for relatively large samples, $\overline{X}_{ij}$ is distributed approximately as a normal distribution. Under these conditions, the end points of the $(1-\alpha)$ confidence interval may be obtained as follows.

Upper Limit for $\mu_{ij} = UL_{ij}$

$$= \overline{X}_{ij} + t_\alpha \left(\frac{S_{ij}^2}{n_{ij}}\right)^{1/2} \tag{3}$$

Lower Limit for $\mu_{ij} = LL_{ij}$

$$= \overline{X}_{ij} - t_\alpha \left(\frac{S_{ij}^2}{n_{ij}}\right)^{1/2}$$

where t_α is the Student's t - value associated with the $(1-\alpha)$ probability level and degrees of freedom equal to $(n_{ij} - 1)$.

The results shown in equations (1) and (3) may be used to obtain point and interval estimates of the number of individuals of a particular invertebrate species on a given cover type in the entire study area. This may be accomplished as follows.

If there are C_j square meters of cover type j and if from equation (1) $\overline{X}_{ij}$ is an estimate of the average number of individuals of species i on cover type j, then

$$I_{ij} = C_j \overline{X}_{ij} \tag{4}$$

where I_{ij} is an estimate of the total number of individuals of species i on cover type j. In addition, an estimate of the total number of individuals of species

i, call it P_i, on the study area is

$$P_i = \sum_j I_{ij} \tag{5}$$

An estimate of the total number of individuals on cover type j, call it V_j, is

$$V_j = \sum_i I_{ij} \tag{6}$$

Finally, an estimate of the total number of individuals on the entire study area, call it T, is

$$T = \sum_i \sum_j I_{ij} \tag{7}$$

For the estimates shown in equations (4), (5), (6), and (7), the standard deviation may be obtained as follows:

$$SE\ (I_{ij}) = C_j\ (S_{ij}^2/n_{ij})^{1/2} \tag{8}$$

$$SE\ (P_i) = (\sum_j C_j^2 S_{ij}^2/n_{ij})^{1/2} \tag{9}$$

$$SE\ (V_j) = C_j\ (\sum_i S_{ij}^2/n_{ij})^{1/2} \tag{10}$$

$$SE\ (T) = (\sum_j C_j \sum_i S_{ij}^2/n_{ij})^{1/2} \tag{11}$$

where S_{ij}^2 was defined in equation (2).

RESULTS

The first step in the analysis of this data concerned itself with establishing whether the variability in the data could be reasonably well approximated by a normal distribution. One approach to examining this question was to make a plot of the mean versus the standard deviation. This plot is shown in Figure 1. If the data follow a normal distribution, then no relationship should be observed in this graph. In Figure 1, a linear relationship is seen which suggests that the data follow a log normal distribution, (Davies 1960). A log transformation of the data, as suggested by Davies (1960) was performed. The resulting plot of the mean against the standard deviation of the transformed data is shown in Figure 2. In this plot, while the strong linear trend observed in Figure 1 is not seen, the pattern of points is still not random. This suggests that the variability in the data cannot be reasonably well approximated by a log normal distribution. Other attempts at classifying the distribution were also unsuccessful and so it was decided that no distributional assumption would be made concerning the variability of the counts. Consequently, no transformation of the data was made and a summary of the means and standard deviations of the original counts is shown in Appendix D.

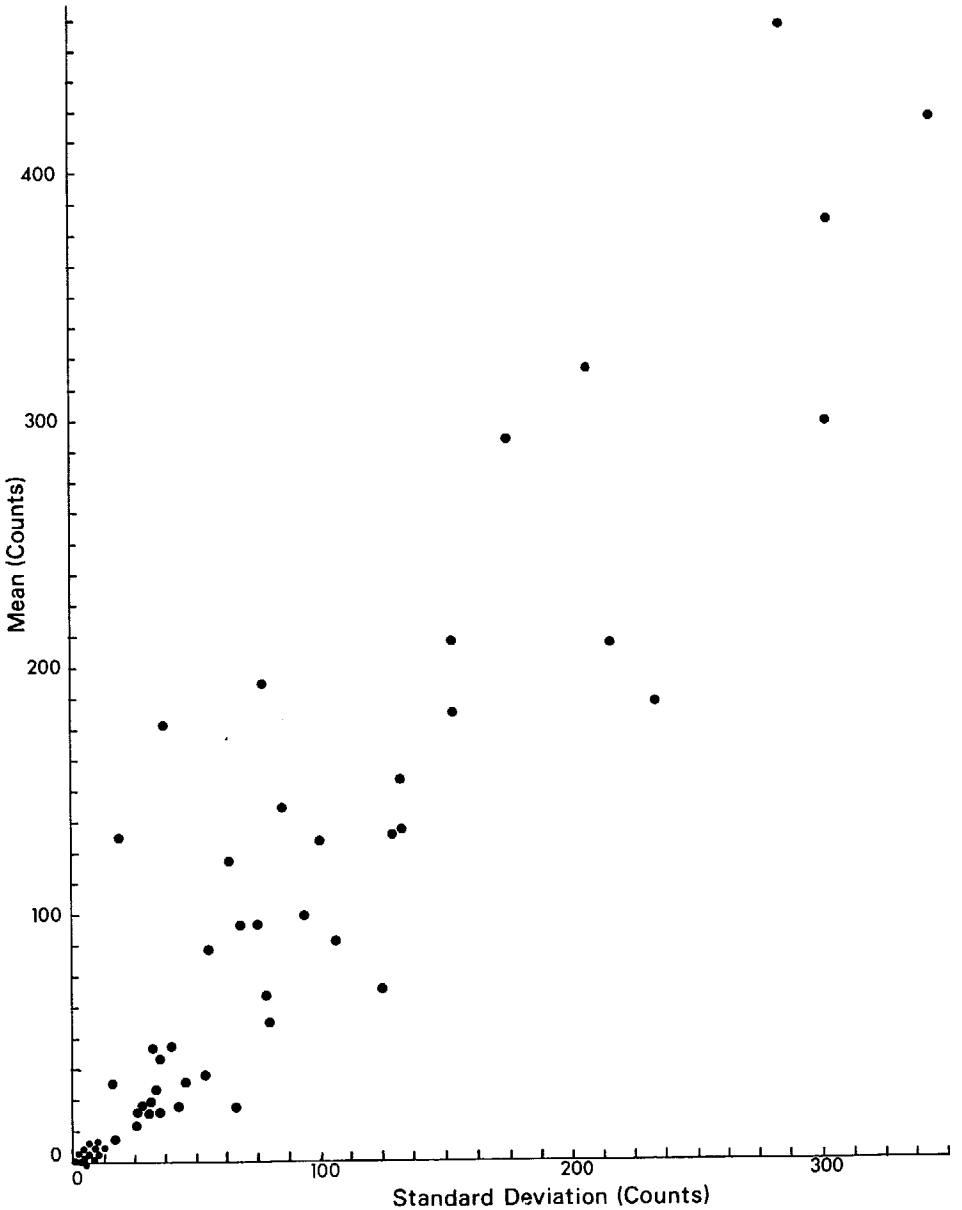

Fig. 1. Plot of the mean versus the standard deviation of the untransformed counts.

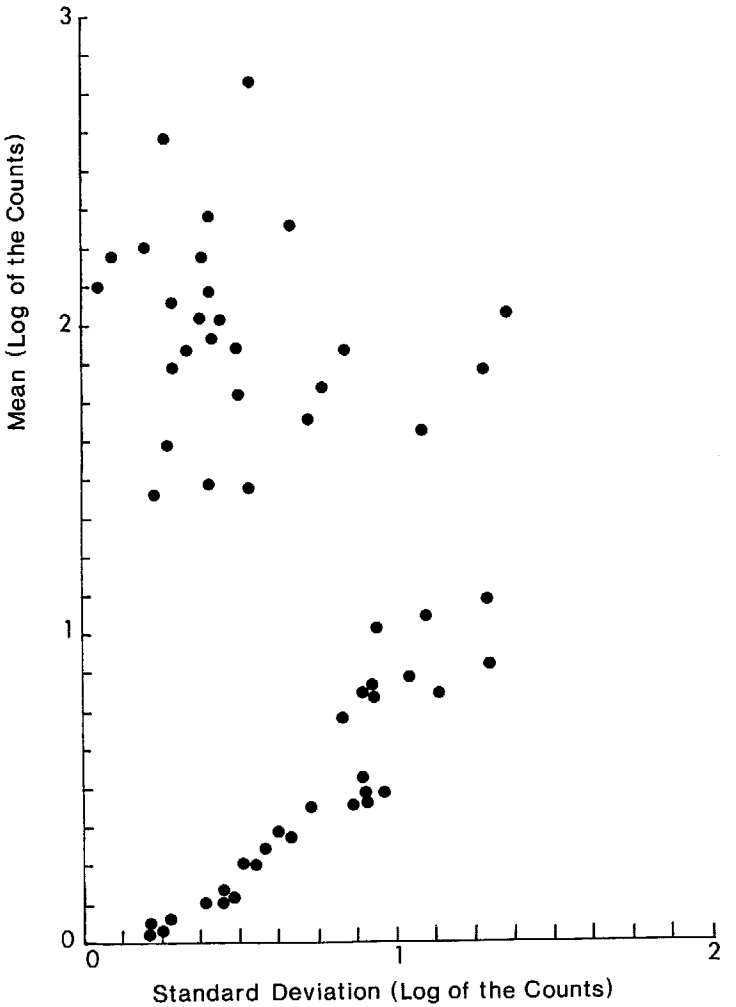

Fig. 2. Plot of the mean versus the standard deviation of the log transformed counts.

Using equations (4) and (8), the mean and the standard deviation were obtained for each of the 11 invertebrate species on each of the 10 cover types on the study area. The results of this analysis are displayed in Table 1.

For vegetation types 5, 8, 9, and 10, it was felt that large enough samples had been collected to allow the distribution of $\bar{X}_{ij}$ to be reasonably well approximated by a normal distribution. This assumption allowed the use of equation (3) to obtain a 95% confidence interval for μ_{ij}. These intervals are shown in Table 2.

The estimates found in Table 1 were then added together to obtain an estimate of the total number of individuals on each cover type as well as an estimate of the total number of individuals for each invertebrate species. The standard deviation of each estimate was obtained by using either equation (9) or (10). The results of this analysis may be found in Table 3 and 4. Finally, the estimates found in Table 3 or Table 4 may be added together to obtain an estimate of the total number of individuals on the entire study area. The standard deviation of this estimate may be obtained with the use of equation (11). These results are shown in both Tables 3 and 4.

CONCLUSIONS

In Tables 1, 3, and 4 it is seen that the variability of many of the estimates is quite large. This is in part attributable to the fact that this type of data is inherently subject to high variability. Additionally, in cover types 1 to 4, 6, and 7 a limited sampling effort was expended resulting in low precision of the invertebrate population estimates. In the remaining four vegetation types, where an increase in the sampling effort was accomplished, the precision in the population estimate is considerably improved. Additionally, the standard deviation associated with the estimate of the total number of individuals in the study area was found to be acceptable. In particular, it is seen that the ratio of the standard deviation to the mean is about 7%. The reason for this relatively good precision is that vegetation types 5 and 10, which contain over 96% of the estimated total number of invertebrates on the study area, received almost 60% of the sampling effort expended in the study. Thus, while some of the vegetation types had low precision, those cover types which contributed heavily to the overall population size in the study area received enough sampling effort to yield acceptable standard deviations for the population estimates.

Table 1. Estimated number of individuals for each vegetation type and invertebrate species found in the Cedar Run marsh study area. Vegetation types and invertebrate species are identified in Appendix A and B.

Vegetation type	Species 1		Species 2		Species 3	
	$\hat{N}$*	SE#	$\hat{N}$	SE	$\hat{N}$	SE
1	395,000	395,000	1,596,000	152,000		
2	211,000	211,000	1,619,000	661,000	4,893,000	2,644,000
3	2,097,000	2,097,000	35,093,000	18,282,000	25,020,000	8,901,000
4	322,000	560,000†	546,000	499,000		
5	213,372,000	37,479,000	170,221,000	22,384,000	657,641,000	82,049,000
6	5,280,000	569,000	4,294,000	1,304,000	11,426,000	4,612,000
7			537,000	537,000		
8	2,800,000	869,000	2,084,000	817,000	17,595,000	5,922,000
9	12,309,000	3,686,000	9,094,000	2,798,000	16,488,000	4,408,000
10	310,771,000	41,554,000	155,703,000	22,399,000	3,395,372,000	426,933,000

Vegetation type	Species 4		Species 5		Species 6	
	$\hat{N}$	SE	$\hat{N}$	SE	$\hat{N}$	SE
1						
2						
3	2,511,000	2,511,000	14,976,000	5,930,000	650,000	650,000
4						
5	937,000	697,000	448,654,000	59,389,000		
6	1,199,000	521,000	12,701,000	5,247,000		
7			2,559,000	1,321,000	812,000	316,000
8	18,432,000	1,888,000	364,000	214,000		
9	156,000	156,000	5,952,000	2,272,000		
10	23,778,000	9,415,000	224,119,000	69,232,000		

Table 1. Continued.

Vegetation type	Species 7 $\hat{N}$	Species 7 SE	Species 8 $\hat{N}$	Species 8 SE	Species 9 $\hat{N}$	Species 9 SE
1						
2						
3	1,507,000	1,507,000				
4	127,000	50,000				
5			527,000	527,000	4,802,000	3,325,000
6	106,000	106,000	637,000	388,000		
7						
8			8,120,000	1,464,000		
9	312,000	312,000				
10	1,310,000	1,310,000	13,194,000	4,942,000	1,872,000	1,304,000

Vegetation type	Species 10 $\hat{N}$	Species 10 SE	Species 11 $\hat{N}$	Species 11 SE
1				
2				
3				
4				
5	3,921,000	2,236,000	291,783,000	62,496,000
6	501,000	501,000	2,655,000	1,640,000
7				
8			3,344,000	1,361,000
9			2,021,000	1,224,000
10			176,674,000	44,499,000

* $\hat{N}$ is the estimated number of individuals found in the entire study area for indicated invertebrate species and vegetation type combination.

\# SE is the standard error of the estimate, N.

† The standard errors shown for vegetation type 4 are based on the pooled standard deviations associated with the other vegetation types for the indicated invertebrate species.

Table 2. Approximate 95% confidence intervals for the number of individuals for each invertebrate species and selected vegetation type found in the Cedar Run marsh study area. Invertebrate species and vegetation types are identified in Appendix B and A.

Invertebrate species	Vegetation type 5			Vegetation type 8		
	$\hat{N}$*	LL#	UL†	$\hat{N}$	LL	UL
1	213,372,000	135,828,000	290,916,000	2,800,000	936,000	4,664,000
2	170,221,000	123,909,000	216,533,000	2,084,000	332,000	3,836,000
3	657,641,000	487,881,000	827,400,000	17,595,000	4,892,000	30,298,000
4	937,000	0,000	2,379,000	18,432,000	14,382,000	22,482,000
5	448,654,000	325,778,000	571,530,000	364,000	0,000	823,000
6						
7						
8	527,000	0,000	1,617,000	8,120,000	4,980,000	11,260,000
9	4,802,000	0,000	11,681,000			
10	3,921,000	0,000	8,547,000			
11	291,783,000	162,479,000	421,087,000	3,344,000	425,000	6,263,000

Invertebrate species	Vegetation type 9			Vegetation type 10		
	$\hat{N}$	LL	UL	$\hat{N}$	LL	UL
1	12,309,000	3,971,000	20,647,000	310,771,000	226,333,000	395,209,000
2	9,094,000	2,765,000	15,423,000	155,703,000	110,188,000	201,218,000
3	16,488,000	6,517,000	26,459,000	3,395,372,000	2,527,844,000	4,262,900,000
4	156,000	0,000	509,000	23,778,000	4,647,000	42,909,000
5	5,952,000	813,000	11,091,000	224,119,000	83,440,000	364,798,000
6						
7	312,000	0,000	1,018,000	1,310,000	0,000	3,972,000
8				13,194,000	3,152,000	23,236,000
9				1,872,000	0,000	4,522,000
10						
11	2,021,000	0,000	4,790,000	176,674,000	86,252,000	267,096,000

Table 2. Continued.

* $\hat{N}$ is the estimated number of individuals found in the entire study area for the indicated invertebrate species and vegetation type combination.

\# LL is the lower limit of the 95% confidence interval.

† UL is the upper limit of the 95% confidence interval.

Table 3. Estimated number of invertebrates for each vegetation type in the Cedar Run marsh study area. Vegetation types are identified in Appendix A.

Vegetation type	Estimated number of invertebrates	Standard deviation of estimate
1	1,991,000	423,000
2	6,723,000	2,734,000
3	81,854,000	21,495,000
4	995,000	752,000
5	1,791,858,000	126,836,000
6	38,799,000	7,362,000
7	3,908,000	1,461,000
8	52,739,000	6,641,000
9	46,332,000	6,901,000
10	4,302,793,000	437,481,000
Total	6,327,992,000	456,175,000

Table 4. Estimated number of invertebrates for each invertebrate species found in the Cedar Run marsh study area. Invertebrate species are identified in Appendix B.

Invertebrate species	Estimated number of invertebrate	Standard deviation of estimate
1	547,557,000	56,134,000
2	380,787,000	36,718,000
3	4,128,435,000	434,932,000
4	47,013,000	9,965,000
5	709,325,000	91,596,000
6	1,462,000	723,000
7	3,362,000	2,024,000
8	22,478,000	5,196,000
9	6,674,000	3,572,000
10	4,422,000	2,291,000
11	476,477,000	76,759,000
Total	6,327,992,000	456,175,000

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APPENDIX A

Vegetation types on the Cedar Run marsh study area.

Vegetation number	Vegetation type	Acres Total	Acres Percent	Number of sampling plots
1	Threesquare (*Scirpus olneyi*)	3.0	0.2	2
2	Reed (*Phragmites australis*)	8.7	0.6	3
3	Marsh elder (*Iva frutescens*)	29.2	2.2	4
4	Switchgrass (*Panicum virgatum*)	1.5	0.1	1
5	Salt hay or saltmeadow cordgrass (*Spartina patens*)	347.3	25.7	24
6	Mosquito ditches	7.5	0.6	4
7	Fill	6.8	0.5	2
8	Tall, high vigor, salt marsh cordgrass (*Spartina alterniflora*)	23.7	1.8	15
9	Spike grass (*Distichlis spicata*)	22.7	1.7	10
10	Short, low vigor, salt marsh cordgrass (*Spartina alterniflora*)	809.4	59.9	35
11	Permanent salt marsh ponds, Widgeon grass (*Ruppia maritima*)	90.6	6.7	0*
Total		1,350.4	100.0	100

* To be considered in other studies and will not be further mentioned in this analysis.

APPENDIX B

Invertebrate organisms caught on the Cedar Run marsh study area.

Species number	Order	Organism family	Genus	Species
1	Homoptera	Cicadellidae	(leaf-hoppers)	
2	Araneida	Lycosidae	(spiders)	
3	Basommatophora	Ellobiidae	*Melampus*	*bidentatus*
4	Decapoda	Ocypodidae	*Uca*	*pugnax*
5	Isopoda	Oniscidae	*Philoscia*	*vittata*
6	Hymenoptera	Formicidae	(ants)	
7	Hemiptera		(bugs)	
8	Prionodesmacea	Mytilidae	*Modiolus*	*demissus*
9	Orthoptera	Locustidae	(grasshoppers)	
10	Orthoptera	Gryllidae	(crickets)	
11	Amphipoda	Orchestiidae	*Orchestia*	*palustris* and *grillus*

APPENDIX C

Number of invertebrates collected on the Cedar Run marsh study area.

Vegetation type	Plot no.	Invertebrate species										
		1	2	3	4	5	6	7	8	9	10	11
1	A-2	0	144	*								
	A-8	65	119									
2	A-10	0	83	288								
	A-11	0	22	81								
	A-12	18	33	48								
3	A-5	0	0	150	0	239	0	51				
	B-2	0	667	55	85	0	0	0				
	B-6	0	433	410	0	161	22	0				
	B-9	71	88	232	0	107	0	0				
4	A-1	53	90					21				
5	B-1	131	189	381	0	222			0	43	30	0
	B-4	99	52	143	0	175			0	39	19	0
	B-10	277	119	1,222	0	120			0	0	0	54
	B-11	228	188	253	0	38			0	0	0	51
	B-12	201	269	632	0	537			0	0	0	66
	B-13	605	198	452	0	431			0	0	0	257
	C-1	306	158	729	5	431			0	0	0	143
	C-5	65	32	98	0	18			0	0	0	10
	D-5	106	52	966	0	477			0	0	0	121
	D-6	30	44	832	0	380			0	0	0	175
	D-10	32	69	800	0	118			0	0	0	218
	E-1	238	71	453	0	55			9	0	0	113
	E-2	132	93	521	0	201			0	0	18	938
	E-3	48	82	238	0	395			0	0	0	57
	F-2	55	0	184	0	696			0	0	0	36
	G-1	153	108	475	0	709			0	0	0	418
	G-2	54	228	326	0	438			0	0	0	418
	G-6	194	237	391	0	218			0	0	0	333
	G-11	97	205	331	0	297			0	0	0	299
	G-12	166	213	304	0	501			0	0	0	377
	H-1	137	91	178	0	219			0	0	0	318
	H-2	271	137	246	0	372			0	0	0	488
	H-9	14	35	339	0	33			0	0	0	93
	H-10	5	37	737	11	581			0	0	0	0
6	B-5	197	247	22	15	0		0	0		66	0
	B-8	135	97	231	11	497		14	0		0	0
	C-2	214	171	575	47	833		0	52		0	128
	C-7	150	51	678	85	344		0	32		0	222
7	I-1		0			141	18					
	I-2		39			45	41					

Vegetation type	Plot no.	Invertebrate species										
		1	2	3	4	5	6	7	8	9	10	11
8	E-6	35	0	594	163	0			19			48
	E-10	0	111	350	238	0			88			179
	E-12	0	0	63	158	10			233			31
	E-13	0	0	21	202	0			89			0
	E-14	0	0	56	72	0			187			0
	F-5	55	0	270	148	0			66			0
	F-6	0	23	0	251	0			39			0
	F-7	0	0	18	160	0			29			0
	F-8	98	0	63	315	0			42			20
	F-12	77	63	444	51	29			125			59
	F-15	51	27	735	197	0			56			138
	G-9	0	24	14	159	0			96			48
	H-6	51	63	22	327	0			80			0
	H-11	0	0	17	233	18			38			0
	H-13	71	15	85	209	0			83			0
9	A-3	42	0	384	0	0		0				60
	A-4	79	91	110	0	0		0				0
	A-6	394	176	29	0	197		0				0
	A-7	111	91	66	0	0		0				0
	B-3	51	88	157	0	183		0				0
	C-3	216	81	289	17	0		0				33
	C-4	108	101	473	0	101		34				127
	C-6	295	330	141	0	66		0				0
	D-3	18	21	107	0	0		0				0
	D-4	26	11	39	0	101		0				0
10	B-7	158	51	1,288	0	0		0	0	10		0
	B-9	193	173	1,671	7	0		0	0	10		0
	D-1	108	52	149	0	44		0	0	0		34
	D-2	62	27	85	0	0		0	0	0		0
	D-7	10	22	544	0	0		0	0	0		0
	D-8	18	5	209	0	0		0	14	0		0
	D-9	21	52	730	0	18		0	15	0		0
	E-4	244	28	35	9	0		0	0	0		0
	E-5	0	36	1,893	0	0		0	0	0		0
	E-7	18	27	1,923	46	344		0	14	0		181
	E-8	53	21	1,455	0	198		0	0	0		73
	E-9	127	31	1,022	0	541		0	0	0		49
	E-11	66	14	75	0	18		0	0	0		0
	E-15	225	57	932	0	0		0	0	0		108
	E-16	103	117	178	0	202		0	0	0		63
	F-1	57	0	1,184	0	88		0	0	0		120
	F-3	32	0	96	28	97		0	0	0		15
	F-4	17	0	103	14	0		0	24	0		0

Vegetation type	Plot no.	Invertebrate species										
		1	2	3	4	5	6	7	8	9	10	11
10	F-9	237	121	435	0	0		0	0	0		0
	F-10	46	63	29	0	0		0	0	0		0
	F-11	99	41	1,751	0	0		0	0	0		5
	F-13	30	41	1,534	0	0		0	0	0		0
	F-14	21	75	1,688	0	37		0	0	0		236
	G-3	215	81	1,212	0	0		0	0	0		188
	G-4	39	18	2,497	0	295		0	0	0		91
	G-5	150	108	1,291	0	0		0	28	0		44
	G-7	161	100	642	33	0		0	0	0		166
	G-8	77	56	2,181	82	18		0	0	0		23
	G-10	113	18	1,074	0	121		0	0	0		335
	H-3	221	66	2,831	0	0		14	12	0		0
	H-4	11	10	1,548	21	0		0	0	0		33
	H-5	140	91	420	0	0		0	0	0		25
	H-6	136	41	1,487	14	0		0	34	0		0
	H-8	30	10	511	0	111		0	0	0		23
	H-12	83	11	1,581	0	163		0	0	0		76

*When no information is displayed, this indicates that no individuals were collected for that particular invertebrate species on any of the plots for the indicated vegetation type.

APPENDIX D

Mean and standard deviation of the number of individuals per square meter for each invertebrate species and vegetation type combination found in the Cedar Run marsh study area.

Vegetation type	Species 1 Mean	Species 1 SD	Species 2 Mean	Species 2 SD	Species 3 Mean	Species 3 SD	Species 4 Mean	Species 4 SD
1	32.5	45.9	131.5	17.6				
2	6.0	10.3	46.0	32.5	139.0	130.0		
3	17.7	35.5	297.0	309.4	211.7	150.6	21.2	42.5
4	53.0	*	90.0					
5	151.8	130.6	121.1	78.0	467.9	286.0	0.6	2.4
6	174.0	37.5	141.5	85.9	376.5	303.9	39.5	34.3
7	#		19.5	27.5				
8	29.2	35.0	21.7	32.9	183.4	239.1	192.2	76.2
9	134.0	126.9	99.0	96.3	179.5	151.7	1.7	5.3
10	94.8	75.0	47.5	40.4	1036.6	771.1	7.2	17.0

Vegetation type	Species 5 Mean	Species 5 SD	Species 6 Mean	Species 6 SD	Species 7 Mean	Species 7 SD	Species 8 Mean	Species 8 SD
1								
2								
3	126.7	100.3	5.5	11.0	12.7	25.5		
4					21.0			
5	319.2	207.0					0.3	1.8
6	418.5	345.7			3.5	7.0	21.0	25.5
7	93.0	67.8	29.5	16.2				
8	3.8	8.6					84.6	59.1
9	64.8	78.2			3.4	10.7		
10	68.4	125.0			0.4	2.3	4.0	8.9

Vegetation type	Species 9 Mean	Species 9 SD	Species 10 Mean	Species 10 SD	Species 11 Mean	Species 11 SD
1						
2						
3						
4						
5	3.4	11.5	2.8	7.7	207.6	217.8
6			16.5	33.0	87.5	108.0
7						
8					34.8	54.9
9					22.0	42.1
10	0.5	2.3			53.9	80.3

* No standard deviation can be computed as only one observation was collected in this vegetation type.

\# A blank indicates that no individuals of the particular species were found in the indicated vegetation type.