ENERGY RELATIONSHIPS AND THE PRODUCTIVITY OF APALACHICOLA BAY

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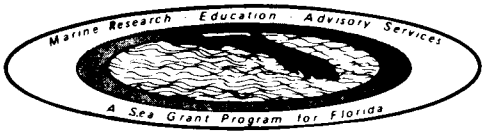

Florida Sea Grant
Technical Paper

ENERGY RELATIONSHIPS AND THE PRODUCTIVITY OF APALACHICOLA BAY

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Final Report of Project R/EM-4

The information contained in this paper was developed under the auspices of the Florida Sea Grant College Program, with support from the NOAA Office of Sea Grant, U. S. Department of Commerce, grant number 04-6-158-44055. This document is a Technical Paper of the State University System of Florida Sea Grant College Program, 2001 McCarty Hall, University of Florida, Gainesville, FL 32611. Technical Papers are duplicated in limited quantities for specialized audiences requiring rapid access to information, which may be unedited.

June, 1976

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i. Summary of Results

This report respresents an integration of the results of 5 years of study concerning short- and long-term changes in habitat structure, energy relationships, and biotic functions of the Apalachicola Estuary.

Sediment analysis in the bay showed that seasonal variations, proximity to the river, spatial relationships with benthic macrophytes, and upland drainage patterns all influenced the qualitative characteristics of the surface sediments. There was a reduction in grain size and an increase in organic content from the outer portions of Apalachicola Bay to the upper reaches of East Bay. While seasonal variation of water temperature appeared relatively stable from year to year, there was a long-term trend toward reduced salinity which could not be entirely explained in terms of river flow and local rainfall patterns. Seasonal salinity levels were determined by fluctuations of the Apalachicola River, proximity to land runoff, and local rainfall. Winter-spring flooding of the river was associated with reductions in salinity and light transmission, and increases in color, turbidity, and nutrients. Long-term changes in various water quality parameters were noted, and were particularly evident in East Bay. Spatial variability and long-term trends in major physico-chemical variables were thus determined by river flow, local rainfall (land runoff), basin configuration, and various meteorological phenomena.

Apalachicola River discharge was the primary factor controlling nutrient concentration in the Apalachicola Estuary. Nitrates peaked during winter periods of high river flow; phosphates increased during these periods although maxima resulted from episodic wind-mixing of the sediments. Phytoplankton productivity was maximal during spring months. During summer periods, phosphate was the primary nutrient limiting phytoplankton productivity in East Bay and Apalachicola Bay, with nitrates becoming limiting in Apalachicola Bay with less frequency than phosphate. Overall, temperature was a major limiting factor for phytoplankton productivity. Phytoplankton productivity in this estuary was higher than that in other areas along the coast, and was considered to be a major source of organic carbon for various organisms in this area.

A survey of macrodetritus in the Bay showed that there are spatial and temporal patterns of occurrence. During winter-spring periods of increased river flow and upland flooding, leaf matter and wood debris predominate at stations influenced by the river. Such matter comes from flood-plain tree associations including various species of oak, maple, water Tupelo, river birch, sweetgum, and cottenwood. Fall peaks of macrodetritus are dominated by benthic macrophytes such as Gracilaria foliifera, Halodule wrightii, and Ulva lactuca. The annual bimodal distribution of macroparticulates was evident only during years when river flow exceeded certain flow rates, with bay-wide (conservative) estimates approximating 150 tons (dry weight) per month during such periods. Microdetritus (45 μ-2mm) found at the mouth of the Apalachicola River had a similar relationship with river flow; the organic fractions (ash-free dry weight) approximated 900 tons/month during periods of peak river flow. Although functions such as residence time , flushing rates, utilization patterns, etc remain unknown, the general relationship of detritus movement and availability in the bay appears to be closely associated with the seasonally pulsed patterns of river flow and flooding. Micro- and macroparticulate matter reached peak levels only at times when river flooding exceeded 60,000 cubic feet per second. There was thus an association of the presence of particulate matter in the bay with a pulsed river system and periodic flooding of upland flood plain areas.

Preliminary estimates of the total contribution of allochthonous particulate matter to the energy budget of the bay indicate that such detritus is comparable to the phytoplankton productivity as a source of energy.

Methods to assess the mass, activity, and population structure of the estuarine detrital microflora have and are being developed. These methods could provide data with which to initiate correlations between the activities of these heretofore unstudied microbes and the rest of the estuarine food web. The methods were designed to preserve the community associations and interactions with as little selective pressure as possible. Measures of mass such as the muramic acid level, the total phospholipid formed from $H_3{}^{32}PO_4$, and ATP level, correlate with the expected respiratory activity. Measures of growth by pulse chase experiments show correlations between rates of phospholipid synthesis, muramic acid turnover, glycolipid turnover, and saturation of the cardiolipid precusor pool. Initial comparisons show when microbial mass and activity increase, so do the species diversity and numbers of the detrital benthic fauna. Comparison of types of detritus, or between pine needles and teflon mimics of pine needles, show coordination of microbial activities and the benthic food webs. By analysis of the components of the newlyformed lipids, it has been possible to document successional sequences on detrial surfaces that coordinate with scanning electron micrographs. With these and subsequently developed methods, we hope to determine the role of microfloral communities in the trophodynamics of the estuarine food web with special emphasis on controlling external functions such as pollution.

Litter-associated organisms were surveyed in a series of field experiments. This fauna was dominated by isopods, amphipods, and decapods. Preliminary experiments indicated that macrodetritus such as leaf matter may serve as a substrate for shelter and/or microbial accumulation. Numbers of individuals and species and species richness generally increased with increases in salinity at all stations. The allochthonous leaf matter was associated with a distinctive biota which subsequently serves as a source of food for various dominant juvenile fishes in the area.

The benthic infauna in the Apalachicola Bay System was surveyed for seasonal distribution and spatial relationships of biomass, species composition, and community structure. This was dominated by euryhaline and eurythermal crustaceans (Tanaidaceans, amphipods) and polychaete worms which tend to reach peak abundance during late winter and spring months. Many such species, as selective and nonselective deposit feeders, feed on fine detrital matter and, in turn, are fed upon by predacious polychaetes, crustaceans, and benthic fishes. There were considerable differences in biomass distribution in the bay with a range from 0.065 to 56.378 g (ash-free dry weight)/ m^2. The highest such values were found off St. George Island and portions of East Bay in areas associated with grassbeds. Grassbed (Vallisneria americana) productivity was estimated from 322 to 353 $g/m^2/yr$ with standing crops between 500-600 g/m^2 peaking during summer and fall months. Die-offs of such grasses occurred during fall periods of reduced water temperature, and were associated with fall peaks of secondary productivity in the bay. Certain East Bay grassbeds were dominated by the gastropod, Neritina reclivata. Other organisms such as crustaceans and fishes were also represented. Peak animal biomass occurred during spring (March-May) and late fall (November-December) periods, and such changes seemed to be timed in a general way with spring peaks of epibenthic organisms and fall increases in macrophyte-derived detritus.

Long-term (5 year) trends of epibenthic fishes and invertebrates were noted. After the first year, there were regular seasonal patterns of fish abundance, species representation, and community structure. There was a regular succession

of dominant fishes each year (late winter-spring: Micropogon undulatus, Leiostomus xanthurus; summer-fall: Cynoscion arenarius; late fall: Anchoa mitchilli). Three of 4 dominant fish associations were strongly affected by time pulses of river flow. Generally, fish numbers and biomass peaked in spring and fall. During the five-year study period, total numbers of fishes reached a low point during the third year of sampling (3/74-2/75). Invertebrate numbers and biomass usually peaked during spring and fall months. In this case, reduced numbers occurred during the third and fourth years of sampling (3/74-2/76).

Resource (food) partitioning of the dominant juvenile fishes of the Apalachicola Estuary was studied. Anchoa mitchilli fed primarily on copepods (Acartia sp.) during spring and summer. During fall and winter periods, anchovies switched from copepods to epibenthic and benthic organsims such as mysids and insect larvae. Polychaetes formed the basis of the diet of Micropogon undulatus which peaked during winter periods. This species fed primarily on infauna, detritus, shrimp, and juvenile fishes. Leiostomus xanthurus fed on a variety of items including harpacticoid copepods, polychaetes, insect larvae, and bivalves. Cynoscion arenarius fed primarily on fishes (including Anchoa mitchilli) and mysids. A size class analysis indicated trends in intraspecific trophic relationships within a temporal and spatial context. There was efficient partitioning of food resources in the Apalachicola Estuary with each of the dominant species participating in a different trophic spectrum. The various biotic components were linked to a seasonal succession of energy inputs which were related to river flow, detritus influxes, phytoplankton blooms, and benthic macrophyte die-offs. The seasonal river flow pattern, as a major determinant of the physico-chemical environment of the bay, contributed to the seasonal succession of trophic phenomena. These data tend to clarify various aspects of the distinct temporal succession of biota in the Apalachicola Estuary as a function of energy input and physico-chemical limiting functions.

The scientific data generated from this project have been used for various planning and management decisions. This has involved associated projects with Franklin County officials, state and federal agencies, and private concerns such as pulp mill interests and local developers. Personnel of this project have continued to work with the Florida agencies toward identification of environmentally sensitive portions of the system. This has resulted in the $8 million purchase of wetlands along the Lower Apalachicola Valley. More than 28,000 acres have been purchased to date, and Sea Grant information has also been used in purchases of thousands of acres of St. George Island and Little St. George Island.

Sea Grant personnel were also involved in the generation of a published compendium of data on the entire Apalachicola Valley to serve as a basis for further management decisions in this area. In addition, contributions were made to local planning functions including D.R.I. evaluations, water hyacinth control programs, public educational programs, etc. Various educational applications of the data base through newspaper articles and public meetings allowed a translation of key scientific concepts for public consumption. In addition, direct interactions have been made with various federal agencies (Environmental Protection Agency, National Aeronautics and Space Administration, Army Corps of Engineers). This has resulted in the current evaluation by the Office of Coastal Zone Management for designation of the Apalachicola Estuary as an Estuarine Sanctuary. Eventually, through local, state, and federal interactions, a comprehensive plan for the Apalachicola Valley may be developed which can serve as a model for future wetlands planning in other drainage systems. A six county planning group has been established which, with advice from various state agencies, will attempt to develop a set of guidelines for local planning (Zoning ordinances, etc.).

Overall, this Sea Grant project could serve as a catalyst for a basin-wide planning program which would permit orderly development of the Apalachicola Valley while protecting the important natural resources of this area.

V. THESES AND DISSERTATIONS

1. Bechtold, R.E. 1976. A kinetic analysis of leaf litter-associated microbial activity in Apalachicola Bay. Master's Thesis, Florida State University. (White)

2. Bobbie, R.J. 1976. Esterase activities and oxygen uptake of the endogenous microflora associated with three types of litter in a North Florida estuary. Master's Thesis, Florida State University. (White)

3. Duncan, James. 1977. Short-term impact of upland clear-cutting activities on assemblages of epibenthic fishes and invertebrates in East Bay. Master's Thesis, Florida State University. (Livingston)

4. Laughlin, Roger A. 1976. Avoidance of blue crabs (Callinectes sapidus) to storm water runoff. Master's Thesis, Florida State University. (Livingston)

5. McLane, Bradford G. 1977. Effects of clear-cutting on the benthic infauna of the Apalachicola Estuary. Master's Thesis, Florida State University. (Livingston)

6. Myers, Vernon B. 1977. Aspects of nutrient limitation of phytoplankton productivity in the Apalachicola Bay System. Ph.D. Dissertation, Florida State University. (Iverson)

7. Purcell, Bruce. 1977. Effects of stormwater runoff on grassbed assemblages in East Bay. Master's Thesis, Florida State University. (Livingston)

8. Sheridan, Peter F. 1977. Trophic relationships in the dominant juvenile fishes in the Apalachicola Bay System. Ph.D. Dissertation, Florida State University. (Livingston)

INTRODUCTION

There is an established base of published information on the Apalachicola Bay System which will provide the background for this report. Most of the published data in the Apalachicola Drainage System (taken prior to this project) has been reviewed by Livingston et al. (1974). Methods of sampling, together with basic fluctuations of epibenthic fishes and invertebrates in the Apalachicola estuary have been outlined by Livingston (1976). The temporal progression of dominant epibenthic populations has been described by Livingston et al. (1976). The biological associations of this system have been analyzed with respect to biomonitoring procedures (Livingston, 1976) and specific responses of individual populations to key physico-chemical functions (Livingston et al, 1976). A complete list of species taken by various sampling procedures (including benthic infauna, detritus associated organisms, epibenthic fishes and invertebrates, etc.) has been published (Livingston et al., 1977). This includes analyses of major physico-chemical relationships, fluxes of detritus, and a comparison of the natural history of dominant populations of organisms in the Apalachicola estuary with that in other coastal systems of the Gulf of Mexico (Livingston et al., 1977). Livingston et al. (in press) have described long-term changes in pesticide levels and fish associations in the Apalachicola estuary. Myers and Iverson (1977) have described aspects of nutrient limitation of phytoplankton productivity in the Apalachicola estuary. Oesterling (1976, 1977) has indicated general patterns of blue crab migration and the spawning potential for this species in the Apalachicola Bay region. Supporting data concerning other biological associations in the entire Apalachicola Valley are also available (Livingston and Joyce, 1977). Overall, there is a rapidly growing base of published information concerning the physico-chemical and biological relationships in the

Apalachicola Drainage System.

The published data have been supplemented by various unpublished studies and reports concerning a broad range of subjects relevent to the Apalachicola region. This includes the following documents:

"Survey: Chattahoochee-Flint-Apalachicola River System" (Florida State Board of Health, 1962)

"A management program for the oyster resource in Apalachicola Bay, Florida" (C.E. Rockwood et al., 1973)

"Strategy for change: an interim plan for the northwest Florida region" (RMBR Planning/Design group, 1973: for the Northwest Florida Development Council)

"Draft Environmental Statement. Lake Seminole and Jim Woodruff Lock and Dam, Alabama, Florida and Georgia. Operation and Maintenance." (U.S. Army Engineer District, Mobile, Alabama, 1975)

"Apalachicola River Basin Water Quality Management Plan" (Florida Department of Environmental Regulation, 1975)

"Field and laboratory studies concerning the effects of various pollutants on estuarine and coastal organisms with application to the management of the Apalachicola Bay System. (R. J. Livingston and N. P. Thompson: Final report for Florida Sea Grant, 1975)

"Progress Report for Florida Sea Grant: Energy Relationships and the Productivity of Apalachicola Bay." (R. J. Livingston, R. L. Iverson, and D. C. White: Florida State University, 1976)

"The Apalachicola River and Bay System, A Florida Resource" (Florida Department of Administration; Division of State Planning, 1976)

"Final Environmental Statement. Apalachicola-Chattahoochee, and Flint Rivers, Alabama, Florida, and Georgia (Operation and Maintenance)" (U.S. Army Engineer District, Mobile, Alabama, 1976)

"Proposal to Study the Apalachicola-Chattahoochee-Flint River System and Apalachicola Bay" (Northwest Florida Water Management District, 1976)

"A study on the effects of maintenance dredging on selected ecological parameters in the Gulf intracoastal waterway, Apalachicola Bay, Florida" (U.S. Army Engineer District, Mobile, Alabama)

According to the National Estuary Study (Vol. 3, Fish and Wildlife Service, U.S. Department of the Interior, 1970), the total area of the Apalachicola Bay System is 535,600,000 m^2 (131,840 acres) of which 7% is occupied by submerged

vegetation (38,106,000 m^2 or 9,380 acres) and about 14% is emergent (marsh) vegetation (85,000,000 m^2 or 21,300 acres). Oyster beds account for about 24,374,840 m^2 or 4.6% of the total bay (Rockwood et al., 1973). Mean depth approximates 2.7 m while the total volume is about 1,446,120,000 m^3. This project was designed to study various aspects of the energy system in the Apalachicola Estuary. The following objectives were part of the program.

1. Determination of the river derived input of organic plant nutrients, and particulate and dissolved organic carbon into the bay system.

2. Analysis of phytoplankton assemblages and phytoplankton productivity of the Apalachicola Bay System.

3. Determination of the role of phytoplankton productivity in the overall energy budget of the bay, including nutrient limitation studies of key driving functions.

4. Analyses of the significance, source, and role of allochthonous and autochtonous forms of detritus in the Bay including a preliminary evaluation of the role of microorganisms in detrital breakdown and energy transfer.

5. Continuation of the application of scientific data for the development of a management program for the Apalachicola Drainage System.

As an outgrowth of the original program, a long-term impact analysis is being carried out to determine the potential influence of clearcutting practices in the Tate's Hell Swamp on the Apalachicola Bay System. Preliminary observations will be made concerning these data preparatory to the completion of the first stage of this project in December, 1977. In some instances, data analysis will be carried out within the context of the full 5-year data base which dates back to March, 1972.

This report represents a preliminary analysis of the data base. This will be followed by a more sophisticated review of the data base for publication in a series of scientific papers.

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Oesterling, M. J. and G. L. Evink. (in press). Relationship Between Florida's Blue Crab Population and Apalachicola Bay. In, Proceedings of the Conference on the Apalachicola Drainage System. Fla. Mar. Res. Publ., in press (eds. R. J. Livingston and E. A. Joyce, Jr.).

II. Special Program for Ecological Science (SPECS): Summary of Capabilities *

I. Data Storage

A. Physical-chemical data (by area, station, date, time of day, and depth)
   . dissolved oxygen, color, turbidity, Secchi disk depth, temperature, salinity, pH, river flow, rainfall, bottom type
B. Fish and invertebrate data (by area, station, date, and time of day)
   . genus and species, number of individuals, mean size (with standard deviation), biomass (ash free dry wet.), sex (invertebrates only)
C. Plant data (by area, station, date, and time of day)
   . genus and species, total wet and dry weight, stems and roots (wet and dry weight), tops (wet and dry weight)

II. Data Processing

A. Retrieval
   . for any area, station or group of stations, date or range of dates
B. Sorting
   . by area, date, station, time of day, or any combination of these
   . biological data sorted by species
C. Calculation of biological indices (Based on numbers of individuals or biomass per species for any area, station or group of stations, date or range of dates, or time of day)
   . Species Richness (Number of species, Margalef Index)
   Species diversity (Simpson Index, Brillouin Index, Shannon Index, McIntosh/indices, Hurlbert's E (S_n))
   Species equitability (Brillouin J, Shannon J')
D. Graphics (for any area, station or group of stations, range of dates, or time of day) : plotted as a function of time.
   . all physical chemical variables
   . fish and invertebrates
      1) number of individuals (single species or collective total)
      2) average size
      3) dry weight biomass (single species or collective total)
      4) number of species
   . plants
      1) dry weight biomass(single species or collective total)
      2) number of species
   . any of the biological indices (see "C" above)
E. Statistics (for virtually any set(s) of numbers that can be generated by any other routine in the system)
   . linear regression, Student's t-tests, nonparametric correlations, discriminant analysis, factor analysis, scattergrams, analysis of variance (one, two, and three-way), multivariate ANOVA, canonical correlation, etc.

* This portion of the report has been carried out with support from the U.S Environmental Protection Agency (number R-803339).

F. Cluster analysis
   - . cluster by species, station, or time
   - . total flexibility in how species, stations, and dates are grouped prior to analysis
   - . selection of similarity index from among Orloci's standard distance, product moment correlation, Fager, Jaccard, Sorenson's, Webb, Kendall, Cyekanowski, Canberra metric , C-lambda, rho, and tau
   - . selection of clustering strategy from among unweighted pair group (grp avg), weighted pair (centroid) grouping, nearest neighbor grouping, furthest neighbor grouping, median grouping, and flexible grouping (with beta)

G. Dendrogram
   - . for any output from cluster analysis
   - . three scales available

H. Faunal summary (for any area, station or group of stations, range of dates, and times of day)
   - . number of individuals or dry weight biomass by species, month, and year

I. C-lambda (for any area, station or group of stations, date or range of dates, and times of day)

J. Mapping
   - . physical-chemical data, fish or invertebrate species population totals mapped for all stations in study areas (by month)

K. Data base update
   - . modification of any field in a data base record or records
   - . deletion of data records

Special Program for Ecological Science (SPECS): System Overview

I. Introduction

Long-term field studies in which diverse habitats are regularly sampled for a variety of organisms and physical-chemical factors are associated with the accumulation of large amounts of data. Organization and presentation of such data in a useful form has been aided significantly by modern high-speed computers.

At Florida State, we have designed and developed a computer software system specifically for use with long-term biological data. Primary design criteria have been storage of a large data base, retrieval of virtually any subset of the data, and rapid access to a diverse group of biological, statistical, and graphical data reduction and analysis capabilities.

The SPECS system has been written mostly in the FORTRAN programminng language. A few subroutines are written in the Control Data Corporation (CDC) COMPASS assembly language. SPECS operates on a CDC 6500 or CYBER 73 computer under the KRONOS operating system.

II. Organization of the System

A. Data Storage.

Field data on physical-chemical parameters and fish, invertebrate, and plant populations are assembled and punched on standard 80-column cards. As the formats for each type of data are slightly different, a set of four card-deck programs have been developed to add raw data to a data base tape.

Two data base tapes are maintained, each with four files (one each for the four types of data). When a card-deck program is executed the old data base tape is read, the appropriate file is updated with raw data information, and all information is copied to the new data base tape (see figure1). For a subsequent addition of data, the data base tapes reverse roles. During addition of fish and invertebrate data, mean standard lengths, standard deviation of lengths, and dry weight biomass are calculated and added to the data base. For a repetitive samples data base figures represent sums of the overall samples.

Card-deck programs also copy raw data information to a raw data tape. This tape is thus a backup for all card information and is not in data base format.

B. Data Processing.

User Programs

All user programs, precedure files (predefined sets of oft-used operating system commands), program libraries, and active data files reside on computer center disk packs (for rapid access). Most of the SPECS system is stored as a single file on one of these disks.

B. Data Processing. (continued)

This file contains one large program which has been structured in an overlay format. There is one main overlay and nine secondary overlays. Secondary overlays perform the majority of system functions, such as loading data, sorting, calculating biological indices, preparing for graphics and statistics, etc. The main overlay simply fields a SPECS system command and calls for the loading of a secondary overlay. Thus only two overlays are require in computer core storage at any one time - the main overlay and one of the secondary overlays.

Library Programs

The F.S.U. Computer Center program library contains many routines accessed by the SPECS system. Among these are the Statistical Package for Social Science (SPSS), the FSU plotting package, a mapping package (SYMAP), and a SORT/MERGE routine. The function of some SPECS secondary overlays is therefore to prepare data base information for input to these higher level routines.

III. Operation of the System

With the exception of programs in the data storage card decks, all programs in the system are designed to be operated from a remote teletype or CRT terminal. System operation is interactive in that there is two-way communication between the user and the program. The user guides the program through each step of analysis by entering commands or other information in response to questions displayed by the program.

A. Terminal session.

A terminal session with the SPECS system begins with a user call of the INIT (initiate) procedure file. This procedure first asks the user for the location of the data to be used in this run(possibly a data base tape or an active data file). It then gets the SPECS program and initiates its execution.

The main overlay of SPECS writes a "COMMAND?" message to the terminal screen. In response the user enters a SPECS system command. The LOAD (retrieve) and SORT commands are used to create an active data file from a data base tape. If the user began this run with an active data file (created in a previous run), the LOAD and SORT commands are not needed. Once an active data file is available for use the user selects from among a group of commands that initiate execution of secondary overlays which perform analyses of active data. A summary of these commands and the operations performed is presented in Table 1.

Following execution of a secondary overlay, the main overlay is calledand the "COMMAND?" message is again printed at the terminal. At this point the user may wish to load more data (create an additional active data file), request another type of analysis on the same data file, or terminate SPECS system operation. When system operation is

ended file disposition is under user control. Printer output files created during SPECS operation may be listed on a line printer. Active data files or other intermediate files may be saved if they will be used again in the near future. This is especially valuable if an important file has taken a long time to generate (that time need not be invested again, for the file may be kept indefinitely).

This allows a person with limited computer background to use an interactive computer system with immediate access to a broad-based data file containing diverse forms of information. Using the various options, this facilitates a rapid, relatively inexpensive yet comprehensive analysis with great flexibility regarding access to data and forms of analysis. All operations are carried out at the terminal, and new options can be added easily in addition to routine periodic updates of the data base. This gives the biologist the use of a sophisticated computerized software system as a research tool.

IV. SUMMARY

The SPECS system consists of a collection of programs written expressly for the storage, retrieval, and analysis of long-term ecological data. It provides a wide range of analytic approaches and data reduction capabilities. Some programs perform direct calculations or data manipulations while others serve as interface programs which prepare data for higher level (and widely available) program packages.

The system is operated from a remote computer terminal or teletype, from which the user supervises program execution in a step-by-step manner. Operation is interactive in that the program prompts the user for informational input required before each step is executed. Output consists of terminal display, printed listing, and electrostatic plots. Theorizing(the fun part) is left to the user.

Table 1 - Summary of SPECS commands and functions of corresponding secondary overlays

Command	Overlay function
LOAD	Forms active data file by retrieving data by data base file, area, station (or group of stations, and date (or range of dates)
SORT	Sorts active data file by area, date, station, and time of day (and species, if biological data)
CALC	Computes ten separate diversity, evenness, and richness indices for every combination of area, station, date, and time of day present in active data file. Output written to file suitable for printing.
GRAPH	Prepares for time-based plots of virtually any subset of data base information. Requested data is extracted from active data file. A procedure file is called which executes a graphics interface program (prepares data for FSU Plotting package), then executes the plotting package. Output may be displayed on terminal screen or plotted on a Gould electrostatic plotter.
SPSS	Extracts requested data from active data file, prepares on SPSS control card file, and executes SPSS (via a procedure file). Output placed on a file suitable for printing.
CLUST	Performs cluster analysis on data in active date file. User selects from 10 similarity indices and 6 clustering strategies. Clusters are based on species, stations, and time. Any one or all may be collapsed to any desired degree, allowing great flexibility in grouping of data prior to analysis. Output is on two files, one for printing and one for input to dendrogram program.
DENDO	Calls procedure file which executes dendrogram drawing program.
SUMRY	Prepares time-based summaries of fish or invertebrate data in active data file. For each species, monthly and yearly catch (and per cent of total catch) are presented for number of individuals or dry weight biomass. Output on file suitable for printing.
CLAMB	Computes the C-lambda faunal affinity index for combinations of stations and dates found in the active data file. Output on file suitable for printing.
UPDAT	Provides for user editing of a data base file. User enters commands to modify or delete data base records when error conditions require correction.

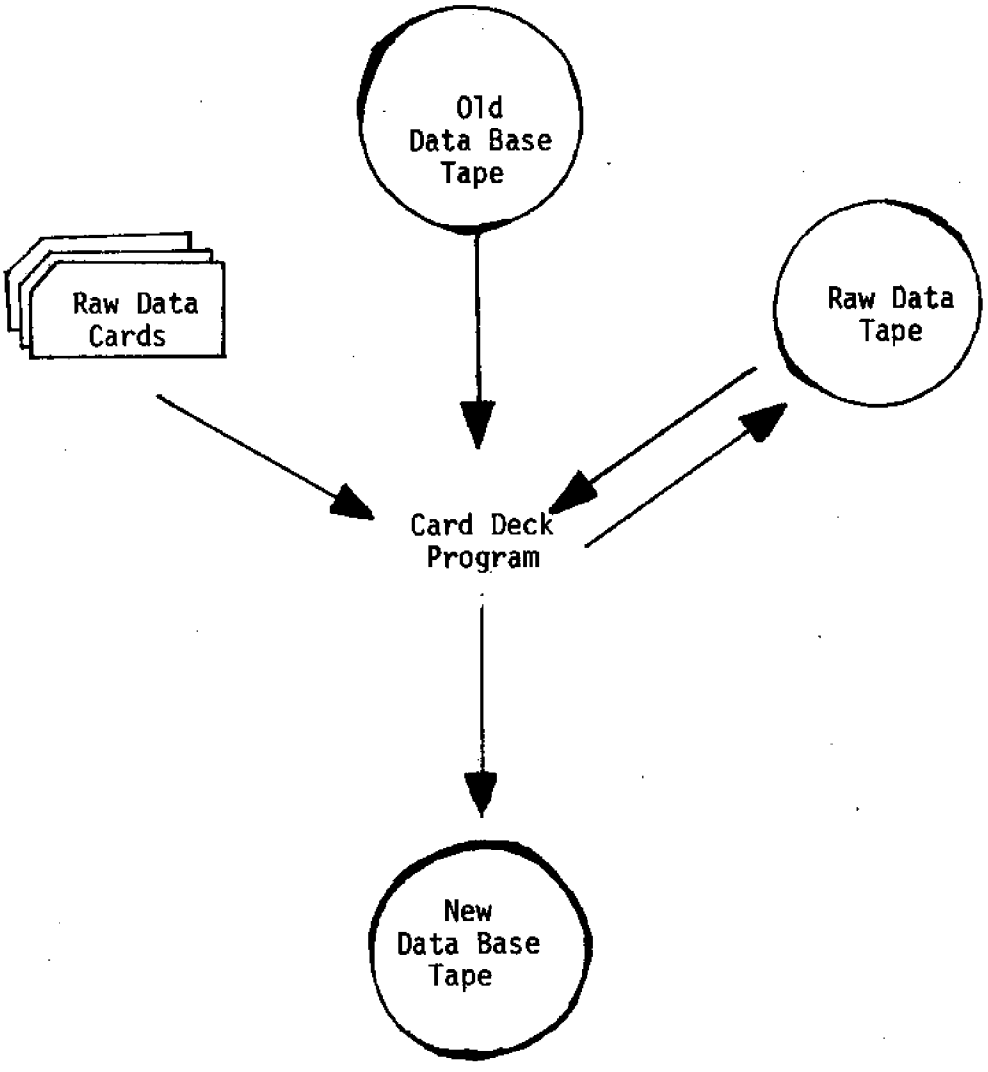

Figure 1 - SPECS Data Storage Procedure

III. Biomass transformations

Because of the volume and diversity of field collections in this and other Bay systems (i.e., Apalachee Bay, the Econfina and Fenholloway drainage systems) presently under study by our group, the method of analysis for biomass determinations was standardized for each species. This allowed the computerized conversion of number/length data into dry weight or ash-free dry weight figures after a determination of a regression formula based on empirical information. Whenever possible, various individuals for a given species (representing a normal range of size variation) were counted, measured, and weighed for such analysis. Species which did not have any real variation in size were simply counted and weighed for a computation of mean weight per individual. Those species which were too rare for such analysis were assigned figures from the more common species. Species pairing was achieved subjectively based on configurational and/or taxonomic similarity.

In this way, a regression equation or a conversion factor (based on weight per individual) was computed for each species taken in the survey. A biomass file was then constructed by species based on length/frequency data. This file was used for all operations having to do with biomass figures.

Methods and Materials

All specimens used in the weight conversion study were taken fresh (on ice) to the laboratory for analysis. Standard lengths, together with wet and dry weights, were measured for all fish specimens. Various invertebrate species were measured for total length, (tip of the telson to tip of the rostrum, shrimp; carapace width, crabs) wet, dry and ash-free dry weight. For those invertebrates normally counted in our data base (worms, mollusks,

amphipods, isopods, etc.), only mean ash-free dry weights were determined per species.

Dry weights were obtained by oven-drying samples for 48 hours at 105°C. Ash-free dry weights were obtained by ignition of the specimens in a muffle furnace for 1 hour at 550°C. Preliminary samples indicated less than 1% error was introduced by reducing the ignition time from the recommended 3 hours (Cummins and Waycheck, 1971) to 1 hour.

Linear regression equations utilizing a log-log (natural logs) transformation were calculated for each species where data were available (Table 1). These were calculated according to the following general equation;

ln (weight*) = ln (length**) a-b
where a&b = regression coefficients
* weight = dry weight (fishes)
= ash free dry weight (invertebrates)
** length = standard length (fishes)
= total or carapace width (invertebrates)

For those invertebrate species where no length or width measurements were taken a representative grouping according to size was dried and/or ashed; a single mean weight per individual was given for that species. For those species collected so rarely that no length-weight relationship could be established, regression equations or average weights of similar species (similar body shape, size, etc.) were substituted. These equations are also included in Table 1 along with the type species.

Literature cited:

Cummins, K.W. and J.C. Waycheck. (1971). Caloric equivalents for investigations in ecological energetics. Mitt. Internat. Verein. Limnol. No. 18, 158 pp.

Table 1. Biomass regression and conversion figures for organisms taken in Apalachicola Bay and Apalachee Bay from 1972 to 1976

A. Fishes, regression analysis by species (ln dry wt. = a· ln standard length -b)

Species	# of individuals		regression equation
ALU SCH	11		= 3.40541 (X) - 14.97588
ANC LYO	4		= 4.05558 (X) - 17.13343
ANC MIT	209		= 2.92631 (X) - 12.60137
ANG ROS	6		= 3.21520 (X) - 15.84540
ARI FEL	30		= 3.24073 (X) - 13.56112
AST GRA	6		= 2.31036 (X) - 9.11249
BAG MAR	8		= 3.49714 (X) - 14.94788
BAI CHR	284		= 2.90410 (X) - 11.76128
BRE PAT	10		= 5.33190 (X) - 20.55185
CAL ARC	13		= 3.08486 (X) - 12.23879
CEN MEL	115		= 2.95025 (X) - 11.85323
CHA FAB	4		= 3.36763 (X) - 12.66714
CHA SAB	8		= 2.27591 (X) - 10.00217
CHI SCH	51		= 2.69654 (X) - 9.69103
CHL CHR	12		= 2.46994 (X) - 10.40515
CYN ARE	29		= 2.85506 (X) - 12.09550
CYN NEB	47		= 3.05722 (X) - 12.79894
DAS SAB	12		= 3.17554 (X) - 12.61179
DIP HOL	63		= 3.43800 (X) - 13.50773
DOR CEP	4		= 3.69685 (X) - 15.64947
DOR PET	6		= 3.46547 (X) - 14.19044
ETR CRO	17		= 2.99338 (X) - 12.30726
EUC ARG	35		= 3.40790 (X) - 13.88700
EUC GUL	17		= 2.64359 (X) - 10.80122
GOB BOS	14		= 2.81134 (X) - 11.66922
GOB ROB	13		= 2.99185 (X) - 12.17209
HAE PLU	31		= 2.82564 (X) - 11.39730
HAR PEN		(DOR PET)	= 3.46547 (X) - 14.19044
HIP SPE	5		= 2.82587 (X) - 11.96161
ICT CAT	8		= 3.02830 (X) - 12.31003
ICT PUN	4		= 3.91137 (X) - 16.83136
LAC MAX	4		= 4.25871 (X) - 17.00627
LAC QUA	15		= 2.34179 (X) - 8.20714
LAG RHO	573		= 3.24457 (X) - 12.94101
LEI XAN	77		= 3.15892 (X) - 12.81603
LEP OSS	8		= 3.28379 (X) - 15.53650
MEN AME	18		= 2.93110 (X) - 12.15889
MEN BER	2		= 1.33401 (X) - 5.79181
MIC CRI	14		= 3.42472 (X) - 17.69587

Species	# of individuals	regression equation
MIC GUL	22	=3.15783 (X) - 13.17557
MIC UND	174	=3.30722 (X) - 13.59050
MON CIL	115	=2.68766 (X) - 11.00337
MON HIS	86	=2.76823 (X) - 11.04164
MUG CEP	7	=3.04576 (X) - 12.49192
NIC UST	10	=3.28415 (X) - 13.28714
OGC RAD	2	=3.91484 (X) - 16.05968
OPS BET	27	=2.51062 (X) - 10.34034
ORT CHR	99	=3.08003 (X) - 12.54686
PAR ALB	26	=3.13787 (X) - 13.23092
PAR FAS	14	=3.68192 (X) - 15.60141
PAR LET	33	=3.06070 (X) - 12.73843
PEP BUR	5	=2.63529 (X) - 10.45042
POG CRO	2	=2.46761 (X) - 9.21713
POR POR	3	=3.27791 (X) - 14.04788
PRI SCI	4	=3.26012 (X) - 13.36732
PRI TRI	20	=3.07717 (X) - 12.21250
SPH GUA	7	=2.76380 (X) - 12.47892
SPH NEP	24	=2.82279 (X) - 10.95111
STR MAR	4	=3.42754 (X) - 16.83563
SYM PLA	14	=3.19256 (X) - 13.76772
SYN FLO	58	=3.39967 (X) - 17.79450
SYN FOE	21	=3.33944 (X) - 14.67424
SYN SCO	10	=4.20130 (X) - 21.00771
TRI MAC	30	=3.35751 (X) - 13.05926
URO FLO	33	=3.35273 (X) - 14.52737
CYP VAR	6	=3.49504 (X) - 13.50708
FUN GRA	6	=3.11153 (X) - 12.77763
FUN SIM	3	=3.53472 (X) - 14.48805
LEP MAC	10	=3.19176 (X) - 12.50672
LUC PAR	5	=3.51483 (X) - 13.99182
MIC SAL	4	=3.87904 (X) - 15.92254
NOT PET	7	=2.66732 (X) - 11.73939
POE LAT	3	=2.19844 (X) - 9.12226

B. Fishes (rare), assigned regression equations

Species	comparable species	regression equation
ADI XEZ	LUC PAR	=3.51483 (X) - 13.99182
GAM AFF	LUC PAR	=3.51483 (X) - 13.99182
NOT VEN	NOT PET	=2.66732 (X) - 11.73939
FUN CON	FUN GRA	=3.11153 (X) - 12.77763
LEP MIC	LEP MAC	=3.19176 (X) - 12.50672
SYN LOU	SYN FLO	=3.39967 (X) - 17.79450
DIP FOR	CEN MEL	=2.95025 (X) - 11.85323
GYN NIG	ANG ROS	=3.21520 (X) - 15.84540
HYP HEN	CHA SAB	=2.27591 (X) - 10.00217
MEN SAX	MEN AME	=2.93110 (X) - 12.15889
HAE AUR	HAE PLU	=2.82564 (X) - 11.39730
LUT GRI	ORT CHR	=3.08003 (X) - 12.54686
ANC HEP	ANC MIT	=2.92631 (X) - 12.60137
PAR MAR	PAR FAS	=3.68192 (X) - 15.60141

Species	comparable species	regression equation
SEL VOM	CHL CHR	= 2.46994 (X) - 10.40515
POL OCT	BAI CHR	= 2.90410 (X) - 11.76128
SCI OCE	MIC UND	= 3.30722 (X) - 13.59050
ANC QUA	PAR ALB	= 3.13787 (X) - 13.23090
HYP GEM	CHA SAB	= 2.27591 (X) - 10.00217
CAR HIP	CHL CHR	= 2.46994 (X) - 10.40515
HAE SPE	HAE PLU	= 2.82564 (X) - 11.39730
HIP ERE	HIP SPE	= 2.82587 (X) - 11.96161
HIP ZOS	HIS SPE	= 2.82587 (X) - 11.96161
SPH BAR	SPH GUA	= 2.76380 (X) - 12.47892
SPH BOR	SPH GUA	= 2.76380 (X) - 12.47892
SER SUB	CEN MEL	= 2.95025 (X) - 11.85323
MEN SPE	MEN AME	= 2.93110 (X) - 12.15889
EUC SPE	EUC ARG	= 3.40790 (X) - 13.8870
OPH BEA	URO FLO	= 3.35273 (X) - 14.52737
SCO BRA	CEN MEL	= 2.95025 (X) - 11.85323
MYC MIC	CEN MEL	= 2.95025 (X) - 11.85323
MUL AUR	MIC UND	= 3.30722 (X) - 13.59050
CLU SPE	BRE PAT	= 5.33190 (X) - 20.55185
OPH GOM	ANG ROS	= 3.21520 (X) - 15.84540
BAT SOP	GOB BOS	= 2.81134 (X) - 11.66922
GOB STR	GOB BOS	= 2.81134 (X) - 11.66922
LAB SIC	MEN BER	= 1.33401 (X) - 5.79181
ECH NAU	ARI FEL	= 3.24073 (X) - 13.56112
RAJ TEX	DAS SAB	= 3.17554 (X) - 12.61179
STE CAP	DIP HOL	= 3.4380 (X)- 13.50773
HEM BRA	STR MAR	= 3.42754 (X) - 16.83563
TRA CAR	CHL CHR	= 2.46994 (X) - 10.40515
GOB BOL	MIC GUL	= 3.15783 (X) - 13.17557
SAR ANC	ANC MIT	= 2.92631 (X) - 12.60137
HAL BIV	NIC UST	= 3.28415 (X) - 13.28714
SER PUM	CEN MEL	= 2.95025 (X) - 11.85323
ELO SAU	SPH GUA	= 2.76380 (X) - 12.47892
SCA SPE	NIC UST	= 3.28415 (X) - 13.28714
ARC PRO	LAG RHO	= 3.24457 (X) - 12.94101
APO TOW	BAI CHR	= 2.90410 (X) - 11.76128
AST STE	BAI CHR	= 2.90410 (X) - 11.76128
MIC THA	MIC GUL	= 3.15783 (X) - 13.17557
PEP PAR	PEP BUR	= 2.63529 (X) - 10.45042
STE LAN	BAI CHR	= 2.90410 (X) - 11.76128
GOB HAS	(MIC GUL + GOB HAS)	= 2.83401 (X) - 11.90954
MUG SPE	MUG CEP	= 3.04576 (X) - 12.49192
MYR PUN	ANG ROS	= 3.21510 (X) - 15.84540
ALO ALA	DOR CEP	= 3.69685 (X) - 15.64947
OLI SAU	CHL CHR	= 2.46994 (X) - 10.40515
RHI BON	DAS SAB	= 3.17554 (X) - 12.61179
MON CHR	BAI CHR	= 2.90410 (X) - 11.76128
ANC SPE	ANC MIT	= 2.92631 (X) - 12.60137
SYN SPE	SYN FLO	= 3.39967 (X) - 17.79450
POM SAL	LAG RHO	= 3.24457 (X) - 12.94101
CAR BAR	CHL CHR	= 2.46994 (X) - 10.40515
SPH TIB	BAG MAR	= 3.49714 (X) - 14.94788

Species	comparable species	regression equation
MUG CUG	MUG CEP	= 3.04576 (X) - 12.49192
PRI RUB	PRI TRI	= 3.07717 (X) - 12.21250
PAR SPE	PAR LET	= 3.06070 (X) - 12.73843
GYM MIC	DAS SAB	= 3.17554 (X) - 12.61179
CYN SPE	CYN ARE	= 2.85506 (X) - 12.09550
LOB SUR	CHA FAB	= 3.36763 (X) - 12.66714

C. Invertebrates, regression analysis by species.

Species	# of individuals	regression equation
ALP HET	22	= 2.75501 (X) - 11.52437
CAL SAP	49	= 2.67979 (X) - 10.51993
LIB DUB	15	= 2.51633 (X) - 8.99184
NEO TEX	49	= 2.64410 (X) - 9.04336
PAL FLO	14	= 2.51735 (X) - 11.73789
PAL INT	8	= 3.29106 (X) - 14.03450
PEN DUO	50	= 3.18888 (X) - 14.31392
PEN SET	62	= 2.75088 (X) - 12.56506
PER AME	9	= 1.70501 (X) - 9.43702
TOZ CAR	10	= 3.77633 (X) - 18.02926
MET CAL		= 2.05252 (X) - 7.31573
PAL PUG		= 3.23535 (X) - 14.16662

D. Invertebrates, calculated conversion coefficients per individual based on narrow range of length frequency data.

Species	mean ash free dry wt.
PER LON	0.0036 (gu)
THO DOB	.0032
HIP ZOS	.0022
PET ARM	.0431
PAG BON	.0067
PAG LON	.1468
LOL BRE	.6788
LYT VAR	3.2713
ECH SPE	.6914
ECH PAR	.2050
OPH BRE	.0360

E. Invertebrates, assigned regression equations or weight/individual.

Species	comparable species	regression equation or mean ash free
PEN AZT	PEN DUO	= 3.18888 (X) - 14.31392
POR GIB	CAL SAP	= 2.67979 (X) - 10.51993
CAL SIM	CAL SAP	= 2.67979 (X) - 10.51993
TRA CON	PEN SET	= 2.75088 (X) - 12.56506

LAE MOR	small RAN CUN	.5066
STR ALA	AEQ IRR	2.1975
CRE FOR	CRE PLA	(.0002)
PSE FLO		(.0031)
TRA EGM	small RAN CUN	.5066
BUR LEA		2.0000
APL FLO		2.0000
BRA AME	large chaetes	.0100
DIO CUP		.0100
PLA DUM		.0100
PAR CAU		(.0030)
CLE PLA		(.0030)

* Those figures in parentheses represent weights of juveniles of a given species

Species	comparable species	regression equation or mean ash free dry wt.
LEA TEN	PAL FLO	= 2.51735 (X) - 11.73789
SYN TON	ALP HET	= 2.75501 (X) - 11.52437
SYN LON	ALP HET	= 2.75501 (X) - 11.52437
UCA SPE	NEO TEX	= 2.64410 (X) - 9.04336
LIB EMA	LIB DUB	= 2.51633 (X) - 8.99184
SES CIN	NEO TEX	= 2.64410 (X) - 9.04336
PAG ANN	PAG LON	= .1468
PRO SPE	PEN DUO	= 3.18888 (X) - 14.31392
AMB SYM	PAL INT	= 3.29106 (X) - 14.03450
SIC DOR	PEN DUO	= 3.18888 (X) - 14.31392
SIC BRE	PEN DUO	= 3.18888 (X) - 14.31392
SIC TYP	PEN DUO	= 3.18888 (X) - 14.31392
SIC LAE	PEN DUO	= 3.18888 (X) - 14.31392
POD RLL	LIB DUB	= 2.51633 (X) - 8.99184
EPI DIL	LIB DUB	= .0306
PEL MUT	LIB DUB	= .0306
PIT ANI	LIB DUB	= 2.51633 (X) - 8.99184
MEG SOR	PET ARM	= .0282
POR SIG	PET ARM	= .0282
MAC CAM	LIB DUB	= 2.51633 (X) - 8.99184
SQU EMP	PEN DUO	= 3.1888 (X) - 14.31392
URO PER	CAL JAM	= .0111
CAL JAM	CAL JAM	= .0111
LUI CLA	3 (ECH SPE)	= 2.0742
HEM ELO	OPH BRE	= .0360
OPH ANG	OPH BRE	= .0360
LUI SAG	ECH SPE	= .6914
LUI SPE	ECH SPE	= .6914
LUI ALT	ECH SPE	= .6914
OPH ELE	OPH BRE	= .0360
OCT VUL	2 (LOL BRE)	= 1.3576

IV. Physico-chemical Relationships: Sedimentology and Habitat Structure

Livingston et al. (1975) showed that the aquatic environment in the Apalachicola Estuary is affected to a considerable degree by seasonally-directed fluctuations of the Apalachicola River. Variables such as local rainfall, tides, wind-induced currents, temperature, salinity, dissolved oxygen, turbidity, color, and pH, are important determinants of the population and community structure of this bay system; together, these parameters define the array of habitats in the area.

The sediments determine to a considerable degree the forms of benthic organisms which occur in a given area. This is particularly true of the benthic infauna, where feeding types are often correlated with sediment forms. This includes direct sedimentary control of trophic distribution (Sanders, 1958), coincidental correlation between water movement factors and trophic distribution (Sanders, 1958; McNulty et al., 1962), and trophic group amensalism mediated by the sediments (Rhoads and Young, 1970). Support for these observations is available (Bloom et al., 1972). Thus, sediment analysis was conducted concurrently with the analysis of the infauna of the Apalachicola Estuary.

Materials and Methods:

Sediment Analysis

Sediment samples were taken with a corer (d., 7.62 cm) monthly from March, 1975 through February, 1976. This was carried out at fixed stations around the bay (Fig. 1). These analyses were conducted on the top 5-10 cm of each core.

Two methods were used (the second method represents a standard geological analysis which eliminates biological functions). At monthly intervals, a sample of 50-150 g was wet-sieved through a series of U.S. Standard sieves. Each fraction was dried at 100°C for 24 hours and weighed. Sieve-class weights were then used to construct cumulative percent particle size curves (Inman, 1952) on arithmetic probability paper. A second analysis involved a supplementary subset of the above samples (Ingram, 1971). A 30-50 g sample was dried at 100°C for 24 hours and then treated with 10% HCl for 12 hours to remove carbonates. After redrying the sample, organic matter was removed by treatment with 30% H_2O_2 for 12 hours. The sample was then dried, and dry-sieved through a series of sieves on a mechanical shaker for 30 minutes. Sieve class weights were analyzed by the method of moments (Folk, 1966) using a computer program developed by J. P. May (Dept. of Geology, Florida State University). Sediment organic matter was analyzed monthly by drying a subsample at 100°C for 24 hours and ashing at 500°C for 4 hours (Cummings and Waycheck, 1971).

Physico-chemical Functions:

Surface and bottom water samples were taken monthly at fixed stations in the Apalachicola Estuary (Fig. 1) with a 1 ℓ Kemmerer bottle. Dissolved oxygen and temperature were measured with a Y.S.I. dissolved oxygen meter and a stick thermometer. Salinity was taken with a temperature-compensated refractometer calibrated periodically with standard sea water. River flow data taken at Blountstown, Florida were provided by the U.S. Army Corps of Engineers (Mobile, Alabama) while local rainfall data were provided by the National Oceanic and Atmospheric Administration (Environmental Data Service,

Apalachicola, Florida) and the East Bay Forestry tower. Turbidity was determined using a Hach Model 2100-A turbidimeter and was expressed as Jackson Turbidity Units (J.T.U.). Water color was measured using an A.P.H.A. platinum-cobalt standard test. Light penetration was estimated with a standard Secchi disk. Data concerning chlorophyll A, orthophosphate (inorganic, soluble, reactive), nitrite, nitrate, and silicate were provided through a Florida Sea Grant Program directed by Dr. Richard L. Iverson (Department of Oceanography, Florida State University); these parameters were measured according to standard procedures (Livingston et al., 1974).

A. Sediments:

Results of sediment analyses are presented in Table 1.

Station 1

This is a mid-bay station approximately 2 m in depth. The bottom is somewhat loose, barren of vegetation, with occasional large wood and shell fragments. There are scattered coarse, sandy deposits in an otherwise fine sand area. The monthly average grain size is 2.60 ϕ units and contains 6.52% organic matter. There was considerable variation between samples both for grain size and organic content, with no obvious trends. The concurrent decrease in grain size and increase in organic content noted in February, 1976, coincided with maintenance dredging activities nearby.

Station IX

This station is situated in a shallow (1 m) protected grass bed, composed mainly of Halodule wrightii. The bottom is very firm sand with scattered oyster bars in the area. The average monthly grain size is 2.02 ϕ units and the organic content averages 2.06%. There was a little

between-sample variation in grain size but the sediment organic content increased from July to January, coinciding with the die-off and deposition of Halodule blades.

Station 3

This station is located in a shallow (1 m) channel leading from the Apalachicola River into East Bay. Winter and spring deposits of wood and leaf debris, washed in by peak river discharges, are found in this area. The bottom is firm, fine sand with beds of Ruppia maritima and Vallisneria americana in the vicinity. The average grain size is 2.83 ϕ units and organic content averages 3.52%. There was some variability between samples for grain size and organic content, probably resulting from the river-deposited debris.

Station 6

This station is located in the middle of a shallow (1 m), protected embayment close to the Apalachicola River with seasonally dense beds of Ruppia nearby. The bottom is a loose, fine sand-silt. Woody debris was almost always noted in the samples. The monthly average grain size is 3.64 ϕ units and organic content averages 5.60%. Samples were variable with respect to grain size and organic content, with no trends observed.

Station 4

This station is moderately deep (2 m) and influenced to some extent by river discharge. The bottom is barren, loose silty-sand, and contains large wood fragments. The monthly average grain size is 3.93 ϕ units and organic content averages 7.98%. Grain sizes were somewhat variable in the spring (perhaps due to river effects) and appeared stable for the rest of the year. Organic content was highest in summer and fall, coinciding to

some extent with the die-off of upper bay grass beds.

Station 4A

This station is in a shallow (4 m) Vallisneria bed in upper East Bay. The bottom is fairly loose, silty-sand. The monthly average grain size is 3.98 ϕ units and organic content averages 8.61%. A fall peak in organic content probably results from the die-off of Vallisneria blades.

Station 5A

This station is located off a sandy beach in upper East Bay. The bottom is firm, fairly coarse sand, and the nearby shore is fringed with Vallisneria. The average grain size is 1.82 ϕ units and organic content averages 2.58%. Between-sample variation in grain size is low, but organic content increases from summer through winter, to some extent due to the Vallisneria die-off.

Station 5B

This station is located in an upper East Bay tributary. The bottom is loose silt with Vallisneria fringing the shoreline. The average grain size is 4.22 ϕ units and organic content averages 11.23%. Grain sizes exhibited low variability as did organic content, which was relatively high all year.

In summary, grain size decreases and organic content increases moving from the outer Apalchicola Bay into the upper reaches of East Bay. The observed late summer-fall die-off of benthic macrophytes coincides generally with an increase in sediment organic content. The relationships between the above observations and the reactions of the infaunal and epibenthic organisms to both general sedimentary characteristics and the fall increase in organic content will be examined in other sections of this report.

B. Physico-chemical parameters:

Water temperatures at a representative station are shown in Figs. 2 and 3. Although temperature peaks tended to remain stable from year to year, there was a general decrease in temperature with time which was particularly pronounced during the fifth year of the study. The winter of 1976-77 was extremely cold, and this should be taken into consideration in any long-term evaluation of the biota of the bay. There was a general reduction in salinity (Figs. 4-7) with time. Seasonal variation, based to a considerable degree on river flow (Fig. 30), was a major determinant of the salinity regimes in the system. There were also decreases in salinity during summer and fall months which appeared to reflect surface runoff from local rainfall patterns. Such changes were more pronounced in East Bay than Apalachicola Bay. The general salinity pattern was thus relatively stable from year to year. Low salinities occurred during winter and spring months (associated with river flow) followed by increasing salinity during the summer. There was then a rapid decline in the late summer or fall, (coincident with increased local precipitation) and this was followed by a fall or winter salinity peak just prior to the ensuing decrease in salinity with renewed increases in river flow. The general annual patterns of salinity (Figs. 4-7), with relatively low levels during the past 3 years, may not be entirely consistent with the mean annual river flow and rainfall data (Table 2). This is especially true during the last year of sampling. This will be the subject of further study involving mass flow models.

Color values for representative stations in the Apalachicola Estuary are shown in Figs. 8-11. The influence of the major river flooding during

the winter of 1973 (Fig. 30) is apparent throughout the bay. A secondary peak appears during the spring of 1975. On the whole, there was a general decrease in color at Station 1; this was especially significant at greater depths. The reverse was true in East Bay, especially at the surface. Spikes of high water color were particular pronounced during the latter part of 1974. Peaks generally occurred during spring and late summer, thus reflecting rainfall patterns (Fig. 30) during this period. East Bay was thus more highly colored than Apalachicola Bay, and showed a trend which appeared to be linked to patterns of local rainfall and runoff in the Tate's Hell Swamp area. This was not the case with respect to turbidity which tended to decrease during the study period in the bay as a whole. Turbidity seemed to be closely correlated with river flow. Turbidity peaks usually occurred during winter and spring months. One notable exception to this occurred during the summer of 1974 in benthic areas of East Bay. These trends in color and turbidity were generally reflected in the Secchi disk data (Figs. 16, 17) where significant decreases occurred in East Bay with time relative to the Apalachicola Bay area.

Dissolved oxygen data are shown in Figs. 18-21. There was considerable seasonal variation at both stations with peak levels generally occurring during winter and spring months indicating the usual relationship with water temperature and salinity. In East Bay, there was a significant increase in dissolved oxygen during the 5 year period of study which was not as apparent in Apalachicola Bay. Relatively low levels of dissolved oxygen were apparent in East Bay during the late summer of 1974. Levels of pH in the Apalachicola Estuary are shown in Figs. 22-25. There was a significant decrease in pH in Apalachicola Bay during the fall and early

winter of 1976. This remains unexplained at this time. The East Bay data will be more thoroughly reviewed in another report involving potential impact of clearcutting on the Bay.

Orthophosphate and nitrate levels in the Apalachicola Estuary are shown in Figs. 26-29. These data will be analyzed in detail by Iverson and Myers (Section V of this report).

Analysis and Discussion:

A statistical treatment was carried out with the first four years of physico-chemical data. The seasonal changes in various physico-chemical variables in the Apalachicola Bay System have already been described (Livingston, 1974, 1976; Livingston et al., 1974a: Livingston et al., 1976) and will not be reviewed in detail here. Overall, this is a shallow barrier island estuary dominated physically by the widely fluctuating Apalachicola River (Fig. 30). During the 4-year period of study, the river flow usually peaked during the period from January to April. At these times, the range of extreme diurnal flows usually was maximal. The range and mean flow usually reached low levels during late summer and fall periods. This pattern was almost completely out of phase with local rainfall which ordinarily peaked during the summer and early fall. There was considerable annual variation of river flow with relatively low levels during the first and third years of sampling. During the winter and spring of 1973, there was especially pronounced river flow and flooding throughout the Apalachicola Valley.

Water temperature followed seasonal patterns with no substantial variation from year to year. At any given time, there was usually little vertical or horizontal variation in water temperature throughout the bay

system (Livingston et al., 1977). River flow generally dominated the seasonal characteristics of parameters such as salinity, color, turbidity, and nutrient levels with increased flow associated with increases in the latter 3 functions. Generally, this is a highly turbid bay with considerable oyster bar development and little benthic macrophyte productivity except in shallow (fringing) areas. Tides in the Apalachicola Estuary are semi-diurnal (mixed, unsymmetrical) with a small small range (up to 1 m). Winds in the area follow no clear directional trend although during fall and winter there is a northerly flow which becomes southerly during the rest of the year. In June, 1972, Hurricane Agnes came ashore near the Apalachicola region with winds gusting to 55 knots and tides around 2 m above the norm.

Statistical analysis of the physico-chemical data taken over the 4-year study period included simple linear regression and correlation for distribution with time. Significant changes in the regressions (original and $\log_e$ units) were found for salinity, rainfall, and turbidity. The results of a 2-way (month x year) analysis of variance of these data are shown in Table 3. Since in a 2-way analysis with one observation per cell, the mean square is of necessity used as an error term, the occurrence of annually high significance levels probably indicates that considerable interaction exists. There was significant ($p < .05$) annual variation of river flow although no trend was apparent during the study period. There were reductions in salinity and turbidity in the Apalachicola system with time. The results of a factor analysis (Table 4) indicate that high river flow is usually associated with increased color and turbidity and reduced Secchi readings, and low levels of salinity, temperature, and

chlorophyll A. This is consistent with the known seasonal pattern of these factors, and indicates the important influence of the Apalachicola River on the physical environment of the Apalachicola Estuary. While the river dominates the seasonal fluctuations of parameters such as salinity, long-term changes in the overall salinity of the bay appear to be related also to other functions such as local rainfall and runoff. This would indicate that causation reflects multiple interactions thus allowing apparently contradictory results in the short- versus long-term trends (e.g., turbidity and salinity relationships).

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Table 1. Monthly sediment analyses of various stations in Apalachicola Bay. Median grain size determined by Method 1 (Inman, 1952; Folk and Ward, 1975) and Method 2 (Folk, 1966; Ingram, 1971). Organic content determined according to Cummins and Waycheck (1971).

		MEDIAN GRAIN SIZE (Φ)		
STATION	DATE	METHOD 1	METHOD 2	% ORGANICS
1	3/75	1.90		4.66
	4/75	2.20		4.05
	5/75	2.55		5.14
	6/75	2.50		6.26
	7/75	3.10		6.70
	8/75	3.35	2.08	7.18
	9/75	2.40		5.84
	10/75	2.20		4.29
	11/75	2.20		8.79
	12/75	2.25	2.00	6.13
	1/76	2.35		6.41
	2/76	4.20	4.20	12.88
IX	3/75	2.00		1.78
	4/75	1.85		1.76
	5/75	1.95		1.68
	6/75	2.00		1.64
	7/75	2.00		2.00
	8/75	1.95	2.36	2.42
	9/75	2.05		2.16
	10/75	2.15		2.26
	11/75	2.10		2.47

Table 1 (continued)

STATION	DATE	METHOD 1	METHOD 2	% ORGANICS
	12/75	2.10	2.37	2.56
	1/76	2.05		2.36
	2/76	2.05	2.04	1.68
3	3/75	2.45		4.17
	4/75	3.10		3.93
	5/75	2.70		3.67
	6/75	2.70		2.82
	7/75	2.55		2.92
	8.75	3.45	2.87	2.38
	9.75	3.10		6.47
	10/75	2.65		4.25
	11/75	2.85		2.96
	12/75	3.10	2.98	4.30
	1/76	2.65		2.11
	2/76	2.70	2.43	2.30
6	3/75	3.00		5.73
	4/75	3.65		6.61
	5/75	3.30		4.18
	6/75	3.95		6.33
	7/75	4.10		7.98
	8/75	3.80	2.97	6.48
	9/75	3.55		4.80
	10/75	3.95		6.63
	11/75	3.75		3.62
	12/75	3.50	3.05	5.11

Table 1 (continued)

STATION	DATE	METHOD 1	METHOD 2	% ORGANICS
	1/75	3.55		3.87
	2/76	3.60	2.81	5.80
4	3/75	3.45		6.21
	4/75	3.85		5.86
	5/75	3.45		5.41
	6/75	4.15		9.48
	7/75	4.05		9.10
	8/75	3.95		8.23
	9/75	4.00		9.00
	10/75	4.05		9.75
	11/75	4.00		11.23
	12/75	4.00		8.36
	1/76	4.20		7.06
	2/76	4.00		6.02
4A	3/75	4.15		6.10
	4/75	4.00		6.25
	5/75	3.90	1.89	6.52
	6/75	4.00		7.75
	7/75	3.85	2.18	8.30
	8/75	3.45		9.39
	9/75	4.10		11.09
	10/75	4.05		9.10
	11/75	4.05		12.05
	12/75	4.05		10.55

Table 1 (continued)

STATION	DATE	METHOD 1	METHOD 2	% ORGANICS
	1/76	4.05		7.97
	2/76	4.10		8.30
5A	3/75	1.70		1.11
	4/75	1.75		1.03
	5/75	1.60		1.40
	6/75	1.85		0.97
	7/75	1.75		2.38
	8/75	1.95	1.79	2.83
	9/75	1.80		1.41
	10/75	1.85		1.70
	11/75	1.90		4.64
	12/75	2.10	1.93	8.45
	1/76	1.80		2.78
	2/76	1.80	1.72	2.33
5B	5/75	4.20		11.45
	6/75	4.45		10.61
	7/75	4.25		12.32
	8/75	4.20		12.51
	9/75	4.15		11.95
	10/75	4.20		12.20
	11/75	4.20		12.21
	12/75	4.20		9.39
	1/76	4.20		9.19
	2/76	4.20		10.52

Table 2: Annual monthly means:
Apalachicola River Flow (Blountstown, Florida: U.S. Army Corps of Engineers, Mobile District) and Local Rainfall (Combined data from NOAA climatological Station in Apalachicola and the East Bay Fire Tower).

Time Period	Apalachicola River Flow (Cubic) Feet Per Second)	Local Rainfall (inches)
3/72 - 2/73	25,185	4.98
3/73 - 2/74	32,955	5.20
3/74 - 2/75	21,550	6.23
3/75 - 2/76	30,708	5.80
3/76 - 2/77	26,174	4.66

TABLE 3 : Results of 2-way analysis of variance (by month, by year) for physicochemical and biological parameters of the Apalachicola Bay System taken over a 48 month period (March, 1972-February, 1976). Included are various indices used in the overall statistical analysis.

Parameter	Number of cases	Mean	Standard Deviation	Deviations from the mean by year 1972-73	1973-74	1974-75	1975-76	Significance (P) Month	Year
Physicochemical									
River Flow (C.F.S.)	48	27,586	15,366	-2401	5369	-6088	3122	0.001	0.025
Secchi (m)	48	0.82	0.37	0.08	-0.19	0.10	0.01	0.172	0.194
Color (P+-Co units)	48	42.4	74.5	22.8	-11.7	-16.7	5.1	0.203	0.999
Turbidity (J.T.U.)	48	20.2	33.4	16.2	9.9	-13.7	-12.7	0.999	0.180
Temperature (°C)	48	20.2	6.3	1.6	-2.6	0.9	-0.2	0.016	0.240
Salinity (°100)	48	16.1	8.3	2.7	0.8	1.3	-5.5	0.003	0.114
Dissolved oxygen (mg/L)	48	8.2	2.3	-0.4	0.1	-0.1	0.2	0.058	0.999
Nitrate (ug/L)	42								
Phosphate (ug/L)	42								
DDT (Rangia: PPB)	29	145	173	160	-125	-83	---	0.303	0.001
PCB (Rangia: PPB)	29	85	85	79	-61	-41	---	0.402	0.001
Chlorophyll A (mg/m^3)	44	5.3	2.1	1.9	0.7	-0.9	-1.1	0.331	0.002
Rainfall	48	5.0	4.0	01.3	-1.1	0.5	2.0	0.398	0.999
Wind	48	---	---	---	---	---	---	---	---
Tides	48	---	---	---	---	---	---	---	---
DDP**	48	---	---	---	---	---	---	---	---
m_1 m_{11}***	48	---	---	---	---	---	---	---	---
Invertebrates									
Number of individuals (N)*	45	647	763	-73	-170	25	224	0.999	0.999
-N-N_1 (dominant species)*	45	209	125	-14	-39	-108	162	0.999	0.021
Margalef richness	45	1.78	0.56	0.02	-0.13	-0.01	0.16	0.999	0.999
Relative dominance (%)	45	56.4	16.6	-2.4	1.9	7.2	-4.9	0.358	0.999
Shannon diversity	45	1.34	0.36	-0.05	-0.14	0.04	0.16	0.999	0.257
Number of species (5)	45	11.7	3.8	1.2	-1.0	0.8	1.6	0.999	0.255
Fishes									
Number of individuals (N)*	45	1670	1219	202	14	170	46	0.217	0.999
N-N_1 (dominant species)*	45	663	221	-160	17	20	162	0.108	0.009
Margalef richness	45	3.52	0.71	-0.22	-0.09	-0.06	0.37	0.114	0.146
Relative dominance (%)	45	54.9	16.6	10.6	-1.0	-5.4	-4.2	0.099	0.041
Shannon diversity	45	1.48	0.33	-0.23	-0.03	0.11	0.08	0.051	0.030
Number of species (5)	45	26.4	5.9	-1.6	-0.9	-0.3	2.8	0.237	0.236
Anchoa group*	45	2.57	0.70	0.20	-0.22	-0.02	0.04	0.003	0.050
Micropogon group*	45	2.14	0.80	-0.15	0.37	-0.23	0.01	0.001	0.050
Cynoscion group*	45	1.58	0.94	0.11	-0.21	0.11	-0.01	0.001	0.095
Gobiosoma group*	45	1.12	0.57	-0.28	-0.24	-0.11	0.42	0.064	0.011
Chlororscombrus group*	45	0.59	0.86	0.19	-0.07	0.07	-0.18	0.001	0.204

Table 4: Factor analysis of a set of physicochemical variables taken from March, 1972 to February, 1976. Color, turbidity, Secchi readings, salinity, temperature, and chlorophyll A were noted at Station 1 in the Apalachicola Estuary Tidal Data included the stages of the tide on the day of collection while the wind variable was represented by 2 vector components.

Variable	Factor 1 (49.0% of the variance)	Factor 2 (22.3% of the variance	Factor 3 (17.9% of the variance	Factor 4 (10.8% of the variance
River flow	-0.82	-0.08	-0.07	-0.08
Local rainfall	-0.04	-0.30	-0.09	0.20
Tide (incoming or outcoming	0.26	0.61	-0.68	0.06
Tide (high or low)	0.09	0.39	0.61	-0.37
Wind direction (E-W)	-0.02	0.09	0.36	0.37
Wind direction (N-S)	0.10	-0.20	0.22	0.31
Secchi	0.57	-0.07	-0.17	0.24
Color	-0.80	0.33	0.01	0.07
Turbidity	-0.73	0.54	0.08	0.23
Temperature	0.38	0.15	0.02	-0.18
Salinity	0.68	0.21	0.23	-0.02
Chlorophyll A	0.47	0.51	0.09	0.31

Fig. 1: The Apalachicola Bay System showing assigned (permanent) stations for all research operations.

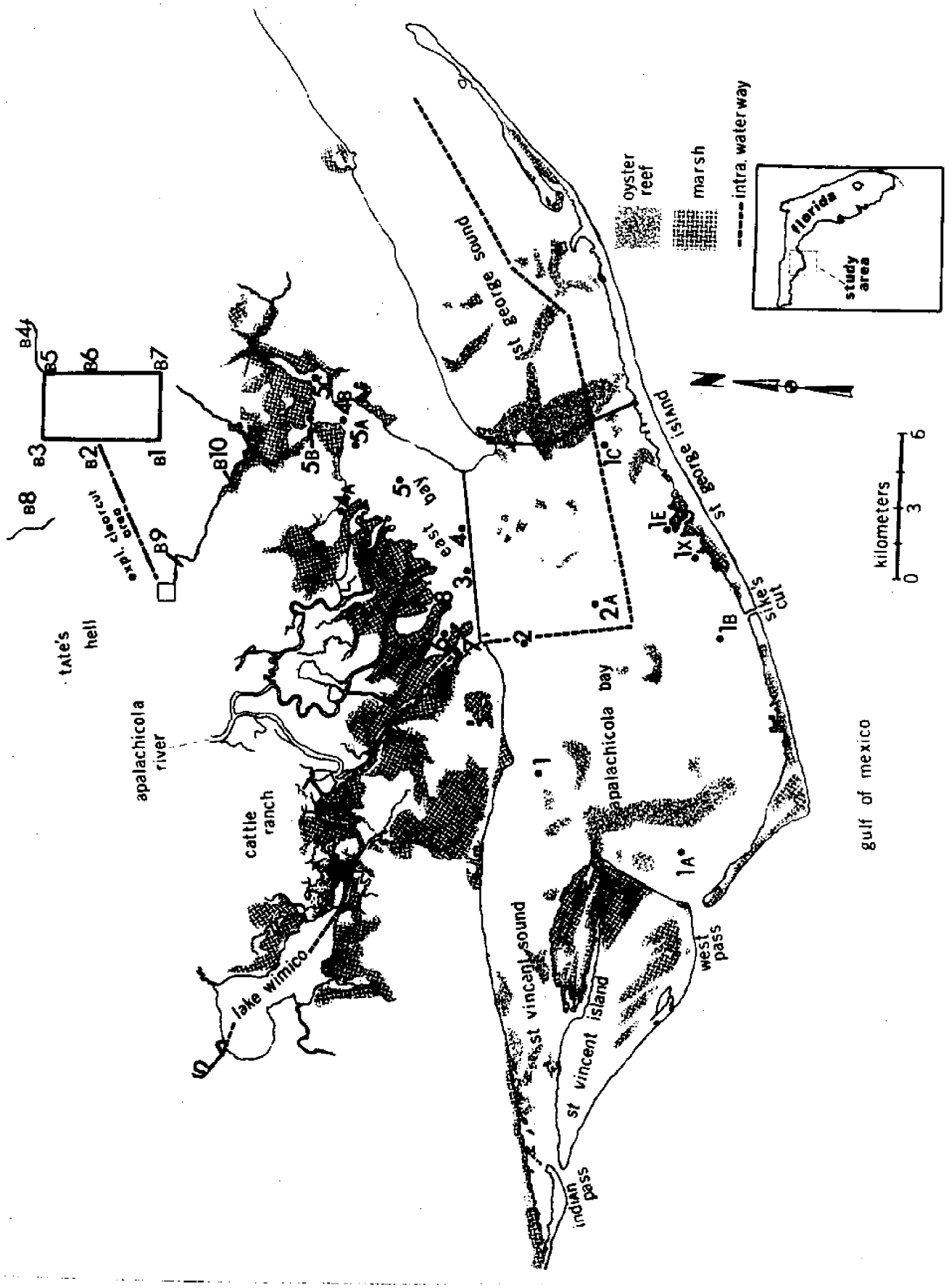
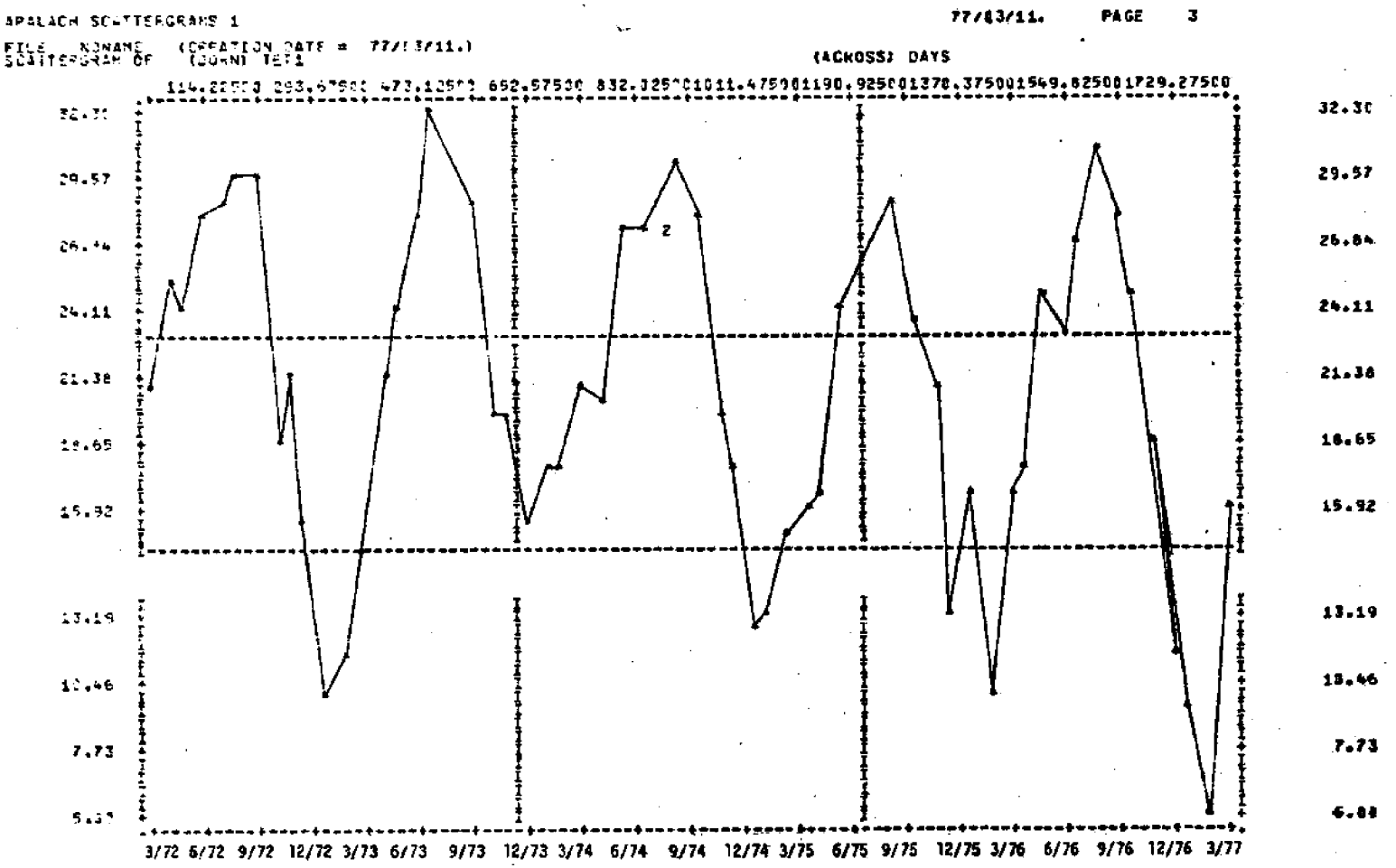


Fig. 2: Surface water temperature (^{o}C) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.



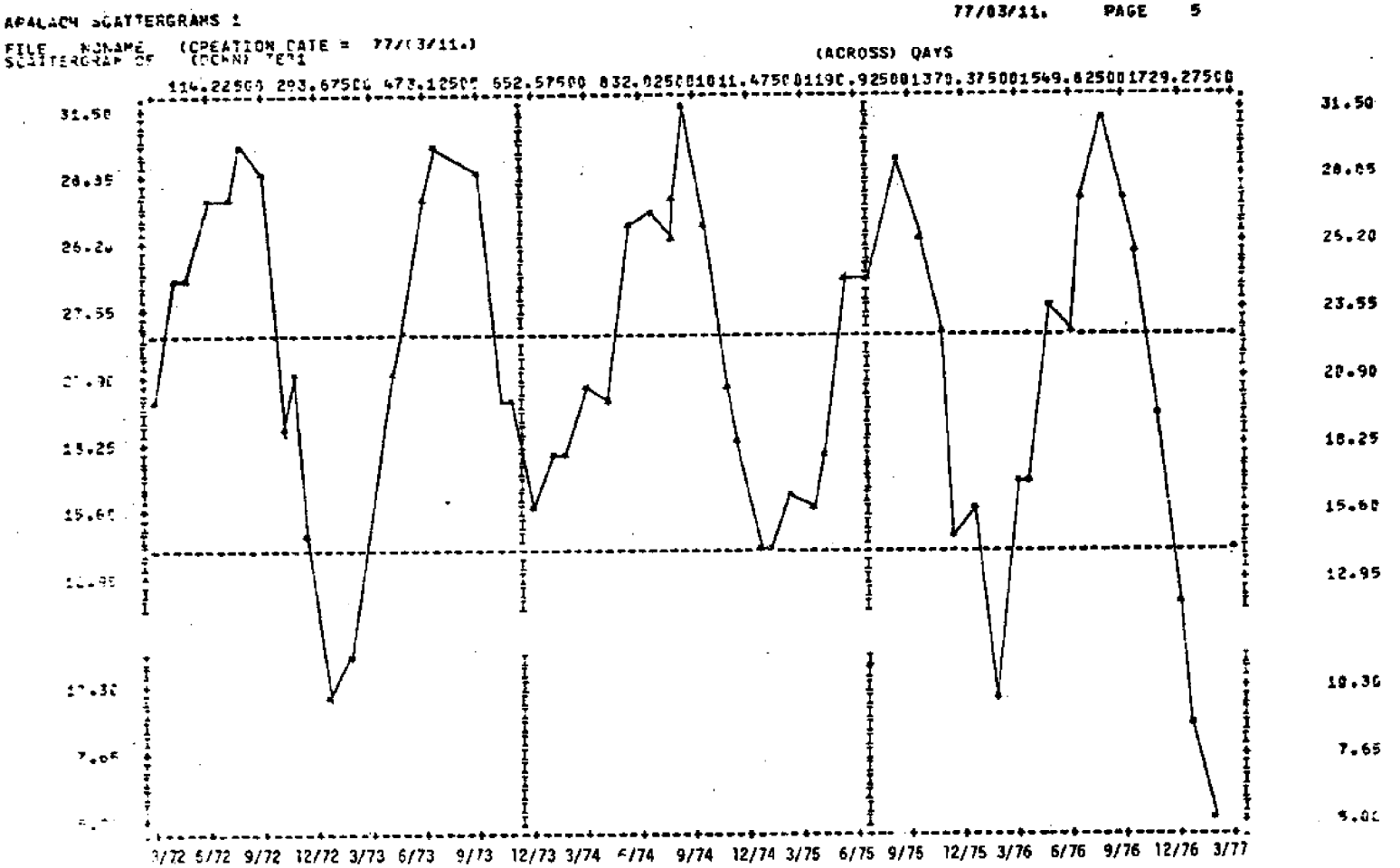
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R)-	-.27444	R SQUARED -	.07532	SIGNIFICANCE R -	.01854
STD ERR OF EST -	6.3[illegible]	INTERCEPT (A) -	24.41248	STD ERROR OF A -	1.67141
SIGNIFICANCE A -	.[illegible]	SLOPE (B) -	-.00335	STD ERROR OF B -	.00157
SIGNIFICANCE B -	.01854				
PLOTTED VALUES -	58	EXCLUDED VALUES-	0	MISSING VALUES -	47

********** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED

Fig. 3: Bottom water temperature °C at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.



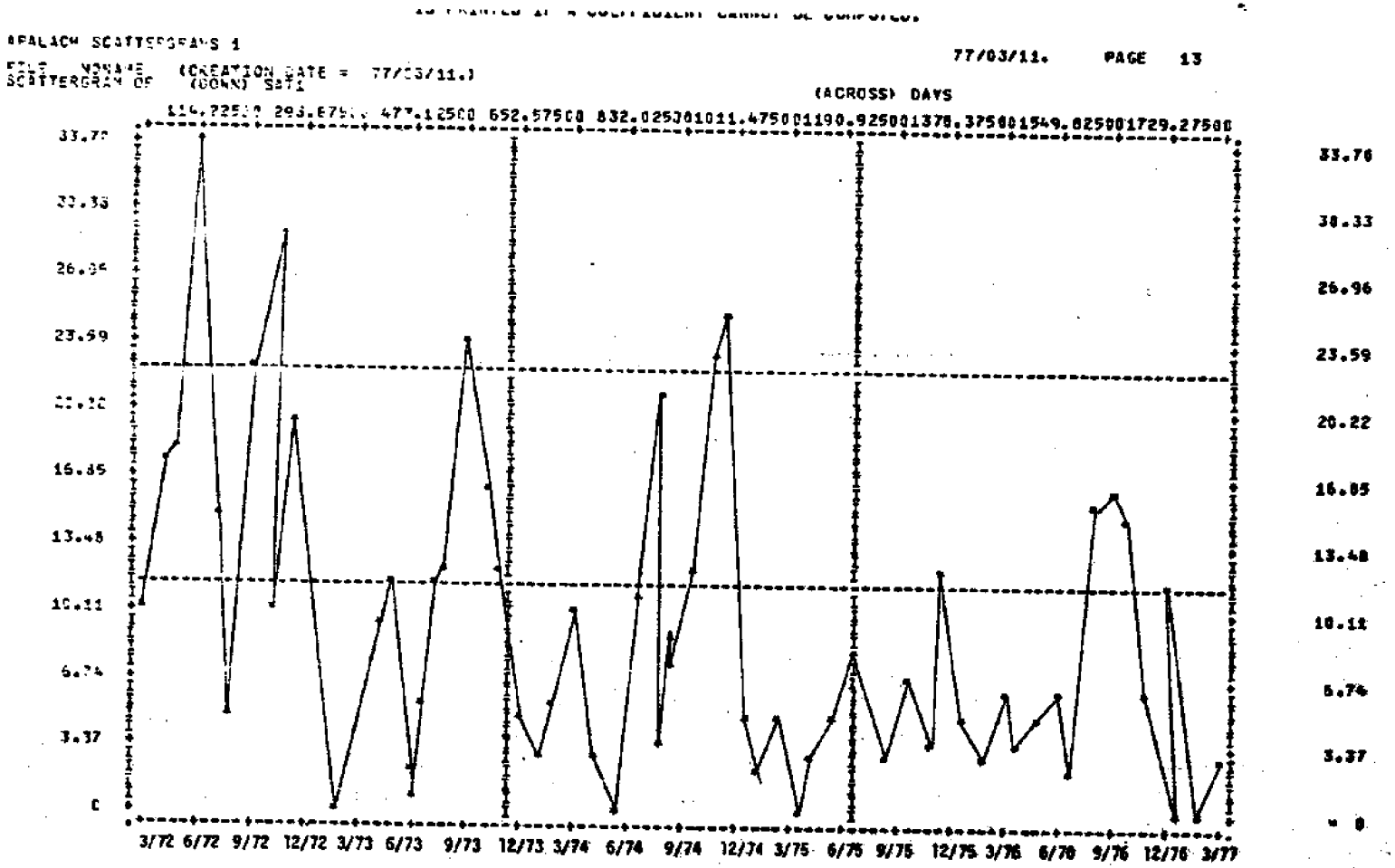
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) =	-.24719	R SQUARED =	.06110	SIGNIFICANCE R =	.03670
STD ERR OF EST =	6.27119	INTERCEPT (A) =	24.03222	STD ERROR OF A =	1.66139
SIGNIFICANCE A =	.0001	SLOPE (B) =	-.00297	STD ERROR OF B =	.00156
SIGNIFICANCE B =	.0370				
PLOTTED VALUES =	59	EXCLUDED VALUES =	0	MISSING VALUES =	47

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 4: Surface salinity $^{o}/_{oo}$ at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.

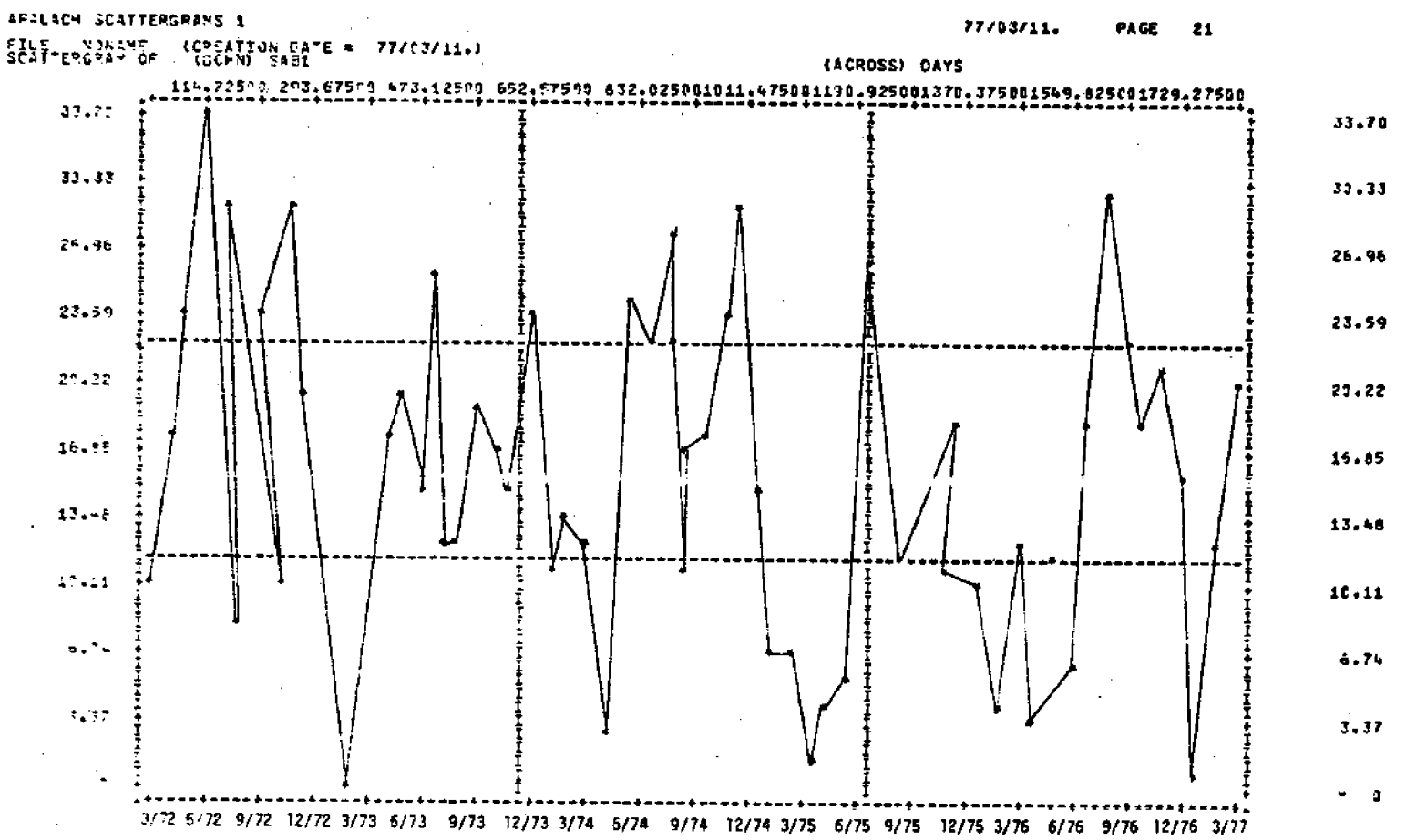


APALACH SCATTERGRAMS 1 77/03/11. PAGE 14

STATISTICS..

CORRELATION (R) -	-.39378	R SQUARED -	.15506	SIGNIFICANCE R -	.00085
STD ERR OF EST -	7.25242	INTERCEPT (A) -	15.04093	STD ERROR OF A -	1.88468
SIGNIFICANCE A -	.00031	SLOPE (B) -	-.86590	STD ERROR OF B -	.26179
SIGNIFICANCE B -	.00085				
PLOTTED VALUES -	61	EXCLUDED VALUES-	0	MISSING VALUES -	44

Fig. 5: Bottom salinity $^{0}/_{00}$ at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.



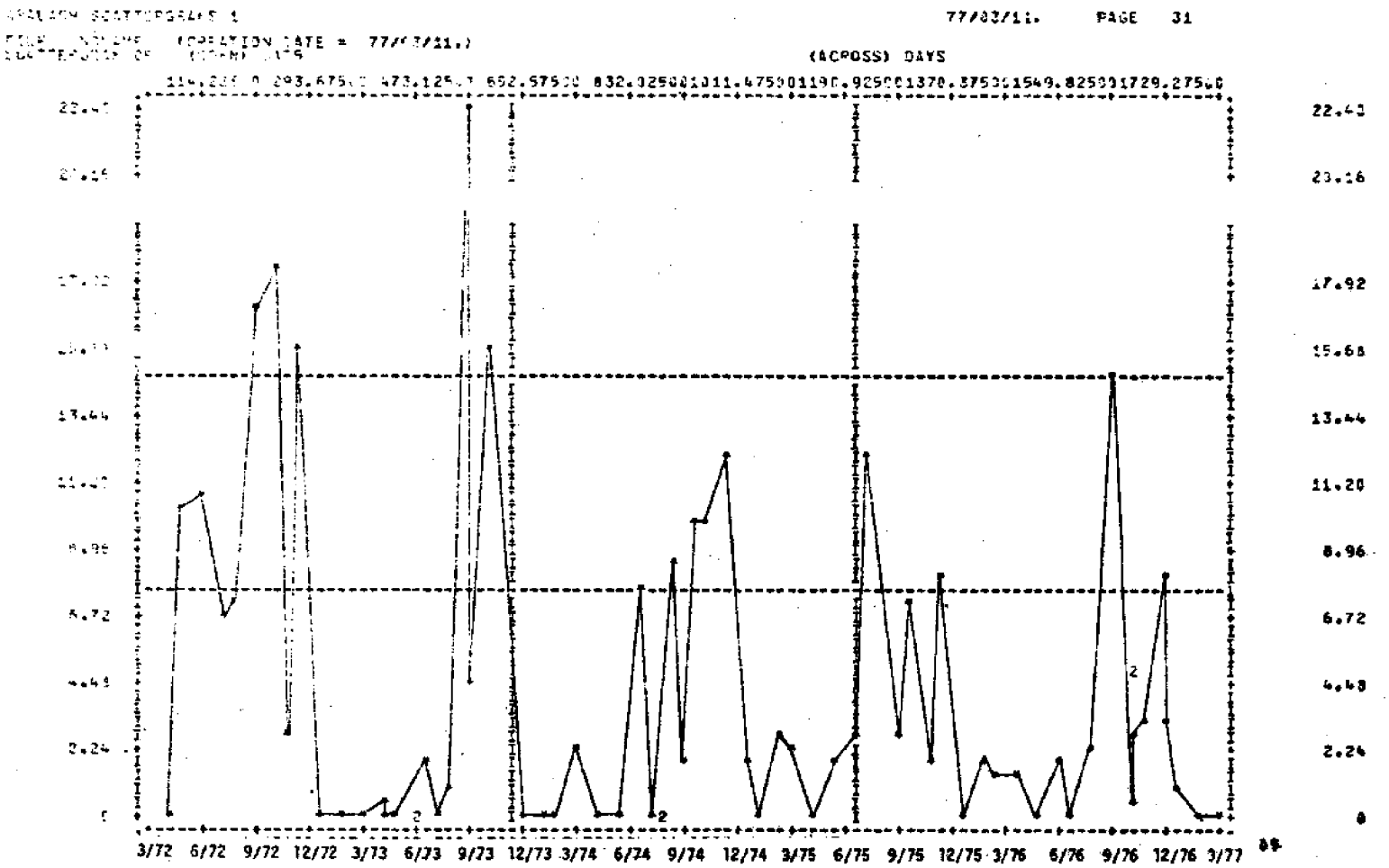
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R)-	-.22201	R SQUARED -	.04929	SIGNIFICANCE R -	.04411
STD ERR OF EST -	8.14624	INTERCEPT (A) -	19.11606	STD ERROR OF A -	2.09143
SIGNIFICANCE A -	.0471	SLOPE (B) -	-.00347	STD ERROR OF B -	.00220
SIGNIFICANCE B -	.04411				
PLOTTED VALUES -	61	EXCLUDED VALUES-	0	MISSING VALUES -	45

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 6: Surface salinity $^{o}/_{oo}$ at Station 5 (East Bay) from March, 1972 to March, 1977.



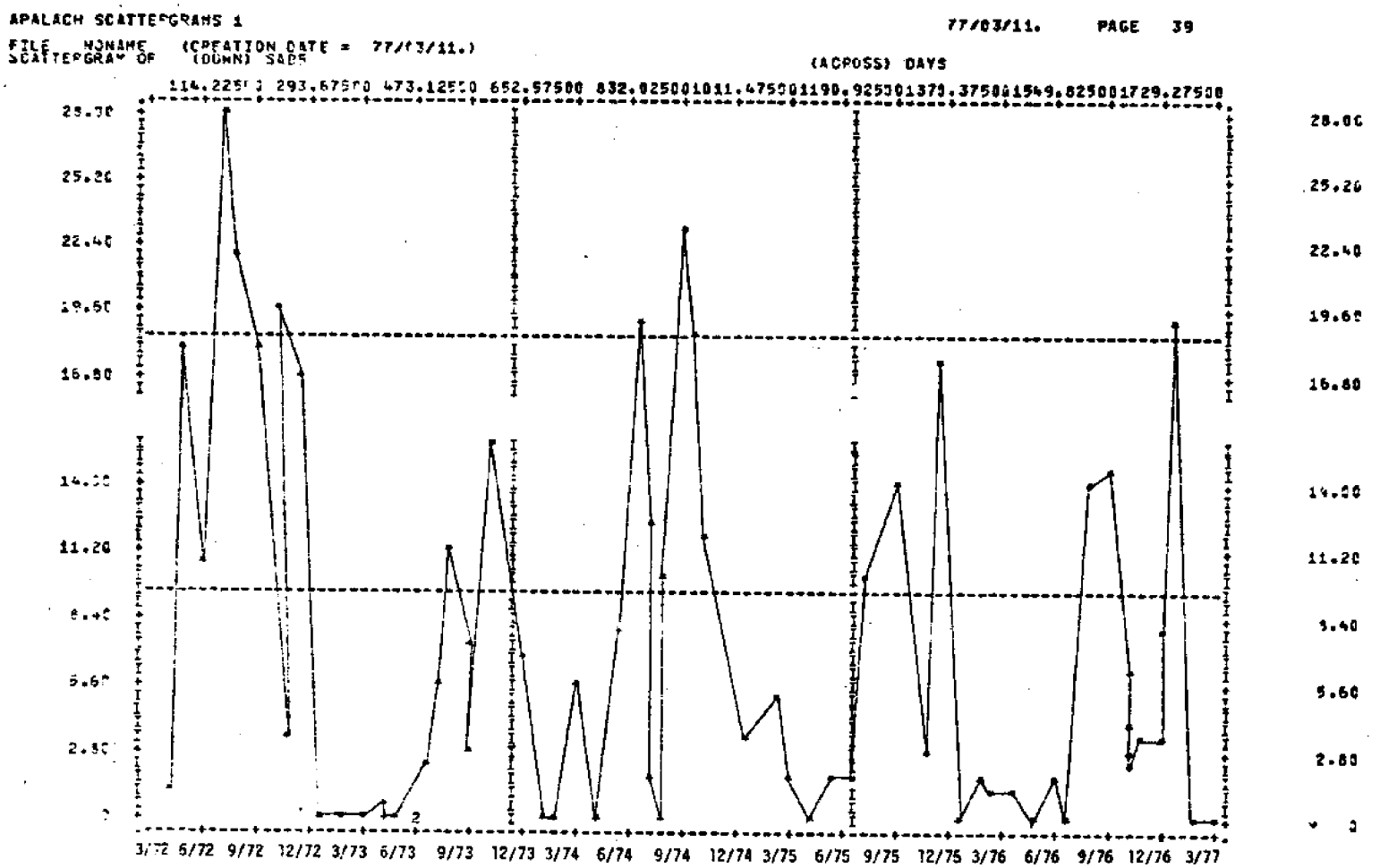
APALACHI SCATTERGRAMS 1

STATISTICS...

CORRELATION (R) =	-.19905	R SQUARED =	.03974	SIGNIFICANCE R =	.05651
STD ERR OF EST =	5.37693	INTERCEPT (A) =	6.06213	STD ERROR OF A =	1.33982
SIGNIFICANCE A =	.00011	SLOPE (B) =	-.00196	STD ERROR OF B =	.00123
SIGNIFICANCE B =	.05851				
PLOTTED VALUES =	7	EXCLUDED VALUES=	0	MISSING VALUES =	30

** ***** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 7; Bottom salinity $^{o}/_{oo}$ at Station 5 (East Bay) from March, 1972 to March, 1977.



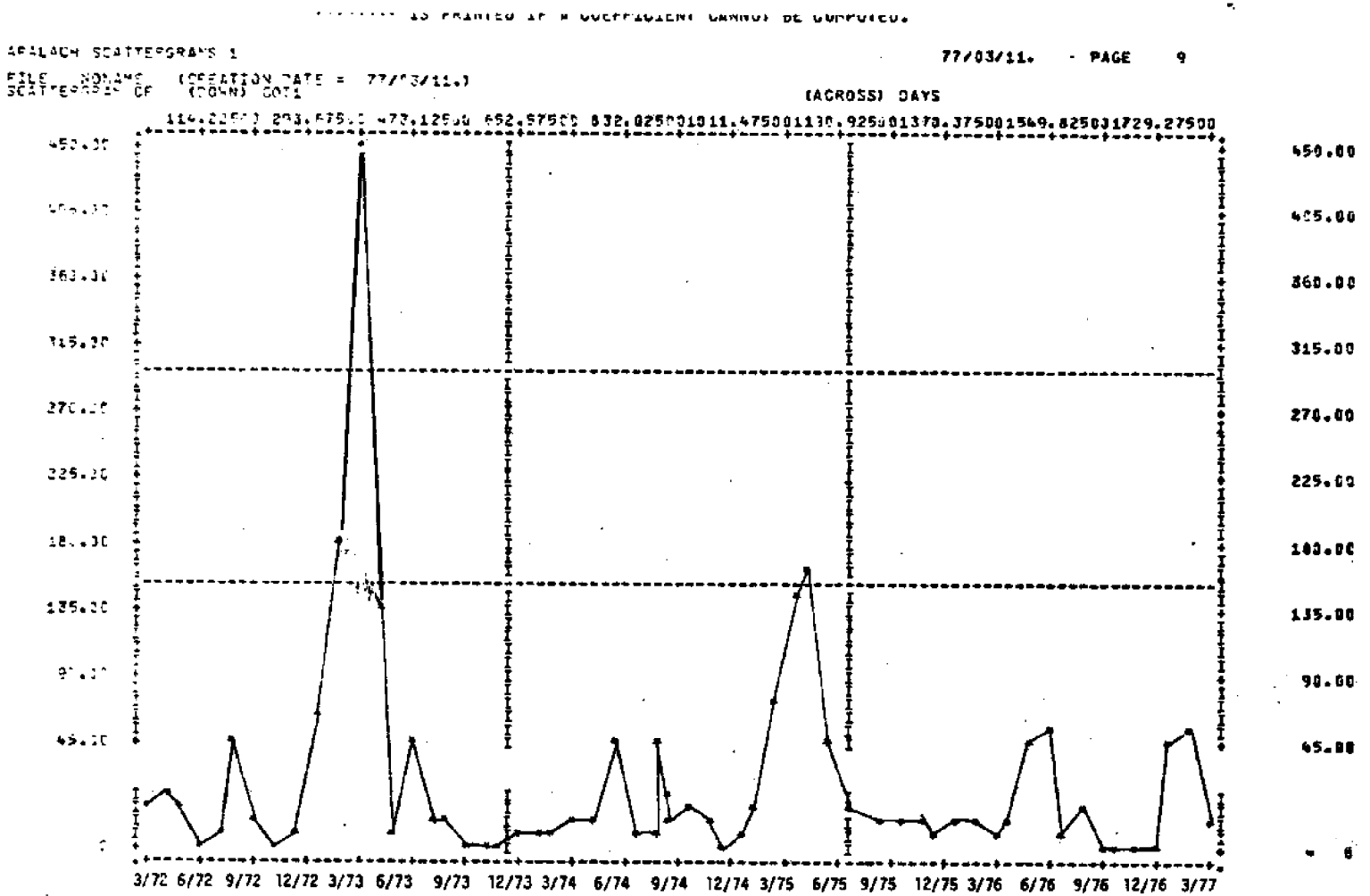
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) =	-.2[illegible]	R SQUARED =	.04036	SIGNIFICANCE R =	.05238
STD ERR OF EST =	7.[illegible]	INTERCEPT (A) =	9.48788	STD ERROR OF A =	1.54479
SIGNIFICANCE A =	.[illegible]	SLOPE (B) =	-.00279	STD ERROR OF B =	.00173
SIGNIFICANCE B =	.5284				
PLOTTED VALUES =	66	EXCLUDED VALUES =	0	MISSING VALUES =	39

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 8: Surface water color (Pt-Co units) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.

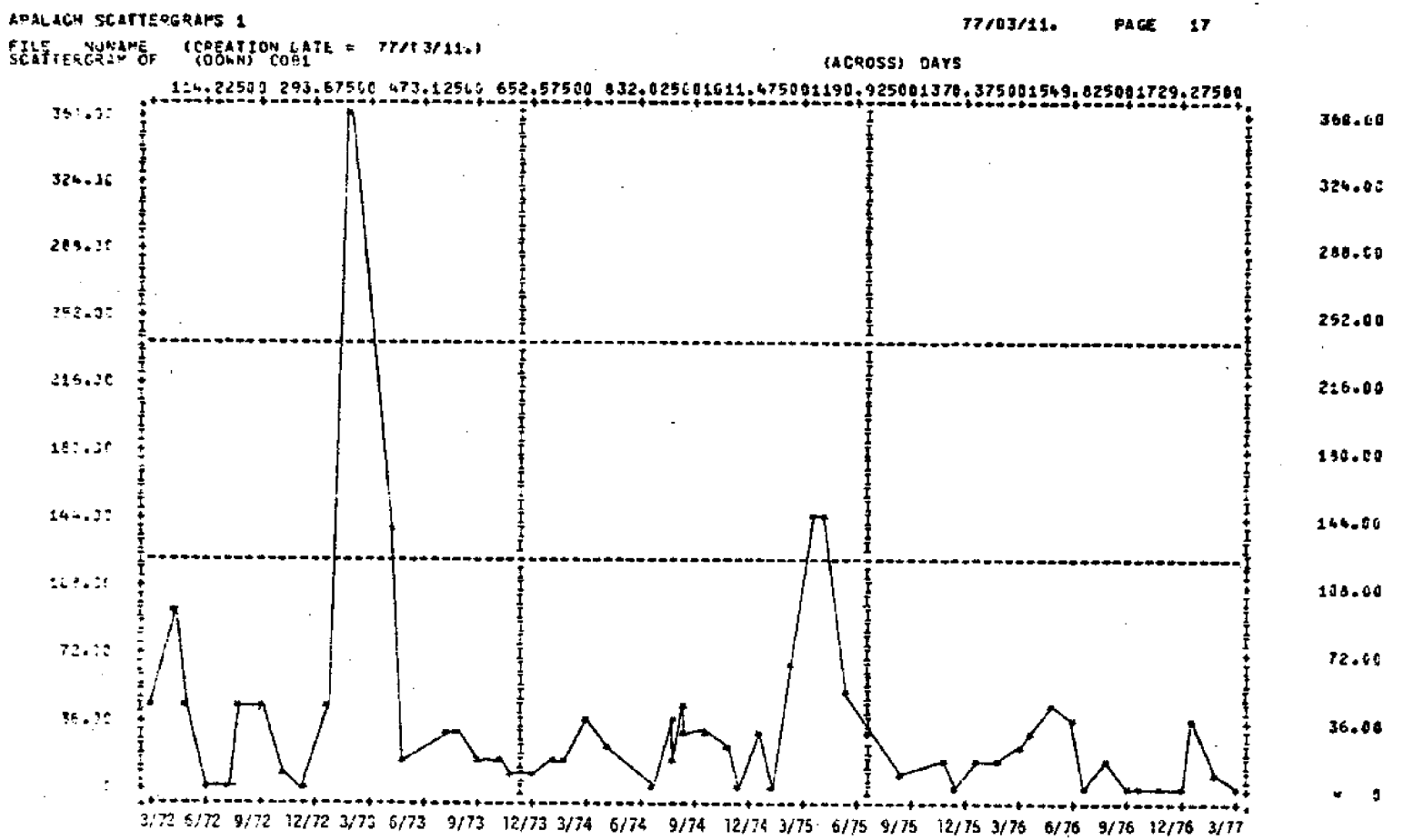


APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R)=	-.15400	R SQUARED =	.02372	SIGNIFICANCE R =	.12600
STD ERR OF EST =	66.13117	INTERCEPT (A) =	58.27630	STD ERROR OF A =	17.38341
SIGNIFICANCE A =	.[illegible]	SLOPE (B) =	-.01951	STD ERROR OF B =	.01643
SIGNIFICANCE B =	.12[illegible]				
PLOTTED VALUES =	59	EXCLUDED VALUES=	0	MISSING VALUES =	45

Fig. 9: Bottom water color (Pt-Co units) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.



APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

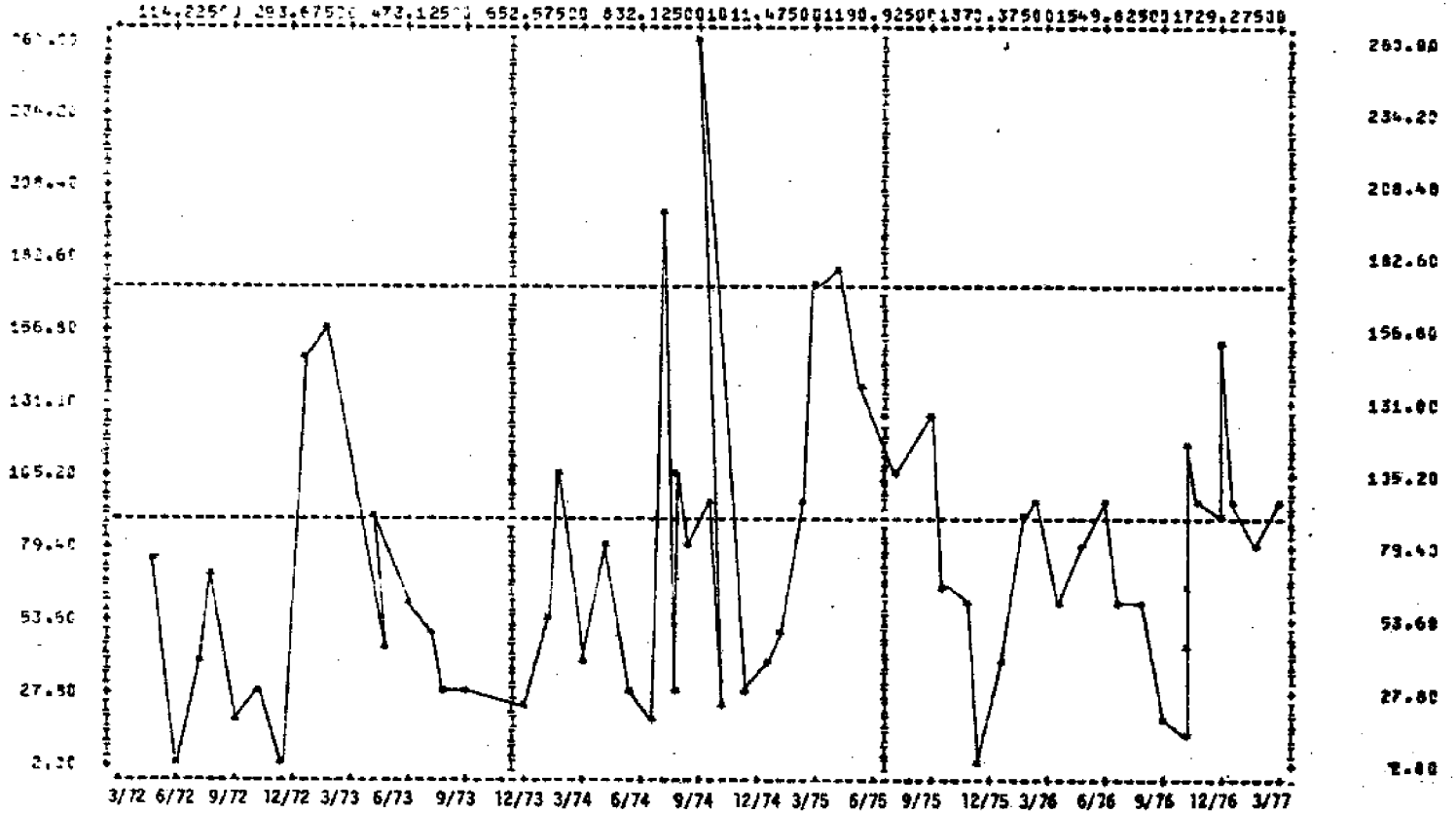
CORRELATION (R)=	-.24178	R SQUARED =	.05797	SIGNIFICANCE R =	.03693
STD ERR OF EST =	54.33729	INTERCEPT (A) =	68.01596	STD ERROR OF A =	14.78659
SIGNIFICANCE A =	.00108	SLOPE (B) =	-.02513	STD ERROR OF B =	.01179
SIGNIFICANCE B =	.03693				
PLOTTED VALUES =	96	EXCLUDED VALUES=	0	MISSING VALUES =	49

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 10: Surface water color (Pt-Co units) at Station 5 (East Bay) from March, 1972 to March, 1977.

APALACH SCATTERGRAMS 1 77/03/11. PAGE 27

FILE NONAME (CREATION DATE = 77/03/11.)
SCATTERGRAM OF (DOWN) COTS (ACROSS) DAYS



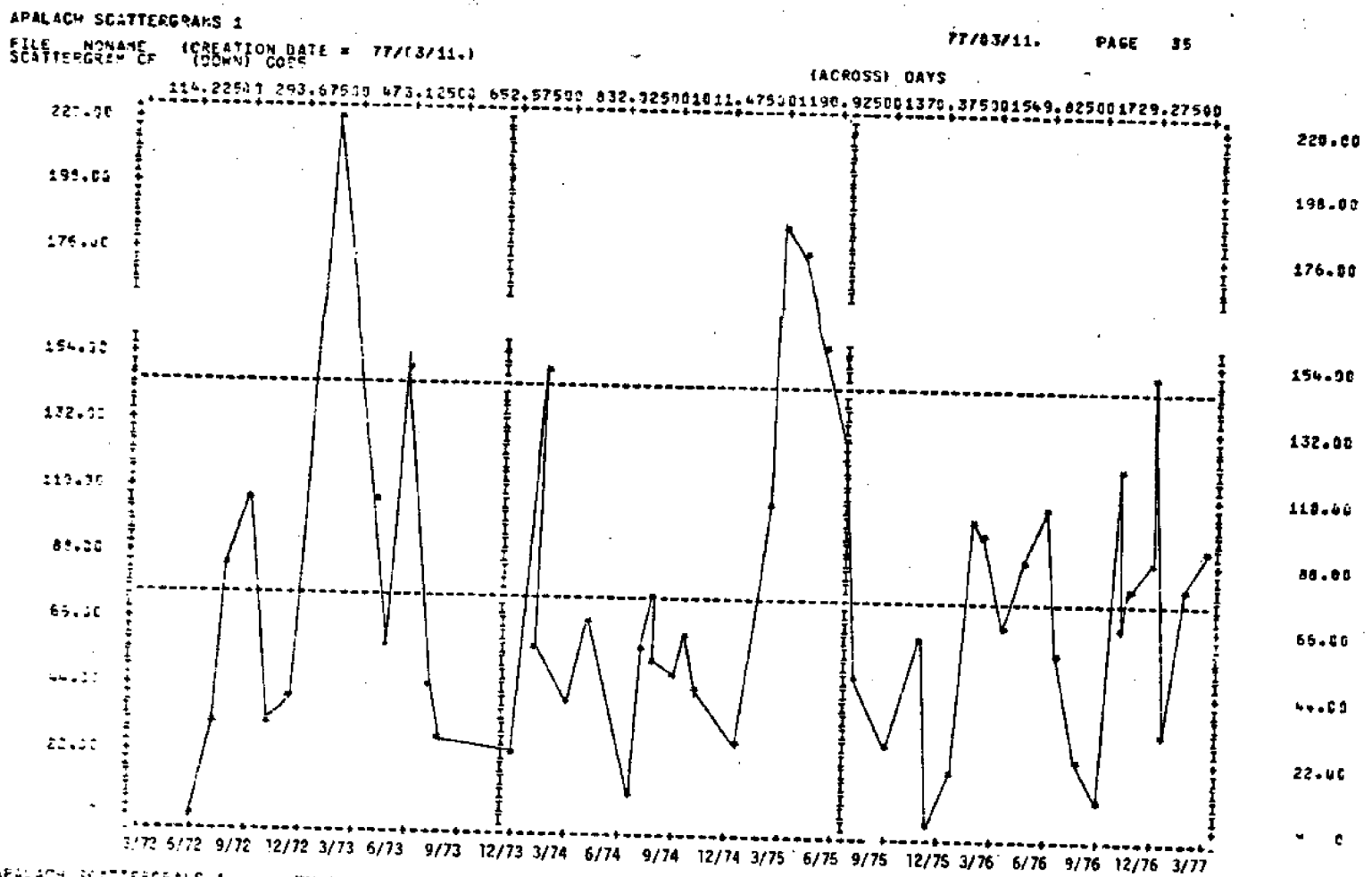
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) =	.16904	R SQUARED =	.02858	SIGNIFICANCE R =	.09640
STD ERR OF EST =	52.17412	INTERCEPT (A) =	59.47875	STD ERROR OF A =	14.93898
SIGNIFICANCE A =	.0001	SLOPE (B) =	.01718	STD ERROR OF B =	.01304
SIGNIFICANCE B =	.09640				
PLOTTED VALUES =	61	EXCLUDED VALUES=	0	MISSING VALUES =	44

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 11: Bottom water color (Pt-Co units) at Station 5 (East Bay) from March, 1972 to March 1977.



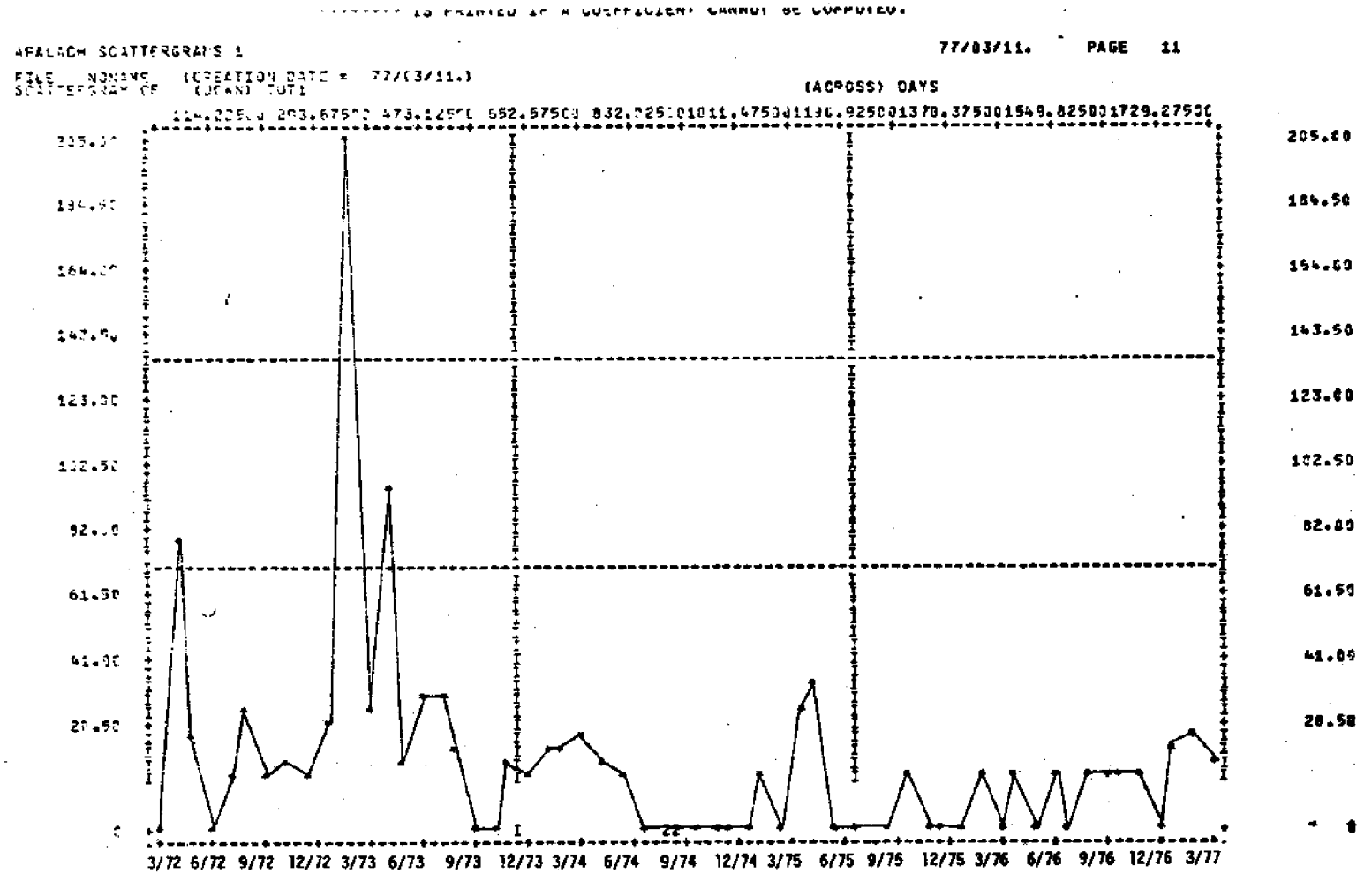
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) =	.03264	R SQUARED =	.00044	SIGNIFICANCE R =	.44057
STD DEV OF EST =	39.27644	INTERCEPT (A) =	72.29389	STD ERROR OF A =	15.84756
SIGNIFICANCE A =	.10072	SLOPE (B) =	.00201	STD ERROR OF B =	.01338
SIGNIFICANCE B =	.44057				
PLOTTED VALUES =	53	EXCLUDED VALUES =	0	MISSING VALUES =	52

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 12: Surface turbidity (J.T.U.) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.

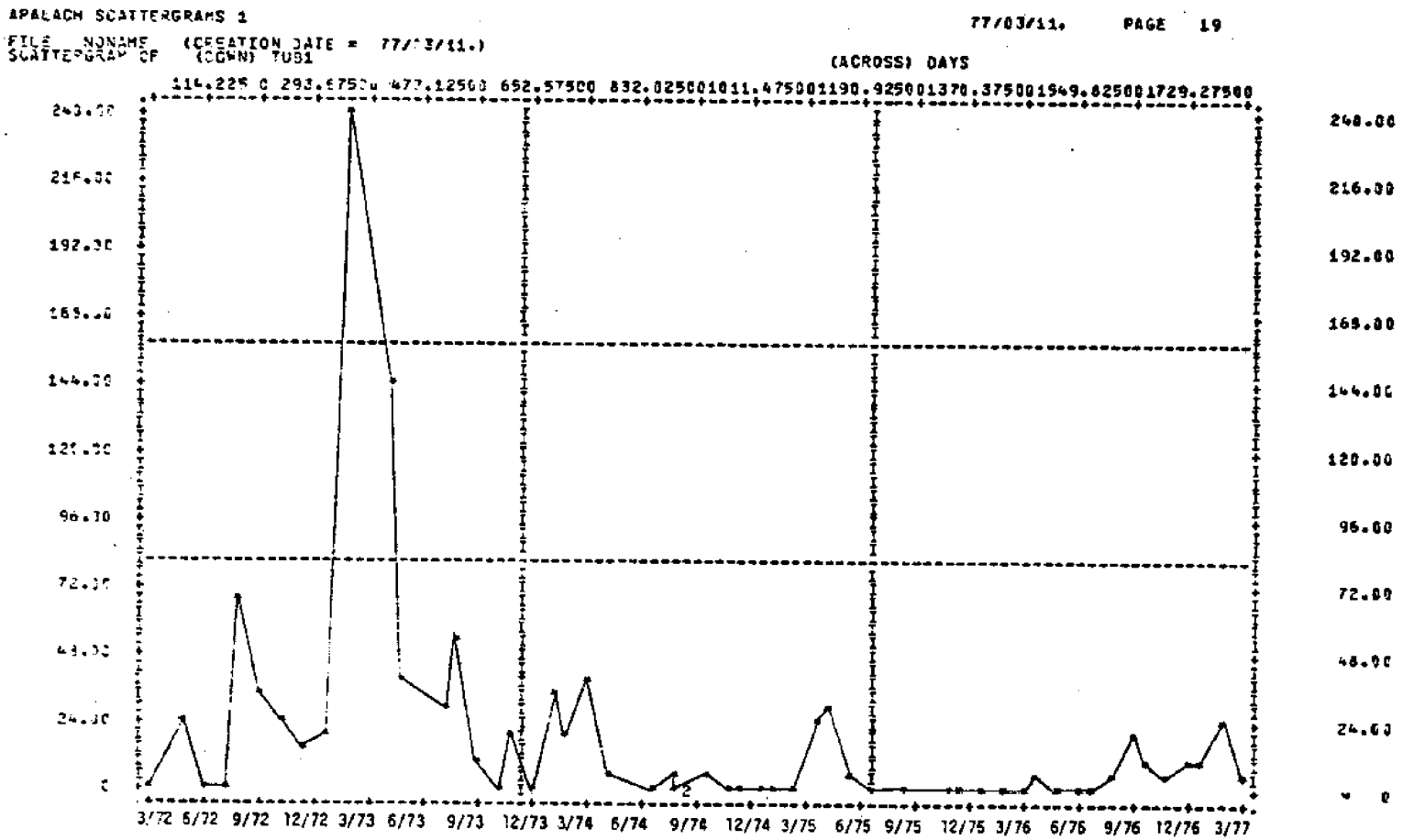


APALACH-SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) -	-.[illegible]	R SQUARED -	.00036	SIGNIFICANCE R -	.0000
STD ERR OF EST -	28.63485	INTERCEPT (A) -	30.44832	STD ERROR OF A -	7.57959
SIGNIFICANCE A -	.[illegible]	SLOPE (B) -	-.01723	STD ERROR OF B -	.00717
SIGNIFICANCE B -	.[illegible]				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	45

Fig. 13: Bottom turbidity (J.T.U.) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.



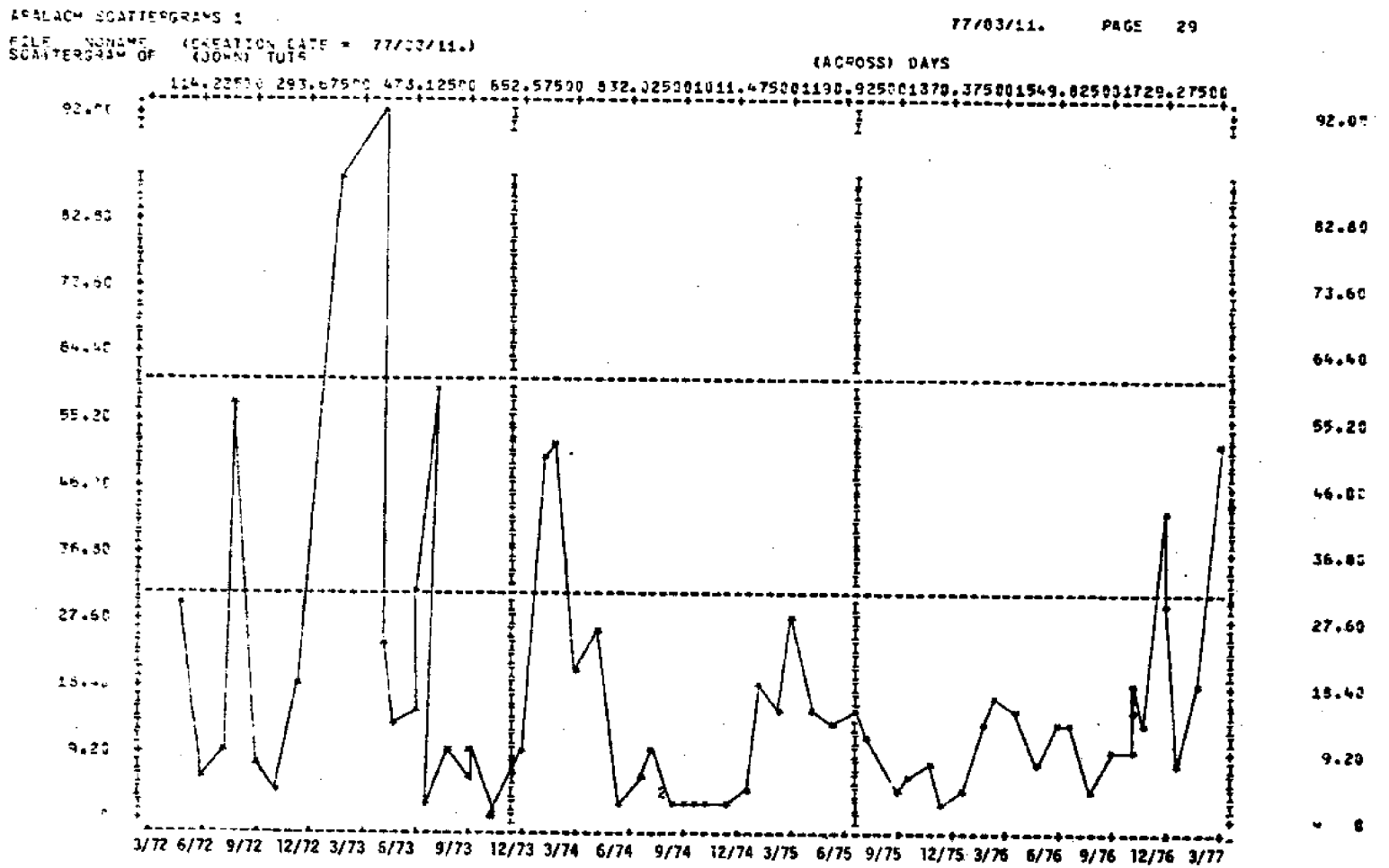
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) =	-.33267	R SQUARED =	.11067	SIGNIFICANCE R =	.00654
STD ERR OF EST =	76.71176	INTERCEPT (A) =	42.56471	STD ERROR OF A =	15.23514
SIGNIFICANCE A =	.0015	SLOPE (B) =	-.02429	STD ERROR OF B =	.0046
SIGNIFICANCE B =	.0054				
PLOTTED VALUES =	59	EXCLUDED VALUES=	0	MISSING VALUES =	50

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 14: Surface turbidity (J.T.U.) at Station 5 (East Bay) from March, 1972 to March, 1977.



APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R)=	-.18571	R SQUARED =	.03449	SIGNIFICANCE R =	.06929
STD ERR OF EST =	19.76693	INTERCEPT (A) =	25.11766	STD ERROR OF A =	5.20082
SIGNIFICANCE A =	.00001	SLOPE (B) =	-.00698	STD ERROR OF B =	.00465
SIGNIFICANCE B =	.06929				
PLOTTED VALUES =	65	EXCLUDED VALUES=	0	MISSING VALUES =	40

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 15: Bottom turbidity (J.T.U.) at Station 5 (East Bay) from March, 1972 to March, 1977.

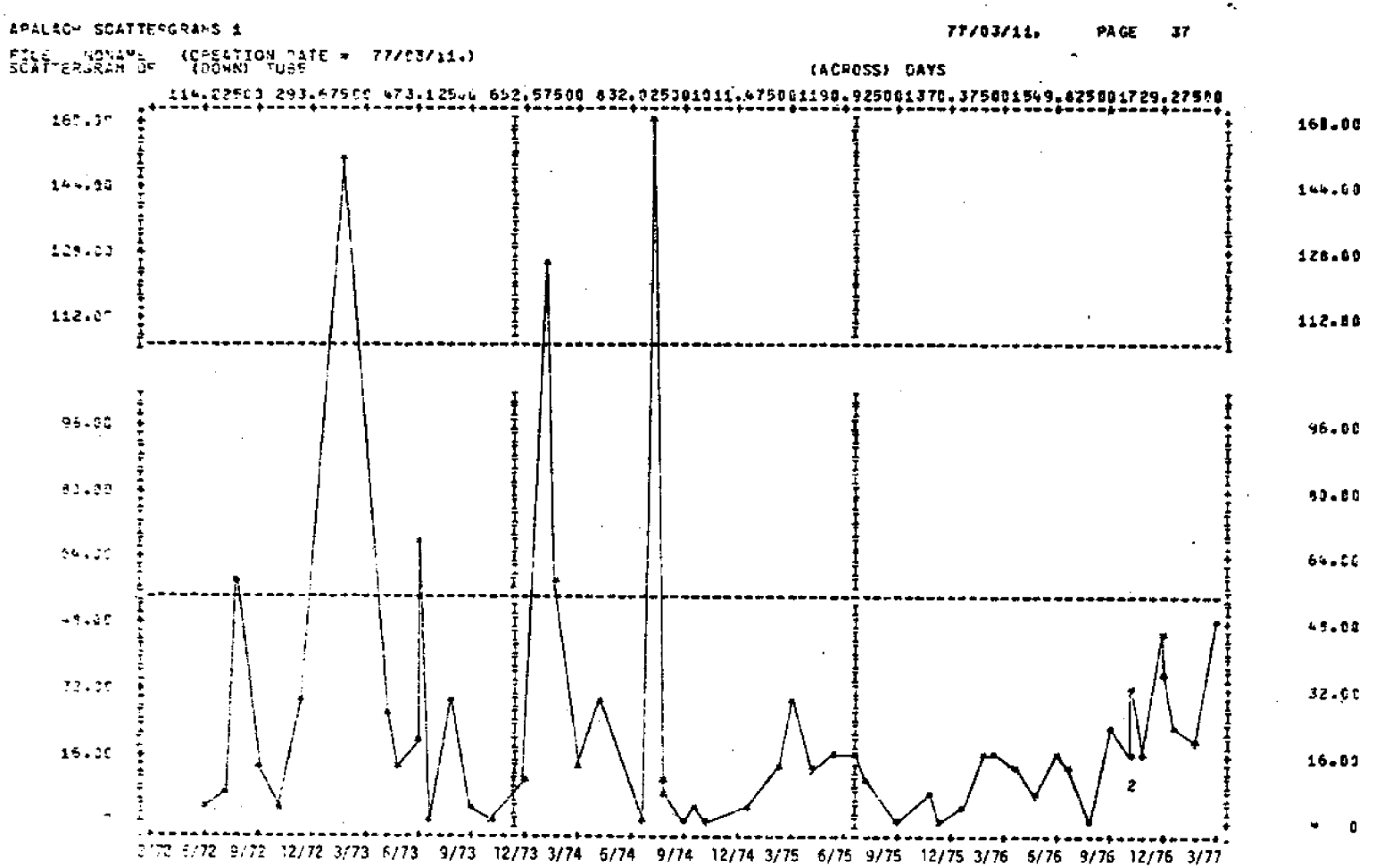


Fig. 16: Secchi disk readings (m) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.

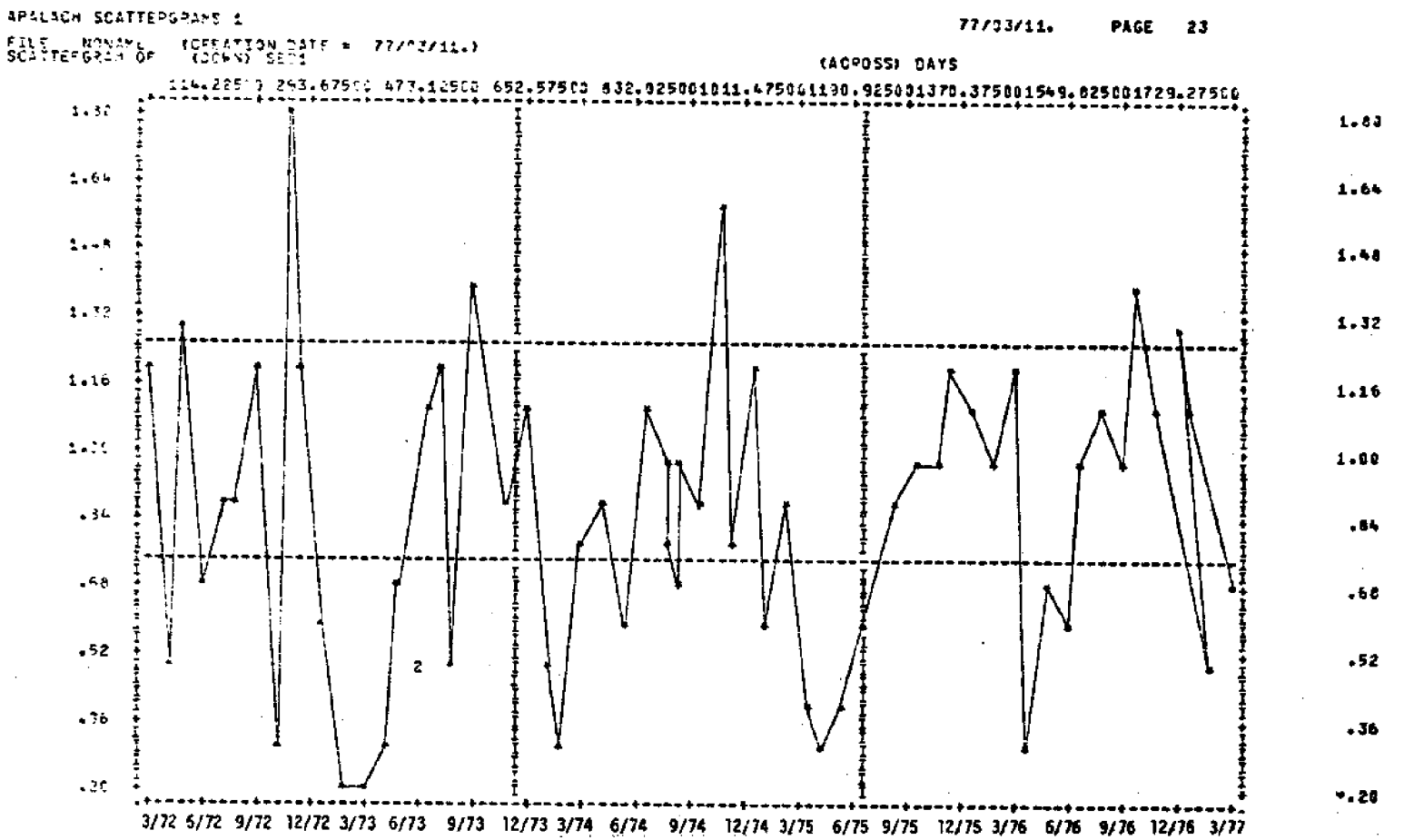
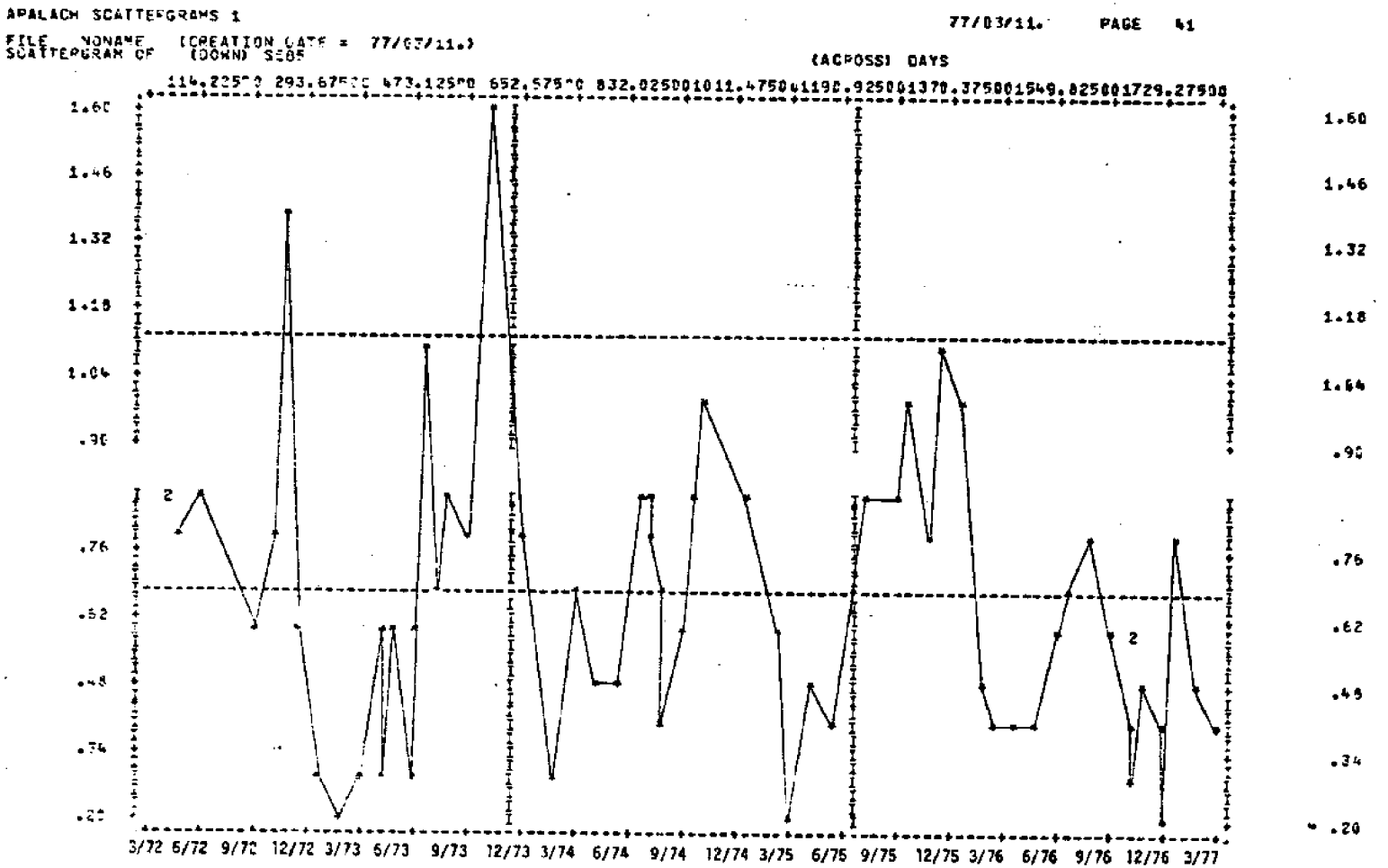


Fig. 17: Secchi disk readings (m) at Station 5 (East Bay) from March, 1972 to March, 1977.



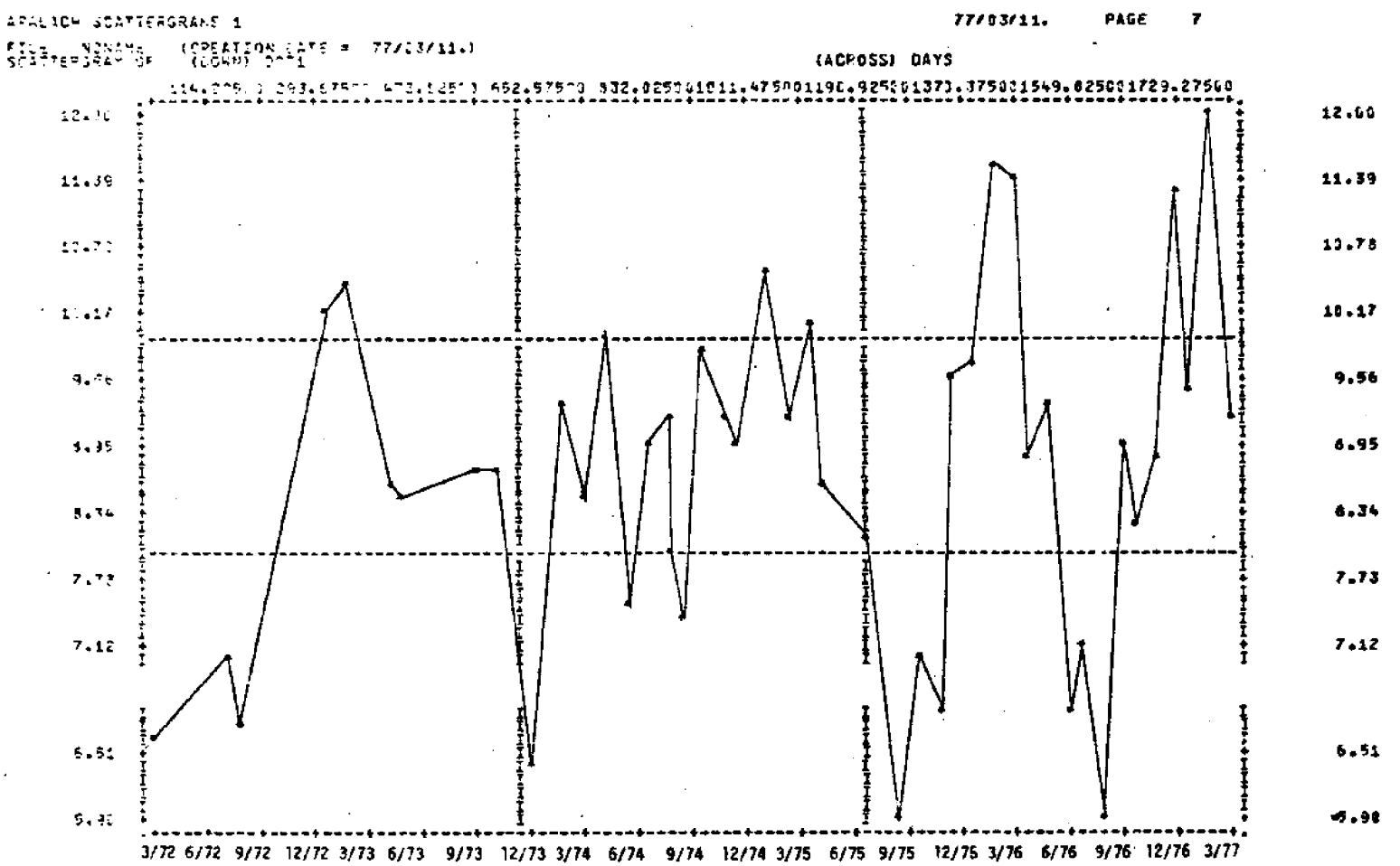
APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) =	-.22790	R SQUARED =	.05197	SIGNIFICANCE R =	.03602
STD ERR OF EST =	.27795	INTERCEPT (A) =	.77744	STD ERROR OF A =	.07212
SIGNIFICANCE A =	.70181	SLOPE (B) =	-.01012	STD ERROR OF B =	.00487
SIGNIFICANCE B =	.03602				
PLOTTED VALUES =	64	EXCLUDED VALUES=	0	MISSING VALUES =	41

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 18: Surface dissolved oxygen (PPM) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.



APALACH SCATTERGRAMS 1 TIME IN MONTHS: March, 1972 to February, 1977

STATISTICS..

CORRELATION (R) -	.22549	R SQUARED -	.05085	SIGNIFICANCE R -	.06823
STD ERR OF EST -	1.47497	INTERCEPT (A) -	8.05301	STD ERROR OF A -	.52971
SIGNIFICANCE A -	.0001	SLOPE (B) -	-.00069	STD ERROR OF B -	.00045
SIGNIFICANCE B -	.0926				
PLOTTED VALUES -	45	EXCLUDED VALUES-	0	MISSING VALUES -	60

Fig. 19: Bottom dissolved oxygen (PPM) at Station 1 (Apalachicola Bay) from March, 1972 to March, 1977.

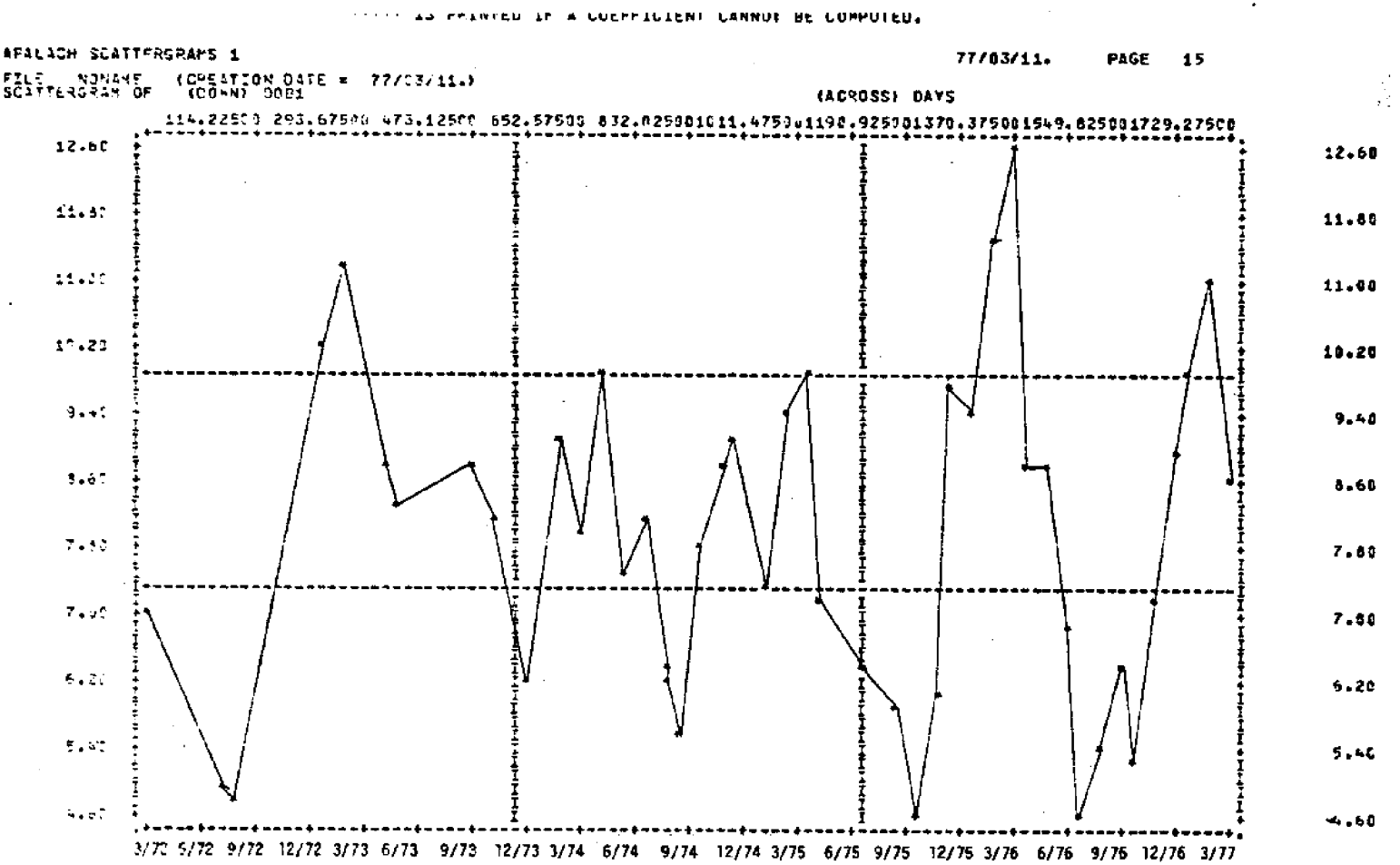


Fig. 20: Surface dissolved oxygen (PPM) at Station 5 (East Bay) from March, 1972 to March, 1977.

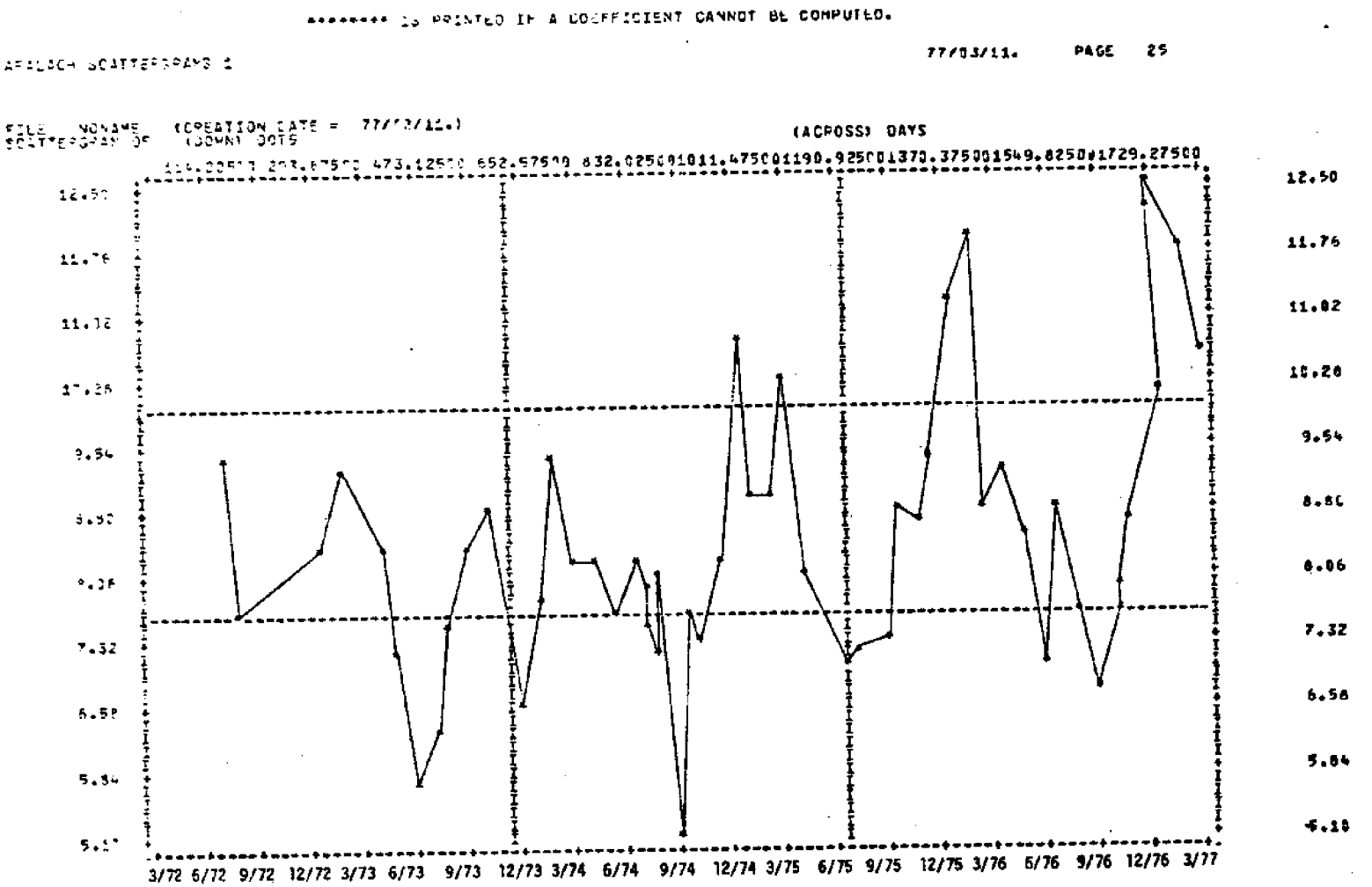


Fig. 21: Bottom dissolved oxygen (PPM) at Station 5 (East Bay) from March, 1972 to March, 1977.

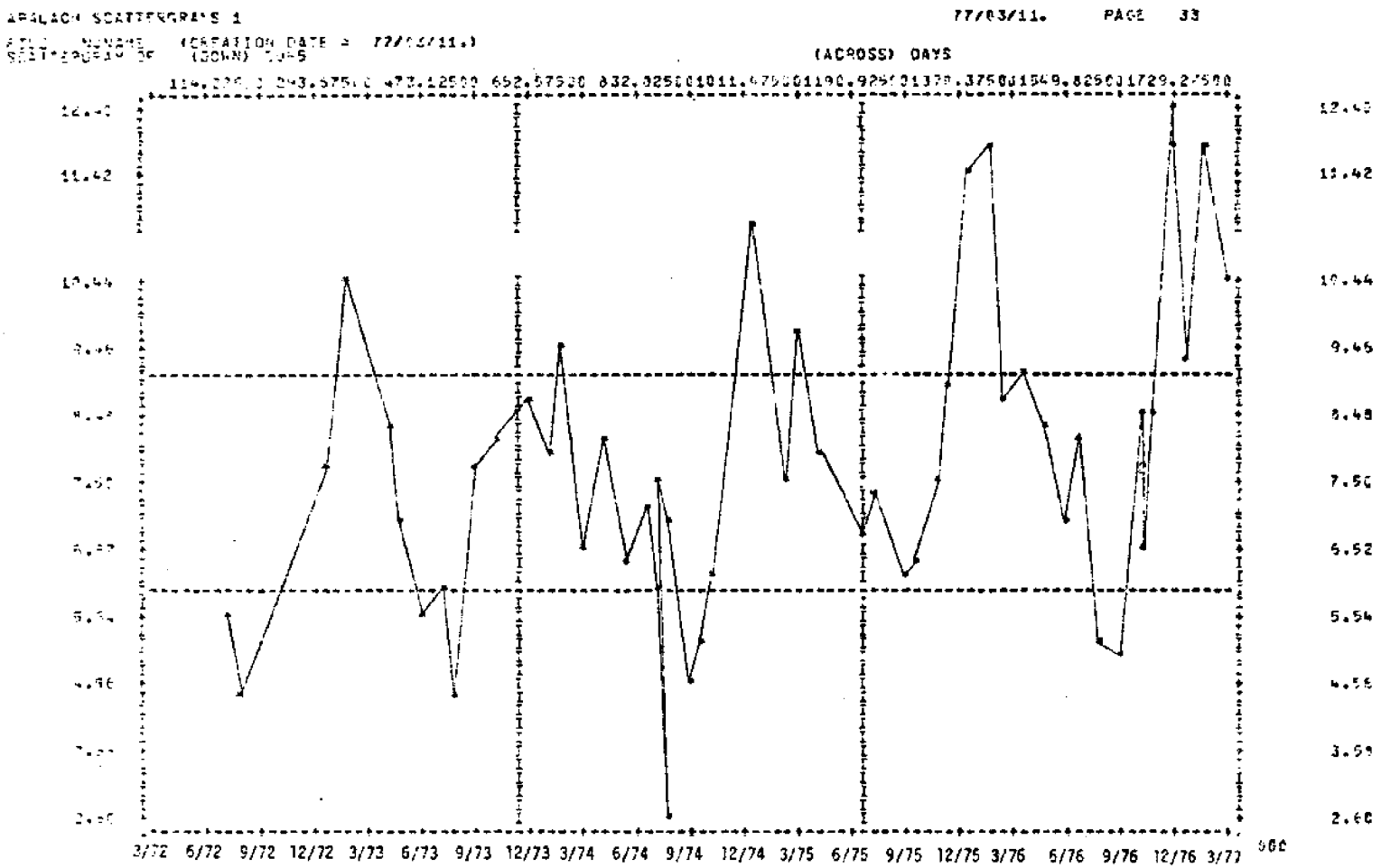
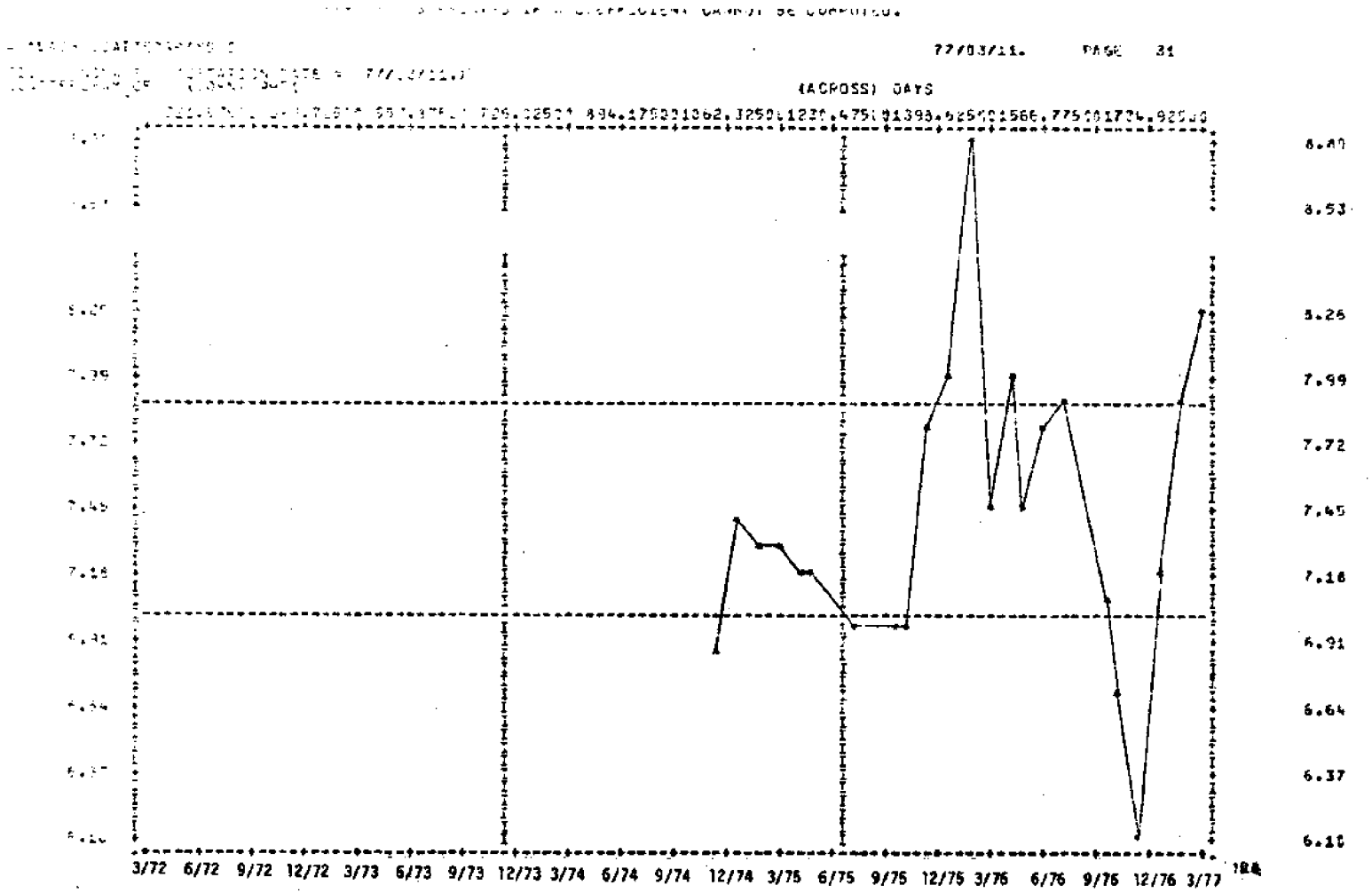


Fig. 22: Surface pH at Station 1 (Apalachicola Bay) from November, 1974 to March, 1977.



APALACH SCATTERGRAMS 2

STATISTICS..

CORRELATION (R) =	.17272	R SQUARED =	.02983	SIGNIFICANCE R =	.21533
STD ERR OF EST =	.75662	INTERCEPT (A) =	6.82676	STD ERROR OF A =	.75566
SIGNIFICANCE A =	.28164	SLOPE (B) =	.00042	STD ERROR OF B =	.00152
SIGNIFICANCE B =	.21533				
SCATTER VALUES =	23	EXCLUDED VALUES=	0	MISSING VALUES =	86

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 23: Bottom pH at Station 1 (Apalachicola Bay) from November, 1974 to March, 1977.

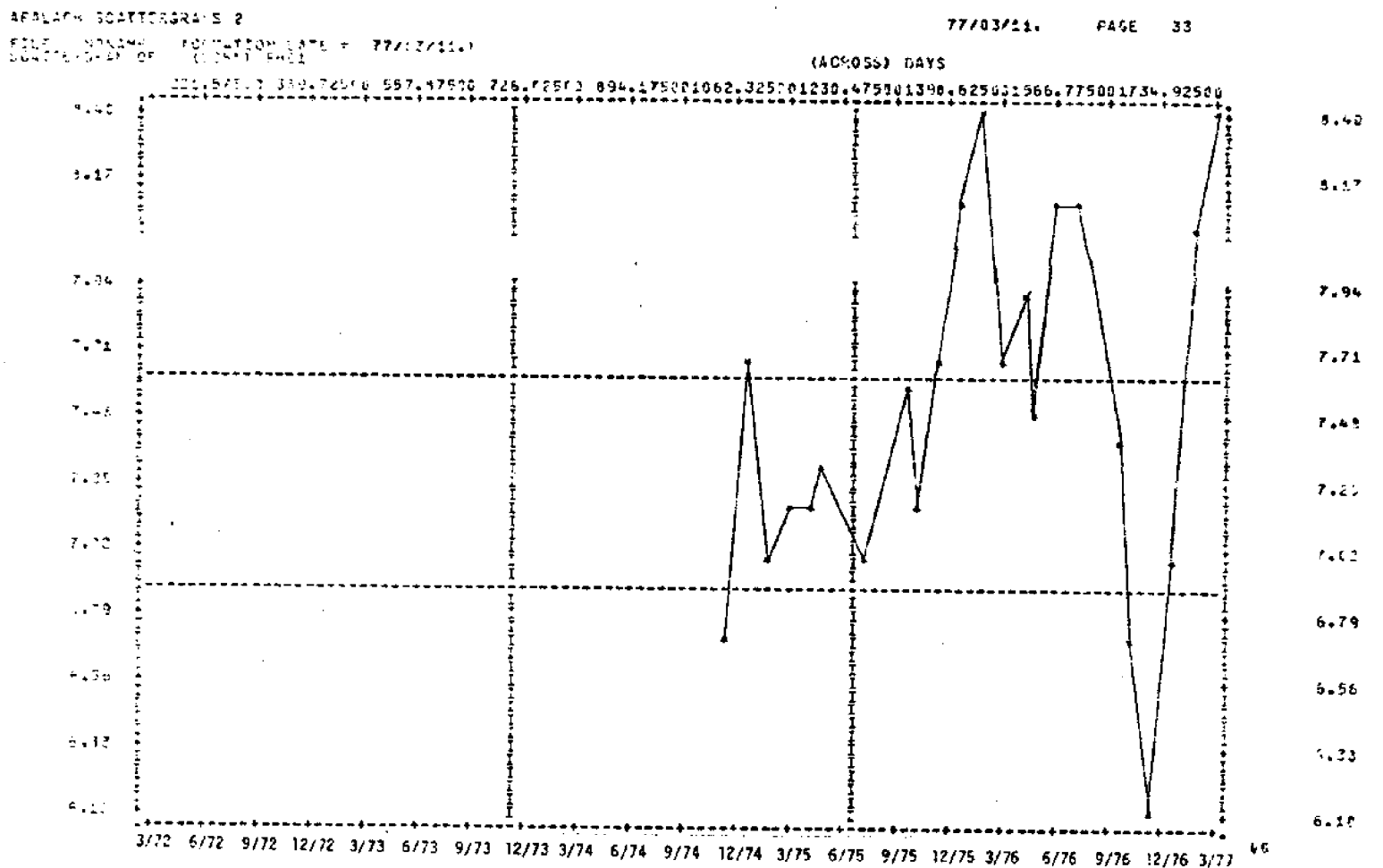
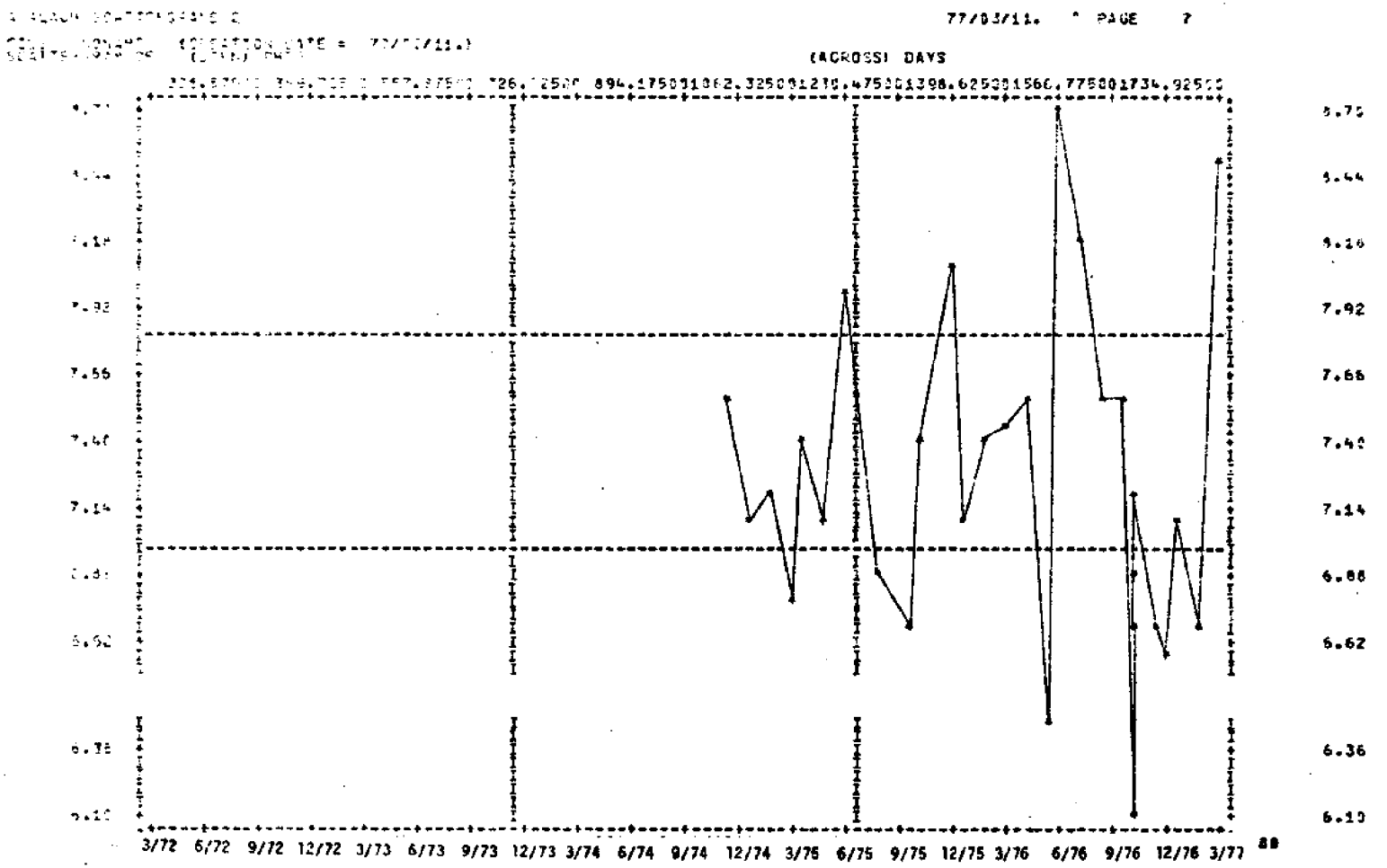


Fig. 24: Surface pH at Station 5 (East Bay) from November, 1974 to March, 1977



APALACH SCATTERGRAMS 2

STATISTICS..

CORRELATION (R)-	-.05780	R SQUARED -	.00335	SIGNIFICANCE R -	.38272
STD DEV OF Y -	.28295	INTERCEPT (A) -	7.49544	STD ERROR OF A -	.73775
SIGNIFICANCE A -	.10001	SLOPE (B) -	-.00915	STD ERROR OF B -	.00949
SIGNIFICANCE B -	.78272				
PLOTTED VALUES -	20	EXCLUDED VALUES-	0	MISSING VALUES -	80

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 25: Bottom pH at Station 5 (East Bay) from November, 1974 to March, 1977.

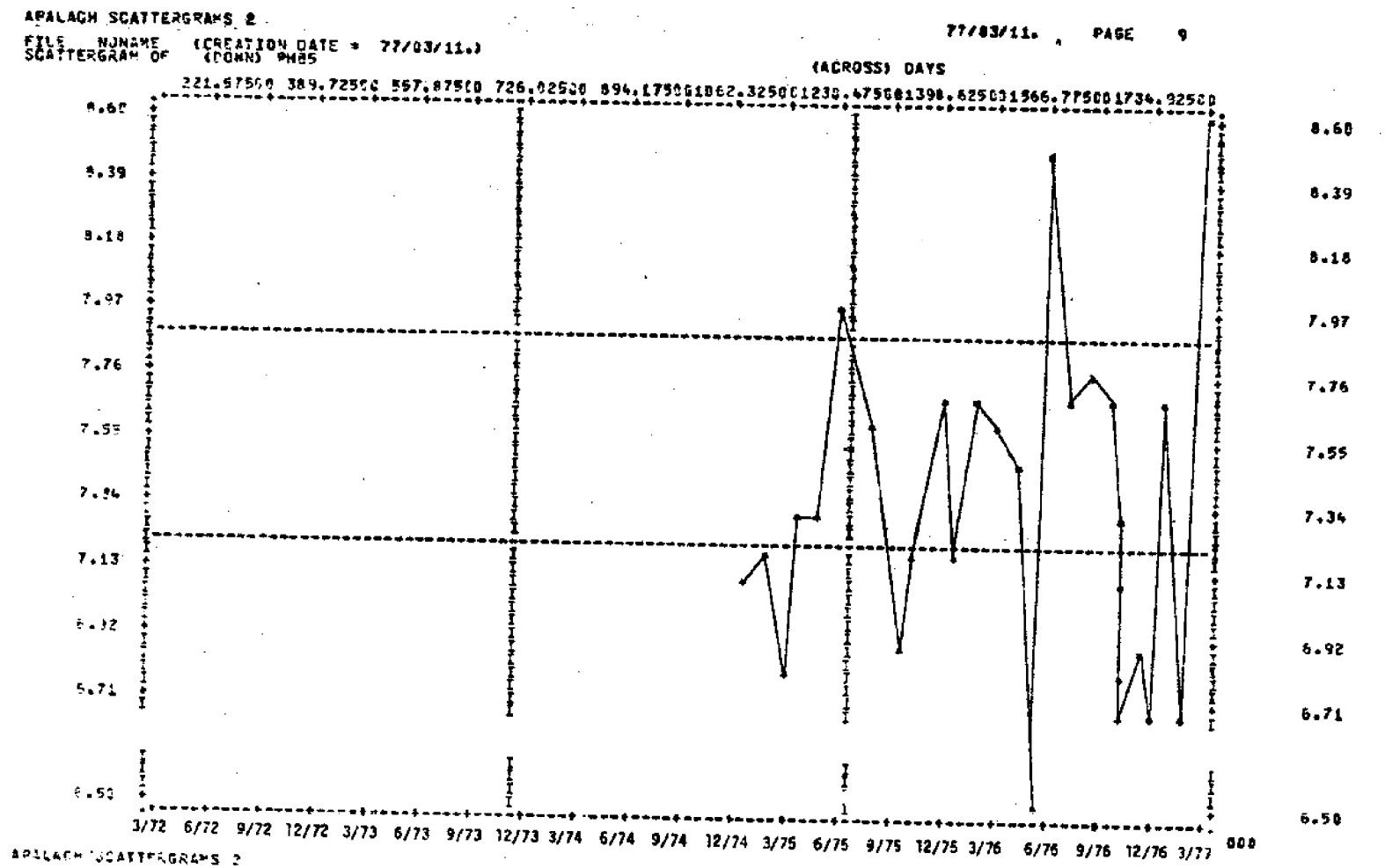
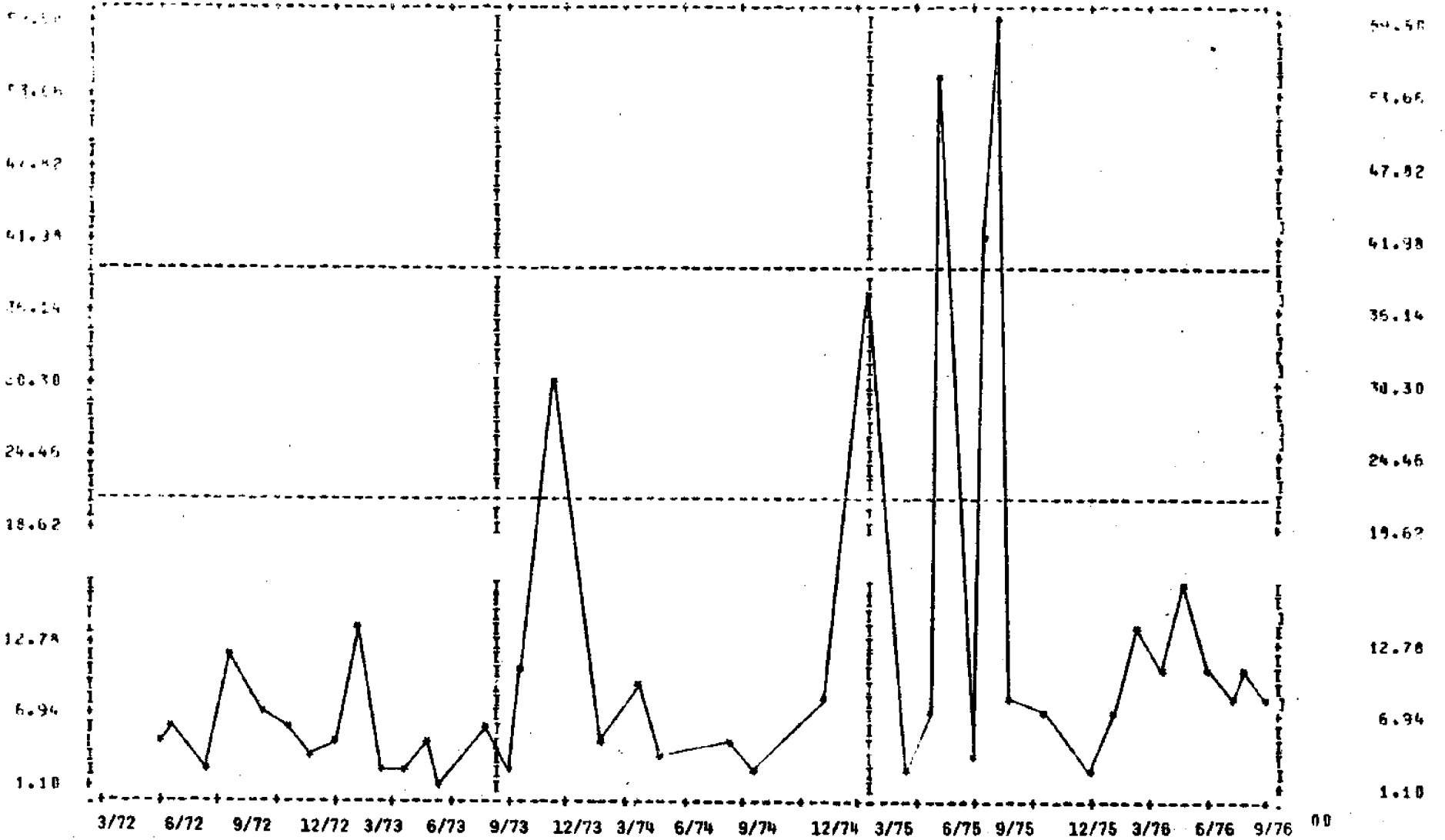


Fig. 26: Surface orthophosphate levels (µg/ℓ) at Station 2A (Apalachicola Bay) from June, 1972 to September, 1976.



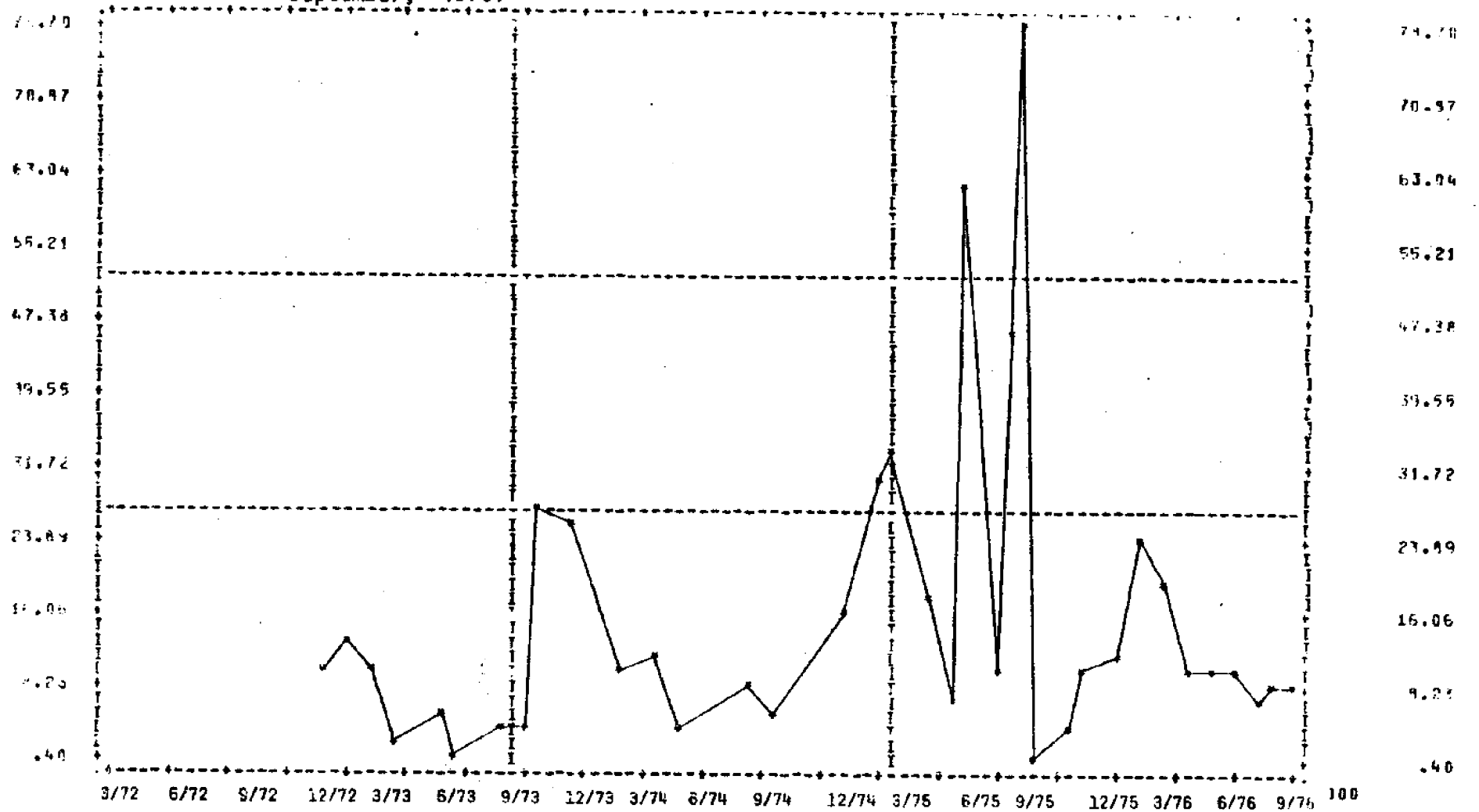
SCATTERGRAM IVERSON PHYSCHEM 77/07/23. PAGE 10

STATISTICS..

CORRELATION (R)-	.28148	R SQUARED -	.07923	SIGNIFICANCE R -	.03731
STD ERR OF EST -	13.24320	INTERCEPT (A) -	3.97436	STD ERROR OF A -	4.74998
SIGNIFICANCE A -	.20392	SLOPE (B) -	.00829	STD ERROR OF B -	.00451
SIGNIFICANCE B -	.03731				
PLOTTED VALUES -	41	EXCLUDED VALUES-	0	MISSING VALUES -	5

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Fig. 27: Surface orthophosphate levels (µg/ℓ) at Station 5 (East Bay) from November, 1972 to September, 1976.

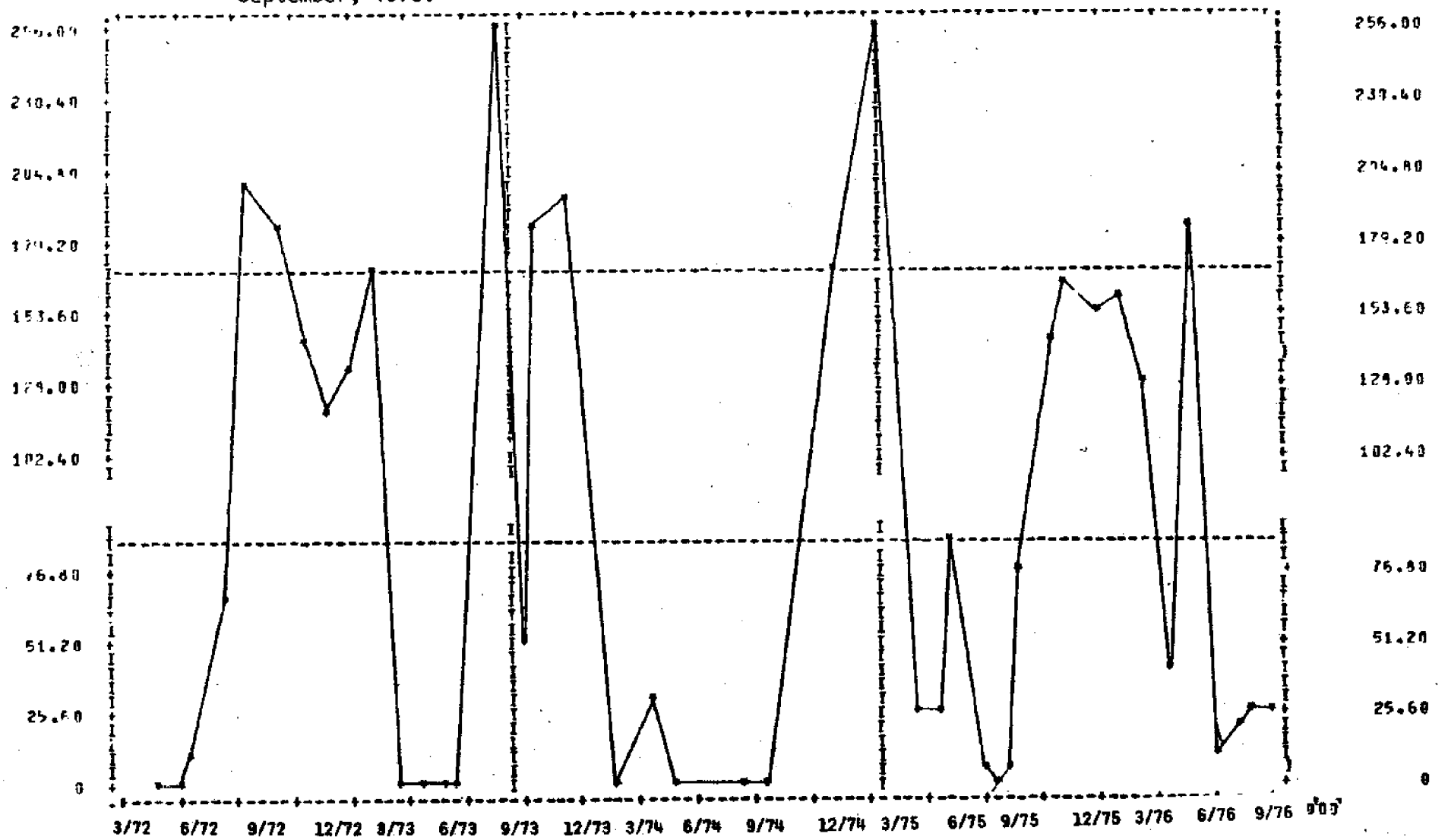


STICS..

RELATION (R)-	.17811	R SQUARED -	.02894	SIGNIFICANCE R -	.16362
D ERR OF EST -	16.82472	INTERCEPT (A) -	8.33982	STD ERROR OF A -	6.34373
IFICANCE A -	.16230	SLOPE (B) -	.90731	STD ERROR OF B -	.00726
[illegible] -	.16862				
ITED VALUES -	36	EXCLUDED VALUES-	0	MISSING VALUES -	10

******* IS A TYPED A COEFFICIENT CANNOT BE COMPUTED.

Fig. 28: Surface nitrate values (µg/ℓ) at Station 2A (Apalachicola Bay) from May, 1972 to September, 1976.

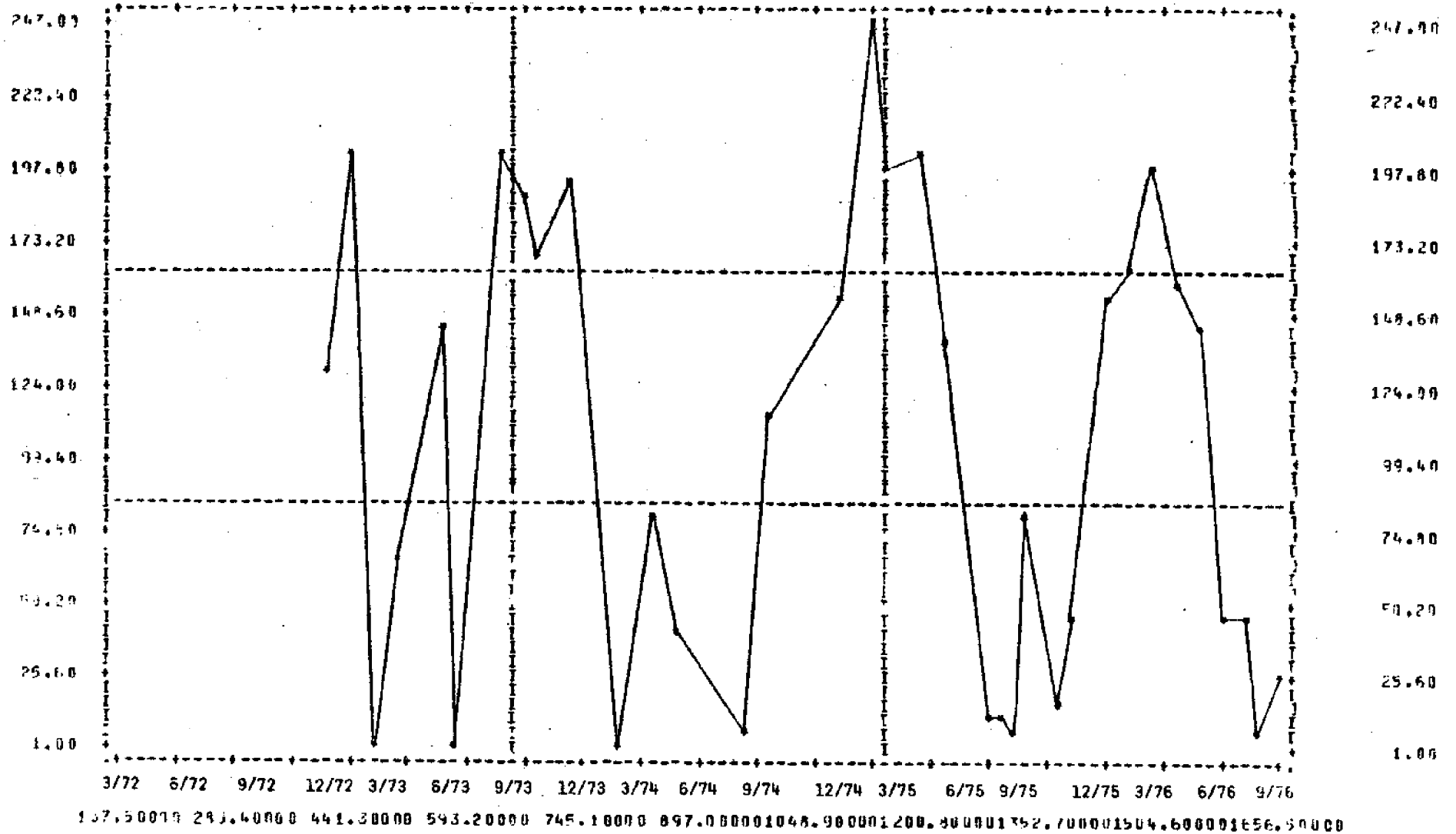


SCATTERPLOT EVERSON PHYSCHEM 77/03/23. PAGE 8

STATISTICS..

CORRELATION (R) -	-.03207	R SQUARED -	.00103	SIGNIFICANCE P -	.41910
STD ERR OF EST -	82.67656	INTERCEPT (A) -	87.76641	STD ERROR OF A -	28.30387
SIGNIFICANCE A -	.00174	SLOPE (B) -	-.00556	STD ERROR OF B -	.02704
SIGNIFICANCE B -	.41910				
PLOTTED VALUES -	41	EXCLUDED VALUES-	0	MISSING VALUES -	3

Fig. 29: Surface nitrate values (µg/ℓ) at Station 5 (East Bay) from October, 1972 to September, 1976.



197.50010 295.40000 441.30000 593.20000 745.10000 897.00000 1048.90000 1200.80000 1352.70000 1504.60000 1656.50000

PEARSON CORRELATION (R) -	-.15014	R SQUARED -	.02254	SIGNIFICANCE P -	.19466
STD ERR OF EST -	78.66238	INTERCEPT (A) -	136.90321	STD ERROR OF A -	39.10377
SIGNIFICANCE A -	.00068	SLOPE (B) -	-.02976	STD ERROR OF B -	.03411
SIGNIFICANCE B -	.19466				
PLOTTED VALUES -	39	EXCLUDED VALUES-	0	MISSING VALUES -	11

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

V. Phytoplankton Productivity and Nutrient Analysis

PHYTOPLANKTON ECOLOGY OF APALACHICOLA BAY, FLORIDA

Richard L. Iverson

Vernon B. Myers

Department of Oceanography

Florida State University

INTRODUCTION

Apalachicola Bay is a shallow, bar-built estuary approximately 12 miles long and 7 miles wide with a mean depth of 2.7 meters (M.L.W.). The bay is protected to the south by a line of barrier islands adjacent to the Gulf of Mexico (Fig. 1) and receives an average daily freshwater input of 22,000 cfs from the Apalachicola River (U.S. Geological Survey, 1971). Apalachicola Bay supports the major Florida oyster fishery (Colberg, et al., 1968; Menzel and Cake, 1969). Dawson (1955) investigated the hydrography of the bay while Gorsline (1963) described hydrographic and submarine geological features of the bay. Less than 7 percent of the bay bottom supports macrophyte growth (National Estuarine Study, 1970) suggesting that phytoplankton are the primary autotrophs in Apalachicola Bay. The investigation reported here was designed to determine patterns of phytoplankton standing crop and productivity as well as factors controlling phytoplankton productivity in Apalachicola Bay.

MATERIALS AND METHODS

Stations were set at various locations in Apalachicola Bay (Fig. 2) and sampling was started July, 1972. Water temperature and salinity were measured with a Beckman RS5-3 in situ CSTD. Solar radiation data was obtained from a pyrheliometer located at the FSU Marine Laboratory. Apalachicola River discharge, measured at a gauging station near Chattahoochee, Florida, was obtained from the U.S. Geological Survey. Samples for chemical and biological analysis were taken at the surface and bottom of the water column. Turbidity was measured with a Hach Model 2100A turbidimeter. Total carbon dioxide for use in computing phytoplankton productivity data was measured with an Oceanography

International carbon analyzer using the method of Menzel and Vaccaro (1964). Nutrient samples were filtered through pre-washed Whatman GF/A glass fiber filters and poured into nalgene bottles. After addition of 1 ml of a 2 percent (w/v) solution of mercuric chloride, the samples were placed on ice where they were kept until analyzed. Molybdate-reactive phosphorus was measured using the Murphy and Riley method (Strickland and Parsons, 1972). Nitrate was analyzed with a modification of the Morris and Riley method (Strickland and Parsons, 1972) Nitrite was measured with the Bendschneider-Robinson method (Strickland and Parsons, 1972). Reactive silicate was measured according to the Mullin-Riley method with modifications as given in Strickland and Parsons (1972).

Five hundred milliliters of water were passed through a Whatman GF/A glass fiber filter for chlorophyll analysis with the spectrophotometric method given in Strickland and Parsons (1972). Phytoplankton productivity was measured with the carbon-14 method (Steeman-Nielsen, 1952). Samples were incubated in situ for about three hours after which the contents of the 180 ml incubation bottles were filtered through Whatman GF/C scintillation grade glass fiber filters. Radiocarbon activity on the filters was measured by liquid scintillation spectrometry using Aquasol as the scintillation cocktail. One hundred millliliter aliquotes of bay water were filtered through Millipore 0.45 micron filters for analysis of phytoplankton species composition by the method of McNabb (1960). Nutrient enrichment experiments were conducted with water from East Bay and from Apalachicola Bay using modifications of the methods of Ryther and Guillard (1959) and Menzel and Ryther (1961). (See appendices I and II for details of the methods).

RESULTS AND DISCUSSION

The circulation of surface waters of Apalachicola Bay is controlled by wind (Fig. 2). Bottom circulation was uncoupled from wind except following periods when wind speeds were high enough to mix the water column.

River discharge is the primary factor which controls nutrient concentrations in Apalachicola Bay (Table 1). Surface nitrate concentrations in both East Bay and Apalachicola Bay were highest during winter periods of maximum river discharge (Fig. 3, 4). An increase in surface phosphate concentration was also observed during winter periods of maximum river discharge (Fig. 5,6). Maxima in phosphate contentrations observed during 1976 were the result of wind-mixing of sediments into the water column during periods of strong winds over the bay (Myers, manuscript in preparation). Phosphate maxima of this magnitude are not observed in the data record prior to 1976 since boats available for use were not capable of operation during periods of high winds. There do not appear to have been significant changes in yearly cycles of surface nitrate or phosphate concentrations at these two stations over the sampling period.

Surface phytoplankton productivity patterns exhibit maxima in the spring and minima in the fall and winter (Fig. 7,8). Results of nutrient enrichment experiments suggest that nutrients are not limiting for phytoplankton productivity during the winter but are limiting during the summer (Estabrook, 1973). An extensive investigation of summer nutrient limitation revealed that phosphate was the primary nutrient limiting phytoplankton productivity both in East Bay and in Apalachicola Bay with nitrate limiting productivity with frequency less than phosphate in

Apalachicola Bay (Appendices I and II). Water temperature is a major factor which limits phytoplankton productivity in this estuarine system (Fig. 9).

Chlorophyll *a* can be used to estimate phytoplankton biomass (Lorenzen, 1968). A comparison of surface chlorophyll *a* values reveals a general decrease in maximum values for Apalachicola Bay (Fig. 10) compared to East Bay (Fig. 11). Further data analysis will be required to determine the cause of this apparent decrease.

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TABLE 4

CORRELATION COEFFICIENTS OF LINEAR REGRESSIONS OF NITRATE, ORTHOPHOSPHATE, SILICATE, AND AMMONIA ON SALINITY

Date		NO_3	PO_4	SiO_3	NH_3
Oct 14, 1972	T	-.70	-.73		
	B	+.12	-.14		
Dec 2, 1972	T	-.88	-.20	-.98	
	B	-.75	-.55	-.85	
Jan 6, 1973	T	-.55	-.89	-.99	
	B	-.84	-.82	-.87	
Feb 17, 1973	T	+.002	-.95	-.33	-.02
	B	+.58	-.11	-.002	-.15
Mar 19, 1973	T	-.95	-.78	-.98	-.85
	B	-.97	-.60	-.998	-.45
Apr 22, 1973	T	-.76	-.77	-.93	-.67
	B	-.62	-.62	-.80	-.93
May 19, 1973	T	-.88	-.54	-.998	-.48
	B	-.96	-.65	-.99	-.81
Jun 11, 1973	T	-.60	-.01	-.995	-.55
	B	-.94	-.61	-.93	+.06
Jul 12, 1973	T	-.82	-.10	-.97	-.82
	B	-.80	+.42	-.93	+.03
Aug 22, 1973	T	-.90	+.04	-.95	-.50
	B	-.91	-.84	-.94	-.91
Sep 10, 1973	T	-.99	-.29	-.995	-.83
	B	-.98	+.15	-.99	-.98

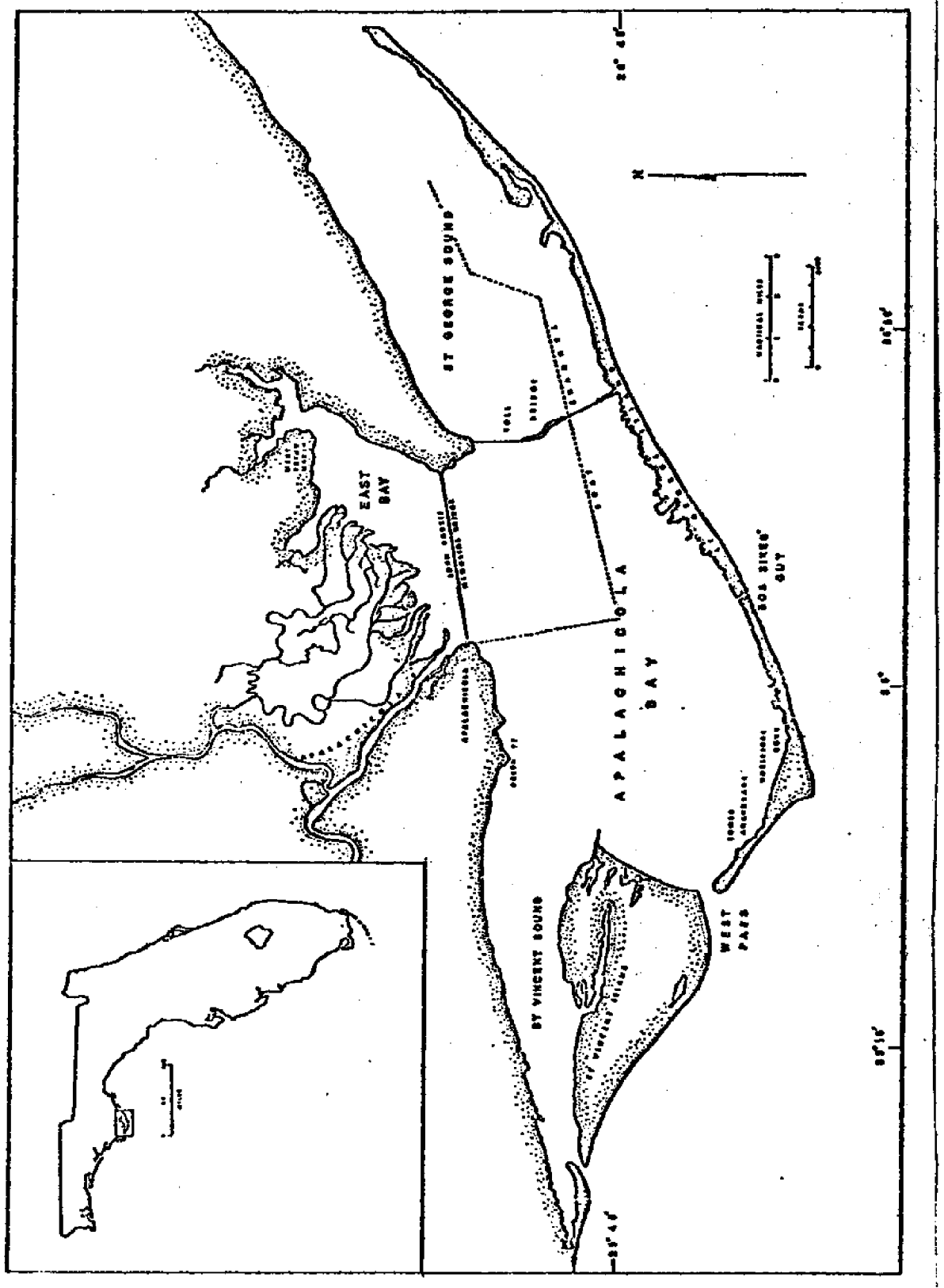

Figure 1. Map of Apalachicola Bay

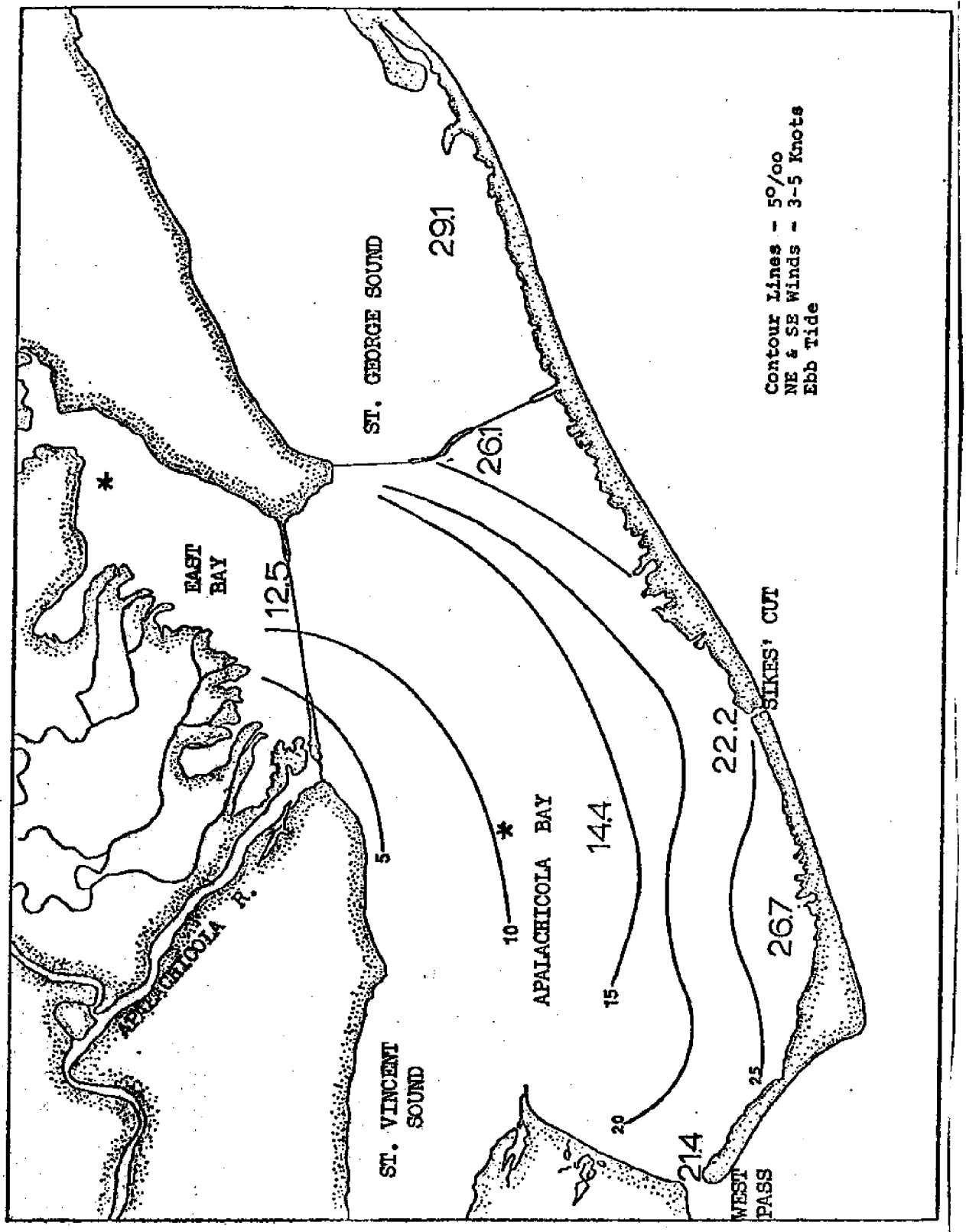

Figure 2. Surface salinity isopleths. East Bay and Apalachicola Bay sample locations are indicated asterisks.

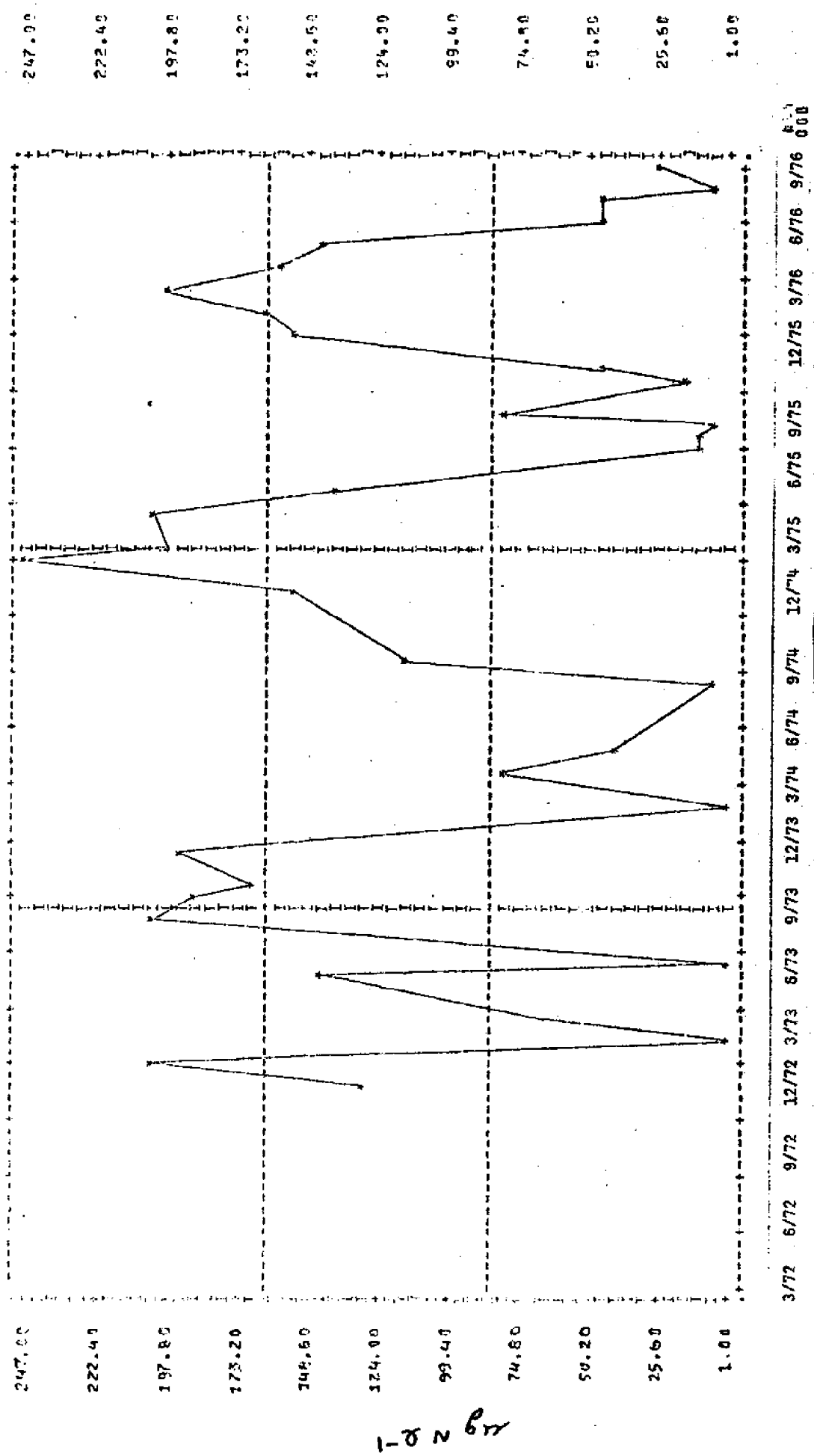

Figure 3. Surface nitrate-nitrogen in East Bay.

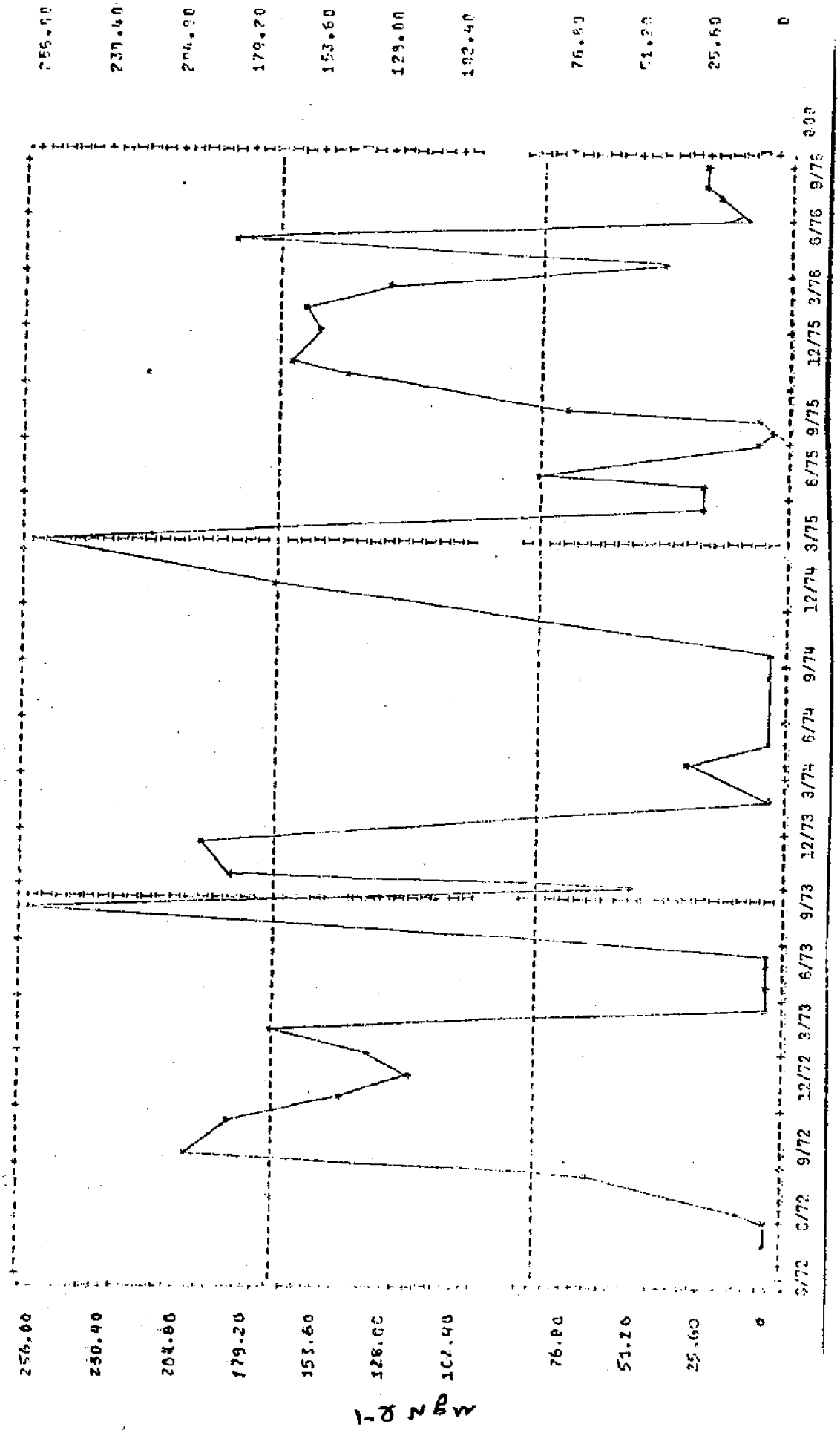

Figure 4. Surface nitrate-nitrogen in East Bay.

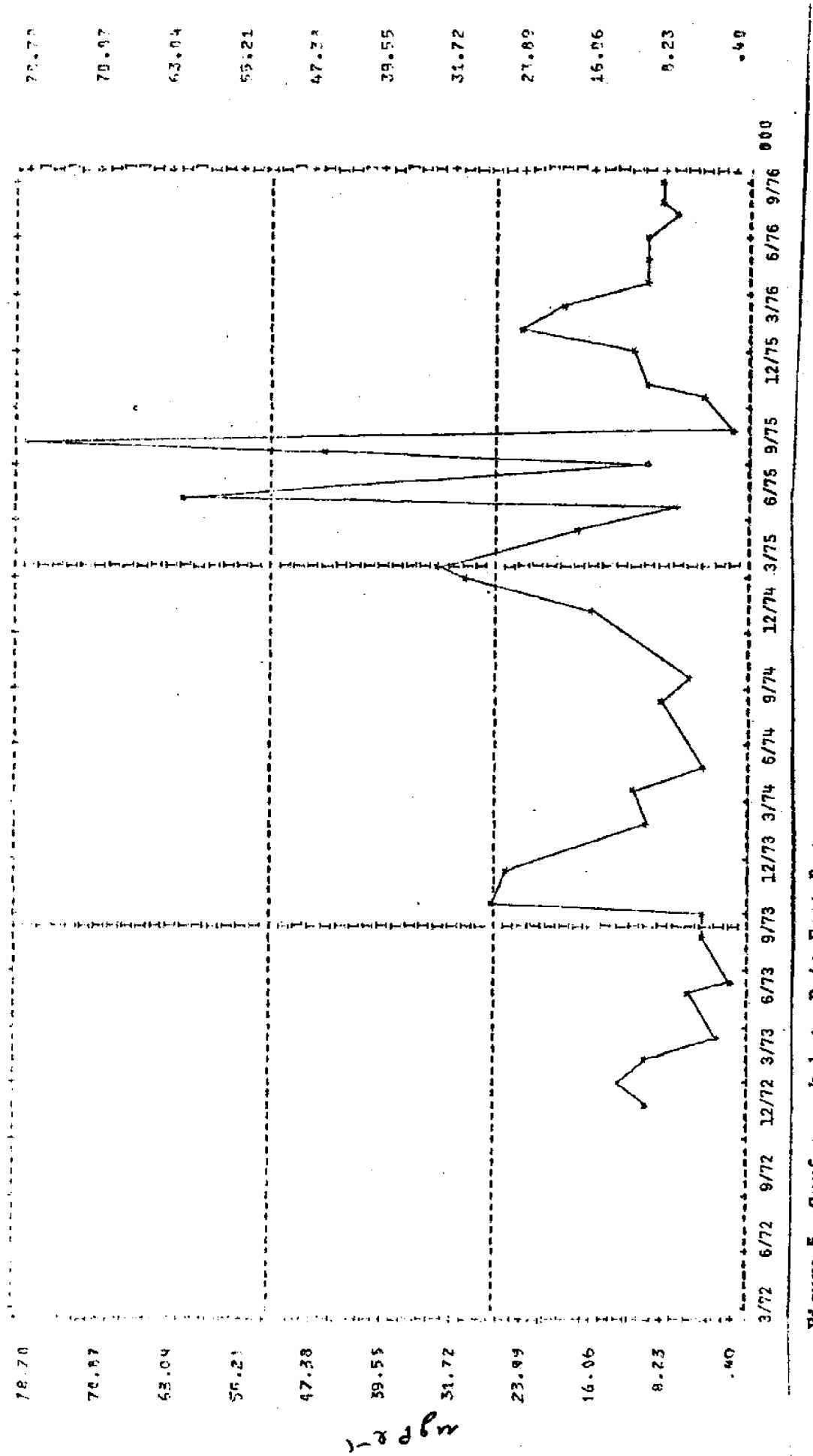

Figure 5. Surface phosphate-P in East Bay.

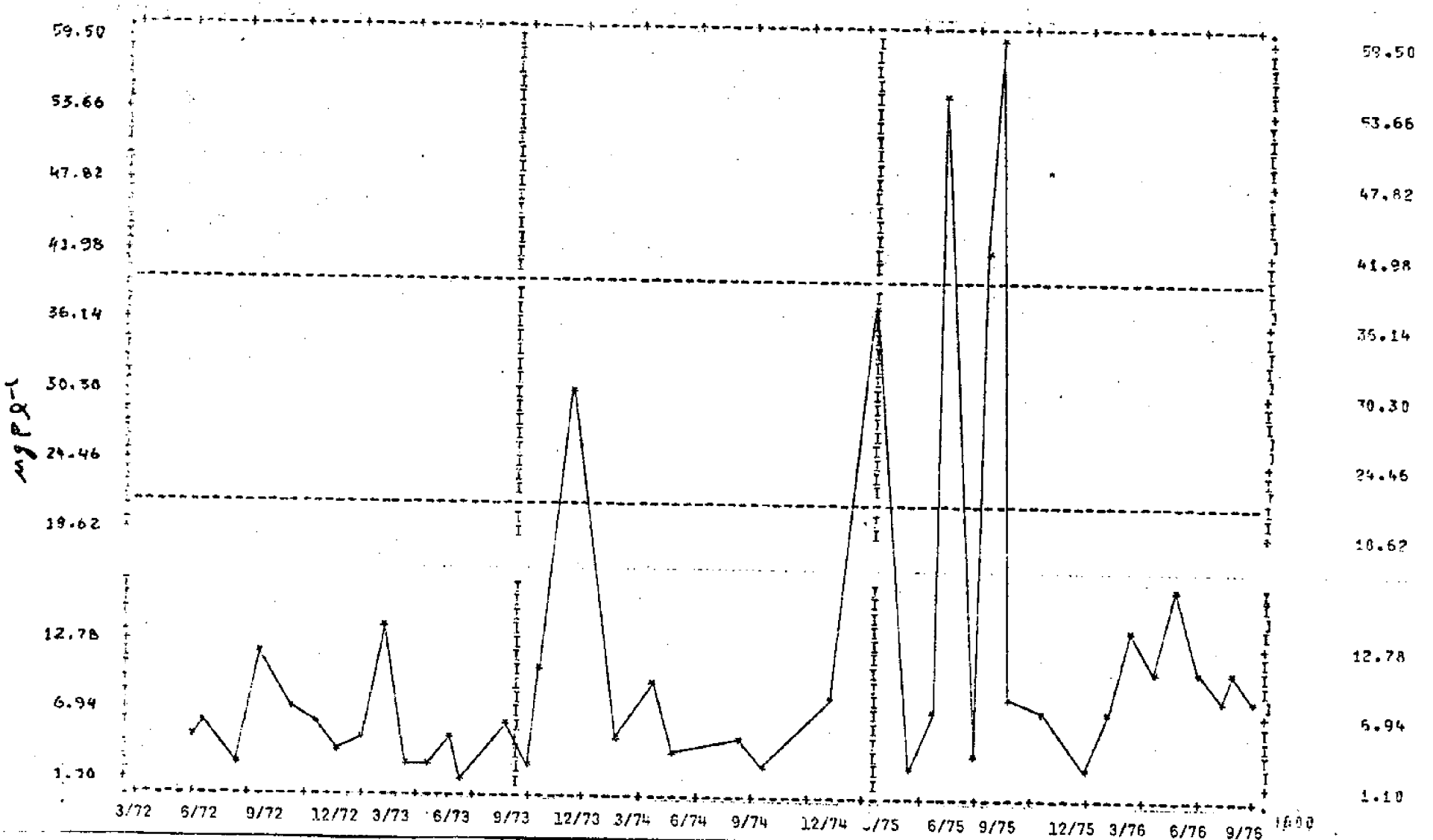

Figure 6. Surface Phosphate-P in Apalachicola Bay.

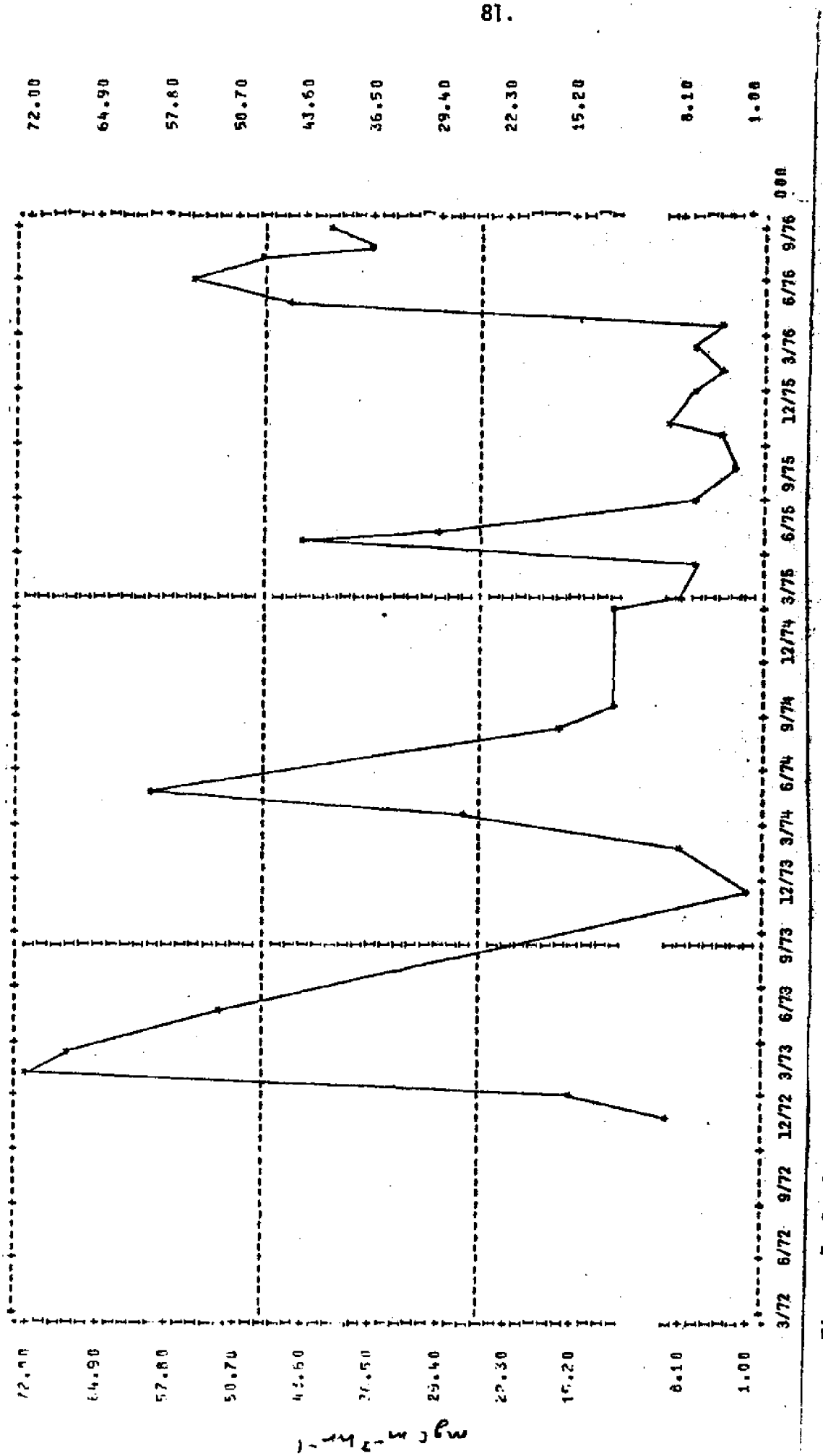

Figure 7. Surface primary productivity in East Bay.

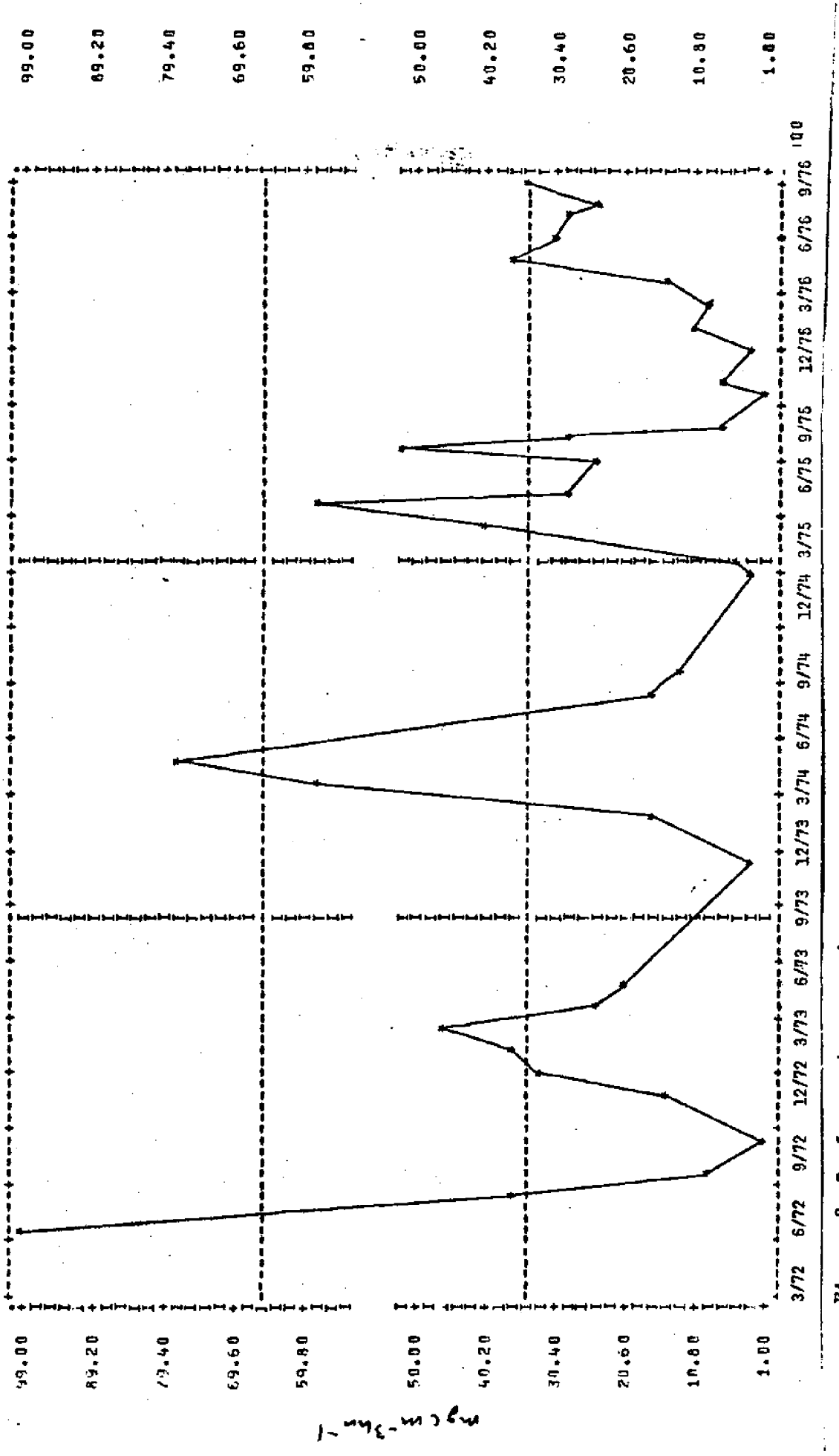

Figure 8. Surface primary productivity in Apalachicola Bay.

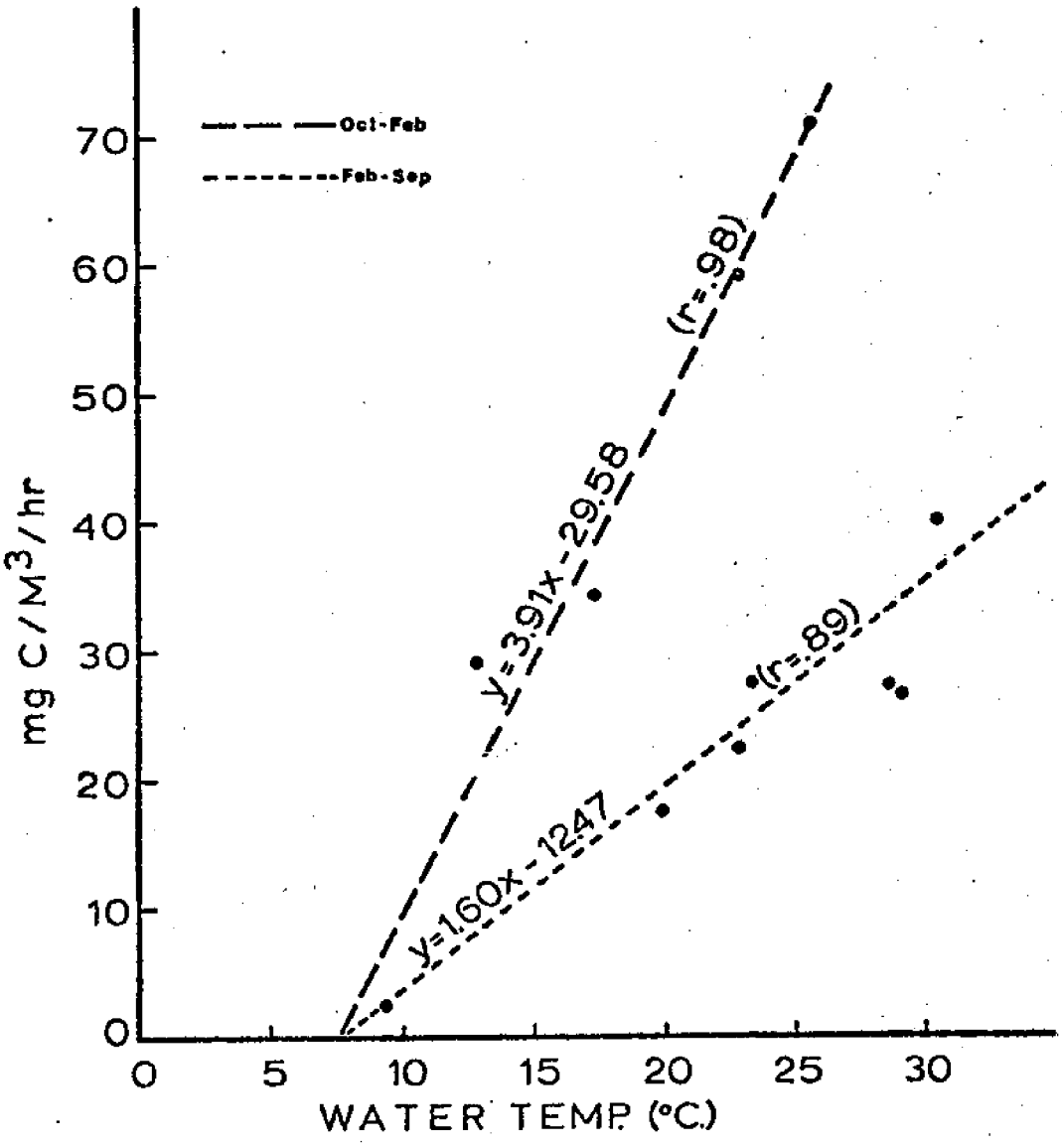

Figure 9. Productivity as a function of temperature.

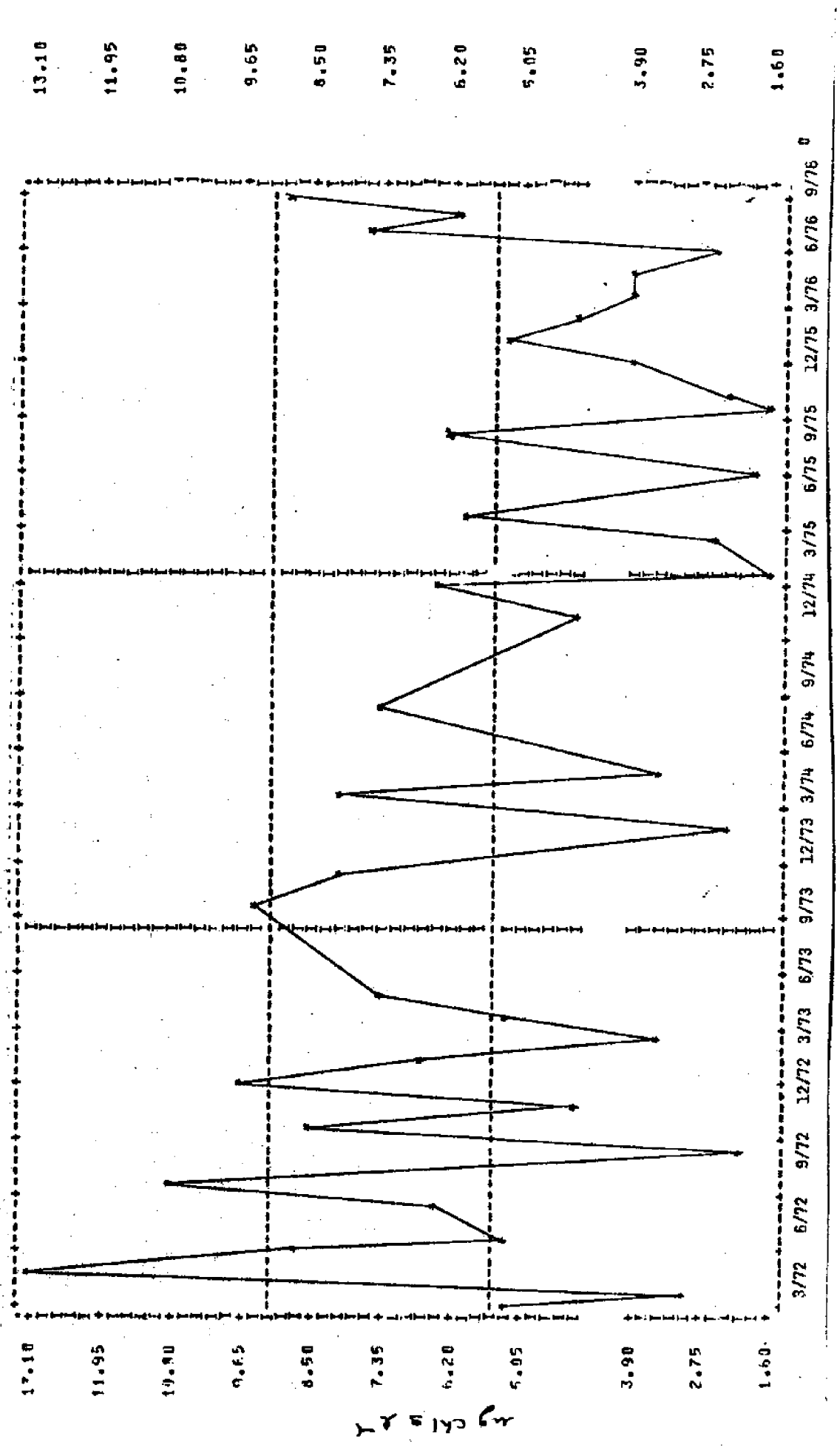

Figure 10. Surface chlrophyll a for Apalachicola Bay.

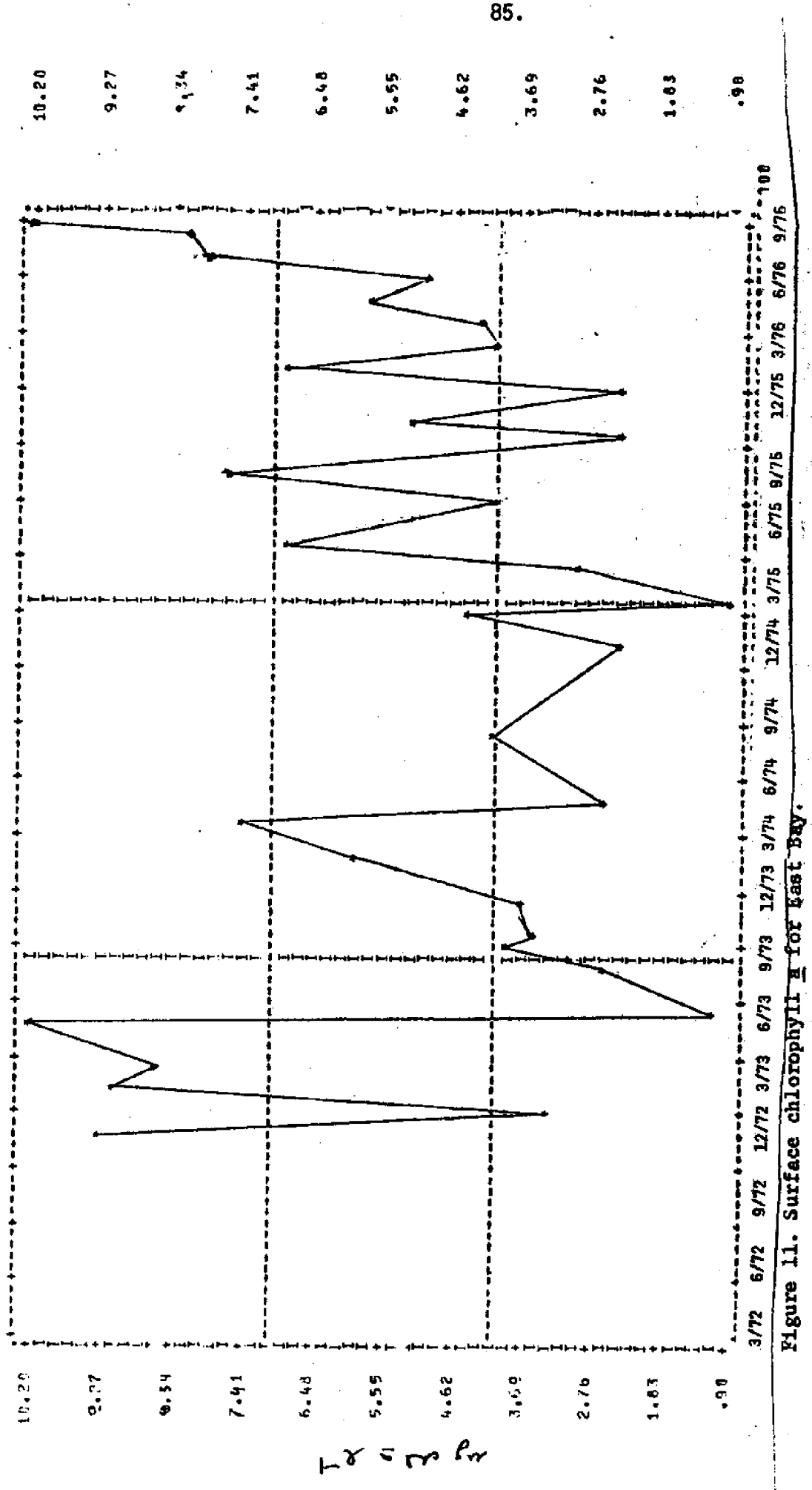

Figure 11. Surface chlorophyll a for East Bay.

APPENDIX 1

ASPECTS OF NUTRIENT LIMITATION OF PHYTOPLANKTON PRODUCTIVITY IN THE APALACHICOLA BAY SYSTEM

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INTRODUCTION

The quantification of the extent of nutrient limitation in a marine ecosystem is critical for the prediction of the response of the system to various nutrient related stresses. To make sound environmental policy, the critical nutrients and the relationships between these nutrients and plant productivity must be known.

In estuarine systems, patterns of nutrient limited phytoplankton production are complex and variable. It has been suggested that while nutrients can limit phytoplankton growth in stratified estuaries, shallow, well-mixed estuaries usually have nutrients, and especially phosporus, present in excess of phytoplankton demands (Pomeroy, et al, 1972). However, spatial and temporal variability in nitrogen and phosphorus limitation have been identified in both types of estuaries (Putnam, 1967; Flemer, 1970; Carpenter, 1971; Ryther & Dunstan, 1971; Thayer, 1971; Kraswick & Caperon, 1973).

Nitrogen occurs in estuarine systems in various dissolved, and particulate forms. Nitrite, nitrate, molecular nitrogen, ammonium, urea, dissolved organic nitrogen, particulate organic nitrogen, and amino acids are nitrogen forms that can be used directly or indirectly by plankton in marine ecosystems (Dugdale & Goering, 1967; Riley & Chester, 1971; Carpenter, 1971; Thayer, 1971). The distribution of the different nitrogen forms in marine environments is controlled by complex interactions between biological, physical, and chemical processes.

Phosphorus occurs in estuarine systems, in a variety of collodial, dissolved, and particulate forms (Taft, et al, 1975). The distribution of the forms of phosporus in marine systems is controlled by physical, chemical, and biological processes. The residence time of phosphate in coastal systems is

fairly short, between 5 and 100 hours (Pomeroy, 1960). Phosphorus concentrations in estuarine systems may be controlled by reversible sorption reactions between sediments and the overlying water (Rochford, 1951; Carritt & Goodgal, 1954; Jitts, 1959). Biological activity within the sediments can also move significant amounts of phosphorus between the sediments and the water column (Pomeroy et al, 1965; Hale, 1975), and has been shown to control the seasonal cycle of phosphorus concentrations in several shallow turbid estuaries (Pomeroy, et al, 1972). Phosphorus fluxes within estuaries can also be dominated by reactions occurring within the water column. Phosphorus uptake within the water column is usually due to phytoplankton and/or bacteria (Correll, et al, 1975; Taft, et al; 1975). Regeneration of phosphorus within the water column can take place by autolysis, zooplankton consumption and remineralization, or bacterial degradation (Pomeroy, et al, 1963; Martin, 1968; Hargrave & Geen, 1968; Peters & Rigler, 1973; Barsdate, et al, 1974).

Previous phytoplankton productivity studies in Apalachicola Bay indicated that nitrogen and phosphorus were potential limiting nutrients, while silicate and trace metal additions never stimulated phytoplankton productivity (Estabrook, 1973). This paper presents preliminary results of nutrient enrichment experiments and phosphate uptake experiments designed to quantify the extent of nutrient limited phytoplankton production and to determine the importance of phosphorus in the Apalachicola Bay System.

MATERIALS & METHODS

Sampling trips to Apalachicola Bay and East Bay (Fig. 1, Livingston et al. 1977) were taken seasonally during 1975 and 1976 to determine the extent of nutrient limitation in the Bay System. A detailed description of the physiography and biota of the Apalachicola Bay System can be found in Livingston et al (1974).

Water temperature and salinity were determined with a Beckman RS 5-3 Portable salinometer. Secchi disc measurements were taken to estimate light attenuation with depth. Turbidities were analyzed with a Hach model 2100 A Turbidometer. Suspended solids were determined gravimetically. Inorganic suspended solids were also determined gravimetically after ashing the samples at 550°C for 4 hrs.

500 ml water samples were collected at stations 1A in East Bay and 7 in Apalachicola Bay, for nutrient analysis (Fig. 1, Livingston et al). Samples were immediately filtered through Whatman GF/A glass fiber filters upon collection. One ml of 2% $HgCl_2$ solution was added to eliminate microbial processes and the samples were then placed on ice. All nutrients were analyzed within 48 hrs. Soluble reactive phosphate was analyzed by the method of Murphy and Riley as out lined in Strickland & Parsons (1972). Total dissolved phosphate was analyzed by the persulfate oxidation method listed in Standard Methods (1971). Nitrite was determined by the method of Bendschneider & Robinson given in Strickland & Parsons (1972). Nitrate determinations were based on the method of Morris & Riley with modifications given in Strickland & Parsons (1972).

Chlorophyll-a was determined by the method of Loftus & Carpenter

(1971) or the spectrophotometric method given in Strickland & Parsons (1972). The total inorganic carbon (CO_2) content of the water was either determined with a Total Carbon Analyzer (Oceanography International, Inc.) using an infrared detector or from a salinity vs CO_2 standard curve determined from 2 years of data collected in the Bay System. Dissolved organic carbon was determined by the method of Menzel & Vaccaro (1964) using the Total Carbon Analyzer. Phytoplankton taxonomy was determined by the method of Holmes (1962). Cell carbon was estimated from cell volumes according to the method of Strathmann (1967).

Two-factorial nutrient enrichment experiments with nitrogen and phosphorus were conducted with phytoplankton in water samples from stations in East Bay and Apalachicola Bay. General methods of nutrient enrichment experiments can be found in Scheleske, et al (1974) and Gerhart & Likens (1975). Water was collected in 20 l polyethylene carboys and aliquots were placed in 500 ml glass incubation bottles. Samples from each station were treated with either 0, 5, or 50 ug-atm/l nitrate-nitrogen or 0.0,0.2,0.5, or 5.0 ug-atm/l phosphate-phosphorus. Nutrients were added as 1 ml volumes. Duplicates were prepared for each concentration. A 4 hour acclimation period was begun about 10 hours and was followed by an incubation with either 2 or 4 uCi ^{14}C labeled bicarbonate for approximately 4 hours. Incubation and acclimation were performed in situ . Two 100 ml aliquots from each bottle were filtered through Whatman GF/C glass fiber filters. The filters were placed in 5 ml of Aquasol^{R} and the activity was determined by liquid scintillation counting (LSC). Primary productivity was calculated by the method of Strickland and Parsons (1972).

Phosphorus uptake was measured in the Apalachicola Bay System to determine phosphate dynamics and uptake rates of natural plankton communities.

General methods of planktonic phosphorus uptake as a function of concentration can be found in Halmann & Stiller (1974) and Taft et al (1975). Water was collected in 20 l polyetheylene carboys and aliquots were placed in 500 ml glass incubation bottles. Samples were treated with 0.0, 0.2, 0.5, or 2.0 ug-atm/l phosphate-phosphorus. Half of the samples were poisoned with 1 ml of 2% $HgCl_2$ solution. Between 500,000 and 1,000,000 dpm/ml of carrier free ^{32}P phosphoric acid was added to the samples. Samples were incubated *in situ*. Fifteen 15 ml subsamples were periodically removed from all bottles and filtered thru Whatman GF/A glass fiber filters. Ten ml of filtrate was then pipetted into on LSC vial for counting. The ^{32}P was counted by measuring Cerenkov radiation of the filtrate (Curtis & Toms, 1972; Fric & Palovickova, 1975) with a liquid scintillation spectrometer. Planktonic phosphate uptake rates were estimated from linear regression slopes of total minus $HgCl_2$-treated phosphate uptake *vs* time.

RESULTS AND DISCUSSION

The results of nutrient enrichment experiments can be found in Table I. At station 1A, phosphate enhanced phytoplankton carbon fixation more than nitrate. Phosphate enhanced carbon fixation during July and September 1975 and June and July 1976. No significant enhancement occurred during January and March 1976. Nitrate additions did not affect carbon fixation by phytoplankton at this station and no significant phosphate-nitrate interactions were observed.

Enrichment experiments at station 7 indicated both nitrate and phosphate enhanced fixation of carbon during certain times of the year. Significant nitrate enhancement occurred during September 1976; while significant phosphate-nitrate interactions were found during July 1975 and July 1976.

Nutrient enhanced phytoplankton carbon fixation occurred only when water temperatures were above 21.5°C and nitrate and phosphate concentrations were low (see Table II). Nitrate levels less than 0.47 ug-atm NO_3-N/l limited phytoplankton production in Apalachicola Bay; however, significant nitrate-phosphate interactions were observed at nitrate concentrations up to 3.49 ug-atm NO_3-N/l and phosphate concentrations as high as 0.43 ug-at PO_4-P/l. Phosphate enhanced phytoplankton carbon fixation in East Bay when concentrations were less than 0.35 ug-atm PO_4-P/l.

The nutrient enrichment experiments suggest that at phosphate concentrations less than 0.35 ug-atm PO_4-P/l the internal functional phosphorus pools (Fuhs, 1969; Rhee, 1973) of the Bay phytoplankton were unsaturated. Phosphorus uptake data tends to support this hypothesis (see Table III). Planktonic phosphate uptake rates did not maximize until external phosphate concentrations

were between 0.57 and 0.93 ug-atm PO_4-P/l under phosphate limited conditions. However, when phosphate was not limiting maximum uptake rates were obtained at lower phosphate concentrations. Similar observations have been cited in the literature (Perry, 1976).

The differences in the spatial responses of phytoplankton of the Apalachicola Bay-East Bay system to nutrient additions cannot be satisfactorially explained by species composition differences (see Table IV). Phytoplankton species differences do occur between the two stations; however, the majority of the species are common to both areas. Spatial differences in nitrate enrichment responses may be due to the presence of other assimilitive forms of nitrogen, such as ammonium, nitrite, or urea. Differences in phosphate limitation between the two stations can not be explained by concentration differences alone and may be due to suspended sediment and water column interactions.

Temporal differences in the response of phytoplankton to nutrient additions suggests that temperature limits phytoplankton productivity during colder months (Estabrook, 1973) and that nutrients limit productivity during the warmer seasons. The nutrient enrichment and phosphorus uptake experiments presented in this paper suggest that phosphorus is the most critical limiting nutrient in this estuarine system and that a reduction in phosphate level during summer months could reduce phytoplankton productivity.

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ACKNOWLEDGEMENTS

Field collections were funded by grants from NOAA Office of Sea Grant, U.S. Department of Commerce (Grant Number 04-3-158-43), and the Board of County Commissioners of Franklin County, Fla.

TABLE I

Nutrient enrichment response: phytoplankton photosynthetic enhancement in response to nutrient additions*.

1A 7/11/75

PO_4 \ NO_3	0.0	5.0	50.0
0.0	29.8	30.1	32.3
0.5	40.9	41.8	42.2
2.0	41.0	39.9	41.1

7 7/13/75

PO_4 \ NO_3	0.0	5.0	50.0
0.0	28.7	30.2	32.3
0.5	30.4	31.6	33.4
2.0	33.0	32.6	34.1

1A 9/25/75

PO_4 \ NO_3	0.0	5.0
0.0	46.8	47.0
0.5	57.4	56.4
2.0	60.8	59.5

7 9/26/75

PO_4 \ NO_3	0.0	5.0
0.0	29.8	35.6
0.5	30.3	36.5
2.0	30.8	38.2

1A 1/13/76

PO_4 \ NO_3	0.0	5.0
0.0	35.6	38.3
0.5	34.4	32.4
2.0	35.7	32.1

7 1/13/76

PO_4 \ NO_3	0.0	5.0
0.0	26.9	27.1
0.5	28.6	27.2
2.0	28.5	27.6

1A 3/29/76

PO_4 \ NO_3	0.0	5.0
0.0	21.4	22.7
0.5	23.7	20.5

7 3/29/76

PO_4 \ NO_3	0.0	5.0
0.0	18.9	18.0
0.5	18.4	18.1

1A 6/10/76

PO_4 \ NO_3	0.0	5.0
0.0	56.7	55.1
0.25	64.2	----
0.5	72.3	74.7
2.0	70.9	71.3

7 6/10/76

PO_4 \ NO_3	0.0	5.0
0.0	36.8	37.0
0.25	37.6	----
0.5	40.1	39.5
2.0	39.5	38.0

1A 7/5/76

PO_4 \ NO_3	0.0	5.0
0.0	50.2	50.7
0.25	58.7	----
0.5	59.2	56.2
2.0	55.2	57.2

7 7/5/76

PO_4 \ NO_3	0.0	5.0
0.0	40.4	46.7
0.25	43.7	----
0.5	49.2	50.2
2.0	47.4	52.3

(Nitrate concentrations in μg-atm NO_3-N/l and phosphate concentrations in μg-atm PO_4-P/l.) (Photosynthetic enchancement in ug C hr^{-1} l^{-1}.)

TABLE II

Environmental and Nutrient Data*

Station & Date	Temp	Sal	NO_2	NO_3	PO_4	Turb	Chl-a	Car
1A 7/11/75	27.2	0.0	0.09	0.86	0.32	12.4	5.22	---
7 7/13/75	26.3	4.2	0.03	0.57	0.27	6.8	3.46	---
1A 9/25/75	21.7	3.2	----	1.67	0.28	12.4	5.32	231
7 9/26/75	22.1	11.3	----	0.45	0.34	7.4	3.10	130
1A 1/13/76	11.2	0.0	----	4.05	0.38	18.7	4.64	219
7 1/13/76	10.3	1.8	0.27	4.52	0.40	7.3	3.86	196
1A 3/29/76	20.9	2.3	----	11.24	0.64	21.0	2.72	129
7 3/29/76	21.1	2.1	0.31	12.41	0.47	12.4	2.35	108
1A 6/10/76	25.0	4.9	0.04	9.62	0.35	10.8	5.76	282
7 6/10/76	25.1	6.9	0.17	12.71	0.41	12.0	3.84	133
1A 7/5/76	28.7	0.3	0.07	2.81	0.32	14.0	6.07	258
7 7/5/76	28.4	2.4	0.17	3.49	0.43	7.8	4.09	150

* Temp is temperature in °C; Sal is Salinity in ‰; NO_2 in μg-atm NO_2-N NO_3 in μg-atm NO_3-N/l; PO_4 is soluble reactive phosphate in μg-atm P Turb is turbidity in FTU; Chl-a is chlorophyll-a in μg/l; Carbon is ph plankton carbon in μg/l.

TABLE III

Phosphate uptake rates: ng-atm l^{-1} hr^{-1}*

Station & Date	Phosphate additions: µg-atm PO_4-P/l			
	0.00	0.25	0.50	2.00
1A 9/26/75	40.51	-----	79.40	79.40
7 9/26/75	43.48	-----	51.38	44.49
1A 1/13/76	53.17	-----	43.83	54.07
7 1/13/76	26.51	-----	32.20	27.69
1A 3/29/76	61.01	-----	67.43	69.79
7 3/29/76	25.60	-----	30.56	29.83
1A 6/10/76	86.11	101.87	118.34	125.63
7 6/10/75	44.47	42.52	41.09	43.17
1A 7/5/76	53.56	65.46	75.55	72.19
7 7/5/76	52.76	67.83	67.23	64.07

* Phosphate uptake rates were estimated from the slope of linear regressions ~~done on~~ of plankton phosphate uptake vs time. All R^2 were greater than 0.90.

TABLE IV

Phytoplankton Species Data*

	9/76		1/76		3/76		6/76		7/76	
Amphiprora spp	--	--	+-	--	--	--	+-	--	--	--
Bacillaria paxillifer	--	--	++	--	--	--	--	--	--	--
Bacteriastrum spp	--	--	--	--	--	--	--	+-	--	--
Ceratium furca	--	--	--	--	--	--	--	+-	--	--
Chaetoceros lorenzianum	++	--	--	+-	--	--	--	--	--	--
Chaetoceros spp 1	--	--	--	--	--	--	--	+-	--	++
Chaetoceros spp 2	--	--	--	--	--	--	--	++	--	+-
Cocconeis disculodes	+-	+-	+-	--	--	+-	+-	+-	+-	+-
Coscinodiscus radiatus	+-	+-	--	--	+-	--	+-	--	--	+-
Coscinodiscus spp	--	--	--	--	--	--	--	+-	+-	--
Cyclotella spp 1	++	++	--	--	--	--	++	++	++	++
Cyclotella spp 2	++	++	+-	++	++	++	++	++	++	++
Gyrosigma spp 1	+-	--	+-	--	+-	+-	++	+-	++	+-
Gyrosigma spp 2	--	--	--	--	--	--	+-	--	+-	--
Melosira granulata	--	--	--	++	++	++	--	--	--	--
Navicula spp 1	+-	+-	+-	+-	+-	+-	+-	+-	+-	+-
Navicula spp 2	--	--	--	--	--	+-	--	--	--	--
Nitzchia closterium	+-	--	+-	+-	+-	+-	+-	+-	+-	+-
Nitzchia paradoxa	--	--	--	--	--	--	--	+-	--	--
Rizosolenia spp	--	--	--	--	--	--	--	+-	--	--
Striatella spp	--	--	--	--	--	--	--	+-	--	--
Surirella smithii	--	--	--	--	--	--	--	+-	--	--

Synedra fulgens	--	--	--	++	+-	+-	--	--	--	--	--	--	--	--
Thallasionema nitzchiodes	+-	+-	--	--	--	--	--	--	--	+-	+-	--	--	--
Thallasionema spp	--	--	--	--	--	--	--	--	+-	--	+-	+-	--	--

* Under each date the left column represents station 1A and the right column represents station 7. Species absent --; species present greater than 5000/l but less than 100,000/l +-; species present greater than 100,000/l. ++.

APPENDIX 2

Phosphorus Limited Phytoplankton Productivity in Northeastern Gulf of Mexico Coastal Waters

An understanding of nutrient limitation of marine phytoplankton growth is important in elucidating mechanisms of phytoplankton competition and succession (1) and in making decisions concerning the use of the aquatic environment for waste disposal (2). Nitrogen has been identified as the primary limiting nutrient for phytoplankton in marine waters at various locations in the Pacific and Atlantic Oceans, offshore Northeastern Gulf of Mexico, and in California and New England coastal waters (3). We report results of nutrient enrichment experiments conducted in coastal and estuarine waters which suggest that phosphorus is frequently more important than nitrogen in limiting phytoplankton productivity in the Northeastern Gulf of Mexico.

Experiments to determine nutrient limitation of phytoplankton productivity were conducted monthly during the summers of 1975 and 1976 in several shallow North Florida coastal systems (Fig. 1) by inorganic carbon-14 uptake and phosphorus-32 bioassays. The carbon uptake bioassays were two-factorial designs in which different concentrations of phosphate and nitrate were added to water samples along with ^{14}C labeled bicarbonate (4). The phosphate uptake experiments were one-way designs in which different concentrations of phosphate were added to water samples along with ^{32}P labeled phosphate (5). Environmental factors including temperature, salinity, turbidity, and $\sum CO_2$ were measured (6). Nutrient samples were collected, stored, and analyzed according to prescribed methods (7).

Water samples were collected for chlorophyll-a and phytoplankton species composition determinations (8).

This discussion of nutrient limited phytoplankton productivity in the coastal waters of the Northeastern Gulf of Mexico will be limited to months where water temperatures are greater than 25° C. Previous investigations of the phytoplankton ecology of these systems suggest that during the rest of the year nutrient concentrations are either high enough to meet phytoplankton demands or temperatures are low enough to be the primary factor limiting phytoplankton productivity (9).

Light and temperature did not vary widely between the various sampling dates and locations (Table 1). Significant differences were observed in salinity, turbidity, nutrient concentration, and phytoplankton productivity between stations. The relatively low mean salinity values observed at the Apalachicola and Ochlockonee estuarine stations are the result of river drainage. The higher turbidity values at the Apalachicola stations relative to the other stations are probably a result of river discharge and mixing processes (10). The Apalachicola and Ocklochnee stations exhibited higher nutrient concentrations and higher primary productivity and chlorophyll-a than the other stations. Phytoplankton species diifferences were observed between the high and low salinity stations (11). Phytoplankton and nutrient data were treated with linear regression techniques. Linear correlation coefficients were determined between phytoplankton productivity and soluble reactive phosphate, soluble nitrate, and soluble nitrite concentrations. Phytoplankton productivity was more strongly correlated with soluble

reactive phosphate concentration (r = +0.73) and was weakly correlated with soluble reactive nitrate (r = +0.41) or soluble nitrate (r = +0.2 This suggests that soluble reactive phosphate concentration was more important than dissolved nitrate or nitrite levels in explaining summer phytoplankton productivity in the coastal systems of the Northeastern Gulf of Mexico.

A multiple regression model was constructed to determine which combinations of environmental or nutrient variables could explain the most variation of phytoplankton productivity in these coastal systems. A multiple linear regression model was designed with phytoplankton primary productivity as the dependent variable and temperature, salinity, turbidity, surface light intensity, soluble nitrate, soluble nitrite, and soluble reactive phosphate as possible independent variables. Soluble reactive phosphate and salinity were the only variables which met the model constraints (12) and together they explained 64% of the variation in phytoplankton productivity in these coastal systems.

Results of both the carbon uptake and phosphate uptake nutrient enrichment bioassays also indicated that soluble reactive phosphate was more important than soluble nitrate in limiting phytoplankton productivity during the summer months in these coastal systems. (Table 2). Phosphate additions stimulated phytoplankton carbon fixation more frequently than nitrate additions . When phosphate additions stimulated carbon uptake, phytoplankton phosphate uptake was also stimulated (13).

The nearshore Northeastern Gulf of Mexico environments investigated in this study receive runoff which does not contain high dissolved phosphate concentrations, in contrast to New England

coastal waters (14). Shallow, clear waters overlie sandy sediments which remain in the water column for only short periods after suspension (15) in contrast to the silty, turbid waters of the nearshore Georgia coast. Pomeroy (16) suggested that phosphorus does not seem to be a limiting nutrient for phytoplankton growth in any except some of the clearest, sediment-free estuaries. The Apalachicola Bay water column contains high turbidity for several days following periods of high winds. Phytoplankton are not phosphate limited under these conditions but become phosphate limited after sediments settle to the bottom (10). The observation that phosphorus is important as a limiting nutrient for phytoplankton in the nearshore Northeastern Gulf of Mexico suggests that water quality planning for the coastal zone is best done on a regional basis, with consideration given to the bio-geo-physical characteristics which control nutrient cycling.

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4. Surface water (z = 0.5 m) was collected and placed in 500 ml glass incubation bottles. Nutrient concentrations of 0.0, 5.0, or 50.0 μg-atm NO_3-N l^{-1} and 0.00, 0.25, 0.50, 2.00, or 5.00 μg-atm PO_4-P l^{-1} were obtained by adding appropriate ammounts of $NaNO_3$ or Na_2PO_4 to each bottle. Phytoplankton were acclimated in situ to the added nutrients for 4 hours and then incubated in situ with 4 μ Ci of ^{14}C labeled bicarbonate. Two 100 ml aliquots from each bottle were filtered through Whatman GF/C glass fiber filters. The filters were place in 5 ml of Aquasol and the activity was determined by liquid scintillation counting. Carbon fixation was calculated by the method in J. D. H. Strickland and T. R. Parsons, A Practical Handbook of Seawater Analysis, Fish. Res. Bd. Canada (1972).

5. Surface water was collected and placed in 500 ml glass incubation bottles after which Na_2PO_4 was added to obtain concentrations of 0.00, 0.25, 0.50, or 2.00 µg-atm PO_4-P l^{-1}. Half the samples were poisoned with 1 ml of 2% $HgCl_2$ solution. One ml of between 500,000 and 1,000,000 dpm/ml of carrier free ^{32}P phosphoric acid was added to the bottles and the samples were incubated in situ. Fifteen ml subsamples were periodically removed from all bottles and filtered through Whatman GF/A glass fiber filters. Ten mls of filtrate were pipeted into LSC vials and the ^{32}P activity was determined by Cherenkov radiation measuremnts with a liquid spectrometer (E. J. C. Curtis and I. P. Toms, In: Liquid Scintillation Counting, Heyden & Sons, (1972); F. Fric and V. Palovickova, Int. J. App. Rad. Iso. 26, 305 (1975)). Plankton phosphate uptake rates were estimated from linear regression slopes of total phosphate uptake minus $HgCl_2$ poisoned uptake vs time for R^2 greater than 0.80.

6. Water temperature and salinity were determined with a Beckman RS 5-3 portable salinometer. Turbidities were analyzed with a Hach model 2100 A Turbidometer. $\sum CO_2$ was measured with an Oceanographic International Corperation Total Carbon Analyzer model 0524.

7. Water samples were collected and immediately filtered through prewashed Whatman GF/A glass fiber filters and then placed in 500 ml nalgene bottles. One ml of 2% $HgCl_2$ solution was added to the sample after which it was placed on ice. All nutrients

were analyzed within 48 hours. Soluble reactive phosphate, nitrate, and nitrite were determined by the methods given in Strickland and Parsons (4).

8. Chlorophyll-a was determined by the method given in Strickland and Parsons (4). Phytoplankton taxonomy was determined by the technique of R. Holmes (U.S. Fish and Wildlife Serv. Spec. Rep. Fish, 433 (1962)).

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11. Significant differences in species composition and size fraction exist between M. L. and E-12 stations and Ock and Apal stations. The phytoplankton communities at stations M. L. and E-12 had a greater proportion of individuals in the larger size fraction (35% of total numbers had log cell volumes between 4.0 and 5.0) than did station Ock and Apal (15% of total numbers were in this larger size fraction). Cyclotella meneghiniana was the dominant diatom at all stations and comprised 18 to 38 % of the total phytoplankton cell numbers.

12. A stepwise regression method was used to enter independent variables into the model. The lower limit of the change of R^2 for addition of a variable to the model was set at 0.05. Soluble reactive phosphate was the first variable entered into

the model and it gave an R^2 of 0.54. Salinity was added next to the model and it increased the R^2 by 0.10. The other variables did not meet the constraints of the method and therefore were not entered in the model. The final regression model was:

$$P.P. = 32.1 + 48.4\ S.R.P. - 0.54\ Sal.$$

where: P.P. is phytoplankton primary productivity in $\mu g\ C\ l^{-1}\ hr^{-1}$; S.R.P. is soluble reactive phosphate in $\mu g\text{-atm}\ PO_4\text{-}P\ l^{-1}$; and Sal. is salinity in parts per thousand. This final model was significant at $\alpha = 0.001$.

13. The high positive correlation coefficients between phosphate uptake and both chlorophyll-a ($r = +0.83$) and phytoplankton primary production ($r = +0.77$) during the summer suggests that phytoplankton are the primary phosphate uptake fraction of the plankton in these coastal systems. This conclusion is consistent with results of J. L. Taft, W. R. Taylor, and J. J. McCarthy (Mar. Biol. 33,21 (1975)), who found that phytoplankton were the main fraction taking up phosphate in the Chesapeake Bay.
14. J. H. Ryther and W. R. Dunstan (3)
15. Median phi values of 3 (125 μ) were observed for sediment samples obtained from stations Apal-1A, M. L., and E-12.
16. L. R. Pomeroy, L. R. Shenton, R. D. H. Jones, and R. J. Reimold, Limnol. Oceanogr. Special Symp. Vol 1, 274 (1972).
17. Financial support was provided by the Florida Sea Grant Program under NOAA contract 04-3-158-43. We thank D. Menzel for commenting during preparation of the manuscript and R. Harriss for critically reading the manuscript.

Figure 1. Location of sampling station in the Northeastern Gulf of Mexico.

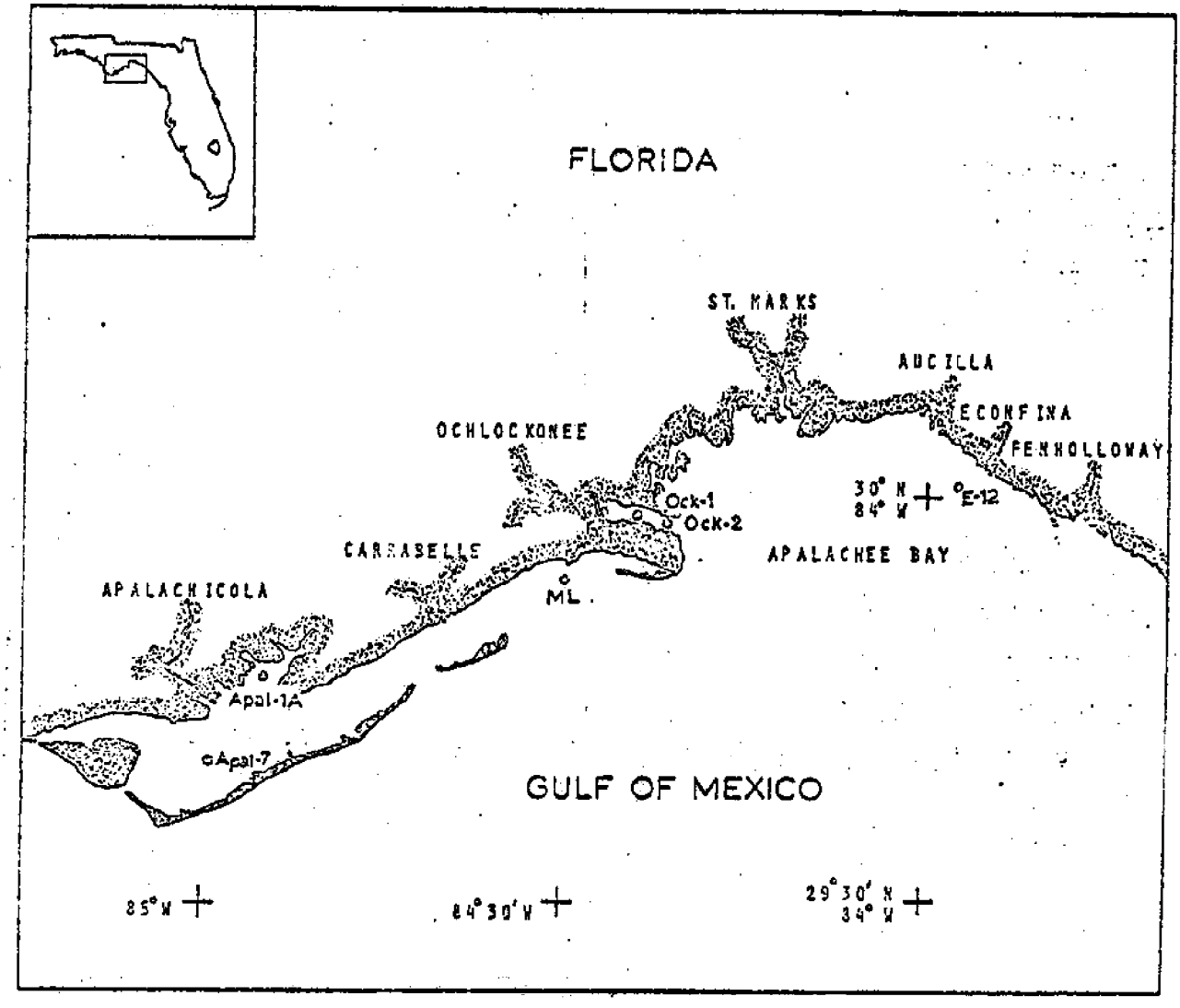

Table 1. Summary of environmental, nutrient, and phytoplankton data. The first value under each parameter is the mean value of that parameter for a given station and the second value is the standard deviation of the values. Temp is temperature, Salin is salinity, Turb is turbidity, and Pri. Prod. is phytoplankton primary production.

Station	Temp °C	Salin ‰	Turb. FTU	Light ly hr^{-1}	NO_3	NO_2	PO_4	Pri. Prod.	Chl-a
					μg atm l^{-1}.			mg C m^{-3} hr^{-1}	mg m^{-3}
E-12	29.4	26.2	3.15	26.5	0.32	0.01	0.04	6.00	0.61
	1.01	2.48	0.35	5.60	0.14	0.03	0.01	1.25	0.17
M. L.	27.9	29.7	3.15	37.8	0.55	0.02	0.19	9.20	0.52
	1.78	3.53	0.49	3.73	0.10	0.02	0.04	0.58	0.21
Ock-1	28.2	4.20	4.97	37.9	1.83	0.05	0.37	30.8	2.14
	0.90	1.06	0.78	7.22	0.37	0.01	0.07	2.57	0.41
Ock-2	28.2	10.3	4.93	37.9	2.24	0.12	0.36	26.4	3.00
	0.80	0.70	0.61	7.22	0.83	0.05	0.09	4.74	0.51
Apal-1A	27.5	3.74	16.5	33.9	3.08	0.15	0.34	40.3	5.13
	1.19	2.58	8.96	9.17	2.63	0.16	0.08	10.7	1.12
Apal-7	27.5	11.7	11.7	36.9	3.55	0.21	0.40	36.7	4.11
	1.34	8.26	6.88	3.50	3.69	0.16	0.09	5.81	0.84

Table 2. Summary of analysis of variance of carbon uptake and phosphate uptake nutrient enrichment bioassays. The symbols under PO_4 and NO_3 indicate the statistical significance of the effect of that nutrient on either carbon uptake or phosphate uptake. An F test was used to determine the values N indicates no data, * indicates $\alpha \leq 0.05$, and - indicates $\alpha \geq 0.05$. When $\alpha \leq 0.05$ the effect of the nutrient additions was always stimulatory to the physiological process measured.

Station	Date	Carbon Uptake NO_3	Carbon Uptake PO_4	Phosphate Uptake PO_4
E-12	6/03/75	*	*	N
E-12	7/18/75	-	*	N
E-12	7/12/76	-	*	*
E-12	9/10/76	-	-	-
M. L.	6/13/76	-	*	*
M. L.	7/03/76	-	*	*
M. L.	8/30/76	-	-	-
M. L.	9/22/76	-	*	-
Ock-1	6/17/76	-	-	-
Ock-1	7/28/76	-	*	*
Ock-1	8/30/76	*	-	-
Ock-2	6/17/76	*	-	-
Ock-2	7/28/76	-	*	*
Ock-2	8/30/76	-	-	-
Apal-1A	9/02/74	*	*	N
Apal-1A	5/29/75	-	-	N
Apal-1A	7/11/75	-	*	N
Apal-1A	9/11/75	-	*	*
Apal-1A	9/15/75	-	-	-

Apal-1A	6/10/76	-	*	*
Apal-1A	6/24/76	-	*	*
Apal-1A	7/05/76	-	*	*
Apal-1A	8/15/76	-	*	*
Apal-1A	8/26/76	-	-	-
Apal-7	9/02/74	*	-	N
Apal-7	5/29/75	-	-	N
Apal-7	7/11/75	*	*	N
Apal-7	9/11/75	*	-	-
Apal-7	9/15/75	-	-	-
Apal-7	6/10/76	-	-	-
Apal-7	6/24/76	-	-	-
Apal-7	7/05/76	*	*	*
Apal-7	8/15/76	-	*	*
Apal-7	8/26/76	-	-	-

APPENDIX 3

LOSS OF RADIOCARBON IN DIRECT USE OF AQUASOL FOR LIQUID SCINTILLATION COUNTING OF SOLUTIONS CONTAINING ^{14}C-$NaHCO_3$

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Reprinted from Limnology and Oceanography
Vol. 21, No. 5, September 1976
pp. 756–758
Made in the United States of America

Loss of radiocarbon in direct use of Aquasol for liquid scintillation counting of solutions containing ^{14}C-$NaHCO_3$[1]

Abstract—Carbon-14 activity was lost when ^{14}C-$NaHCO_3$ in aqueous solution was added to Aquasol. Phenethylamine can be used to form carbamates which are stable in Aquasol in order to achieve complete retention of ^{14}C in the liquid scintillation cocktail.

[1] Financial support was provided by the Florida Sea Grant Program under NOAA contract 04-3-158-43.

Premixed cocktails which accept aqueous samples have gained popularity for use in liquid scintillation counting of carbon-14 in phytoplankton productivity measurements. Aquasol, a product of New England Nuclear Corporation, was one of the first cocktails developed for such use. Since Aquasol will accept up to a third of its vol-

ume of aqueous sample, it is a simple process to standardize ^{14}C-$NaHCO_3$ solutions for primary productivity measurements by adding aliquots of dilutions of ^{14}C-$NaHCO_3$ solutions directly to Aquasol. After chemiluminescence caused by NaOH in the radiocarbon solution (Strickland and Parsons 1972) has decreased, ^{14}C activity of the solution can be measured with a liquid scintillation spectrometer.

We observed lower than expected ^{14}C activity during standardization of ^{14}C-$NaHCO_3$ solutions using Aquasol as the liquid scintillation cocktail. It is difficult to interpret pH measurements in a nonaqueous medium; however, the Aquasol-water emulsion was strongly acidic with pH-Hydrion paper. To assess the magnitude of the ^{14}C activity losses, we added 1.0-ml aliquots of a 1 : 50 dilution of solution containing 1 μCi of ^{14}C ml^{-1} as ^{14}C-$NaHCO_3$ to 10.0 ml of Aquasol in glass liquid scintillation vials: carbon-14 activity decreased with time to a value 36% less than the amount of activity initially added to the Aquasol (Fig. 1).

Rapid loss of radiocarbon from the cocktail immediately after addition of ^{14}C-$NaHCO_3$ solution precludes immediate liquid scintillation counting as a solution to the problem. We added duplicate 1-ml volumes of the diluted ^{14}C-$NaHCO_3$ solution to 5-ml and to 15-ml volumes of Aquasol in glass liquid scintillation vials to test the effects of variation in Aquasol volume on retention of ^{14}C. After 500 min, the sample containing 5 ml of Aquasol contained 40% less activity and that containing 15 ml contained 26% less activity than the amount initially added.

Phenethylamine reacts rapidly with CO_2 to form carbamates which are stable in liquid scintillation cocktails (Woeller 1961). Phenethylamine absorbs 99.5% of available CO_2 (Duncombe and Rising 1969) and is used as the CO_2 absorber in several methods where ^{14}C-CO_2 is captured in liquid scintillation cocktails (Peterson 1969; Smith et al. 1972). We added 1.0-ml aliquots of the diluted ^{14}C-$NaHCO_3$ aqueous solution to 2.0 ml of redistilled

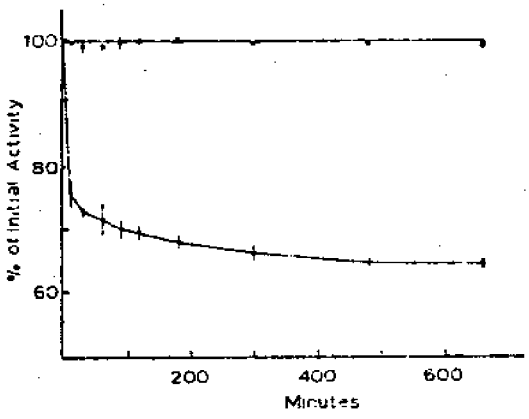

Fig. 1. Carbon-14 activity of an aqueous solution of ^{14}C-$NaHCO_3$ in 10 ml of Aquasol (●) and in phenethylamine plus 10 ml of Aquasol (■). Error bars are $\pm 2\sigma$ for each point ($N = 2$).

phenethylamine in glass liquid scintillation vials.

The carbon dioxide absorption capacity of phenethylamine is about 0.2 g (4.5 mmoles) per ml (New England Nuclear Corp. 1975). We used a quantity of phenethylamine in excess of stoichiometric requirements to ensure rapid carbamate formation. After adding 10.0 ml of Aquasol to the vials, we measured the ^{14}C activity of the samples with a Picker liquid scintillation spectrometer. Carbon-14 activity was not significantly different over the experimental period (Fig. 1). In the phenethylamine-Aquasol cocktail it was stable at 25 h and has been reported stable up to 72 h in a phenethylamine-toluene-methanol cocktail (Davis et al. 1975).

Unless scintillation grade phenethylamine is used, it may be necessary to redestill phenethylamine by flash evaporation before use to remove colored compounds that cause quenching during liquid scintillation counting (Francis and Hawkins 1967). Aquasol is a xylene-based cocktail. When phenethylamine is used in toluene-based cocktails, a small amount of methanol is added to the cocktail to aid in solubilizing the phenethylamine (Smith et al. 1972). Phenethylamine has greater trapping capacity than hyamine-hydroxide (Parmentier and Ten Haaf 1969) and

causes less chemiluminescence than NaOH, which has been used to retain ^{14}C activity in liquid scintillation cocktails (Waite et al. 1973). Organic bases or organic base-containing compounds that have been used by other investigators to retain inorganic ^{14}C in toluene-based liquid scintillation cocktails include Bio-Sol (Beckman), NCS tissue solubilizer (Amersham/Searle), and monethylamine. Inorganic ^{14}C retention of all premixed liquid scintillation cocktails designed to accept aqueous solutions should be assessed before the cocktails are used for counting inorganic ^{14}C. Through conversations with several investigators, we find that this is not widely understood.

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Submitted: 16 December 1975
Accepted: 7 April 1976

APPENDIX 4

UPTAKE OF GLYCOLIC ACID BY A MARINE BIVALVE

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In Press: J. Experimental Marine Biology and Ecology

ABSTRACT

Glycolic acid was accumulated by *in vitro* preparations of gill tissue from the quahog clam, *Mercenaria sp.*, by a process exhibiting diffusion kinetics. Carbon-14 from labelled glycolic acid was found in the lipid fraction of the gill tissue. Evolution of labelled carbon dioxide suggested the glycolic acid was metabolized in gill tissue.

INTRODUCTION

Excretion and extracellular loss of metabolites by phytoplankton and macrophytes is a significant source of soluble organic carbon compounds in the sea (Parsons and Takahashi, 1973). Photosynthetically fixed carbon excreted by marine phytoplankton communities varies in magnitude, with increased proportion of fixed carbon excreted by communities growing under oligotrophic conditions (Anderson and Zeutschel, 1970; Thomas, 1971; Samuel, et al., 1971; Berman and Holm-Hansen, 1974). Glycolic acid is probably quantitatively the most important component of phytoplankton extracellularly released carbon (Hellebust, 1974). Algal and bacterial species exhibit variability in their ability to take up and use exogenous glycolate for growth. Bacterial species which took up glycolate were unable to grow using glycolate as the sole carbon source but could metabolize it with greater efficiency than other organic acids, sugars, or amino acids taken up from solution (Wright and Shaw, 1975). Excreted glycolate may be reassimilated to serve as an energy source for phytoplankton populations during conditions limiting photosynthesis (Fogg, 1963).

Marine invertebrates, including mollusks, have been shown to remove dissolved organic compounds from solution, yet the uptake and significance of glycolic acid in the metabolism of marine animals has not been established. Six genera of marine mollusks, including Mercenaria mercenaria, removed amino acids from seawater (Stephens and Shinske, 1961). Sorokin and Wyshkwarzev (1973) reported uptake of ^{14}C - labelled algal hydrolysate by 15 species of marine invertebrates, including a bivalve mollusk. Glucose and glycine were taken

up from solution at low concentrations by Pisidium, a fresh water bivalve (Efford and Tsumura, 1973). Pequignat (1973) found significant uptake of labelled amino acids and glucose from sea water by different organs of the mussel Mytilus edulis. He concluded that uptake of organic solutes would constitute a significant part of the diet of the mussel if continually supplied in the environment. Glucose can be removed from solution in seawater and may be an important nutritional supplement for oysters (Gillespie, et al., 1964, 1966).

The ciliated epithelium of the bivalve gill plays a major role in the direct absorption of organic solutes. The gill epithelium was one of the most active tissues involved with the uptake of dissolved amino acids and glucose in Mytilus edulis (Pequignat, 1973). Gills have been shown to exhibit an active role in the uptake of labelled glucose and amino acids in bivalves such as Mya arenaria (Stewart and Bamford, 1975), Crassostrea gigas (Bamford and Gingles, 1974) and Cerastoderma edule (Bamford and McCrea, 1975).

This investigation was designed to determine the capability and mechanism of absorption of glycolic acid from solution by gills of the bivalve Mercenaria sp. Experiments were conducted to determine whether or not glycolic acid was incorporated into the energy yielding and biosynthetic pathways of the gill.

MATERIALS AND METHODS

Experimental organisms

The experimental organisms were specimens of the northern quahog, Mercenaria (Venus) mercenaria (Linne) and the southern quahog, Mercenaria campechiensis (Gmelin) or their hybrids obtained from R.W. Menzel. Specimens of Mercenaria sp. (80 to 100 mm) were obtained several days prior to an experiment. Collections were planned over the period September to February so that seawater temperatures and salinities coincided as closely as possible to experimental conditions (T = 20°C, 30°C, S = 28.3°/oo). Seawater temperatures at the time of collection varied less than 3°C from experimental temperatures. Salinity remained between 28 and 29 parts per thousand.

The bivalves were thoroughly scrubbed with a stiff brush and were rinsed with seawater before being placed in glass holding tanks containing aerated seawater. Salinity was adjusted, if necessary, by addition of distilled water. Water was changed daily and animals were allowed at least 48 hours to acclimate to experimental conditions. Experiments were conducted in a Tenney Relialab Model B910U Environmental Room which controlled temperature to within 0.15°C.

Tissue preparation

Animals were taken from the holding tanks and opened by fracturing one valve on the dorsal side immediately before an experiment. The anterior and posterior adductor muscles were severed with a clean stainless steel scalpel. Remaining portions of the valve were removed and the mantle was peeled back to expose the gills. The gill tissue was visually inspected and discarded if damage had occurred during opening.

Segments of gill tissue approximately 0.75 cm^2 were dissected out using clean stainless steel surgical scissors and tweezers and were transferred to a beaker containing 100 ml of artificial sea water (ASW) at the experimental temperature and salinity. Each animal yielded 8 to 12 gill tissue segments which were pooled with segments randomly selected for each experiment to minimize effects of individual variability.

Artificial sea water used in experiments was a modified Lyman and Fleming (1940) formula made with distilled water and membrane filtered before use. Its composition was: NaCl, 0.40166 M; $MgCl \cdot 6H_2O$, 0.05231 M; Na_2SO_4, 0.02758 M; $CaCl_2 \cdot 2H_2O$, 0.00993 M; $NaCO_3$, 0.00238 M; KCl, 0.00891 M; H_3BO_3, 0.00042 M. Salinity was adjusted to 28.3°/oo with distilled water. All unlabelled glycolic acid solutions were made using this ASW. Labelled sodium glycolate (S.A. = 116 μ Ci mg^{-1}, Amersham/Searle) was prepared as a stock solution (1.0 μ Ci ml^{-1}) with glass distilled water and stored at 4°C.

Since fatty acids have been observed to stick to untreated glass surfaces (Testerman, 1972) experimental glassware was silicone coated with "Siliclad" (Clay-Adams, Inc.) to reduce the possibility of glycolic acid absorption onto the glass walls.

Accumulation of ^{14}C-labelled glycolic acid

For each kinetic experiment a single segment of gill tissue was placed in a 30 ml siliconized beaker with 5 ml ASW containing a known concentration of unlabelled glycolic acid and 0.1 ml ^{14}C-labelled glycolic acid (0.02 μCi ml^{-1}). Experiments were conducted with six different concentrations run simultaneously for different time intervals. Triplicate samples were taken at each time period for each concentration.

After incubation, segments were removed from the radioactive solution and rinsed twice by transfers to beakers of clean unlabelled ASW. Following the final rinse the segments were quickly frozen in siliconized glass vials held in an alcohol-dry ice mixture. Time from end of incubation to freezing for each set of triplicates averaged 1.5 minutes. Frozen samples were stored in a Revco Ultra Low freezer at minus 60°C until lyophilization. All segments were lyophilized within 72 hours after incubation and were stored in a dessicator until radioactivity assay.

The lyophilized samples were weighed in tared polycarbonate capsules (Teledyne-Intertechnique) on an analytical balance and processed for liquid scintillation counting with a high temperature combustion technique (Peterson, 1969). This technique utilizes catalyst enhanced dry combustion at 600°C, followed by collection of evolved $^{14}CO_2$ with a phenethylamine based liquid scintillation cocktail in a spinning band collector. Composition of the cocktail was: 430 ml redistilled toluene, 300 ml redistilled methanol, 270 ml redistilled (flash evaporated) B-phenethylamine, 50 ml distilled water; 5.0 grams PPO and 0.5 grams POPOP per liter of cocktail.

Combustion of gill tissue was enhanced by addition of approximately 10 mg of highly combustible finely ground (Tekman Model A-10 Analytical Mill) lyophilized plant tissue (Thalassia testudinum) to each capsule. After combustion and collection of the $^{14}CO_2$ containing cocktail in scintillation vials, the vials were tightly capped with polyethylene lined screw down caps and kept in the dark at least 12 hours to reduce chemiluminescence caused by phenethylamine. Carbon -14 activity was measured with a Picker Nuclear Liquimat 220 liquid scintillation spectrometer calibrated with the external standards channels ratio method.

Evolution of $^{14}CO_2$

Gill segments were excised in the manner previously described and held in ASW until pre-incubation. Pre-incubation consisted of incubation of all segments, including the controls, in a known concentration of ^{14}C glycolate solution for 60 minutes. After pre-incubation all controls were placed in a saturated $HgCl_2$ solution for 15 minutes to poison the tissue.

The evolution of $^{14}CO_2$ from gill tissue was measured using a technique modified from Harrison et al., (1971). After pre-incubation, experimental samples were removed from the labelled glycolate solution and thoroughly rinsed in ASW before being placed in serum bottles containing 5 ml of unlabelled glycolate solution at the pre-incubation concentration. The $HgCl_2$ poisoned controls were rinsed separately. The bottles were then sealed with a rubber stopper fitted with a center well and filter paper assembly (Harrison et al., 1971). Duplicate samples and controls were used for incubation periods of 5, 10, 20, 30, 40, and 60 minutes. Immediately before the end of each incubation period 0.2 ml B-phenethylamine was placed on the accordian folded filter papers with a syringe. At the end of each incubation period replicate samples and controls were poisoned by injecting 2 ml of saturated $HgCl_2$ solution into the bottle. 10% HCL was added dropwise with a syringe to lower the pH to below 3 to release CO_2 from the incubation solution. After acidification the bottles were left for one hour to permit absorption of $^{14}CO_2$. The filter paper was removed and placed in a solution of 10 ml Aquasol (New England Nuclear) plus 2 ml freshly distilled B-phenethylamine for determination of carbon-14 activity

with a liquid scintillation spectrometer. Phenethylamine is necessary to prevent loss of inorganic ^{14}C from Aquasol (Iverson, et al.,1976). The gill segments were frozen and lyophilized to obtain dry weights.

An experiment was conducted to assess uptake and mineralization of labelled glycolic acid by bacteria adhering to gill surfaces. Half the experimental organisms were treated with an antibiotic mix consisting of 200 mg l^{-1} Streptomycin (Nutritional Biochemicals Corp., Cleveland) and 159,000 units l^{-1} Penicillin (Benzylpenicillin, K-salt, 1590 units mg^{-1}; Sigma Chemical Co., St. Louis). These concentrations are similar to those used by Anderson and Stephens (1969) to eliminate uptake of glycine by microbial epiflora present on marine crustaceans. Twelve hours before the experiment was to begin the experimental bivalves were thoroughly scrubbed and placed in a separate glass container with aerated membrane filtered sea water and antibiotic mix. After 12 hours in the filtered sea water and antibiotic mix the animals were opened and the experiment started. Antibiotics were added to all glycolic acid solutions of antibiotic treated animals during the course of the experiment.

Radioactivity in lipids fraction of gill tissue

Gill segments were pre-incubated for 30 minutes in a solution of ASW and antibiotic mix. Following pre-incubation the gill segments were transferred to a 14C glycolate solution (0.01 $\mu Ci\ ml^{-1}$, 855 $\mu g\ l^{-1}$) containing the antibiotic mix. After incubation for two hours in the radioactive solution the tissue was quickly frozen by transfer to glass vials held in an alcohol-dry ice mixture. Segments were lyophilized and the lipids extracted by the method of Bligh and Dyer (1959). Approximately 60 mg of freshly lyophilized

tissue was homogenized with 5 ml of chloroform:methanol:water (1:2:0.8) in a glass tissue homogenizer equipped with a teflon pestle (Thomas tissue grinder, #3431-E15). The tissue was homogenized at room temperature (22°C) for 2 minutes using a hand held variable speed drill as a power source. The homogenate was centrifuged and the supernatant decanted into a 30 ml glass separatory funnel. The supernatant was then diluted with equal volumes of chloroform and water to a final composition of 2:2:1.8 (chloroform:methanol:water). The mixture was agitated after each addition. The lower chloroform layer was withdrawn into a tared mini LSC vial and evaporated to dryness under a stream of nitrogen at room temperature. The vials containing the lipid extract were further dried in an evacuated dessicator for 12 hours at room temperature. The vacuum was broken by introduction of nitrogen and the vials were immediately capped and weighed on an analytical balance. Total radioactivity of the tissue extract was determined with a liquid scintillation spectrometer after addition of 4.5 ml scintillation cocktail containing 4g BBOT dissolved in 1 liter toluene. Extractions were performed on seawater spiked with labelled glycolate. Radioactivity remaining in the chloroform fraction after extraction averaged 0.1% of that added as spike. This value was much lower than that obtained after extraction of tissue incubated in radioactive glycolate.

RESULTS AND DISCUSSION

Glycolic acid uptake as a function of time was determined over a wide range of concentrations in order to establish the period during which initial rate conditions existed. The concentrations were chosen to approximate previously reported concentrations of glycolate in natural waters as well as those concentrations which could reasonably be expected to cause saturation effects. Gill segments were incubated in glycolic acid solutions ranging from 2 μM (164 $\mu g l^{-1}$) to 133 μM (10, 171 $\mu g l^{-1}$). The weight specific uptake of labelled glycolate over the range of weights of experimental tissue was constant due to the close agreement in size between tissue segments. Radioactivity was normalized to lyophilized total tissue dry weight. Uptake increased linearly with time for periods up to 90 minutes (Figure 1). Uptake velocity as a function of concentration was also linear and exhibited no saturation effects. Double logarithmic plots of uptake velocity vs. concentration were prepared to determine the nature of the uptake kinetics. If the relations are linear, the plots will produce straight lines whose slope is the order of reaction (Laidler, 1965). The order with respect to concentration (n_c) is 1 while the order with respect to time (n_t) is 0, indicating that the uptake process for glycolic acid under these experimental conditions is diffusion (Figure 2a, 2b). This method of plotting also allows an accurate estimate of the rate constant of the equation $v=kc^n$, which relates the rate of reaction to concentration. The y intercept (log v) is equal to log k and reveals k=0.108 (Figure 2a).

Micellar or molecular diffusion appear to be the primary mechanisms for absorption of fatty acids and monoglycerides by intestinal epithelium in a variety of organisms (Hubscher, 1970; Kolinska, 1975). Testerman (1972) found uptake of some fatty acids exhibited saturation kinetics with two species of polychaetes. Southward and Southward (1970, 1972) obtained the same results with both pogonophores and polychaetes. Pinocytosis is another route for entry of lipids and fatty acids into the cell. Pasteels (1968) demonstrated pinocytosis of ferritin by gill cells of Mytilus edulis. However, the significance of pinocytosis in lipid transport into epithelium cells is questionable (Hubscher, 1970) and available data favor other means of transport.

The accumulation of labelled glycolic acid by the gill tissue is not likely to be caused by bacteria adhering to the gill surface since bacteria exhibit saturation kinetics with respect to uptake and oxidation of glycolic acid at low concentrations similar to those used here (Robinson et al., 1973; Wright and Shah, 1975). The natural cleansing effect of gill cilia, use of filtered artificial sea water and short incubation times further reduced bacterial effects. Plate counts of smears of gill tissue on both Zobell and Nutrient agar media revealed low (<50 colonies) population of bacteria. Slopes of regression lines on the time course of $^{14}CO_2$ evolution with antibiotic treated vs. untreated Mercenaria sp. gill tissue showed no significant differences ($P<0.05$) for M. mercenaria (Figure 3) or for M. campechiensis (Figure 4).

Accumulation of a radioactive label is not definitive evidence of net accumulation of a compound because of the possibility of exchange diffusion or label exchange. There is evidence that marin-

invertebrates can excrete considerable quantities of organic matter and thus may exhibit no net gain even though there is accumulation of radioactive label (Johannes, et al., 1969; Johannes and Webb, 1965, 1970). Small particles or organic solutes can enter the ostia of the eulamellibranchian gill so that labelled material can be physically trapped rather than incorporated into gill tissue cells. Therefore, the metabolic significance of uptake of a compound where kinetics are diffusion controlled must be clarified. Stephens (1968) considered $^{14}CO_2$ evolution good evidence that a compound enters oxidation pathways. Experiments were performed demonstrating the evolution of $^{14}CO_2$ by M. mercenaria and M. campechiensis (Figure 3,4). The low activity of the control tissues eliminates the possibility that the $^{14}CO_2$ evolved was due to volatilization of absorbed glycolic acid or $NaHCO_3$ contamination. The CO_2 evolved over the experimental period represented approximately 10% of the total uptake of labelled carbon by gill tissue.

Glycolic acid taken up from the surrounding environment enters into the metabolism of Mercenaria sp. gill tissue although the mechanism by which this occurs is unknown. The metabolism of glycolic acid in phytoplankton and higher plants occurs by way of the glycolate oxidizing enzyme glycolate oxidase (higher plants) or glycolate dehydrogenase (algae) (Merrett and Lord, 1973). Glycolate oxidase will oxidize lactate as well as glycolate; however, it is stereochemically specific for L-lactate and does not oxidize the enantiomer D-lactate (Zelitch and Ochoa, 1953). Glycolate dehydrogenase oxidizes D-lactate preferentially to L-lactate (Nelson and Tolbert, 1970). Neither of these two enzymes has been reported in higher organisms but there is the possibility that another enzyme is

in operation. The enzyme lactate dehydrogenase is commonly found in higher animals and occurs in mollusks and M. mercenaria at low activities (Hammen, 1975). This enzyme catalyzes the conversion of lactate to pyruvate and in vertebrates is specific for L-lactate. It will also act on glycolic acid to produce glyoxylate. The enzyme acts upon the stereochemically corresponding α-hydrogen of L-lactate and glycolate (Rose, 1958; Johnson et al., 1965). Recent evidence indicates D-lactate specificity for the enzyme in mollusks (Hammen, 1969). The presence of lactate dehydrogenase provides a mechanism by which glycolate can be incorporated into animal metabolism after entering the cells. If lactate dehydrogenase can convert glycolic acid to glyoxylate, then through the transamination reaction postulated by Hochachka et al. (1973) glycolic acid can be included into amino acid metabolism and ultimately into the tricarboxylic acid cycle (Figure 5). A mechanism similar to this may occur in marine bacteria (Wright and Shah, 1975).

Another mechanism for inclusion into oxidation pathways would be incorporation of glycolate into the complex system of lipid metabolism. Bivalves can synthesize fatty acids from acetate and some may incorporate it into such components as the sterol fraction, although evidence for the latter pathway is contradictory (Tamura et al., 1964; Walton and Pennock, 1972; Voogt, 1975 a,b). Since glycolic and acetic acids are chemically similar, experiments were conducted to determine if glycolic acid was incorporated into the lipid fractions of the gill tissue. Lipid extracts of tissue incubated in a glycolic acid solution with the antibiotic mix showed incorporation

of label into the lipid fraction (Table 1). Incorporation occurred after uptake of the compound from solution for a short period (2 hours), a method which differs from the more popular method of injecting a compound of high specific activity directly into the animal and waiting a considerably longer period before extraction. This may explain the low specific activity of the lipids fraction.

Uptake of glycolic acid and evidence of its inclusion into oxidative and biosynthetic pathways of Mercenaria sp. gill tissue have been demonstrated here. We do not suggest that glycolic acid is a primary carbon or energy source for the organism. However, uptake of reduced carbon by higher organisms can be an important nutritional supplement (Stephens, 1968) which should be considered in quantitative studies on the transfer of energy through a marine ecosystem.

ACKNOWLEDGEMENTS

This research was supported by the Florida Sea Grant Program under the National Oceanic and Atmospheric Administration contract number 04-3-158-43. We wish to thank John Calder and David White for comments on the manuscript.

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FIGURE LEGENDS

Figure 1. Uptake of glycolic acid at various concentrations as a function of incubation time. The error bars represent the mean of triplicate samples ± two s.d. Linear regression lines calculated by the method of least square. T=30°C, hybrid bivalves.

3.56 µM $y = 0.46 + 0.38x$ $r^2 = 0.93$

8.82 µM $y = 0.51 + 1.11x$ $r^2 = 0.93$

15.4 µM $y = 0.26 + 1.49x$ $r^2 = 0.92$

68.0 µM $y = 0.26 + 6.65x$ $r^2 = 0.93$

133. µM $y = -32 + 16.2x$ $r^2 = 0.95$

FIGURE CAPTIONS

Figure 2. Double logarithmic plots of uptake velocity vs. concentration. The slope represents the order of reaction n.

(A) The order with respect to concentration, n_c. Uptake velocities calculated from slope of regression line of uptake vs. time at each concentration (Figure 1).
$y = -0.967 + 1.00\,x, r^2 = 0.99, n_c = 1$

(B) The order with respect to time, n_t. Uptake velocities at each time during an experiment for a single concentration of glycolic acid. The logarithm of the rate at each time is plotted against the logarithm of the concentration of glycolic acid in the tissue at that time. Each point represents the mean rate of three replicates. ◘ 3.56 µM, O 8.82 µ M, ⊖ 15.4 µM, ▲ 68.0 µM, ▲ 133. µM.

Figure 3. Evolution of labelled carbon dioxide by M. mercenaria. No significant difference between slopes of regression lines for antibiotic treated vs. untreated tissue ($p<0.05$). T=20°C ⊖ untreated tissue, ▲ antibiotic treated tissue ◘ $HgCl_2$ poisoned control tissue.

Figure 4. Evolution of labelled carbon dioxide by M. campechiensis. No significant difference between slopes of regression lines for antibiotic treated vs. untreated tissue ($p<0.05$). T=20°C O untreated tissue, ▲ antibiotic treated tissue ◘ $HgCl_2$ poisoned control tissue.

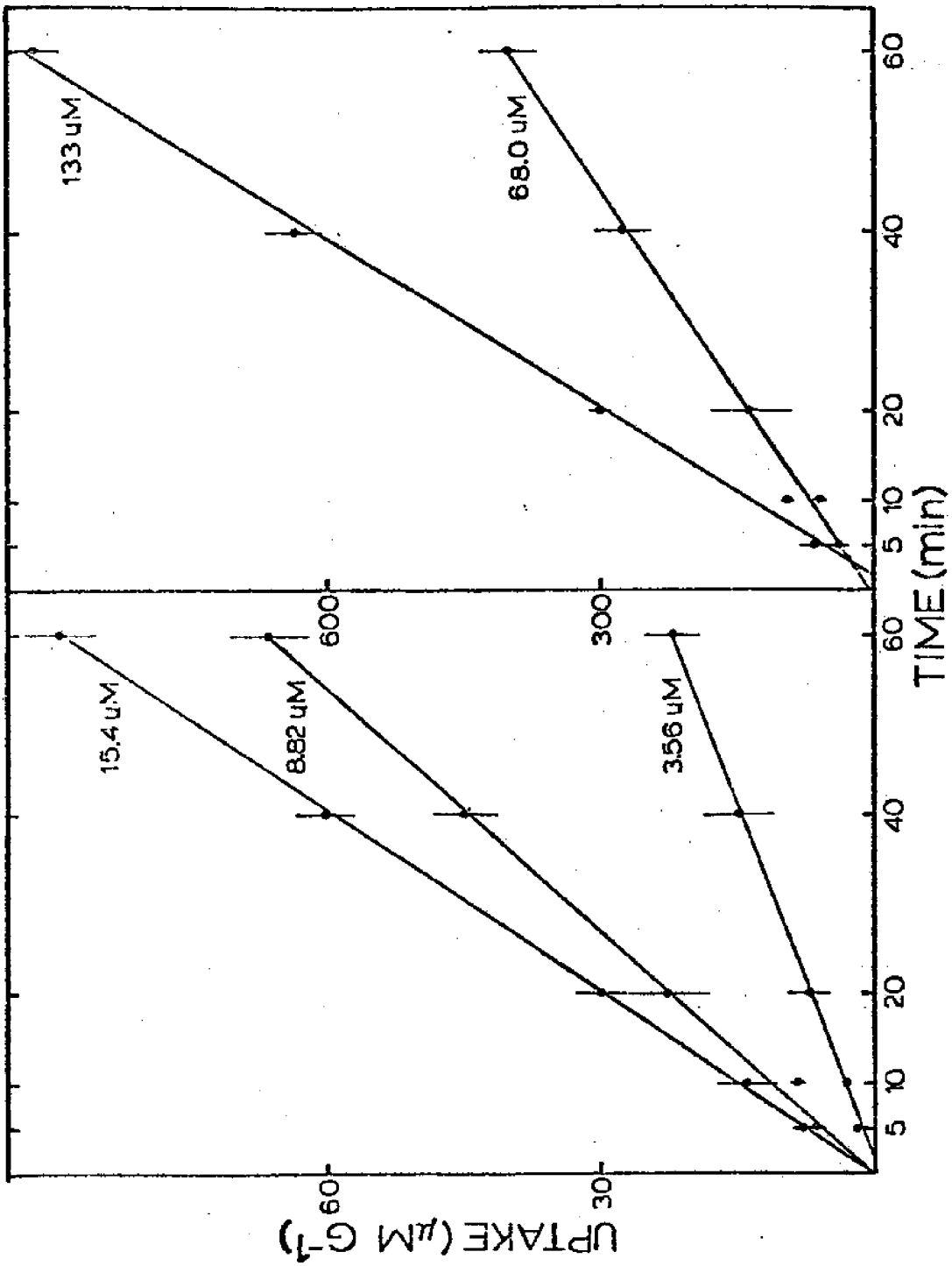
Figure 5. Possible mechanism for inclusion of glycolic acid into bivalve metabolism and evolution of labelled carbon dioxide.

1 lactate dehydrogenese catalyzed reaction.
2 transaminase reaction postulated by Hochachka (1973).
O unlabelled α carbon of glycolic acid.
● labelled carboxyl carbon of glycolic acid.

TABLE 1.

Radioactivity in lipid fraction of gills. M. campechiensis

Number of Samples	6
Radioactive precursor	sodium glycolate-1-^{14}C
Specific activity	116 $\mu Ci\ mg^{-1}$
Dose	0.10 $\mu Ci\ ml^{-1}$
Concentration	855 $\mu g\ l^{-1} HOCH^2COOH$
Incubation time	2 hours
Lyophilized weight	365.7 mg.
Total lipids	27.49 mg.
(% Dry wt.)	7.52%
Radioactivity in lipid fraction	51 dpm mg^{-1}


UPTAKE (μM G⁻¹)
TIME (min)
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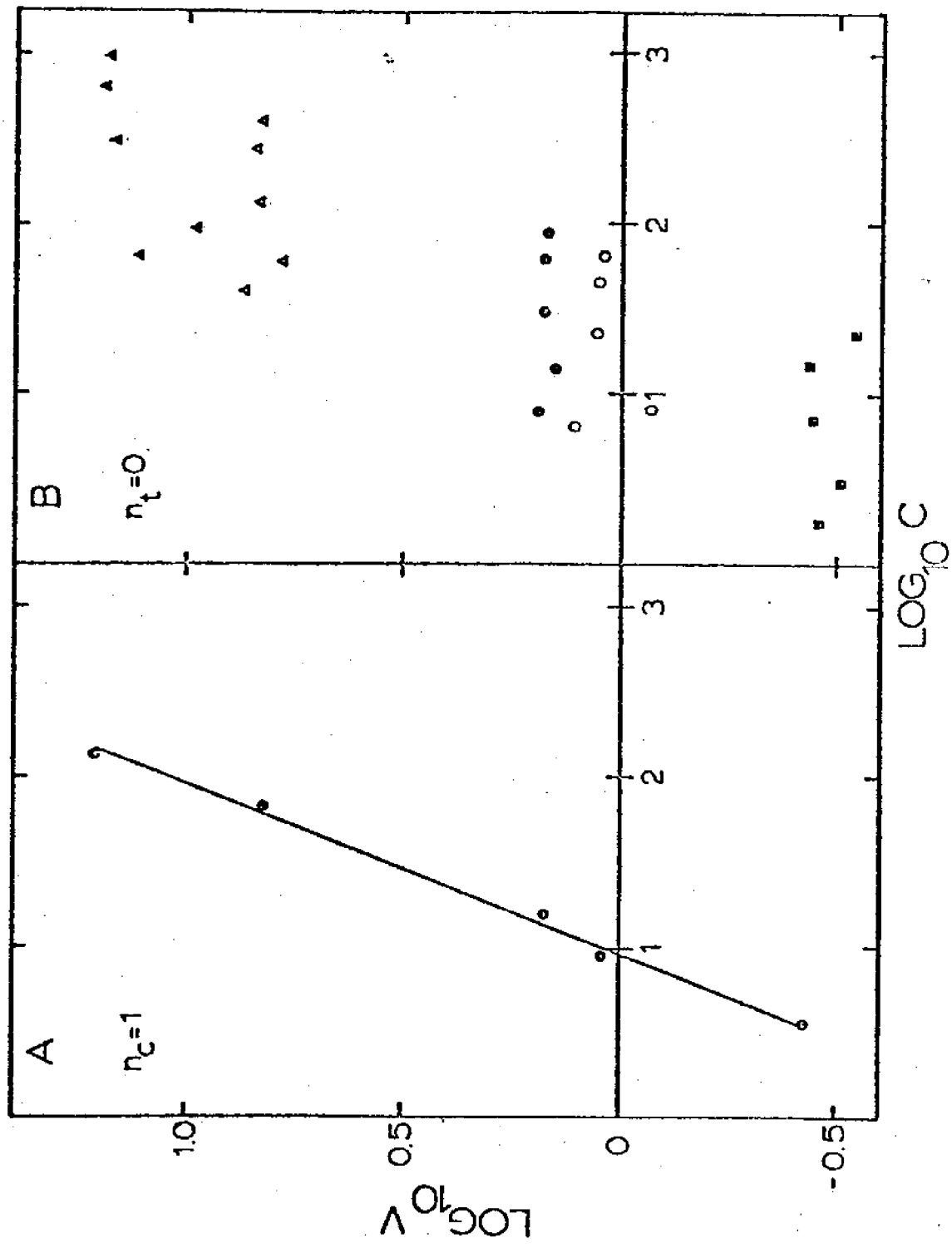
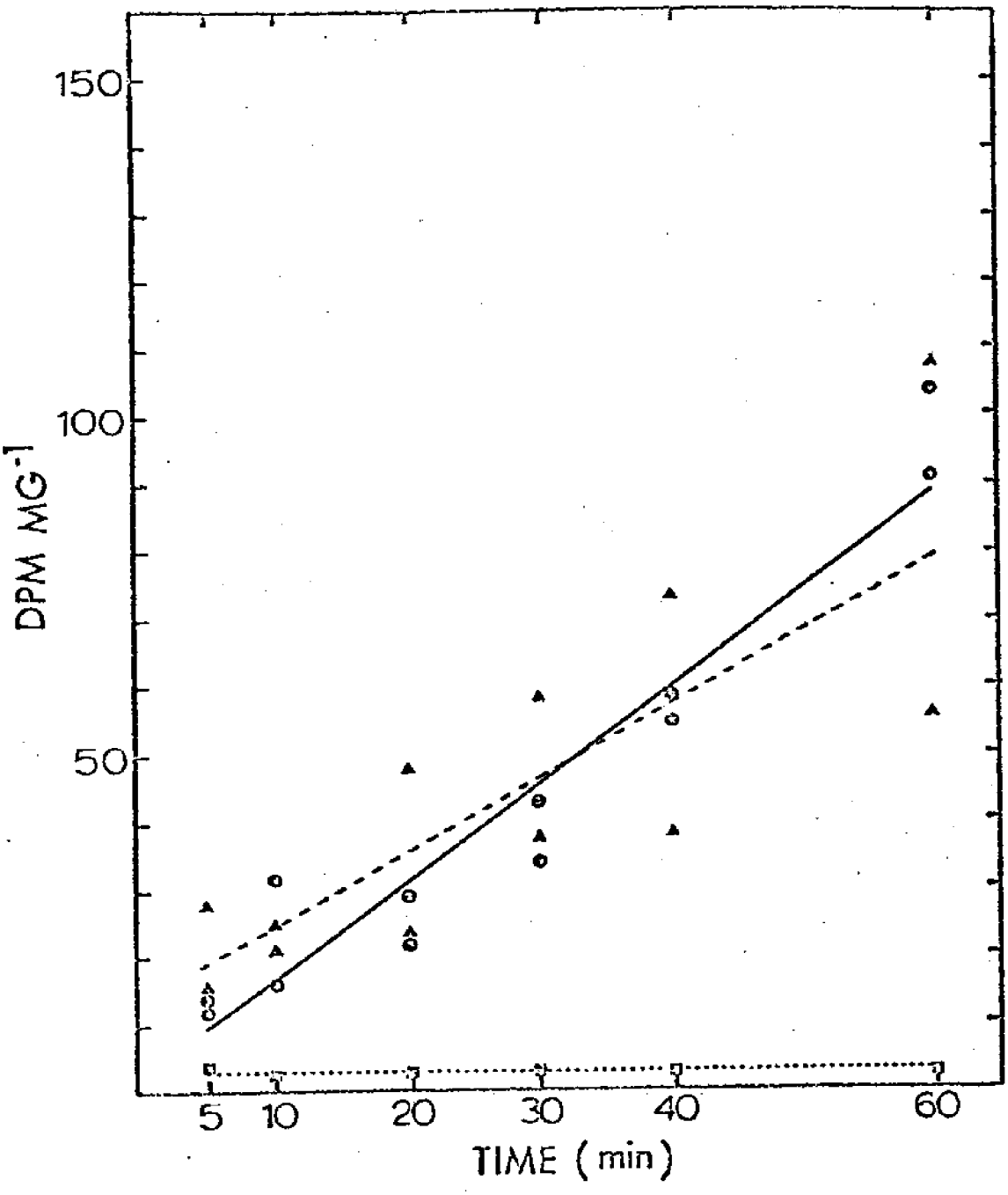
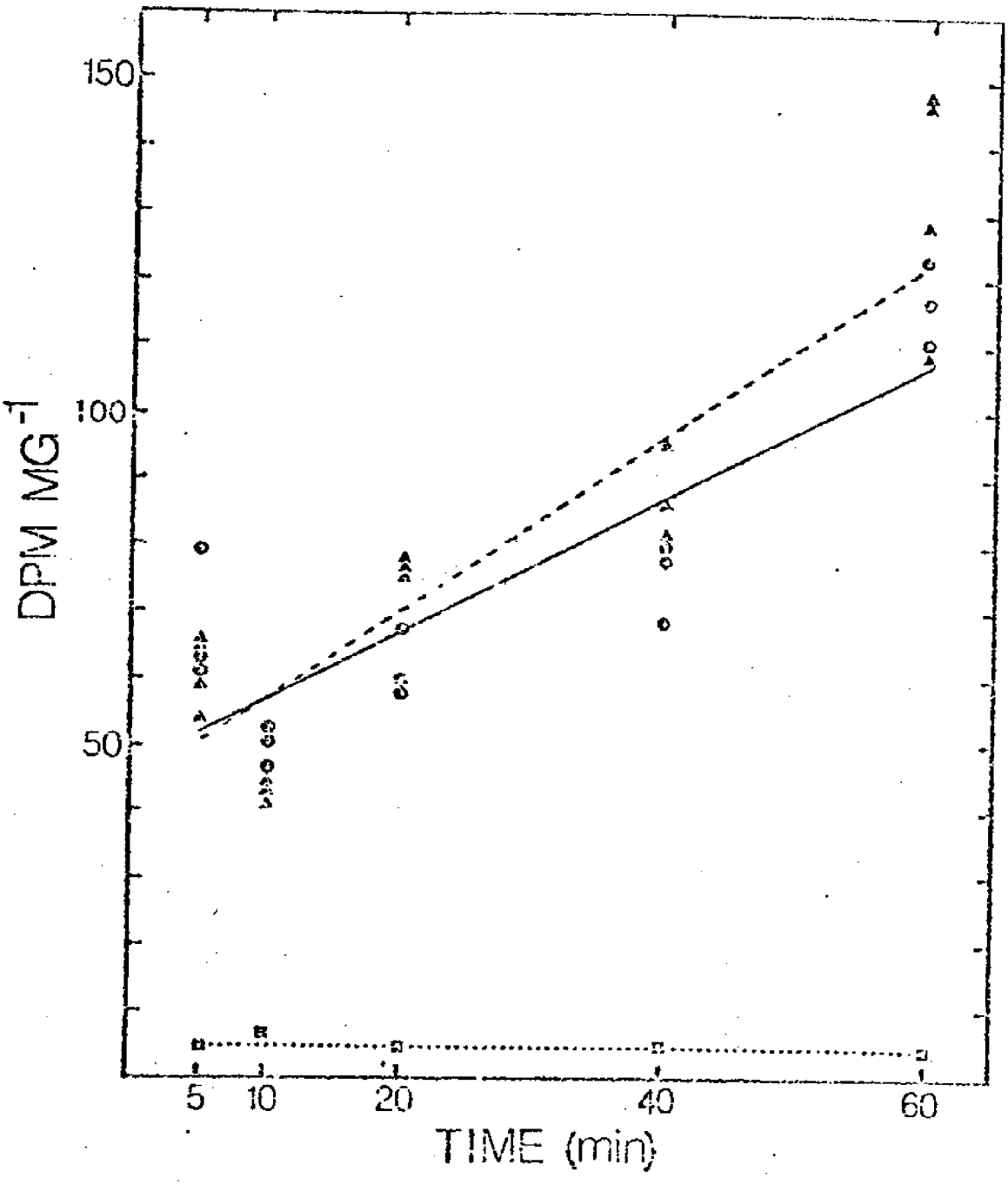
68.0 uM
15.4 uM
8.82 uM
3.56 uM
60
30
600
300
5
10
20
40
60

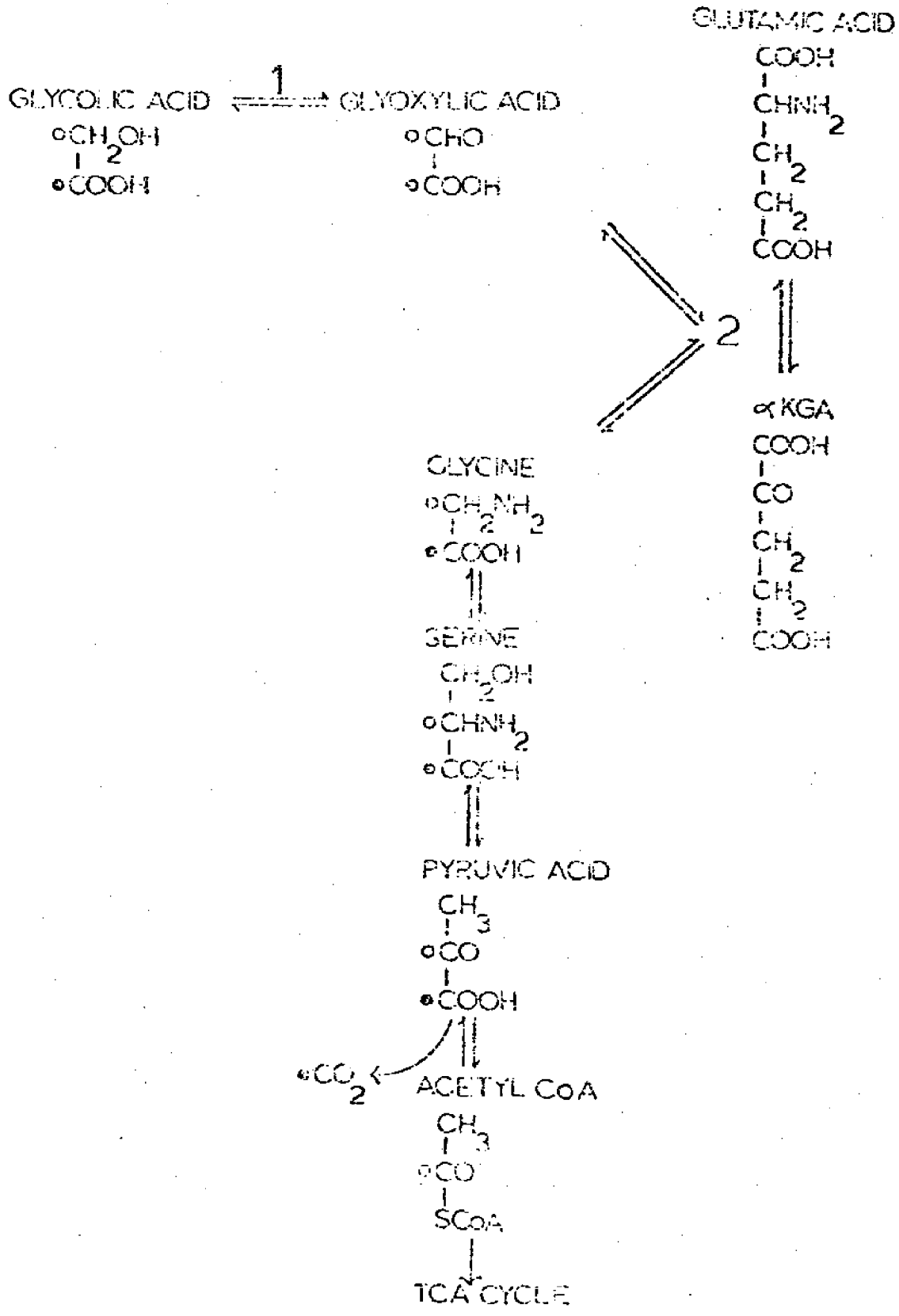


(2)


150
100
50
DPM MG-1
5
10
20
30
40
60
TIME (min)



(4)


GLUTAMIC ACID
COOH
CHNH2
CH2
CH2
COOH
GLYCOLIC ACID
1
GLYOXYLIC ACID
CH2OH
COOH
CHO
COOH
2
αKGA
COOH
CO
CH2
CH2
COOH
GLYCINE
CH2NH2
COOH
SERINE
CH2OH
CHNH2
COOH
PYRUVIC ACID
CH3
CO
COOH
CO2
ACETYL CoA
CH3
CO
SCoA
TCA CYCLE

(5)

VI. Detritus: Micro- and Macro-particulates

Introduction

In his review of the importance of organic matter in the marine environment, Perkins (1974) pointed to a considerable lack of knowledge concerning the fate and importance of macroscopic organic particulate matter in estuarine and coastal systems. Such matter often has its origin in terrestrial areas; subsequent transport, deposition, decomposition, and utilization by various organisms is not well understood. Allochthonous forms of plant litter can be of importance to the energy budget of aquatic systems; this function, however, has been more fully treated in freshwater habitats than estuarine and coastal areas (Willoughby, 1974).

According to Odum and de la Cruz (1963) and Darnell (1967 a and b), the term "detritus" applies to various forms of biogenic material undergoing microbial decomposition. Lenz (1972) considered detritus as particles between 1 and 300 μm, accounting for about 90% of the particulate matter in coastal systems. Odum and Heald (1975) have reviewed the concept, emphasizing that organic detritus includes freshly dead bodies of plants and animals through the finely disintegrated particles and sorbed materials such as bacteria, fungi, protozoans and dissolved organic and inorganic compounds. They noted the annual production (tons per acre) of plant detritus which provides energy for shallow estuarine systems.

The degradation (and subsequent utilization) of organic detritus can be extremely complex, depending on the specific environmental variables involved (Perkins, 1974). Generally, the breakdown of leaf litter includes rapid leaching of soluble constituents (amino acids, sugars, aliphatic acids, etc.; Nykvist, 1959, 1962, 1963; Kaushik and Hynes, 1971;

Willoughby and Archer, 1973), and subsequent colonization by bacteria and fungi (Jones, 1973). This, in addition to various mechanical stresses, eventually leads to a physical breakdown of the leaf matter to smaller particles (Willoughby, 1974). Such particles can then be reworked, aggregated in the form of fecal pellets, etc., and repeatedly run through the system (Odum and Heald, 1975).

During intermediate stages of microbial leaf colonization, leaf litter forms a transient form of microhabitat that is capable of supporting various forms of aquatic organisms. Kaushik and Hynes (1971) found that amphipods (Hyalella azteca, Gammarus lacustris) and an isopod (Asellus communis) consume leaf matter, showing distinct preferences for certain forms of leaves. Odum and Heald (1972) noted that the amphipod Melita nitida grazes on the microbial biota of mangrove leaves, and that M. nitida and the xanthid crab Rhithropanopeus harrisii consume leaf fragments. Although it is widely assumed that much of the utilizable energy resource of such detritus is derived from the microbial component (Newell, 1965; Kaushik, 1969; Odum and Heald, 1972), the ability to digest cellulose has been demonstrated in at least one amphipod (Orchestia gammarella) by Wildish and Poole (1970). Adams and Angelovic (1970) found that gastropods (Bittium varium), crustaceans (Palaemonetes pugio) and polychaetes (Glycera dibranchiata) can assimilate Zostera detritus, and that P. pugio and B. varium derived more nourishment from the detrital substate than from its associated bacteria. Considerable amounts of vascular plant detritus are found in the digestive tract of various organisms such as mussels, harpacticoid, cyclopoid, and calanoid copepods, mysids, cumaceans, isopods, decapods, and various forms of fishes (Pennak, 1953; Darnell, 1958; Tagatz, 1968; Odum and Heald, 1972; Carr and Adams, 1973). Although the nutritional

significance of detritus of various sizes in estuarine systems remains obscure, the potential importance of such material as a direct and indirect source of food for complex food webs cannot be underestimated.

The Apalachicola Bay System (Fig. 1) is a shallow, barrier island estuary in north Florida that is physically dominated by the Apalachicola River (Livingston, 1974; Livingston, 1975; Livingston et al., 1975). This river system is composed of a series of interlocking marsh, swamp, and riverine habitats that empty directly into Apalachicola Bay. The current structure, salinity, nutrient, and detritus regimes of the bay system have been directly associated with river function (Livingston, 1974; Livingston et al., 1974). According to a recent (1970) survey of the Apalachicola River basin by the Florida Division of Forestry (George Reinert, personal communication), there are approximately 253,000 acres of wetland forest (including stream margins, deep swamps, and bay heads). Clewell (1977) has described the terrestrial plant associations in the Apalachicola Valley. The dominant species in the flood plain are as follows:

Sand bars

- Black willow (*Salix nigra*)
- Cottonwood (*Populus deltoides*)
- Sycamore (*Platanus occidentalis*)

River banks

- River birch (*Betula nigra*)
- Ogechee-tupelo (*Nyssa ogeche*)
- Alder (*Alnus serrulata*)

Natural levees

- Southern magnolia (*Magnolia grandiflora*)

Swamp-chestnut oak (Quercus prinus)

Spruce pine (Pinus glabra)

Ironwood (Carpinus caroliniana)

Water oak (Quercus nigra)

Sweetgun (Liquidambar styraciflua)

Low terraces

Overcup oak (Quercus lyrata)

Water hickory (Caryantomentosa aquatica)

Diamond-leaf oak (Quercus laurifolia

Sweetgun (Liquidambar styraciflua)

Ash (Fraxinus sp.)

Sloughs and oxbow ponds

Bald cypress (Taxodium distichum)

Water tupelo (Nyssa aquatica)

A complete list of the terrestrial flora appears in Table 1. According to Clewell (personal communication), many of the deciduous species lose leaves during late fall and winter months. This coincides generally with periods of river flooding.

This portion of the study was designed as a preliminary estimation of seasonal patterns of river-derived detrital influx into the Apalachicola Estuary.

Methods and Materials

Macroparticulate matter was sampled with otter trawls (16 foot; 3/4 in. wing mesh, 1/4 in cod end mesh liner) drawn at speeds of 2 - 2.5 knots at monthly intervals (from January, 1975 to the present). Repetitive two minute trawl tows were made at the following stations (Fig. 1):

1 (7 samples)

1 a (2 samples)

1 b (2 samples)

1 c (2 samples)

1 x (2 samples)

1 e (2 samples)

2 (2 samples)

3 (2 samples)

4 (2 samples)

5a (2 samples)

5 (7 samples)

This amounted to 64 minutes of trawling at representative stations in the bay each month. Detritus was returned to the laboratory where it was sorted, identified to (plant) species, and dried at 100°C for 24 hours. Where no identification to species was possible, the material was sorted to type (i.e., benthic macrophyte debris, leaf debris, wood debris). These data were then entered into the interactive computer system which gave monthly totals (Table 2) for 22 minutes of sampling (a total of the dry weight figures per trawl tow for each of the 11 sampling areas). These were characterized as total detritus (Totdeb), total wood debris (Woodeb), total leaf debris (Leadeb), total benthic macrophyte debris (Benmac), and individual totals for each species of tree or benthic macrophyte.

Microdetritus was taken at monthly intervals from August, 1975, to the present. Samples were collected at Station 7 (near the mouth of the Apalachicola River, surface and bottom, and at Station 8, about 1.5 km. from the mouth of the Little St. Marks River (middepth). Samples were generally taken as close to low tide as possible, although some collections at Station 8 were made shortly after low tide due to the shallowness of the

water. Odum and Heald (1975) found that much of the exported detritus in the North River (Florida) was in the form of particles between 50 and 350μ in size. Accordingly, between 250 and 1000 liters of river water were pumped through a series of standard mesh sieves (45μ, 88μ, 125μ, 250μ, 500μ, 1.0mm 2.0mm). Detritus was washed from each sieve into separate glass vials and preserved in a 3% mercuric chloride solution to inhibit bacteriological decompositon.

In the laboratory, each sieve fraction was filtered onto pre-weighed, pre-combusted glass filter pads and oven dried at 105°C for 48 hours to determine dry weight. Ignition of the sieve fractions and filters in a muffle furnace for 1 hour at 550°C (Heald, 1969) allowed determination of the ash-free dry weight. Weight loss after ashing was used to estimate total organic content although such loss does not constitute the true (total) organic content and remains an estimate.

The shortcomings of these methods of collection are recognized. Otter trawling is a very approximate way to sample detritus, and the trawling patterns could have caused a sampling bias when extending the data for baywide estimates. The macroparticulate data are therefore highly conservative and are most valuable with respect to qualitative temporal changes of individual constituents and the spatial distribution of these components. The microdetrital analysis was problematic due to inadequate cross-sectional analysis (length and depth) of the river and the low (monthly) sampling frequency. These data should be construed as conservative since nothing below 45μ was sampled. Thus, the data tend to be highly conservative with respect to mass flows in time.

Results and discussion

Results of the macrodetrital sampling program are shown in Fig. 2 and

Tables 2 and 3.

The qualitative and quantitative aspects of detritus composition appear to be related to spatial factors with certain common relationships appearing within various groups of stations. Detritus at stations in upland portions of the bay (5A, 6) was characterized by benthic macrophytes such as Ruppia and Vallisneria with lesser amounts of wood and leaf litter. On the other hand, river-dominated stations (2, 3, 4, 5) were largely represented by wood debris and leaf litter with relatively little detritus of benthic macrophyte origin. Leaf matter was contributed by numerous species of terrestrial plants which commonly inhabit upland river and swamp areas. Dominant forms included Quercus spp., Populus deltoides Liquidambar styraciflua, Nyssa aquatica, Betula nigra, and Acer rubum. Benthic macrophyte detrital matter was derived largely from Ruppia maritima, Ulva lactuca, Halodule wrightii, Vallisneria americana, and Gracilaria spp. Outer bay areas receiving river drainage (1, 1A, 1B) were characterized by lesser quantities of wood debris, leaf litter, and benthic macrophytes in nearly equal proportions. Outer bay stations which did not receive direct river runoff (1X, 1E, 1C) were dominated by detritus of benthic macrophyte origin, notably Gracilaria foliifera, Halodule wrightii, and Ulva lactuca.

The data indicate that various forms of detritus of terrigenous origin occur in the bay, and that areas associated with Apalachicola River runoff are typified by seasonally variable concentrations of allochthonous leaf and wood matter.

In a qualitative and quantitative sense, the appearance of macroparticulate matter in the Apalachicola Estuary appears to be a function of river flow. River fluctuations during the sampling period (Fig. 2) re-

lected relatively high mean monthly values during the winter and spring of 1975 and 1977 with relatively low mean flow rates during 1976. Peak flooding occurred during January, February, March, and April of 1975 and March of 1977. During such periods, there were considerable increases in the leaf and wood matter found in the Bay (Table 3, Fig. 2). There was also an increase in benthic macrophyte debris at these times, although major shifts to such macrophyte detritus usually occurred during fall periods. This was probably due to kills of macrophytes as a function of reduced water temperature. The low levels of macroparticulate matter in the bay during 1976 coincided with the relatively low levels of mean river flow as well as reductions in the peak flooding levels. It would appear that both functions are operable in controlling the seasonal appearance of macroparticulate matter in the Apalachicola Estuary. During a given year, when river flooding exceeds 60,000 C.F.S., there was an increased level of allochthonous detritus in the bay during spring months. This led to a bimodal pattern of total macroparticulate detritus in the bay during such a year, with peaks occurring during spring and fall months. These data indicate that there is a direct relationship between river flooding and the appearance of macroparticulate matter in the Apalachicola Estuary, and that if such flooding does not reach a certain level, allochthonous detritus does not appear in the bay at any appreciable level.

The sieved fractions of detritus (the so-called microdetritus) found at the mouth of the Apalachicola River and one of its primary offshoots, the Little St. Marks River, are shown in Tables 4 and 5 and Fig. 2. Once again, river flow and flooding appear to be controlling factors. Moderately high levels of microdetritus appeared during the winter and spring of 1976.

This was followed during the subsequent year (March, 1977) by substantial increases in terms of concentration (mg/l) and total quantities of microparticulates. Unfortunately, the river flooding of 1975 was not sampled; consequently, there is relatively less information available to substantiate the relationship of river flow and microparticulates than in the previous (macroparticulate) analysis. However, the relatively high levels of microparticulates taken during the peak flooding of March, 1977 indicates that similar functional relationships are operational here. Mean river flow and peak river flooding conditions appear to play a critical role in the amount of microdetritus being delivered to the Apalachicola Estuary.

Although the absolute quantities of allochthonous organic matter associated with river flooding (i.e., almost 900 tons, ash free dry weight of microdetritus and about 126 tons, dry weight, of macrodetritus in March, 1977) appears to be substantial, the exact meaning of such figures in terms of energetic input to the bay is still under study. Associated problems with respect to flushing rates in the bay, import-export factors, and mass balance functions have not been analyzed. Also, as pointed out above, the methods used here were restricted in terms of scope and duration of sampling effort. While the figures given would be viewed as quite conservative with respect to total influx of river-derived organic particulate matter in the bay, the general pattern of detrital movement appears to be well established and is closely associated with upland vegetational associations and periodic flooding of the Apalachicola River.

Based on the above assumptions, work is now in process to delineate the functional significance of these findings. This will include a complete statistical analysis of the data and the development of a compartmental model for a comparison of the energetic interrelationships

of the bay system. Although this analysis is still in a preliminary state, the data to date tend to corroborate the importance of the river (in terms of absolute flow rates and temporal patterning) to the Apalachicola Estuary. It would appear that the temporal sequence of upland flooding of this river system could provide a key link to the productivity of the bay system.

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TABLE A. Terrestrial Plants Known to Occur in the Apalachicola Valley (Clewell, 1977)

River.

Acer saccharinum L.

Carex cephalophora Muhl.

Carex frankii Kunth

Clematis viorna L.

Cornus amomum Mill.

Corydalis flavula (Raf.) DC.

Cryptotaenia canadensis (L.) DC. rare

Dentaria laciniata Muhl.

Helianthus strumosus L.

Hypericum frondosum Michx.

Impatiens capensis Meerb. rare

Lysimachia ciliata L. rare

Nemophila aphylla (L.) Brummitt

Scrophularia marilandica L.

Sicyos angulatus L.

Treptocarpus ~~ea~~ ae thusae Nutt.

TABLE 8. Plants Known in Florida only from the Bluffs of the Apalachicola River, or Some of Them also from the Floodplain.

Actaea pachypoda Ell. rare

Arnoglossum atriplicifolium (L.) Pippen

Baptisia megacarpa Chapm.

Carex gracilescens Steud.

Cornus alternifolia L. f. rare

Croomia pauciflora (Nutt.) Torr. threatened

Cynoglossum virginianum L. rare

Dioclea multiflora (T. & G.) Mohr

Hepatica americana (DC.) Ker. rare

Hydrangia arborescens L.

Luzula acuminata Raf.

Luzula echinata (Small) F. J. Hermann

Matelea baldwyniana (Sweet) Woods.

Matelea flavidula (Chapm.) Woods.

Phlox carolina L.

Silene polypetala (Walt.) Fern. endangered

Smilacina racemosa (L.) Desf.

Trillium lancifolium Raf. rare

Uvularia sessilifolia L. rare

Veratrum woodii Robbins endangered

Verbesina alternifolia (L.) Britt.

Viola affinis LeConte

Woodsia obtusa (Spreng.) Torr.

Zizia aurea (L.) Koch

TABLE C. Plants known in Florida only to the Apalachicola River Region, Excluding Those Known only on Bluffs and Floodplains.

Ampelopsis cordata Michx.

Arnica acaulis (Walt.) BSP.

Aster plumosus Small threatened

Cuphea aspera Chapm. endangered

Cyperus aristatus Rottb.

Dicliptera brachiata (Pursh) Spreng.

Eragrostis glomerata (Walt.) Dewey

Eragrostis pectinacea (Michx.) Nees

Euphorbia telepioides Chapm. threatened

Gentiana saponaria L.

Harperocallis flava McDaniel endangered

Heliopsis minor (Hook.) Mohr

Heteranthera dubia (Jacq.) MacM.

Iva annua L.

Justicia americana (L.) Vahl

Justicia crassifolia (Chapm.) Small

Linum sulcatum Ridd var. harperi (Small) Rogers threatened

Macbridea alba Chapm. endangered

Oxypolis greenmanii Math. & Const. endangered

Parnassia caroliniana Michx.

Parnassia grandifolia DC.

Phoebanthus tenuifolia (T. & G.) Blake

Rhexia parviflora Chapman. endangered

Scutellaria floridana Chapman. threatened

TABLE C , concluded

Sphenopholis nitida (Bieler) Scribn.

Taxus floridana Nutt. endangered

Thaspium trifoliatum (L.) Gray

Torreya taxifolia Arn. endangered

Verbesina chapmanii Coleman threatened

Viola hastata Michx.

Vuika hirsutula Braierd

TABLE D. Noteworthy Plants Known in Florida from the Apalachicola River Region and Other Areas.

Adiantum capillus-veneris L. rare

Anemonella thalictroides (L.) Spach rare

Arnoglossum diversifolium (T. & G.) Pippen threatened

Asclepias viridula Chapm. threatened

Aster spinulosus Chapm. threatened

Calamintha dentatum Chapm. threatened

Carex baltzellii Chapm. threatened

Conradina glabra Shinners endangered

Dirca palustris L. rare

Erythronium umbilicatum Parks & Hardin rare

Gentiana pennelliana Fern. endangered

Hedeoma graveolens Chapm. endangered

Heterotheca flexuosa (Nash) Harms threatened

Hexastylis arifolia (Michx.) Small rare

Hypericum lissophloes Adams rare

Isoetes flaccida Schuttlw. threatened

Isopyrum biternatum (Raf.) T. & G. rare

Laportea canadensis (L.) Weddell rare

Liatris provincialis Godfrey endangered

Linum westii Rogers endangered

Lithospermum tuberosum Rugel rare

Magnolia ashei Weatherby threatened

Malaxis unifolia Michx. rare

Manisuris tuberculosa Nash threatened

Mediola virginiana L. rare

Myriophyllum laxum Shuttlw. threatened

TABLE D, concluded

Nolina atopocarpa Bartlett endangered

Pieris phillyreifolia (Hook.) DC. threatened

Pinckneya bracteata (Bartr.) Raf. threatened

Pinguicula ionantha Godfrey endangered

Pinguicula planifolia Chapm. threatened

Polygonella macrophylla Small threatened

Rhapidophyllum hystrix (Pursh) Wendl. & Drude threatened

Rhexia salicifolia Kral & Bostick threatened

Rhododendron austrinum (Small) Rehder threatened

Sarracenia psittacina Michx. threatened

Senecio aureus L. rare

Smilax smallii Morong. threatened

Uvularia floridana Chapm. rare

Uvularia perfoliata L. rare

Warea sessilifolia Nash endangered

Xyris isoetifolia Kral threatened

Xyris longisepala Kral rare

Xyris scabrifolia Harper threatened

Zephyranthes treatiae S. Wats. threatened

Table E. Plant Species, Common & Scientific Terminology

Alder	Alnus serrulata (Ait.) Willd.
Ash	Fraxinus spp.
Birch, River	Betula nigra L.
Blackgum	Nyssa biflora Walt.
Bulrush	Scirpus spp.
Cabbage palm	Sabal palmetto Lodd.
Cat-tail	Typha domingensis Pers.
Cord-grass	Spartina spp.
Cottonwood	Populus deltoides Marsh.
Cut-grass	Zizaniopsis miliacea (Michx.) Doell & Aschers.
Cypress, Bald-	Taxodium distichum (L.) Rich
Cypress, Pond-	T. ascendens Brongn.
Dogwood	Cornus florida L.
Gallberry	Ilex glabra (L.) Gray
Hickory, Mockernut	Carya tomentosa Nutt.
Water	C. aquatica (Michx. f.) Nutt.
Holly, American	Ilex opaca Ait.
Ironwood	Carpinus caroliniana Walt.
Magnolia, Southern	Magnolia grandiflora L.
Maple, Red	Acer rubrum L.
~~Southern Sugar~~ Southern Sugar	A. barbatum Michx.
Needlerush	Juncus roemerianus Scheele
Oak, Chapman's	Quercus chapmanii Sarg.
Diamond-leaf	Q. laurifolia Michx.
Dwarf-live	Q. geminata Small
Myrtle	Q. myrtifolia Willd.

Table E, continued

Overcup	Q. lyrata Walt.
Post	Q. stellata Wang
Red	Q. falcata Michx.
Runner	Q. pumila Walt.
Swamp-chestnut	Q. prinus L.
Turkey	Q. laevis Walt.
Water	Q. nigra L.
Pine, Loblolly	Pinus taeda L.
Longleaf	P. palustris Mill.
Sand	P. clausa (Chapm.) Vasey
Shortleaf	P. echinata Mill.
Spruce	P. glabra Walt.
Planer-tree	Planera aquatica (Walt.) Gmel.
Reedgrass	Phragmites australis (Cab.) Trin.
Rice, Wild	Zizania aquatica L.
Rosemary	Ceratiola ericoides Michx.
Rush	Juncus spp.
St. Johns-wort	Hypericum fasciculatum Lam.
Saw palmetto	Serenoa repens (Bartr.) Small
Sawgrass	Cladium jamaicense Crantz,
Silverbells	Halesia diptera Ellis
Sweetbay	Magnolia virginiana L.
Sweetgum	Liquidambar styraciflua L.
Sycamore	Platanus occidentalis L.
Titi	Cyrilla spp., Cliftonia monophylla (Lam.) Sarg.

Table E concluded

Torreya	Torreya taxifolia Arn.
Tupelo, Ogeeche	Nyssa ogeche Bartr.
Water	N. aquatica L.
Willow, Black	Salix nigra Marsh.
Wiregrass	Aristida stricta Michx.
Yew, Florida	Taxus floridana Nutt.

Table 2. Summary of total (combined) macrodetritus taken from stations in the Apalachicola Estuary (1, 2, 3, 4, 5, 5A 1A, 1B, 1C, 1E, 1X) from January, 1972 through March, 1977. The figures represent the total of all mean values (combined data at each station) so that each monthly figure represents 11 2-minute trawl-tows (558 M^2/station) or 6,138 M^2 of Bay bottom.

[illegible]
[illegible]
[illegible]
[illegible]

SPECIES	SAMPLE DATES 750101	750201	750301	750401	750501	750601	750801	750901	751001	751101	751201	760101
[illegible]	232.79	193.2[illegible]	350.27	715.20	1560.55	121.09	227.50	409.12	782.56	194.36	65.54	119.44
	36.03	39.21	33.[illegible]	44.91	40.84	30.35	46.05	43.50	37.13	44.89	36.57	41.34
[illegible]	9.41	43.22	113.09	107.39	965.21	32.76	153.21	245.25	189.21	118.30	17.10	67.79
	1.52	16.67	13.32	6.61	29.45	9.90	31.02	30.33	8.98	27.32	9.54	23.46
[illegible]	120.14	49.34	163.00	141.96	210.30	87.53	38.89	122.24	527.83	43.64	22.90	48.84
	19.09	19.[illegible]	14.36	1.14	6.31	26.29	7.87	13.00	25.04	10.08	12.78	16.91
[illegible]	91.15	10.64	63.94	426.46	402.04	2.20	34.15	.62	54.43	3.22	25.22	2.71
	14.11	4.10	7.20	26.27	12.07	.66	4.91	.07	2.50	.74	14.07	.94
[illegible]	24.83	14.35	190.12	110.52	41.21	50.14	2.94	17.39	1.46	0.00	0.00	21.83
	3.56	5.54	11.24	6.90	1.24	15.15	.40	1.85	.07	0.00	0.00	7.56
[illegible]	1.26	3.94	2.51	1.40	10.41	19.16	16.81	53.43	201.84	15.30	1.40	9.11
	.16	1.50	.24	.09	.40	5.79	3.40	5.48	9.56	3.53	.78	3.15
GRAVER	0.00	8.40	0.00	0.00	0.00	0.00	4.65	11.42	204.52	5.64	11.84	0.00
	0.00	3.26	0.00	0.00	[illegible].00	0.00	.94	1.24	9.70	1.30	6.61	0.00
[illegible]	42.36	2.41	62.50	57.42	.42	0.40	0.00	0.00	0.00	.19	1.10	8.39
	6.56	.23	7.05	4.56	.01	0.00	0.00	0.00	0.00	.04	.61	2.90
[illegible]	24.21	.92	.55	1.76	24.84	14.02	9.86	6.17	55.38	6.34	.42	.27
	3.75	.15	.06	.11	.75	4.26	2.00	.68	2.63	1.46	.21	.09
[illegible]	0.00	0.00	0.00	0.00	127.03	0.00	3.27	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	3.91	0.00	.66	0.00	0.00	0.00	0.00	0.00
[illegible]	1.37	.11	.21	.09	.39	.50	1.38	7.92	52.54	9.88	6.01	5.03
	.21	.14	.04	.01	.01	.15	.28	.46	2.49	2.26	3.35	1.74
[illegible]	12.55	1.55	9.63	5.90	.05	0.00	0.00	0.00	0.00	.52	9.16	1.04
	1.42	.60	1.09	.44	.06	0.00	0.00	0.00	0.00	.12	5.11	.36
[illegible]	3.19	1.90	2.49	.48	0.00	.09	0.00	24.15	.37	.88	1.08	2.95
	.49	.37	.28	.05	0.00	.03	0.00	2.57	.02	.20	.60	.99
[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.64	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.30	0.00	0.00
[illegible]	22.37	1.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3.46	.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
[illegible]	2.69	0.10	0.00	0.00	0.00	0.00	1.26	1.01	11.09	1.55	0.00	0.00
	.42	0.00	0.00	0.00	0.00	0.00	.26	.11	.53	.36	0.00	0.00
[illegible]	3.15	.57	0.00	5.16	0.00	0.00	0.00	0.00	0.00	5.58	1.40	1.43
	.48	.22	0.00	.32	0.00	0.00	0.00	0.00	0.00	1.27	.78	.49
[illegible]	3.11	.05	1.91	2.61	0.00	0.00	0.00	0.00	4.41	0.00	1.21	0.00
	.44	.25	.22	.14	0.00	0.00	0.00	0.00	.21	0.00	.60	0.00
[illegible]	12.56	0.00	.35	.10	0.00	0.00	0.00	0.00	0.00	0.00	.40	0.00
	1.44	0.00	.04	.01	0.00	0.00	0.00	0.00	0.00	0.00	.22	0.00
[illegible]	3.19	.14	.96	.27	0.00	0.00	0.00	0.00	7.10	0.00	.01	0.00
	[illegible]	[illegible]	.11	.05	0.00	0.00	0.00	0.00	.34	0.00	.01	0.00
[illegible]	[illegible]	[illegible]	[illegible]	0.00	[illegible]	0.00	0.00	1.29	10.55	0.00	0.00	0.00
	[illegible]	[illegible]	0.00	0.00	0.00	0.00	0.00	.14	.50	0.00	0.00	0.00
[illegible]	[illegible]	[illegible]	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[illegible]	[illegible]	0.00	0.00	[illegible]	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00
[illegible]	[illegible]	[illegible]	0.02	.06	0.00	0.00	0.00	0.00	0.00	0.00	7.12	0.00
	[illegible]	[illegible]	0.30	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	3.97	0.00
[illegible]	4.1[illegible]	[illegible]	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[illegible]	[illegible]	0.00	.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
[illegible]	1.[illegible]	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	.15	1.[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
[illegible]	2.57	[illegible]	.04	.72	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.00
	[illegible]	[illegible]	.37	.16	0.00	0.00	0.00	0.00	0.00	0.00	.62	0.00

750101	750201	750301	750401	750501	750601	750701	750801	750901	751001	751101	751201	760101
2.46	.10	.20	.26	0.00	0.00	0.00	0.00	0.00	0.00	1.55	.17	
.37	.05	.04	.01	0.00	0.00	0.00	0.00	0.00	0.00	.46	.06	
1.45	0.00	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	3.02	0.00	
.30	0.00	0.01	.00	0.00	0.00	0.00	0.00	0.00	0.00	1.69	0.00	
3.71	.35	.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.21	0.00	
.59	.14	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.12	0.00	
0.00	0.00	0.00	3.18	0.00	0.00	0.00	0.00	0.00	.01	0.00	0.00	
0.00	0.00	0.00	.26	0.00	0.00	0.00	0.00	0.00	.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	3.12	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	.04	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.55	0.00	.20	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.12	0.00	.11	0.00	
2.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
2.15	.07	.15	0.00	.10	0.00	0.00	0.00	0.00	.04	0.00	0.00	
.33	.03	.02	0.00	.00	0.00	0.00	0.00	0.00	.01	0.00	0.00	
.24	.10	.59	.71	0.00	0.00	0.00	0.00	0.00	0.00	.25	0.00	
.04	.04	.07	.04	0.00	0.00	0.00	0.00	0.00	0.00	.14	0.00	
.77	.01	.04	.10	0.00	0.00	0.00	0.00	.75	.03	.03	0.00	
.12	.00	.01	.01	0.00	0.00	0.00	0.00	.04	.01	.02	0.00	
.42	0.00	.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.11	0.00	.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
1.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15	0.00	0.00	0.00	
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.05	0.00	0.00	0.00	
.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.47	0.00	
.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.25	0.00	
.05000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.55000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.31000	.01000	.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.13	.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.46000	0.00000		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.26	0.00		
.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.14000	.14000	.01000	0.00000	0.00000	0.00000	0.00000	.04000	0.00000	0.00000	0.00000	0.00000	
.03	.03	.00	0.00	0.00	0.00	0.00	.01	0.00	0.00	0.00	0.00	
.03000	.02000	.21000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.00	.01	.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.00000	0.00000	0.00000	.05000	0.00000	0.00000	0.00000	.04000	0.00000	0.00000	.01000	0.00000	
0.00	0.00	0.00	.00	0.00	0.00	0.00	.00	0.00	0.00	.01	0.00	
.00000	.01000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.01	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.00000	0.00000	0.00000	.05000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.01	0.00	0.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00000	.05000	.01000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
0.00	.02	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.02000	.01000	.02000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.00	.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
.05000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
0.00000	0.00000	.05000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
0.00	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

750101	750201	750301	750401	750501	750601	750701	750801	750901	751001	751101	751201	760101
.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	
.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

SUMMARY [illegible]
[illegible]
STATIONS [illegible]
TIMES OF [illegible]

SPECIES	760111	760201	760401	760501	760601	760701	760801	760901	761001	761119	761217	770125
TOTDEN	254.42	116.42	292.52	166.71	243.38	35.46	6.50	21.49	223.81	405.40	222.80	582.24
	41.59	49.01	49.14	44.56	35.39	34.12	33.73	36.03	33.94	30.31	40.85	46.57
WOODEN	97.52	58.42	273.51	122.40	73.56	3.06	.19	4.76	8.71	10.50	83.76	243.05
	19.19	18.25	46.77	32.69	9.14	2.94	.99	7.98	1.33	.73	15.30	22.54
BENMAC	34.55	55.03	10.31	35.17	219.41	32.35	6.29	16.46	218.84	447.90	57.50	44.44
	15.53	19.77	1.73	9.45	27.21	31.31	32.64	27.93	31.97	31.42	10.50	4.12
LEADER	45.85	4.21	1.78	9.05	.31	.06	.01	.06	1.49	4.61	60.30	207.64
	13.78	1.31	.61	2.42	.04	.06	.05	.10	.23	.32	22.12	19.05
SPAFUR	20.27	36.59	3.13	20.00	0.00	1.36	.02	.09	120.04	320.82	41.11	26.32
	3.12	13.14	.53	5.35	0.00	1.12	.10	.15	19.10	22.63	7.51	2.44
RUPHAW	.62	6.69	1.04	1.93	162.19	8.46	5.92	15.56	9.43	5.12	11.41	9.92
	.19	2.37	.18	.52	20.12	4.17	30.72	26.06	1.50	.35	2.16	.92
MALMAI	.48	.15	.22	.46	42.89	14.43	.11	.16	33.03	111.36	1.52	1.46
	.24	.25	.34	.10	5.32	13.54	.57	.27	5.03	7.71	.28	.15
SPAVER	0.00	0.00	0.00	12.52	3.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	3.15	.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JUVLAC	37.33	6.78	.15	0.03	0.00	0.00	0.00	0.00	0.00	0.00	.07	1.19
	6.12	2.44	.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01	.11
SPISHE	0.00	0.00	0.00	0.00	10.04	8.23	0.00	0.00	.41	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	1.25	7.57	0.00	0.00	.05	0.00	0.00	0.00
FICCRA	13.41	.20	1.59	0.00	0.00	0.00	0.00	.16	3.16	33.46	14.96	23.36
	3.31	.07	.27	0.00	0.00	0.00	0.00	.27	.40	2.32	2.73	2.17
VALAME	16.19	2.11	.44	.15	.13	.29	.12	.72	1.46	2.98	1.09	5.40
	2.53	.77	.14	.04	.02	.28	.62	1.21	.22	.18	.35	.50
QUEVIC	2.36	1.29	0.33	.63	0.00	.05	0.00	0.00	.09	.37	7.77	5.20
	.39	.46	0.00	.17	0.00	.05	0.00	0.00	.01	.02	1.42	.40
FILALG	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.24	0.00	0.00	0.00
	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.97	0.00	0.00	0.00
AMPTUB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DUPLYR	.53	0.09	0.00	.03	0.00	0.00	0.00	0.00	0.00	3.24	6.73	1.54
	.11	0.09	0.00	.02	0.00	0.00	0.00	0.00	0.00	.22	1.23	.14
NASGAA	4.77	.75	.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.64
	.79	.27	.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.06
LAUTIT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AGATEN	1.01	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	.17	.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LIOSTY	1.46	.20	0.00	0.00	.05	0.00	0.00	0.00	0.00	0.00	8.04	1.07
	.14	.04	0.00	0.00	.01	0.00	0.00	0.00	0.00	0.00	1.61	.10
PODDEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.18	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.03	0.00
CAPAUU	[illegible]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SAPPIF	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAPIL	0.00	1.12	2.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	.40	.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ACEHOR	.93	.15	0.00	.22	0.00	0.00	0.00	0.00	.31	0.00	2.16	1.55
	.16	.31	0.00	.06	0.00	0.00	0.00	0.00	.05	0.00	.39	.14
NYSAUI	1.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SAMPLE DATES											
760201	760315	760401	760501	760601	760701	760801	760901	761001	761119	761213	770125
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.04	.07	0.00	.05	0.00	0.00	0.00	0.00	0.00	0.00	2.45	.11
.01	.11	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	.45	.01
0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21	0.00
1.25	.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	.11
.21	.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.21	.01
0.00	0.00	0.00	4.46	0.00	0.00	0.00	0.00	.17	0.00	0.00	0.00
0.00	0.00	0.00	1.17	0.00	0.00	0.00	0.00	.03	0.00	0.00	0.00
0.00	0.00	0.00	0.00	.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	0.00	0.00
0.00	.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.15	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.22	1.47
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.59	.15
.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.10	.60	.24	.36
.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02	.04	.04	.01
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.11	.02
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.13	.00
.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.19	.01
.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.03	.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.46	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.16	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.20	0.00
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.13000	0.00000
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.72000	.13000
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.13	.01
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.84000	0.00000
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.15	0.00
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.05000	.61000
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01	.06
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00	0.00	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00000	0.00000	.01000	.04000	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00	0.00	.01	.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SPECIES	SAMPLE DATES											
	760131	760401	760501	760601	760701	760801	760901	761001	761119	761219	770125
DELVID	0.00500	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ACERAC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.26000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.05	0.00
JUNSOP	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.26000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.05	0.00
JUNVIR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.22500
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.92
QUEVEL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.11000	0.30000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	.57	0.00	0.00	0.00	0.00	0.00
RHUCOR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	.01000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
RHUHIR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROBPSE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RUBSPE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RUBSTR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SALSPE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SORSCO	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TILCOR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ULMAME	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SUMMARY ANALYSIS OF VARIANCE
DATES 76131-77031
STATIONS 001 002 003 004 005 013 014 015 016 017
TIMES OF DAY 0

SPECIES			
	[illegible] DATES 770520	770124	TOTALS
POTPER	322.98	1311.60	1634.58
	39.49	48.72	41.41
ANDPER	17.26	447.77	465.03
	2.06	22.69	17.11
BENVAC	150.62	264.01	414.63
	24.76	9.80	15.26
LEADER	39.27	307.19	346.46
	6.41	10.52	8.45
SPAFOL	57.61	104.10	161.71
	9.43	3.84	5.32
RHOVAR	12.45	14.77	27.22
	2.12	.51	.69
HELANT	13.97	5.32	19.29
	2.30	.18	.71
JUVVAC	59.67	65.95	125.62
	9.82	1.97	1.51
SPAVER	0.00	0.00	262.51
	0.00	0.00	1.21
ERICOM	6.17	31.45	37.62
	1.02	1.07	.79
SPISPE	0.00	0.00	148.94
	0.00	0.00	.69
VALSAM	3.59	.92	124.67
	.58	.03	.58
PINSYL	0.00	115.54	115.54
	0.00	3.96	.53
SMIHER	3.45	4.97	48.42
	.57	.16	.22
VARMYR	13.27	15.92	29.19
	2.18	.55	.25
PINALB	0.00	0.00	34.26
	0.00	0.00	.16
JUNCOM	1.25	1.22	24.45
	.21	.04	.13
ANDTEN	3.00	0.00	22.64
	0.00	0.00	.13
LAUINT	0.00	0.00	23.03
	0.00	0.00	.11
ASATEN	0.00	0.00	19.52
	0.00	0.00	.09
LIOSTY	.03	.05	16.69
	.10	.00	.08
PINCON	.35	0.00	17.96
	.06	0.00	.08
CARAQU	0.00	0.00	12.84
	0.00	0.00	.06
SARPIF	0.00	0.00	11.91
	0.00	0.00	.06
ACERUB	1.13	.25	11.46
	.19	.01	.05
CHAPIN	0.00	0.00	10.65
	0.00	0.00	.05

SPECIES	SAMPLE DATES		TOTALS
MYSAPH	0.00	0.04	9.11
	0.00	0.00	.04
RETSIG	.44	.33	4.49
	.04	.00	.04
GRACER	0.00	0.00	4.45
	0.00	0.00	.04
CARCAR	.04	.10	7.46
	.01	.00	.04
FRAANG	0.00	0.00	7.48
	0.00	0.00	.04
TAECOR	0.00	0.00	7.28
	0.00	0.00	.03
LAMPOS	0.00	0.00	6.37
	0.00	0.00	.03
PHYPAT	1.16	.15	6.68
	.10	.01	.03
MACVIR	.46	.45	5.60
	.04	.01	.03
SARDUL	.04	.10	4.84
	.01	.00	.02
FUCIST	0.00	0.00	3.12
	0.00	0.00	.01
TYPLAT	0.00	0.00	2.64
	0.00	0.00	.01
FAXFIS	.35	0.00	2.44
	.05	0.00	.01
SALNIG	.08	.07	2.16
	.01	.00	.01
PERPAL	.00	.00	.04
	.15	.01	.01
HAGGRA	0.00	0.00	1.41
	0.00	0.00	.01
FAGGRA	.04	.01	1.24
	.00	.01	.01
DUFLAU	0.00	0.00	1.07
	0.00	0.00	.01
PLAOCC	0.00	0.00	1.24
	0.00	0.00	.01
POLPAM	0.00	0.00	1.23
	0.00	0.00	.01
SPAAUR	0.00	0.00	1.15
	0.00	0.00	.01
LEMCOR	0.00	0.00	1.10
	0.00	0.00	.01
CELLAF	0.00000	0.00000	.00000
	0.00	0.00	.00
JUGREG	0.00000	0.00000	.00000
	0.00	0.00	.00
TELTES	0.00000	0.00000	.00000
	0.00	0.00	.00
THATES	0.00000	0.00000	.00000
	0.00	0.00	.00
PORPOR	0.00000	0.00000	.00000
	0.00	0.00	.00
HALSUF	0.00000	0.00000	.00000
	0.00	0.00	.00

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  SPECIES                          SAMPLE DATES
                                   770220  770321  TOTALS
 CHORAL                           0.00000 0.00000  .37000
                                     0.00    0.00     .00
 PELVIR                           0.00000 0.00000  .26000
                                     0.00    0.00     .00
 ACEPAR                           0.00000 0.00000  .25000
                                     0.00    0.00     .00
 JLMSPE                           0.00000 0.00000  .24000
                                     0.00    0.00     .00
 JLMAME                           0.00000 0.00000  .22000
                                     0.00    0.00     .00
 SPYSPE                           0.00000 0.00000  .11000
                                     0.00    0.00     .00
 DHESTF                            .11000 0.00000  .11000
                                      .00    0.00     .00
 PINSPE                           0.00000 0.00000  .11000
                                     0.00    0.00     .00
 HYPAOR                           0.00000 0.00000  .09000
                                     0.00    0.00     .00
 POMCOP                           0.00000 0.00000  .09000
                                     0.00    0.00     .00
 DIGSIM                           0.00000 0.00000  .06000
                                     0.00    0.00     .00
 PLASPE                           0.00000 0.00000  .05000
                                     0.00    0.00     .00
 AMIPOF                           0.00000 0.00000  .05000
                                     0.00    0.00     .00
 ILESPF                           0.00000 0.00000  .05000
                                     0.00    0.00     .00
 FLOCAN                           0.00000 0.00000  .02000
                                     0.00    0.00     .00

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OUTPUT DISPOSED FOR 9837401  BUSINES

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Table 3: Macrodetritus in the Apalachicola Estuary expressed in g, dry weight as wood debris/m^2, leaf debris/m^2, benthic macrophyte debris/m^2, total debris/m^2, and total (bay-wide) debris (Kg, tons) on a monthly basis from January, 1975 through March, 1977.

Date	Wood debris g, dry wt./m^2	Leaf debris g, dry wt./m^2	Benthic macrophytes g, dry wt./m^2	Total detritus g, dry wt./m^2	Total detritus in Bay Kg, dry wt.	Total detritus in Bay tons, dry wt.
1/75	0.00323	0.01485	0.02104	0.03794	20,321	22.4
2/75	0.00704	0.00173	0.00804	0.01682	9,008	9.9
3/75	0.01924	0.01041	0.02754	0.0572	30,636	33.7
4/75	0.01750	0.06957	0.02950	0.11656	62,428	68.7
5/75	0.15453	0.06552	0.03427	0.25432	136,218	149.8
6/75	0.00534	0.01418	0.01418	0.01988	10,648	11.7
7/75	-	-	-	-	-	-
8/75	0.02497	0.00557	0.00634	0.03708	19,860	21.8
9/75	0.04649	0.00010	0.01992	0.06668	35,711	39.3
10/75	0.03084	0.00871	0.08602	0.12754	68,310	75.1
11/75	0.01928	0.00052	0.00711	0.03167	16,965	18.7
12/75	0.00279	0.00411	0.00373	0.01068	5,721	6.3
1/76	0.01104	0.00044	0.00796	0.01947	10,426	11.5
2/76	0.01431	0.01073	0.01546	0.04130	22,122	24.3
3/76	0.00828	0.00069	0.00897	0.01806	9,673	10.6
4/76	0.04538	0.00062	0.00168	0.04769	25,542	28.1
5/76	0.01993	0.00147	0.00576	0.02717	14,552	16.0
6/76	0.01200	0.00005	0.03576	0.04781	25,609	28.2
7/76	0.00050	0.00010	0.00527	0.00578	3,095	3.4
8/76	0.00003	0.00002	0.00102	0.00105	567	0.6
9/76	0.00078	0.00010	0.00271	0.00350	1,876	2.1
10/76	0.00142	0.00024	0.03423	0.03634	19,466	21.4
11/76	0.00171	0.00075	0.07300	0.08074	43,242	47.6
12/76	0.01365	0.01081	0.00937	0.03628	19,431	21.4
1/77	0.03961	0.03384	0.00724	0.08185	43,839	48.2
2/77	0.00281	0.00635	0.02451	0.03631	19,447	21.4
3/77	0.10886	0.05005	0.04707	0.21369	114,452	125.9

Table 4 : Microdetritus (g) taken at 2 stations in the Apalachicola Drainage System (7,8). Surface and bottom samples were taken on station 7 while mid-depth areas were sampled at station 8.

Date	Station	Sieve Fraction	New Dry Weight Per Sample	Net Ash-free Dry Weight Per 1000 L	% Organics
8/75	7 T	# 10	-	.0032	-
		18	.0006	.0028	-
		35	.0007	.0036	-
		60	.0030	.0088	73.3
		120	.0075	.0132	44.0
		170	.0096	.0160	41.7
		325	.0513	.0488	23.8
				Total .0964 gm	
	7 B	# 10	-	.0020	-
		18	-	.0028	-
		35	.0007	.0060	-
		60	.0079	.0116	36.7
		120	.0096	.0168	43.8
		170	.0161	.0220	34.2
		325	.1364	.1204	22.1
				Total .1816 gm	
	8 M	# 10	-	-	-
		18	-	-	-
		35	.0005	.0028	-
		60	.0033	.0088	66.7
		120	.0049	.0052	26.5
		170	.0060	.0088	36.7
		325	.0299	.0388	32.4
				Total .0644	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample	Net Ash-free Dry Weight Per 1000 L	% Organics
9/75	7 T	# 10	-	-	-
		18	.0007	.0044	-
		35	-	.0016	-
		60	-	.0008	-
		120	.0017	.0020	29.4
		170	.0007	.0028	-
		325	.0037	.0056	37.8
				Total .0043	
	7 B	# 10	-	.0032	-
		18	-	.0016	-
		35	-	.0020	-
		60	.0025	.0056	56.0
		120	.0081	.0096	29.6
		170	.0043	.0032	18.6
		325	.0146	.0188	32.2
				Total .0440	
	8 M	# 10	-	-	-
		18	-	-	-
		35	-	.0020	-
		60	.0003	.0012	-
		120	.0015	.0004	6.7
		170	.0038	.0028	18.4
		325	.0056	.0084	37.5
				Total .0148	
10/75	7 T	# 10	.0006	-	-
		18	.0001	-	-
		35	.0025	.0060	60.0
		60	.0072	.0148	51.4
		120	.0204	.0292	35.8
		170	.0267	.0236	22.1
		325	.2626	.1064	10.1
				Total .1800	
	7 B	# 10	.0056	.0176	78.6
		18	.0047	.0148	78.7
		35	.0181	.0612	84.5
		60	.0286	.0664	66.8
		120	.0457	.0668	36.5
		170	.0950	.0664	17.5
		325	.5053	.1620	8.0
				Total .1652	
	8 M	# 10	-	-	-
		18	-	-	-
		35	.0029	.0054	65.5
		60	.0059	.0063	37.3
		120	.0137	.0174	44.5
		170	.0204	.0252	43.1
		325	.1211	.0809	23.4
				Total .1352	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample		Net Ash-free Dry Weight Per 1000 L	% Organics
11/75	7 T	# 10	.0011		.0010	45.5
		18	.0006		.0006	50.0
		35	.0013		.0012	46.2
		60	.0043		.0050	58.1
		120	.0240		.0190	35.4
		170	.0703		.0282	20.0
		325	.4858		.0884	9.1
				Total	.1434	
	7 B	# 10	.0012		.0031	91.7
		18	.0007		.0008	42.9
		35	.0015		.0017	40.0
		60	.0080		.0154	67.5
		120	.0394		.0386	34.3
		170	.0602		.0383	22.2
		325	.5845		.1785	10.7
				Total	.2764	
	8 M	# 10	-		-	-
		18	-		-	-
		35	.0018		.0028	77.8
		60	.0057		.0046	40.4
		120	.0191		.0070	18.3
		170	.0174		.0086	24.7
		325	.0813		.0382	23.5
				Total	.0612	
12/75	7 T	# 10	.0004		.0004	50
		18	-		-	-
		35	.0021		.0008	19
		60	.0114		.0058	25.4
		120	.0420		.0164	19.5
		170	.1539		.0214	6.9
		325	1.0426		.0590	2.8
				Total	.1038	
	7 B	# 10	.0042		.0086	71.4
		18	.0025		.0051	72
		35	.0040		.0072	62.5
		60	.0148		.0180	42.6
		120	.0939		.0349	13.0
		170	.2345		.0360	5.3
		325	1.4084		.1044	2.6
				Total	.2142	
	8 M	# 10	-		-	-
		18	-		-	-
		35	-		-	-
		60	.0013		.0006	23
		120	.0026		.0008	15.3
		170	.0038		.0018	23.7
		325	.0175		.0094	26.8
				Total	.0126	

Table 4 : (contined)

Date	Station	Sieve Fraction	New Dry Weight Per Sample	Net Ash-free Dry Weight Per 1000 L	% Organics
1/76	7 T	# 10	-	-	-
		18	-	-	-
		35	.0028	.0034	42.9
		60	.0067	.0077	40.3
		120	.0357	.0212	20.7
		170	.0735	.0214	10.2
		325	.5740	.1121	5.3
				Total .1658	
	7 B	# 10	.0007	.0014	71.4
		18	.0015	.0026	60.0
		35	.0043	.0066	53.4
		60	.0128	.0106	49.2
		120	.0697	.0415	20.8
		170	.1107	.0243	7.6
		325	.8603	.1310	5.2
				Total .2180	
	8 M	# 10	.0018	.0018	50.0
		18	.0033	.0028	42.4
		35	.0049	.0044	44.9
		60	.0163	.0050	15.3
		120	.0265	.0030	9.4
		170	.0118	.0046	19.5
		325	.1073	.0420	19.5
				Total .0636	
2/76	7 T	# 10	-	-	-
		18	-	-	-
		35	.0010	.0026	90.0
		60	.0042	.0077	64.3
		120	.0228	.0220	33.8
		170	.0518	.0223	15.1
		325	.2437	.0744	10.7
				Total .1290	
	7 B	# 10	-	-	-
		18	.0016	.0040	87.5
		35	.0035	.0089	60.0
		60	.0101	.0186	64.4
		120	.0461	.0323	24.5
		170	.1183	.0323	9.6
		325	.4532	.1135	8.7
				Total .2096	
	8 M	# 10	-	-	-
		18	-	-	-
		35	.0006	.0010	83.3
		60	.0041	.0038	46.3
		120	.0152	.0108	35.5
		170	.0213	.0158	28.9
		325	.3542	.1092	15.4
				Total .1406	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample	Net Ash-free Dry Weight Per 1000 L	% Organics
3/76	7 T	# 10	-	-	-
		18	-	-	-
		35	-	-	-
		60	.0019	.0009	47.4
		120	.0079	.0020	25.3
		170	.0110	.0036	32.7
		325	.0610	.0171	28.0
				Total .0236	
	7 B	# 10	-	-	-
		18	-	-	-
		35	.0010	.0007	70
		60	.0038	.0025	65.8
		120	.0238	.0123	51.7
		170	.0317	.0125	39.4
		325	.2434	.0586	24.1
				Total .0866	
	8 M	# 10	.0025	.0015	60.0
		18	-	-	-
		35	.0018	.0011	61.1
		60	.0069	.0031	44.9
		120	.0188	.0090	47.9
		170	.0280	.0100	35.7
		325	.2989	.0606	20.3
				Total .0853	
4/76	7 T	# 10	.0007	-	-
		18	-	-	-
		35	.0024	.0018	75
		60	.0014	.0008	57.1
		120	.0041	.0014	34.1
		170	.0050	.0019	38
		325	.0244	.0045	18.4
				Total .0104	
	7 B	# 10	.0003	-	-
		18	-	-	-
		35	.0045	.0026	80
		60	.0073	.0047	64.4
		120	.0104	.0060	59.6
		170	.0079	.0032	40.5
		325	.0220	.0094	42.7
				Total .0259	
	8 M	# 10	.0003	-	-
		18	.0010	.0007	70
		35	.0016	.0007	43.8
		60	.0037	.0031	78.4
		120	.0065	.0041	63
		170	.0181	.0143	79
		325	.1360	.0220	23.5
				Total .0449	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample		Net Ash-free Dry Weight Per 1000 L	% Organics
5/76	7 T	# 10	-		-	-
		18	.0009		.0014	77.7
		35	.0009		.0008	44.4
		60	.0036		.0054	75.0
		120	.0132		.0128	48.5
		170	.0196		.0146	37.2
		325	.1697		.0598	17.6
				Total	.0948	
	7 B	# 10	.0012		.0014	58.3
		18	.0018		.0032	88.8
		35	.0041		.0064	78.0
		60	.0114		.0156	68.4
		120	.0247		.0234	47.4
		170	.0500		.0330	33.0
		325	.2562		.0808	15.8
				Total	.1638	
	8 M	# 10	-		-	-
		18	.0007		.0010	71.4
		35	.0002		-	-
		60	.0019		.0020	52.6
		120	.0049		.0056	55.1
		170	.0078		.0078	50.0
		325	.0446		.0438	49.1
				Total	.0602	
6/76	7 T	# 10	.0002		-	-
		18	-		-	-
		35	.0009		.0008	67
		60	.0016		.0016	75
		120	.0028		.0025	68
		170	.0059		.0040	51
		325	.0501		.0189	28
				Total	.0278	
	7 B	# 10	-		-	-
		18	-		-	-
		35	.0020		.0024	60
		60	.0022		.0020	45
		120	.0062		.0068	55
		170	.0074		.0056	38
		325	.1850		.0694	19
				Total	.0862	
	8 M	# 10	-		-	-
		18	.0003		-	-
		35	.0016		.0026	81
		60	.0017		.0020	59
		120	.0044		.0022	25
		170	.0040		.0024	30
		325	.0164		.0104	32
				Total	.0196	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample	Net Ash-free Dry Weight Per 1000 L	% Organics
7/76	7 T	# 10	.0003	-	-
		18	.0014	.0012	64
		35	.0018	.0016	67
		60	.0043	.0031	53
		120	.0076	.0053	53
		170	.0043	.0029	51
		325	.0498	.0234	35
				Total .0375	
	7 B	# 10	-	-	-
		18	.0021	-	-
		35	.0018	.0016	44
		60	.0034	.0030	44
		120	.0147	.0158	54
		170	.0301	.0256	43
		325	.1312	.0518	20
				Total .0978	
	8 M	# 10	.0007	-	-
		18	.0024	.0023	71
		35	.0037	.0036	73
		60	.0101	.0068	50
		120	.0067	.0032	36
		170	.0061	.0029	36
		325	.0028	.0088	29
				Total .0276	
8/76	7 T	# 10	.0020	-	-
		18	.0030	.0018	60
		35	.0030	.0025	83
		60	.0089	.0033	37
		120	.0121	.0040	33
		170	.0050	.0018	36
		325	.0555	.0157	28
				Total .0291	
	7 B	# 10	-	-	-
		18	.0015	-	-
		35	.0026	.0020	58
		60	.0050	.0027	40
		120	.0186	.0158	64
		170	.0333	.0179	41
		325	.1219	.0330	20
				Total .0714	
	8 M	# 10	.0010	.0009	90
		18	.0092	.0050	54
		35	.0052	.0040	77
		60	.0161	.0054	34
		120	.0095	.0045	47
		170	.0072	.0028	39
		325	.0308	.0090	29
				Total .0316	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample		Net Ash-free Dry Weight Per 1000 L	% Organics
9/76	7 T	# 10	.0021		.0021	76
		18	.0065		.0057	66
		35	.0144		.0072	38
		60	.0057		.0033	44
		120	.0079		.0017	16
		170	.0074		.0021	22
		325	.1203		.0352	22
				Total	.0573	
	7 B	# 10	-		-	-
		18	.0041		.0028	34
		35	.0018		.0018	50
		60	.0052		.0020	19
		120	.0207		.0042	10
		170	.0280		.0058	10
		325	.3616		.0986	14
				Total	.1152	
	8 M	# 10	.0025		.0020	60
		18	.0041		.0048	88
		35	.0100		.0105	79
		60	.0063		.0053	63
		120	.0068		.0032	35
		170	.0051		.0017	25
		325	.0558		.0250	34
				Total	.0525	
10/76	7 T	# 10	-		-	-
		18	.0015		.0012	60
		35	.0035		.0015	31
		60	.0072		.0015	15
		120	.0039		.0021	41
		170	.0029		.0017	45
		325	.0317		.0109	26
				Total	.0189	
	7 B	# 10	.0005		-	-
		18	.0030		.0029	73
		35	.0022		.0021	73
		60	.0033		.0013	30
		120	.0087		.0021	18
		170	.0125		.0043	26
		325	.1609		.0340	16
				Total	.0467	
	8 M	# 10	-		-	-
		18	.0002		-	-
		35	.0024		.0021	67
		60	.0022		.0009	32
		120	.0037		.0015	30
		170	.0031		.0013	32
		325	.0208		.0077	28
				Total	.0135	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample	Net Ash-free Dry Weight Per 1000 L	% Organics
11/76	7 T	# 10	.0014	.0011	93
		18	.0022	.0021	73
		35	.0034	.0016	35
		60	.0034	.0012	26
		120	.0025	.0012	36
		170	.0031	.0015	35
		325	.0033	.0016	36
				Total .0109	
	7 B	# 10	-	-	-
		18	.0009	-	-
		35	.0014	.0005	29
		60	.0018	.0016	67
		120	.0028	.0013	36
		170	.0016	.0012	56
		325	.0061	.0019	23
				Total .0065	
	8 M	# 10	-	-	-
		18	.0012	.0013	83
		35	.0052	.0037	54
		60	.0043	.0029	51
		120	.0056	.0021	29
		170	.0030	.0016	40
		325	.0173	.0069	30
				Total .0185	
12/76	7 T	# 10	-	-	-
		18	.0028	.0032	57
		35	.0024	.0026	54
		60	.0038	.0040	53
		120	.0080	.0068	43
		170	.0146	.0084	29
		325	.1640	.0492	15
				Total .0742	
	7 B	# 10	.0025	.0030	60
		18	.0010	.0012	60
		35	.0029	.0034	59
		60	.0066	.0086	65
		120	.0292	.0218	37
		170	.0506	.0178	18
		325	.4363	.1056	12
				Total .1614	
	8 M	# 10	.0034	.0060	88
		18	.0007	.0008	57
		35	.0028	.0032	57
		60	.0064	.0090	70
		120	.0196	.0190	48
		170	.0374	.0232	31
		325	.3592	.1158	16
				Total .1770	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample		Net Ash-free Dry Weight Per 1000 L	% Organics
1/77	7 T	# 10	.0009		.0010	56
		18	.0004		.0006	75
		35	.0043		.0048	56
		60	.0069		.0084	61
		120	.0439		.0170	19
		170	.1683		.0220	07
		325	5115		.0678	07
				Total	.1216	
	7 B	# 10	.0057		.0092	81
		18	.0040		.0066	83
		35	.0116		.0144	62
		60	.0308		.0300	49
		120	1777		.0366	10
		170	3995		.0300	04
		325	7367		.0700	05
				Total	.1968	
	8 M	# 10	.0007		.0012	86
		18	.0009		.0014	78
		30	.0031		.0048	77
		60	.0048		.0058	60
		120	.0663		.0206	15
		170	.1219		.0202	08
		325	.5987		.0704	06
				Total	.1244	
2/77	7 T	# 10	.0010		.0016	80
		18	.0003		-	-
		30	.0017		.0016	47
		60	.0026		.0012	23
		120	.0085		.0050	29
		170	.0198		.0068	17
		325	.2384		.0466	10
				Total	.0628	
	7 B	# 10	.0009		.0010	56
		18	.0007		.0010	71
		30	.0016		.0020	63
		60	.0049		.0068	69
		120	.0307		.0198	32
		170	.0754		.0148	10
		325	.6471		.0956	07
				Total	.1410	
	8 M	# 10	-		-	-
		18	.0004		.0006	75
		30	.0011		.0018	81
		60	.0019		.0026	68
		120	.0068		.0042	31
		170	.0171		.0058	17
		325	.1996		.0266	07
				Total	.0416	

Table 4 : (continued)

Date	Station	Sieve Fraction	New Dry Weight Per Sample		Net Ash-free Dry Weight Per 1000 L	% Organics
3/77	7 T	# 10	.0011		.0012	45
		18	.0035		.0050	57
		35	.0038		.0067	71
		60	.0099		.0125	51
		120	.1091		.0247	09
		170	.2563		.0152	02
		325	.4564		.0842	07
				Total	.1495	
	7 B	# 10	.0056		.0130	93
		18	.0073		.0157	86
		35	.0150		.0260	69
		60	.0304		.0342	45
		120	.4512		.0567	05
		170	1.0553		.0355	01
		325	.9564		.1345	06
				Total	.3156	
	8 M	# 10	.0033		.0075	91
		18	.0017		.0035	82
		35	.0038		.0070	74
		60	.0120		.0180	60
		120	.0541		.0397	29
		170	.1593		.0440	11
		325	.9624		.1755	07
				Total	.2952	

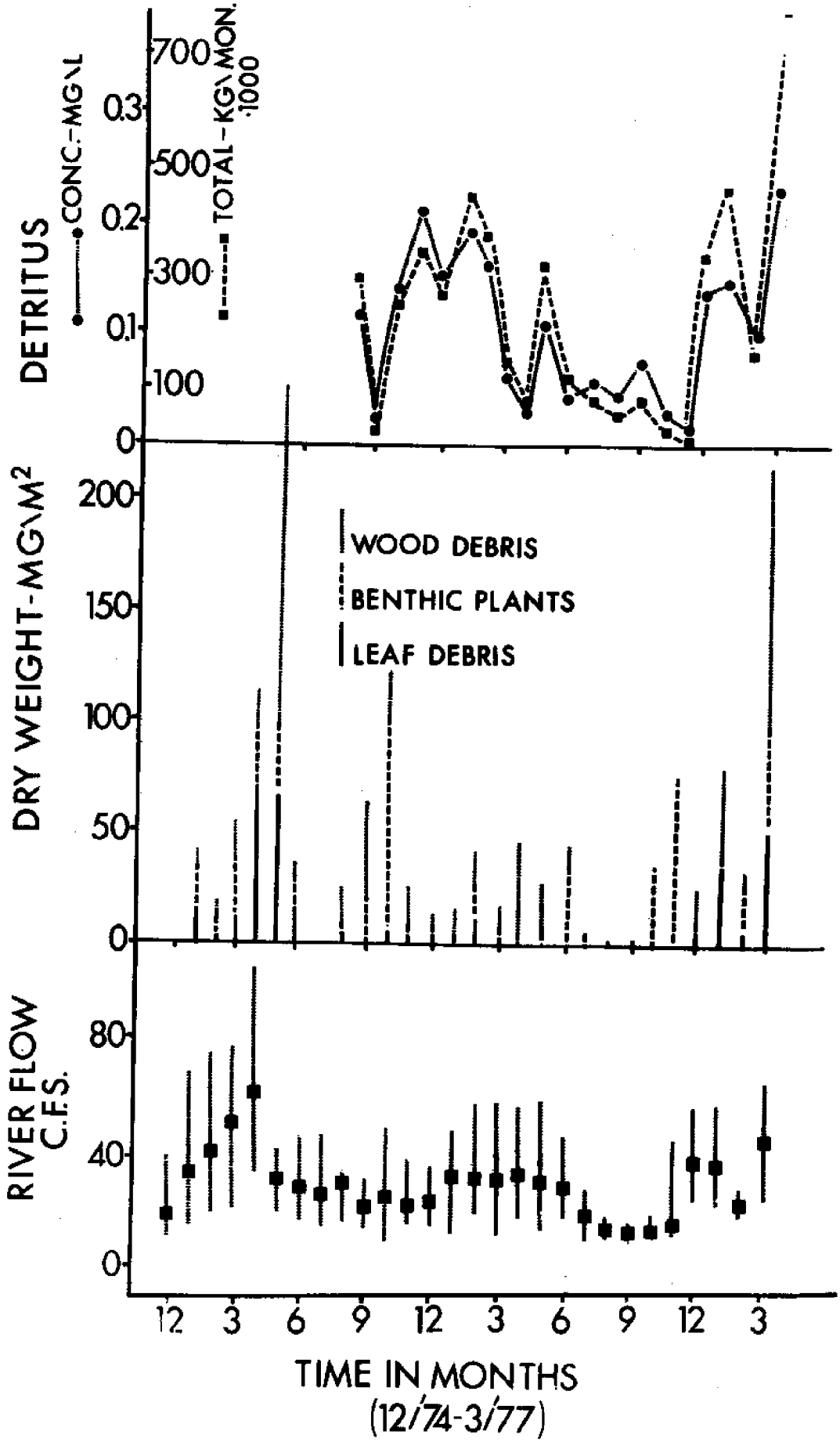
Table 4: Detritus taken in the Apalachicola River in a series of sieves (#10-436) on a monthly basis and expressed as organic matter (ash free dry weight) and total dry weight. Stations sampled included the main portion of the river(surface and bottom: 7T, 7B and a tributary to East Bay, Little St. Marks, mid-depth: 8) with figures adjusted for total flow per month using mean values at station 7 (7m). The organic detritus ratio reflects relative levels (ash free dry weight) at the two stations (7m/8).

Date	Station	Detritus, Ash Free Dry Weight (g/l)	Total, Dry Weight (g/l)	Ratio of Organic detritus	Detritus, Ash Free Dry Weight (7 m) A: total (Kg/month) B: total (tons/month)	
8/75	7T	0.0000964	0.0727		A.	305,915
	7B	0.0001816	0.1707		B.	337
	7M	0.0001392	0.1217	1.57		
	8	0.0000644	0.0446			
9/75	7T	0.0000172	0.0075		A.	40,011
	7B	0.0000440	0.0295		B.	45
	7M	0.0000306	0.0185	2.07		
	8	0.0000148	0.0112			
10/75	7T	0.0001800	0.3201		A.	269,903
	7B	0.0001816	0.7030	2.20	B.	297
	7M	0.0001420	0.5115			
	8	0.0000644	0.1640			
11/75	7T	0.0001434	0.5874		A.	344,227
	7B	0.0002764	0.6955		B.	379
	7M	0.0002099	0.6414	3.43		
	8	0.0000612	0.1253			
12/75	7T	0.0001038	1.2524		A.	269,445
	7B	0.0002142	1.7623		B.	296
	7M	0.0001590	1.5073	3.36		
	8	0.0000126	0.0252			
1/76	7T	0.0001658	0.6927		A.	442,533
	7B	0.0002180	1.0600		B.	487
	7M	0.0001919	0.8763	3.02		
	8	0.0000636	0.1719			
2/76	7T	0.0001290	0.3235		A.	377,030
	7B	0.0002096	0.6328		B.	415
	7M	0.0001693	0.4781	1.20		
	8	0.0001406	0.4014			
3/76	7T	0.0000230	0.0818		A.	138,420
	7B	0.0000866	0.3037		B.	152
	7M	0.0000551	0.1927	0.65		
	8	0.0000853	0.3569			
4/76	7T	0.0000104	0.0380		A.	48,253
	7B	0.0000259	0.0420		B.	53
	7M	0.0000182	0.0400	0.41		
	8	0.0000449	0.1672			

Date	Station	Detritus, Ash Free Dry Weight (g/l)	Total, Dry Weight (g/l)	Ratio of Organic detritus	Detritus, Ash Free Dry Weight (7 m) A: total (Kg/month) B: total (tons/month)	
5/76	7T	0.0000948	0.2079	2.15	A.	324,822
	7B	0.0001638	0.3494		B.	357
	7M	0.0001293	0.2786			
	8	0.0000602	0.0601			
6/76	7T	0.0000278	0.0615	2.91	A.	118,868
	7B	0.0000862	0.2028		B.	131
	7M	0.0000570	0.1321			
	8	0.0000196	0.0284			
7/76	7T	0.0000378	0.0695	2.09	A.	90,776
	7B	0.0000978	0.1833		B.	100
	7M	0.0000577	0.1264			
	8	0.0000276	0.0525			
8/76	7T	0.0000291	0.0895	1.59	A.	59,898
	7B	0.0000714	0.1829		B.	66
	7M	0.0000503	0.1362			
	8	0.0000316	0.0790			
9/76	7T	0.0000573	0.1643	1.64	A.	90,973
	7B	0.0001152	0.4214		B.	100
	7M	0.0000863	0.2928			
	8	0.0000525	0.0906			
10/76	7T	0.0000189	0.0507	2.42	A.	37,155
	7B	0.0000467	0.1911		B.	41
	7M	0.0000328	0.1371			
	8	0.0000135	0.0208			
11/76	7T	0.0000109	0.0193	0.47	A.	11,112
	7B	0.0000065	0.0146		B.	12
	7M	0.0000087	0.0169			
	8	0.0000185	0.0366			
12/76	7T	0.0000742	0.1956	0.67	A.	353,483
	7B	0.0001614	0.5291		B.	389
	7M	0.0001178	0.3623			
	8	0.0001770	0.4295			
1/77	7T	0.0001216	0.7362	1.28	A.	467,504
	7B	0.0001968	1.3660		B.	514
	7M	0.0001592	1.0511			
	8	0.0001244	0.7964			
2/77	7T	0.0000628	0.2723	2.45	A.	166,158
	7B	0.0001410	0.7613		B.	183
	7M	0.0001019	0.5168			
	8	0.0000416	0.2269			

Date	Station	Detritus, Ash Free Dry Weight (g/l)	Total Dry Weight (g/l)	Ratio of Organic detritus	Detritus, Ash Free Dry Weight (7 m) A: total (Kg/month) B: total (tons/month)
	7T	0.0001495	0.8401		A. 814, 794
3/77	7B	0.0003156	2.5212		B. 896
	7M	0.0002326	1.6806	1.42	
	8	0.0002952	1.1966		

Fig. 2: Apalachicola River flow (monthly means and range in cubic feet per second), macrodetritus (wood debris, leaf debris, and benthic macrophytes in mg/m^2), and microdetritus at the mouth of the river (total, Kg/month; concentrations in mg/l) from December, 1974 through March, 1977.


DETRITUS
CONC.-MG\L
TOTAL-KG\MON.
1000
0.3
0.2
0.1
0
700
500
300
100
DRY WEIGHT-MG\M2
200
150
100
50
0
WOOD DEBRIS
BENTHIC PLANTS
LEAF DEBRIS
RIVER FLOW
C.F.S.
80
40
0
12
3
6
9
12
3
6
9
12
3
TIME IN MONTHS
(12/74-3/77)

VII. THE MICROBIAL CONTRIBUTION TO THE ENERGY BUDGET OF APALACHICOLA BAY

MICROBIOLOGICAL STUDIES

I. RATIONALE:

The vital role of macro- and microdetritus in a river-dominated estuary as shown in this study of the Apalachicola estuary, indicated that study of the primary detritus utilizers - the microflora - was essential. It is these microorganisms which have the enzymatic armentarium to mineralize refractory materials and form sufficient cell mass to support a large proportion of the estuarine food web. At the initiation of this study there was little quantitative work done in assessing the composition or population dynamics of the estuarine detrital microflora. Clearly from studies of the water column in fresh and salt water, the sediments and the soil, classical methods of isolation and plating on selective media are of little use in studies of a dynamic population (see the literature reviewed in publications 1 - 4), and so initial phases of this work concentrated on the development or modification of existing methods with which to study the detrital microflora. These methods involve measures of microbial mass and activity. From studies of activity it has been possible to develop methods with which to study population dynamics and the impact of stresses on the microbial community.

II. METHODS:

A. Mass

1. Muramic acid. The murano peptide is a component uniquely found in all known bacteria and blue-green algal cell walls with the exception of the

mycoplasma or PPLO organisms. The murano peptide polymer is the main supporting material of the microbial wall and gives the cell its characteristic shape. Chains of alternating residues of N-acetylglucosamine and N-acetyl muramic acid are covalently linked by amide bonds at the muramic acid by peptide bridges. This polymer apparently completely encloses the cell. Muramic acid (3-O-carboxy-ethyl-D-glucosamine) does not occur in other prokaryotic or eukaryotic cells. Of the 300 or so PPLO, mycoplasma or L-forms described, many are intracellular parasites of plants and animals, although they may survive in high osmotic environments like sewage. They form a minute percentage of the bacterial mass in vertebrates. One thermoplasma has been isolated from a high temperature acidic coal mine gob pile. Others have recently been detected in the sea. No estimate of the number of PPLO organisms detected on estuarine detritus or marine environments has yet been made (5, 6).

Batch cultures of organisms grown to the stationary phase contain organisms of all ages in a relatively poorly controlled environment when compared with organisms grown in a nutrient-limited chemostat (7). Studies of numerous species of bacteria have shown that the proportion of muramic acid in the cell wall and the ratio of muramic acid to glucosamine are essentially invariant (7 - 9). However, differences in the sensitivity to the wall of lytic enzyme lysozyme heat-killed Bacillus subtilis W-23 grown in chemostats with different limiting nutrients have been shown (10). On isolation of the walls after removal of the teichoic acids and analyses of the mucopeptide, the maximum variability in the ratios of glucosamine to muramic acid varied between 0.5 for sulfate-limited growth to 1.07 for NH_3-limited cells, possibly a variation by a factor of 2. No changes in muramic acid levels have been induced with other strains of Bacillus subtilis, however (11). The direct analysis of laboratory-grown batch cultures which showed an average of 3.44 ± 0.5 ($\bar{X} \pm \sigma$) µg/mg dry

weight for seven species of gram-negative bacteria and 9.6 ± 1.9 ($\bar{X} \pm \sigma$) for five species of gram-positive bacteria with the data expressed as µg muramic acid per mg dry weight (12). Spores from gram-positive bacilli averaged 38.8 muramic acid/mg dry weight ± 6.2 ($\bar{X} \pm \sigma$) µg/mg dry weight. The hydrolysates of these spores also contain the amino acid dipicolinic acid, an amino acid that has not yet been found in vegetative bacteria, other prokaryotes or eukaryotes (13). Our Methodology (see below) allows for the detection of this amino acid. As yet dipicolinic acid has been undetectable in estuarine samples. In addition the rates of incorporation and turnover (loss of ^{14}C-labeled wall during incubation in the medium not containing radioactivity) have been shown to serve as indicators of bacterial growth. Our methodology has recently been reported in the literature (3).

2. Adenosine triphosphate (ATP). Adenosine triphosphate is the energy currency of the cell - the ultimate product of catabolism. Elegant studies by Holm-Hansen and Booth (14) and Holm-Hansen (15, 16) have established that for 30 species of unicellular algae, seven strains of marine bacteria grown in batch cultures, marine phytoplankton under conditions of nitrogen, phosphorus or silicon deficiency, algal cells exposed to alternating periods of light and dark, natural phytoplankton populations grown in nutrient-enriched media, as well as micro and macro-zooplankton from laboratory cultures or isolated from the water column, the levels of extractible ATP correspond to 0.04% of the total particulate organic carbon. The total particulate organic carbon correlates directly with the dry weight of the cells. In these and many other experiments the micro-organisms were concentrated on Millipore filters with 0.45 µm pores. ATP is present in all living cells thus far examined. It rapidly hydrolyzes in dead material or cells deprived of metabolizable substrate (17). At least in the water column the ATP exists in reasonably uniform concentrations in all cells,

regardless of the environmental strains. Under specialized and stringent conditions we have been able to change the level of cellular ATP in the bacteria Haemophilus parainfluenzae and Staphylococcus aureus by a factor of two by manipulation of the state of the electron transport system (17).

The assay of ATP in the nanogram ranges typical of ecological studies requires the use of the luciferin-luciferase enzyme system from firefly tails. Methods for standardization of the enzyme have been well worked out (18). Problems with detritus of sediments lie in the quantitative extractibility of the nucleotides. In our laboratory cultures, cellular reactions may be stopped and the nucleotides extracted with ice-cold 1.92 M perchloric acid. Neutralization with ice-cold KOH and precipitation of potassium perchlorate yields a solution that can be measured reproducibly by luciferin-luciferase phosphorescence at sufficient dilution of 1.0 nmole /ml so there is essentially no salt effect on the enzyme. Environmental samples are usually at concentrations where dilutions of the potassium perchlorate are insufficient to remove salt effects from the assay conditions. Extraction from filtered microorganisms by boiling in 0.02 M tris-hydroxyamino methane buffer, pH 7.75, is quantitative. Karl and LaRock (19) have shown that boiling is not satisfactory for microorganisms in sediments, and they have developed a sulfuric acid-ethylenediamine tetraacetic acid extraction procedure that quantitatively extracts ATP from marine sediments yet does not interfere with the enzymes that are essential for the assay.

A liquid scintillation counter operating in the non-coincident mode is satisfactory for detection of the phosphorescence.

ATP then is a measure of microbiomass. The metabolic state of the cells may be better reflected in the so-called energy charge of the total adenylate pool (13, 20). The value $\frac{\text{ATP} + 0.5\ \text{ADP}}{\text{total adenylate}}$ is of primary importance in

regulation of glycolysis, and other vital metabolic processes. ADP can be quantitatively estimated after incubation with phosphoenolpyruvate and pyruvate kinase as the additional ATP generated. This value minus the ATP value equals the ADP level. AMP is determined by adding myokinase to a portion of the ADP reaction. The difference of this value, minus the ADP, minus the ATP level, represents the AMP level. These procedures have been utilized in our laboratory (17).

3. Dipicolonic acid. Dipicolinic acid (DPA) is an amino acid uniquely found in the spores of bacteria and some fungi, where the presence seems to be related to the resistance to heat and drying (21). A method has been developed involving the extraction of DPA from detritus or sediments, its purification chromatographically and its detection by the gas-liquid chromatography of its isopropyl ester. This can lead to studies of the environmental conditions stimulating or repressing sporulation.

B. Microbial activities.

1. Enzyme activities. Methodology that can be performed in the field in time periods short enough to obviate significant distortion by microbial growth after sampling involves a study of enzyme activities.

Ecological studies of specific enzyme activities usually deal with a single enzyme activity rather than considering a variety of enzyme activities simultaneously. However a battery of enzyme indicators encompassing several classes of compounds can be used to define and assess the activity of functional groups within the microbial community. The distribution and role of some specific enzymatic acitvities of fungi, yeast, and bacteria in the marine environment are already well-documented indicating various relationships between environmental substrate and/or breakdown products availability and specific enzyme activity. Such enzyme studies have been published from this laboratory (2, 3, 22, 23).

2. Sulfate reduction. Sulfate reduction is only known to proceed by anaerobic microbial activities of the Desulfovibrio-like organisms. We have developed an assay using the recovery of $H_2{}^{35}S$, generated by reduction of $^{35}SO_4^{=}$, from sediments or water (after acid treatment) or from the air above a sample to measure rates of reduction; hence we are able to estimate anaerobic activity. Sulfate reduction rates in bottom muds have been shown to be related exponentially to sulfate concentrations between 40 and 200 ppm sulfate.

3. Heterotrophic potential. Heterotrophic activity, assayed by the collection and measurement of $^{14}CO_2$ released by microbial utilization of various ^{14}C-labeled substrates has been measured. The correlation between heterotrophic activity in Apalachicola Bay microfloral detrital activity and other measures of activity have been reported (22).

4. Rate of lipid synthesis. Our studies have shown (24) that the rates of phospholipid synthesis and synthesis of total lipids measured as incorporation of ^{14}C and ^{32}P into lipids parallel the adenosine triphosphate levels, alkaline phosphatase, α-D-mannosidase, or rate of oxygen utilization. Methods can be applied to estuarine sediments or detritivore communities. The parameters necessary to control quadrat size, sample variance and assay reproducibility have been determined.

5. Non-invasive semi-continuous monitoring of microbial activity. The detrital microflora on oak leaves incubated in Apalachicola Bay for 4 - 6 weeks is a diverse and active collection of organisms (2). The leaves lose only about 20% of their dry weight in 16 weeks, so remain fairly stable. If cut into discs 6.5 mm in diameter and loosely packed in glass columns and estuarine water is pumped through the columns, various activity measures can be monitored. Differences in oxygen concentration, sulfide concentration and pH have been monitored in the influent and effluent stream pumped through a column loosely

filled with detritus. The oxygen concentration of the influent and effluent streams may then be monitored to assess short-term respiratory response as a function of the experimental variables in order to determine a dose response relationship. The advantage of this method lies in the ability to do repeated experiments with a nearly constant undisturbed microbial population. The methodology has been well worked out in our laboratory, and preliminary data are very encouraging(Table I).

Exploitation of information contained by other chemical parameters of the flow stream will be attempted. The thick epibiotic matrix commonly found associated with detritus suggests the possibility than significant amounts of anaerobic activity may exist, in spite of the high oxygen levels present. With this in mind, sulfate-reducing ability of the system could be determined by following the sulfide concentrations in the flow streams. A preliminary experiment, adapting a spectrophotometric sulfide assay (25) for continuous monitoring via an Autoanalyzer type reaction system, showed promise. The sulfide concentration appeared to fluctuate in a non-random manner: Fourier analysis of the data indicated a 90-hour cycling time of the sulfide levels. Unfortunately stability of the analytical instrumentation is presently inadequate to unequivocably confirm the data. Another possibility of measuring sulfide lies in the use of a specific ion electrode. Again, the problem of detector stability needs to be solved.

Another parameter to be measured is pH, since a number of microbial processes create changes in hydrogen ion concentration. In a sample experiment, a detrital column equipped with a pH electrode showed small changes in response which, when analyzed by Fourier transformation, indicated a cycle time of greater than 70 hours. Again the drift of the electrode introduces a large measure of uncertainty to the results.

Perhaps the most general indicator of activity is enthalpy. To measure enthalpy we propose to build a chamber containing columns in a water bath/air bath container whose temperature is regulated to 10^{-4}°C. The temperature of the flow stream will be monitored to measure the activity of the population. Possible temperature sensors include commercial thermopiles, custom-built dielectric constant devices, or thermistors. An elementary thermistor device was constructed to determine the feasibility of the measurements. The addition of 10^{-4}M glucose resulted in about a 25 μW/gram of detritus increase in heat production. The apparatus was only suitable for short-term measurement (< 1 hour) because of external thermal inputs. A commercially available temperature regulator (Tronac) is expected to remedy these problems.

C. Population dynamics.

1. Lipid classes and lipid metabolism. Methods to reproducibly fractionate the lipids derived from the detrital microfloral assembly have been developed and used to study the metabolism of this community (4). Lipid composition was first used with taxonomic classification of microorganisms by Abel et al (26), using qualitative fatty acid analysis. These workers showed it was possible to differentiate between different groups of bacteria by their fatty acid composition. An elegant compilation of the qualitative lipid composition of various genera and species of bacteria has been prepared by Norman Shaw (27), who points out that the lipids are universally present in bacteria, they are easily and specifically extracted, and can be readily identified. There are a great variety of complex lipids, some of which are unique to prokaryotes and they average about 3-5% of the cellular dry weight. There are four major types of lipids in bacteria, the apolar lipids, neutral lipids, phospholipids and glycolipids. Each class contains distinctive features which form useful measures of microbial diversity and thus can be used to measure microbial succession.

Methods currently in use in our laboratory include:

a. Microbial prokaryote/eukaryote ratios. Preliminary experiments have shown that the detrital microflora synthesizes about 20% of its total fatty acids as C18-, C20-, C22-, and C24-polyenoic fatty acids. These are clearly formed by eukaryotic organisms (28). We will contrast the proportion of polyenoic fatty acids with a characteristic prokaryotic fatty acid such as C-15 iso-branched to develop prokaryotic-eukaryotic ratio and contrast the ratio to that between the triglyceride, steroid, glycerosphingolipid (eukaryotic lipids) versus a typical bacterial lipid such as phosphatidyl glycerol in test systems where we know we would stimulate fungal or algal growth. The proportion of major classes of lipids was a function of the time of incubation with sodium acetate-1-^{14}C. The length of the incubation with ^{14}C shows good correlation with what we expect for the growth rates of different components of the detrital microflora. Slower growing organisms contain more glycolipid and neutral lipid than phospholipid, which is what would be expected for fungi versus bacteria, for example (4). Consequently a study of the proportion of key lipids versus time of incubation with ^{14}C could give correlations to the relative impacts of toxicants on prokaryotes and eukaryotes.

b. Gram-positive to gram-negative ratio. Preliminary evidence indicates the usefulness of the ratio of phosphatidyl glycerol aminoacyl derivatives, or glycosyl diglyceride to a universal microbial lipid like phosphatidyl ethanolamine to determine a gram-negative to gram-positive ratio among the bacteria. Phosphatidyl glycerol aminoacyl derivatives or glycosyl diglycerides are typical components of gram-positive microbes and are not found in classical gram-negative heterotrophs.

c. Distinctive prokaryote-phospholipid markers. The composition of the non-diacyl phospholipids can be used to follow the relative activities of

the Clostridia (plasmalogens), the Bacteroides (sphingophospholipids) or halophilic-thermophilic bacteria (ethers). Our preliminary data indicates 50% of the lipid phosphate was in lipids not made water-soluble by mild alkaline methanolysis (4). Thus these three lipid classes could possibly suggest significant details about the microfloral population.

For each component we assay, we can also measure its synthesis and turnover rates to get an idea of its metabolism. Our preliminary studies on gross separations show a surprising uniformity of turnover times for a large proportion of the community (Table II) and these methods show good (for environmental studies at least) agreement for various estimates of the microbial mass (Table III).

2. Endogenous storage materials. Work as yet unpublished has yielded methods of measuring the rates of synthesis and utilization of the bacterial endogenous storage polymer poly β-hydroxy butyrate (PBHB). PBHB is formed when bacteria are deprived of a growth-limiting substrate in the presence of both energy sources and carbon. Limitations of sulfate, nitrogen, phosphate, pH, trace metals or oxygen lead to its synthesis (29, 30).

We have developed an assay for the quantitative extraction, purification and assay of PBHB from environmental samples, and shown that impacts which affect other activity parameters also affect the metabolism of their endogenous storage products.

3. Scanning electron microscopy. The progressive colonization of the degrading plant litter in East Bay was followed by scanning electron microscopy (SEM). This procedure enables one to determine the extent of colonization of the plant litter surface as well as the classes and relative density of various microbial forms present.

Samples were prepared by a fixation procedure utilizing glutaraldehyde, osmium tetroxide in s-collidine buffer, and ethanol as the dehydrating agent.

Samples were critical point dried in a custom-made critical point dryer utilizing liquid CO_2, mounted on pedestals, and then coated with gold-palladium (60:40:W/W). Samples were examined using a Cambridge Stereoscan S4-10 microscope.

D. Behavior and trophic efficiencies of primary eukaryotic detritivores.

We have chosen as a primary detritivore to study Gammaridean amphipods. Gut analysis amongst the dominant fish in the estuary (31) showed Gammaridean amphipods in 18 of 247 (7%) of Anchoa mitchilli; 31 of 81 (38%) of Leiostomus xanthurus; and 96 of 165 (58%) of Micropogon undulatus. Most of the amphipods found in the fish stomachs were between 30 to 50 mm in length (P. F. Sheridan, unpublished data). Amphipods have been reported in fish stomachs from California (32), Louisiana (33), Mississippi (34), South Florida (35) and Washington (36). Stickney and Shumway (37) in their review of the food habits of fish, show amphipods as a prominent component in the gut of numerous fish.

We find Gammaridean amphipods as the predominant invertebrates in leaf baskets we place in Apalachicola Bay. These amphipods are excellent indicators of the "quality" of the detrital microflora as they have short, relatively simple, digestive tubes where the complication of endosymbiotic microorganisms is minimal (38-40). They survive well in the laboratory, have a relatively simple life cycle (41, 42) and show rapid responses to the environment (43-45).

Preliminary experiments indicate that Gammaridean amphipods can determine if the effects of impacts on the detrital microflora are readily transferred through the food web. Experimental detritus samples will be offered to amphipods in an apparatus consisting of 8 identical small chambers arranged radially around a larger chamber. Since amphipods are photophobic, infrared sensors in the connecting passageways will be used to detect the amphipod flux in the apparatus.

Electronic counters will accumulate the data. Water may be pumped into each radial chamber and drained through an outlet in the central chamber. By varying the composition of the water or food source, food preferences and water avoidance behaviors may be distinguished. The chamber is also suitable for the study of small shrimp and crabs. Presently the chamber has been constructed and the electronic monitoring system has been designed and partially constructed. Preliminary experiments show that use of 200 or more amphipods with the same bait samples in the radial chambers results in a random distribution.

We propose to try to detect the effects of changes in detrital microflora on the amphipods by showing differences in the protein to neutral lipid ratios in the amphipods (preliminary studies show that starving amphipods for 24 hours decreases the lipids selectively).

III. RESULTS:

A. Effects of natural substrates on the activity and succession of the detrital microflora.

Rates of $^{14}CO_2$ formation from ^{14}C-glucose and ^{14}C-glutamate from oak leaves and pine needles incubated in Apalachicola Bay showed an initial colonization period in which there was a rapid increase in activity with the pine needles showing a higher activity than oak leaves (V_{max} 165 and 110 ng substrate/1 hour gram litter) which paralleled the ATP content. The muramic acid levels paralleled the turnover time (the time necessary for the removal of the substrate from the environment). The turnover time was highest initially, reflecting the higher activity of the initial colonizers of the detrital surface which was largely bacterial. Initial turnover times were 41 hrs for pine and 102 hr for oak with glucose and 31 hr for pine and 36 hr for oak with glutamate as substrates (22).

Analysis of esterase activities, oxygen utilization and ATP levels showed seasonal differences between oak and pine litter. Rates of oxygen utilization and β-D-galactosidase activity were higher on oak litter. The alkaline phosphatase activity and phosphodiesterase activities were related to the ambient temperature around 21°C. Alkaline phosphatase activity on the pine always either equalled or exceeded that found on oak, whereas at temperatures below 21°C the activity on the oak always exceeded the pine. Esterase activities and respiration changed with time of exposure in the bay, suggesting a functional succession of the litter-associated microbial communities. β-D-glucosidase, β-D-galactosidase on both oak and pine litter rose rapidly initially, but then showed progressively decreasing increments with longer incubation which correlated inversely with the weight loss. Overall esterase activities correlated well with weight loss. Alkaline phosphatase in phosphate-limited situations of ambient concentrations less than 10^{-6} M showed good correlation with the ATP levels.

The implication that there was a difference in microbial populations between pine needles and oak leaves is borne out by differences in the rates of synthesis of phospholipids and total lipids (1). The relative rates of lipid synthesis paralleled the ATP and muramic acid levels (1, 4) and in the ratios of neutral lipids, phospholipids and glycolipids in the population (4). Sweet gum leaves (which disintegrated most rapidly of those tested), when incubated in the bay showed a significantly more rapid rate of lipid synthesis, a different lipid composition and a higher level of ATP than pine or oak leaves.

The relative rates of colonization differed between plant litter type and the surface observed by scanning electron microscopy. The needle structures of the slash pine needle were clearly visible, and there was little colonization at week zero, prior to placement of the litter in the estuary, but by the first week

colonization was well in progress and continued to increase in time. In the case of the live oak leaves, the stellate hair-covered ventral surface was rapidly covered by microorganisms and accumulated debris, while the relatively smooth dorsal surface was patchily colonized in the early periods with a complete microbial distribution on the surface not observed until weeks 4 and 5.

A variety of microorganisms were observed at different times on both pine needles and oak leaves. Bacteria were commonly observed on most samples; the majority of organisms were cocci, either smooth or rough-surfaced, though bacilli were occasionally observed. The organisms were often seen in colonies, were observed during various stages of divisions, and were frequently attached to the plant litter surface by mucoid-type attachments or mesh-like networks. A variety of diatoms were attached to the plant litter of both types, and while they were present in the early stages, their abundance increased noticeably in the latter stages. The presence of fungi was confirmed by the observation of conidia on week 4 pine needles. Filamentous forms were most extensive during weeks 4, 5 and 6. Other organisms observed suggested the presence of occasional blue-green algae and other algae. The sequence is illustrated in Figures 1 and 2.

B. Comparison between natural degradable substrate, pine needles, and non-degradable surface.

Pine needles and extruded polyvinyl chloride needles from an artificial Christmas tree were analyzed for a 14 weekly period of incubation in Apalachicola Bay. Respiration (rate of oxygen utilization), alkaline phosphatase and phosphodiesterase activities, the rate of incorporation of ^{14}C-acetate into the lipids and the ATP level were 2 to 5 fold higher on the natural surface compared to the plastic. The difference in the microfloral composition was reflected in at least a three order of magnitude difference between the activities of α-D-mannosidase, β-D-galactosidase and β-D-glucosidase on the pine needles compared to the plastic needles. The lipid composition also showed significant

differences on the artificial plastic needle microflora. The artificial pine needle microflora formed lipids containing 20% higher glycolipid ratios than the flora on the pine needles. Scanning electron microscopy showed a sparser population on the artificial surface of organisms with distinctly different shapes.

These microbial data correlate with the recovery of animals from the baskets. There significantly less detritivores and their predators associated with the artificial needles than with the natural substrate.

C. Evidence for succession on the detrital leaf surface.

Scanning electron microscopy, the ATP to muramic acid ratio, the initially high turnover numbers for the heterotrophic potential, the lipid composition of the growing microbial community with a high phospholipid proportion, all support an initial bacterial colonization. There is a more rapid increase in muramic acid in both pine and oak leaves than in the ATP level, suggesting the bacteria (containing muramic acid) colonize the surface more rapidly than do the non-muramic acid-containing eukaryotes (containing ATP but no muramic acid) (2). This has been confirmed by the scanning electron microscope.

D. Rate of growth.

Estimates of the growth rate using several parameters show that the growth of the detrital microflora is slow, even in this rich estuary (Table II). Use of a pulse of sodium acetate-1-^{14}C followed by growth in non-radioactive medium has allowed study of the population dynamics of the detrital bacterial population. The bacterial (muramic acid-containing) component has been shown to contain a small community of rapidly growing heterotrophs (T 1/2 = 3.2 hr) while the bulk of the population has a relatively slower average growth rate (T 1/2 = 72 hr). Using the same pulse chase technique, the bacterial lipids lost ^{14}C most rapidly

from the glycolipids with a T 1/2 equal to that of the slow component of the muramic acid (72 hr). Neutral lipids and phospholipids were slower. Examination of the phospholipids after deacylation and separation of the glycerol esters showed a phospholipid pattern typical of gram-negative bacteria, although 0.58% of the ^{14}C was found in phospholipids not deacylated under mild alkaline conditions, suggesting a complex assortment of microbes. The metabolism of the glycerol phosphate esters shows most rapid turnover of glycerol phosphoryl glycerol (derived from phosphatidyl glycerol) typical of bacteria and a lag in the saturation of the precursor pool of cardiolipin, again typical of bacterial metabolism (4).

The activity of the bacterial component of the detrital microflora measured by the various techniques used in our laboratory is summarized in Table I. These give estimates of 100-1000 hr for average doubling times of the bulk of the bacterial microflora. The organisms divide slowly as is typical of soil (46-48) or lacustrine muds (10 - 280 hr)(49). Even in the relatively rich and warm vertebrate gastrointestinal system doubling rates of 0.5 to 1.4 divisions per day were measured (50) or 1.72 doublings per day in the bovine rumen (51). It is well known that slow-growing microorganisms are remarkably subject to stress (52).

Estimates of the microbial mass (Table III) indicate it represents about 1% of the dry weight of the litter.

The sediment taken from the bay shows about a tenth the activity and muramic acid content of the detrital particles (3).

E. Analysis of impacts.

Preliminary investigations show changes in elasticity, inertia and resiliency of the detrital microflora as water with various pollutional insults is pumped through the glass tubes loosely filled with detritus. Changes in

respiratory activity are illustrated in Table I. Adding glucose or aged tannin-rich water increases immediate activity (elasticity) with little long-term effect (inertia) or effect on the recovery (resiliency). Increase of salinity decreases activity again without effect on inertia or resiliency. Antibiotic treatment however affects all three parameters. Similar changes in activity can be shown in the ATP to ADP ratio and the amount and synthesis of the microbial endogenous storage material poly-β-hydroxy butyric acid by decreasing the pH and by increasing the salinity.

F. Studies on the amphipod behavior and feeding efficiency.

Preliminary studies show that Gammaridean amphipods have a remarkable ability to select leaves with a high microbial population. They prefer the more heavily colonized ventral surface of the oak leaves to the plain dorsal surface. They trim the stellate hairs of the leaves but do not consume intact leaves. When hungry amphipods have been in contact with the detritus, the scanning electron microscopy looks like a lawn mower has run over the surface. This has been confirmed by showing a 10-fold higher incorporation of ^{14}C in the amphipods allowed to graze on the leaves than in those exposed to water in contact with the labeled detrital microbial population (Table IV). Scanning electron microscopy of the amphipod fecal pellets shows the same catholic collection of microbial forms as found on the leaf surface, suggesting they "skim" a proportion of the flora. Comparison with different detrital microfloral populations should help to understand nutritional characteristics of these most important primary detritivores.

TABLE I

Additions	Elasticity [b]	Inertia [c]	Resiliency [d]
Glucose (10^{-4}M)	+ 13.7%	< 1 hr	+
$NaHPO_4$ (10^{-4}M)	+ 1	~	+
Tannin water after aging	+ 23.5%	< 1 hr	+
Salinity (7 ppt)	- 12.2%	< 1 hr	+
Penicillin) Streptomycin) (50 µg/ml)	- 39.6%	20 hr	-

a A column containing 0.77 gm of oak leaf discs, recovered after 11 weeks in Apalachicola Bay, 6 x 150 mm (8 ml volume) was perfused at a flow rate of 0.6 ml/min (exchange time of 13 min). Oxygen utilization was measured with Clark teflon-coated microelectrodes at the input and exit of the column, and the changes in decrement of oxygen concentration recorded continuously. There were no diurnal variations. Since oak leaves last at least 14 weeks in the Bay, with a 18 - 30% dry weight loss but little change in shape, and are a principal detrital component detected in the Bay, they form an ideal substrate.

b Elasticity indicates the maximal change in the respiratory activity

c Inertia indicates the time necessary to read the maximum change in activity

d Resiliency measures the ability of the microbial system to recover the control respiratory activity in less than 4 hours after the removal of the stress.

TABLE II

Estimates of the Estuarine Detrital Bacterial Growth Rates

Method

1. Incorporation of ^{32}P into phospholipid into biomass (assume 50 μmoles lipid per g dry wt)
   a. 0.22% of biomass in 2 hrs (muramic acid)
   b. 0.1% of biomass in 2 hrs (ATP)

   Biomass determined by total muramic acid (a) or extractible ATP (b)

2. Muramic acid turnover T 1/2 = 72 hrs

3. Glycolipid turnover T 1/2 = 78 hrs

4. Saturation of cardiolipin precursors

	T 1/2 GPG	Lag in CL	Doubling time
Monoculture	47 min	< 10 min	40 min
Detritus	110 hrs	> 40 hrs	?

TABLE III

Estimates of the Detrital Microfloral Biomass

Method	% of dry wt litter
1. Muramic acid (assume 4-10 mg/g dry wt)	2 - 17%
2. Extractible ATP (assume 1 mg/g dry wt)	0.2 - 0.8%
3. Oxygen uptake (assume Q_{O_2} = 100 µl/h/g dry wt)	1.4 - 2.2%
4. Phospholipid recovered (assume 50 µmoles lipid/g dry wt)	2 - 4%
5. Glycolipid (assume 2.6 µg glycosyl diglyceride/g dry wt) (gram + organisms)	0.3%

TABLE IV

Distribution of Microbial ^{14}C on Oak Leaf Detritus After Feeding by Gammarus Amphipods.

Oak leaf discs 6.5 mm diameter were incubated in Apalachicola Bay for 4 weeks, recovered and then incubated in the presence of sodium acetate-1-^{14}C for 24 hours at 25°C allowing for the incorporation of approximately 10,000 cpm ^{14}C/disc. Thorough washing of the discs removes the acetate. Using 80 Gammarus amphipods recovered from the Bay and starved (removed from detritus) for 24 hours, half were exposed to leaves containing ^{14}C label. In another the amphipods were prevented from contacting the leaves by a nylon mesh.

	Proportion of the ^{14}C recovered	
	A[a]	B[b]
	Open discs	Excluded
Water[c]	72%	55.5%
Disc[d]	17	42
Total Gammarus[e]	3.14	0.29
Fecal pellets[f]	0.3	0.05
Purge water[g]	8	2

[a] Column A. Discs on which the amphipods could feed directly (Fed)

[b] Column B. Discs enclosed in nylon mesh (Excluded)

[c] The water in which the experiment took place

[d] Discs after 24 hours of feeding

[e] Total Gammarus

[f] Fecal pellets of Gammarus (after 24 hours feeding on labeled detritus).

[g] Water in which amphipods are purged for 24 hours after removal from labeled detritus.

Figure 1. Scanning electron micrographs of the colonization of Quercus virginiana leaves during incubation for various lengths of time in estuarine water.

(A) Dorsal surface, Week 0, 230X, 10Kv

(B) Dorsal surface, Week 2, 200X, 30Kv

(C) Dorsal surface, Week 4, 140X, 5Kv

(D) Dorsal surface, Week 6, 210X, 10Kv

(E) Ventral Surface, Week 0, 210X, 10Kv

(F) Ventral surface, Week 1, 160X, 30Kv

(G) Ventral surface, Week 5, 230X, 10Kv

(H) Ventral surface, Week 6, 290X, 10Kv

Figure 2. Scanning electron micrographs. Organisms observed on surface of Quercus virginiana leaves colonized in estuarine water.

(A) Dorsal surface, Week 1, 5530X, 30Kv

(B) Dorsal surface, Week 1, 2600X, 30Kv

(C) Dorsal surface, Week 2, 5320X, 30Kv

(D) Dorsal surface, Week 3, 8420X, 30Kv

(E) Ventral surface, Week 5, 5400X, 10Kv

(F) Ventral surface, Week 1, 6090X, 30Kv

(G) Ventral surface, Week 3, 1690X, 30Kv

(H) Ventral surface, Week 4, 1440X, 5Kv

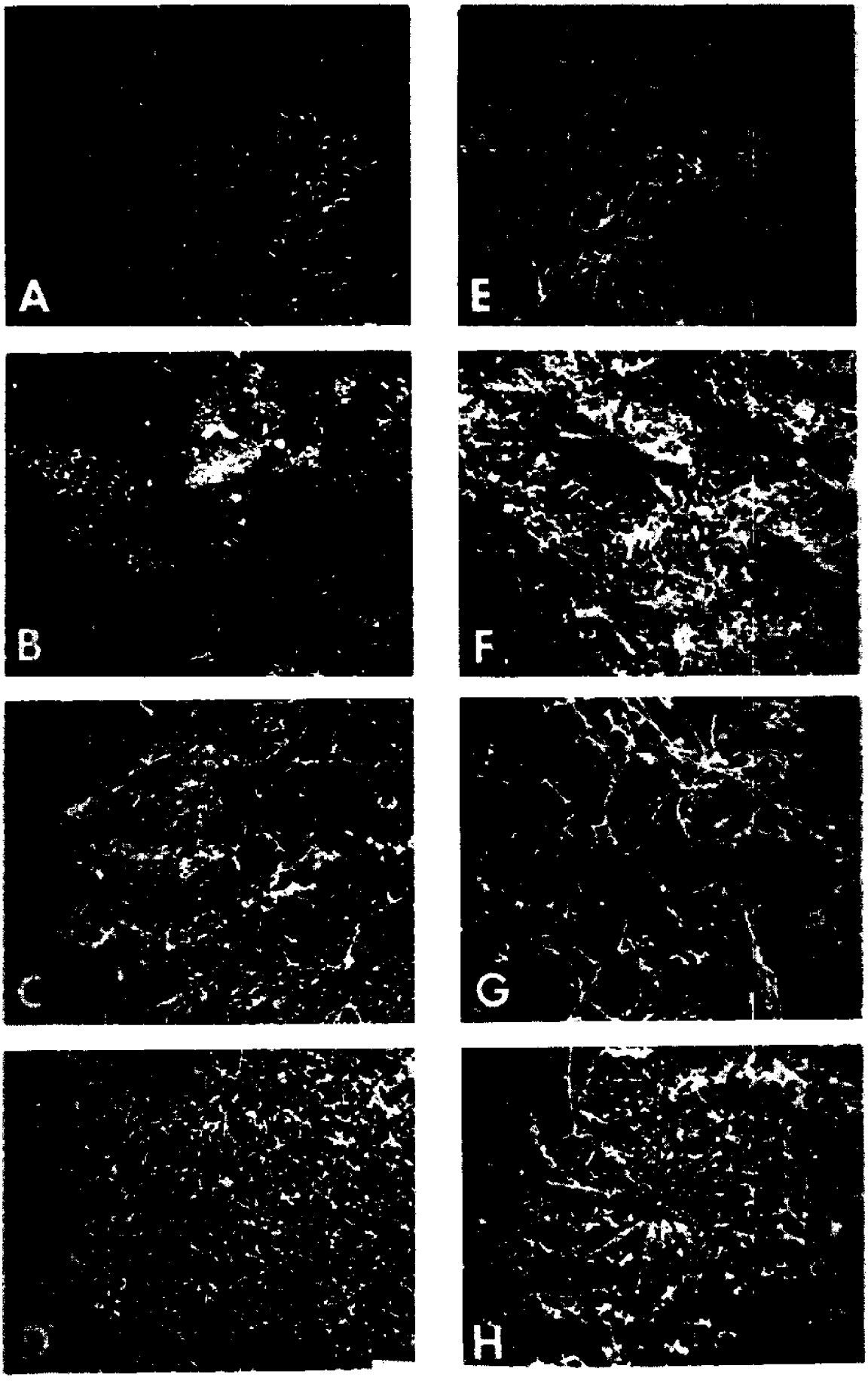


Figure 1.

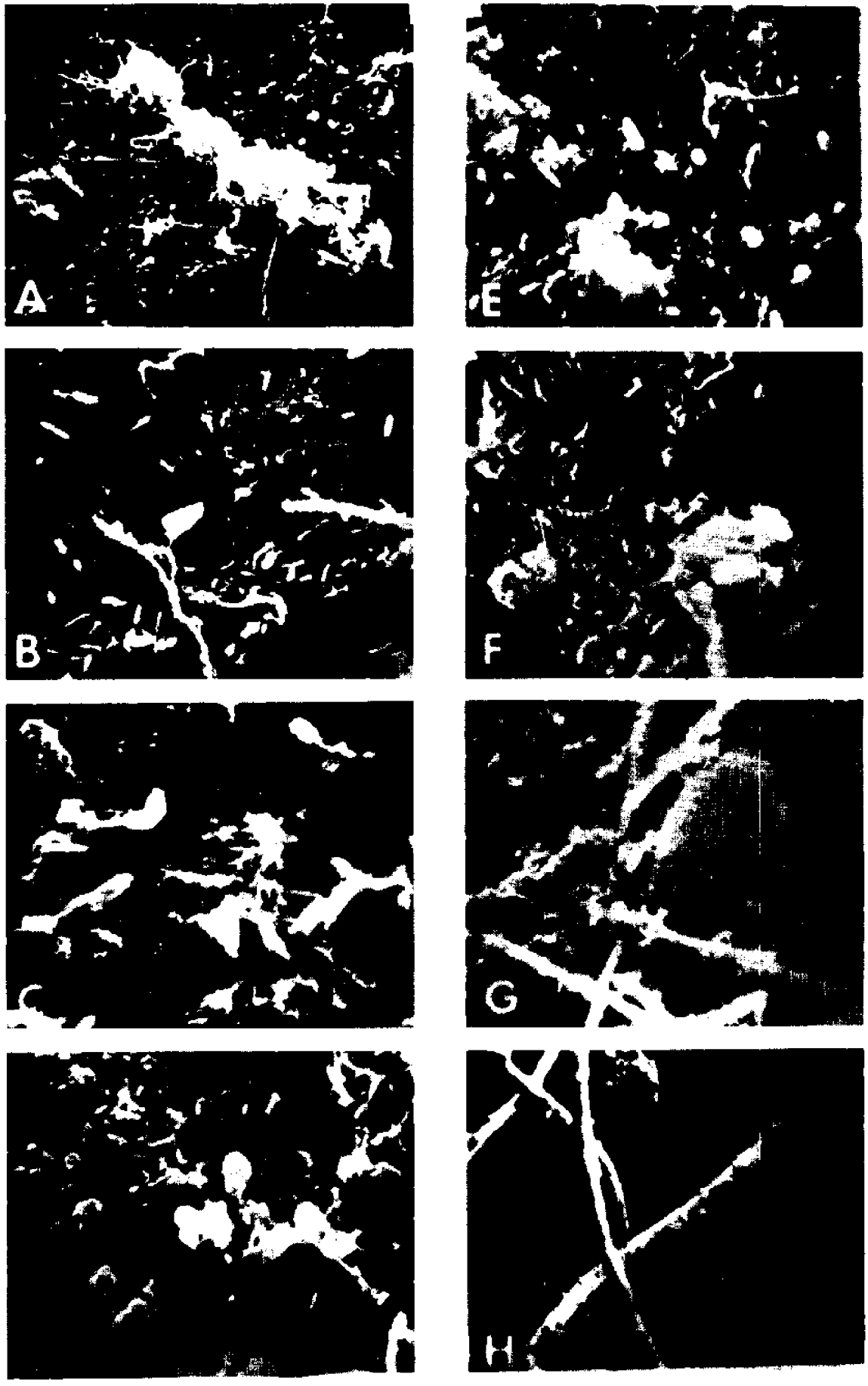


Figure 2.

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VIII. Litter-Associated Organisms

Introduction

For the past 3 years, studies have been carried out concerning organisms associated with allochthonous forms of detritus in the Apalachicola Estuary. This litter fauna is composed primarily of isopods, amphipods, and decapods. Such organisms appear to utilize detritus as substrate for shelter and/or food. Various studies have indicated that these species often depend on the microbial components of detritus for food (Adams and Angelovic, 1970; Fenchel, 1970; Kaushir and Hynes, 1971; Odum and Heald, 1972). However, the actual details of the trophodynamic relationships of detritus-based systems are little known. The leaf litter associations are composed of omnivores and detritovores which ultimately become directly or indirectly available to higher trophic levels. The relative significance of autochthonous and allochthonous detritus in the overall energy budget of the Apalachicola Bay System is still in question. The ultimate importance of detritus is indicated by the major groups of detritus-associated organisms found in this estuary.

This study was designed as a preliminary survey of the leaf-associated organisms in the Apalachicola Bay System with particular emphasis on seasonal variations and the relationship of the biotic associations with key physico-chemical parameters.

Methods and Materials

Stations were established on the basis of previously determined salinity regimes (Fig. 1). Station 5A, a predominantly freshwater habitat during spring and early summer, is characterized by salt water intrusion during late summer and fall periods. Station 3 is a river-dominated area with frequent increases in benthic salinity during summer and fall periods.

Station 1X has relatively high salinities throughout the year except during periods of high river discharge when intermediate salinity levels prevail.

Experiments in the field were carried out with specially designed detritus baskets. These baskets were constructed of plastic-coated hardware cloth (6.5 mm^2 mesh) shaped into cubes (30.5mm/side) with hinged tops. An inner fiberglass screen liner (2 mm^2) covered the sides and bottom of each basket. This allowed organisms access to the inside of the basket; when the basket was pulled to the surface, organisms were trapped inside. Baskets were weighted for stability. Leaf litter was collected along the banks of the lower Apalachicola River. Species composition of such litter was mixed, but consisted primarily of water oak (Quercus nigra), over-cup oak (Q. lyrata), red maple (Acer rubrum), and sweetgun (Liquidambar styraciflua). The leaves were air dried and placed in baskets (400 g. dry weight per basket) which were then situated at the various sampling sites. Sampling times were set according to seasonal fluctuations of key environmental parameters in the Apalachicola Bay System. Three periods were chosen (spring, April-May; summer, August-September; fall, October-November). During the spring series, seven baskets (containing leaves) and two controls (containing no leaves) were placed at stations 1X, 3, and 5A. At weekly intervals over a four to six week period, the baskets were retrieved, and rinsed in a bucket of sea water. During each sampling, leaf matter was removed, placed into the water for a second time, and swirled to remove all organisms. The leaves were then placed in the respective baskets and returned to the bay. Organisms in the buckets were strained through a 297μ sieve, washed into jars, and preserved in 10%

formalin. In the laboratory, they were identified to species, counted, and weighed (wet weight). The surrounding areas were then trawled (16 foot otter trawl; 2 2-minute trawl-tows at 2-3 knots), and collections were typed to species and counted. Representative organisms were preserved (10% formalin) for stomach content analysis. This procedure was followed in subsequent sampling periods until all the leaf matter was gone. Using the data from the first series of samples, it was determined that in each case, 95% of the species were taken by sampling any four baskets. Consequently, further sampling was continued using four experimental baskets and appropriate controls.

During each sampling period, certain physico-chemical parameters were monitored at the designated stations. Surface and bottom water samples were taken using a standard Kemmerer bottle. Water temperature (^{o}C) and dissolved oxygen (ppm) were measured using a YSI Model 54 oxygen meter. Salinity was estimated with a temperature-compensated refractometer calibrated periodically with standard sea water. Water color (Pt-Co standard) was determined using a Hach colorimeter. Turbidity was measured using a Hach model 2100A laboratory turbidimeter ($\pm$ 2% of scale). All physical data were compared with those from a long-term ecological survey of the Apalachicola Bay system (Livingston, 1974).

The data were analyzed using an interactive computer program designed to handle comprehensive field data (Livingston, 1974). In addition to the usual richness (S, number of species) and enumerative (N, number of individuals) functions, several indices were used to evaluate the data. A modification (Pielou, 1966, 1967; Bechtel and Copeland, 1970; Borowitzka, 1972) of the Shannon-Weaver Index (Shannon and Weaver, 1963) was used

where N is the number of individuals in a sample and n_i is the number of individuals in the ith species. Species richness was determined using the Margalef Index (Margalef, 1958)

$$D = \frac{S - 1}{\log_e N}$$

where S in the number of species and N is the number of individuals. The measurement of community similarity for interstation (temporal) comparisons was accomplished using the cλ index of overlap (Morisita, 1959; Horn, 1966). This is a determination of the probability that two randomly drawn samples from populations X and Y will be the same species relative to the probability that two individuals of the same species will be drawn from populations X or Y alone.

$$\lambda x = \frac{\sum_{i=1}^{S} x_i^2}{X^2} \qquad \lambda y = \frac{\sum_{i=1}^{S} y_i^2}{Y^2} \qquad \lambda c = \frac{2\sum_{i=1}^{S} x_i y_i}{(\lambda x + \lambda y)\, XY}$$

where s is the number of species; x_i and y_i are the numbers of the ith species in populations X and Y respectively; X and Y are the total numbers in the two communities, and x and y are measures of diversity (Simpson, 1949) as modified for sampling with replacement (Horn, 1966). Data were broken down according to dominance-diversity curves (seasonal, by station) to present the relative distribution of species numbers in a given collection.

Station characteristics

A detailed analysis of the characteristics and distribution of sediment in East Bay, St. Vincent Sound, and Apalachicola Bay has been made (Kofoed and Gorsline, 1963; Stickney et al., 1969; Livingston et al., this report). Oyster bars are a major source of calcareous matter. The

Apalachicola Bay System is characterized by sand, silt, and shell components in various mixtures; St. Vincent Sound and northern portions of Apalachicola Bay are silty areas that grade into sand/silt and shell gravel as St. George Island is approached. Relic coarse (quartz) sands are covered by fine-grained material deposited by the Apalachicola River. East Bay is composed of silty sand and sandy shell. Relatively high turbidity and sedimentation have significantly reduced benthic macrophyte distribution in all but the shallowest (fringing) portions of the bay.

Station 5A, approxiamtely 1 km south of the upper marshes of East Bay, has a monotonous silty-sand bottom with sparse (scattered) growth of Ruppia maritima. Trawl catches indicate the presence of Gracilaria foliifera. The upper coastline is fringed by beds of Vallisneria americana and upland marshes. Station 3, approximately 0.5 km north of the Gorrie Bridge, is a shallow area (1-1.5 m) subject to strong river action and tidal currents. Various forms of rubble (branches, logs, leaves, etc.), brought in by seasonally variable river flow are commonly found here. A sparse covering of Ruppia maritima is present. During summer months, there is extensive colonization and deposition of various species of blue-green and green algae. Water hyacinth (Eichornia crassipes) is found along the shore. Marsh grasses in this area include Phragmites communis, Typha latifolia, and Juncus roemerianus. Station 1X, located just north of St. George Island, is dominated by Halodule wrightii. Various forms of benthic macrophytes such as Ulva lactuca and Gracilaria spp. are found here. A barrier oyster bar lies just offshore; inside this reef, detritus is deposited in the protected embayments by northerly and westerly winds. Considerable amounts of such detritus are found in this area. Various

marshes (Juncus roemerianus, Spartina spp.) fringe the island in this area. During periods of extensive discharge and/or tidal fluctuations, occasional deposits of leaf litter are found.

Although this portion of the report will concentrate on the preliminary determination of the litter associations, subsequent experiments have been carried out. Determinations using methods described above were made using 3 sets of baskets at Station 3. Each set of 4 baskets was filled with oak leaves, pine needles, or artificial (teflon) substrate; 12 baskets were set at Station 3 and collected at monthly intervals from July, 1975 to November, 1975. A third series of experiments was carried out at Stations 5A, 3, and 1X from January, 1976 to January, 1977. Four baskets of oak leaves were placed at each station at monthly intervals and the previous month's baskets were sampled. This was carried out to determine seasonal variation of litter associations. Although all samples have been taken, the data are still being analyzed and will not be presented here.

Results and Discussion

Physico-chemical parameters

A one year profile of various physical conditions in the three primary study sites is presented in Fig. 2. Water temperature varied little from one station to the next; peaks occurred during late summer months. Biological sampling took place during periods of increasing, peak, and decreasing water temperature levels. Peak river flows occurred during late winter and spring months. Increased turbidity paralleted river flow at Stations 3 and 5A. However, farther out in the bay, Station 1X was characterized by constant low turbidity levels (being less affected by such flow). Local rainfall, out of phase with river flow, peaked during late

summer and early fall. Such rainfall was correlated with increased levels of color at inshore stations (3 and 5A). Color appeared to be more variable than turbidity and often had a direct relationship with salinity. Color was uniformly low at Station 1X which, after a period of low salinity during the early spring of 1974, also was characterized by uniformly higher salinities than the other two stations. Station 5A had a low mean salinity over the study period with considerable seasonal variation. During spring months, salinity was not detected in this area. Increases in salinity occurred during summer and fall periods with significant variation due to local rainfall and runoff conditions. During the fall, there was a significant increase in color at Station 5A which was not evident elsewhere to any degree. This factor will be studied in more detail in an analysis of clearcutting operations. Station 3, with somewhat higher mean salinities, reflected the same pattern although variation was somewhat less extreme and there were generally higher salinity levels during the spring than in more upland portions of the bay. The reduced influence of contiguous land areas on Station 3 was also reflected in the color data. Thus, the physical parameters at the three primary collection stations were based primarily on physiographic location, temporal variations of river flow and meteorological phenomena, and local rainfall and land runoff conditions.

Sampling efficiency

Multiple samples (7) were used to evaluate the method of collection. A composite species accumulation is shown in Fig. 3. Each point represents the mean number of species found in the 6 subsamples taken at weekly intervals from 9 April to 14 May. In each instance, an asymptotic relationship was reached by the fourth sample. Further analysis was carried out using a

modification of a program described by Livingston et al., 1976. At each sampling period, fifty random draws were made of the 7 possible combinations of species. Numbers of species accumulated with each sample were averaged and plotted as a percentage of the total number of species taken for the 7 samples. The cumulative distribution function showed that at Station 3, between 90 and 95% of all species were taken by the fourth sample. At Station 5A, these figures ranged from 90 to 97% during the sampling period with asymptotes routinely established by the fourth sample. An analysis was also made of the variablility in the determination of total numbers of individuals (N) taken within a group of subsamples. Analysis of variance (ANOVA) results from Station 5A indicated no significant variation of N from week to week. A theoretical standard error was calculated with confidence limits established to determine variation by sample $(\frac{S.E.}{\bar{x}} \times 100\%)$ for a given set of samples. This permitted a comparison of the true mean of any number of samples with the mean for the total number of samples (42). At Station 5A, four samples of a given time period were within ± 30.8% of the mean ($p < 0.05$). At Station 3, the ANOVA results indicated marked differences in N from week to week. Consequently, data were analyzed on a weekly basis. The four samples taken in each period were within ± 51.0% of the mean ($p < 0.05$). Thus, the data indicate that in terms of the number of species taken in a given set of samples, by the fourth sample, a representative S value was achieved at each site. At Station 5A, relatively uniform N values were noted from sample to sample so that four samples would again allow adequate sampling effort. However, at Station 3, due to higher variability of N, more samples were necessary to achieve the same confidence level. Based on these data, it was determined that four

samples per station at a given time would be adequate for the purpose of this study. All further analysis was based on this sampling regime.

Leaf Litter Associations

The results of the leaf basket experiments are shown in Tables 1 and 2. In every instance, there was a significant difference (in terms of numbers of species and individuals) between empty baskets and those containing leaf litter. The presence of organisms in empty sampling devices indicates that such enclosures could perform a shelter function in some instances. In terms of biomass (dry weight), more was associated with pine needles than oak leaves and a considerable amount was found in the baskets filled with teflon leaves indicating that the leaf matter itself may simply serve as a substrate for shelter and/or microbial accumulation. More information is needed here before a difinitive statement can be made.

Within and between station comparisons of species assemblages are shown in Table 3. There was usually a consistent within-station similarity with time. With one exception (3-1X), marked interstation similarity coincided with moderate to high salinity levels. Although there was station to station variation in species associations, increased salinity was associated with interstation similarity which superceded geographic variation. Such changes were often characterized by increased dominance of species such as Gammarus mucronatus, Melita sp., Ericthonius brasiliensis, and Gitanopsis sp. Since such associations were most prevalent during the fall period of sampling, it is quite likely that factors other than salinity are also involved in the determination of species composition of the leaf litter associations. The most obvious seasonal function in this case would be water temperature. The low numbers of individuals at Station 5A

during the summer ran counter to trends in other portions of the bay, and could be related to an entirely different set of variables related to storm water runoff in the area.

Temporal variation of various community parameters is presented in Fig. 4. In terms of numbers of individuals(N), there was a general increase during the year of sampling at Stations 3 and 5A. At Station 1X, there was a decrease of N with time. Other parameters such as number of species (S), Margalef richness (Ma), and Shannon-Weaver diversity (H') increased at all three stations with time. Such indices usually peaked during the fall. Associated with this, there was a general decrease in relative dominance. Correlation coefficients of physico-chemical and biological functions are shown in Table 4. Relative dominance was negatively correlated with H'. High positive correlations were found between S and two parameters (Margalef richness and log N). There were also significant correlations of salinity with S, log N, and species richness. It appears that salinity is a primary determinant of leaf litter assemblages. Interstation relationships of salinity, S, and log N are shown in Fig. 5. Regression analysis confirms these results ($F = 30.4$; $R^2 = 0.45$ for salinity and S; $F = 13.2$; $R^2 = 0.26$ for salinity and Log_e N). The numbers of species and individuals taken at a given time vary directly with salinity rather than station location. General salinity increases in the fall did coincide with increased similarity coefficients so that even qualitative changes in leaf litter fauna were not unrelated to salinity. The data would thus indicate that salinity is an important parameter concerning the leaf litter assemblages in the Apalachicola Bay System.

The allochthonous litter deposited in the Apalachicola Bay System thus attracts a considerable invertebrate fauna primarily composed of

isopods, amphipods, and decapods. Presumably, these crustaceans use this debris as a source of food and shelter. Various studies indicate that such species often depend on the microbial component of the detritus as food (Adams and Angelovic, 1970; Fenchel, 1970; Kaushik and Hynes, 1971; Odum and Heald, 1972). The details of the actual energy transfer mechanism are little known, however.

The small invertebrates are in turn consumed by larger organisms. A summary of trawl-susceptible organisms found in the vicinity of the leaf-basket stations is shown in Table 5. Many invertebrate species (Penaeus spp., Palaemonetes spp., etc.) are detritovores, feeding on small fragments of organic matter deposited on or within the substrate (Odum and Heald, 1972; Nixon and Oviatt, 1973). Others, such as Callinectes sapidus, are omnivores (Tagatz, 1968). Major predators of the leaf-associated biota would be the fishes, primarily Bairdiella chrysura, Lagodon rhomboides, Orthopristis chrysoptera, Eucinostomous argenteus, and Cynoscion arenarius (Odum and Heald, 1972; Carr and Adams, 1973). As shown previously, leaf litter and other allochthonous forms of detritus are either indirectly or directly available to various estuarine organisms both as a primary substrate and as a source of smaller (fragmented) portions of the organic detrital pool. These trophic relationships will be analyzed in more detail elsewhere in this report.

In summary, various estuarine organisms were associated with mixed (deciduous) leaf litter that was dropped in baskets throughout the bay during 1974. Such species assemblages were dominated by amphipod, isopod, and decapod crustaceans. Qualitative and quantitative characteristics of leaf litter associations were highly correlated with salinity. Increased salinity was often accompanied by increased numbers of Gammarus

mucronatus, Melita sp., Erichthonius brasiliensis, and Gitanopsis sp. Salinity was directly correlated with the number of species(S), number of individuals ($\log_e$ N), and Margalef richness (Ma). Such indices as Shannon-Weaver diversity (H'), S, and Ma peaked during the fall; associated with this was a reduction in relative dominance (D_1) at this time. Experiments with leaf litter indicated that it was used for shelter and/or as a substrate for microbial deposition although this remained open for further analysis.

Organisms associated with leaf litter are part of the food webs of various estuarine systems. Therefore, although the direct (quantitative) energy relationships of such matter remain speculative, allochthonous detritus in river-dominated estuaries such as the Apalachicola System should be considered in any estimate of the total trophic structure of such systems.

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Table 1: Total numbers of leaf-litter associated organisms taken at 3 stations in Apalachicola Bay during the spring, summer, and fall of 1974.

SPRING (April-May)

Totals: 4 baskets with 2 controls (no leaves) - samples weekly, 4-6 weeks

Invertebrates		
Neritina reclivata	882	152
Palaemonetes pugio	263	73
Corophium louisianum	242	5
Gammarus sp. (2)	218	10
Gammarus mucronatus	130	
Grandidierella bonnieroides	107	
Rhithropanopeus harrisii	98	8
Callinectes sapidus	54	11
Melita sp.	37	
Cerapus sp.	15	3
Munna reynoldsi	7	
Cassidinidea ovalis	3	
Leptochelia rapax	3	
Fishes		
Bairdiella chrysura	21	6
Brevoortia patronus	1	
Syngnathus scovelli		1

Invertebrates		
Corophium louisianum	601	45
Tephromysis bowmani	339	2
Grandidierella bonnieroides	246	2
Neritina reclivata	186	30
Melita sp.	71	
Gammarus mucronatus	29	1
Callinectes sapidus	22	2
Munna reynoldsi	20	3
Penaeus setiferus	18	2
Gammarus sp. (2)	16	
Palaemonetes pugio	15	1
Rhithropanopeus harrisii	7	
Cerapus sp.	7	1
Gitanopsis sp.	7	
Edotea montosa	5	
Cassidinidea ovalis	4	
Sphaeroma terebrans	1	
Fishes		
Gobiosoma bosci	42	9
Bairdiella chrysura	17	2
Syngnathus floridae	2	

Invertebrates		
Erichthonius brasiliensis	2,337	235
Gammarus mucronatus	1,179	67
Munna reynoldsi	1,291	46
Gitanopsis sp.	1,129	59
Polydora websteri	[illegible]	253
Melita sp.	[illegible]	25
Corophium louisianum	[illegible]	11
Cassidinidea ovalis	[illegible]	8
Neanthes succinea	[illegible]	5
Callinectes sapidus	[illegible]	4
Neritina reclivata	[illegible]	8
Palaemonetes vulgaris	24	8
Grandidierella bonnieroides	[illegible]	
Edotea montosa	[illegible]	
Cerapus sp.	[illegible]	
Rhithropanopeus harrisii	[illegible]	1
Melita fresnelii	[illegible]	
Cymadusa filosa	[illegible]	
Ampelisca abdita	[illegible]	1
Nemerteans	[illegible]	
Sphaeroma quadridentatum	[illegible]	
Penaeus duorarum	[illegible]	
Parametapella cypris	[illegible]	
Paranaites speciosa	[illegible]	
Mysidopsis bigelowi	[illegible]	3
Fishes		
Gobiosoma bosci	12	5

SUMMER (August-September)

	with leaves	without leaves
Invertebrates		
Melita sp.	2,068	82
Munna reynoldsi	1,400	126
Gammarus sp. (2)	788	39
Cerapus sp.	382	118
Grandidierella bonnieroides	325	81
Palaemonetes pugio	306	91
Rhithropanopeus harrisii	295	14
Corophium louisianum	292	90
Cassidinidea ovalis	99	11
Xanthid juveniles	70	
Neritina reclivata	56	6
Palaemonetid juveniles	33	6
Gammarus mucronatus	23	
Edotea montosa	10	1
Callinectes sapidus	10	
Sphaeroma terebrans	2	
Fishes		
Gobiosoma bosci	45	10
Ictalurus catus	4	
Logodon rhomboides	1	
Bathygobius soporator	1	

	with leaves	without leaves
Invertebrates		
Munna reynoldsi	3,137	23
Grandidierella bonnieroides	1,725	26
Melita sp.	1,471	15
Gitanopsis sp.	1,460	4
Corophium louisianum	522	10
Cassidinidea ovalis	380	7
Gammarus mucronatus	290	18
Palaemonetes pugio	130	
Palaemonetes vulgaris	90	49
Gammarus sp. (2)	84	2
Callinectes sapidus	40	6
Edotea montosa	24	
Neritina reclivata	18	3
Penaeus setiferus	8	
Cerapus sp.	7	
Rhithropanopeus harrisii	4	
Sphaeroma terebrans	2	
Xanthid juveniles	2	6
Penaeus aztecus	1	
Argulus sp.	1	
Fishes		
Bairdiella chrysura	56	
Gobiosoma bosci	29	4
Gobiosoma robustum	4	
Orthopristis chrysoptera	1	

	with leaves	without leaves
Invertebrates		
Gammarus mucronatus	[illegible]	160
Gitanopsis sp.	1,346	51
Corophium louisianum	[illegible]	11
Erichthonius brasiliensis	[illegible]	23
Munna reynoldsi	[illegible]	18
Cassidinidea ovalis	[illegible]	11
Melita sp.	[illegible]	2
Bittium varium	[illegible]	5
Neanthes succinea	[illegible]	2
Palaemonetes vulgaris	[illegible]	1
Callinectes sapidus	[illegible]	2
Cerapus sp.	[illegible]	
Neritina reclivata	[illegible]	
Leptochelia rapax	[illegible]	
Polydora websteri	[illegible]	
Edotea montosa	[illegible]	
Rhithropanopeus harrisii	[illegible]	
Amphicteis gunneri	[illegible]	
Nemerteans	[illegible]	
Palaemonetes pugio		1
Fishes		
Gobiosoma bosci	[illegible]	
Lutjanus griseus	[illegible]	

	with leaves	without leaves
Invertebrates		
Gammarus mucronatus	9,982	82
Melita sp.	2,504	24
Erichthonius brasiliensis	1,961	79
Corophium louisianum	609	32
Cassidinidea ovalis	308	5
Xanthid juveniles	224	3
Leptochelia rapax	148	
Palaemonetes vulgaris	125	
Gitanopsis sp.	104	2
Nemerteans	41	
Edotea montosa	38	4
Erichsonella filiformis	37	
Amoelisca oldita	37	5
Neanthes succinea	35	4
Cymadusa sp.	15	3
Neopanope texana	10	
Sphaeroma quadridentatum	8	
Callinectes sapidus	5	
Haploscoloplos fragilis	3	2
Penaeus duorarum	1	
Alpheus heterochaelis	1	
Rhithropanopeus harrisii	1	
Cerapus sp.	1	
Taphromysis bowmani		1
Leptochelia rapax		105
Fishes		
Opsanus beta	1	
Lagodon rhomboides	1	
Strongylura marina	1	1

	with leaves	without leaves
Invertebrates		
Melita sp.	6,017	27
Erichthonius brasiliensis	2,569	149
Gitanopsis sp.	424	1
Cassidinidea ovalis	314	7
Cymadusa sp.	219	17
Nemerteans	101	12
Xanthid juveniles	93	
Gammarus mucronatus	92	19
Palaemonetes vulgaris	82	7
Edotea montosa	22	3
Callinectes sapidus	17	4
Palaemonetid juveniles	16	1
Leptochelia rapax	14	4
Taphromysis bowmani	13	3
Neopanope texana	12	1
Corophium louisianum	5	1
Erichsonella filiformis	3	
Penaeus duorarum	3	
Palaemonetes pugio	2	1
Clibanarius vittatus	1	2
Neritina reclivata	1	1
Nudibranch species	1	
Fishes		
Gobiosoma bosci	7	
Fundulus grandis	3	
Opsanus beta	2	
Lutjanus griseus		1

	with leaves	without leaves
Invertebrates		
Melita sp.	1,662	32
Gammarus mucronatus	904	16
Cymadusa sp.	605	40
Erichthonius brasiliensis	417	26
Cassidinidea ovalis	255	14
Neanthes succinea	198	35
Gitanopsis sp.	152	
Podarke sp.	151	
Palaemonetes vulgaris	114	15
Nemerteans	59	
Crepidula plana	43	
Leptochelia rapax	38	4
Bittium varium	27	5
Corophium louisianum	19	1
Haploscoloplos fragilis	18	2
Erichsonella filiformis	13	
Febricia sp.	8	
Anachis avara	7	2
Neopanope texana	7	
Edotea montosa	6	
Neritina reclivata	5	
Polydora websteri	5	7
Taphromysis bowmani	5	5
Clymenella sp.	4	
Paranaites speciosa	2	
Penaeus duorarum	2	
Callinectes sapidus	2	1
Hemigonia minuta	1	
Penaeus aztecus	1	
Streblospio benedicti		1

1. Summary of organisms associated with oak leaves at station 3 (East Bay) from 15 July, 1975 to 15 November, 1975

SPECIES	SAMPLE DATES 750715	750815	751015	751115	TOTALS
CALSAP	26.55	9.48	0.00	1.90	37.92
	82.35	41.28	0.00	35.94	62.27
NERREC	5.16	11.51	.11	1.33	18.10
	16.01	50.09	26.54	25.12	29.73
RHIHAR	0.00	1.84	.31	1.84	3.99
	0.00	8.01	72.19	34.89	6.55
PALPUG	.47960	.04360	0.00000	.04360	.56680
	1.49	.19	0.00	.83	.93
GAMMAC	.03861	.06110	.00325	.03549	.13845
	.12	.27	.76	.67	.23
PALVUL	0.00000	0.00000	0.00000	.09720	.09720
	0.00	0.00	0.00	1.84	.16
GAMNSP	.00108	.00486	.00108	.01566	.02268
	.00	.02	.25	.30	.04
MELINT	.00132	.01684	.00012	.00380	.02208
	.00	.07	.03	.07	.04
MUNREY	.00129	.00804	0.00000	.00807	.01740
	.00	.04	0.00	.15	.03
CASOVA	.00330	.00363	0.00000	.00308	.01001
	.01	.02	0.00	.06	.02
GRABON	.00306	.00066	.00072	.00306	.00750
	.01	.00	.17	.06	.01
DICSPE	.00003	.00150	.00021	.00108	.00282
	.00	.01	.05	.02	.00
CYAPOL	0.00000	0.00000	0.00000	.00234	.00234
	0.00	0.00	0.00	.04	.00
CORSPE	.00056	.00014	0.00000	0.00000	.00070
	.00	.00	0.00	0.00	.00
CORLOU	.00002	.00018	0.00000	.00010	.00030
	.00	.00	0.00	.00	.00
TAPBOW	0.00000	0.00000	0.00000	.00019	.00019
	0.00	0.00	0.00	.00	.00
AMPGUN	0.00000	0.00000	0.00000	.00014	.00014
	0.00	0.00	0.00	.00	.00
TURSPE	.00002	.00012	0.00000	0.00000	.00014
	.00	.00	0.00	0.00	.00
GITSPE	0.00000	0.00000	0.00000	.00007	.00007
	0.00	0.00	0.00	.00	.00
CERSPE	0.00000	0.00000	0.00000	.00006	.00006
	0.00	0.00	0.00	.00	.00
TOTALS	32.2	23.0	.4	5.3	60.9

A1YY076. 13.43.22. 77/02/23.

2. Summary of organisms associated with pine needles at station 3 (East Bay) from 15 July, 1975 to 15 November, 1975

SPECIES	SAMPLE DATES 750715	750815	751015	751115	TOTALS
CALSAP	32.23	36.03	0.00	36.03	104.29
	84.83	65.33	0.00	78.44	74.45
NERREC	3.33	14.75	.23	1.66	19.97
	8.76	26.74	22.49	3.62	14.25
RHIHAR	.46	2.45	.46	6.90	10.28
	1.21	4.45	45.87	15.03	7.34
PALPUG	1.42	1.26	.24	.63	3.55
	3.73	2.29	23.90	1.38	2.54
PENSET	.52	.52	0.00	0.00	1.04
	1.37	.94	0.00	0.00	.74
PALINT	0.00000	0.00000	.06900	.39100	.46000.
	0.00	0.00	6.88	.85	.33
PALVUL	0.00000	0.00000	0.00000	.19440	.19440
	0.00	0.00	0.00	.42	.14
GAMMAC	.02808	.07423	.00442	.05044	.15717
	.07	.13	.44	.11	.11
GAMNSP	0.00000	.00054	.00054	.03240	.03348
	0.00	.00	.05	.07	.02
CASOVA	.00572	.01958	.00055	.00671	.03256
	.02	.04	.05	.01	.02
MUNREY	.00063	.01926	.00018	.00918	.02925
	.00	.03	.02	.02	.02
MELINT	.00032	.01080	.00024	.01320	.02456
	.00	.02	.02	.03	.02
GRABON	.00612	.00342	.00210	.00180	.01344
	.02	.01	.21	.00	.01
DICSPE	.00012	.00255	.00063	.00417	.00747
	.00	.00	.06	.01	.01
PERLON	0.00000	.00360	0.00000	0.00000	.00360
	0.00	.01	0.00	0.00	.00
CYAPOL	0.00000	0.00000	0.00000	.00234	.00234
	0.00	0.00	0.00	.01	.00
CORLOU	.00008	.00030	.00004	.00020	.00062
	.00	.00	.00	.00	.00
TURSPE	0.00000	.00038	0.00000	0.00000	.00038
	0.00	.00	0.00	0.00	.00
CORSPE	.00014	.00014	0.00000	0.00000	.00028
	.00	.00	0.00	0.00	.00
GITSPE	0.00000	0.00000	0.00000	.00006	.00006
	0.00	0.00	0.00	.00	.00
TOTALS	38.0	55.1	1.0	45.9	140.1

A1YY076. 13.43.21. 77/02/23.

3. Summary of organisms associated with artificial (teflon) leaves at station 3 (East Bay) from 15 July, 1975 to 15 November, 1975

SPECIES	SAMPLE DATES 751015	751115	TOTALS
CALSAP	5.69	41.71	47.40
	89.90	74.07	75.67
RHIHAR	.31	8.59	8.90
	4.85	15.25	14.20
NERREC	.20	2.65	2.85
	3.12	4.71	4.55
PALPUG	.07	1.07	1.13
	1.03	1.90	1.81
PROPEN	0.00	1.13	1.13
	0.00	2.00	1.80
PALINT	.02300	.50600	.52900
	.36	.90	.84
PALVUL	.03240	.45360	.48600
	.51	.81	.78
GAMMAC	.01118	.07943	.09061
	.18	.14	.14
GAMNSP	.00162	.05400	.05562
	.03	.10	.09
MUNREY	0.00000	.03441	.03441
	0.00	.06	.05
MELINT	.00032	.02048	.02080
	.01	.04	.03
CASOVA	0.00000	.00649	.00649
	0.00	.01	.01
CYAPOL	0.00000	.00468	.00468
	0.00	.01	.01
GRABON	.00060	.00396	.00456
	.01	.01	.01
DICSPE	.00024	.00189	.00213
	.00	.00	.00
CORLOU	.00004	.00088	.00092
	.00	.00	.00
AMPGUN	0.00000	.00042	.00042
	0.00	.00	.00
GITSPE	.00001	.00027	.00028
	.00	.00	.00
TAPBOW	0.00000	.00019	.00019
	0.00	.00	.00
CERSPE	0.00000	.00012	.00012
	0.00	.00	.00
TURSPE	0.00000	.00002	.00002
	0.00	.00	.00
TOTALS	6.3	56.3	62.6

Table 3 Cλ values for interstation comparisons during the three sampling periods. Seasonal (within station) comparisons are also shown.

Data analyzed include leaf litter associated invertebrates in Apalachicola Bay.

	Spring			Summer			Fall		
Station	$5A_1$	3_1	IX_1	$5A_2$	3_2	IX_2	$5A_3$	3_3	IX_3
$5A_1$	--	.21	.18	.49	.15	.03	.12	.23	.11
3_1		--	.18	.32	.77	.63	.42	.19	.60
IX_1			--	.13	.15	.31	.52	.72	.60
$5A_2$				--	.35	.19	.18	.30	.20
3_2					--	.33	.52	.42	.35
IX_2						--	.44	.14	.80
$5A_3$							--	.70	.55
3_3								--	.48
IX_3									--

Table 4: Comparison of Correlation Coefficients (and P values) of Major Physical and Biological Parameters Concerning Leaf Litter Associations (invertebrates) in the Apalachicola Bay System.

	Temperature	Salinity	Secchi	D_1	H'	D	S	log N
emperature		-0.00 (0.50)	-0.43 (0.00)	-0.31 (0.03)	-0.10 (0.28)	0.12 (0.22)	0.13 (0.22)	.28 (0.04)
linity			0.14 (0.19)	-0.06 (0.34)	0.19 (0.13)	.50 (0.00)	0.67 (0.00)	0.51 (0.00)
cchi				-0.31 (0.03)	0.47 (0.00)	0.29 (0.04)	0.18 (0.13)	-0.08 (0.32)
					-0.91 (0.00)	-0.11 (0.24)	0.08 (0.31)	0.22 (0.09)
						0.24 (0.07)	0.03 (0.42)	-0.24 (0.07)
							0.83 (0.00)	0.37 (0.10)
								0.75 (0.00)
g N								

Table 5 Trawl-susceptible fishes and invertebrates taken at sampling stations in Apalachicola Bay during 1974.

Station	IX		3		5A	
Fishes						
	Bairdiella chrysura	523	Anchoa mitchilli	168	Cynoscion arenarius	204
	Lagodon rhomboides	372	Cynoscion arenarius	106	Anchoa mitchilli	142
	Orthopristis chrysoptera	205	Eucinostomus argenteus	37	Opisthonema oglinum	18
	Eucinostomus argenteus	169	Cynoscion nebulosus	11	Eucinostomus argenteus	10
	Cynoscion nebulosus	71	Syngnathus scovelli	8	Bairdiella chrysura	5
	Eucinostomus gula	43	Micropogon undulatus	3	Cynoscion nebulosus	4
	Lucania parva	26	Microgobius thalassinus	2	Trinectes maculatus	4
	Microgobius gulosus	20	Syngnathus louisianae	1	Prionotus scitulus	3
	Syngnathus scovelli	17	Syngnathus floridae	1	Lagodon rhomboides	2
	Monacanthus hispidus	13	Prionotus scitulus	1	Arius felis	2
	Sphoeroides nephelus	8	Menticirrhus americanus	1	Syngnathus louisianae	2
	Chilomycterus schoepfi	8	Gobiosoma robustum	1	Sphoeroides nephelus	1
	Anchoa mitchilli	7	Bathygobius soporator	1	Micropogon undulatus	1
	Cynoscion arenarius	6	Arius felis	1	Microgobius thalassinus	1
	Lutjanus griseus	6			Microgobius gulosus	1
	Synodus foetens	6			Gobiosoma bosci	1
	Dasyatis sabina	4			Gobionellus boleosoma	1
	Syngnathus louisianae	3				
	Hypsoblennius hentzi	2				
	Paralichthys lethostigma	2				
	Prionotus tribulus	2				
	Sciaenops ocellata	1				
	Leiostomus xanthurus	1				
	Gobionellus boleosoma	1				
	Etropus crossotus	1				
	Centropristis melana	1				
	Anchoa hepsetus	1				
	Menticirrhus americanus	1				
Invertebrates						
	Palaemonetes vulgaris	306	Penaeus setiferus	320	Penaeus setiferus	285
	Tozeuma carolinense	57	Callinectes sapidus	35	Penaeus duorarum	21
	Periclimenes longicaudatus	47	Penaeus aztecus	21	Callinectes sapidus	15
	Callinectes sapidus	44	Penaeus duorarum	10	Penaeus aztecus	5
	Penaeus aztecus	30	Palaemonetes vulgaris	6	Neritina reclivata	4
	Penaeus duorarum	20	Palaemonetes pugio	3	Palaemonetes pugio	2
	Penaeus setiferus	5	Rhithropanopeus harrissi	1	Acetes americanus	1
	Hippolyte pleuracantha	5	Lolliguncula brevis	1		
	Acetes americanus	2				
	Neopanope texana	1				
	Clibanarius vittatus	1				

Figure 1: The Apalachicola Bay System showing sampling stations, oyster bars, and marshes.

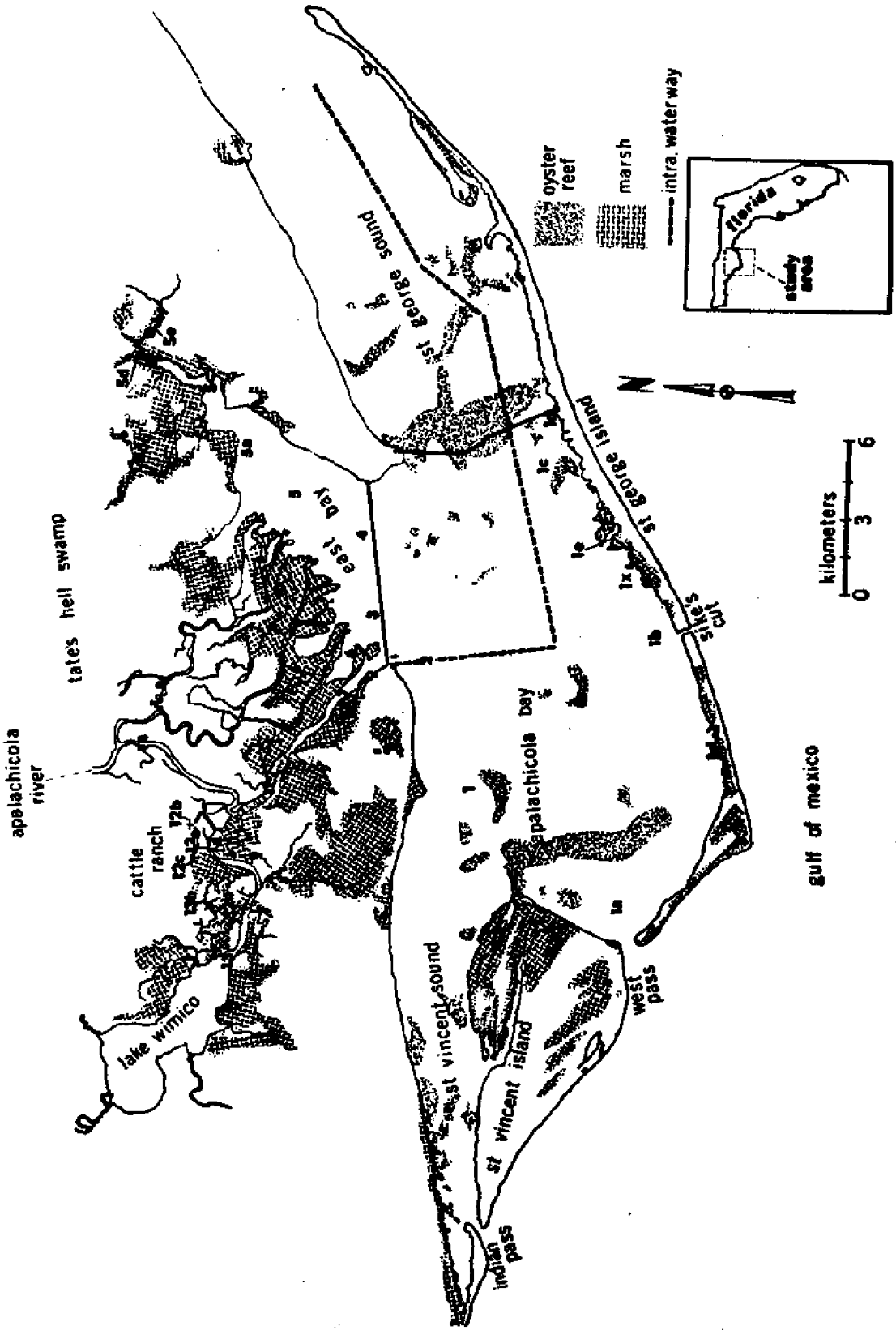


Figure 2: Apalachicola River flow, local rainfall, and physical parameters (temperature, salinity, color, turbidity) at primary sampling stations from January to December 1974.

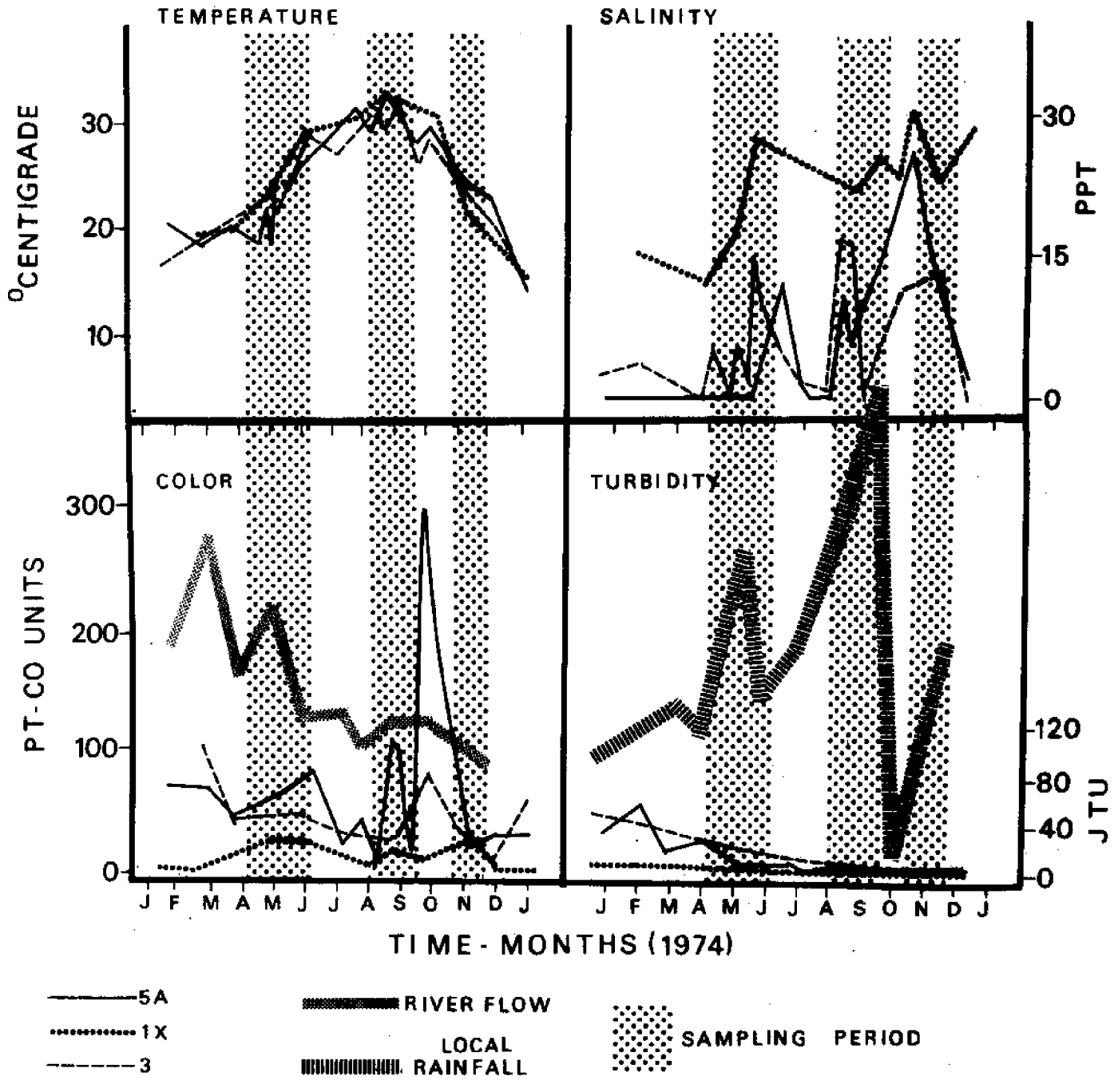


Figure 3: Species accumulation curve of leaf litter invertebrates taken at stations 3 and 5A in Apalachicola Bay during the spring (1974). Each point represents a mean of the number of species taken in each sub-sample over the period of collection.

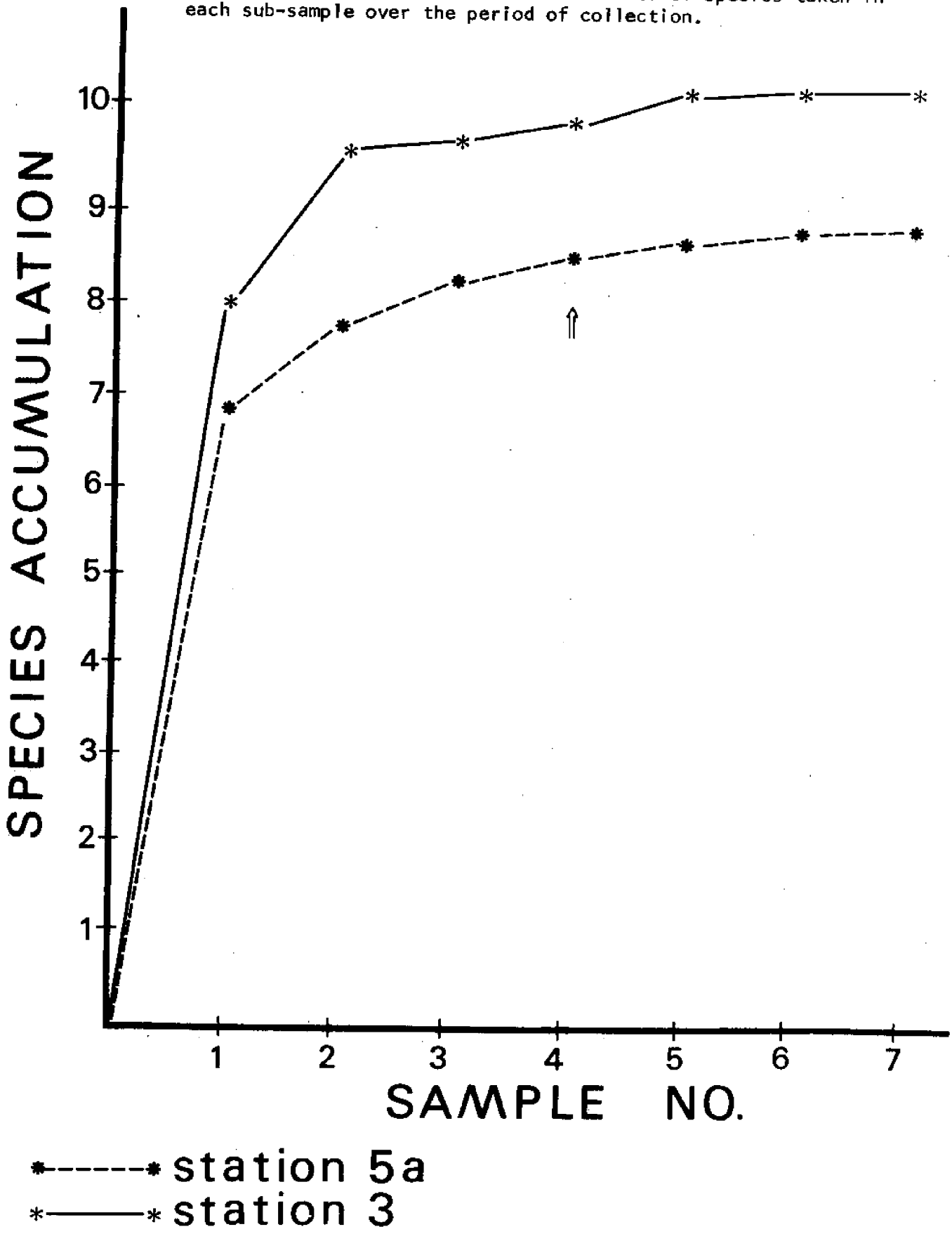
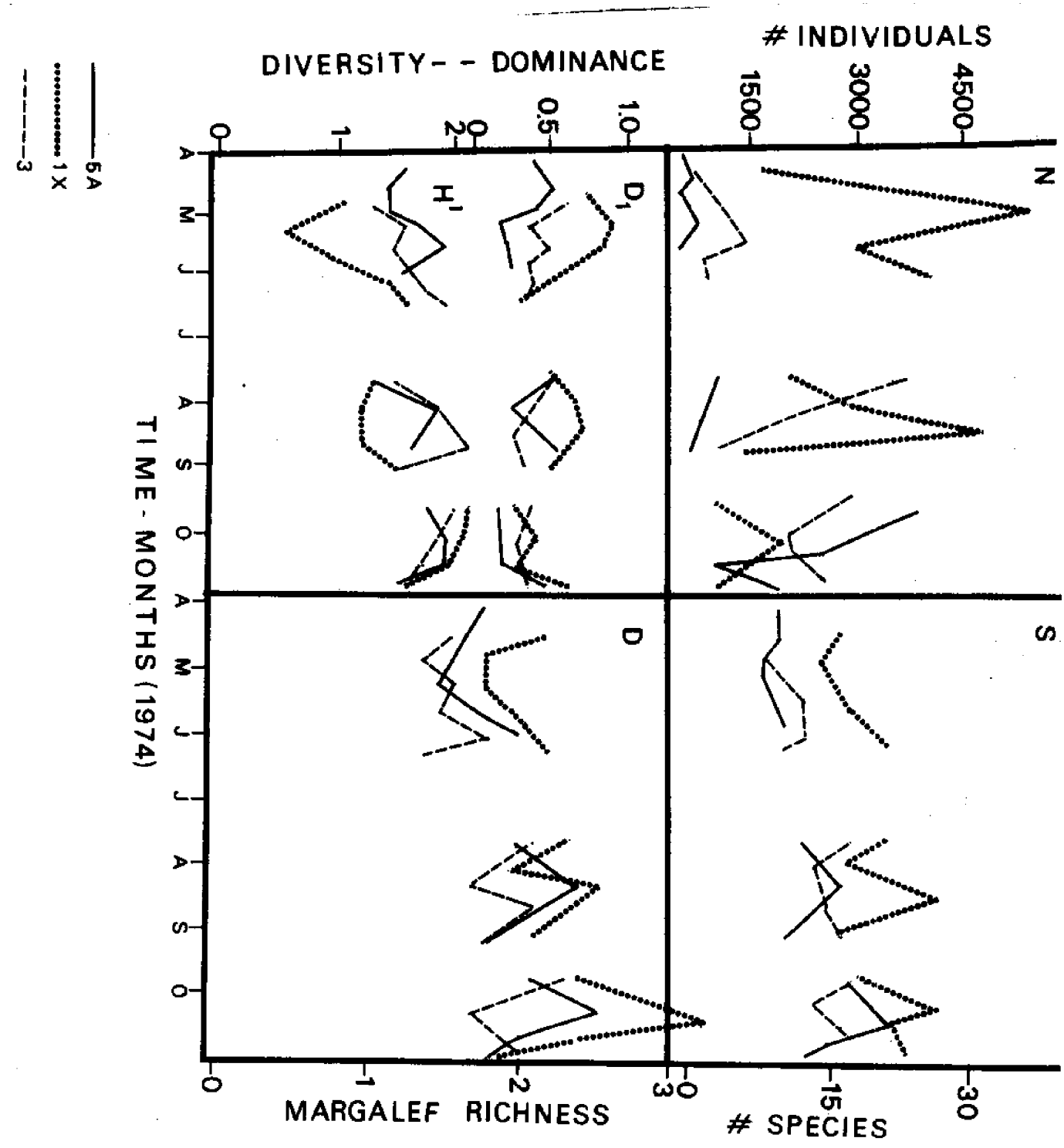


Figure 4: Total number of individuals (N), species (S), relative dominance (D) Shannon-Weaver diversity (H') and Margalef richness of leaf litter invertebrates taken at 3 sampling sites in Apalachicola Bay during 1974.



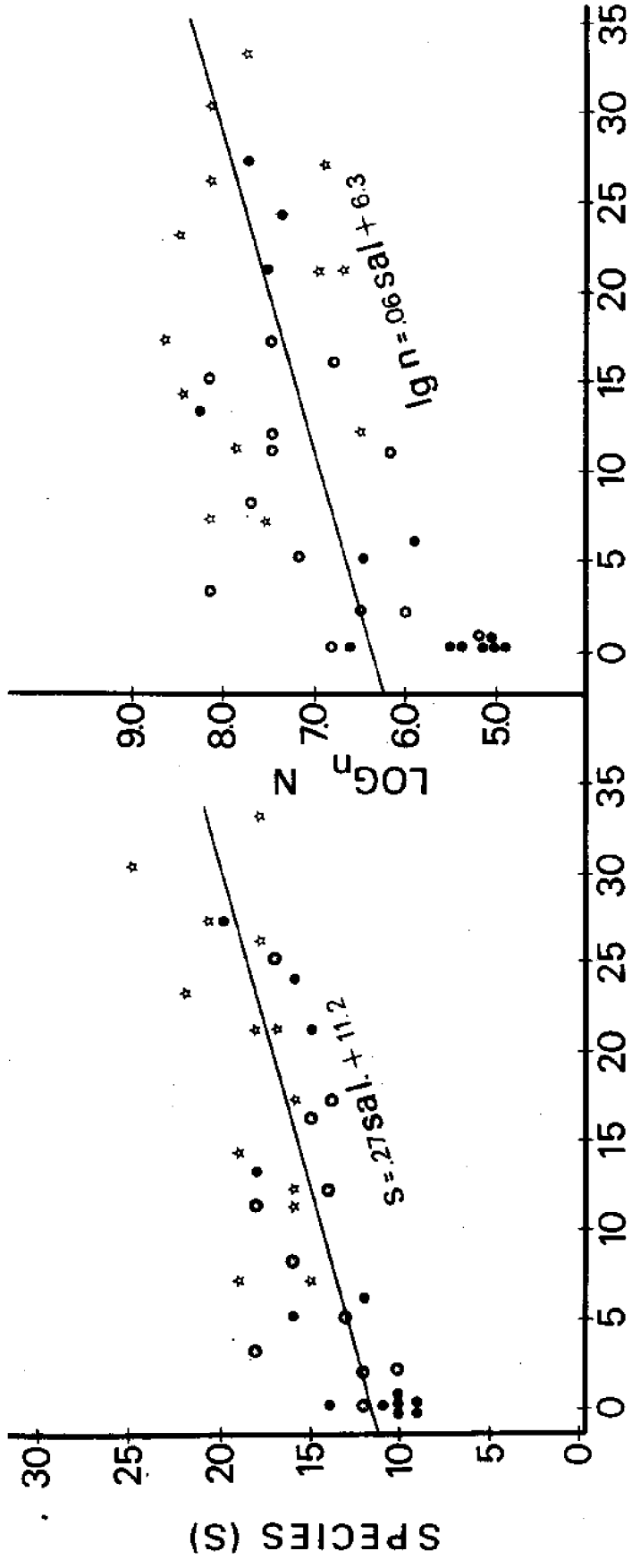


Figure 5: Regressions of numbers of species (S) and number of individuals ($\log_e N$) of leaf litter invertebrates with salinity for data taken at 3 stations in Apalachicola Bay.

IX. Benthic infauna

An investigation was made concerning the benthic infauna in the Apalachicola Estuary. Benthic macroinvertebrates are considered good indicators of water quality due in part to their limited motility. Portions of East Bay and Apalachicola Bay were sampled to determine seasonal changes and spatial relationships of biomass, species composition, and community structure.

Methods and Materials

Permanent stations were chosen in established areas of study (Fig. 1; 1, 1x, 3, 4, 4A, 5A, 5B, 6). A hand operated corer (d. 7.7 cm) was used and 10 subsamples were taken monthly to depths of 15 cm at each station (1, 1x, 3, 6; from March, 1975 to February, 1976: 4, 4A, 5A, 5B; from February, 1975 to the present). All samples were washed through a 0.5mm screen and fixed in 10% formalin. Rose bengal was added at a concentration of 200mg/l (Mason and Yevich, 1967). Animals were rough sorted and placed in 40% isopropyl alcohol, identified to species, and counted. Biomass (ash-free dry weight) was determined by oven drying each sample at 100°C for 12 hours. After weighing the sample, it was heated at 500°C for four hours. Standard determinations for each species were made using 100-200 individuals for computations of mean dry weight/individual. This was then used for all conversions to biomass.

Station descriptions, methods, results of physico-chemical sampling, and other supportive data appear elsewhere in this report.

Results and Discussion

A list of species taken is presented in Table 1. The 11 most abundant species are described below:

Leptochelia rapax (Crustacea, Tanaidaceans)

This crustacean was the most abundant invertebrate taken from infaunal samples in Apalachicola Bay. It was almost entirely restricted to the Halodule wrightii beds on the inner side of St. George Island where it builds tubes on the substrate or attached to seagrass blades. In this area, the salinity ranged from 6.3 - 26.8°/oo and the water temperature ranged from 11.5 - 32.5°C. Peak abundances were noted in the spring (February - April) with lowest numbers found in September. Tanaidaceans in general are hermaphroditic (Barnes, 1968); ovigerous females were noted throughout the year, being most abundant in the spring, as were individuals showing male characteristics. Leptochelia apparently feeds on fine detrital matter, sand, and benthic diatoms, and is preyed upon by small carnivorous fishes (Odum and Heald, 1972).

Grandidierella bonnieroides (Crustacea, Amphipoda)

This species was the second most abundant organism taken in the core samples. It ranges from the Halodule beds on the inner side of St. George Island up into the freshwater areas of East Bay, where it was most abundant. It was found in salinities of 0 - 26.8°/oo and water temperatures of 6.0 - 32.5°C. Abundance peaks were noted in early spring (March) and late summer (August), with lowest numbers during early summer (May) and intermediate abundances in winter months. Ovigerous females were collected from November through April. Grandidierella feeds upon very fine detrital matter and is in turn con-

sumed by small carnivorous fishes (Odum and Heald, 1972).

Heteromastus filiformis (Polychaeta, Sedentaria)

This polychaete ranked third in the bay in terms of overall abundance of numbers even though it was largely restricted to grass beds (dominated by Halodule wrightii) just inside St. George Island (1X). Peak abundance was noted in April with low numbers taken during October and November, corroborating the findings of Santon and Simon (1974). This species was collected over a range of salinities from 6.3 - 26.8°/oo and temperatures from 11.5 - 32.5°C.

Mediomastus californiensis (Polychaeta, Sedentaria)

As the fourth most prevalent species of infauna, this polychaete inhabits fine mud bottoms throughout the bay, ranging in length from 20 - 40 mm. It occurred in salinities from 0 - 18.8°/oo and temperatures from 6 - 31°C. Peak abundance occurred in March with lows in the summer (July - August).

Ampelisca vadorum (Crustacea, Amphipoda)

Ampelisca vadorum was the fifth most abundant organism collected. It was almost entirely restricted to the St. George Island grass flats, where it builds weak tubes on (or slightly within) the substrate. This crustacean was found to be nocturnally active. It was found at salinities of 6.3 - 26.8°/oo and water temperatures of 11.5 - 32.5°C. Peak abundance was noted in the spring (February) with a minor peak in early fall (October). Ovigerous females were noted in all months of the year (except August), with a peak in February. This organism is probably omnivorous, feeding mainly on detrital particles: it is preyed upon by small carnivorous and (at night) planktivorous fishes.

Streblospio benedicti (Polychaeta, Sedentaria)

This species of polychaete was the sixth most abundant form of benthic infauna in the bay. This worm utilizes a variety of habitats in the Apalachicola Bay System including Halodule beds on the bay side of St. George Island and fine mud flats in East Bay. Ranging from 10 - 20mm in length, this species secretes a thin membranous tube in salinities from 0 - 26.5°/oo and temperatures from 6 - 32°C.

Amphicteis gunneri floridus (Polychaeta, Sedentaria)

As the seventh most abundant form of benthic invertebrate in the Apalachicola estuary, this polychaete is found throughout the bay from the grassbeds of St. George Island to oligohaline mud flats in East Bay. It was found in salinities ranging from 0 - 26.8°/oo and temperatures from 6 - 32.5°C, peak abundance was noted in September with low numbers observed in the summer (May - August).

Oligochaete sp. 2

This unidentified oligochaete was found to be the eighth most abundant form of infauna in the Bay. This organism was restricted to a Halodule bed on the inside of St. George Island. It ranges from 20 - 40 mm in length. Salinity varies in this area from 6.3 - 26.8°/oo and temperatures range from 11.5 - 32.5°C. Peak numbers occurred in winter and early spring with low numbers in August and September.

Aricidea fragilis (Polychaeta, Sedentaria)

This polychaete species was the ninth most prevalent form of benthic infauna and was largely restricted to the St. George Island Halodule grass beds. It ranges from 10 - 20 mm in length and was found in salinities from 6.3 - 26.8°/oo and temperatures from 11.5 - 32.5°C. Peak numbers occurred in April with low numbers taken during the fall (September - October).

Dicrontendipes sp. (Insecta, Diptera)

Dicrontendipes was the tenth most abundant species collected. It was mainly found in oligohaline marsh embayments in East Bay in salinities of 0 - 10°/oo and temperatures of 6 - 31°C. Peak abundance was noted in late fall and winter (November - February). Chironomid larvae are generally herbivorous, feeding upon submerged plants, algae, and detritus, and being consumed by predatory invertebrates and fishes (Odum and Heald, 1972).

Cerapus sp. (Crustacea, Amphipoda)

Cerapus sp., apparently an undescribed species (E.L. Bousfield, pers. comm.), was the eleventh most abundant organism collected. Cerapus builds tubes attached to the substrate and often forms large colonies. It is also known to detach a small portion of the tube and enter the plankton of Apalachicola Bay (H. Lee Edmiston, pers. comm.). It was mainly found in riverine and oligohaline marsh embayments in East Bay at salinities of 0 - 10°/oo and temperatures of 10 - 30°C. Peak abundances were noted in late spring and summer months. Ovigerous females were noted in May through July. Although its food habits are unknown, Cerapus sp. may utilize its long antennae, which are abundantly covered by setae, either to filter the water column or scrape the surface of the substrate. Both small carnivorous fishes (Gobiosoma bosci) and planktivorous fishes (Anchoa mitchilli) are known to feed upon Cerapus in Apalachicola Bay.

In general the polychaetes mentioned above were eurythermal and euryhaline species, and were composed largely of selective and non-selective deposit feeders. These species are usually preyed upon by predacious polychaetes, crustaceans, and benthic fishes.

Biomass figures are shown in Table 2. Large transients (i.e., Callinectes, Penaeus, Rhithropanopeus) were excluded from this analysis since they were sampled elsewhere and were not considered a part of the infaunal assemblage. Biomass was highest at stations 1X, 5A, and 3. In all portions of the Bay, biomass of the infauna peaked during winter and spring months. A more detailed analysis of these data will be developed in the analysis of the impact of clearcutting practices in Tate's Hell Swamp on the estuarine system.

Table 1: Invertebrates taken in cores, leaf-basket samples, and dredge-nets in the Apalachicola Bay System (1975-1977)

Mollusca
- Pelecypoda
  - Tagelus plebeius
  - Amygdalum papyria
  - Ensis minor
  - Tellina texana
  - Dosinia elegans
  - Mulinia lateralis
  - Rangia cuneata
  - Crassostrea virginica
  - Pseudocyrena floridana
  - Mactra fragilis
  - Macoma mitchelli
  - Spisula solidissima
  - Congeria leucophaeta
  - Abra aedualis
- Gastropoda
  - Odostomia laevigata
  - Odostomia bisuturalis
  - Mangelia sp.
  - Retusa canaliculata
  - Anachis avara
  - Littoridina sphinctostoma
  - Prunum apicinum
  - Mitrella lunata
  - Bittium varium
  - Neritina reclivata
  - Epitonium rupicola
  - Crepidula plana

Polychaeta
- Sedentaria
  - Amphicteis gunneri floridus
  - Polydora ligni
  - Streblospio benedicti
  - Paraprionospio pinnata
  - Mediomastus californiensis
  - Capitella capitata
  - Heteromastus filiformis
  - Capitellides jonesi
  - Prionospio heterobranchia
  - Arenicola cristata
  - Melinna maculata
  - Aricidea fragilis
  - Magelona polydentata
  - Diopatra cuprea
  - Fabricia sp.
  - Spiophanes bombyx
  - Onuphis sp.
- Errantia
  - Glycinde solitaria
  - Loandalia americana
  - Laeonereis culveri
  - Sigambra bassi
  - Neanthes succinea
  - Phyllodoce fragilis
  - Polyodontes lupina
  - Ancistrosyllis sp.
  - Haploscoloplos fragilis
  - Eteone heteropoda
  - Scoloplos rubra
  - Amphinome rostrata
  - Marphysa sanguinea
  - Podarke sp.

Oligochaeta
- sp. 1
- sp. 2

Arthropoda
- Branchiura
  - Argulus sp.

Table 1 continued

Mysidacea
- Taphromysis bowmani
- Bowmaniella dissimilis
- Mysidopsis bahia
- Taphromysis louisianae
- Mysidopsis bigelowi
- Mysidopsis almyra
- Mysidopsis sp. 4 & sp. 5

Cumacea
- sp. 1
- sp. 2
- sp. 3

Tanaidacea
- Leptochelia rapax
- Tanaid #2

Isopoda
- Sphaeroma quadridentatum
- Sphaeroma terebrans
- Cyathura polita
- Erichsonella filiformis
- Edotea montosa
- Xenanthura brevitelson
- Munna reynoldsi
- Cassidinidea ovalis

Amphipoda
- Gammarus mucronatus
- Gammarus n.sp. 1 (G. "macromucronatus")
- Gammarus n. sp. 2
- Melita appendiculata
- Melita nitida
- Melita n. sp. 1 (M. "elongata")
- Melita n. sp. 2 (M. "intermedia")
- Melita n. sp. 3 (M. "longisetosa")
- Cerapus n. sp.
- Corophium louisianum
- Batea catharinensis
- Grandidierella bonnieroides
- Ampelisca vadorum
- Ampelisca verrilli
- Carinobatea sp.
- Cymadusa compta
- Gitanopsis n. sp.
- Paracaprella tenuis
- Microsprotopus n. sp.
- Parametopella cypris
- Orchestia uhleri

Turbellaria
- sp. 1 (?)

Rhynchocoela
- sp. 1 (?)

Aschelminthes
- Nematode #1

Phoronida
- Phoronis architecta

Insecta (underlined if genus known)
- Anisopteran #1
- Anisopteran #2
- Caenis sp.
- Callibaetis sp.
- Ceratopogonid #1
- Chironomid #2
- Corixid #1
- Dicrontendipes sp.
- Dipteran #1 (non-aquatic)
- Nymphula sp.
- Zygopteran #1

Table 2: Biomass (ash-free dry wgt., G/M^2) of benthic infauna in the Apalachicola Estuary (excluding *Calinectes sapidus*, *Penaeus* spp., and *Rhithropanopeus*)

	STATIONS							
DATE	IX	1	3	4	4A	5A	5B	6
2/75				0.592	1.205	7.211		1.359
3/75	19.508	0.241	4.753	1.227	1.468	7.781		0.526
4/75	56.378	1.074	5.129	1.074	0.898	5.019		0.613
5/75	13.743	1.644	2.608	1.994	0.460	7.277	0.416	0.153
6/75	15.957	1.512	4.384	0.197	0.065	6.334	0.306	1.293
7/75	4.690	0.635	1.709	0.328	0.767	1.161	0.109	0.569
8/75	7.365	0.854	3.265	2.301	0.504	1.950	0.021	1.008
9/75	7.832	1.490	1.994	1.841	2.082	2.717	0.065	1.205
10/75	9.314	3.068	2.321	0.679	2.520	4.690	2.476	0.152
11/75	7.080	0.635	2.586	0.460	1.446	0.591	0.372	1.249
12/75	9.074	1.337	2.338	0.920	0.876	9.469	3.178	0.328
1/76	13.261	4.932	1.578	1.534	0.723	9.359	2.564	0.964
2/76	27.354	0.197	2.410	0.109	0.766	6.554	2.630	0.613
3/76				1.139	0.438	4.186	0.679	
4/76				2.783	0.153	2.411	0.742	
5/76				1.753	0.372	1.578	0.350	
6/76				1.424	0.175	0.591	0.043	
7/76				0.854	0.284	1.490	0.087	
8/76				0.394	3.441	1.885	0.175	
9/76				0.591	1.753	0.131	0.043	
12 month means								
	15.96	1.45	2.92	1.06	1.05	5.24	1.21	0.72

X. Grassbed (Vallisneria americana) Assemblages in East Bay

Although there is limited benthic macrophyte development in the Apalachicola Bay System relative to contiguous areas along the Gulf coast (Zimmerman, 1974; Zimmerman and Livingston, 1975, 1976; Livingston et al., 1976), various shallow areas of St. George Island and East Bay are characterized by macrophyte associations. A project was thus designed to determine the seasonal variation of Vallisneria beds in East Bay in terms of plant biomass and the associated assembages of organisms. In addition, sampling sites were placed in such a way to determine the potential effects of storm water runoff from the clear-cut areas in the Tate's Hell Swamp.

Methods and Materials

Macrophyte samples were taken in two grassbed areas (stations 4a and 4b; Fig. 1). These were dominated by Vallisneria americana. A detailed analysis of sampling criteria is given by Livingston et al. (1976). Samples were taken monthly from November, 1975 to October, 1976. Vegetation was sampled by haphazardly throwing 8 0.25m^2 hoops at each station and gathering all plant matter within each hoop. The plant matter was placed in plastic bags, and the samples were taken to the laboratory where they were washed, sorted to species, and identified. Collections were dried in ovens at 105°C for about 12 hours (until there was no further weight loss). Total (whole plant) dry weight for each species was determined and recorded by station, and data were entered into the computer files as biomass (dry weight)/m^2.

The species Vallisneria americana composed 99% (+) of the overall biomass. Consequently, an effort was made to estimate the productivity of this species from periodic standing crop measurements according to a

method developed by Westlake (1965). Vallisneria, as a perennial, dies off in the late fall of each year. Minimal biomass was determined by averaging the dry weight figures taken during the dormant period (i.e. the winter months) and subtracting this from (summer) biomass figures at each station. The confidence limits were broad due to extreme seasonal and spatial variability; maximal biomass for station 4a was calculated from June rather than September (which is when biomass peaks were actually observed).

Physico-chemical data were taken according to methods described earlier in this report. Sampling for grassbed organisms was carried out in identical fashion at stations 4a and 4b during the day and the succeeding night (about one hour after sunset). Six one-minute trawl tows (at speeds of about 1.5 knots) were made using a 32cm dredge net (D-net) (nylon bag: 1mm mesh) for benthic sampling and a 30cm plankton net (1mm mesh) for the surface biota. Sampling was carried out in such a way that the same volume of water ($15m^3/6$ samples) was sampled by each net. All organisms were preserved in 10% formalin in the field and later washed and transferred to 40% isopropyl alcohol in the laboratory. Samples were sorted, identified to species, measured, and counted. Data were entered in files of the interactive computer system (described by Livingston and Woodsum in this report), and biomass transformations were made according to previously described procedures.

Results and discussion

Measurements of biomass in the East Bay grassbeds are shown in Table 1 and Fig. 2. Differences in the spatial distribution of such macrophytes were responsible for some month to month variability as a result of the sampling methods used. It was estimated that some Vallisneria leaves had died by September and the generally high levels of biomass at this time were considered

an artifact of the sampling procedures. Consequently, biomass maxima for estimates of productivity were taken from the June data. Losses due to grazing were considered negligible and there was no observable leaf loss prior to August. There was some loss of female flowering parts prior to the summer maxima which could have made the productivity estimates somewhat conservative. This was probably counterbalanced by the presence of unremoved epiphytes, although few calcified epiphytes were observed throughout the period of sampling. The grassbeds at Station 4A showed higher biomass than those at Station 4B although the seasonal patterns were generally similar with low biomass occurring during winter and early spring months (December - April) and high biomass during the summer and early fall (June - October). Transition periods occurred in November and May with the first new growth noted in March. Leaves reached the surface by April, and leaf death was first sighted in August. Productivity figures (Table 2) were comparable in both study areas.

The top 10 species in terms of biomass are given in Table 3. As shown, the gastopod Neritina reclivata was a strong dominant in the area of study. Monthly biomass figures for the study areas are shown in Table 4. The figures at Stations 4A and 4B are comparable with generally higher figures at depth except during the period from May to July when peak values in surface collections were taken. Peak biomass figures were evident in both areas during spring (March-May) and late fall (November-December) periods. This roughly coincided with periods of transition in grassbed areas (i.e., growth and death) and probably reflected changes in habitat associated with shelter-seeking and feeding functions of the individual species.

These data have been analyzed in a report concerning the effects of clearcutting on the Bay system.

Table 1: Biomass (g/m^2) of macrophytes taken in East Bay. Values include root stocks and uncalcified epiphytes.

DATE	4A	4B
11/02/75	455.7	334.4
12/14/75	200.6	213.0
1/17/76	287.2	167.8
2/18/76	206.8	263.2
3/20/76	269.2	196.6
4/20/76	220.8	138.6
5/20/76	316.9	268.1
6/18/76	563.0	354.9
7/17/76	358.4	568.4
8/14/76	538.8	365.6
9/11/76	585.1	489.8
10/10/76	486.9	438.7
Total	4,489.4	3,799.1
Mean/month	374.1	316.6

Table 2: Estimated productivity of Vallisneria beds in East Bay. Data were taken from November, 1975 through October, 1976.

	Round Bay (4a)	West Bayou (4b)
Max. summer biomass:	563 g/m^2 (June) 95% Confidence interval: ± 122	568 g/m^2 (July) ± 121
Mean winter biomass:	241 g/m^2 (Dec. - Mar.) 95% Confidence interval: ± 122	215 g/m^2 (Dec. - Feb.) ± 54 new growth occurred in Mar @ 4B
Change in biomass or Max. cumulative net production:	322 g/m^2	353 g/m^2
Productivity:	322 g/m^2/yr.	353 g/m^2/yr.

Table 3: Top dominants (fishes and invertebrates) at Stations 4a and 4b (East Bay) in terms of biomass (dry weight) taken over the 12 month sampling period (November, 1975 - October, 1976)

Species	Percentage of total
Neritina reclivata	95.67
Callinectes sapidus	0.79
Palaemonetes pugio	0.73
Menidia beryllina	0.43
Syngnathus scovelli	0.43
Zygoptera sp.	0.41
Lucania parva	0.26
Taphromysis bowmanni	0.24
Gammarus macromucronatus	0.18
Odostromia sp.	0.11

Table 4: Biomass (g, dry weight) of fishes and invertebrates taken in Vallisneria beds in East Bay at night from November, 1975 to October, 1976:

A. Total Biomass/15 m^3

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
4A(Bottom)	197.99	103.79	4.75	5.88	171.11	109.96	143.63	100.58	67.27	84.28	102.95	112.23
4A(Surface)	----	0.010	0.43	0.71	1.23	12.18	120.97	96.07	46.46	1.98	4.40	1.79
4B(Bottom)	373.56	133.79	3.57	7.14	141.46	201.51	195.16	83.97	35.68	124.43	95.40	47.43
4B(Surface)	----	.003	0.14	1.23	0.89	7.26	25.61	75.28	44.05	30.09	5.37	0.60

B. Biomass/m^2

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
4A(Bottom)	2.20	1.15	.0528	.0653	1.90	1.22	1.60	1.22	.747	.936	1.14	1.25
4B(Bottom)	4.15	1.49	.0397	.0793	1.57	2.44	2.17	0.933	0.396	1.38	1.06	0.527

XI. ASSOCIATIONS OF EPIBENTHIC FISHES AND INVERTEBRATES*

Introduction

This analysis will include 5 years of information concerning long-term fluctuations of epibenthic assemblages in the Apalachicola Estuary. Portions of this report have been statistically analyzed and cover the first 4 years of sampling (March, 1972 - February, 1977). Data analysis includes trends in the movement of organochlorine compounds through the system during first 3 years of study.

Laboratory effects of organochlorine compounds such as DDT and the polychlorinated biphenyls (PCB's) on aquatic organisms have been well documented (Johnson, 1968; Walsh, 1972; Livingston, 1976). Such chemicals are noted for environmental persistence, a capacity for bioaccumulation and biomagnification, and species-specific patterns of acute toxicity. While earlier work stressed the ubiquitous nature of organochlorine residues in aquatic biota (Butler, 1969), more recent work (Butler, 1973; Johnston, 1974) noted declines in DDT residues during the early 1970's which were attributed to the total ban of DDT use in the U.S. by the end of 1972. This was accomplished by serious restriction of PCB use during the same period (Nesbit and Sarofim, 1972).

In addition to marked variations of pesticide occurrence from one estuarine system to the next (Butler, 1973), seasonal variation in residue peaks in estuaries can be considered due to temporal patterns of pesticide application (Bradshaw et al., 1972; Butler, 1973), rainfall (Richard et al.,

*Portions of this section of the report are included in a paper currently in review for publication in Marine Biology. The authorship of this paper is as follows: R.J. Livingston, N.P. Thompson, and D.A. Meeter.

1975), stream discharge (Bradshaw et al., 1972), and degradation functions (Brodtmann, 1976). This would indicate that the type and level of pesticide residues in a given estuary depend on various factors such as agricultural activity, regional rainfall and drainage characteristics, soil composition, movement of particulates, and metabolic activity. Although long-term fluctuations of estuarine biota have been described in various coastal systems (Dahlberg and Odum, 1970; McErlean et al., 1973; Oviatt and Nixon, 1973; Haedrich and Haedrich, 1974; Livingston, 1975, 1976; Livingston et al., 1976) and the importance of the steady (oscillatory) state to impact analysis has been considered (Duke and Dumas, 1974; Livingston et al., 1976), there are suprisingly few data concerning the actual effects of organochlorine compounds at the systems level. Field analyses of the acute impact of dieldrin (Harrington and Bidlingmayer, 1958) and DDT (Croker and Wilson, 1970) on salt marsh assemblages are available. Reimold (1974) and Reimold et al., (1974) described temporal changes in estuarine assemblages as a function of reduced toxaphene contamination in a Georgia (U.S.A.) system. However, the direct reaction of an estuarine system to organochlorine stress remains largely undocumented.

There is a growing data base regarding biotic interactions in the Apalachicola Estuary (Livingston, 1974, 1976b; Livingston et al., 1974a, 1976, 1977). In addition, various short-term pesticide analyses indicated moderately high levels of organochlorine contamination in this system prior to 1973 (Breidenbach et al., 1967; Henderson et al., 1971; Giam et al., 1972; Butler, 1973). This portion of the report will describe recent changes in the organochlorine burden in the Apalachicola Drainage System, and will present data concerning long-term trends of the epibenthic assemblages in the Apalachicola estuary.

Materials and Methods

Field Procedures

Surface and bottom water samples were taken monthly at fixed stations in the Apalachicola Estuary (Fig. 1) with a 1 liter Kemmerer bottle. Dissolved oxygen and temperature were measured with a Y.S.I. dissolved oxygen meter. Salinity was taken with a temperature-compensated refractometer calibrated periodically with standard sea water. River flow data taken at Blountstown, Florida were provided by the U.S. Army Corps of Engineers (Mobile, Alabama) while local rainfall data were taken by the National Oceanic and Atmospheric Administration (Environmental Data Service, Apalachicola, Florida). Turbidity (Jackson Turbidity units) was determined using a Hach Model 2100-A turbidimeter, and water color was measured by a platinum-cobalt standard test. Light penetration was estimated with a standard Secchi disk. Data concerning chlorophyll A, orthophosphate (inorganic, soluble, reactive), nitrite, nitrate, and silicate were provided by Dr. Richard Iverson (Department of Oceanography, Florida State University); these parameters were measured according to standard procedures (Livingston et al., 1974).

Biological sampling was carried out in the bay at fixed stations (Fig. 1) with 5-m (16 foot) otter trawls (1.9 cm mesh wing and body; 0.6 cm mesh liner) towed at speeds of 2.0-2.5 knots. The determination of station placement and sampling procedures has been described by Livingston (1974, 1975, 1976). Station placement was determined by visual (diving) examination. Much of the study area consisted of shallow mud flat habitats with Station 6 characterized by seasonally heavy concentrations of benthic macrophytes dominated by Ruppia maritina. Day and night samples were taken at monthly intervals from March, 1972 to May, 1974. Only day samples were taken there-

after. Complete data were not taken during 3 summer months of 1974. All collections were preserved in 10% formalin and identified to species. Analysis was carried out on composite samples including Stations 1, 5, and 6, and 2 (2-minute) tows taken at Stations 1A, 1B, 1C, 2, 3, 4, and 5A. Varying combinations of stations and time periods were used for calculations which generally were performed on composite data at monthly intervals.

Pesticide Residue Analysis

Animal samples from Lake Seminole (Fig. 1) were taken for pesticide determinations by the use of bag seines and hook-and-line fishing. Multiple samples were taken with otter trawls from the various stations in the Apalachicola Bay System. All samples were immediately wrapped in aluminum foil and frozen with dry ice in the field; such samples were kept frozen until analysis. Clam (Rangia cuneata), shrimp, and (small) fish samples were usually pooled composites of 3-6 individual organisms. Sediment samples were taken at various stations with a small coring device (7.2 cm d); the top 10 cm were placed in aluminum foil and frozen for analysis.

Samples were prepared as described by Thompson et al. (1974). Animal samples were dissected, weighed, and ground in sodium sulfate. Samples of very small fish included the entire fish; larger fish samples consisted of the dorsal muscle. Clam samples included the entire body except the shell. Crab samples consisted of the muscle base of the last pair of walking legs and the hepatopancreas. Total sample size was usually less than or equal to 25 grams. Sediment samples were dried under a hood for two days and 50 gram portions were analyzed.

The samples were extracted for six hours with 200 ml of petroleum ether in a Soxhlet apparatus. If the weight of the sample was greater

than 10 grams, the extract was then divided into the two equal portions; one to analyze for various organochlorine compounds, the second to check for Mirex. The extract was poured into a 250 ml beaker and evaporated to dryness under a hood. After evaporation, the beakers were weighed and 50 mls of hexane saturated with acetonitrile were added to the sample residue. This was transferred to a 250 ml separatory funnel and 50 mls of acetonitrile saturated with hexane was added. After shaking, the acetonitrile layer was drained, and the hexane layer was washed 3 times with 50 ml acetonitrile. The hexane portion was discarded and the combined acetonitrile washings were evaporated to dryness under a hood. The residue beaker was reweighed; the difference was recorded as lipid weight. Sediment samples were placed on Florisil directly after extraction eliminating the acetonitrile partitioning.

Further residue cleanup was accomplsihed by quantitatively transferring the sample with 30 ml of hexane to a column (22 x 180 mm) of 7% water deactivated Florisil and eluting the columns with 200 ml of hexane: benzene (3:1) solution. The eluate was then concentrated to 0.5 ml and analyzed by electron capture gas chromatography. A Varian 2400 gas chromatograph with 6' x 1/4" glass column of 1.5%) V-17 + 101 was used for confirmation. Operations parameters for the gas chromatograph were: injections port temperature 210°C; column temperature 198°C; detector temperature 250°C; and a N_2 carrier gas flow rate of 60 ml/min. While the presence of polychlorinated biphenyls interferred with the quantification of pesticides, a further separation was made on a silica gel column. The sample was placed on a column (10 x 70 mm) of Grace-Davidson grade 950 silica gel (60-200 mesh) and eluted with 70 mls of pentane and 50 mls of benzene. These eluates were collected separately, concentrated and injected as above, with the eluates

being analyzed separately, the pentane portion for chlorinated hydrocarbons. Silica gel separations were not attempted on samples where the maximum possible DDD concentrations was less than 0.005 ppm.

After the sample was extracted and divided, the Mirex portion was evaporated to dryness and eluted with 50 ml of hexane on a column of activated Florisil (12 x 100 mm). The eluate was concentrated to 0.5 ml and injected on the gas chromatograph.

Statistical Methods

In all computations, numbers of individuals (N), dry weight biomass (B), and number of species (S) were used. Various indices were determined from the invertebrate and fish data. These included the Margalef Index (MA) (Margalef, 1958), the Simpson Index (SI) (Simpson, 1949), and the Shannon Index (H') (Shannon and Weaver, 1963; Pielou, 1966 a, b, 1967, 1969). Relative dominance (D_T) was determined by dividing the number of individuals of the single most dominant species by the total number of individuals (McNaughton, 1968; Berger and Parker, 1970). The rationale for the use of these indices has been developed elsewhere (Livingston, 1975, 1976) and will not be detailed here. The measure of affinity (Matusita, 1955; van Belle and Ahmad, 1973) was used for the cluster analysis with a locally modified version of a program furnished by Dr. D.F. Boesch. All other statistical calculations were run with programs taken from the Statistical Package for the Social Sciences (S.P.S.S., 1975) and Biomedical Computer Program (B.M.D., 1973).

Results

Physico-chemical Functions

The physico-chemical data appear in full in another portion of this report. A brief summary of these parameters is presented here. Data indicate

that the Apalachicola Bay System is a shallow barrier island estuary dominated physically by the Apalachicola River which has a highly variable discharge (Fig. 2). During the first four years of the study period, river flow usually peaked from January to April at which time the range of extreme diurnal flows was usually maximal. The range and mean flow reached low levels during late summer and fall. This pattern was usually out of phase with local rainfall which often peaked during the summer and early fall. There was considerable annual variation of river flow with relatively low levels during the first and third years of sampling. During the winter and spring of 1973, there was especially pronounced river flow and flooding throughout the Apalachicola Valley.

Water temperature (Fig. 2) followed seasonal patterns with no substantial variation from year to year. At any given time, there was usually little vertical or horizontal variation in water temperature throughout the bay system (Livingston et al., 1977). River flow generally influenced other environmental parameters. Increased flow caused increased water color, turbidity, detritus, and nutrients. Generally, this is a highly turbid bay with considerable oyster bar development and relatively little benthic macrophyte productivity except in shallow (fringing) areas. Tides in the Apalachicola Estuary are semi-diurnal (mixed, unsymmetrical) with a small tidal range (up to 1 m). Winds in the area follow no clear directional trend although during fall and winter there is a northerly flow which becomes southerly during the rest of the year (Dawson, 1955).

Statistical analysis of the physico-chemical data taken over the 4-year study period included simple linear regression and correlation for distribution with time. Significant changes in the regressions (original and $\log_e$ units)

were found for salinity (B = -0.26, p <0.02), rainfall (B = + 0.09, p <0.01), nitrate (B = -2.1 p <0.004), and turbidity (B = -0.63, p <0.04). The results of a 2-way (month x year) analysis of variance of these data are shown in Table 1. Since in a 2-way analysis with one observation per cell, the mean square is of necessity used as an error term, the occurrence of annually high significance levels probably indicates that considerable interaction exists. There was significant (p <.05) annual variation of river flow although no trend was apparent during the study period. There were reductions in salinity, turbidity, and nitrate in the Apalachicola system with time. The results of a factor analysis (Table 2) indicate that high river flow is usually associated with increased color and turbidity and reduced Secchi readings, and low levels of salinity, temperature, and chlorophyll A. This is consistent with the known seasonal pattern of these factors, and indicates the important influence of the Apalachicola River on the physical environment of the Apalachicola Estuary. While the river dominates the seasonal fluctuations of parameters such as salinity, long-term changes in the overall salinity of the bay appear to be related to other functions such as local rainfall and runoff. This would indicate that causation reflects multiple interactions thus allowing apparently contradictory results in the short- versus long-term trends (e.g., turbidity and salinity relationships).

Pesticide Analysis

Organochlorine residues in sediments taken from the Apalachicola Drainage Area are presented in Table 3. Generally low values were found for DDT-R and Arochlor 1254 while other pesticides were not detected. Due to these results, sediment analysis was discontinued after October, 1973. There were moderate levels of organochlorine compounds (DDT-R and PCB's) in organisms taken

above and below the impoundment behind the Woodruff Dam (Table 4); these levels were not dependent on station placement (above or below the dam) or the passage of time from 1972 to 1974.

Mean organochlorine resides in various species taken in the Apalachicola Estuary from March 1972 to November, 1974 are shown in Table 5. Graphical representations of monthly maxima of organochlorine residues for selected species are shown in Figs. 3 and 4. The results of an analysis of variance of the station-specific distribution of organochlorine residues in the Bay showed no significant spatial relationship in the occurrence of such compounds in estuarine organisms. Therefore, station locations were not given in the final data presentation. The temporal patterns of DDT occurrence were correlated with PCB distributions,with generally increased residues during winter and early spring months. Such increases coincided with river flooding. During the sampling period, there was a marked reduction of organochlorine residues for all species, with relatively low levels found subsequent to the first year of analysis. This overall decrease appeared to be timed in a general way with the reduced use of the organochlorine compounds although river flow patterns appeared to be related to both seasonal and annual variations of the residues. The two-way Anova results (Table 1) confirm a significant decrease in DDT-R and PCB residues in R. cuneata after the first year of sampling.

A comparison of changes of relative percentages of the DDT metabolites with time in Rangia cuneata and the sciaenid fishes is shown in Figs. 4A and 4B. During the study period, there was a general decline in the relative level of DDT and DDD while the DDE percentages increased. This indicates that relatively little new DDT entered the bay system during the period of

study. This is consistent with the marked decline of organochlorine residues after the first year of monitoring. The long-term trends of organochlorine residues in the Apalachicola Estuary thus reflect reduced upland usage and flushing patterns which may have been related to the major river flooding during the winter and spring of 1973.

Biological Parameters

Analysis of the composite collections is shown in Figs. 5 and 6. There was a general increase in the invertebrate Shannon index with time. There were also increased numbers of invertebrates (N) during the final 18 months of sampling and slight increases with time in the number of species and the Margalef index. After the first 6 months, there was a gradual decrease in the relative dominance with time. Although these trends appear to be real, there was no statistically significant variation from year to year (Table 1); this was possibly due to the aforementioned use of the year-month interaction as an error term.

The fishes (Fig. 6) showed a similar though more pronounced pattern of changes during the study. During the first year of sampling, all indices were relatively low while relative dominance was high. After a further decrease which coincided with the increased river flooding during the winter and spring of 1973, there was an increase in the number of species, Margalef Index, and Shannon diversity. The relative dominance was inversely related to the diversity index. The six-month mean values for all indices tended to stabilize by the winter of 1974. Further analysis of these data (Table 1) indicated that increased $N\text{-}N_1$ and Shannon diversity and decreased relative dominance with time were statistically significant on an annual basis. Except for Shannon diversity, monthly variations were not significantly

different. In general, most of the indices representing the first year of sampling (1972-73) were divergent from subsequent results. Such differences coincided in time with the precipitous decrease in organochlorine residues and relatively high levels of dissolved nutrients and chlorophyll A.

Species Composition

Changes in the species compositon of fishes taken at night at Stations 1 and 4 in the Apalachicola Estuary are shown in Fig. 7. During the first year of sampling, Anchoa mitchilli was a major dominant, and accounted for a considerable proportion of the total numbers of fish taken. By the second year of sampling, this dominance was largely reduced to the months of October and November. A succession of dominant species became apparent, Anchoa in the late fall, Micropogon in the winter and spring, and Cynoscion in the summer. With the exception of June, July, and August, the number of species taken per month was generally higher during the second year of sampling. These data explain the distribution of relative dominance and diversity. During the first year, there was a general trend toward increased dominance (and consequently, reduced diversity) when compared to the second year. There was an increase in numbers of individuals in species other than the dominant during the second year of sampling. The nocturnal distribution of trawl-susceptible fishes in the Apalachicola Estuary thus follows a clear pattern of time-dependent changes in relative abundance and temporal species succession which are consistent with previous analysis at the community level.

These results are further explained by long-term population variations of the numerically dominant fish species (Fig. 8). During 9 of the first 12 months of sampling (1972-73), Anchoa mitchilli was the dominant species,

while maximal river flooding (winter and spring, 1973) coincided with the preeminence of Micropogon undulatus. Starting in the summer of 1973, a consistent pattern emerged whereby there was a regular (temporal) succession of dominants. During the fall months, Anchoa was the top species with lesser peaks occurring during the spring and summer. In winter and early spring months, Micropogon undulatus and Leiostomus xanthurus were dominant followed by Cynoscion arenarius in the summer and early fall. Other species such as Harengula pensacolae and Brevoortia patronus were dominant during the spring of each year. Although there were usally minor variations in this sequence from year to year, the general pattern prevailed subsequent to the spring and summer of 1973. The total number of species taken the first year was less than the following 3 years. Although more fish were taken during the first year, when the top dominants were removed from analysis, there was a substantial increase in the numbers of fishes taken during the succeeding 3 years of sampling. These data are consistent with the night collections, and provide a qualitiative basis for the observed patterns of temporal fluctuations of the community indices.

A cluster analysis was used to determine the species groups which tended to co-occur in time during the sampling period. The 48 monthly totals of absolute abundance of each fish species were used to cluster species which tended to co-occur during the 4 years of sampling. The similarity coefficient

$$p(F_1, F_2) = \int f_1(x)\, f_2(x)^{\frac{1}{2}}\, du(x);$$

(Matusita, 1955; van Belle ad Ahmed, 1973) was used in conjunction with the flexible grouping cluster strategy ($\beta = -0.25$). The use of this procedure has been described elsewhere (Sneath and Sokal, 1973; Boesch, 1973). The

results of this analysis (using the top 45 species taken during the survey) are shown in Fig. 9. As might be expected, the key clusters were centered around particular dominant species. Based on relative abundance, five such groups were chosen for further analysis. Associations were determined somewhat arbitrarily on the closeness of fit. By using clusters of species instead of individual populations in our statistical analysis, the annual variability of population abundance tended to be smoothed from one year to the next. Of these groups, none showed a statistically significant change in a linear regression with time. However, there were significant variations based on annual fluctuations as shown in Table 1. The Anchoa group was particularly abundant during the first year of sampling and was largely absent during the second year whereas the Micropogon group prevailed to a considerable degree during the second year of sampling. There was a steady increase in the predominance of the Gobiosoma group;this was especially pronounced during the fourth year of sampling. In general, the relative dominance of the major clusters of fishes in the Apalachicola Estuary appeared to be consistent with a change in conditions subsequent to the second year of study.

The results of stepwise regressions run with various combinations of variables (listed in Table 1) are given in Table 6. Due to the fact that nutrients, chlorophyll A, and organochlorine residues were not sampled for the entire 48-month study period, three difference sets of regression data are presented. The DDP (dummy) variable was set up to provide a contrast between the first year of relatively high levels of organochlorine residues (+1) and the subsequent two years of low residue (0). Dummy variables for months of the year were provided to determine temporal relationships. Overall,

with minor discrepancies, the results of the three data sets were consistent. Numbers of species and individuals generally peaked during October or November. The relative dominance and Shannon diversity were inversely related to the DDP variable with increases in both functions occurring during late summer and fall periods. In addition, the Simpson Index (Livingston, 1976) was computed with similar results. The Margalef Richness Index was associated with tidal characteristics, and was high during periods of low river flow. The results with the various fish clusters were largely consistent with the previous analysis. The Anchoa group , dominant during fall periods, was associated with DDT residues in the bay. Three of the four remaining clusters showed strong associations with river flow thus confirming the importance of this parameter to the estuarine fishes. The use of stepwise regression is not without problems. The relatively large number of variables increases the potential for obtaining significance, thereby tending to affirm postulated associations. Such analysis should thus be viewed within the context of the study as a whole.

Long-term Fluctuations of Individual Populations

The total numbers and biomass (dry weight) of epibenthic invertebrates taken at stations in the Apalachicola Estuary are given in Figs. 10 and 11 and Tables 8 and 9. Although there were some differences in peak values between numbers and biomass figures, peak placement was similar in both. There was a general pattern of increased numbers and biomass of invertebrates during spring (February - May) and fall (Septemter - November) periods. In terms of numbers, there was no long-term trend although the lowest cumulative figures occurred during the third and fourth years of sampling (3/74 - 2/76). Spring peaks were generally due to Palaemonetes pugio and Callinectes sapidus

while fall periods were characterized by penaeid shrimp (largely Penaeus setiferus) and Callinectes sapidus. In terms of biomass, blue crabs and white shrimp were by far the most significant species in the bay. There was a longterm downward trend in the invertebrate biomass figures due to the relatively high biomass figures during the first two years of sampling. The third year of sampling (3/74 - 2/75) was a low point in total biomass of invertebrates in the Bay. This was followed by increases in the 2 succeeding years. This was due to relative declines in most of the species normally caught in the area.

Monthly variations of numbers (A) and biomass (B) of the top 9 species of epibenthic invertebrates are given in Figs. 12 -19. The reductions during 1974 and 1975 are reflected in the figures of penaeid shirmp and blue crabs (Figs. 12 and 13). Varied patterns are evident, however which indicate reduced numbers during the river flooding of 1973 (Figs. 14, 15, 17, 15).

The total numbers and biomass (dry weight) of fishes taken at stations in the Apalachicola Estuary are shown in Figs. 20 and 21 and tables 10 and 11. Although the general trends were similar regarding numbers of individuals and biomass, there were some differences which in some instances related to species such as Dasyatis sabina and Lepisosteus osseus which tended to dominate biomass figures while being relatively insignificant in terms of numbers of individuals. Numbers tended to peak in spring and fall although this pattern showed some variation (as with biomass) where there would be a continuous series of peaks in spring, fall, and winter. This reflected patterns of individual populations which have been described above and are shown in Figs.22-31. Total number of fishes reached a low point in the third year of sampling (3/74 - 2/75) and, due to large numbers of Brevoortia patronus, Leiostomus xanthurus, Anchoa mitchilli, and Micropogon

undulatus, almost twice as many fishes were taken during the fifth year of sampling (3/76 - 2/77) than any of the previous years. As noted previously dominants (numbers) in this bay include Anchoa mitchilli, Micropogon undulatus, and Cynoscion arenarius.

These data are currently under review to determine the relationships of the individual population distributions with the various other parameters (physico-chemical, biological) which are available in this report.

Discussion

Various episodic sources of stress, natural and anthropogenic, occurred during the study. In June, 1972, Hurricane Agnes came ashore near the Apalachicola region with winds gusting to 55 knots and tides around 2 m above the norm. Routine dampling of the bay immediately after the storm revealed little overt change in the physico-chemical and biological functions of the Apalachicola Estuary although several fish species were taken which were not found in the bay before the hurricane. While such storms can cause mass mortalities of coastal organisms (Brongeersma-Sanders, 1957; Robins, 1957; Tabb and Jones, 1962), none was observed here. Also, the extreme flooding of the Apalachicola River in 1973 had an immediate effect on the bay fauna. This was particularly pronounced with respect to epibenthic invertebrate distributions. Such natural phenomena can influence long-term biotic trends in such areas. In addition, periodic maintenance dredging and spoil disposal in the vicinity of Stations 1 and 2 and clearcutting and draining activities in the Tate's Hell Swamp (above Stations 5 and 5A) could have been responsible for habitat changes which caused local trends in the biotic indices. The relative significance of clearcutting will be presented as a separate report.

Although the residue analysis in this study is consistent with known trends of organochlorine contamination in other areas with respect to seasonal

fluctuations (Smith and Cole, 1970; Bradshaw et al., 1972; Butler, 1973; Brodtmann, 1976) and long-term variation (Butler, 1973; Johnston, 1974; White, 1976), the relatively steep decline of such residues in the Apalachicola Estuary during 1973 could have been associated with the extreme river flooding during this period. Decreased upland use undoubtedly contributed to this phenomenon; this is corroborated by increased DDE:DDT ratios subsequent to the first year of sampling (Table 7); this could result from contined DDT without replenishment (MacGregor, 1974). The relatively low levels of organochlorine compounds found in sediments throughout the Apalachicola System could be associated with solubilization of such compounds by humates (Wershaw et a., 1969) and/or transport out of the immediate drainage system via suspended particulate matter. Peakall and Lincer (1970) showed that DDT and PCB compounds often undergo similar routes of dispersion with transport through riverine systems. This has been described as a function of solution and readsorption to particulate matter (Nisbet and Sarofin, 1972). Such accumulation of organochlorines by suspended matter (Wilson, 1976) together with detrital ingestion by certain estuarine organisms could account for the observed distribution of such compounds in the Apalachicola Estuary. Seasonal migratory movement of the juvenile populations out of the bay could contribute to the net transport of organochlorine compounds out of the system. The relatively rapid decline of such compounds in this instance is thus viewed as a function of the peculiar ecological characteristics of this river-dominated estuarine system.

Various statistical applications were used in this study to test environmental relationships in the Apalachicola Estuary beyond those already established by Livingston (1974, 1976) and Livingston et al., (1976, 1977).

The 2-way ANOVA tested the main effects of month and year using year-month interaction as an error term. This resulted in a conservative test so that significant main effect differences were not revealed when substantial interaction was present. To check this, the postulated measures were calculated separately for Stations 1, 5, and 6 thus allowing a 4 x 12 x 3 analysis of variance using the three-way interaction as an error term. Using year, month, and station as factors with three-way interaction, significant differences among years and months existed for almost all measurements at the 3 stations indicating that significant annual (main) effects calculated from the entire data base for various parameters were due to small year-by-month interactions. This interpretation is complicated by the fact that trends in parameters taken at Stations 1 and 5 differed from the composite results. Overall, significant levels of variation for annual changes were found for such factors as relative dominance and species diversity of the pooled fish data.

The use of dummy variables for representation of months (M_1 to M_{12}) and years (DDP, year 2, year 3, year 4) in the stepwise multiple regression analysis (Table 6) allowed certain generalizations concerning the identification of significant variables. This was possible despite the relatively large number of candidate predictors. The fact that the late summer-fall period is characterized by high productivity, considerable biological activity, and peaks in various community parameters is consistent with past studies (Livingston, 1976; Livingston et al., 1976). The first year of data, characterized as the DDP variable, showed fundamental differences in terms of fish diversity, species richness, and relative dominance. The dominance of the Anchoa group at this time coincided with these observations just

as river flow was closely associated with the temporal patterns of occurrence of three other fish groups of clusters. The use of time-related species associations in the multivariate analysis tended to dampen otherwise erratic annual variations in the numbers of individual species. Overall, the relatively consistent temporal distribution of fishes in the Apalachicola Estuary allowed the identification of river flow and a year 1 phenomenon (possibly the presence of organochlorine compounds) as primary determinants of community structure. This leads to the possibility that there are predictable temporal successions of dominant species in "undistrubed" estuaries which can be summarized as annual patterns or "fingerprints" of species associations despite broad seasonal variations in key physical forcing functions. Such patterns could serve as models to test the relative influence of discrete shocks to the system in the form of natural events or human activities.

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Fig. 1: Chart showing the primary study areas in the Apalachicola Drainage System. This includes distribution of permanent stations in the impoundment above the Jim Woodruff Dam (Lake Seminole) and the Apalachicola Estuary (42° 40' N; 85° 00' W).

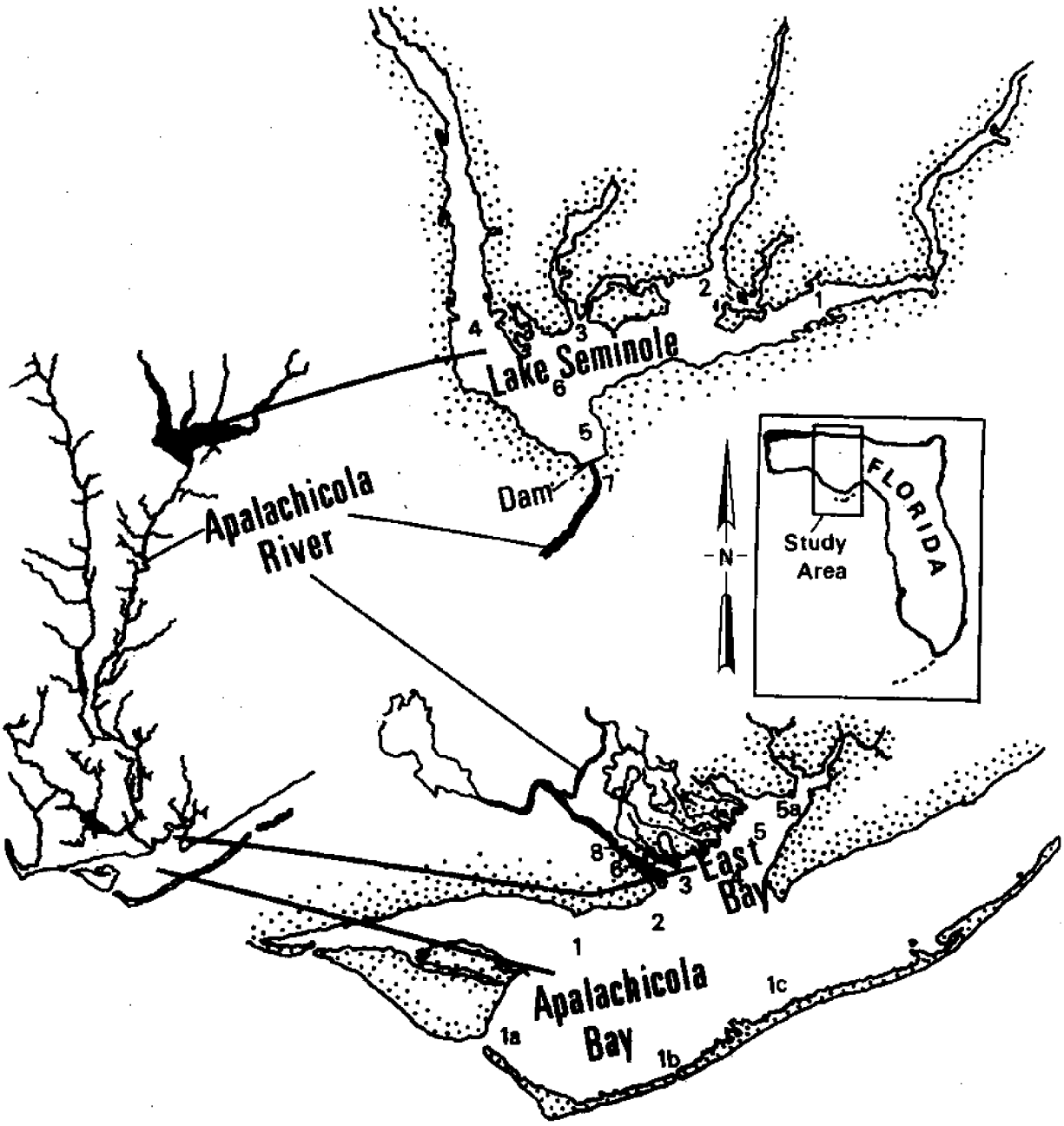


Fig. 2: Changes, by month, of Apalachicola River flow (cubic feet per second) and two major physical functions (temperature, in ^{o}centigrade; salinity in parts per thousand) monitored at station 1 (bottom) in the Apalachicola Estuary from March, 1972 to February, 1976. The monthly means and ranges of river flow at Blountstown (Florida), as measured by the U.S. Army Corps of Engineers (Mobile, Alabama), are represented.

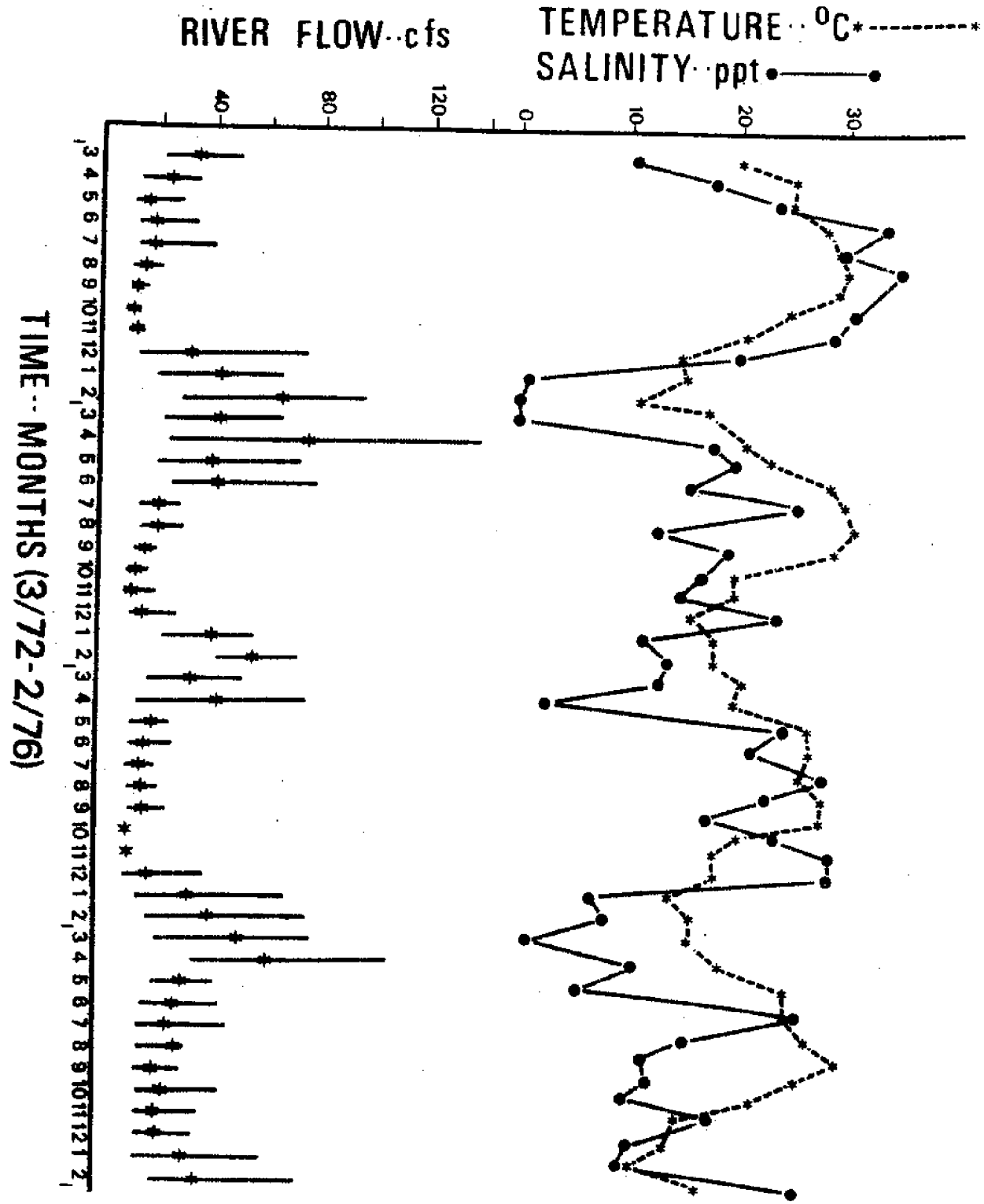

RIVER FLOW--cfs
TEMPERATURE--°C
SALINITY--ppt
40
80
120
0
10
20
30
TIME--MONTHS (3/72-2/76)

Fig. 3: Residues of DDT-R and Arochlor 1254 found in organisms taken in the Apalachicola Estuary from March, 1972 to November, 1974.

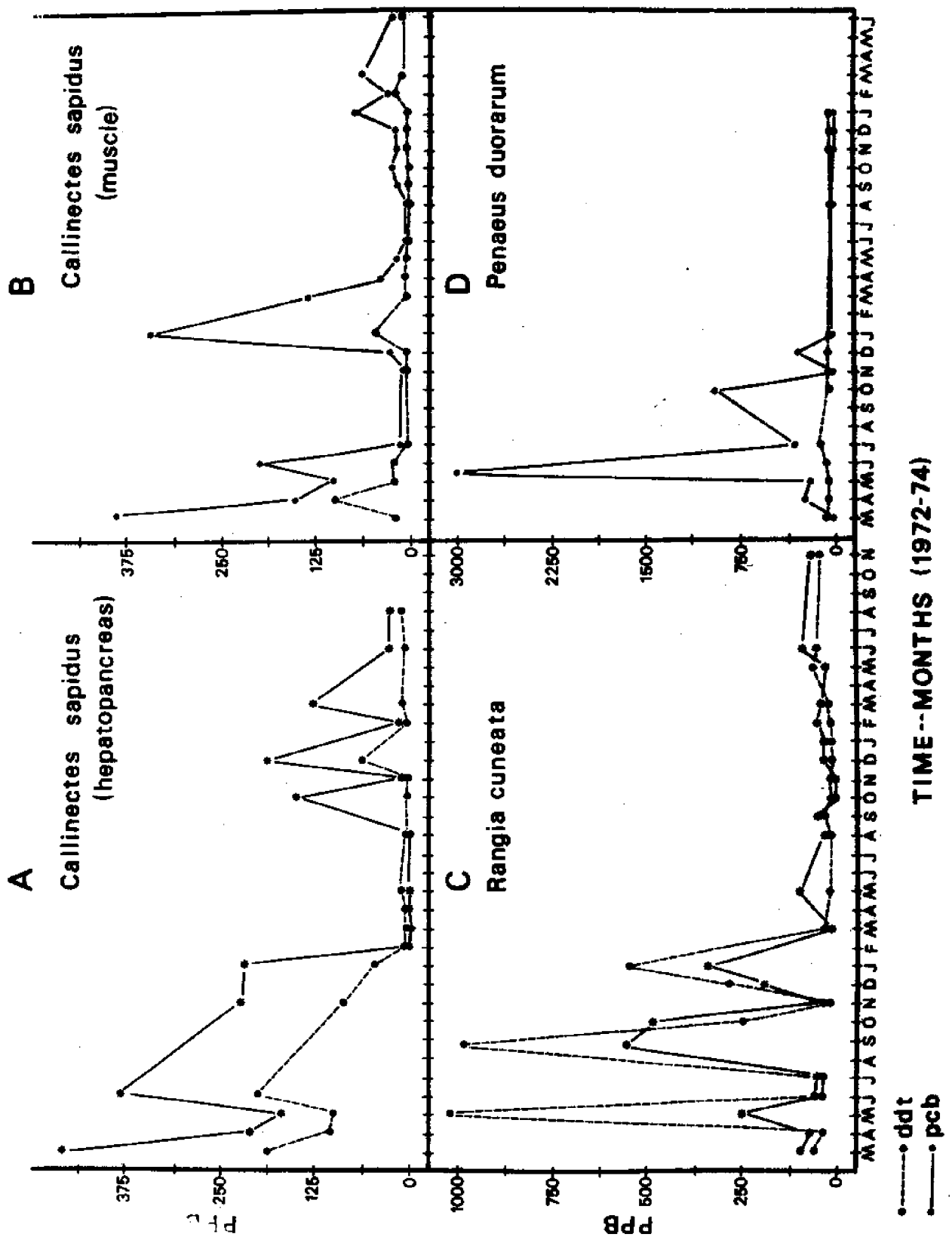


Fig 4: Residues of DDT and its major metabolites found in the bivalve Rangia cuneata (A) and sciaenid fishes (B) in the Apalachicola Estuary and expressed as percentages of the total (DDT-R) monthly from March, 1972 to November, 1974. Residues of DDT-R and Arachlor 1254 found in sciaenid fishes (C) and Micropogon undulatus (D) in the Apalachicola Estuary from March, 1972 to June, 1974.

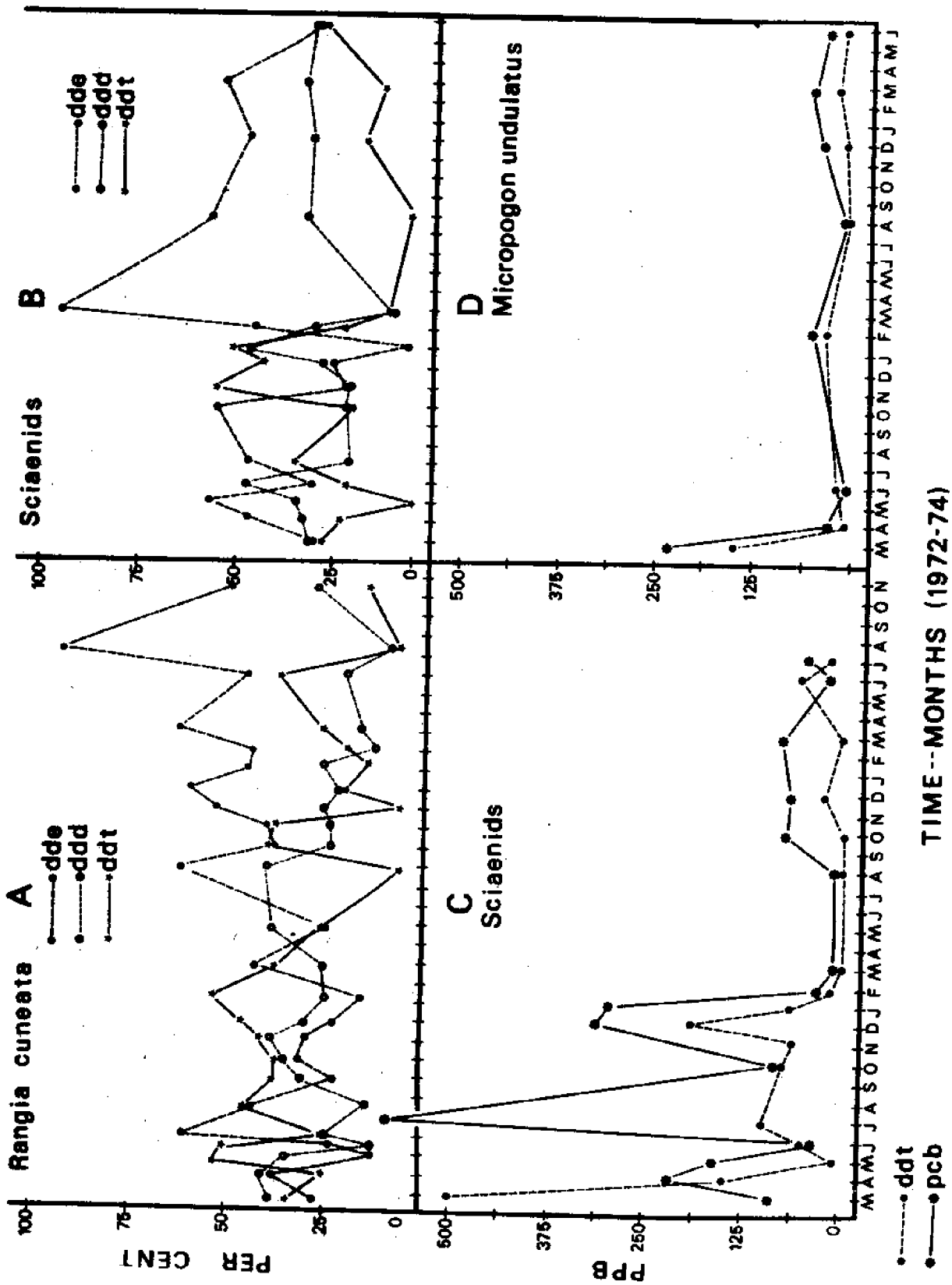


Fig 5: Changes in Margalef Richness (Mar), sumber of species (S), Shannon diversity (H'), and the number of individuals of invertebrates taken monthly from the combined stations (35 trawl tows) in the Apalachicola Estuary from March, 1972 to February, 1976. Dashed lines represent 6-month mean values of these indices and relative dominance of the top species.

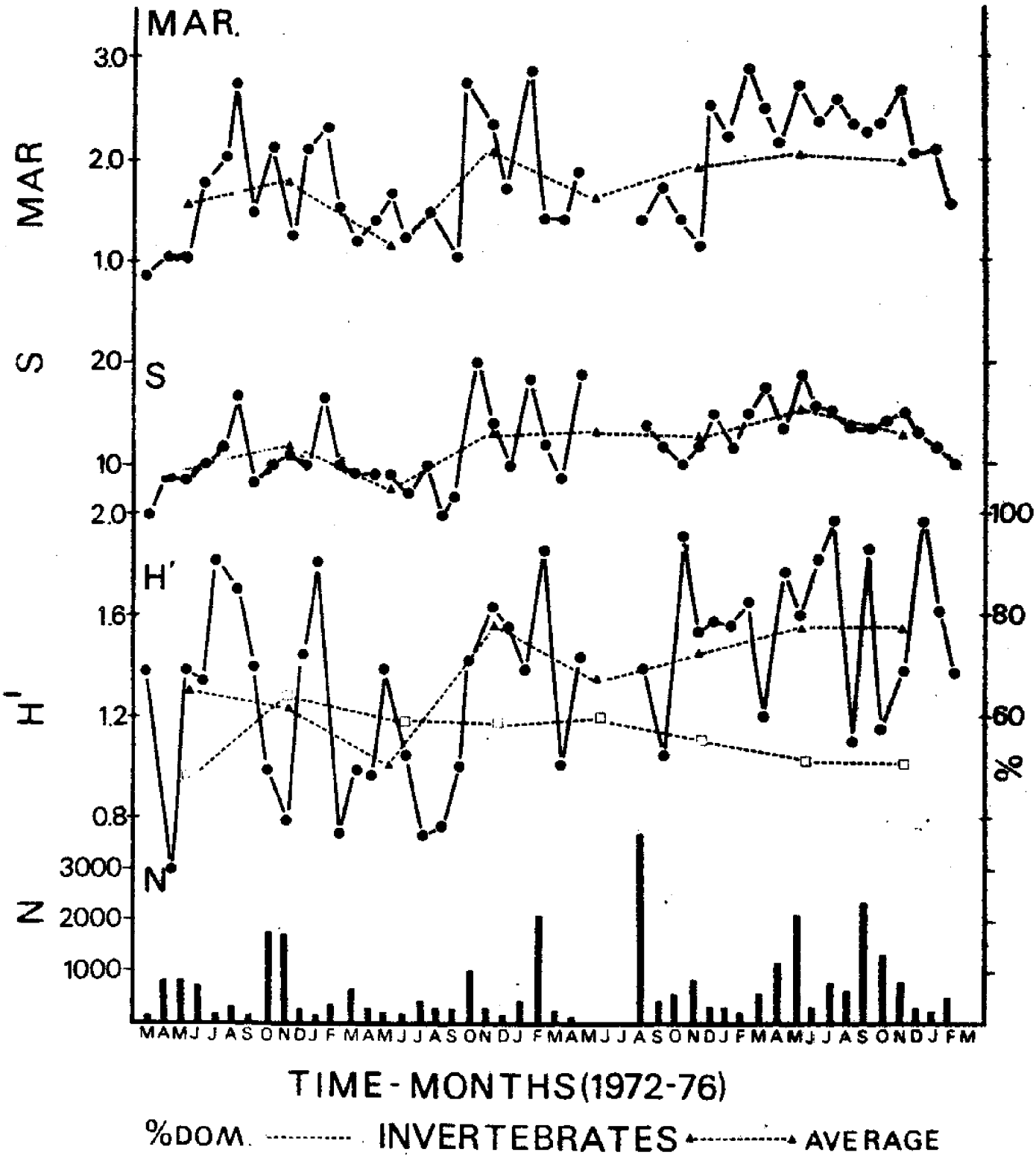


Fig. 6: Changes in Margalef Richness (Mar), number of species (S), Shannon diversity (H'), and the number of individuals of fishes taken monthly from the combined stations (35 trawl tows) in the Apalachicola Estuary from March, 1972 to February, 1976. Dashed lines represent 6-month mean values of these indices and relative dominance of the top species.

FIGURE 6

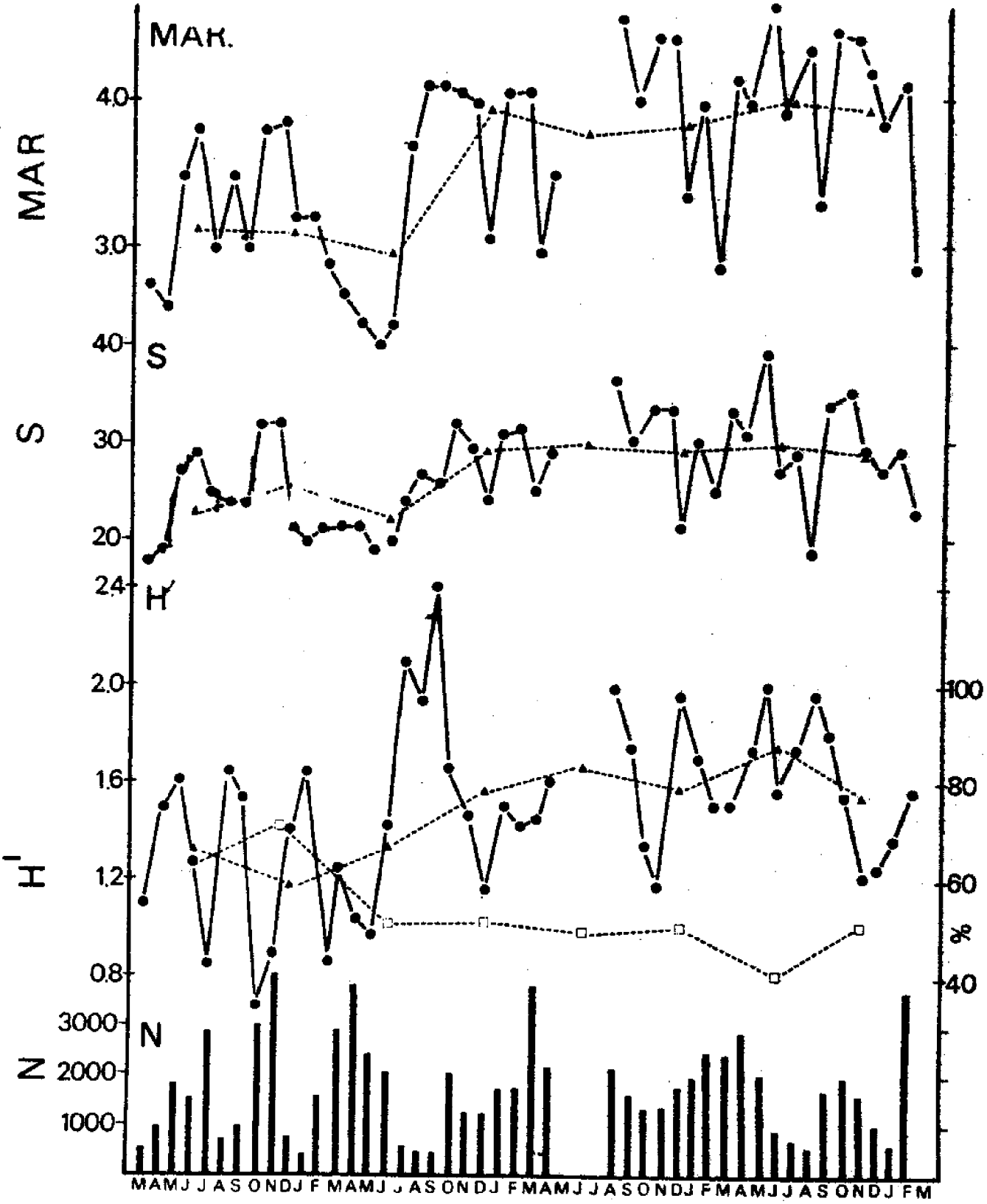

MAR.
MAR
4.0
3.0
S
40
30
20
H'
2.4
2.0
1.6
1.2
0.8
N
3000
2000
1000
100
80
60
40
%
MAMJ J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M
TIME-MONTHS(1972-76)
%DOAA
FISHES
AVERAGE

Fig. 7: A. Numbers of individuals and species of fishes taken at night from Stations 1 and 4 (14 trawl tows) in the Apalachicola Estuary from April, 1972 to March, 1974. Also shown is the top dominant for each month so that total numbers ($N-N_1$) appear as a function of time.

B. Comparison of Shannon diversity/% dominance $\left(\frac{N_1}{N}\right)$ of fishes taken at night from Stations 1 and 4 (14 trawl tows) in the Apalachicola Estuary from April, 1972 to March, 1974.

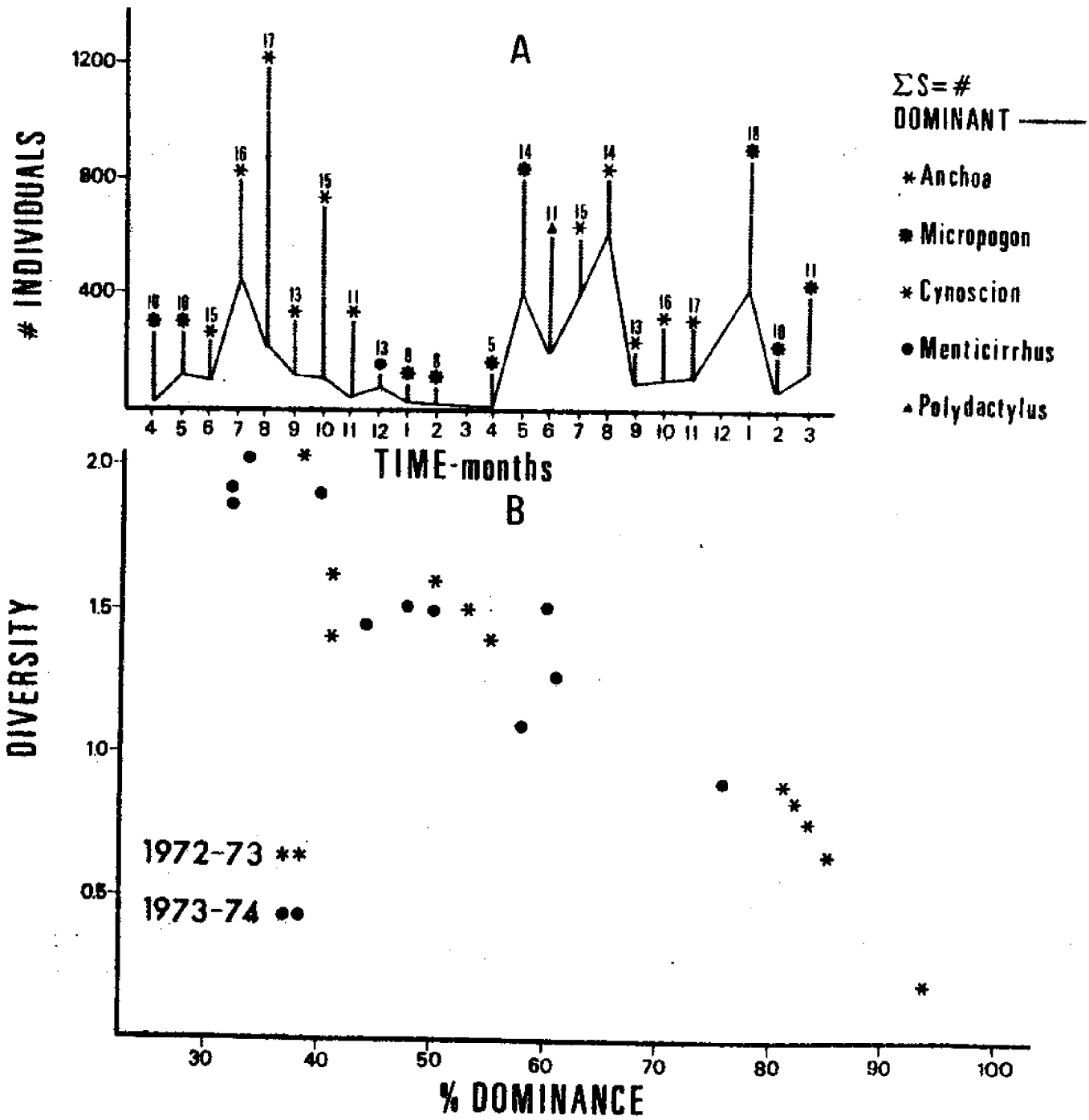
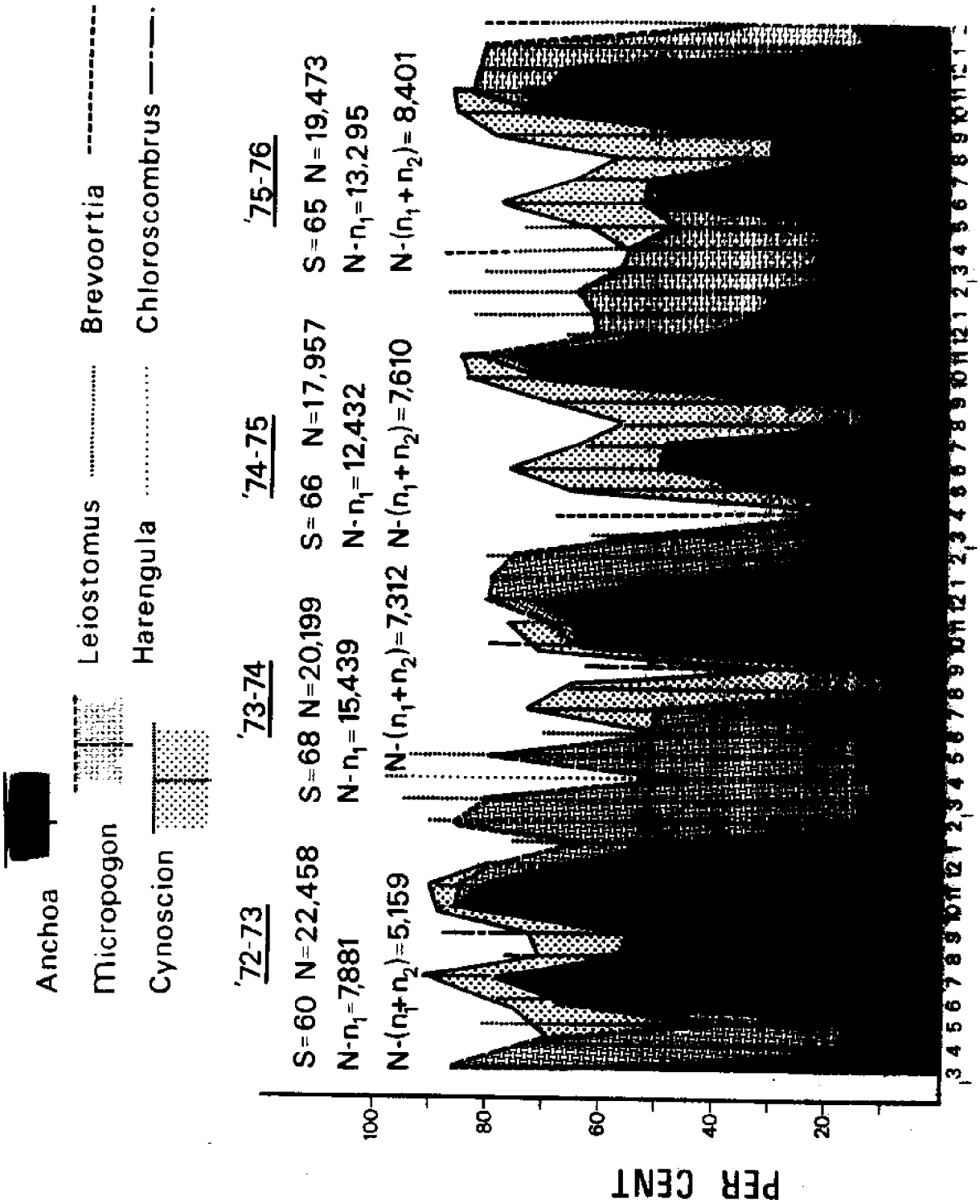


Fig 8: Relative abundance (numbers of individuals) of the seven top species of fishes taken at all stations in the Apalachicola Estuary on a monthly basis from March, 1972 to February, 1974. Also shown are annual totals of numbers of species (S), numbers of individuals (N), numbers of individuals of all except the top dominant (N-N1), and numbers or individuals of all except the top 2 dominants $N-(N_1 + N_2)$.



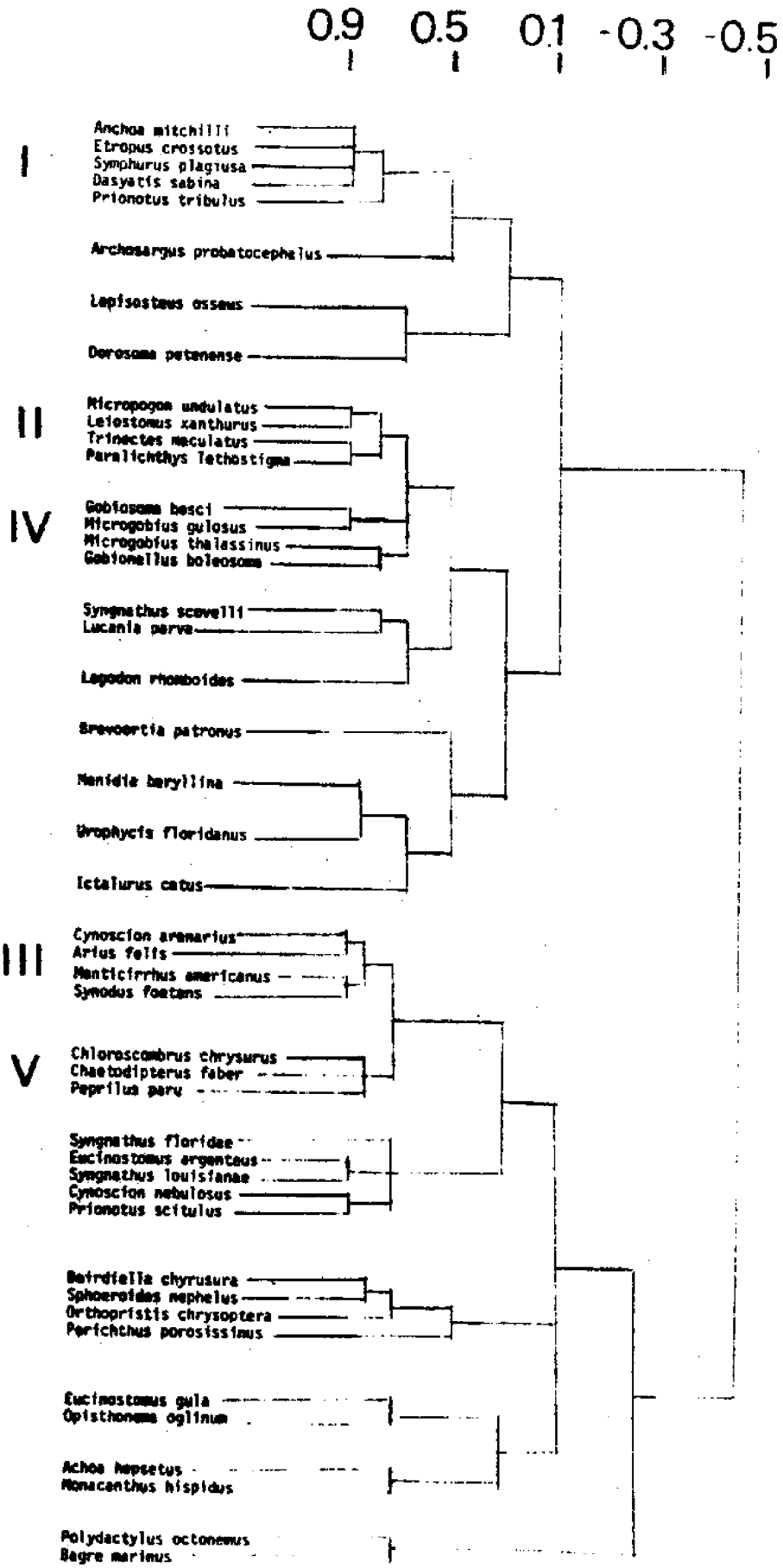


Fig 9: Dendogram representing temporal associations of fishes taken in the Apalachicola Estuary from March, 1972 to February, 1974. Only the top 45 species (in terms of total numbers of individuals) are shown. Clusters show those species which co-occur on a monthly basis from one year to the next.

TABLE 1: Results of 2-way analyses of variance (by month, by year) for physico-chemical and biological parameters of the Apalachicola Bay System taken over a 48-month period (March, 1972 to February, 1976). Included are various indices used in the overall statistical analysis.

Parameter	Number of cases	Mean	Standard Deviation	Deviations from the mean by year 1972-73	1973-74	1974-75	1975-76	Significance (P) Month	Year
PHYSCICO-CHEMICAL									
River flow (CFS)	48	27,586.	15,366.	-2401.	5369.	-6088.	3122.	0.001	0.025
Secchi (m)	48	0.82	0.37	0.08	- 0.19	0.10	0.01	0.172	0.194
Color (Pt-Co units)	48	42.4	74.5	22.8	- 11.7	- 16.7	5.1	0.203	0.999
Turbidity (JTU)	48	20.2	33.4	16.2	9.9	- 13.7	- 12.7	0.999	0.180
Temperature (^{o}C)	48	20.2	6.3	1.6	- 2.6	0.9	- 0.2	0.016	0.240
Salinity (^{o}/oo)	48	16.1	8.3	2.7	0.8	1.3	- 5.5	0.003	0.114
Dissolved oxygen (mg/L)	48	8.2	2.3	- 0.4	0.1	- 0.1	0.2	0.058	0.999
Nitrate (g/L)	42	113.0	62.7	49.5	25.1	- 42.4	- 7.4	0.172	0.002
Phosphate	42	12.3	7.9	2.2	1.2	- 3.0	0.7	0.999	0.395
DDT (Rangia: PPB)	29	145.	173.	160.	- 125.0	- 83.	---	0.303	0.001
PCB (Rangia: PPB)	29	85.	85.	79.	- 61.	- 41.	---	0.402	0.001
Chlorophyll A (mg/m^3)	44	5.3	2.1	1.9	0.7	- 0.9	- 1.1	0.331	0.002
Rainfall	48	5.0	4.0	1.3	- 1.1	0.5	2.0	0.398	0.999
Wind	48	---	---	---	---	---	---	---	---
Tides	48	---	---	---	---	---	---	---	---
DOP**	48	---	---	---	---	---	---	---	---
m_1 m_{11}	48	---	---	---	---	---	---	---	---
INVERTEBRATES									
Number of individuals (N)*	45	647.	763.	- 73.	- 170.	25.	224.	0.999	0.999
$N\text{-}N_1$ (dominant species)*	45	209.	125.	- 14.	- 39.	- 108.	162.	0.999	0.021
Margalef richness	45	1.78	0.56	0.02	- 0.13	- 0.01	0.16	0.999	0.999
Relative dominance (%)	45	56.4	16.6	- 2.4	1.9	7.2	- 4.9	0.358	0.999
Shannon diversity	45	1.34	0.36	- 0.05	- 0.14	0.04	0.16	0.999	0.257
Number of species (S)	45	11.7	3.8	1.2	- 1.0	0.8	1.6	0.999	0.255
FISHES									
Number of individuals (N)*	45	1670.	1219.	202.	14.	170.	46.	0.217	0.999
$N\text{-}N_1$	45	663.	221.	- 160.	17.	20.	162.	0.108	0.009
Margalef richness	45	3.52	0.71	- 0.22	- 0.09	- 0.06	0.37	0.114	0.146
Relative dominance (%)	45	54.9	16.6	10.6	- 1.0	- 5.4	- 4.2	0.099	0.041
Shannon diversity	45	1.48	0.33	- 0.23	- 0.03	0.11	0.08	0.051	0.030
Number of species (S)	45	26.4	5.9	- 1.6	- 0.9	- 0.3	2.8	0.237	0.236
Anchoa group*	45	2.57	0.70	0.20	- 0.22	- 0.02	0.04	0.003	0.050
Micropogon group*	45	2.14	0.80	- 0.15	0.37	- 0.23	0.01	0.001	0.050
Cynoscion group*	45	1.58	0.64	0.11	- 0.21	0.11	- 0.01	0.001	0.095
Gobiosoma group*	45	1.12	0.57	- 0.28	- 0.24	- 0.11	0.42	0.064	0.011
Chloroscombrus group*	45	0.59	0.86	0.19	- 0.07	0.07	- 0.18	0.001	0.204

*Logarithms used in analysis of variance

**Dummy variable for DDT and PCB

***Dummy variables for month of the year

Table 2: Factor analysis of a set of physicochemical variables taken from March, 1972 to February, 1976. Color, turbidity, Secchi readings, salinity, temperature, and chlorophyll A were noted at Station 1 in the Apalachicola Estuary. Tidal Data included the stages of the tide on the day of collection while the wind variable was represented by 2 vector components.

Variable	Factor 1 (49.0% of the variance)	Factor 2 (22.3% of the variance	Factor 3 (17.9% of the variance	Factor 4 (10.8% of the variance
River flow	-0.82	-0.08	-0.07	-0.06
Local rainfall	-0.04	-0.30	-0.09	0.20
Tide (incoming or outgoing	0.26	0.61	-0.68	0.06
Tide (high or low)	0.09	0.39	0.61	-0.37
Wind direction (E-W)	-0.02	0.09	0.36	0.37
Wind direction (N-S)	0.10	-0.20	0.22	0.31
Secchi	0.57	-0.07	-0.17	0.24
Color	-0.80	0.33	0.01	0.07
Turbidity	-0.73	0.54	0.08	0.23
Temperature	0.38	0.15	0.02	-0.18
Salinity	0.68	0.21	0.23	-0.02
Chlorophyll A	0.47	0.51	0.09	0.31

Table 3 : Concentrations of DDT-R and Arochlor 1254 (µg/g) in sediments taken from Lake Seminole and the Apalachicola Bay System from March, 1972 to October, 1973

Lake Seminole

Station	Date	DDT-R	Arochlor 1254
1	4/72	0.000	0.000
	5/72	0.006	0.005
	7/72	0.000	0.000
	10/72	0.007	0.000
	7/73	0.002	0.009
	8/73	0.000	0.000
	10/73	0.005	0.016
2	4/72	0.005	0.039
	5/72	0.000	0.000
	6/72	0.000	0.000
	7/72	0.000	0.009
	8/72	0.000	0.000
	4/73	0.002	0.002
3	4/72	0.010	0.000
	5/72	0.016	0.000
	6/72	0.000	0.000
4	4/72	0.024	0.000
	5/72	0.007	0.000
	10/72	0.000	0.000
	4/73	0.028	0.003
	7/73	0.000	0.008
	8/73	0.000	0.000
5	4/72	0.003	0.000
	5/72	0.000	0.000
	7/72	0.000	0.009
	8/72	0.000	0.000
	10/72	0.000	0.019
	4/73	0.002	0.001
	7/73	0.014	0.008
6	4/72	0.000	0.000
	5/72	0.052	0.000
	6/72	0.000	0.000
	7/72	0.000	0.000
7	5/72	0.000	0.000

Apalachicola Bay System

Station	Date	DDT-R	Arochlor 1254
1	3/73	0.000	0.000
2	3/72	0.000	0.000
	4/72	0.000	0.000
	6/72	0.000	0.000
	7/72	0.000	0.000
3	3/72	0.000	0.040
	4/72	0.000	0.000
	7/72	0.000	0.000
	11/72	0.000	0.000
4	6/72	0.000	0.000
	7/72	0.000	0.000
	11/72	0.000	0.000
	1/73	0.000	0.000
5	11/72	0.000	0.000
	12/72	0.000	0.000
6	6/72	0.000	0.000
	7/72	0.000	0.000
	11/72	0.000	0.000
7	3/72	0.000	0.000
	6/72	0.000	0.000
	7/72	0.000	0.000
	11/72	0.000	0.000

Table 4 : Mean residues of DDT-R and Arochlor 1254 (µg/g) in selected species of aquatic organisms taken above and below the Jim Woodruff Dam from April, 1972 to January, 1974

Lake Seminole (stations 1-6)

Species	Tissue	Date	DDT-R	Arochlor 1254
Ictalurus catus	muscle	4/72	0.165	0.145
Dorosoma petenense	muscle		0.052	0.088
Micropterus salmoides	muscle		0.183	0.063
Strongylura marina	muscle		0.129	0.200
Lepomis sp.	muscle		0.515	0.377
Lepomis sp.	whole body	5/72	0.171	0.104
Corbicula manilensis	whole body	8/72	0.105	0.138
Corbicula manilensis	whole body	1/73	0.201	0.073
Dorosoma petenense	whole body	3/73	0.349	0.090
Corbicula manilensis	whole body	4/73	0.056	0.004
Corbicula manilensis	whole body	8/73	0.081	0.125
Corbicula manilensis	whole body	10/73	0.110	0.071
Lepomis sp.	muscle		0.088	0.038
Micropterus salmoides	muscle	11/73	0.044	0.025
Notropis venustrus	muscle		0.060	0.132
Rana nigra	liver		1.747	1.530

Apalachicola River (station 7)

Species	Tissue	Date	DDT-R	Arochlor 1254
Morone chrysops	liver	4/72	1.619	1.000
Brevoortia patronus			0.366	0.521
Dorosoma petenense	muscle	5/72	0.008	0.063
Strongylura marina	whole body	3/73	0.133	0.244
Dorosoma cepedianum	muscle	4/73	0.173	0.118
Dorosoma petenense	muscle		0.171	0.167
Notropis venustrus	muscle		0.236	0.036
Dorosoma cepedianum	muscle	7/73	0.024	0.020
Dorosoma petenense	muscle		0.063	0.104
Notropis venustrus	muscle		0.304	0.310
Trinectes maculatus	whole body		0.106	0.255
Dorosoma petenense	muscle	8/73	0.015	0.009
Notropis venustrus	muscle		0.251	0.307
Micropterus salmoides	muscle		0.133	0.106
Trinectes maculatus	whole body		0.057	0.326
Fundulus pulvereus	whole body		0.077	0.251
Lepomis sp.	muscle	10/73	0.008	0.034
Dorosoma cepedianum	muscle	11/73	0.003	0.093
Lepomis sp.	muscle		0.012	0.058
Dorosoma cepedianum	muscle	1/74	0.027	0.041
Notropis venustrus	muscle		0.228	0.323
Trinectes maculatus	muscle		0.401	0.243
Fundulus pulvereus	muscle		0.151	0.576

Invertebrates

Species	Tissue	Date	ppm-w	Aroclor 1254
Pisces survey	whole body	1/72	0.017	0.089
		4/72	0.021	0.044
		5/72	1.015	0.260
		6/72	0.165	0.020
		7/72	0.027	0.016
		9/72	0.950	0.347
		10/72	0.133	0.271
		11/72	0.017	0.029
		12/72	0.158	0.078
		1/73	0.239	0.166
		3/73	0.012	0.020
		5/73	0.0215	0.051
		7/73	0.021	0.021
		8/73	0.017	0.010
		9/73	0.020	0.027
		10/73	0.013	0.008
		11/73	0.062	0.026
		12/73	0.010	0.010
		1/74	0.062	0.025
		2/74	0.069	0.029
		3/74	0.021	0.026
		5/74	0.461	0.033
		6/74	0.143	0.065
		11/74	0.014	0.025
Callinectes sapidus	whole body	3/72	0.053	0.044
	muscle		0.023	0.392
	hepatopancreas		0.188	0.455
	whole body	4/72	0.030	0.030
	muscle		0.035	0.058
	hepatopancreas		0.315	0.204
	whole body	5/72	0.019	0.008
	muscle		0.017	0.008
	hepatopancreas		0.138	0.079
	whole body	6/72	0.027	0.203
	muscle		0.015	0.022
	hepatopancreas		0.109	0.297
	whole body	7/72	0.013	0.134
	muscle		0.001	0.012
	whole body	11/72	0.000	0.025
	muscle		0.001	0.010
	hepatopancreas		0.005	0.207
	whole body	12/72	0.001	0.031
	muscle		0.000	0.005
	muscle	1/73	0.028	0.175
	hepatopancreas		0.066	0.237
	hepatopancreas	3/73	0.004	0.000
	muscle	3/73	0.000	0.014
	hepatopancreas		0.023	0.000
	whole body	4/73	0.024	0.050
	muscle		0.007	0.021
	hepatopancreas		0.014	0.000
	muscle	5/73	0.002	0.009
	hepatopancreas		0.011	0.023
	muscle	6/73	0.000	0.005
	muscle	8/73	0.001	0.002
	muscle	9/73	0.001	0.022
	whole body	10/73	0.000	0.000
	muscle		0.000	0.016
	hepatopancreas		0.001	0.164
	muscle	11/73	0.002	0.018
	hepatopancreas		0.000	0.016
	muscle	12/73	0.001	0.018
	hepatopancreas		0.068	0.153
	muscle	1/74	0.000	0.016
	hepatopancreas		0.007	0.069
	muscle	2/74	0.012	0.019
	hepatopancreas		0.000	0.020
	muscle	3/74	0.012	0.069
	hepatopancreas		0.010	0.147
	muscle	6/74	0.011	0.018
	hepatopancreas		0.010	0.012
	hepatopancreas	8/74	0.014	0.019
Penaeus setiferus	whole body	3/72	0.051	0.000
		4/72	0.183	0.105
		5/72	0.026	0.143
		6/72	0.073	0.000
		7/72	0.035	0.036
		10/72	0.003	0.020
		11/72	0.011	0.000
		12/72	0.026	0.143
		1/73	0.000	0.000
		3/73	0.009	0.019
		11/73	0.000	0.011
		12/73	0.002	0.003
		1/74	0.030	0.009

Fishes

Species	Tissue	Date	ppm-w	Aroclor 1254
Leiostomus xanthurus	whole body	3/72	0.011	0.036
Anchoa mitchilli	whole body		0.415	0.140
Arius felis	muscle		0.053	0.018
Trinectes maculatus	whole body		0.044	0.021
Leiostomus xanthurus	whole body	4/72	0.010	0.005
Micropogon undulatus	whole body		0.040	0.018
Arius felis	muscle		0.061	0.007
Trinectes maculatus	whole body		0.029	0.015
Bairdiella chrysoura	whole body	5/72	0.015	0.013
Arius felis	muscle		0.044	0.019
Trinectes maculatus	whole body		0.050	0.150
Leiostomus xanthurus	whole body	6/72	0.135	0.013
Micropogon undulatus	whole body		0.015	0.050
Arius felis	muscle		0.008	0.018
Leiostomus xanthurus	hepatopancreas	7/72	0.029	0.220
Anchoa mitchilli	whole body		0.490	0.170
Arius felis	hepatopancreas		0.150	0.140
Trinectes maculatus	whole body		0.034	0.000
Trinectes maculatus	whole body	8/72	0.216	0.733
Anchoa mitchilli	whole body	10/72	0.067	0.028
Leiostomus xanthurus	whole body		0.018	0.036
Bairdiella chrysoura	whole body	11/72	0.061	0.160
C. ovalis sabina	hepatopancreas		0.659	0.150
Bairdiella chrysoura	whole body	12/72	0.071	0.144
Micropogon undulatus	whole body		0.022	0.055
Menticirrhus americanus	whole body		0.201	0.156
Eucinostomus gula	whole body		0.059	0.250
Menticirrhus americanus	whole body	1/73	0.094	0.144
Archosargus probatocephalus	muscle		0.075	0.085
Diapterus olisthostomus	hepatopancreas		0.290	1.082
Micropogon undulatus	whole body	3/73	0.016	0.016
Leiostomus xanthurus	muscle	3/73	0.015	0.027
Micropogon undulatus	whole body	8/73	0.000	0.000
Bairdiella chrysoura	whole body		0.011	0.019
Trinectes maculatus	whole body		0.021	0.019
Arius felis	muscle		0.007	0.023
Opsanus beta	muscle		0.000	0.000
Chaetodipterus faber	muscle		0.006	0.000
Paralichthys lethostigma	muscle		0.007	0.033
Arius felis	hepatopancreas	9/73	0.095	0.091
Rhinoptera bonasus	hepatopancreas		0.000	0.024
Symphurus fasciana	muscle	10/73	0.001	0.000
Paralichthys lethostigma	muscle		0.000	0.000
Sphyraena tiburo	hepatopancreas		0.064	0.017
Mugil cephalus	hepatopancreas	11/73	0.006	0.154
Stromateus stellatus	hepatopancreas		0.064	0.006
Bairdiella chrysoura	whole body	12/73	0.011	0.019
Anchoa mitchilli	whole body		0.003	0.023
Dasyatis sabina	muscle		0.027	0.041
	hepatopancreas		0.203	1.053
Arius felis	muscle	1/74	0.048	0.041
Leiostomus xanthurus	hepatopancreas		0.064	0.057
Leiostomus xanthurus	hepatopancreas	2/74	0.075	0.052
Micropogon undulatus	whole body	3/74	0.010	0.019
Bairdiella chrysoura	whole body		0.070	0.010
Dasyatis sabina	hepatopancreas		0.042	0.045
Leiostomus xanthurus	muscle		0.000	0.000
Micropogon undulatus	whole body	4/74	0.018	0.067
Micropogon undulatus	whole body	5/74	0.017	0.042
Micropogon undulatus	whole body	6/74	0.033	0.027
Arius felis	muscle		0.015	0.024
Micropogon undulatus	whole body	7/74	0.028	0.017
Leiostomus xanthurus	whole body		0.007	0.011
Arius felis	muscle		0.010	0.011

Table 6 : Stepwise regression analysis involving predictive equations for independent variables (Listed in Table 1), dummy variables for months of the year, and the dependent (biological) functions. Variables were selected in order of entry with R values and significance probabilities. Several runs were made with different sets of variables for maximal use of the data.

Dependent variable	Set 1: All variables		Set 2: All varibles except nitrates, phosphates and chlorophyll A		Set 3: All variables except nitrates, phosphates, chlorophyll A, DDT (Rangia and PCB (Rangia)	
Number of individuals(N)	--		--		October River flow	R = 0.39 p < 0.043
Number of species(S)	October	R = 0.54 p < 0.05	October Low tide November	R = 0.59 p < 0.019	October Low tide November	R = 0.63 p < 0.001
Species diversity(H')	-DDP(dummy) August	R = 0.60 p < 0.032	-DDP(dummy) August	R = 0.52 p < 0.021	-DDP(dummy) August November	R = 0.061 p < 0.001
Simpson Index(Si)	DDP(dummy) - November	R = 0.56 p < 0.024	DDP(dummy) - November	R = 0.56 p < 0.011	DDP(dummy) - November - October	R = 0.64 p < 0.0005
Margalef Index(M)	Low tide - River flow	R = 0.56 P < 0.024	Low tide - River flow	R = 0.56 p < 0.012	Low tide - River flow	R = 0.62 p < 0.0005
Relative Dominance(D)	DDP(dummy)	R = 0.60 p < 0.056	DDP(dummy) November October	R = 0.60 p < 0.014	DDP(dummy) November October	R = 0.60 p < 0.001
Anchoa group	October November DDT	R = 0.65 p < .014	October November DDT	R = 0.65 p < 0.005	October November -Year 2 -May	R = 0.73 p < 0.0005
Micropogon group	River flow	R = 0.68 p < 0.001	River flow	R = 0.71 p < 0.0001	River flow -Temperature	R = 0.71 p < 0.0001
Cynoscion group	-River flow -March -January	R = 0.80 p < 0.0001	-River flow -March -January	R = 0.80 p < 0.0001	-River flow -March -January	R = 0.86 p < 0.0001
Gobiosoma group	----	----	----	----	----	----
Chloroscombrus group	-River flow October	R = 0.68 p < 0.002	-Riverflow October	R = 0.68 p < 0.001	-River flow October	R = 0.68 p < 0.0001

Table 7 : Ratios of DDE:DDT found in Rangia cuneata at the head of the Apalachicola estuary from March, 1972 to November, 1974.

Date	DDE:DDT
March, 1972	1.00
April	1.60
May	0.24
June	0.85
July	0.47
September	0.36
October	0.36
November	0.40
December	0.48
January, 1973	0.36
March	1.18
May	1.38
August	14.00
September	0.63
October	1.20
November	7.00
December	3.00
January, 1974	3.00
February	1.00
March	2.17
May	1.00
June	35.25
November	6.40

INVERT SUMMARY, WHOLE DAY 1ST YEAR
DATES 720301-730228
STATIONS 3 4 5 6 1A 1B 1C 5A
TIMES OF DAY 0

Table 8: Summary of total numbers (by species, by month) and percent dominance of epibenthic invertebrates taken in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) from March, 1972 through February 1977.

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
PENAEUS SETIFERUS	24 20.17	3 .39	3 2.80	0 .00	28 31.83	7 3.50	2 1.08	80 72.73	432 81.72	18 35.11	2 1.89	5 1.55	604 41.04
PALAEMONETES PUGIO	61 16.81	657 85.64	49 49.00	26 30.93	6 3.98	6 2.57	0 .00	0 .00	0 .00	1 .73	56 52.83	46 14.29	1471 21.66
CALLINECTES SAPIDUS	47 39.51	51 6.65	132 16.10	281 39.91	36 19.67	56 33.33	41 36.94	175 3.92	115 7.06	27 21.43	13 12.26	255 79.19	1259 18.19
PENAEUS DUORARUM	1 0.80	40 5.13	45 5.49	3 2.00	5 2.73	21 8.33	44 33.64	145 3.33	50 3.44	40 31.75	16 9.43	2 .62	411 5.94
PENAEUS AZTECUS	6 1.68	1 .13	182 22.20	146 14.49	16 8.74	3 1.19	3 2.75	1 .23	4 .00	1 .00	6 3.02	3 1.08	316 4.48
LOLLIGUNCULA BREVIS	0 0.00	0 0.00	6 .73	28 3.98	44 24.04	74 29.25	6 5.41	22 1.41	46 2.94	1 .00	1 .94	0 0.00	232 3.35
PORTUNUS GIBBESII	0 0.00	0 0.00	0 0.00	1 .14	0 0.00	1 .40	0 0.00	43 2.83	41 2.62	1 .73	4 3.77	1 .31	92 1.33
SQUILLA EMPUSA	0 0.00	0 0.00	0 0.00	0 0.00	1 .55	0 0.00	0 0.00	31 1.73	13 .83	1 .73	0 0.00	5 1.55	50 .72
CALLINECTES SIMILIS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .40	0 0.00	22 1.41	12 .74	2 1.59	6 5.66	2 .62	48 .69
NERITINA RECLIVATA	1 0.80	9 1.16	22 2.68	8 1.14	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .00	0 0.00	1 .31	42 .58
PALAEMONETES VULGARIS	26 21.85	4 .51	0 0.00	5 .71	0 0.00	2 .79	0 0.00	1 .23	1 .08	3 1.01	0 0.00	1 .31	46 .58
TRACHYPENAEUS CONSTRICTUS	0 0.00	0 0.00	0 0.00	0 0.00	1 .55	1 .40	2 1.80	17 .98	6 .42	0 0.00	0 0.00	0 0.00	27 .38
RHITHROPANOPEUS HARRISII	0 0.00	4 .51	1 .12	3 .43	7 3.83	1 .40	1 .90	3 .00	1 .00	0 0.00	0 0.00	4 1.24	21 .30
RANGIA CUNEATA	0 0.00	0 0.00	0 0.00	5 .71	3 1.64	5 1.98	0 0.00	1 .08	1 .06	1 .79	2 1.89	0 0.00	18 .25
POLLINICES DUPLICATUS	0 0.00	0 0.00	0 0.00	1 .14	5 2.73	0 0.00	2 1.08	5 .34	3 .00	1 .00	0 0.00	0 0.00	16 .23
MULINIA LATERALIS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	9 .59	1 .00	2 1.89	0 0.00	11 .16
PALAEMONETES INTERMEDIUS	0 0.00	0 0.00	0 0.00	4 .57	0 0.00	0 0.00	0 0.00	1 .08	0 0.00	0 0.00	0 0.00	0 0.00	5 .07
BRANCHIOASYCHUS AMERICANA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 4.72	0 0.00	5 .07
PALAEMON FLORIDANUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .79	0 0.00	1 .08	0 0.00	1 .79	0 0.00	0 0.00	4 .06
MENIPPE MERCENARIA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .08	0 0.00	2 1.59	0 0.00	0 0.00	3 .04
NEOPANOPE PACKARDII	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .40	0 0.00	0 0.00	0 0.00	1 .79	1 .94	0 0.00	3 .04
NEOPANOPE TEXANA	0 0.00	0 0.00	0 0.00	1 .14	0 0.00	0 0.00	0 0.00	2 .11	0 0.00	1 .00	0 0.00	0 0.00	3 .04
PAGURUS POLLICARIS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .17	0 0.00	1 .00	0 0.00	0 0.00	3 .04
HEXAPANOPEUS ANGUSTIFRONS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .79	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .03
PERICLIMENES LONGICAUDATUS	0 0.00	0 0.00	0 0.00	2 .28	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .03
ALPHEUS NORMANNI	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .94	0 0.00	1 .01

Table 8, continued

SPECIES	SAMPLE DATES 72.315	72.415	72.515	72.615	72.715	72.815	72.915	72.1015	72.1115	72.1215	73.115	73.215	TOTALS
OGYRIDES LIMICOLA	1	1	1	14	1	1	1	3	1	3	1	1	31
PERICLIMENES AMERICANUS	1	1	1	14	1	1	1	1	1	1	1	1	21
BUSYCON CONTRARIUM	1	1	1	1	1	1	1	1	1	1	1	1	21
KIPHOPENEUS KROYERI	1	1	1	1	55	1	1	1	1	1	1	1	21
ALPHEUS ARMILLATUS	1	1	1	14	1	1	1	1	1	1	1	1	21
SICYONIA DORSALIS	1	1	1	1	1	1	1	5	1	1	1	1	21
ANADARA BRASILIANA	1	1	1	1	1	1	1	1	1	1	94	1	21
DINOCARDIUM ROBUSTUM	1	1	1	1	1	1	1	1	1	1	94	1	21
PROCAMBARUS PENAENSALANUS	1	1	1	1	1	1	1	1	1	1	94	1	21
TOTALS	119.1	779.1	820.0	734.0	183.1	253.1	411.1	1737.1	463.1	125.3	185.1	322.1	5921.1

INVERT SUMMARY N WHOLE BAY 2ND YEAR
DATES 730501-731231
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY 0

Table 8, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
PALAEMONETES PUGIO	374 66.91	118 47.37	33 29.20	67 54.92	4 .27	1 .28	0 0.00	0 0.00	0 0.00	0 0.00	35 8.41	1543 75.79	2167 37.20
CALLINECTES SAPIDUS	115 20.57	109 47.81	53 46.90	37 30.33	66 17.89	139 50.88	141 55.95	69 5.94	75 28.90	66 52.80	277 66.59	245 12.03	1358 23.31
PENAEUS SETIFERUS	8 1.43	1 .44	2 1.77	0 0.00	284 76.69	153 46.18	1 .40	321 62.47	51 13.69	15 12.80	1 .24	6 .29	1151 19.75
LOLLIGUNCULA BREVIS	0 0.00	2 .88	2 1.77	0 0.00	6 3.25	7 1.98	5 35.71	117 11.77	5 35.14	13 1.40	1 .24	0 0.00	335 5.75
NERITINA RECLIVATA	48 8.59	0 0.00	3 2.65	11 9.02	1 .27	0 0.00	0 0.00	1 0.00	0 0.00	1 0.00	5 1.20	177 3.69	245 4.21
PENAEUS DUORARUM	1 .18	1 .44	1 .88	0 0.00	2 .54	68 19.26	14 5.56	84 5.25	21 5.11	5 5.60	24 5.29	9 .44	267 3.90
PORTUNUS GIBBESII	0 0.00	1 .44	0 0.00	1 .82	0 0.00	1 .28	3 1.19	31 3.12	5 1.95	1 .20	27 6.49	30 1.47	99 1.70
SQUILLA EMPUSA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .40	12 1.21	2 .77	1 0.00	18 4.33	7 .34	46 .69
RHITHROPANOPEUS HARRISII	8 1.43	0 0.00	0 0.00	1 .82	0 0.00	0 0.00	0 0.00	1 0.00	2 .77	11 8.80	13 3.13	2 .16	37 .64
NEOPANOPE TEXANA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	23 2.31	1 0.00	0 0.00	2 .48	0 0.00	25 .43
PENAEUS AZTECUS	4 0.00	0 0.00	15 13.27	4 3.28	1 .27	0 0.00	0 0.00	1 .10	1 .39	2 1.60	0 0.00	1 .05	25 .43
TRACHYPENAEUS CONSTRICTUS	0 0.00	0 0.00	1 .88	0 0.00	0 0.00	0 0.00	0 0.00	5 .51	1 .77	0 0.00	2 .48	7 .34	17 .29
CALLINECTES SIMILIS	0 0.00	3 1.32	0 0.00	0 0.00	0 0.00	3 .85	0 0.00	0 0.00	0 0.00	1 .80	2 .48	7 .34	16 .27
ALPHEUS HETEROCHAELIS	1 .18	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	12 1.21	0 0.00	0 0.00	0 0.00	0 0.00	13 .22
PALAEMONETES VULGARIS	1 .18	2 .88	0 0.00	0 0.00	3 0.00	0 0.00	0 0.00	4 .40	3 1.16	0 0.00	4 .48	0 0.00	12 .21
MENIPPE MERCENARIA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	14 1.41	0 0.00	0 0.00	0 0.00	0 0.00	14 .17
PAGURUS POLLICARIS	0 0.00	0 0.00	3 2.65	1 .82	0 0.00	0 0.00	0 0.00	1 .10	3 1.16	0 0.00	0 0.00	0 0.00	8 .14
NEOPANOPE PACKARDII	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .30	1 .39	0 0.00	3 .72	0 0.00	7 .12
ACETES AMERICANUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .10	0 0.00	3 2.40	0 0.00	0 0.00	4 .07
BRACHIODONTES EXUSTUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .30	0 0.00	0 0.00	4 .96	0 0.00	4 .07
PALAEMONETES INTERMEDIUS	3 .54	1 .44	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .07
POLLINICES DUPLICATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .20	0 0.00	0 0.00	0 0.00	2 .10	4 .07
BUSYCON CONTRARIUS	0 0.00	0 0.00	0 0.00	0 0.00	1 .27	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02
LATREUTES PARVULUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .20	0 0.00	0 0.00	0 0.00	0 0.00	2 .03
PERICLIMENES AMERICANUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .20	0 0.00	0 0.00	0 0.00	0 0.00	2 .03
XIPHOPENEUS KROYERI	1	0	0	0	0	0	0	0	0	0	0	1	2

Table 8, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
CLIBANARIUS VITTATUS	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.39	0.00	0.00	0.00	0.0
HIPPOLYSMATA WURDEMANNI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
LUCUCIA CLATHRATA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.0
METAPORHAPHIS CALCARATA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.0
MULINIA LATERALIS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.0
NEMIPHOLUS ELONGATA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.0
TOTALS	559.0	228.0	113.0	422.0	369.0	353.0	252.0	994.0	259.0	123.0	418.0	2838.0	5826.0

INVERT SUMMARY N. WHOLE BAY 3RD YEAR
DATES 740301-750228
STATIONS 001 002 003 004 005 006 01A 018 01C 05A
TIMES OF DAY D

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215	TOTALS
PENAEUS SETIFERUS	17 16.19	5 4.95	3 4.23	13 45.45	122 55.20	3335 92.78	293 73.86	443 79.11	297 59.64	14 3.95	7 2.33	6 4.47	4519 72.23
PALAEMONETES PUGIO	6 4.29	21 3.43	0 0.00	0 0.00	45 9.05	34 .32	9 2.27	4 .71	4 .80	196 55.92	157 52.16	146 59.22	493 7.73
CALLINECTES SAPIDUS	101 72.14	33 47.83	6 11.27	4 14.29	44 6.33	38 1.59	23 5.79	14 2.51	64 12.85	26 8.72	93 29.94	33 18.44	466 7.21
PENAEUS DJORARUM	2 1.43	2 2.90	0 0.00	1 3.57	19 8.01	64 1.75	28 7.05	37 6.61	56 11.24	7 6.72	5 1.66	2 4.79	230 3.74
LOLLIGUNCULA BREVIS	0 0.00	0 0.00	56 81.69	6 21.43	41 18.55	14 .38	18 4.53	44 7.85	12 2.41	2 .79	0 0.00	1 .56	196 3.07
PENAEUS AZTECUS	0 0.00	2 5.80	0 0.00	2 7.14	6 2.60	77 2.10	16 4.03	3 .89	16 3.21	3 1.19	1 .33	1 .56	121 1.97
PALAEMONETES VULGARIS	3 2.14	0 0.00	0 0.00	0 0.00	0 0.00	5 .14	0 0.00	3 .53	43 8.63	37 14.62	18 5.98	3 1.68	112 1.76
CALLINECTES SIMILIS	0 0.00	3 4.35	1 1.41	2 7.14	4 1.81	4 .11	2 .50	3 .53	7 1.41	2 .79	4 1.33	1 .56	33 .52
NERITINA RECLIVATA	0 0.00	3 4.35	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 0.23	1 0.20	7 3.55	7 2.33	7 5.15	24 .37
RHITHROPANOPEUS HARRISII	0 0.00	0 0.00	0 0.00	0 0.00	1 .45	0 0.00	1 .25	1 .18	0 0.00	2 .79	9 2.99	0 0.00	14 .22
PAGURUS POLLICARIS	0 0.00	1 1.45	1 1.41	0 0.00	0 0.00	6 .16	0 0.00	0 0.00	3 .60	1 0.00	0 0.00	0 0.00	11 .17
ACETES AMERICANUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 1.43	2 .40	0 0.00	0 0.00	0 0.00	10 .16
PORTUNUS GIBBESII	3 2.14	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .35	0 0.00	1 0.00	0 0.00	3 1.68	9 .13
TRACHYPENAEUS CONSTRICTUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 1.20	0 0.00	0 0.00	0 0.00	4 1.33	3 1.68	8 .13
METAPORHAPHIS CALCARATA	4 2.86	0 0.00	0 0.00	0 0.00	0 0.00	1 .03	0 0.00	0 0.00	0 0.00	1 .40	0 0.00	1 .56	7 .11
SQUILLA EMPUSA	0 0.00	1 1.45	0 0.00	0 0.00	0 0.00	2 .05	0 0.00	0 0.00	0 0.00	1 .40	0 0.00	1 .56	5 .08
TRACHYPENAEUS SIMILIS	4 2.86	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .25	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 .08
NEOPANOPE TEXANA	0 0.00	4 5.80	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .06
PERSEPHONA MEDITERRANEA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .03
MYSID SP.	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .66	0 0.00	0 0.00	2 .03
EURYPANOPEUS DEPRESSUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .20	0 0.00	0 0.00	0 0.00	1 .02
MEXAPANOPEUS ANGUSTIFRONS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .20	0 0.00	0 0.00	0 0.00	0 0.00	1 .02
PALAEMON FLORIDANUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .33	0 0.00	0 0.00	1 .02
PERICLIMENES LONGICAUDATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .25	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02
PODOCHELA RIISEI	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .03	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02
TOZEUMA CAROLINENSE	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .20	0 0.00	0 0.00	0 0.00	1 .02

Table 8, continued

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215	TOTALS
NUDIBRANCH SP.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
HEMIPHOLUS ELONGATA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.01
OVALIPES GUADULPENSIS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
PAGURUS LONGICARPUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56	0.01
TOTALS	140.0	69.0	71.0	28.0	221.0	3659.0	397.0	550.0	498.0	293.0	341.0	173.0	6376.0

Table 8, continued

INVERT SUMMARY, N. WHOLE BAY 4IN YEAR
DATES 751301-760228
STATIONS 001 002 003 004 005 01A 01B 01C 05A
TIMES OF DAY D

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
PENAEUS SETIFERUS	18 8.78	5 4.35	64 5.81	52 47.33	65 19.72	251 76.39	913 63.98	513 73.35	131 51.58	22 19.13	1 2.38	2 2.34	2121 48.39
PENAEUS DUORARUM	2 .98	11 9.57	49 11.80	11 7.03	0 0.00	4 1.23	447 31.32	34 4.87	49 19.37	5 4.35	1 2.38	2 2.34	614 14.17
CALLINECTES SAPIDUS	155 75.61	22 19.13	68 16.46	33 25.19	53 12.30	51 15.64	19 1.33	35 4.53	23 9.13	63 22.61	11 25.19	35 35.71	533 12.34
PALAEMONETES PUGIO	1 .49	39 33.91	41 9.93	2 1.53	33 7.66	6 0.26	1 .07	33 4.92	7 2.72	13 11.30	16 38.10	35 35.71	225 5.22
PENAEUS AZTECUS	0 0.00	0 0.00	177 42.86	2 1.53	14 3.25	3 .92	16 1.12	3 .65	5 1.95	1 .87	0 0.00	0 0.00	223 5.15
TRACHYPENAEUS CONSTRICTUS	0 0.00	0 0.00	0 0.00	0 0.00	153 35.50	0 0.10	2 .14	1 .13	0 0.00	7 5.39	0 0.00	0 0.00	163 3.76
LOLLIGUNCULA BREVIS	0 0.00	3 2.61	3 .73	16 12.21	36 8.35	7 2.15	6 .42	18 2.33	21 7.78	31 23.93	0 0.00	3 3.06	143 3.30
RHITHROPANOPEUS HARRISII	2 .98	4 3.48	31 7.51	0 0.00	26 6.03	2 .01	2 .14	11 1.42	5 1.95	2 1.74	6 14.29	15 15.31	105 2.45
CALLINECTES SIMILIS	1 .49	4 3.48	2 .48	1 .76	7 1.62	4 1.23	18 1.26	14 1.29	12 4.67	5 5.22	0 0.00	0 0.00	65 1.50
NERITINA RECLIVATA	0 0.00	4 3.48	14 2.66	0 0.00	7 1.62	1 .31	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 1.32	24 .55
PAGURUS POLLICARIS	3 1.46	9 7.83	1 .24	4 3.00	3 .70	0 0.01	0 0.00	0 0.00	0 0.00	1 .87	6 9.52	0 0.00	21 .48
PALAEMONETES VULGARIS	10 4.88	8 6.96	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 2.34	21 .46
CLIBANARIUS VITTATUS	5 2.44	1 .87	0 0.00	1 .76	4 .93	1 .31	1 .07	4 .52	1 .39	0 0.00	0 0.00	0 0.00	18 .42
PORTUNUS GIBBESII	1 .98	0 0.00	0 0.00	0 0.00	7 1.62	0 0.00	1 .07	3 .65	1 .39	0 0.00	0 0.00	0 0.00	13 .27
TRACHYPENAEUS SIMILIS	0 0.00	3 2.61	1 .24	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 3.06	7 .16
SQUILLA EMPUSA	0 0.00	2 1.74	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .39	1 .39	0 0.00	0 0.00	0 0.00	6 .14
PERICLIMENES AMERICANUS	0 0.00	0 0.00	0 0.00	3 2.29	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .07
POLLINICES DUPLICATUS	0 0.00	0 0.00	1 .24	0 0.00	1 .23	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 2.38	0 0.00	3 .07
ACETES AMERICANUS	1 .49	0 0.00	0 0.00	1 .76	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .05
ALPHEUS HETEROCHAELIS	0 0.00	0 0.00	1 .24	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 2.38	0 0.00	2 .05
NEOPANOPE TEXANA	1 .49	0 0.00	0 0.00	0 0.00	1 .23	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .05
PAGURUS BONAIRENSIS	0 0.00	0 0.00	1 .24	0 0.00	0 0.00	0 0.00	0 0.00	1 .13	0 0.00	0 0.00	0 0.00	0 0.00	2 .05
CRASSOSTREA VIRGINICA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .31	0 0.00	0 0.00	1 .87	0 0.00	0 0.00	0 0.00	2 .05
XIPHOPENEUS KROYERI	0 0.00	0 0.00	0 0.00	0 0.00	1 .23	0 0.00	0 0.00	0 0.00	1 .39	0 0.00	0 0.00	0 0.00	2 .05
PERICLIMENES LONGICAUDATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .31	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02
PETROLISTHES ARMATUS	1 .49	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02

Table 8, continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
SICYONIA BREVIROSTRIS			.24										.02
TOZEUMA CAROLINENSE							.17						.02
NUDIBRANCH SP.	.49												.02
BUSYCON CONTRARIUM													.02
RANGIA CUNEATA										2.38			.02
PROCAMBARUS PENAENSALANUS	.49												.02
HEMIPHOLUS ELONGATA			.24										.02
TOTALS	.49												.02
	205.0	115.0	413.0	131.0	431.0	326.0	1427.0	773.1	257.0	115.1	42.0	38.0	4333.0

INVERT SUMMARY, N. WHOLE DAY 5TH YEAR
DATES 760501-770228
STATIONS 001 002 003 004 005 006 01A 11B 21C 05A
TIMES OF DAY 0

Table 8, continued

SPECIES	SAMPLE DATES 760319	760415	760519	760615	760715	760815	760915	761011	761111	761213	770125	770224	TOTALS
PENAEUS SETIFERUS	1.45	4.23	.05	3.74	83.36	84.27	95.83	73.75	2.19	1.75	.00	.00	3835 48.42
CALLINECTES SAPIDUS	19.69	48.64	29.56	2.98	5.35	8.00	7.17	5.95	51.59	73.24	62.69	21.97	1741
PALAEMONETES PUGIO	72.25	13.90	9.69	3.39	.27	1.25	.17	1.21	3.55	2.06	11.86	.65	767 9.68
NERITINA RECLIVATA	1.30	4.53	15.03	47.20	2.97	.32	4.99	3.15	1.91	29.12	3.09	25.14	524 6.62
ACETES AMERICANUS	.29	.00	.00	.00	1.42	1.16	2.74	1.21	.55	.00	1.63	1.31	245 2.59
PENAEUS AZTECUS	.00	.30	24.22	4.90	.09	1.79	.85	.35	.27	.00	0.00	.00	243 2.56
LOLLIGUNCULA BREVIS	.43	1.82	13.32	5.24	1.59	.54	1.19	.12	.27	1.18	.00	1.31	142 1.79
PENAEUS DUORARUM	1.88	9.57	4.15	.05	1.24	.24	.17	2.26	.68	1.18	.52	.00	117 1.48
CALLINECTES SIMILIS	.87	8.16	8.13	1.65	.62	.05	.34	.73	.68	.29	.52	.00	106 1.34
RHITHROPANOPEUS HARRISII	.43	4.53	.35	2.45	.80	.39	.51	.00	.41	3.24	2.06	3.27	70 .88
XIPHOPENEUS KROYERI	0.00	.00	0.00	0.00	1.36	1.11	.00	1.45	0.00	.00	0.00	0.00	47 .59
PAGURUS POLLICARIS	.14	.00	0.00	0.00	.00	0.00	.51	1.81	.27	1.18	0.00	0.00	45 .32
RANGIA CUNEATA	.14	.30	0.00	.70	0.00	.00	1.71	.35	0.00	1.18	0.00	0.00	21 .27
PALAEMONETES VULGARIS	0.00	.30	.00	0.00	.62	.00	.51	.53	0.00	.59	0.00	0.00	18 .23
TRACHYPENAEUS SIMILIS	.58	.60	0.00	.00	0.00	0.00	0.00	1.21	.00	.00	0.00	.00	16 .20
SQUILLA EMPUSA	0.00	3.02	0.00	.00	.09	0.00	.17	0.00	0.00	0.00	1.55	0.00	15 .19
POLLINICES DUPLICATUS	0.00	0.00	0.00	.00	0.00	0.00	0.00	.24	0.00	1.75	2.06	.65	13 .16
PALAEMONETES INTERMEDIUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.65	0.00	0.00	9 .11
METAPORHAPHIS CALCARATA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.29	0.00	3.27	6 .08
OGYRIDES LIMICOLA	.14	0.00	0.00	.00	0.00	0.00	.00	.24	0.00	0.00	1.55	.00	6 .08
CRASSOSTREA VIRGINICA	0.00	0.00	0.00	0.00	0.00	0.00	.17	.24	.14	.59	0.00	0.00	6 .08
NEOPANOPE TEXANA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.18	0.00	.65	5 .06
CLIBANARIUS VITTATUS	.14	0.00	.17	.00	.18	0.00	0.00	.12	.00	0.00	0.00	.00	5 .06
PORTUNUS GIBBESII	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.24	0.00	.59	0.00	0.00	4 .05
TRACHYPENAEUS CONSTRICTUS	.00	.00	.00	.00	.09	0.00	.00	0.00	.27	0.00	0.00	.00	3 .04
APLYSIA SP.	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.03	0.00	2 .03

Table 8, continued

SPECIES	SAMPLE DATES 760315	760415	760515	760615	760715	760815	760915	761111	761119	761213	770125	770220	TOTALS
HIPPOLYTE PLEURACANTHA	0.07	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	.59	0.00	0.00	.03
NUDIBRANCH SP.	.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.03
HEMIPHOLIS ELONGATA	0.00	0.00	0.00	0.00	.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.03
PAGURUS LONGICARPUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.24	0.00	0.00	0.00	0.00	.03
ALPHEUS HETEROCHAELIS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.52	0.00	.01
ECHINARACHNIUS PARMA	0.00	0.00	0.00	0.00	0.00	.05	0.00	0.00	0.00	0.00	0.00	0.00	.01
LUIDIA CLATHRATA	0.00	0.00	0.00	0.00	0.00	.05	0.00	0.00	0.00	0.00	0.00	0.00	.01
PAGURUS BONAIRENSIS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.52	0.00	.01
PALAEMON FLORIDANUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.65	.01
BUSYCON CONTRARIUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.12	0.00	0.00	0.00	0.00	.01
PROCAMBARUS PENAENSALANUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.52	0.00	.01
TOTALS	692.0	331.0	578.0	286.0	1129.0	2072.0	536.0	827.0	733.0	341.0	194.0	153.0	7921.0

INLET SUMMARY BIOMASS WHOLE BAY 1ST YEAR
DATES 720301-730228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

Table 3: Summary of (dry weight) biomass (by species, by month) and percentage abundance of epibenthic invertebrates taken in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) from March, 1972 through February, 1977.

SPECIES	SAMPLE DATES 720329	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
CALLINECTES SAPIDUS	160.26 82.97	110.35 81.17	5.00 67.01	97.72 91.11	110.01 83.14	320.3 82.3	160.72 89.72	541.4 29.59	3.80 19.31	165.62 57.54	89.53 87.65	178.98 91.24	1667.74 54.52
PENAEUS SETIFERUS	36.11 15.95	3.61 2.31	43.68 6.34	1.01 .14	12.54 7.39	1.04 .52	1.86 .97	1413.7 57.33	14.63 73.52	13.4 3.74	1.58 1.20	2.27 1.16	2717.17 37.93
PENAEUS AZTECUS	1.72 .84	1.95 1.34	184.61 23.25	64.78 9.16	16.38 8.94	3.07 .98	3.61 1.92	1.33 .13	1.03 .052	1.03 .281	1.08 .608	1.44 .808	274.75 3.83
PENAEUS DUORARUM	0.00 0.00	5.89 4.25	14.57 1.82	1.26 0.02	4.36 1.29	5.30 1.39	8.72 4.65	77.33 3.57	33.77 2.24	32.11 17.34	18.74 14.18	1.81 .92	200.79 2.80
LOLLIGUNCULA BREVIS	0.00 0.00	0.00 0.00	4.07 .52	19.01 1.78	29.67 16.30	5.63 12.72	1.07 2.17	15.37 .91	3.58 2.04	1.01 1.01	.68 .51	0.00 0.00	157.48 2.20
CALLINECTES SIMILIS	0.00 0.00	0.00 0.00	1.01 0.00	3.00 3.00	0.00 0.00	.46 .12	1.00 1.00	47.13 1.81	2.01 1.50	2.62 1.41	16.59 12.54	3.64 1.91	76.36 .98
PALAEMONETES PUGIO	.44 .22	14.54 10.49	8.92 1.15	5.67 .53	.13 .07	.13 .03	1.66 1.00	1.44 1.01	1.00 1.00	.12 .01	1.22 .92	1.00 .51	32.07 .45
SQUILLA EMPUSA	0.00 0.00	0.00 0.00	1.00 0.00	1.00 1.00	.07 .04	1.00 1.00	1.00 1.00	14.14 .57	5.30 .52	3.13 1.72	1.00 1.00	1.40 .75	27.22 .38
PORTUNUS GIBBESII	1.00 0.00	0.00 0.00	1.01 0.00	.06 .01	1.00 1.00	.18 .05	1.00 1.00	11.53 .52	12.85 .80	.23 .13	.93 .74	.77 .39	26.59 .37
RANGIA CUNEATA	1.01 1.00	1.01 1.00	.00 0.00	4.34 .40	6.38 1.41	4.34 1.19	1.00 1.00	.85 .14	.86 .49	.85 .47	1.72 1.34	1.64 1.00	15.34 .22
POLLINICES DUPLICATUS	0.00 0.00	0.00 0.00	1.00 1.00	.51 .05	2.53 1.38	1.06 1.00	1.41 .54	3.14 .14	1.13 1.03	1.01 .01	1.01 0.00	1.00 1.00	7.09 .10
MENIPPE MERCENARIA	0.00 1.00	1.00 1.00	0.00 0.00	1.00 1.00	1.00 1.00	1.00 1.00	1.00 1.00	2.79 .13	1.04 1.00	.58 .31	1.06 1.00	1.00 1.00	3.38 .05
BUSYCON CONTRARIUM	0.00 0.00	1.00 0.00	1.00 1.00	1.00 0.00	1.00 1.00	1.10 1.10	1.00 1.10	1.01 1.01	1.01 1.00	2.28 1.19	0.00 0.00	1.00 1.00	2.24 .11
PALAEMONETES VULGARIS	.84 .42	.13 .09	0.00 0.00	.16 .02	0.00 0.00	.16 .02	1.00 1.00	.13 .01	.03 .00	1.01 1.01	1.00 0.00	.03 .02	1.31 .02
NERITINA RECLIVATA	1.00 1.00	.29 .18	.62 .08	.23 .02	0.00 0.00	1.00 1.00	1.00 1.00	1.01 1.01	1.00 1.00	1.01 1.01	1.00 1.00	.03 .01	1.13 .02
RHITHROPANOPEUS HARRISII	1.000000 0.00	.24054 .17	.24637 .03	.13648 .01	.13360 .07	.01349 .00	.01349 .01	1.01001 1.01	1.00000 1.00	1.01001 1.01	0.01000 0.00	.16314 .08	.94707 .01
TRACHYPENAEUS CONSTRICTUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.06672 .04	1.07702 .02	.03444 .02	.63513 .03	.08867 .01	1.00000 1.00	0.00000 0.00	0.01000 0.00	.90336 .01
ANADARA BRASILIANA	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.01000 0.00	0.00000 0.00	1.00000 1.00	0.01000 0.00	0.01000 0.00	.51564 .38	0.00000 0.00	.50564 .01
DINOCARDIUM ROBUSTUM	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.51564 .38	0.00000 0.00	.51564 .01
PAGURUS POLLICARIS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.44141 .32	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.44141 .01
SICYONIA DORSALIS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.15399 .01	0.01000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.15398 .00
NEOPANOPE PACKARDII	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.02426 .01	0.00000 0.00	0.00000 0.00	.02857 .02	.10421 .08	0.00000 0.00	.15836 .00
PALAEMON FLORIDANUS	0.00000 0.00	0.00001 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.00648 .00	0.00000 0.00	.03243 .01	0.00000 0.00	.03243 .02	0.00000 0.00	0.00000 0.00	.12964 .00
PALAEMONETES INTERMEDIUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	.00924 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.02333 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.11509 .00
HEXAPANOPEUS ANGUSTIFRONS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.10414 .03	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.10414 .00
PROGNABARUS PENAENSALANUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.09828 .07	0.00000 0.00	.09828 .00

Table 9, continued

SPECIES	SAMPLE DATES 720315	720415	72.515	72.615	72.715	72.815	72.915	721015	721115	721215	73.115	73.215	TOTALS
ALPHEUS ARMILLATUS	0.0 (0.0)	0.0 0.0	0.0 0.0	0.0 3593 0.1	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 0.0	0.0
ALPHEUS NORMANNI	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 0.0	0.0 0.0	0.0 0.0	0.0	0.0 0.0	0.0
XIPHOPENEUS KROYERI	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 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0
NEOPANOPE TEXANA	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	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0
BRANCHIOASYCHUS AMERICANA	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 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0
MULINIA LATERALIS	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	0.0 0.0	0.0	0.0 0.0	0.0	0.0 0.0	0.0
PERICLIMENES LONGICAUDATUS	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 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0
PERICLIMENES AMERICANUS	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	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0
OGYRIDES LIMICOLA	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	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.0
TOTALS	201.3	138.7	776.8	1068.8	183.2	395.1	137.5	2135.5	1536.0	185.1	132.3	135.6	7169.2

INVERT SUMMARY BIOMASS WHOLE BAY 2ND YEAR
DATES 73JUL1-74JUL2
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

SPECIES	SAMPLE DATES 73JUL15	73AUG15	73SEP15	73OCT15	73NOV15	73DEC15	74JAN15	74FEB15	74MAR15	74APR15	TOTALS
CALLINECTES SAPIDUS	233.41 92.28	367.12 96.43	249.69 94.37	448.99 93.87	317.31 79.68	373.09 85.13	413.66 85.82	3.3.37 23.79	55.55 49.73	6.8. 69.55	034.67 93.05	43.54 82.93	3595.44 74.19
PENAEUS SETIFERUS	0.91 3.53	.73 .19	1.93 .73	.04 1.06	64.62 16.08	31.49 7.17	.17 .01	502.82 54.39	23.49 11.07	7.52 8.09	1.3. .24	3.57 1.73	714.99 14.66
LOLLIGUNCULA BREVIS	0.01 0.00	1.36 .36	1.36 .51	0.00 0.00	0.15 2.05	4.75 1.08	61.69 12.73	73.42 7.75	61.77 29.11	8.52 9.49	.08 .14	0.14 0.00	227.61 4.69
PENAEUS DJORARUM	.11 .34	.01 .00	.96 .36	0.00 0.00	.85 .21	27.26 6.21	1.83 .38	51.33 5.83	13.07 7.13	3.44 3.95	16.65 2.56	13.43 2.81	143.52 2.95
PALAEMONETES PUGIO	8.15 3.23	4.35 .52	.72 .27	1.46 .92	.42 .01	.12 .20	0.00 0.00	0.01 0.01	.11 .12	.76 .12	34.64 8.79	47.61 .97
PORTUNUS SIBBESII	0.01 0.01	.46 .12	0.01 0.00	.36 .61	0.00 0.00	.29 .07	.19 .04	.77 .07	1.65 .78	0.01 0.01	9.91 1.52	3.71 1.96	27.35 .58
SQUILLA EMPUSA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.01	0.00 0.00	0.00 0.00	.06 .01	5.47 .53	.56 .26	0.00 0.00	13.73 2.11	5.51 1.11	25.28 .52
PENAEUS AZTECUS	0.00 0.00	0.00 0.00	9.15 3.46	0.79 4.28	1.27 .32	0.00 0.00	0.08 0.00	.51 .05	1.15 .54	2.85 3.58	0.00 0.00	.13 .03	21.85 .45
CALLINECTES SIMILIS	0.00 0.00	8.57 2.25	0.00 0.00	0.00 0.00	6.00 0.00	1.32 .30	0.00 0.00	0.01 0.01	0.00 0.00	1.93 2.09	1.21 .19	7.59 1.52	26.53 .42
NERITINA RECLIVATA	1.35 .54	0.10 0.00	.08 .03	.31 .20	.03 .01	0.06 0.00	0.00 0.00	0.01 0.01	0.01 0.01	.14 .02	0.99 1.01	6.91 .14
BUSYCON CONTRARIUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	6.59 1.66	1.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	6.59 .14
RHITHROPANOPEUS HARRISII	.05 .26	0.00 0.00	0.00 0.00	.05 .13	0.00 0.00	0.00 0.00	0.00 0.00	.17 .08	1.08 1.59	.07 .07	.12 .02	2.94 .06
LUIDIA CLATHRATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.01	0.00 0.00	0.00 0.00	0.00 0.01	2.07 .98	0.00 0.00	0.00 0.00	0.00 0.00	2.07 .04
POLLINICES DUPLICATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.01 .11	0.00 0.00	0.00 0.00	0.00 0.00	1.01 .20	2.03 .04
TRACHYPENAEUS CONSTRICTUS	0.00 0.00	0.00 0.00	.25 .09	0.00 0.00	0.00 0.00	0.00 0.00	.25 .03	.02 .01	0.00 0.00	.05 .01	1.51 .28	1.98 .04
NEOPANOPE TEXANA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.89 .13	0.00 0.00	0.00 0.00	.06 .01	0.00 0.00	1.95 .04
MENIPPE MERCENARIA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.53 .15	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.53 .03
PAGURUS POLLICARIS	0.00 0.00	0.00 0.00	.04 .17	.15 .09	0.00 0.00	0.00 0.00	.45 .01	.44 .21	0.01 0.01	0.00 0.00	0.00 0.00	1.17 .02
PALAEMONETES VULGARIS	.03246 .01	.06486 .02	0.00000 0.00	0.00000 0.00	0.01001 0.00	0.00000 0.00	0.00000 0.00	.12956 .01	.03726 .03	0.00000 0.00	.0648. .01	0.01296 0.00	.3888. .01
ALPHEUS HETEROCHAELIS	.22251 .09	0.00486 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.15473 .02	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.38724 .01
NEOPANOPE PACKARDII	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.03513 .02	.12687 .04	0.00000 0.00	.05586 .01	0.00000 0.00	.25986 .01
CLIBANARIUS VITTATUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.14010 .03	0.00000 0.00	0.00000 0.00	.10807 .07	0.00000 0.00	0.00000 0.00	0.00000 0.00	.29368 .01
PALAEMONETES INTERMEDIUS	.06900 .03	.12300 .04	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.09225 .00
METAPORHAPHIS CALCARATA	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.04747 .00	0.00000 0.00	.04747 .00
XIPHOPENEUS KROYERI	0.00000 0.00	0.01000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.01000 0.00	.03745 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.04745 .00
HEMIPHOLUS ELONGATA	0.00000 0.00	0.01000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.03500 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	.03500 .00

Table 9, continued

SPECIES	SAMPLE DATES 736415	736415	736515	736615	736715	736815	736915	731015	731115	731215	740115	740215	TOTALS
PERICLIMENES AMERICANUS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
BRACHIODONTES EXUSTUS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MULINIA LATERALIS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTALS	252.5	380.6	264.6	258.7	398.2	489.6	479.9	624.3	612.2	33.0	693.8	435.1	4848.6

INVERT SUMMARY BIOMASS MOBILE BAY 3RD YEAR
DATES 7405.1-7502.8
STATIONS 001 002 003 004 005 006 01A 01B 01C 35A
TIMES OF DAY D

Table 9, continued

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215	TOTALS
CALLINECTES SAPIDUS	28[illegible]	171.16	52.09	63.41	10.06	140.49	191.44	3.13	133.78	23.12	41.91	3.51	1,54.82
	92.12	93.72	55.39	75.91	31.34	13.30	55.75	22.57	25.71	3.37	73.71	6.51	43.21
PENAEUS SETIFERUS	18.54	2.48	.26	.61	9.38	1[illegible].5	7.03	273.76	207.97	1.[illegible]	4.68	3.56	1,33.5[illegible]
	5.99	1.57	.55	1.79	15.28	7.44	3.95	52.72	53.03	3.23	7.53	12.95	42.41
LOLLIGUNCULA BREVIS	2.00	(.0[illegible]	39.37	4.07	27.83	9.50	12.22	69.57	3.[illegible]	1.35	1.00	.68	133.44
	1.01	0.00	41.98	12.04	45.35	1.97	5.9	7.17	1.51	2.57	0.00	.87	4.38
PENAEUS DUORARUM	3.64	4.73	.04	.33	4.38	8.35	4.51	3.73	34.26	13.32	4.59	2.45	129.15
	1.17	2.57	0.00	2.75	7.13	1.42	1.58	2.11	11.93	3.74	8.06	3.24	4.83
PENAEUS AZTECUS	0.00	0.00	0.00	1.54	0.00	16.12	3.45	2.82	13.01	3.13	.66	1.54	44.16
	0.00	0.00	0.00	4.54	0.00	2.05	2.27	.53	2.41	3.79	1.23	1.97	1.65
CALLINECTES SIMILIS	0.00	3.42	.86	.67	.66	1.18	1.89	1.91	23.82	3.33	.93	1.44	42.53
	0.00	1.66	.92	1.97	1.18	.18	.79	.43	4.78	7.43	1.67	1.83	1.59
PALAEMONETES PUGIO	.13	.46	0.00	0.00	.04	.05	.06	0.00	0.00	3.14	3.42	2.31	16.81
	.04	.25	0.00	0.00	.71	.11	.11	0.00	0.00	5.93	5.02	2.95	.60
PORTUNUS GIBBESII	.91	0.00	2.68	0.00	0.00	0.00	0.00	5.23	0.00	0.00	0.00	2.12	8.25
	.29	0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	0.00	2.71	.31
SQUILLA EMPUSA	0.00	.83	0.00	1.00	0.00	.34	1.00	0.00	0.00	1.23	3.00	3.78	8.15
	0.00	.43	0.00	0.00	0.00	.16	0.00	0.00	0.00	2.33	0.00	4.82	.23
PALAEMONETES VULGARIS	.16	0.00	3.00	0.00	0.00	.22	0.00	.13	1.33	1.21	.58	.14	3.59
	.03	0.00	0.00	0.00	0.00	.04	0.00	.02	.26	2.27	1.23	.12	.14
PAGURUS POLLICARIS	0.00	.15	.15	0.00	0.00	.08	0.00	0.00	.44	0.00	0.00	0.00	1.61
	0.00	.08	.16	0.00	0.00	.15	0.00	0.00	.08	0.00	0.00	0.00	.45
TRACHYPENAEUS SIMILIS	.97	0.00	0.00	0.00	0.00	0.00	.16	0.00	0.00	0.00	0.00	0.00	1.13
	.31	0.00	0.00	0.00	0.00	0.00	.07	0.00	0.00	0.00	0.00	0.00	.04
NERITINA RECLIVATA	0.000000	.08450	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.25331	.13744	.31320	.84600
	0.00	.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.48	.35	.42	.23
OVALIPES GUADULPENSIS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.06[illegible]25	0.000000	0.000000	.06[illegible]25
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.00	0.00	.02
METAPORHAPHIS CALCARATA	.27262	0.000000	0.000000	0.000000	0.000000	.07525	0.000000	0.000000	0.000000	.07525	0.000000	.07565	.49777
	.39	0.00	0.00	0.00	0.00	.11	0.00	0.00	0.00	.14	0.00	.14	.12
TRACHYPENAEUS CONSTRICTUS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.21208	0.000000	0.000000	0.000000	.23444	.44652
	0.00	0.00	0.00	0.00	0.00	0.00	.09	0.00	0.00	0.00	.30	.12	
PERSEPHONA MEDITERRANEA	0.000000	0.000000	0.000000	0.000000	0.000000	.41313	0.000000	0.000000	0.000000	0.000000	0.000000	.41303	
	0.00	0.00	0.00	0.00	0.00	.17	0.00	0.00	0.00	0.00	0.00	0.00	.02
RHITHROPANOPEUS HARRISII	0.000000	0.000000	0.000000	0.000000	.06714	0.000000	.01833	.03963	0.000000	.09555	.21468	0.000000	.39426
	0.00	0.00	0.00	0.00	.01	0.00	.00	.02	0.00	.13	.38	0.00	.01
HEXAPANOPEUS ANGUSTIFRONS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.19344	0.000000	0.000000	0.000000	.18344
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.03	0.00	0.00	0.00	.01
PAGURUS LONGICARPUS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.14586	.14586	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.19	.31	
NEOPANOPE TEXANA	0.000000	.11938	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.11938
	0.00	.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
EURYPANOPEUS DEPRESSUS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.05207	0.000000	0.000000	.05207
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.13	0.00	0.00	.00
POJOCHELA RIISEI	0.000000	0.000000	0.000000	0.000000	0.000000	.04485	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.04485
	0.00	0.00	0.00	0.00	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	.00
HEMIPHOLUS ELONGATA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.03360	.03360
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.05	.00
PALAEMON FLORIDANUS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.03245	0.000000	.03245
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.06	0.00	.00
TOZEUMA CAROLINENSE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	.00714	0.000000	0.000000	0.000000	.00714
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00	0.00	0.00	0.00	.00

Table 9, continued

SPECIES	SAMPLE DATES 740415	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215	TOTALS
MYSID SP.	0.00 (0.0)	0.00 (0.0)	1.00 (1.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
NUDIBRANCH SP.	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)	0.00 (0.0)
TOTALS	321.5	184.1	93.8	33.8	61.4	6.3.4	249.1	415.5	5[illegible]	32.7	58.3	79.3	2672.6

INVERT SUMMARY BIOMASS WHOLE BAY 4TH YEAR
DATES 75[illegible]-7[illegible]
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

Table 9, continued

SPECIES	SAMPLE DATES 75.315	75.415	75.515	75.615	75.715	75.815	75.915	751015	751115	751215	76.115	76.215	TOTALS
CALLINECTES SAPIDUS	754.29 95.81	[illegible] 89.17	492.17 54.49	431.14 79.35	266.57 76.76	186.67 78.42	135.60 2.54	227.55 91.52	87.62 32.58	147.65 72.21	53.16 92.39	33.26 82.25	2700.37 65.49
PENAEUS SETIFERUS	17.61 2.19	7.03 .15	61.4 5.97	4.21 .55	7.48 2.5[illegible]	64.63 26.7[illegible]	94[illegible].09 63.[illegible]	172.19 39.13	83.77 42.77	18.34 9.92	.42 .04	2.44 4.29	716.9[illegible] 18.1[illegible]
PENAEUS DUORARUM	2.53 .32	19.44 2.7[illegible]	19.29 5.47	15.08 8.46	[illegible].0[illegible] [illegible].[illegible]	.23 .31	37.37 7.22	3.31 .91	8.51 4.1[illegible]	2.42 1.27	.37 .6[illegible]	.72 1.51	169.37 2.78
PENAEUS AZTECUS	0.[illegible] 0.[illegible]	[illegible].[illegible] 0.[illegible]	68.95 19.55	4.32 1.51	10.77 3.75	.78 .58	14.[illegible] 2.[illegible]	1.35 .44	4.93 2.58	.2[illegible] .11	[illegible].[illegible] 0.[illegible]	[illegible].[illegible] 3.8[illegible]	144.82 2.65
LOLLIGUNCULA BREVIS	[illegible].[illegible] 0.[illegible]	2.[illegible] .33	2.[illegible] .58	1.[illegible] 5.14	24.[illegible] 8.[illegible]	[illegible].75 2.32	[illegible].7 .79	12.22 2.75	1[illegible].25 5.87	21.[illegible] 11.32	[illegible].06 [illegible].[illegible]	2.34 4.27	97.75 2.47
PALAEMONETES PUGIO	7.13 .91	24.38 3.66	19.49 5.56	.74 .42	1.68 .58	.32 .26	.7[illegible] .[illegible]3	5.33 1.52	3.18 4.42	.33 .17	.74 1.21	2.49 3.21	74.65 1.83
CALLINECTES SIMILIS	1.57 .2[illegible]	1[illegible].21 1.5[illegible]	2.41 .68	2.96 1.67	4.[illegible] 1.97	.56 .3[illegible]	1[illegible].88 2.1[illegible]	11.[illegible]3 2.51	11.[illegible]7 5.43	7.[illegible] 3.59	[illegible].[illegible] [illegible].[illegible]	[illegible].[illegible] [illegible].[illegible]	62.54 1.58
NERITINA RECLIVATA	.06 .01	5.33 .78	23.6[illegible] 5.69	1.64 .92	6.[illegible]2 2.2[illegible]	.17 .[illegible]8	.[illegible]8 .[illegible]2	[illegible].[illegible]4 [illegible].[illegible]7	.39 .19	[illegible].[illegible]3 [illegible].[illegible]7	[illegible].[illegible]6 [illegible].[illegible]3	.23 .47	37.32 .35
TRACHYPENAEUS CONSTRICTUS	[illegible].00 0.00	[illegible].[illegible]4 [illegible].00	[illegible].[illegible]0 [illegible].[illegible]	[illegible].00 [illegible].[illegible]	7.77 2.7[illegible]	[illegible].[illegible]6 [illegible].[illegible]8	.[illegible]4 .[illegible]1	.[illegible]3 .[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	.33 .33	[illegible].[illegible]3 [illegible].[illegible]4	[illegible].[illegible]6 [illegible].[illegible]3	8.88 .22
PORTUNUS SIBBESII	[illegible].8[illegible] .23	0.[illegible] [illegible].00	0.[illegible]4 [illegible].[illegible]6	[illegible].[illegible]8 [illegible].[illegible]6	1.[illegible]7 .65	[illegible].[illegible]0 [illegible].[illegible]8	.2[illegible] .[illegible]4	.97 .22	.25 .12	[illegible].[illegible]1 [illegible].[illegible]0	[illegible].[illegible]8 [illegible].[illegible]8	[illegible].[illegible]3 [illegible].[illegible]6	5.11 .13
RHITHROPANOPEUS HARRISII	.[illegible]5 .[illegible]1	.54 .[illegible]8	1.94 .55	[illegible].[illegible]6 [illegible].[illegible]6	.46 .16	.[illegible]1 .[illegible]5	.15 .[illegible]3	.2[illegible] .[illegible]5	.23 .11	.14 .[illegible]7	.14 .23	.62 1.36	4.64 .12
CRASSOSTREA VIRGINICA	[illegible].00 [illegible].[illegible]	0.[illegible]0 [illegible].[illegible]3	0.[illegible]0 [illegible].[illegible]0	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	2.26 1.[illegible]8	[illegible].[illegible]6 [illegible].[illegible]3	[illegible].[illegible]1 [illegible].[illegible]3	[illegible].[illegible]1 [illegible].[illegible]3	2.[illegible] 1.15	0.[illegible] [illegible].[illegible]0	[illegible].[illegible]8 [illegible].[illegible]6	4.[illegible] .11
SQUILLA EMPUSA	[illegible].[illegible]0 0.[illegible]6	2.[illegible]1 .29	[illegible].[illegible]6 [illegible].[illegible]0	[illegible].[illegible]6 [illegible].[illegible]0	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]10 [illegible].[illegible]0	[illegible].00 [illegible].[illegible]6	.30 .11	.71 .34	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]6	[illegible].[illegible]0 [illegible].[illegible]6	3.22 .18
PAGURUS POLLICARIS	.44 .06	1.32 .19	.15 .04	[illegible].[illegible]6 [illegible].[illegible]6	.44 .15	[illegible].[illegible]0 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]1 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	.15 .[illegible]8	.59 .96	[illegible].[illegible]3 [illegible].[illegible]6	3.18 .08
CLIBANARIUS VITTATUS	.73 .09	.15 .02	[illegible].[illegible]3 [illegible].[illegible]3	.15 .08	.39 .20	.15 .17	.15 .03	.53 .13	.15 .07	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]4 [illegible].[illegible]3	[illegible].[illegible]6 [illegible].[illegible]6	2.64 .17
RANGIA CUNEATA	.86 .11	[illegible].[illegible]8 0.[illegible]	0.[illegible]6 [illegible].[illegible]6	[illegible].[illegible]0 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	0.[illegible]0 [illegible].[illegible]0	[illegible].[illegible]4 [illegible].[illegible]6	.[illegible]3 .[illegible]2	.[illegible]5 .41	[illegible].[illegible]1 [illegible].[illegible]1	[illegible].[illegible]4 [illegible].[illegible]6	[illegible].[illegible]0 [illegible].[illegible]0	2.58 .17
BUSYCON CONTRARIUM	[illegible].[illegible]6 0.[illegible]0	[illegible].[illegible]0 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]0 [illegible].[illegible]0	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]1 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]1 [illegible].[illegible]3	6.26 3.60	[illegible].[illegible]6 [illegible].[illegible]6	2.20 .16
TRACHYPENAEUS SIMILIS	[illegible].[illegible]3 [illegible].[illegible]0	.89 .13	.43 .12	[illegible].[illegible]0 [illegible].[illegible]0	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]0 [illegible].[illegible]0	[illegible].[illegible]6 [illegible].[illegible]0	[illegible].[illegible]1 [illegible].[illegible]3	[illegible].[illegible]1 [illegible].[illegible]3	[illegible].[illegible]1 [illegible].[illegible]3	[illegible].[illegible]0 8.66	.27 .57	1.59 .04
POLLINICES DUPLICATUS	0.[illegible]0 [illegible].00	[illegible].[illegible]0 [illegible].[illegible]3	.51 .14	[illegible].[illegible]0 0.[illegible]6	.51 .18	0.[illegible]0 [illegible].[illegible]0	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]0 [illegible].[illegible]3	[illegible].[illegible]1 [illegible].[illegible]0	[illegible].[illegible]1 [illegible].[illegible]1	.54 .83	[illegible].[illegible]6 [illegible].[illegible]6	1.52 .04
PALAEMONETES VULGARIS	.32401 .04	.2592[illegible] .4	0.0[illegible]6 [illegible].[illegible]0	0.0[illegible]6 [illegible].[illegible]8	0.[illegible]6 [illegible].[illegible]6	0.[illegible]6 [illegible].[illegible]0	0.[illegible]6 [illegible].[illegible]0	[illegible].[illegible]4 [illegible].[illegible]3	.13240 .02	[illegible].[illegible]8 [illegible].[illegible]4	0.[illegible]6 [illegible].[illegible]3	.[illegible]6[illegible]6 .14	.88[illegible]40 .02
XIPHOPENEUS KROYERI	0.[illegible]0 0.[illegible]0	[illegible].[illegible]0 [illegible].[illegible]3	0.[illegible]0 [illegible].[illegible]0	0.[illegible]0 [illegible].[illegible]6	.17393 .[illegible]6	[illegible].[illegible]0 [illegible].[illegible]0	[illegible].[illegible]0 [illegible].[illegible]0	.[illegible]5377 .18	[illegible].[illegible]4 [illegible].[illegible]3	[illegible].[illegible]6 [illegible].[illegible]3	[illegible].[illegible]0 [illegible].[illegible]0	[illegible].[illegible]1 [illegible].[illegible]0	.5577[illegible] .[illegible]1
ALPHEUS HETEROCHAELIS	0.[illegible]0 0.[illegible]0	[illegible].[illegible]6 [illegible].[illegible]0	.25628 .07	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]6 [illegible].[illegible]3	[illegible].[illegible]6 [illegible].[illegible]4	.2562[illegible] .42	0.[illegible]0 [illegible].[illegible]6	.51256 .[illegible]1
PROGEBARUS PENAENSALANUS	0.[illegible]6 [illegible].[illegible]0	0.[illegible]6 [illegible].[illegible]0	.28435 .08	0.[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]6 [illegible].[illegible]0	0.[illegible]0 [illegible].[illegible]6	.28435 .[illegible]1
SICYONIA BREVIROSTRIS	0.[illegible]0 [illegible].[illegible]0	0.[illegible]6 [illegible].[illegible]3	.[illegible]7804 .[illegible]2	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	0.[illegible]6 [illegible].[illegible]6	0.[illegible]0 [illegible].[illegible]6	.[illegible]7804 .[illegible]1
NEOPANOPE TEXANA	.[illegible]0833 .[illegible]1	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	.[illegible]67[illegible] .[illegible]2	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	0.[illegible]6 [illegible].[illegible]6	0.[illegible]0 [illegible].[illegible]6	.[illegible]7533 .[illegible]0
MENIPHOLIS ELONGATA	.[illegible]3[illegible] .[illegible]	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]3 [illegible].[illegible]3	[illegible].[illegible]6 [illegible].[illegible]6	[illegible].[illegible]0 [illegible].[illegible]6	.[illegible]35[illegible] .[illegible]

Table 9, continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
PAGURUS BINAIRENSIS	0.0030	.0000	.0070	0.0000	.0000	.0000	.0000	.0000	.0010	0.0000	.0000	.0000	.0130
PERICLIMENES AMERICANUS	.0000	.0000	.0000	.0035	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0035
TOZEUMA CAROLINENSE	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0000	.0000	.0000	.0000	.0000	.0001
MYSID SP.	.0010	.0000	.0011	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0021
NUDIBRANCH SP.	.0002	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0002
TOTALS	787.1	681.9	352.6	177.0	267.4	2.4.4	57.6	439.1	237.5	191.1	61.2	47.7	4954.6

INVERT SUMMARY BIOMASS MOBILE BAY 5TH YEAR
DATES 76JUL-77DEC8
STATIONS 611 612 613 614 615 616 617A 617B 617C 654
TIMES OF DAY D

Table 9, continued

SPECIES	SAMPLE DATES 76JUL15	76AUG16	76AUG26	76SEP15	76SEP16	76OCT15	76OCT27	76NOV11	76NOV19	76DEC13	77JAN25	77FEB20	TOTALS
CALLINECTES SAPIDUS	279.68 89.25	427.70 79.75	519.15 62.03	260.03 84.12	294.39 62.28	120.17 20.36	91.10 21.01	73.31 22.42	147.18 94.97	91.65 77.73	31.24 79.19	33.44 85.22	2346.23 55.13
PENAEUS SETIFERUS	11.77 3.59	14.10 2.64	3.56 .42	1.19 .44	149.93 32.15	457.24 74.41	32.71 7.83	231.24 71.34	51.93 25.93	3.44 2.92	.00 .00	.00 .00	1268.23 29.84
PENAEUS AZTECUS	0.00 0.00	2.59 .48	180.95 22.49	13.22 7.13	5.11 .66	14.26 1.64	3.68 .79	1.37 .37	.83 .39	3.03 .00	0.00 .00	.00 .00	227.52 5.35
CALLINECTES SIMILIS	12.61 3.85	34.84 6.49	32.54 3.91	9.42 1.04	.99 .21	.27 .06	.83 .20	3.32 1.49	11.84 4.79	2.95 2.42	.22 .57	0.00 .00	105.74 2.48
PENAEUS DUORARUM	9.22 2.81	39.99 7.45	34.79 4.19	1.45 .54	6.72 1.44	.37 .16	.37 .09	2.26 .52	.32 .14	1.05 .88	3.86 9.79	.00 .00	141.44 2.37
LOLLIGUNCULA BREVIS	2.04 .62	4.07 .76	52.27 6.29	14.18 3.78	16.22 2.61	4.75 .77	4.75 1.14	.53 .13	1.36 .62	2.72 2.23	.00 .00	1.36 3.59	95.39 2.25
RANGIA CUNEATA	.86 .26	.86 .16	1.00 .00	1.72 .64	0.00 .00	3.26 .00	3.61 2.06	2.53 .71	.00 .00	3.44 2.83	.00 .00	.00 .00	18.15 .42
PALAEMONETES PUGIO	10.9 3.32	1.00 .19	1.22 .15	.52 .19	.07 .01	.57 .09	.52 .01	.22 .05	1.54 .67	.15 .13	.50 1.27	.02 .06	16.72 .39
MERITINA RECLIVATA	.25 .08	.42 .08	1.64 .25	3.81 1.41	.82 .17	.34 .09	.82 .20	1.83 .52	.39 .17	2.74 2.34	.17 .43	1.13 2.98	14.66 .34
CRASSOSTREA VIRGINICA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.20 .53	0.43 1.23	2.24 .97	0.43 3.59	0.00 0.00	0.00 0.00	13.18 .31
SQUILLA EMPUSA	0.00 0.00	9.51 1.79	0.00 0.00	0.00 0.00	.66 .14	0.00 0.00	.90 .21	1.11 1.03	1.11 1.00	0.00 0.00	.99 2.50	0.00 0.00	12.14 .29
XIPHOPENEUS KROYERI	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.04 .00	3.42 1.53	0.00 0.00	.55 .13	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	10.32 .26
POLLINICES DUPLICATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.01 .28	0.00 0.00	0.00 2.99	2.03 5.13	.51 1.34	6.53 .15
PAGURUS POLLICARIS	.15 .04	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.44 .11	2.21 .58	.29 .13	.53 .43	0.00 0.00	0.00 0.00	3.67 .09
RHITHROPANOPEUS HARRISII	.27 .08	.52 .10	.03 .00	.30 .11	.47 .10	.15 .02	.11 .03	0.00 0.00	.01 .14	.85 .71	.15 .39	.27 .71	3.44 .08
BUSYCON CONTRARIUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.21 .51	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.21 .05
LUIDIA CLATHRATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.07 .34	0.00 0.00	0.00 0.00	0.00 0.00	3.03 2.83	0.00 0.00	0.00 0.00	2.07 .05
TRACHYPENAEUS SIMILIS	.13 .04	.66 .12	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.73 .21	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.54 .04
METAPORHAPHIS CALCARATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.41 .25	0.00 0.00	1.00 2.09	1.41 .03
PORTUNUS GIBBESII	0.00006 0.00	0.00004 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.41325 .11	0.11003 0.00	.53371 .43	0.00000 0.00	0.00000 0.00	.95196 .02
CLIBANARIUS VITTATUS	.14688 .04	0.00000 0.00	.14688 .02	0.00000 0.00	.29376 .06	0.00000 0.00	0.00000 0.00	.14688 .04	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.73440 .02
PALAEMONETES VULGARIS	0.00000 0.00	.13245 .01	0.00000 0.00	0.00000 0.00	.22688 .05	0.00000 0.00	.03729 .01	.15233 .04	0.00000 0.00	.05601 .05	0.00000 0.00	0.00000 0.00	.58328 .01
NEOPANOPE TEXANA	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.43699 .33	0.00000 0.00	.05700 .18	.52398 .01
TRACHYPENAEUS CONSTRICTUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.04826 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	.27817 .12	0.00000 0.00	0.00000 0.00	0.00000 0.00	.32643 .01
PAGURUS LONGICARPUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.23365 .05	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.23365 .01
ALPHEUS HETEROCHAELIS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.29316 .74	0.00000 0.00	.29316 .01

Table 9, continued

SPECIES	SAMPLE DATES 76.315	76.415	76.515	76.615	76.715	76.815	76.915	761111	761119	761213	771125	77.224	TOTALS
PALAEMONETES INTERMEDIUS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ECHINARACHNIUS PARMA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HEMIPHOLIS ELONGATA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PALAEMON FLORIDANUS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAGURUS BONAIRENSIS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PROCAMBARUS PENAENSALANUS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NUDIBRANCH SP.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTALS	328.3	536.5	831.2	269.6	467.9	614.8	418.4	356.3	226.4	119.1	39.5	37.9	4255.9

FISH SUMMARY 1ST YEAR
DATES 720301-730228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

Table 10: Summary of total numbers (by species, by month) and percent dominance of fishes taken in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
ANCHOA MITCHILLI	304 67.26	181 18.26	269 15.96	1077 68.21	2189 78.07	393 57.71	507 54.81	5070 86.30	3867 80.56	455 65.08	176 49.72	74 4.79	14582 64.76
MICROPOGON UNDULATUS	84 18.58	548 55.30	421 23.25	4 .25	25 .89	1 .15	19 2.05	1 .02	259 5.40	93 13.29	48 13.56	1267 82.06	2770 12.30
CYNOSCION ARENARIUS	0 0.00	9 .91	750 41.41	127 8.04	394 14.05	66 9.69	135 14.59	141 2.40	249 5.19	23 3.29	2 .56	0 0.00	1696 8.42
CHLOROSCOMBRUS CHRYSURUS	3 .66	0 0.00	2 .11	0 0.00	3 .11	27 3.96	146 15.78	265 4.51	14 .29	0 0.00	0 0.00	0 0.00	460 2.04
BAIRDIELLA CHRYSURA	2 .44	0 0.00	8 .44	207 13.11	8 .29	23 3.38	0 0.00	37 .63	125 2.60	33 4.71	2 .56	3 .19	448 1.99
LEIOSTOMUS XANTHURUS	2 .44	0 0.00	208 11.49	6 .38	12 .43	2 .29	1 .11	2 .03	7 .15	7 1.00	59 16.67	66 4.27	372 1.65
ARIUS FELIS	1 .22	0 0.00	2 .11	9 .57	55 1.96	73 10.72	30 3.24	53 .90	30 .62	0 0.00	0 0.00	0 0.00	253 1.12
MENTICIRRHUS AMERICANUS	0 0.00	0 0.00	9 .50	16 1.01	54 1.93	23 3.38	14 1.51	53 .90	46 .96	21 3.00	0 0.00	2 .13	238 1.06
TRINECTES MACULATUS	23 5.09	17 1.72	62 3.42	17 1.08	11 .39	3 .44	4 .43	10 .17	4 .08	0 0.00	0 0.00	4 .26	155 .69
PRIONOTUS TRIBULUS	0 0.00	0 0.00	0 0.00	3 .19	3 .11	4 .59	20 2.16	54 .92	58 1.21	2 .29	1 .28	4 .26	149 .66
ETROPUS CROSSOTUS	1 .22	5 .50	8 .44	6 .38	12 .43	8 1.17	9 .97	49 .83	36 .75	4 .57	7 1.98	3 .19	148 .66
SYMPHURUS PLAGIUSA	1 .22	2 .20	2 .11	5 .32	3 .11	2 .29	6 .65	55 .94	18 .37	10 1.43	4 1.13	20 1.30	128 .57
LUCANIA PARVA	2 .44	114 11.50	2 .11	1 .06	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	1 .14	1 .28	0 0.00	122 .54
MENIDIA BERYLLINA	21 4.65	0 0.00	3 .17	0 0.00	0 0.00	0 0.00	0 0.00	6 .10	1 .02	0 0.00	27 7.63	56 3.63	114 .51
GOBIOSOMA BOSCI	1 .22	21 2.12	8 .44	5 .32	1 .04	2 .29	3 .32	8 .14	24 .50	2 .29	0 0.00	7 .45	82 .36
LAGODON RHOMBOIDES	0 0.00	38 3.83	3 .17	4 .25	2 .07	0 0.00	0 0.00	6 .10	4 .08	3 .43	7 1.98	1 .06	68 .30
MICROGOBIUS GULOSUS	1 .22	6 .61	9 .50	8 .51	1 .04	2 .29	0 0.00	11 .19	13 .27	0 0.00	0 0.00	0 0.00	51 .23
CYNOSCION NEBULOSUS	0 0.00	3 .30	0 0.00	1 .06	0 0.00	7 1.03	1 .11	8 .14	6 .12	12 1.71	5 1.41	0 0.00	43 .19
DASYATIS SABINA	1 .22	3 .30	3 .17	6 .38	1 .04	0 0.00	1 .11	10 .17	3 .06	4 .57	0 0.00	1 .06	33 .15
ORTHOPRISTIS CHRYSOPTERA	0 0.00	0 0.00	6 .33	24 1.52	0 0.00	0 0.00	0 0.00	0 0.00	1 .02	1 .14	0 0.00	0 0.00	32 .14
SYNGNATHUS SCOVELLI	0 0.00	9 .91	3 .17	13 .82	1 .04	4 .59	1 .11	0 0.00	0 0.00	0 0.00	0 0.00	1 .06	32 .14
EUCINOSTOMUS ARGENTEUS	0 0.00	0 0.00	0 0.00	0 0.00	6 0.00	22 3.23	0 0.00	0 0.00	5 .10	0 0.00	3 .85	0 0.00	30 .13
BREVOORTIA PATRONUS	0 0.00	29 2.93	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	29 .13
EUCINOSTOMUS GULA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .43	2 .03	1 .02	19 2.71	0 0.00	1 .06	27 .12
SYNODUS FOETENS	0 0.00	0 0.00	3 .17	4 .25	3 .11	1 .15	2 .22	5 .09	5 .10	1 .14	0 0.00	0 0.00	24 .11
SPHOEROIDES NEPHELUS	0 0.00	0 0.00	1 .06	11 .70	3 .11	0 0.00	2 .22	5 .09	0 0.00	0 0.00	1 .28	0 0.00	23 .10

Table 10, continued

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
PEPRILUS PARU	0 0.00	0 0.00	0 0.00	0 0.00	6 .21	1 .15	12 1.30	3 .05	1 .02	0 0.00	0 0.00	0 0.00	23 .10
PARALICHTHYS LETHOSTIGMA	0 0.00	0 0.00	2 .11	2 .13	7 .25	3 .44	3 .32	1 .02	0 0.00	0 0.00	0 0.00	0 0.00	18 .08
PRIONOTUS SCITULUS	0 0.00	1 .10	0 0.00	0 0.00	0 0.00	0 0.00	1 .11	4 .07	4 .08	3 .43	2 .56	2 .13	17 .08
CHAETODIPTERUS FABER	0 0.00	0 0.00	0 0.00	0 0.00	6 .21	3 .44	1 .11	5 .09	0 0.00	0 0.00	0 0.00	0 0.00	15 .07
PORICHTHYS POROSISSIMUS	1 .22	0 0.00	0 0.00	12 .76	0 0.00	0 0.00	0 0.00	2 .03	0 0.00	0 0.00	0 0.00	0 0.00	15 .07
SYNGNATHUS FLORIDAE	0 0.00	0 0.00	1 .06	3 .19	0 0.00	3 .44	2 .22	3 .05	1 .02	0 0.00	0 0.00	0 0.00	13 .06
MICROGOBIUS THALASSINUS	1 .22	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .28	10 .65	12 .05
LEPISOSTEUS OSSEUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02	1 .02	1 .14	0 0.00	8 .52	11 .05
SYNGNATHUS LOUISIANAE	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	7 1.03	0 0.00	0 0.00	2 .04	0 0.00	0 0.00	0 0.00	10 .04
UROPHYCIS FLORIDANUS	1 .22	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .28	8 .52	10 .04
ARCHOSARGUS PROBATOCEPHALUS	2 .44	0 0.00	0 0.00	1 .06	0 0.00	0 0.00	0 0.00	0 0.00	3 .06	0 0.00	0 0.00	1 .06	7 .03
GOBIONELLUS HASTATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02	6 .12	0 0.00	0 0.00	0 0.00	7 .03
MONACANTHUS CILIATUS	0 0.00	0 0.00	0 0.00	4 .25	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 .02
DOROSOMA PETENENSE	0 0.00	1 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .04	1 .14	0 0.00	0 0.00	4 .02
HARENGULA PENSACOLAE	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .26	4 .02
CENTROPRISTIS MELANA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02	1 .02	0 0.00	0 0.00	1 .06	3 .01
GOBIOSOMA ROBUSTUM	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .43	0 0.00	0 0.00	3 .01
MICROPTERUS SALMOIDES	0 0.00	0 0.00	3 .17	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
SCIAENOPS OCELLATA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .85	0 0.00	3 .01
STRONGYLURA MARINA	0 0.00	1 .10	2 .11	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
ALOSA ALABAMAE	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .04	0 0.00	0 0.00	0 0.00	2 .01
CHILOMYCTERUS SCHOEPFI	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	0 0.00	0 0.00	1 .02	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
ICTALURUS CATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .56	0 0.00	2 .01
ICTALURUS PUNCTATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .56	0 0.00	2 .01
MONACANTHUS HISPIDUS	0 0.00	2 .20	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
SELENE VOMER	0 0.00	0 0.00	0 0.00	0 0.00	1 .04	0 0.00	1 .11	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
ALUTERUS SCHOEPFI	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .00

Table 10, continued

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
ANCHOA HEPSETUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00	0.00	0.00	0.00	.00
APLECTRUM FORMOSUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00	0.00	0.00	.00
BOBOSOMA CEPEDIANUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.14	0.00	0.00	.00
LUTJANUS GRISEUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.02	0.00	0.00	0.00	0.00	.00
OPHICHTHUS GOMESI	0.00	.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
PRIONOTUS RUBIO	0.00	0.00	.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
SCHINOPTERA BONASUS	0.00	0.00	0.00	0.00	0.00	.15	0.00	0.00	0.00	0.00	0.00	0.00	.00
SYRACHINOTUS FALCATUS	0.00	0.00	0.00	0.00	.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
TOTALS	452.0	991.0	1811.0	1573.0	2004.0	681.0	925.0	5875.0	4888.0	788.0	354.0	1544.0	22516.0

DATES 730301-740228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

Table 10, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
MICROPOGON UNDULATUS	1931 65.06	1557 40.45	1787 74.09	871 44.53	84 15.67	35 6.34	1 .24	3 .16	36 3.02	150 12.61	544 34.65	1128 67.38	8127 40.21
ANCHOA MITCHILLI	444 14.96	136 3.53	79 3.28	75 3.83	181 33.77	43 7.79	27 6.59	1225 64.51	787 66.02	865 72.77	756 48.15	156 9.31	4775 23.63
HARENGULA PENSACOLAE	0 0.00	1879 48.82	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1879 9.30
LEIOSTOMUS XANTHURUS	433 14.59	160 4.16	342 14.18	371 18.97	1 .19	0 0.00	1 .24	17 .90	67 5.62	6 .50	6 .38	69 4.12	1473 7.29
CYNOSCION ARENARIUS	1 .03	3 .08	37 1.53	31 1.58	101 18.84	268 48.55	94 22.93	137 7.21	37 3.10	6 .50	0 0.00	1 .06	716 3.54
POLYDACTYLUS OCTONEMUS	12 .40	28 .73	43 1.78	544 27.81	33 6.16	3 .54	1 .24	2 .11	8 0.00	0 0.00	1 .06	0 0.00	667 3.30
CHLOROSCOMBRUS CHRYSURUS	0 0.00	0 0.00	0 0.00	0 0.00	11 2.05	3 .54	108 26.34	192 10.11	0 0.00	0 0.00	0 0.00	0 0.00	314 1.55
TRINECTES MACULATUS	21 .71	17 .44	58 2.40	29 1.48	36 6.72	19 3.44	14 3.41	45 2.37	1 .08	0 0.00	29 1.85	26 1.55	295 1.46
EUCINOSTOMUS ARGENTEUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .36	35 8.54	35 1.84	124 10.40	27 2.27	0 0.00	2 .12	225 1.11
BAIRDIELLA CHRYSURA	1 .03	7 .18	0 0.00	1 .05	3 .56	17 3.88	0 0.00	36 1.90	23 1.93	57 4.79	68 4.33	5 .38	218 1.08
ARIUS FELIS	1 .03	3 .08	7 .29	10 .51	27 5.04	70 12.68	21 5.12	10 .53	8 .67	0 0.00	0 0.00	0 0.00	157 .78
MENTICIRRHUS AMERICANUS	0 0.00	0 0.00	0 0.00	1 .05	6 1.12	21 3.80	18 4.39	44 2.32	38 3.19	4 .34	1 .06	0 0.00	133 .66
MICROGOBIUS GULOSUS	20 .67	24 .62	3 .12	2 .10	8 1.49	9 1.63	10 2.44	5 .26	1 .08	7 .59	8 .51	9 .54	186 .92
PARALICHTHYS LETHOSTIGMA	1 .03	14 .36	14 .58	4 .20	6 1.12	17 3.80	2 .49	4 .21	4 .34	0 0.00	4 .25	18 1.07	88 .44
LAGODON RHOMBOIDES	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	1 .10	0 0.00	3 .16	1 .08	17 1.43	3 .19	55 3.28	81 .40
ANCHOA HEPSETUS	0 0.00	0 0.00	0 0.00	0 0.00	12 2.24	6 1.09	54 13.17	2 .11	2 .17	1 .08	3 .19	0 0.00	80 .40
LUCANIA PARVA	0 0.00	1 .03	2 .08	0 0.00	0 0.00	1 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	74 4.42	78 .39
SYMPHURUS PLAGIUSA	31 1.04	3 .08	2 .08	1 .05	3 .56	6 1.09	0 0.00	5 .26	0 0.00	6 .50	11 .78	8 .48	76 .38
PRIONOTUS TRIBULUS	4 .13	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .49	35 1.84	6 .50	0 0.00	19 1.21	3 .18	69 .34
GOBIOSOMA BOSCI	12 .40	1 .03	0 0.00	0 0.00	0 0.00	1 .10	0 0.00	0 0.00	1 .08	5 .42	29 1.85	17 1.01	66 .33
ETROPUS CROSSOTUS	0 0.00	1 .03	2 .08	0 0.00	1 .19	7 1.27	1 .24	9 .47	5 .42	8 .67	9 .57	22 1.31	65 .32
EUCINOSTOMUS GULA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	36 1.90	23 1.93	5 .42	0 0.00	0 0.00	64 .32
MICROGOBIUS THALASSINUS	31 1.04	1 .03	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	2 .11	0 0.00	0 0.00	26 1.66	2 .12	63 .31
SYNGNATHUS SCOVELLI	5 .17	0 0.00	0 0.00	0 0.00	2 .37	0 0.00	3 .73	0 0.00	1 .08	7 .59	3 .19	31 1.85	52 .26
MENIDIA BERYLLINA	7 .24	2 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	6 .50	1 .08	2 .13	21 1.25	39 .19
BREVOORTIA PATRONUS	0 0.00	0 0.00	27 1.12	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	9 .54	36 .18

Table 10, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
DOROSOMA PETENENSE	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	15 .79	2 .17	2 .17	9 .57	1 .06	29 .14
GOBIONELLUS BOLEOSOMA	3 .27	0 0.00	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	2 .11	0 0.00	3 .25	7 .45	5 .38	26 .13
GYNOSCION NEBULOSUS	0 0.00	1 .03	0 0.00	0 0.00	0 0.00	0 0.00	4 .96	4 .32	4 .34	8 .67	2 .13	0 0.00	25 .12
ORTHOPRISTIS CHRYSOPTERA	0 0.00	0 0.00	0 0.00	0 0.00	1 .19	0 0.00	0 0.00	0 0.00	3 .25	0 0.00	17 1.08	1 .06	22 .11
SYNODUS FOETENS	0 0.00	0 0.00	0 0.00	0 0.00	1 .19	1 .10	7 .73	11 .58	1 .08	1 .08	0 0.00	0 0.00	18 .09
PEPRILUS BURTI	0 0.00	0 0.00	4 .17	0 0.00	12 2.24	1 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	17 .08
HASYATIS SABINA	1 .03	1 .03	0 0.00	2 .10	3 .56	0 0.00	0 0.00	2 .11	2 .17	2 .17	1 .06	2 .12	16 .08
PORICHTHYS POROSISSIMUS	0 0.00	1 .03	1 .04	0 0.00	0 0.00	12 2.17	0 0.00	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	15 .07
MONACANTHUS HISPIDUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .10	2 .49	7 .37	2 .17	0 0.00	0 0.00	0 0.00	12 .06
MICROPHYCIS FLORIDANUS	0 0.00	3 .21	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .12	10 .05
SYNGNATHUS LOUISIANAE	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .24	5 .26	2 .17	0 0.00	6 .39	0 0.00	14 .07
CHAETODIPTERUS FABER	0 0.00	0 0.00	0 0.00	0 0.00	1 .19	3 .54	3 .73	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	7 .03
LEPISOSTEUS OSSEUS	1 .03	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .25	1 .06	6 .03
PRIONOTUS SCITULUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .24	0 0.00	3 .25	0 0.00	1 .06	1 .06	6 .03
ICTALURUS CATUS	0 0.00	0 0.00	0 0.00	2 .10	1 .19	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .06	1 .06	5 .02
SPHOEROIDES NEPHELUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	1 .08	1 .06	2 .12	5 .02
BAGRE MARINUS	0 0.00	0 0.00	0 0.00	3 .15	1 .19	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .02
MUGIL CUREMA	0 0.00	0 0.00	0 0.00	3 .15	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
STELLIFER LANCEOLATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .36	0 0.00	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	3 .01
ENCYCLOPSETTA QUADROCELLATA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .12	2 .01
CENTROPRISTIS MELANA	0 0.00	0 0.00	0 0.00	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
GOBIONELLUS HASTATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .13	0 0.00	2 .01
ICTALURUS PUNCTATUS	1 .03	0 0.00	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
MICROPTERUS SALMOIDES	0 0.00	0 0.00	0 0.00	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
OPHICHTHUS GOMESI	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .13	0 0.00	2 .01
MICROGONIAS CROMIS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	0 0.00	1 .06	0 0.00	2 .01
PEPRILUS PARU	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .30	1 .24	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	2 .01

Table 10, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
ANGUILLA ROSTRATA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04	.04
ARCHOSARGUS PROBATOCEPHALUS	0.00	0.00	0.00	0.00	0.00	0.00	.24	0.00	0.00	0.00	0.00	0.00	.04
CARANX HIPPOS	0.00	0.00	0.00	0.00	0.00	.16	0.00	0.00	0.00	0.00	0.00	0.00	.04
ECHENEIS NAUCRATES	0.00	0.00	0.00	0.00	.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04
GOBIOSOMA ROBUSTUM	.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04
MYROPHIS PUNCTATUS	.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04
OLIGOPLITES SAURUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.08	0.00	0.00	0.00	.04
OPSANUS BETA	0.00	0.00	0.00	0.00	0.00	.16	0.00	0.00	0.00	0.00	0.00	0.00	.04
PARALICHTHYS ALBIGUTTA	0.00	0.00	.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04
RHINOPTERA BONASUS	0.00	0.00	0.00	0.00	0.00	0.00	.24	0.00	0.00	0.00	0.00	0.00	.04
SCIAENOPS OCELLATA	0.00	.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04
SELENE VOMER	0.00	0.00	0.00	0.00	0.00	0.00	.24	0.00	0.00	0.00	0.00	0.00	.04
STRONGYLURA MARINA	0.00	0.00	0.00	.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.04
SYNGNATHUS FLORIDAE	0.00	0.00	0.00	0.00	0.00	.16	0.00	0.00	0.00	0.00	0.00	0.00	.04
SPHYRNA TIBURO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.05	0.00	0.00	0.00	0.00	.04
TOTALS	2968.0	3849.0	2412.0	1956.0	536.0	552.0	410.0	1899.0	1192.0	1196.0	1578.0	1676.0	28218.0

FISH SUMMARY JED YEAR
DATES 740301-750228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

Table 10, continued

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215	TOTALS
ANCHOA MITCHILLI	776 20.83	246 11.83	48 28.92	213 53.12	426 49.36	252 12.37	238 16.27	948 68.90	1036 77.54	160 40.71	505 29.17	677 28.81	5525 30.74
MICROPOGON UNDULATUS	2531 67.93	702 33.75	4 2.41	4 1.00	6 .70	26 1.25	6 .41	9 .65	49 3.67	76 19.34	544 31.43	848 36.09	4805 26.74
CYNOSCION ARENARIUS	0 0.00	54 2.60	62 37.35	104 25.94	114 13.21	974 46.67	814 55.64	222 16.13	44 3.29	3 .76	2 .12	2 .09	2395 13.33
LEIOSTOMUS XANTHURUS	234 6.28	265 12.74	0 0.00	0 0.00	1 .12	3 .14	2 .14	2 .15	0 0.00	21 5.34	429 24.78	581 24.72	1538 8.56
BREVOORTIA PATRONUS	4 .11	717 34.47	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .12	121 5.15	844 4.70
ARIUS FELIS	1 .03	2 .10	7 4.22	2 .50	115 13.33	236 11.31	66 4.51	14 1.02	3 .22	0 0.00	0 0.00	0 0.00	446 2.48
STELLIFER LANCEOLATUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	158 7.57	86 5.88	3 .22	3 .22	0 0.00	0 0.00	0 0.00	250 1.39
BAIRDIELLA CHRYSURA	9 .24	0 0.00	1 .60	0 0.00	56 6.49	11 .53	18 1.23	19 1.38	22 1.65	26 6.62	37 2.14	47 2.80	246 1.37
CHLOROSCOMBRUS CHRYSURUS	0 0.00	0 0.00	0 0.00	8 2.00	75 8.69	86 4.12	6 .41	54 3.92	0 0.00	0 0.00	0 0.00	4 .17	233 1.30
MENIDIA BERYLLINA	27 .72	4 .19	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .29	25 1.87	9 2.29	95 5.49	9 .38	173 .96
EUCINOSTOMUS ARGENTEUS	0 0.00	0 0.00	0 0.00	0 0.00	16 1.85	66 3.16	57 3.90	8 .58	6 .45	3 .76	1 .06	0 0.00	157 .87
MICROGOBIUS GULOSUS	30 .81	27 1.30	0 0.00	0 0.00	0 0.00	23 1.10	9 .62	0 0.00	8 .60	6 1.53	7 .40	16 .68	126 .70
MENTICIRRHUS AMERICANUS	3 .08	0 0.00	22 13.25	13 3.24	16 1.85	42 2.01	3 .21	10 .73	14 1.05	0 0.00	0 0.00	0 0.00	123 .68
SYNGNATHUS SCOVELLI	13 .35	3 .14	0 0.00	1 .25	8 .93	27 1.29	3 .21	7 .51	17 1.27	16 4.07	6 .35	3 .13	104 .58
TRINECTES MACULATUS	36 .97	14 .67	0 0.00	0 0.00	2 .23	3 .14	8 .55	4 .29	10 .75	1 .25	5 .29	7 .38	94 .52
SYNGNATHUS FLORIDAE	0 0.00	0 0.00	0 0.00	0 0.00	2 .23	70 3.35	21 1.44	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	93 .52
ETROPUS CROSSOTUS	5 .13	5 .24	0 0.00	4 1.00	1 .12	22 1.05	12 .82	10 .73	17 1.27	2 .51	3 .17	3 .13	84 .47
LUCANIA PARVA	3 .08	4 .19	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .07	3 0.00	51 12.98	10 .58	12 .51	81 .45
SYMPHURUS PLAGIUSA	4 .11	4 .19	0 0.00	1 .25	3 .35	17 .81	9 .62	7 .51	17 1.27	6 1.53	7 .40	4 .17	79 .44
MICROGOBIUS THALASSINUS	2 .05	4 .19	1 .60	1 .25	0 0.00	6 .29	39 2.67	3 .22	4 .30	0 0.00	0 0.00	2 .09	62 .34
PARALICHTHYS LETHOSTIGMA	15 .43	8 .38	0 0.00	0 0.00	2 .23	3 .14	12 .82	9 .65	2 .15	0 0.00	0 0.00	1 .04	53 .29
ANCHOA HEPSETUS	0 0.00	0 0.00	6 3.61	35 8.73	3 .35	0 0.00	0 0.00	6 .44	0 0.00	0 0.00	0 0.00	0 0.00	50 .28
CYNOSCION NEBULOSUS	1 .03	1 .05	0 0.00	0 0.00	1 .12	24 1.15	15 1.03	4 .29	1 .07	1 .25	0 0.00	0 0.00	48 .27
DOROSOMA PETENENSE	1 .03	2 .10	0 0.00	2 .50	5 .58	2 .10	0 0.00	0 0.00	0 0.00	5 1.27	22 1.27	1 .04	46 .22
EUCINOSTOMUS GULA	2 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	10 .73	15 1.12	1 .25	8 .46	0 0.00	36 .20
PRIONOTUS SCITULUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	8 .38	16 1.09	4 .29	6 .45	0 0.00	2 .12	0 0.00	36 .20

Table 10, continued

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215	TOTALS
GOBIOSOMA BOSCI	8 .21	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	3 .21	0 0.00	6 .45	0 0.00	11 .64	4 .17	34 .19
SYNODUS FOETENS	0 0.00	1 .05	13 7.83	10 2.49	1 .12	1 .05	0 0.00	4 .29	3 .22	0 0.00	1 .06	0 0.00	34 .19
GOBIONELLUS BOLEOSOMA	11 .30	0 0.00	0 0.00	1 .25	0 0.00	2 .10	11 .75	1 .07	1 .07	0 0.00	3 .17	0 0.00	30 .17
UROPHYCIS FLORIDANUS	2 .05	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	20 1.16	6 .26	29 .16
DASYATIS SABINA	1 .03	2 .10	0 0.00	0 0.00	2 .23	1 .05	0 0.00	2 .15	9 .67	0 0.00	1 .06	0 0.00	18 .10
PRIONOTUS TRIBULUS	4 .11	0 0.00	1 .60	1 .25	0 0.00	0 0.00	2 .14	2 .15	5 .37	1 .25	2 .12	0 0.00	18 .10
SYNGNATHUS LOUISIANUS	0 0.00	1 .05	0 0.00	0 0.00	4 .46	2 .10	3 .21	3 .22	2 .15	1 .25	0 0.00	0 0.00	16 .09
LAGODON RHOMBOIDES	0 0.00	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .07	4 .30	0 0.00	2 .12	2 .09	10 .06
GOBIOSOMA ROBUSTUM	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .38	0 0.00	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	5 .03
ICTALURUS CATUS	2 .05	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	4 .02
SPHOEROIDES NEPHELUS	0 0.00	0 0.00	1 .60	0 0.00	0 0.00	1 .05	0 0.00	0 0.00	1 .07	0 0.00	1 .06	0 0.00	4 .02
BAGRE MARINUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .19	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .02
CHAETODIPTERUS FABER	0 0.00	0 0.00	0 0.00	0 0.00	2 .12	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .02
PORICHTHYS POROSISSIMUS	0 0.00	0 0.00	0 0.00	0 0.00	2 .12	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .02
PEPRILUS PARU	0 0.00	0 0.00	0 0.00	1 .25	2 .12	0 0.00	0 0.00	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	3 .02
ARCHOSARGUS PROBATOCEPHALUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	2 .01
ASTROSCOPUS Y-GRAECUM	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .51	0 0.00	0 0.00	2 .01
CARANX HIPPOS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
DIPLECTRUM FORMOSUM	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
LEPISOSTEUS OSSEUS	0 0.00	1 .05	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
ORTHOPRISTIS CHRYSOPTERA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .07	1 .25	0 0.00	0 0.00	2 .01
POLYDACTYLUS OCTONEMUS	0 0.00	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
ANCYCLOPSETTA QUADROCELLATA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	1 .01
CHILOMYCTERUS SCHOEPFI	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .01
DIPLODUS HOLBROOKI	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .01
HYPSOBLENNIUS HENTZI	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .25	0 0.00	0 0.00	1 .01
LUTJANUS GRISEUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	1 .01

Table 10 continued

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215	TOTALS
MENTICIRRHUS SAXATILIS	0.00 0	0.00 0	0.00 0	0.00 0	.12 1	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
MONACANTHUS HISPIDUS	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.07 1	0.00 0	0.00 0	0.00 0	.01 1
MOTROPIS PETERSONI	0.00 0	.05 1	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
OLIGOPLITES SAURUS	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.07 1	0.00 0	0.00 0	0.00 0	.01 1
OPHICHTHUS GOMESI	0.00 0	.05 1	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
OPSANUS BETA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.07 1	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
PEPRILUS BURTI	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.07 1	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
POMATOMUS SALTATRIX	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.07 1	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
SCIAENOPS OCELLATA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.06 1	0.00 0	.01 1
SPHYRAENA BOREALIS	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.05 1	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
SARDINELLA ANCHOVIA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.05 1	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
CARANX BARTHOLOMAEI	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.07 1	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
SYNNURA MICRURA	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.07 1	0.00 0	0.00 0	0.00 0	0.00 0	0.00 0	.01 1
TOTALS	3726.0	2088.0	166.0	401.0	863.0	2087.0	1463.0	1376.0	1336.0	393.0	1731.0	2350.0	17972.0

DATES 750301-760228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY 0

Table 10, continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
ANCHOA MITCHILLI	182 7.85	657 23.12	142 7.19	447 53.60	402 56.94	143 29.24	420 29.01	1330 69.09	1136 73.43	680 68.46	71 11.27	560 14.99	6170 31.71
MICROPOGON UNDULATUS	1109 47.84	1006 35.40	798 39.92	56 6.71	4 .57	0 0.00	2 .14	2 .10	169 10.92	163 16.22	454 72.06	1131 30.26	4894 25.12
LEIOSTOMUS XANTHURUS	727 31.36	617 21.71	243 12.16	4 .48	0 0.00	0 0.00	4 .28	1 .05	0 0.00	8 .80	7 1.11	1338 35.80	2949 15.14
CYNOSCION ARENARIUS	0 0.00	2 .07	319 15.96	212 25.42	93 13.17	125 25.56	726 50.14	329 17.09	18 1.16	9 .98	0 0.00	0 0.00	1833 9.41
BREVOORTIA PATRONUS	85 3.67	251 8.83	34 1.70	9 1.08	0 0.00	0 0.00	0 0.00	1 0.00	0 0.00	10 1.00	15 2.38	526 14.08	930 4.77
MICROGOBIUS GULOSUS	22 .95	121 4.26	49 2.45	9 1.08	3 .42	35 7.16	82 5.66	64 3.32	2 .13	7 .70	3 .48	56 1.50	453 2.33
LUCANIA PARVA	26 1.12	56 1.97	227 11.36	1 .12	4 .57	30 6.13	0 0.00	4 .21	11 .71	1 .10	0 0.00	0 0.00	360 1.85
SYNGNATHUS SCOVELLI	5 .22	17 .60	34 1.70	18 2.16	29 4.11	98 20.04	5 .35	6 .31	16 1.03	1 .10	2 .32	6 .16	237 1.22
ETROPUS CROSSOTUS	1 .04	3 .11	1 .05	2 .24	1 .14	7 1.43	22 1.52	44 2.29	53 3.43	49 4.88	9 1.43	3 .08	195 1.00
TRINECTES MACULATUS	68 2.93	7 .25	39 1.95	7 .84	0 0.00	8 1.64	10 .69	6 .31	6 .39	2 .20	2 .32	10 .48	173 .89
GOBIOSOMA BOSCI	9 .39	9 .32	0 0.00	0 0.00	0 0.00	13 2.66	19 1.31	37 1.92	14 .90	7 .70	3 .48	37 .99	148 .76
MENTICIRRHUS AMERICANUS	0 0.00	0 0.00	25 1.25	10 1.20	30 4.25	4 .82	24 1.66	16 .83	11 .71	9 .90	0 0.00	0 0.00	129 .66
SYMPHURUS PLAGIUSA	22 .95	5 .18	9 .45	1 .12	5 .71	1 .20	26 1.80	17 .88	14 .90	3 .30	7 1.11	2 .05	112 .57
BAIRDIELLA CHRYSURA	13 .56	2 .07	4 .20	26 3.12	16 2.27	0 0.00	20 1.38	2 .10	8 .52	3 .30	0 0.00	1 .03	95 .49
ARIUS FELIS	1 .04	3 .11	4 .20	5 .60	33 4.67	6 1.23	4 .28	2 .10	6 .39	0 0.00	0 0.00	0 0.00	64 .33
PRIONOTUS TRIBULUS	3 .13	1 .04	2 .10	0 0.00	0 0.00	0 0.00	1 .07	5 .26	33 2.13	10 1.00	3 .48	1 .03	59 .30
GOBIONELLUS BOLEOSOMA	5 .22	0 0.00	4 .20	0 0.00	0 0.00	0 0.00	2 .14	1 .05	5 .32	3 .30	5 .79	26 .70	51 .26
CHLOROSCOMBRUS CHRYSURUS	1 .04	0 0.00	2 .10	1 .12	20 2.83	0 0.00	12 .83	11 .57	2 .13	0 0.00	0 0.00	0 0.00	49 .25
MENIDIA BERYLLINA	1 .04	25 .88	7 .35	1 .12	0 0.00	0 0.00	0 0.00	0 0.00	1 .06	2 .20	4 .63	0 0.00	41 .21
CYNOSCION NEBULOSUS	1 .04	1 .04	1 .05	0 0.00	4 .57	0 0.00	19 1.31	6 .31	1 .06	2 .20	3 .48	1 .03	39 .20
SYNODUS FOETENS	0 0.00	0 0.00	2 .10	1 .12	13 1.84	7 1.43	1 .07	7 .36	1 .06	2 .20	4 .63	0 0.00	38 .20
EUCINOSTOMUS ARGENTEUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	8 1.64	11 .76	5 .26	11 .71	1 .10	0 0.00	0 0.00	36 .18
EUCINOSTOMUS GULA	2 .09	0 0.00	1 .05	0 0.00	0 0.00	0 0.00	14 .97	0 0.00	2 .13	17 1.69	0 0.00	0 0.00	36 .18
ANCHOA HEPSETUS	0 0.00	0 0.00	0 0.00	7 .84	22 3.12	0 0.00	4 .28	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	33 .17
LAGODON RHOMBOIDES	1 .04	6 .28	5 .25	0 0.00	0 0.00	0 0.00	0 0.00	2 .10	3 .19	0 0.00	4 .63	10 .27	33 .17
DASYATIS SABINA	2 .09	1 .04	3 .15	0 0.00	4 .57	1 .20	2 .14	1 .05	11 .71	0 0.00	5 .79	0 0.00	30 .15

Table 10, continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
OPHYCIS FLORIDANUS	8 .35	0 0.00	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	9 1.43	0 .21	27 .14
GIL SPECIES	0 0.00	25 .88	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	26 .13
CROGOBIUS THALASSINUS	5 .22	13 .46	0 0.00	0 0.00	1 .14	1 .20	1 .07	2 .10	0 0.00	0 0.00	0 0.00	1 .03	24 .12
CROPTERUS SALMOIDES	0 0.00	0 0.00	16 .90	2 .24	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .16	0 0.00	21 .11
RALICHTHYS LETHOSTIGMA	1 .04	2 .07	4 .20	4 .48	2 .28	1 .20	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	4 .11	19 .10
NGNATHUS FLORIDAE	0 0.00	0 0.00	0 0.00	0 0.00	1 .14	0 0.00	0 0.00	13 .52	7 .45	0 0.00	0 0.00	0 0.00	18 .09
CTALURUS CATUS	8 .35	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	1 .06	1 .16	1 .16	2 .05	14 .07
DROSOMA PETENENSE	3 .13	2 .07	1 .05	0 0.00	0 0.00	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	5 .95	0 0.00	13 .07
EPRILUS PARU	0 0.00	0 0.00	4 .20	0 0.00	2 .28	1 .20	0 0.00	4 .21	1 .06	0 0.00	0 0.00	0 0.00	12 .06
EPISOSTEUS OSSEUS	2 .09	1 .04	0 0.00	1 .12	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .16	5 .79	0 0.00	10 .05
ORICHTHYS POROSISSIMUS	0 0.00	0 0.00	2 .10	4 .48	4 .57	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	10 .05
RCHOSARGUS PROBATOCEPHALUS	0 0.00	0 0.00	1 .05	0 0.00	0 0.00	0 0.00	2 .14	3 .16	2 .13	0 0.00	1 .16	0 0.00	9 .05
PHOEROIDES NEPHELUS	1 .04	1 .04	0 0.00	3 .36	3 .42	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	9 .05
IPLECTRUM FORMOSUM	0 0.00	1 .04	1 .05	0 0.00	0 0.00	0 0.00	2 .14	1 .05	1 .06	1 .10	0 0.00	0 0.00	7 .04
HAETODIPTERUS FABER	0 0.00	0 0.00	0 0.00	0 0.00	1 .14	0 0.00	5 .35	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	6 .03
OBIOSOMA ROBUSTUM	0 0.00	0 0.00	0 0.00	1 .12	1 .14	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .11	6 .03
UGIL CEPHALUS	0 0.00	2 .07	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	0 0.00	1 .16	1 .03	6 .03
EPRILUS BURTI	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	4 .48	0 0.00	1 .03	6 .03
FUNDULUS GRANDIS	0 0.00	0 0.00	0 0.00	0 0.00	5 .71	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 .03
LEPOMIS MICROLOPHUS	0 0.00	0 0.00	5 .25	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 .03
PRIONOTUS SCITULUS	1 .04	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	2 .14	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	4 .02
ANCYCLOPSETTA QUADROCELLATA	1 .04	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .10	0 0.00	0 0.00	3 .02
MONACANTHUS HISPIDUS	0 0.00	0 0.00	0 0.00	0 0.00	1 .14	0 0.00	0 0.00	2 .10	0 0.00	0 0.00	0 0.00	0 0.00	3 .02
SCIAENOPS OCELLATA	1 .04	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .05	0 0.00	0 0.00	1 .16	0 0.00	3 .02
BAGRE MARINUS	0 0.00	0 0.00	0 0.00	1 .12	1 .14	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .02
ANGUILLA ROSTRATA	0 0.00	3 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .07	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	2 .01
GOBIONELLUS HASTATUS	0 0.00	1 .04	1 .05	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .01

Table 10 continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
NOTROPIS PETERSONI	0.00	0.00	.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01
POGONIAS CROMIS	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.32	0.00	.01
MORONE CHRYSOPS	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	.32	0.00	.01
CENTROPRISTIS MELANA	.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01
LEPOMIS MACROCHIRUS	0.00	0.00	0.00	0.00	.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01
NONACANTHUS CILIATUS	0.00	0.00	.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01
SYNGNATHUS LOUISIANAE	0.00	0.00	0.00	.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.01
TOTALS	2318.0	2842.0	1999.0	834.0	706.0	489.0	1448.0	1925.0	1547.0	1085.0	638.0	3737.0	19480.0

TIMES OF DAY D

SPECIES	SAMPLE DATES 760315	760415	760515	760615	760715	760815	760915	761011	761119	761213	770125	770220	TOTALS
MICROPOGON UNDULATUS	3599 27.43	3674 62.24	1302 38.40	369 17.61	37 4.14	71 1.49	14 2.42	4 .26	428 13.62	223 31.86	1113 47.75	793 12.60	11567 26.05
ANCHOA MITCHILLI	517 3.94	163 2.76	227 6.69	335 19.09	545 61.03	3916 82.08	232 40.07	477 31.51	2101 66.85	384 54.86	509 21.84	1271 20.19	10677 24.05
LEIOSTOMUS XANTHURUS	2994 22.81	1664 28.19	939 27.69	279 15.90	2 .22	69 1.45	1 .17	60 3.96	308 9.80	14 2.00	509 21.84	3456 54.91	10295 23.19
BREVOORTIA PATRONUS	5716 43.56	187 3.17	495 14.60	2 .11	0 0.00	0 0.00	1 .17	1 .07	0 0.00	0 0.00	131 5.62	651 10.34	7184 16.18
CYNOSCION ARENARIUS	2 .02	9 .15	181 5.34	726 41.37	193 21.61	462 9.68	144 24.87	634 41.88	29 .92	7 1.00	0 0.00	3 .05	2390 5.38
TRINECTES MACULATUS	54 .41	53 .90	54 1.59	16 .91	19 2.13	37 .78	28 4.84	53 3.50	0 0.00	1 .14	0 0.00	0 0.00	315 .71
SYMPHURUS PLAGIUSA	12 .09	23 .39	54 1.59	5 .28	8 .90	8 .17	33 5.70	80 5.28	22 .70	1 .14	1 .04	8 0.00	247 .56
BAIRDIELLA CHRYSURA	6 .05	1 .02	57 1.68	16 .91	31 3.47	13 .27	6 1.04	14 .92	84 2.67	5 .71	2 .09	6 .10	241 .54
ETROPUS CROSSOTUS	11 .08	17 .29	15 .44	1 .06	3 .34	8 .17	17 2.94	64 4.23	32 1.02	5 .71	4 .17	3 .05	180 .41
MICROGOBIUS GULOSUS	83 .63	21 .36	5 .15	6 .34	4 .45	2 .04	1 .17	2 .13	3 .10	0 0.00	1 .04	0 0.00	128 .29
PARALICHTHYS LETHOSTIGMA	19 .14	14 .24	15 .44	18 1.03	10 1.12	6 .13	6 1.04	9 .59	1 .03	3 .43	3 .13	12 .19	116 .26
ARIUS FELIS	0 0.00	1 .02	3 .09	1 .06	8 .90	10 .21	52 8.98	22 1.45	7 .22	4 .57	0 0.00	0 0.00	106 .24
LAGODON RHOMBOIDES	30 .23	9 .15	10 .29	10 .57	1 .11	6 .13	3 .52	6 .40	2 .06	1 .14	5 .21	15 .24	98 .22
STELLIFER LANCEOLATUS	0 0.00	0 0.00	0 0.00	0 0.00	11 1.23	76 1.59	8 1.38	2 .13	0 0.00	0 0.00	0 0.00	0 0.00	97 .22
UROPHYCIS FLORIDANUS	7 .05	6 .10	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .14	16 .69	61 .97	91 .20
PRIONOTUS TRIBULUS	11 .08	1 .02	2 .06	0 0.00	0 0.00	2 .04	9 1.55	29 1.92	9 .29	2 .29	0 0.00	2 .03	67 .15
GOBIONELLUS BOLEOSOMA	24 .18	17 .29	3 .09	5 .28	0 0.00	2 .04	0 0.00	0 0.00	2 .06	0 0.00	3 .13	7 .11	63 .14
SYNGNATHUS FLORIDAE	0 0.00	0 0.00	2 .06	0 0.00	0 0.00	37 .78	0 0.00	0 0.00	10 .57	0 0.00	0 0.00	0 0.00	57 .13
SYNGNATHUS SCOVELLI	7 .05	1 .02	3 .09	6 .46	0 0.00	4 .08	0 0.00	2 .13	3 .10	7 1.00	5 .21	2 .03	42 .09
CYNOSCION NEBULOSUS	1 .01	1 .02	0 0.00	0 0.00	0 0.00	6 .13	0 0.00	12 .79	15 .48	0 0.00	1 .04	1 .02	37 .08
LUCANIA PARVA	2 .02	0 0.00	3 .09	0 0.00	0 0.00	2 .04	0 0.00	1 .07	29 .92	0 0.00	0 0.00	0 0.00	37 .08
MICROGOBIUS THALASSINUS	0 0.00	8 .14	1 .03	1 .06	1 .11	3 .06	3 .52	13 .86	1 .03	4 .57	0 0.00	0 0.00	35 .08
MENTICIRRHUS AMERICANUS	2 .02	0 0.00	2 .06	6 .34	0 0.00	4 .08	3 .52	13 .86	4 .13	0 0.00	0 0.00	0 0.00	34 .08
DASYATIS SABINA	6 .05	5 .10	2 .06	0 0.00	1 .11	0 0.00	2 .35	2 .13	5 .16	2 .29	4 .17	2 .03	32 .07
EUCINOSTOMUS ARGENTEUS	0 0.00	0 0.00	0 0.00	0 0.00	3 .34	1 .02	2 .35	1 .07	24 .76	0 0.00	0 0.00	0 0.00	31 .07
MENIDIA BERYLLINA	2 .02	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .20	1 .03	16 2.29	0 .34	0 0.00	30 .07

	760315	760415	760515	760615	760715	760815	760915	761011	761119	761213	770125	770220	TOTALS
PEPRILUS BURTI	3 .02	17 .29	7 .21	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .06	0 0.00	0 0.00	1 .02	30 .07
GOBIOSOMA BOSCI	13 .10	3 .05	0 0.00	0 0.00	0 0.00	0 0.00	1 .17	2 .13	1 .03	0 0.00	4 .17	2 .03	26 .06
DOROSOMA PETENENSE	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	5 .16	17 2.43	1 .04	1 .02	24 .05
CHLOROSCOMBRUS CHRYSURUS	0 0.00	0 0.00	0 0.00	0 0.00	2 .22	6 .13	7 1.21	2 .13	0 0.00	0 0.00	0 0.00	0 0.00	17 .04
PORICHTHYS POROSISSIMUS	0 0.00	0 0.00	3 .09	2 .11	7 .78	2 .04	1 .17	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	16 .04
BAGRE MARINUS	0 0.00	0 0.00	2 .06	1 .06	0 0.00	4 .08	4 .69	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	11 .02
MUGIL CEPHALUS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	10 .43	0 0.00	10 .02
ICTALURUS PUNCTATUS	0 0.00	3 .05	1 .03	2 .11	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	6 .01
SPHOEROIDES NEPHELUS	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	3 .06	0 0.00	0 0.00	2 .06	0 0.00	0 0.00	0 0.00	6 .01
SYNODUS FOETENS	0 0.00	0 0.00	0 0.00	0 0.00	1 .11	2 .04	0 0.00	1 .07	1 .03	0 0.00	0 0.00	0 0.00	5 .01
ARCHOSARGUS PROBATOCEPHALUS	0 0.00	0 0.00	0 0.00	0 0.00	1 .11	1 .02	0 0.00	0 0.00	1 .03	1 .14	0 0.00	0 0.00	4 .01
ICTALURUS CATUS	2 .02	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .14	0 0.00	1 .02	4 .01
ANCHOA HEPSETUS	0 0.00	0 0.00	0 0.00	1 .06	2 .22	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
ANCYCLOPSETTA QUADROCELLATA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .08	0 0.00	0 0.00	0 0.00	3 .05	3 .01
CARANX HIPPOS	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .04	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
EUCINOSTOMUS GULA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .04	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
MICROPTERUS SALMOIDES	0 0.00	0 0.00	3 .09	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
SYNGNATHUS LOUISIANAE	0 0.00	1 .02	0 0.00	0 0.00	1 .11	1 .02	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 .01
GOBIONELLUS HASTATUS	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	0 0.00	0 0.00	1 .07	0 0.00	0 0.00	0 0.00	0 0.00	2 .00
LEPISOSTEUS OSSEUS	0 0.00	1 .02	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .03	0 0.00	0 0.00	0 0.00	2 .00
ORTHOPRISTIS CHRYSOPTERA	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .03	0 0.00	1 .04	0 0.00	2 .00
PARALICHTHYS ALBIGUTTA	0 0.00	0 0.00	0 0.00	1 .06	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02	2 .00
PRIONOTUS SCITULUS	0 0.00	1 .02	0 0.00	1 .06	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .00
SELENE VOMER	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02	1 .17	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .00
PEPRILUS PARU	0 0.00	0 0.00	0 0.00	0 0.00	2 .22	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	2 .00
CHAETODIPTERUS FABER	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .02	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .00
CHASMODES SABURRAE	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	1 .14	0 0.00	0 0.00	1 .00

Table 10, continued

SPECIES	SAMPLE DATES 760315	760415	760515	760615	760715	760815	760915	761011	761119	761213	770125	770220	TOTALS
DIPLECTRUM FORMOSUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.03	0.00	0.00	0.00	.00
ELOPS SAURUS	0.00	0.00	0.00	.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
HARENGULA PENSACOLAE	0.00	.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.00
LUTJANUS GRISEUS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.07	0.00	0.00	0.00	0.00	.00
RHINOPTERA BONASUS	0.00	0.00	0.00	0.00	0.00	.02	0.00	0.00	0.00	0.00	0.00	0.00	.00
TOTALS	13123.0	5903.0	3391.0	1755.0	893.0	4771.0	579.0	1514.0	3143.0	780.0	2331.0	6294.0	44397.0

DATES 720301-730228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY A

epibenthic invertebrates taken in the Apalachicola estuary (stations 1,2,3,4, 5,6, 1A, 1B, 1C, 5A) from March, 1972, through February, 1977.

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
DASYATIS SABINA	219.89 46.34	134.95 43.51	476.39 26.21	976.39 32.47	2212.58 56.22	0.00 0.00	399.54 20.64	1581.27 41.79	781.59 10.85	634.51 31.89	0.00 0.00	244.89 5.13	7564.05 25.06
ANCHOA MITCHILLI	59.79 13.69	27.03 8.71	60.00 4.15	71.35 3.87	245.50 6.24	18.99 1.18	69.00 3.56	974.09 25.74	4224.68 54.33	72.61 3.65	23.06 10.13	17.92 .38	5864.09 19.43
LEPISOSTEUS OSSEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	92.29 2.44	237.38 3.05	493.95 24.82	0.00 0.00	4262.98 89.26	5886.52 16.85
ARIUS FELIS	1.12 .26	0.00 0.00	7.82 .54	249.03 15.53	366.96 9.32	704.11 43.69	481.82 24.89	282.66 7.47	679.65 8.74	0.00 0.00	0.00 0.00	0.00 0.00	2813.17 9.32
MICROPOGON UNDULATUS	47.54 10.88	186.30 46.26	476.06 32.97	158.15 9.50	582.95 14.81	.49 .03	824.99 42.61	51.02 1.35	18.51 .24	15.57 .78	7.37 3.24	113.57 2.38	2482.81 8.23
BAIRDIELLA CHRYSURA	8.56 1.96	0.00 0.00	44.42 3.05	36.79 1.98	2.04 .05	1.29 .08	0.00 0.00	196.20 5.18	1101.80 14.17	176.85 8.89	10.80 4.75	17.61 .37	1595.96 5.29
LEIOSTOMUS XANTHURUS	25.97 5.92	0.00 0.00	242.67 16.90	192.07 9.78	243.77 6.19	53.42 3.31	12.63 .65	18.28 .48	66.16 .85	22.40 1.13	16.49 7.25	5.33 .11	891.09 2.95
RHINOPTERA BONASUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	610.54 37.88	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	610.54 2.02
PAPALICHTHYS LETHOSTIGMA	0.00 0.00	0.00 0.00	35.63 2.47	14.29 .77	162.68 4.13	192.42 11.94	76.23 3.94	64.14 1.69	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	545.39 1.81
CYNOSCION ARENARIUS	0.00 0.00	.64 .16	147.61 10.22	15.21 .87	64.76 1.65	9.18 .57	11.04 .57	46.03 1.22	229.31 2.95	16.26 .82	2.32 1.02	0.00 0.00	542.36 1.80
DOROSOMA CEPEDIANUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	406.03 20.41	0.00 0.00	0.00 0.00	406.03 1.35
CYNOSCION NEBULOSUS	0.00 0.00	.13 .03	0.00 0.00	2.52 .14	0.00 0.00	.53 .03	.04 .00	108.17 2.86	75.36 .97	79.96 4.02	44.23 19.44	0.00 0.00	310.94 1.03
ETROPUS CROSSOTUS	2.42 .55	.89 .22	7.36 .51	5.00 .27	4.55 .12	4.11 .26	11.64 .60	70.44 1.86	74.17 .95	7.60 .38	11.20 4.92	3.96 .08	203.34 .67
TRINECTES MACULATUS	39.75 9.10	14.86 3.44	38.02 2.08	8.14 .44	11.09 .28	1.37 .09	7.13 .37	31.07 .82	6.19 .08	0.00 0.00	0.00 0.00	21.46 .45	170.08 .56
MENTICIRRHUS AMERICANUS	0.00 0.00	0.00 0.00	1.40 .10	2.94 .16	18.27 .46	6.83 .42	1.75 .09	25.71 .68	75.76 .97	9.33 .47	0.00 0.00	12.52 .26	154.53 .51
LAGODON RHOMBOIDES	0.00 0.00	2.91 .72	1.48 .10	2.83 .15	11.76 .30	0.00 0.00	0.00 0.00	51.28 1.36	25.19 .32	5.98 .30	16.96 7.45	2.43 .05	120.72 .40
SYMPHURUS PLAGIUSA	.13 .03	1.63 .40	2.26 .16	4.08 .22	.90 .02	.55 .03	2.88 .15	54.21 1.43	13.44 .17	5.53 .28	3.35 1.47	7.44 .16	96.40 .32
SYNODUS FOETENS	0.00 0.00	0.00 0.00	.87 .06	1.55 .08	1.31 .03	.10 .01	4.69 .24	24.76 .65	50.80 .65	9.72 .49	0.00 0.00	0.00 0.00	93.80 .31
MENIDIA BERYLLINA	13.84 3.17	0.00 0.00	.69 .05	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.47 .09	.69 .01	0.00 0.00	22.94 10.00	36.60 .77	78.23 .26
CHLOROSCOMBRUS CHRYSURUS	.15 .03	0.00 0.00	1.75 .12	0.00 0.00	.34 .01	3.42 .21	17.56 .91	46.07 1.22	4.11 .05	0.00 0.00	0.00 0.00	0.00 0.00	73.40 .24
CHILOMYCTERUS SCHOEPFI	0.00 0.00	0.00 0.00	0.00 0.00	69.13 3.72	0.00 0.00	0.00 0.00	0.00 0.00	2.36 .06	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	71.49 .24
PRIONOTUS TRIBULUS	0.00 0.00	0.00 0.00	0.00 0.00	.43 .02	1.11 .03	.19 .01	2.73 .14	18.99 .50	30.31 .40	1.10 .06	.23 .10	2.81 .06	58.50 .19
ARCHOSARGUS PROBATOCEPHALUS	12.74 2.92	0.00 0.00	0.00 0.00	.38 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	24.24 .31	0.00 0.00	0.00 0.00	15.25 .32	52.61 .17
EUCINOSTOMUS GULA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.77 .19	1.48 .04	1.84 .02	24.87 1.25	0.00 0.00	2.19 .05	34.15 .11
ICTALURUS PUNCTATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	23.71 10.42	0.00 0.00	23.71 .08
SPHOEROIDES NEPHELUS	0.00 0.00	0.00 0.00	.34 .02	1.97 .11	.50 .01	0.00 0.00	.58 .03	9.26 .24	0.00 0.00	0.00 0.00	10.15 4.46	0.00 0.00	22.80 .08

Table II, continued

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
?TALUPUS CATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	22.66 9.96	0.00 0.00	22.66 .08
?THOPPISTIS CHRYSOPTERA	0.00 0.00	0.00 0.00	1.08 .07	14.11 .76	0.70 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.38 .03	3.72 .19	0.00 0.00	0.00 0.00	21.21 .07
ENTROPRISTIS MELANA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	6.53 .17	8.55 .11	0.00 0.00	0.00 0.00	3.50 .07	18.58 .06
HAETODIPTERUS FABER	0.00 0.00	0.00 1.00	0.00 0.00	0.00 0.00	1.53 .04	.49 .03	1.77 .09	14.34 .38	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	18.13 .06
UCINOSTOMUS ARGENTEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.31 .14	0.00 0.00	0.00 0.00	7.23 .09	0.00 0.00	4.97 2.18	0.00 0.00	14.51 .05
PHICHTHUS GOMESI	0.00 0.00	13.17 3.27	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	13.17 .04
UCANIA PARVA	.26 .06	11.85 2.94	.11 .01	.03 .00	.13 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.10 .01	.03 .01	0.00 0.00	12.53 .04
EPRILUS PARU	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.38 .06	.04 .00	3.85 .20	3.03 .08	2.03 .03	0.00 0.00	0.00 0.00	0.00 0.00	11.33 .04
OROSOMA PETENENSE	0.00 0.00	1.79 .44	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	6.89 .09	2.16 .11	0.00 0.00	0.00 0.00	10.84 .04
LOSA ALABAMAE	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	6.65 .11	0.00 0.00	0.00 0.00	0.00 0.00	6.65 .03
GOBIOSOMA BOSCI	.08 .02	1.59 .39	.35 .02	.44 .02	.09 .00	.18 .01	.27 .01	.81 .02	3.42 .04	.17 .01	0.00 0.00	.93 .02	8.38 .03
MICROGOBIUS GULOSUS	.13 .03	1.25 .31	2.57 .18	1.09 .06	.22 .01	.37 .02	0.00 0.00	.64 .02	1.72 .02	0.00 0.00	0.00 0.00	0.00 0.00	7.99 .03
PRIONOTUS SCITULUS	0.00 0.00	.19 .05	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.02 .00	.84 .02	1.77 .02	1.15 .06	2.40 1.05	.55 .01	6.92 .02
PORICHTHYS POROSISSIMUS	2.58 .59	0.00 0.00	0.00 0.00	.62 .03	0.00 0.00	0.00 0.00	0.00 0.00	2.15 .06	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.35 .02
DIPLECTRUM FORMOSUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.02 .06	0.00 0.00	0.00 0.00	0.00 0.00	5.02 .02
UROPHYCIS FLORIDANUS	1.88 .43	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.14 .06	2.44 .05	4.46 .01
SCIAENOPS OCELLATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.40 1.93	0.00 0.00	4.40 .01
SYNGNATHUS FLORIDAE	0.00 0.00	0.00 0.00	.06 .00	.42 .02	0.00 0.00	.12 .01	1.83 .09	1.61 .04	.03 .00	0.00 0.00	0.00 0.00	0.00 0.00	4.07 .01
SYNGNATHUS SCOVELLI	0.00 0.00	1.98 .49	.24 .02	1.05 .06	.15 .00	.26 .02	.09 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.21 .00	3.98 .01
GOBIONELLUS HASTATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.25 .01	3.14 .04	0.00 0.00	0.00 0.00	0.00 0.00	3.39 .01
SYNGNATHUS LOUISIANAE	0.00 0.00	0.00 0.00	0.00 0.00	.16 .01	0.00 0.00	.35 .02	0.00 0.00	0.00 0.00	1.07 .01	0.00 0.00	0.00 0.00	0.00 0.00	1.58 .01
MONACANTHUS HISPIDUS	0.00 0.00	1.45 .36	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.45 .00
PRIONOTUS RUBIO	0.00 0.00	0.00 0.00	1.19 .18	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.19 .00
BREVOORTIA PATRONUS	0.00 0.00	1.12 .28	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.12 .00
MICROGOBIUS THALASSINUS	.09 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.13 .06	.83 .02	1.05 .00
ALUTERUS SCHOEPFI	0.00000 0.00	0.00000 0.00	0.00000 0.00	.47000 .03	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.47000 .00
LUTJANUS GRISEUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.44000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.44000 .00

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215	TOTALS
SEVERAL WORMS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.10000 .00	0.00000 0.00	.29000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.39000 .00
ANCHOA MERSETUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.25000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.25000 .00	
HAPENULA SENSALULAE	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.25000 .01	.25000 .00	
GOBIOSOMA ROBUSTUM	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.20000 .01	0.00000 0.00	0.00000 0.00	.20000 .00
MONACANTHUS CILIATUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	.17000 .01	.02000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.19000 .00
STRONGYLURA MARINA	0.00000 0.00	.03000 .01	.09000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.12000 .00
MICROPTERUS SALMOIDES	0.00000 0.00	0.00000 0.00	.07000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.07000 .00
TOTALS	436.8	402.8	1444.1	1860.8	3935.8	1611.7	1936.1	3784.1	7775.9	1989.8	227.5	4775.6	30181.8

FISH SUMMARY BIOMASS 2ND YEAR
DATES 730301-740228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY 0

Table II, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
ARIUS FELIS	.56 .00	48.05 3.65	84.47 2.94	835.73 17.23	1210.75 50.03	851.70 29.65	624.47 27.07	449.43 18.36	993.33 36.01	0.00 0.00	0.00 0.00	0.00 0.00	5099.12 15.80
MICROPOGON UNDULATUS	294.58 31.37	504.89 38.63	957.38 33.07	1534.19 25.35	147.24 5.98	249.07 8.67	21.96 .95	.12 .00	7.93 .14	17.21 1.09	116.46 2.11	205.02 22.76	4116.11 12.76
LEPISOSTEUS OSSEUS	92.29 9.82	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3736.06 67.82	237.38 26.35	4065.78 12.60
DASYATIS SABINA	395.54 41.19	244.89 18.59	0.00 0.00	459.78 7.79	393.60 16.14	0.00 0.00	0.00 0.00	497.76 20.34	742.29 26.90	644.43 40.70	137.25 2.49	208.96 22.31	3747.50 11.61
ANCHOA MITCHILLI	31.65 3.25	36.96 2.81	477.64 16.30	18.61 .30	28.23 1.17	1107.06 38.54	.78 .03	156.77 6.41	138.46 5.02	183.85 11.61	259.47 4.71	28.49 3.16	2467.97 7.65
BAGRE MARINUS	0.00 0.00	0.00 0.00	0.00 0.00	2043.42 32.50	254.20 10.50	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2297.62 7.12
LEIOSTOMUS XANTHURUS	75.39 7.77	68.83 5.22	336.02 11.51	612.02 9.73	18.27 .75	0.00 0.00	18.27 .79	154.50 6.31	388.20 14.07	54.40 3.44	48.33 .88	31.15 3.46	1805.38 5.59
POLYDACTYLUS OCTONEMUS	12.23 1.26	34.83 2.64	959.20 33.13	618.91 9.84	37.55 1.55	4.47 .16	1.25 .05	5.44 .22	0.00 0.00	0.00 0.00	6.27 .11	0.00 0.00	1680.15 5.21
BAIRDIELLA CHRYSURA	1.78 .18	62.91 4.78	0.00 0.00	4.19 .07	36.92 1.53	8.72 .38	0.00 0.00	180.55 7.38	165.42 6.00	505.83 31.95	611.74 11.11	17.79 1.99	1595.85 4.95
PARALICHTHYS LETHOSTIGMA	.24 .02	71.15 5.40	32.33 1.12	15.90 .25	112.61 4.65	557.36 19.40	277.09 12.01	276.99 11.32	47.93 1.74	0.00 0.00	64.81 1.18	16.36 1.82	1472.77 4.56
RHINOPTERA BONASUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1240.10 53.75	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1240.10 3.84
SMYRNA TIBURO	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	323.57 13.22	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	323.57 1.00
ICTALURUS CATUS	0.00 0.00	0.00 0.00	0.00 0.00	.15 .00	7.84 .32	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	220.05 4.14	19.36 2.15	255.40 .79
EPINEPHELUS MACULATUS	22.29 2.30	10.64 .81	16.15 .56	10.67 .17	15.10 .62	15.98 .56	14.13 .61	65.53 2.68	1.77 .05	0.00 0.00	29.96 .54	25.41 2.82	227.63 .71
SYNODUS FOETENS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.29 .01	.96 .03	10.04 .44	149.85 6.12	1.27 .05	5.24 .33	0.00 0.00	0.00 0.00	167.69 .52
HARENGULA PENSACOLAE	0.00 0.00	155.38 11.79	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	155.38 .48
CYNOSCION NEBULOSUS	0.00 0.00	8.60 .65	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.30 .01	15.29 .62	44.47 1.61	65.84 4.11	18.32 .33	0.00 0.00	152.02 .47
LAGODON RHOMBOIDES	0.00 0.00	0.00 0.00	0.00 0.00	7.39 .12	0.00 0.00	10.07 .35	0.00 0.00	36.97 1.51	6.26 .23	54.96 3.47	8.84 .16	6.43 .71	130.92 .41
MICROGONIAS CROMIS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	47.33 1.72	0.00 0.00	82.08 1.49	0.00 0.00	129.41 .40
CYNOSCION ARENARIUS	1.52 .16	7.07 .54	2.44 .09	5.86 .09	10.47 .43	26.55 .92	5.52 .24	31.39 1.28	18.53 .67	6.34 .40	0.00 0.00	1.03 .11	116.78 .36
ECHENEIS NAUCRATES	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	103.68 4.28	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	103.68 .32
ETROPUS CROSSOTUS	0.00 0.00	1.78 .14	3.54 .12	0.00 0.00	1.38 .06	9.27 .32	7.56 .33	4.84 .28	6.38 .23	0.63 .05	9.61 .17	36.18 4.01	89.89 .28
EUCINOSTOMUS ARGENTEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.73 .03	2.68 .12	7.27 .30	59.09 2.14	15.23 .96	0.00 0.00	2.13 .24	87.13 .27
ORTHOPRISTIS CHRYSOPTERA	0.00 0.00	2.00 0.00	0.00 0.00	0.00 0.00	.61 .03	0.00 0.00	0.00 0.00	0.00 0.00	10.23 .37	0.00 0.00	59.98 1.09	5.97 .66	76.79 .24
EUCINOSTOMUS GULA	0.00 0.00	0.00 0.00	0.00 0.00	0.47 3.00	0.00 0.00	0.00 0.00	0.00 0.00	24.09 .98	31.65 1.15	6.48 .41	0.00 0.00	0.00 0.00	62.23 .19
MENTICIRRHUS AMERICANUS	1.00 .10	3.48 .31	0.00 0.00	1.00 .15	.99 .04	2.44 .09	1.79 .08	5.96 .24	37.64 1.36	3.79 .24	.22 .00	0.00 0.00	62.03 .19

Table II, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
ARCHOSARGUS PROBATOCEPHALUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	59.34 2.57	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	59.34 .18
SYMPHURUS PLACIUSA	11.26 1.15	2.05 .16	3.37 .14	.40 .01	1.85 .04	4.25 .15	0.00 0.00	5.64 .23	0.00 0.00	4.24 .27	9.85 .18	7.80 .47	50.51 .16
CHLOROSCOMBRUS CHRYSURUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.19 .09	.82 .03	11.79 .51	26.99 1.10	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	41.02 .13
CHAETODIPTERUS FABER	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	31.67 1.31	8.25 .29	1.03 .04	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	40.95 .13
PRIONOTUS TRIBULUS	1.49 .15	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.08 .00	11.28 .46	2.29 .08	0.00 0.00	12.14 .22	9.66 1.07	36.93 .11
OPHICHTHUS GOMESI	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	33.31 .60	0.00 0.00	33.31 .10
UROPHYCIS FLORIDANUS	0.00 0.00	26.27 1.99	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.39 .38	29.66 .09
MENIDIA BERYLLINA	5.41 .56	1.86 .14	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.55 .13	.88 .06	1.55 .03	11.44 1.27	24.69 .08
ANCHOA HEPSETUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.04 .17	1.68 .06	7.36 .32	.96 .04	2.78 .10	2.40 .15	.90 .02	0.00 0.00	20.12 .06
MICROGOBIUS GULOSUS	3.57 .37	5.51 .42	.50 .02	.46 .01	.98 .04	.44 .02	.49 .02	.36 .01	.22 .01	1.08 .07	1.76 .03	3.59 .40	18.86 .06
CENTROPRISTIS MELANA	0.00 0.00	0.00 0.00	0.00 0.00	18.43 .29	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	18.43 .06
GOBIONELLUS HASTATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	17.76 .32	0.00 0.00	17.76 .06
PORICHTHYS POROSISSIMUS	0.00 0.00	10.77 .82	3.30 .13	0.00 0.00	0.00 0.00	.36 .01	0.00 0.00	1.37 .06	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	16.40 .05
DOROSOMA PETENENSE	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.91 .20	.78 .03	1.72 .11	4.71 .89	1.25 .14	13.37 .04
ICTALURUS PUNCTATUS	8.30 .86	0.00 0.00	4.73 .16	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	13.03 .04
SPHOEROIDES NEPHELUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.76 .24	0.00 0.00	.37 .02	2.20 .04	2.81 .31	11.14 .03
PEPRILUS BURTI	0.00 0.00	0.00 0.00	7.85 .27	0.00 0.00	3.24 .13	.04 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	11.13 .03
SCIAENOPS OCELLATA	0.00 0.00	10.78 .82	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	10.78 .03
GOBIOSOMA BOSCI	1.13 .12	.03 .00	0.00 0.00	0.00 0.00	0.00 0.00	.24 .01	0.00 0.00	0.00 0.00	.04 .00	.20 .01	3.36 .06	3.16 .35	8.16 .03
STELLIFER LANCEOLATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.53 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	7.53 .84	8.06 .02
OPSANUS BETA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.94 .21	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.94 .02
BREVOORTIA PATRONUS	0.00 0.00	0.00 0.00	3.05 .11	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.48 .28	5.53 .02
MONACANTHUS HISPIDUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.18 .11	.10 .00	1.24 .05	.73 .03	0.00 0.00	0.00 0.00	0.00 0.00	5.25 .02
LUCANIA PARVA	0.00 0.00	.06 .00	1.09 .04	0.00 0.00	0.00 0.00	.13 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.88 .43	5.16 .02
ANGUILLA ROSTRATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.15 .57	5.15 .02
PRIONOTUS SCITULUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.02 .00	0.00 0.00	2.71 .10	0.00 0.00	1.09 .02	1.04 .12	4.86 .02
MYROPHIS PUNCTATUS	3.84 .40	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.84 .01

Table 11, continued

SPECIES	SAMPLE DATES 730315	730415	730515	730615	730715	730815	730915	731015	731115	731215	740115	740215	TOTALS
ACROCNBIUS THALASSINUS	1.83 .19	.06 .00	.03 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.06 .00	0.00 0.00	0.00 0.00	1.36 .02	.06 .01	3.40 .01
SYNGNATHUS SCOVELLI	.23 .02	0.00 0.00	0.00 0.00	0.00 0.00	.10 .00	0.30 0.00	.18 .01	0.00 0.00	.03 .00	.76 .06	.16 .00	1.55 .17	3.07 .01
OPIONELLUS BOLFOSOMA	.72 .07	0.00 0.00	.03 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.18 .01	0.00 0.00	.30 .02	1.00 .02	.84 .09	3.07 .01
SYNGNATHUS LOUISIANAE	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.39 .02	1.52 .06	1.07 .04	0.00 0.00	0.00 0.00	0.00 0.00	2.98 .01
UGIL CUREMA	0.00 0.00	0.00 0.00	0.00 0.00	2.97 .05	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.97 .01
ARANX HIPPOS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.03 .07	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.03 .01
NCYCLOPSETTA QUADROCELLATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.52 .17	1.52 .00
EPRILUS PARU	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.17 .01	.96 .04	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.13 .00
LIGOPLITES SAURUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.41000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	.41000 .00
ELENE VOMER	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.35000 .02	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.35000 .00
SYNGNATHUS FLORIDAE	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.19000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.19000 .00
ARALICHTHYS ALBIGUTTA	0.00000 0.00	0.00000 0.00	.09000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.09000 .00
OPIOSOMA ROBUSTUM	.05000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.05000 .00
MICROPTERUS SALMOIDES	0.00000 0.00	0.00000 0.00	0.00000 0.00	.05000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.05000 .00
STRONGYLURA MARINA	0.00000 0.00	0.00000 0.00	0.00000 0.00	.02000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.02000 .00
TOTALS	969.9	1317.4	2894.9	6268.4	2419.9	2872.5	2307.3	2447.5	2759.8	1583.4	5508.6	900.7	32269.6

FISH SUMMARY BIOMASS FIVE YEARS
DATES 720301-770229
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

SPECIES	SAMPLE DATES 720315	720415	720515	720615	720715	720815	720915	721015	721115	721215	730115	730215
DASYATIS SABINA	219.89 50.34	134.95 33.51	378.39 26.20	976.39 52.47	2212.58 56.22	0.00 0.00	399.54 20.64	1581.23 41.79	781.58 10.85	634.51 31.89	0.00 0.00	244.89 5.13
ANCHOA MITCHILLI	59.79 13.69	27.03 6.71	60.00 4.15	71.32 3.83	245.60 6.24	18.99 1.18	69.00 3.56	974.09 25.74	4224.68 54.33	72.61 3.65	23.06 10.13	17.92 .38
LEPISOSTEUS OSSEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	92.29 2.44	237.38 3.05	493.95 24.82	0.00 0.00	4262.90 89.26
ARIUS FELIS	1.12 .26	0.00 0.00	7.82 .54	209.03 15.53	366.96 9.32	704.11 43.69	481.82 24.89	282.66 7.47	679.65 8.74	0.00 0.00	0.00 0.00	0.00 0.00
MICROPOGON UNDULATUS	47.54 10.68	186.30 46.26	476.06 32.97	158.15 8.50	582.95 14.81	.49 .03	824.98 42.61	51.02 1.35	18.91 .24	15.57 .78	7.37 3.24	113.57 2.38
BAIRDIELLA CHRYSURA	8.56 1.96	0.00 0.00	44.02 3.05	36.79 1.98	2.04 .05	1.29 .08	0.00 0.00	196.28 5.18	1101.90 14.17	176.85 8.89	10.90 4.75	17.61 .37
LEIOSTOMUS XANTHURUS	25.87 5.92	0.00 0.00	242.67 16.80	152.07 9.78	243.77 6.19	53.42 3.31	12.63 .65	18.28 .48	68.15 .88	22.40 1.13	16.49 7.25	5.33 .11
RHINOPTERA BONASUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	610.54 37.88	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
PARALICHTHYS LETHOSTIGMA	0.00 0.00	0.00 0.00	35.53 2.47	14.29 .77	162.68 4.13	192.42 11.94	76.23 3.94	64.14 1.69	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
CYNOSCION ARENARIUS	0.00 0.00	.64 .16	147.61 10.22	15.21 .82	64.76 1.65	9.18 .57	11.04 .57	46.83 1.22	229.31 2.95	16.26 .82	2.32 1.02	0.00 0.00
DOROSOMA CEPEDIANUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	406.03 20.41	0.00 0.00	0.00 0.00
CYNOSCION NEBULOSUS	0.00 0.00	.13 .03	0.00 0.00	2.52 .14	0.00 0.00	.53 .03	.04 .00	108.17 2.86	75.36 .97	79.96 4.02	44.23 19.44	0.00 0.00
ETROPUS CROSSOTUS	2.42 .55	.89 .22	7.36 .51	5.00 .27	4.55 .12	4.11 .26	11.64 .60	70.44 1.86	74.17 .95	7.60 .38	11.20 4.92	3.96 .08
TRINECTES MACULATUS	39.75 9.10	13.86 3.44	30.02 2.08	8.14 .44	11.09 .28	1.37 .09	7.13 .37	31.07 .82	6.19 .08	0.00 0.00	0.00 0.00	21.46 .45
MENTICIRRHUS AMERICANUS	0.00 0.00	0.00 0.00	1.40 .10	2.94 .16	18.27 .46	6.83 .42	1.75 .09	25.71 .68	75.78 .97	9.33 .47	0.00 0.00	12.52 .26
LAGODON RHOMBOIDES	0.00 0.00	2.91 .72	1.48 .10	2.83 .15	11.76 .30	0.00 0.00	0.00 0.00	51.78 1.36	25.09 .32	5.98 .30	16.96 7.45	2.43 .05
SYMPHURUS PLAGIUSA	.13 .03	1.63 .40	2.26 .16	4.08 .22	.90 .02	.55 .03	2.88 .15	54.21 1.43	13.44 .17	5.53 .28	3.35 1.47	7.44 .16
SYNODUS FOETENS	0.00 0.00	0.00 0.00	.87 .06	1.55 .08	1.31 .03	.10 .01	4.69 .24	24.76 .65	50.80 .65	9.72 .49	0.00 0.00	0.00 0.00
MENIDIA BERYLLINA	13.84 3.17	0.00 0.00	.69 .05	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.47 .09	.69 .31	0.00 0.00	22.94 10.08	36.60 .77
CHLOROSCOMBRUS CHRYSURUS	.15 .03	0.00 0.00	1.75 .12	0.00 0.00	.34 .01	3.42 .21	17.56 .91	46.87 1.22	4.11 .05	0.00 0.00	0.00 0.00	0.00 0.00
CHILOMYCTERUS SCHOEPFI	0.00 0.00	0.00 0.00	0.00 0.00	59.13 3.72	0.00 0.00	0.00 0.00	0.00 0.00	2.36 .06	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
PRIONOTUS TRIBULUS	0.00 0.00	0.00 0.00	0.00 0.00	.43 .02	1.11 .03	.19 .01	2.73 .14	18.99 .50	30.31 .40	1.10 .06	.23 .10	2.81 .06
ARCHOSARGUS PROBATOCEPHALUS	12.74 2.92	0.00 0.00	0.00 0.00	.38 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	24.24 .31	0.00 0.00	0.00 0.00	15.25 .32
EUCINOSTOMUS GULA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.77 .19	1.48 .04	1.34 .02	24.87 1.25	0.00 0.00	2.19 .05
ICTALURUS PUNCTATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	23.71 10.42	0.00 0.00
SPHOEROIDES NEPHELUS	0.00	0.00	.34	1.97	.50	0.00	.58	9.26	0.00	0.00	10.15	0.00

Table 11, continued

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215
STELLIFER LANCEOLATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	50.92 2.43	122.08 1.55	3.61 .29	3.07 .14	0.00 0.00	0.00 0.00	0.00 0.00
MARENTULA PENSACOLAE	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
EUCINOSTOMUS GULA	2.63 .16	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	16.29 1.30	24.54 1.13	1.32 .75	9.98 2.12	0.00 0.00
CHLOROSCOMBRUS CHRYSURUS	0.00 0.00	0.00 0.00	0.00 0.00	.67 .48	4.32 .39	12.90 .62	1.45 .02	7.09 .57	0.00 0.00	0.00 0.00	0.00 0.00	4.08 .78
POGONIAS CROMIS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
PRIONOTUS TRIBULUS	3.34 .21	0.00 0.00	.10 .03	.03 .02	0.00 0.00	0.00 0.00	2.31 .03	1.16 .09	1.28 .06	.33 .19	.49 .10	0.00 0.00
ECHENEIS NAUCRATES	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
ORTHOPRISTIS CHRYSOPTERA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
MENTICIRRHUS SAXATILIS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	95.53 8.69	0.00 0.00	0.00 0.00	0.00 0.00	1.36 .06	2.59 1.47	0.00 0.00	0.00 0.00
BREVOORTIA PATRONUS	.13 .01	68.60 2.57	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
CHILOMYCTERUS SCHOEPFI	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.06 .01	3.98 .76
DOROSOMA PETENENSE	1.39 .09	3.95 .15	0.00 0.00	.11 .08	3.39 .31	1.11 .05	0.00 0.00	0.00 0.00	0.00 0.00	11.14 6.34	19.20 4.07	1.00 .19
CHAETODIPTERUS FABER	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.78 .07	1.96 .09	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
UPOPHYCIS FLORIDANUS	7.17 .44	2.10 .08	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
MICROGOBIUS GULOSUS	8.00 .49	9.18 .34	0.00 0.00	0.00 0.00	0.00 0.00	5.89 .28	.81 .01	0.00 0.00	1.22 .06	.38 .22	1.57 .33	4.27 .81
OPHICHTHUS GOMESI	0.00 0.00	3.84 .14	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
SPHOEROIDES NEPHELUS	0.00 0.00	0.00 0.00	.02 .01	0.00 0.00	0.00 0.00	.67 .03	0.00 0.00	0.00 0.00	8.30 .41	0.00 0.00	1.83 .39	0.00 0.00
CENTROPRISTIS MELANA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
ICTALURUS PUNCTATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
ANCHOA HEPSETUS	0.00 0.00	0.00 0.00	1.48 .46	6.17 4.38	1.12 .10	0.00 0.00	0.00 0.00	1.56 .12	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
PORICHTHYS POROSISSIMUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.08 .01	1.67 .08	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
LUCANIA PARVA	.42 .03	.36 .01	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.07 .01	0.00 0.00	3.59 2.04	.67 .14	.69 .13
GOBIOSOMA BOSCI	.92 .06	.31 .01	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.06 .00	0.00 0.00	.34 .04	0.00 0.00	2.55 .54	1.10 .21
GOBIONELLUS HASTATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
SYNGNATHUS SCOVELLI	1.11 .07	.48 .02	0.00 0.00	.01 .01	1.08 .10	2.83 .14	.37 .00	.87 .07	2.24 .10	1.68 .96	.67 .14	.61 .12
PRIONOTUS SCITULUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.23 .01	.97 .01	.36 .03	1.64 .08	0.00 0.00	1.37 .29	0.00 0.00
SCIAENOPS OCELLATA	0.00	0.00	0.00									

SPECIES	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215
PEPRILUS PARU	0.00 0.00	0.00 0.00	0.00 0.00	.17 .12	.09 .01	0.00 0.00	0.00 0.00	0.00 0.00	1.23 .06	0.00 0.00	0.00 0.00	0.00 0.00
PEPRILUS BURTI	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.96 .04	0.00 0.00	0.00 0.00	0.00 0.00
SYNGNATHUS LOUISIANAE	0.00 0.00	1.16 .04	0.00 0.00	0.00 0.00	.80 .07	.69 .03	1.59 .02	1.13 .09	.62 .03	.07 .04	0.00 0.00	0.00 0.00
DIPLECTRUM FORMOSUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.61 .03	0.00 0.00	4.86 .39	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
ALOSA ALABAMAE	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
MICROPOGIUS THALASSINUS	.12 .01	.47 .02	.08 .03	.01 .01	0.00 0.00	.11 .01	1.71 .02	.08 .01	.24 .01	0.00 0.00	0.00 0.00	.13 .02
MONACANTHUS HISPIDUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.60 .03	0.00 0.00	0.00 0.00	0.00 0.00
SYNGNATHUS FLORIDAE	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.03 .00	2.30 .11	.64 .01	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
OPSANUS BETA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.19 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
ANGUILLA ROSTRATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
GOBIONELLUS BOLEOSOMA	1.01 .06	0.00 0.00	0.00 0.00	.09 .06	0.00 0.00	.07 .00	.36 .00	.03 .00	.18 .00	0.00 0.00	.35 .07	0.00 0.00
MYKOPHIS PUNCTATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
CARANX HIPPOS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.17 .06	0.00 0.00	.33 .03	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
DIPLODUS HOLBROOKI	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.00 .04	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
MUGIL CUREMA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
LUTJANUS GRISEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.12 .45	0.00 0.00
GOBIOSOMA ROBUSTUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.96 .09	0.00 0.00	0.00 0.00	.23 .01	0.00 0.00	0.00 0.00	0.00 0.00
ANCYCLOPSETTA QUADROCELLATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.68 .14	0.00 0.00
PRIONOTUS RUBIO	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
OLIGOPLITES SAURUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.50000 .02	0.00000 0.00	0.00000 0.00	0.00000 0.00
HYPSOBLENNIUS HENTZI	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.74000 .42	0.00000 0.00	0.00000 0.00
SELENE VOMER	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
SARDINELLA ANCHOVIA	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.68000 .03	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
ALUTERUS SCHOEPFI	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
SPHYRAENA BOREALIS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	1.00000 1.00	.31000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
POMATOMUS SALTATRIX	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.29000 .02	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
MONACANTHUS CILIATUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00

Table 11, continued

:TROSCOPUS Y-GRAECUM	0.00	.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
:PECIES	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 -0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.15000 .09	0.00000 0.00	0.00000 0.00
	SAMPLE DATES 740315	740415	740515	740615	740715	740815	740915	741015	741115	741215	750115	750215
:RONGYLURA MARINA	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
:CROPTERUS SALMOIDES	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
:RALICHTHYS ALBIGUTTA	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
:RANX BARTHOLOMAEI	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00
TOTALS	1677.7	2664.4	318.4	140.7	1098.7	2095.3	7883.5	1250.6	2172.4	175.7	471.4	524.7

FISH SUMMARY BIOMASS 4TH YEAR
DATES 750301-760228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

Table 11, continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
OASYATIS SABINA	274.50 23.04	98.22 6.71	220.01 8.25	0.00 0.00	909.64 49.59	67.57 11.31	164.75 11.62	244.89 10.61	2018.51 66.72	0.00 0.00	325.61 7.70	0.00 0.00	4324.30 20.76
LEPISOSTEUS OSSEUS	244.53 20.53	264.37 18.05	0.00 0.00	40.44 4.19	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	40.44 6.00	3354.84 79.05	0.00 0.00	3944.62 18.94
ARIUS FELIS	36.94 3.10	438.54 29.94	274.49 10.30	135.43 14.04	483.98 26.49	347.75 58.22	114.40 8.09	77.10 3.34	608.77 20.12	0.00 0.00	0.00 0.00	0.00 0.00	2519.40 12.10
ARCHOSARGUS PROBATOCEPHALUS	0.00 0.00	0.00 0.00	19.11 .72	0.00 0.00	0.00 0.00	0.00 0.00	246.30 17.42	1109.53 48.06	21.70 .72	0.00 0.00	5.66 .20	0.00 0.00	1405.30 6.75
MICROPOGON UNDULATUS	182.77 13.66	256.70 17.52	477.86 17.93	92.90 9.63	41.48 2.26	0.00 0.00	85.60 6.05	.08 .00	4.73 .16	10.87 1.61	37.53 .88	68.65 15.50	1239.19 5.95
BREVOORTIA PATRONUS	2.71 .23	11.23 .77	990.27 37.15	.66 .07	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.25 .04	.45 .01	21.10 4.76	1026.67 4.93
ANCHOA MITCHILLI	22.04 1.85	67.67 4.60	28.88 1.08	26.60 2.76	90.15 4.91	16.17 2.71	49.95 3.53	299.40 12.97	139.16 4.50	114.50 16.98	2.68 .06	59.60 13.46	916.50 4.40
PARALICHTHYS LETHOSTIGMA	49.59 4.17	20.87 1.42	159.56 6.00	281.17 29.15	125.92 6.92	112.07 18.76	37.62 2.66	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	64.29 14.51	852.49 4.09
LEIOSTOMUS XANTHURUS	125.90 10.57	189.11 12.91	250.36 9.39	39.59 4.11	0.00 0.00	0.00 0.00	16.20 1.15	33.09 1.43	0.00 0.00	39.65 5.88	8.83 .21	47.54 10.73	750.27 3.60
BAGRE MARINUS	0.00 0.00	0.00 0.00	0.00 0.00	254.20 26.36	78.37 4.27	0.00 0.00	405.58 28.68	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	738.07 3.54
ICTALURUS CATUS	39.24 3.29	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.15 .09	17.53 .58	341.70 50.68	142.98 3.37	101.71 22.96	645.31 3.10
CYNOSCION ARENARIUS	0.00 0.00	3.22 .22	51.51 1.94	59.37 6.16	21.73 1.18	16.66 2.79	129.03 9.13	80.39 3.48	7.22 .24	9.09 1.20	0.00 0.00	0.00 0.00	377.32 1.81
BAIRDIELLA CHRYSURA	54.09 4.54	6.22 .42	4.77 .18	11.66 1.21	2.39 .13	0.00 0.00	51.12 3.62	.12 .01	63.51 2.10	28.85 4.28	0.00 0.00	14.76 3.33	237.59 1.14
TRINECTES MACULATUS	89.30 7.50	6.75 .46	50.01 1.88	2.66 .28	0.00 0.00	4.15 .69	12.61 .89	5.60 .24	10.99 .36	3.36 .50	.70 .02	32.27 7.29	218.40 1.05
SCIAENOPS OCELLATA	2.46 .21	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	195.03 8.45	0.00 0.00	0.00 0.00	1.37 .03	0.00 0.00	198.86 .95
MORONE CHRYSOPS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	188.39 4.44	0.00 0.00	188.39 .90
ETROPUS CROSSOTUS	2.25 .19	10.29 .70	2.99 .11	2.79 .29	.52 .03	2.76 .46	26.41 1.87	51.73 2.24	55.53 1.54	25.39 3.77	4.71 .11	1.71 .39	187.08 .90
SYNODUS FOETENS	0.00 0.00	0.00 0.00	.08 .00	.09 .01	8.80 .48	9.78 1.64	9.12 .65	59.26 2.57	1.53 .05	2.71 .40	8.12 .19	0.00 0.00	99.49 .48
CYNOSCION NEBULOSUS	7.47 .63	13.20 .90	10.05 .38	0.00 0.00	.26 .01	0.00 0.00	2.46 .17	18.69 .81	1.62 .05	7.32 1.09	33.26 .78	2.11 .48	96.45 .46
MICROGOBIUS GULOSUS	6.47 .54	35.47 2.42	12.30 .46	2.03 .21	.49 .03	2.37 .40	7.73 .55	8.76 .38	.50 .02	1.99 .30	1.09 .03	15.56 3.51	94.76 .45
MUGIL CEPHALUS	0.00 0.00	.38 .03	.19 .01	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	75.57 3.27	0.00 0.00	0.00 0.00	.07 .00	.04 .01	76.25 .37
POGONIAS CROMIS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	75.74 1.78	0.00 0.00	75.74 .36
MENTICIRRHUS AMERICANUS	0.00 0.00	0.10 0.00	.84 .03	5.74 .68	18.56 1.01	.24 .04	5.88 .42	7.04 .30	13.59 .45	15.75 2.34	0.00 0.00	0.00 0.00	67.64 .32
SYMPHURUS PLAGIUSA	14.11 1.18	4.53 .31	7.46 .28	1.30 .13	4.61 .25	.23 .04	5.96 .42	7.63 .33	9.13 .30	3.48 .52	2.60 .06	.49 .11	61.53 .30
LAGODON RHOMBOIDES	.05 .00	1.17 .08	1.18 .04	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	9.24 .40	26.22 .87	0.00 0.00	7.03 .17	.33 .07	45.22 .22
LEPOMIS MICROLOPHUS	0.00	0.00	40.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.39

Table 11, continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
JROPHYCIS FLORIDANUS	20.63 1.73	0.00 0.00	6.74 .25	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.53 .04	6.25 1.41	35.15 .17
DOROSOMA PETENENSE	3.54 .30	4.07 .28	.74 .03	0.00 0.00	0.00 0.00	0.00 0.00	3.76 .27	0.00 0.00	0.00 0.00	0.00 0.00	22.31 .53	0.00 0.00	34.42 .17
LUCANIA PARVA	6.26 .53	4.18 .29	20.03 .75	.15 .02	.53 .03	1.65 .28	0.00 0.00	.24 .01	.79 .03	.07 .01	0.00 0.00	0.00 0.00	34.00 .16
EUCINOSTOMUS GULA	2.47 .21	0.00 0.00	1.42 .05	0.00 0.00	0.00 0.00	0.00 0.00	10.72 .76	0.00 0.00	2.04 .07	16.94 2.51	0.00 0.00	0.00 0.00	33.59 .16
CHLOROSCOMBRUS CHRYSURUS	.01 .00	0.00 0.00	2.32 .09	.94 .10	16.17 .99	0.00 0.00	3.65 .26	2.70 .12	.79 .03	0.00 0.00	0.00 0.00	0.00 0.00	28.58 .14
DIPLECTRUM FORMOSUM	0.00 0.00	1.25 .09	4.15 .16	0.00 0.00	0.00 0.00	0.00 0.00	5.19 .37	4.15 .18	4.15 .14	4.28 .63	0.00 0.00	0.00 0.00	23.17 .11
ANCHOA HEPSETUS	0.00 0.00	0.00 0.00	0.00 0.00	3.60 .37	17.22 .94	0.00 0.00	1.45 .10	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	22.27 .11
MENIDIA BERYLLINA	.85 .07	10.78 .74	3.28 .12	.72 .07	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.72 .02	1.74 .26	3.12 .07	0.00 0.00	21.21 .10
PEPRILUS PARU	0.00 0.00	0.00 0.00	8.14 .31	0.00 0.00	4.91 .27	5.40 .90	0.00 0.00	1.81 .08	.10 .00	0.00 0.00	0.00 0.00	0.00 0.00	20.36 .10
PRIONOTUS TRIBULUS	2.33 .20	.11 .01	2.60 .10	0.00 0.00	0.00 0.00	0.00 0.00	.05 .00	.32 .01	7.24 .24	2.49 .37	.79 .02	.21 .05	16.14 .08
ANGUILLA ROSTRATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	12.18 .86	3.29 .14	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	15.39 .07
SYNGNATHUS SCOVELLI	.52 .04	1.45 .10	3.58 .13	1.46 .15	1.84 .10	3.43 .57	.24 .02	.53 .02	1.14 .04	.05 .01	.08 .00	.63 .14	14.95 .07
GOBIOSOMA BOSCI	.96 .08	.81 .06	0.00 0.00	0.00 0.00	0.00 0.00	.39 .07	.95 .07	4.91 .21	1.79 .06	1.08 .16	.30 .01	3.42 .77	14.61 .07
EUCINOSTOMUS ARGENTEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	6.64 1.11	.95 .07	4.28 .19	2.40 .08	.23 .03	0.00 0.00	0.00 0.00	14.50 .07
SPHOEROIDES NEPHELUS	8.20 .59	4.13 .28	0.00 0.00	.09 .01	.28 .02	0.00 0.00	.98 .07	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	13.68 .07
MICROPTERUS SALMOIDES	0.00 0.00	0.00 0.00	.36 .01	.21 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	9.39 .22	0.00 0.00	9.96 .05
PORICHTHYS POROSISSIMUS	0.00 0.00	0.00 0.00	7.29 .27	.18 .02	.68 .04	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	8.15 .04
LUTJANUS GRISEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.12 .15	0.00 0.00	3.35 .11	0.00 0.00	0.00 0.00	0.00 0.00	5.47 .03
PRIONOTUS SCITULUS	4.86 .41	.54 .04	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.06 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.46 .03
CENTROPRISTIS MELANA	5.17 .43	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.17 .02
GOBIONELLUS HASTATUS	0.00 0.00	3.22 .22	1.39 .05	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.61 .02
MUGIL SPECIES	0.00 0.00	3.61 .25	.12 .00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.73 .02
GORIONELLUS BOLEOSOMA	.38 .03	0.00 0.00	.25 .01	0.00 0.00	0.00 0.00	0.00 0.00	.28 .02	.08 .00	.16 .01	.13 .02	.57 .01	1.82 .41	3.67 .02
PEPRILUS BURTI	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.00 0.00	0.00 0.00	0.00 0.00	.17 .01	0.00 0.00	2.73 .40	0.00 0.00	.14 .03	3.04 .01
ANCYCLOPSETTA QUADROCELLATA	.19 .02	2.03 .14	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.08 .01	0.00 0.00	0.00 0.00	2.30 .01
MICROBIUS THALASSINUS	.42 .04	1.03 .07	0.00 0.00	0.00 0.00	.01 .00	.04 .01	.01 .00	.04 .00	0.00 0.00	0.00 0.00	0.00 0.00	.03 .01	1.58 .01
CHAETODIPTERUS FABER	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.21 .01	0.00 0.00	1.20 .08	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.41 .01

Table II, continued

SPECIES	SAMPLE DATES 750315	750415	750515	750615	750715	750815	750915	751015	751115	751215	760115	760215	TOTALS
YNGNATHUS FLORIDAE	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.12000 .01	0.00000 0.00	0.00000 0.00	.40000 .02	.34000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	.86000 .00
OTROPIS PETERSONI	0.00000 0.00	0.00000 0.00	.56000 .02	0.00000 0.00	0.01000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.56000 .00
OBIOSOMA ROBUSTUM	0.00000 0.00	0.00000 0.00	0.00000 0.00	.08000 .01	.05000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.29000 .07	.42000 .00
YNGNATHUS LOUISIANAE	0.00000 0.00	0.00000 0.00	0.00000 0.00	.37000 .04	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.37000 .00
ONACANTHUS HISPIDUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.02000 .00	0.00000 0.00	0.00000 0.00	.23000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.25000 .00
UNDULUS GRANDIS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.22000 .01	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.22000 .00
EPOMIS MACROCHIRUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.08000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.08000 .00
ONACANTHUS CILIATUS	0.00000 0.00	0.00000 0.00	.05000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.05000 .00
TOTALS	1191.3	1464.8	2665.8	964.4	1834.3	597.3	1413.9	2308.4	3025.3	674.2	4243.7	442.9	20826.6

FISH SUMMARY BIOMASS 4TH YEAR
DATES 760301-770228
STATIONS 001 002 003 004 005 006 01A 01B 01C 05A
TIMES OF DAY D

Table 11, continued

SPECIES	SAMPLE DATES 760315	760415	760515	760615	760715	760815	760915	761011	761113	761213	770125	770220	TOTALS
MICROPOGON UNDULATUS	474.44 22.54	905.39 27.64	990.52 38.37	514.81 36.59	73.61 5.10	518.05 36.20	160.37 13.64	57.98 3.39	66.22 2.09	5.07 1.07	79.49 14.73	174.74 13.78	3976.29 19.81
LEIOSTOMUS XANTHURUS	326.22 17.09	642.59 26.85	580.00 22.29	234.58 17.00	2.67 .19	96.85 4.90	5.30 .45	199.75 11.68	1172.66 36.95	73.75 15.55	9.33 1.73	109.33 8.57	3455.03 17.22
DASYATIS SABINA	550.64 28.87	437.99 18.30	135.15 5.19	0.00 0.00	137.25 9.52	0.00 0.00	312.50 26.49	426.64 24.94	274.05 8.64	196.45 41.42	368.43 68.26	312.46 24.49	3151.56 15.70
PARALICHTHYS LETHOSTIGMA	7.43 .39	32.13 1.34	100.82 3.87	237.10 16.42	158.88 11.02	45.80 2.32	190.48 16.15	202.21 11.82	535.19 16.87	64.80 13.66	6.31 1.17	340.65 26.70	1915.80 9.55
ANCHOA MITCHILLI	66.31 3.45	50.69 2.12	37.82 1.45	53.84 3.90	95.17 6.60	698.84 35.35	48.68 4.13	80.05 4.68	158.82 5.11	41.34 8.72	28.30 5.24	76.67 6.01	1436.53 7.16
ARIUS FELIS	0.00 0.00	36.94 1.54	49.39 1.90	14.54 1.05	191.97 13.31	69.63 3.52	170.56 14.46	93.49 5.46	145.01 4.57	4.17 .88	0.00 0.00	0.00 0.00	775.70 3.87
ARCHOSARGUS PROBATOCEPHALUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	664.29 46.06	1.57 .08	0.00 0.00	0.00 0.00	17.32 .55	13.36 2.82	0.00 0.00	0.00 0.00	696.54 3.47
BAIRDIELLA CHRYSURA	26.41 1.37	3.94 .16	10.69 .41	6.02 .44	21.11 1.46	12.20 .62	15.41 1.31	37.67 2.20	464.53 14.64	23.25 4.90	2.99 .55	15.64 1.23	639.86 3.19
CYNOSCION ARENARIUS	2.67 .14	14.74 .62	23.09 .89	153.85 11.15	45.06 3.12	124.30 6.29	70.85 6.01	96.29 5.63	15.38 .48	2.13 .45	0.00 0.00	1.29 .10	549.65 2.74
BAGRE MARINUS	0.00 0.00	0.00 0.00	402.47 15.47	78.37 5.68	0.00 0.00	9.72 .49	12.17 1.03	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	502.73 2.51
TRINECTES MACULATUS	77.38 4.06	64.79 2.67	54.94 2.11	13.38 .97	23.79 1.65	39.89 2.02	56.26 4.77	118.72 6.94	0.00 0.00	1.40 .30	0.00 0.00	0.00 0.00	450.15 2.24
BREVOORTIA PATRONUS	311.65 16.23	14.25 .60	44.18 1.70	11.94 .87	0.00 0.00	0.00 0.00	31.21 2.65	.69 .04	0.00 0.00	0.00 0.00	4.01 .74	26.22 2.05	444.15 2.21
ETROPUS CROSSOTUS	11.39 .59	28.67 1.20	30.71 1.18	2.69 .19	.78 .05	8.84 .45	28.34 2.40	117.95 6.89	39.98 1.25	2.49 .52	3.21 .59	4.87 .38	279.92 1.39
SYMPHURUS PLAGIUSA	6.22 .32	22.82 .95	55.18 2.12	3.38 .24	9.35 .65	7.55 .38	34.58 2.93	113.73 6.65	15.20 .48	1.02 .22	1.95 .36	0.00 0.00	270.98 1.35
RHINOPTERA BONASUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	244.89 12.39	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	244.89 1.22
LAGODON RHOMBOIDES	2.63 .12	10.10 .42	19.41 .75	24.96 1.81	2.02 .14	28.79 1.46	28.08 2.38	54.66 3.19	9.34 .28	2.91 .61	10.73 1.99	2.86 .23	195.91 .98
ICTALURUS CATUS	26.40 1.37	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.73 .79	0.00 0.00	142.98 11.21	173.11 .86
LEPISOSTEUS OSSEUS	0.00 0.00	24.37 1.02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	130.45 4.11	0.00 0.00	0.00 0.00	0.00 0.00	154.82 .77
CYNOSCION NEBULOSUS	10.06 .52	9.42 .39	0.00 0.00	0.00 0.00	0.00 0.00	.86 .04	0.00 0.00	16.44 .96	86.31 2.72	0.00 0.00	7.12 1.32	5.09 .40	135.30 .67
UROPHYCIS FLORIDANUS	6.47 .34	35.41 1.48	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.10 .02	5.87 1.09	48.43 3.80	96.28 .48
SYNODUS FOETENS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	7.00 .49	12.16 .62	0.00 0.00	62.98 3.68	6.22 .20	0.00 0.00	0.00 0.00	0.00 0.00	88.36 .44
ICTALURUS PUNCTATUS	0.00 0.00	22.65 .95	4.73 .18	25.42 1.84	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	52.80 .26
PRIONOTUS TRIBULUS	2.52 .13	.31 .01	22.55 .87	0.00 0.00	0.00 0.00	1.09 .06	3.75 .32	14.64 .86	2.32 .07	1.91 .40	0.00 0.00	.63 .05	49.72 .25
STELLIFER LANCEOLATUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.94 .07	40.77 2.06	.24 .02	.11 .01	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	42.06 .21
MICROGOBIUS GULOSUS	24.60 1.28	6.49 .27	2.24 .09	1.37 .10	.63 .04	.21 .01	.11 .01	.27 .02	.17 .01	0.00 0.00	.02 .00	0.00 0.00	36.11 .18
PEPRILUS PURIT	2.76	22.47	10.10	0.00	0.00	0.00	0.00	0.00	.15	0.00	0.00	.37	35.76

Table 11, continued

SPECIES	SAMPLE DATES 760315	760415	760515	760615	760715	760815	760915	761011	761113	761213	770125	770220	TOTALS
POPICHTHYS POROSISSIMUS	0.00 0.00	0.00 0.00	26.59 1.02	.21 .02	.75 .05	.32 .02	2.25 .13	1.11 .06	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	31.23 .16
DOROSOMA PETENENSE	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	5.53 .18	24.14 5.09	.49 .09	.43 .03	30.89 .15
MENTICIRRHUS SPECIOSUS	10.39 .54	0.00 0.00	.11 .00	2.06 .15	0.00 0.00	1.37 .07	1.73 .15	5.48 .32	1.27 .04	0.00 0.00	0.00 0.00	0.00 0.00	22.41 .11
MENIDIA BERYLLINA	2.00 .10	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.83 .11	.77 .02	11.20 2.36	6.45 1.20	0.00 0.00	22.25 .11
PARALICHTHYS ALBIGUTTA	0.00 0.00	0.00 0.00	0.00 0.00	8.09 .59	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	10.63 .83	18.72 .09
EUCINOSTOMUS ARGENTEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.78 .05	2.50 .13	4.49 .38	.01 .00	7.14 .23	0.00 0.00	0.00 0.00	0.00 0.00	14.92 .07
SPHOEROIDES NEPHELUS	0.00 0.00	0.00 0.00	0.00 0.00	1.16 .08	0.00 0.00	.82 .04	0.00 0.00	0.00 0.00	6.88 .22	0.00 0.00	0.00 0.00	0.00 0.00	8.86 .04
ORTHOPRISTIS CHRYSOPTERA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.00 .09	0.00 0.00	3.59 .67	0.00 0.00	6.59 .03
DIPLECTRUM FORMOSUM	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	6.53 .21	0.00 0.00	0.00 0.00	0.00 0.00	6.53 .03
GOBIONELLUS BOLEOSOMA	1.59 .09	1.39 .06	.23 .01	.79 .06	0.00 0.00	.18 .01	0.00 0.00	0.00 0.00	.02 .00	0.00 0.00	.09 .02	.75 .06	5.14 .03
GOBIONELLUS HASTATUS	0.00 0.00	0.00 0.00	0.00 0.00	1.78 .13	0.00 0.00	0.00 0.00	0.00 0.00	3.13 .18	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.91 .02
EUCINOSTOMUS GULA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.29 .12	0.00 0.00	2.12 .12	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	4.41 .02
SYNGNATHUS SCOVELLI	.83 .04	.09 .00	.20 .01	.50 .04	0.00 0.00	.56 .03	0.00 0.00	.06 .00	.63 .02	.57 .12	.38 .07	.23 .02	4.05 .02
HARENGULA PENSACOLAE	0.00 0.00	3.91 .16	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.91 .02
SYNGNATHUS LOUISIANAE	0.00 0.00	1.18 .05	0.00 0.00	0.00 0.00	1.52 .11	1.18 .06	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.88 .02
PEPRILUS PARU	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.47 .24	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.47 .02
PRIONOTUS SCITULUS	0.00 0.00	.19 .01	0.00 0.00	3.17 .23	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	3.36 .02
GORIOSOMA BOSCI	2.10 .11	.48 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.17 .01	.02 .00	0.00 0.00	.34 .06	.09 .01	3.20 .02
SYNGNATHUS FLORIDAE	0.00 0.00	0.00 0.00	.21 .01	0.00 0.00	0.00 0.00	2.48 .13	0.00 0.00	0.00 0.00	.43 .02	0.00 0.00	0.00 0.00	0.00 0.00	3.18 .02
CARANX HIPPOS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.53 .13	0.00 0.00	.37 .02	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	2.90 .01
LUCANIA PARVA	.27 .01	0.00 0.00	.66 .03	0.00 0.00	0.00 0.00	.15 .01	0.00 0.00	.05 .00	1.47 .05	0.00 0.00	0.00 0.00	0.00 0.00	2.60 .01
CHLOROSCOMBRUS CHRYSURUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.25 .02	.38 .02	1.00 .08	.12 .01	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.75 .01
LUTJANUS GRISEUS	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.71 .10	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.71 .01
MICROPOGIAS THALASSINUS	0.00 0.00	.67 .03	.07 .00	0.00 0.00	.04 .00	.12 .01	.06 .01	.48 .03	.83 .00	.21 .04	0.00 0.00	0.00 0.00	1.68 .01
ANCYCLOPSETTA QUADROCELLATA	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.54 .12	1.54 .01
ANCHOA HEPSETUS	0.00 0.00	0.00 0.00	0.00 0.00	.49 .04	.91 .06	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.40 .01
SELENE VOMER	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	.29 .01	.84 .07	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	1.13 .01

MUGIL CEPHALUS Table II, continued

SPECIES	SAMPLE DATES 760315	760415	760515	760615	760715	760815	760915	761011	761113	761213	770125	770220	TOTALS
CHASMODES SABURRAE	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.62000 .11	0.00000 0.00	.62000 .00
ELOPS SAURUS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.33000 .07	0.00000 0.00	0.00000 0.00	.33000 .00
MICROPTERUS SALMOIDES	0.00000 0.00	0.00000 0.00	0.00000 0.00	.28000 .02	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.28000 .00
CHAETODIPTERUS FABER	0.00000 0.00	0.00000 0.00	.05000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.05000 .00
TOTALS	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.01000 .00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	0.00000 0.00	.01000 .00
	1920.8	2393.0	2602.2	1379.8	1442.2	1977.2	1179.8	1710.9	3173.1	474.3	539.7	1275.9	20868.9

Fig 1: Chart showing the primary study areas in the Apalachicola Drainage System. This includes distribution of permanent stations in the impoundment above the Jim Woodruff Dam (Lake Seminole) and the Apalachicola Estuary.

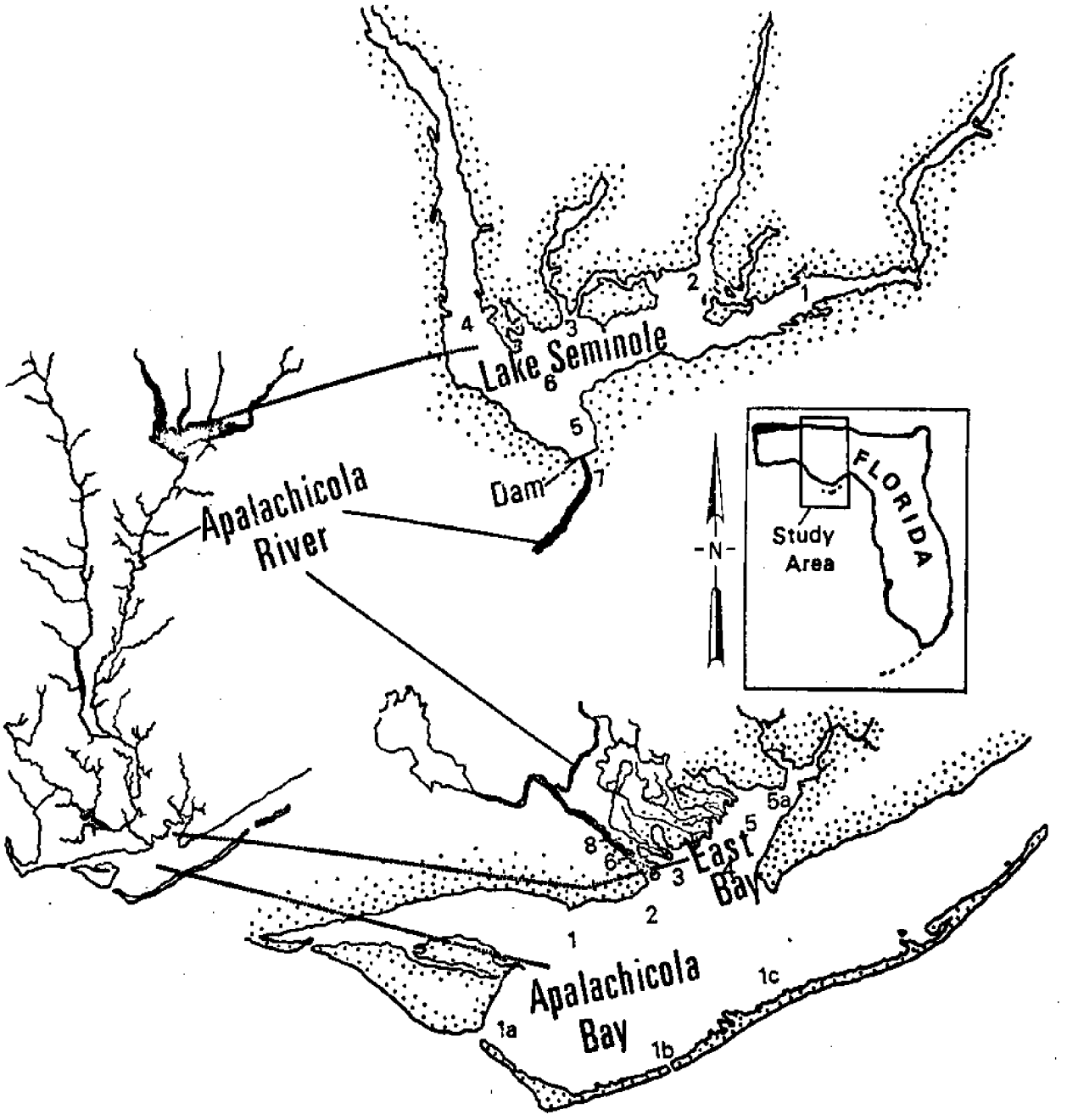


Fig 2: Changes, by month, of Apalachicola River flow (cubic feet per second) and two major physical functions (temperature, in °centigrade; salinity in parts per thousand) monitored at station 1 (bottom) in the Apalachicola Estuary from March, 1972 to February, 1976. The monthly means and ranges of river flow at Blountstown (Florida), as measured by the U.S. Corps of Engineers (Mobile, Alabama), are represented.

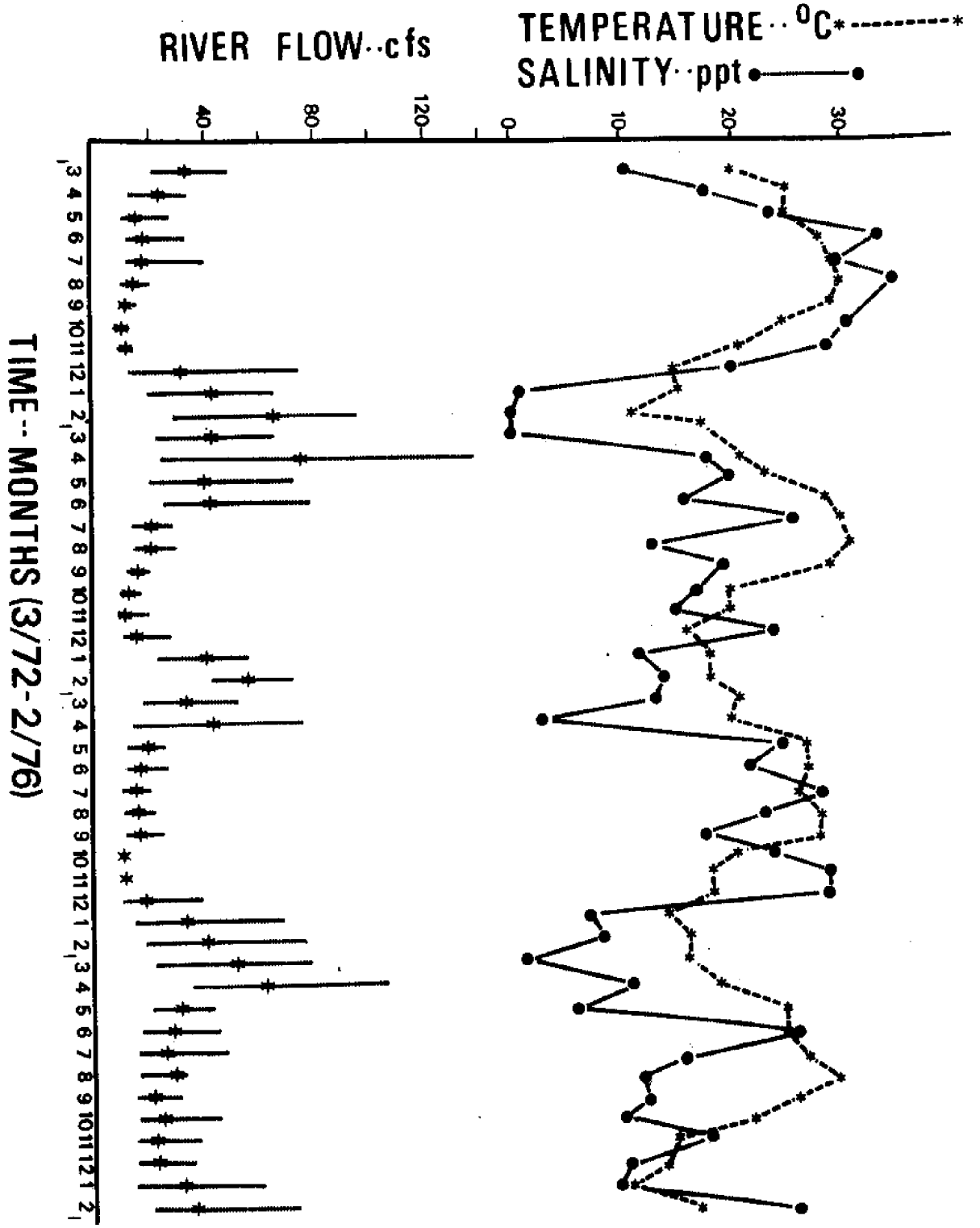


Fig 3: Residues of DDT-R and Arochlor 1254 found in organisms taken in the Apalachicola Estuary from March, 1972 to November, 1974.

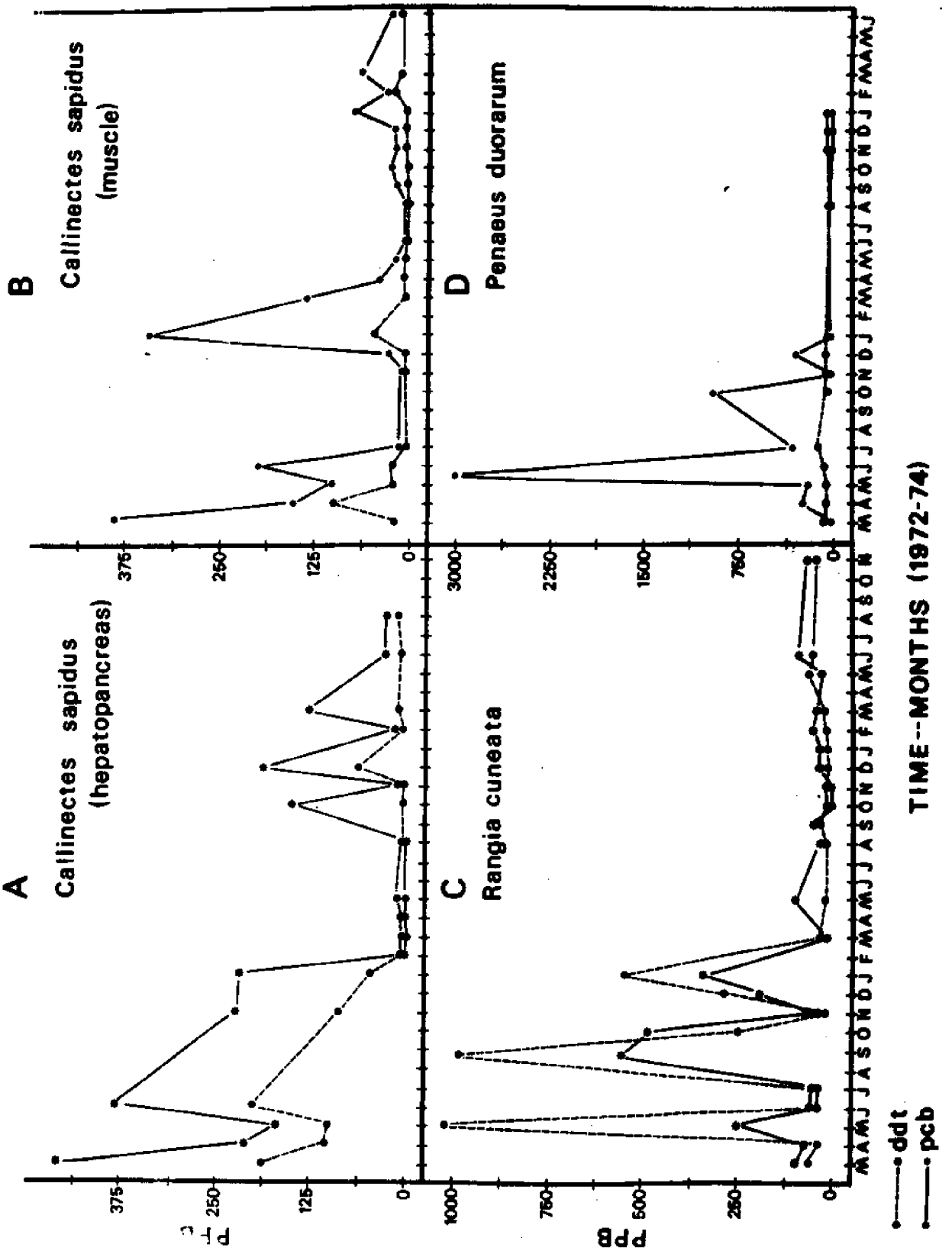


Fig. 4: A. Residues of DDT and its major metabolites found in clams of the Apalachicola Estuary and expressed as percentages of the total (DDT-R) on a monthly basis from March, 1972 to November, 1974.

B. Residues of DDT and its major metabolites found in Sciaenid Fishes of the Apalachicola Estuary and expressed as percentages of the total (DDT-R) on a monthly basis from March, 1972 to July, 1974.

C. Residues of DDT-R and Arochlor 1254 found in Sciaenid Fishes taken in the Apalachicola Estuary March, 1972 to June, 1974.

D. Residues of DDT-R and Arochlor 1254 found in Micropogon undulatus taken in the Apalachicola Estuary from March, 1972 to June, 1974.

FIGURE 4

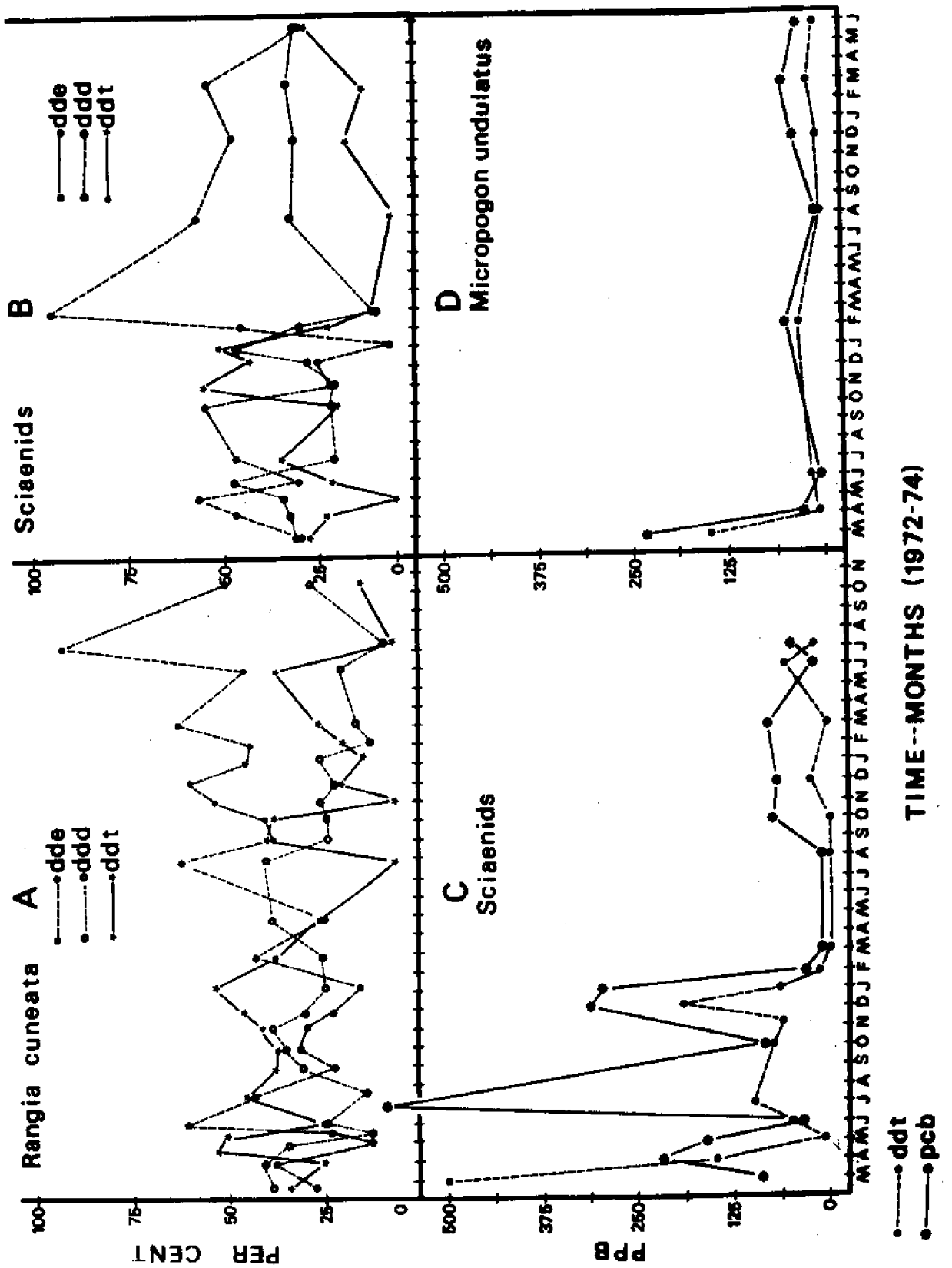

A
Rangia cuneata
dde
ddd
ddt
B
Sciaenids
dde
ddd
ddt
C
Sciaenids
D
Micropogon undulatus
PER CENT
PPB
TIME--MONTHS (1972-74)
ddt
pcb

Fig. 5: Changes in Margalef Richness (Mar), number of species (S), Shannon diversity (H'), and the number of individuals of invertebrates taken monthly from the combined stations (35 trawl tows) in the Apalachicola Estuary from March, 1972 to February, 1976. Dashed lines represent 6-month mean values of these indices are relative dominance of the top species. Also shown are the DDT-R residues found in Rangia cuneata during this period.

FIGURE 5

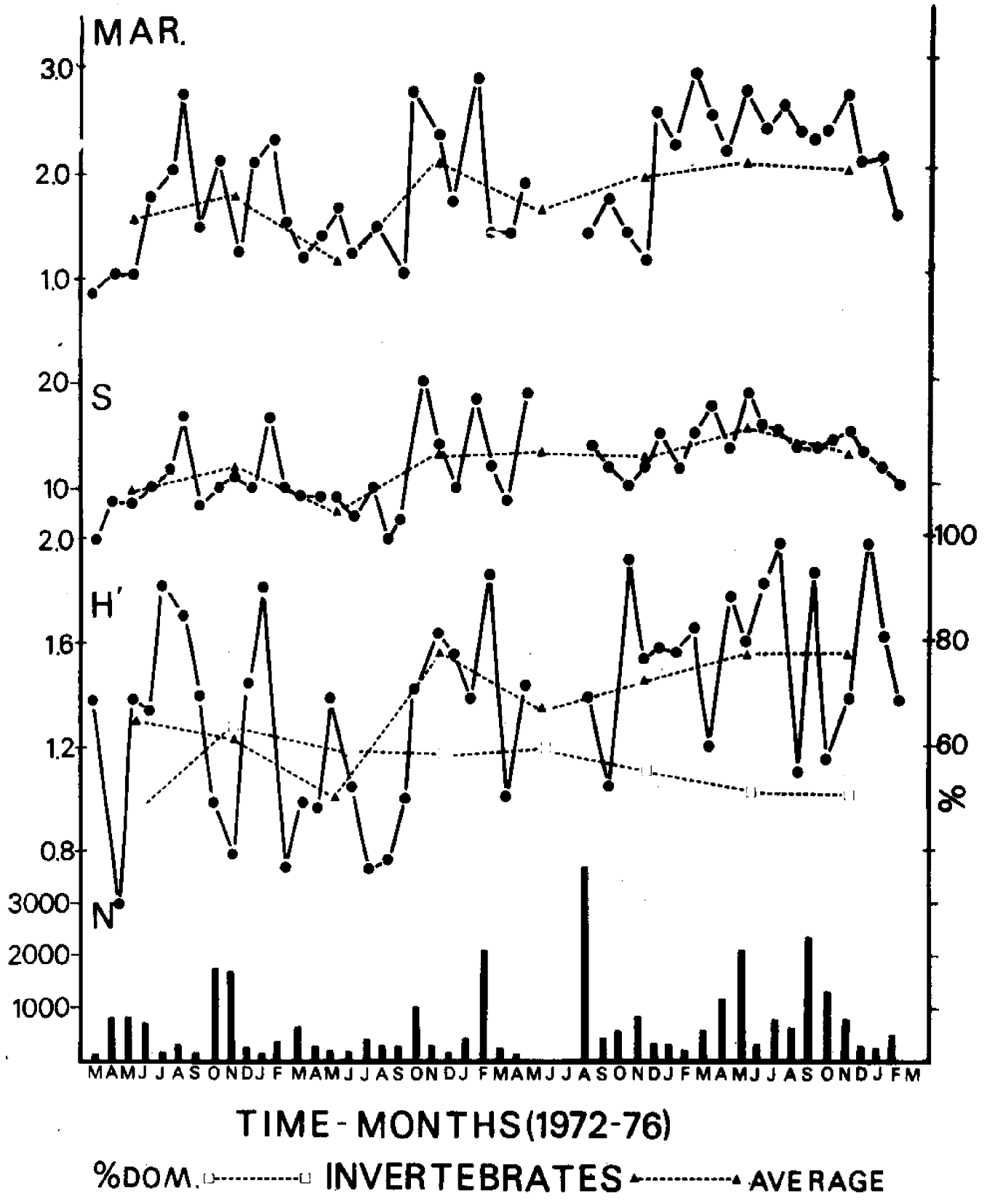

MAR.
3.0
2.0
1.0
S
20
10
2.0
H'
1.6
1.2
0.8
N
3000
2000
1000
100
80
60
%
MAMJ J AS ONDJ F MAMJ J AS ONDJ F MAMJ J AS ONDJ F MAMJ J AS ONDJ F MA
TIME - MONTHS (1972-76)
%DOM. INVERTEBRATES AVERAGE

Fig. 6: Changes in Margalef Richness (Mar), number of species (S), Shannon diversity (H'), and the number of individuals of fishes taken monthly from the combined stations (35 trawl tows) in the Apalachicola Estuary from March, 1972 to February, 1976. Dashed lines represent 6-month mean values of these indices and relative dominance of the top species. Also shown are the DDT-R residues found in Rangia cuneata during this period.

FIGURE 6

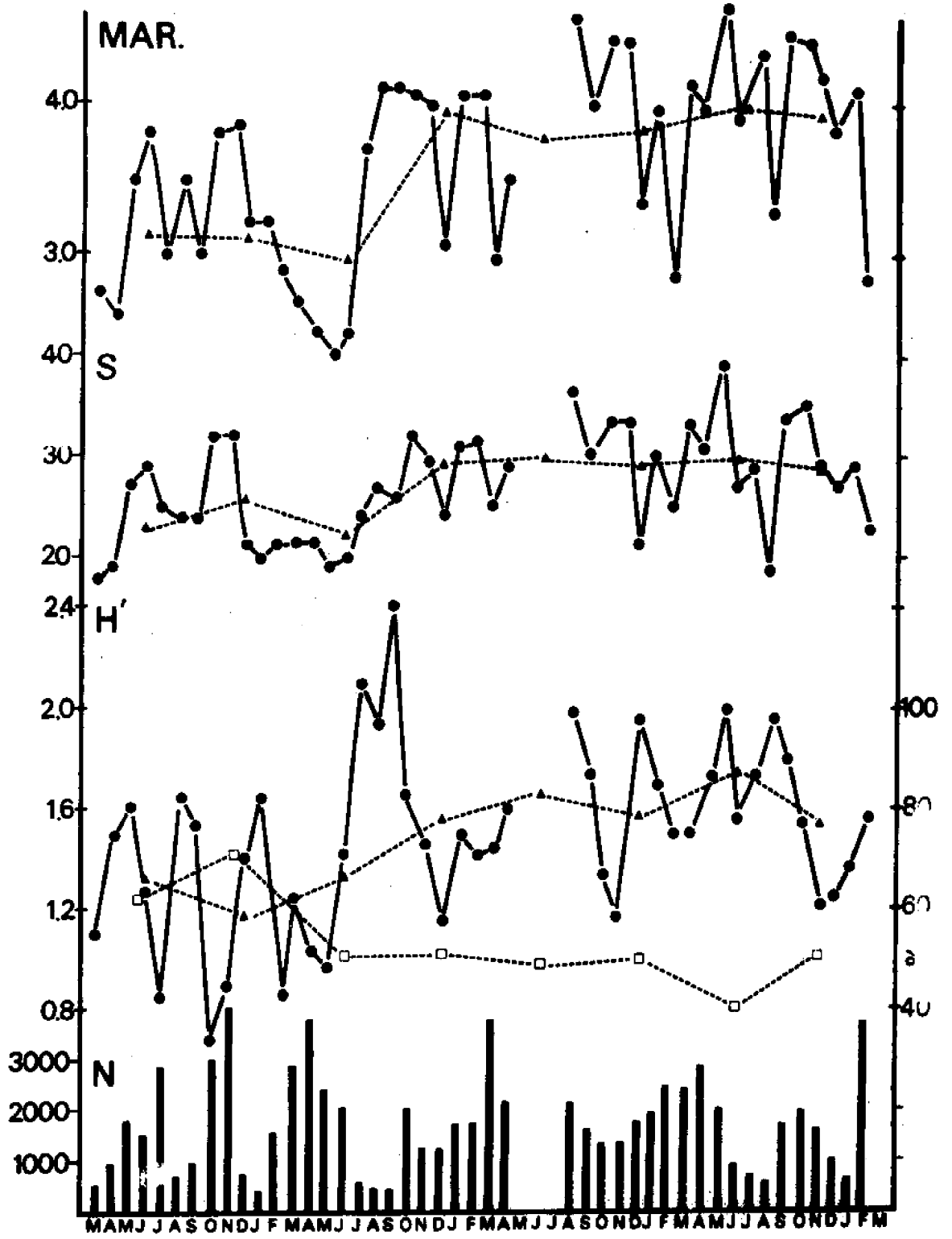

MAR.
4.0
3.0
S
40
30
20
H'
2.4
2.0
1.6
1.2
0.8
100
80
60
40
3000
2000
1000
N
MAMJ J A S O N D J F MAMJ J A S O N D J F MAMJ J A S O N D J F MAMJ J A S O N D J F M
TIME - MONTHS (1972-76)
%DOM. FISHES
AVERAGE

Fig 7: A. Numbers of individuals and species of fishes taken at night from stations 1 and 4 (14 trawl tows) in the Apalachicola Estuary from April, 1972 to March, 1974. Also shown is the top dominant for each month so that total numbers (N-N1) appear as a function of time.

B. Comparison of the diversity/% dominance relationship of fishes taken at night from stations 1 and 4 (14 trawl tows) in the Apalachicola Estuary from April, 1972 to March, 1974. This is shown as a function of the first and second year of sampling.

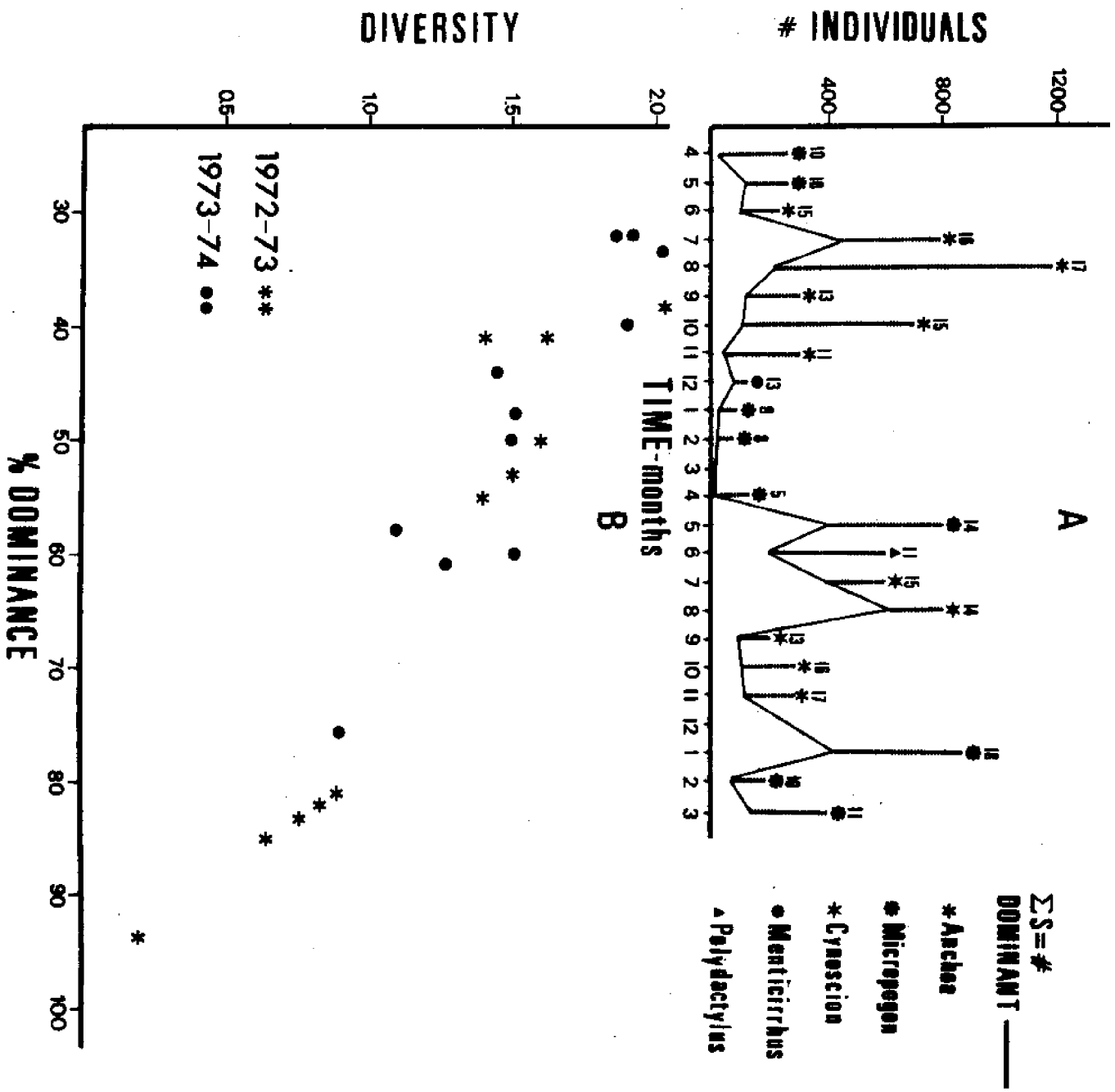
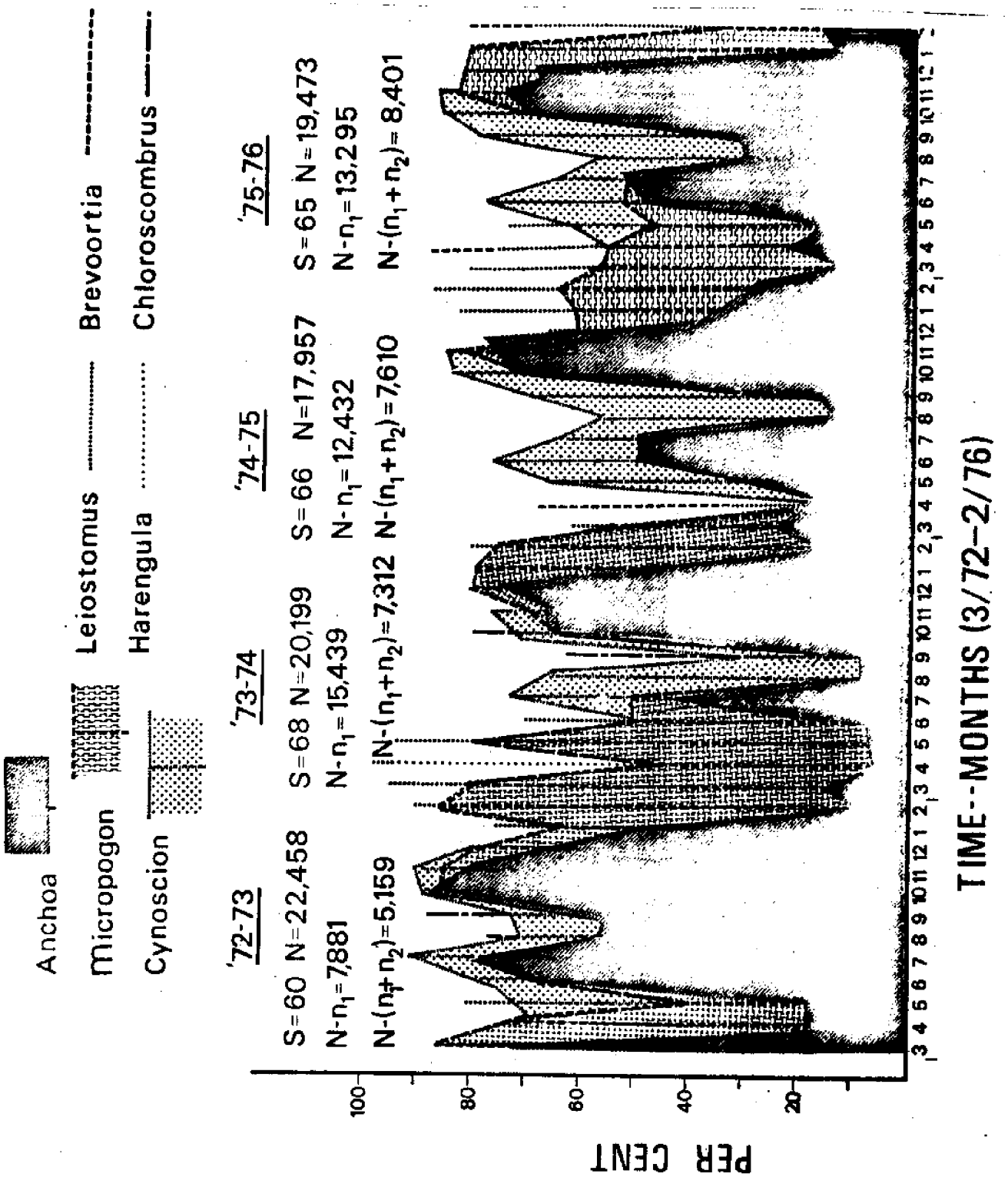


Fig. 8: Relative abundance (numbers of individuals) of the seven top species of fishes taken at all stations in the Apalachicola Estuary on a monthly basis from March, 1972 to February, 1974. Also shown are annual totals of numbers of species (S), numbers of individuals (N), numbers of individuals of all except the top dominant (N-N1), and numbers or individuals of all except the top 2 dominants N-(N1 + N_2).



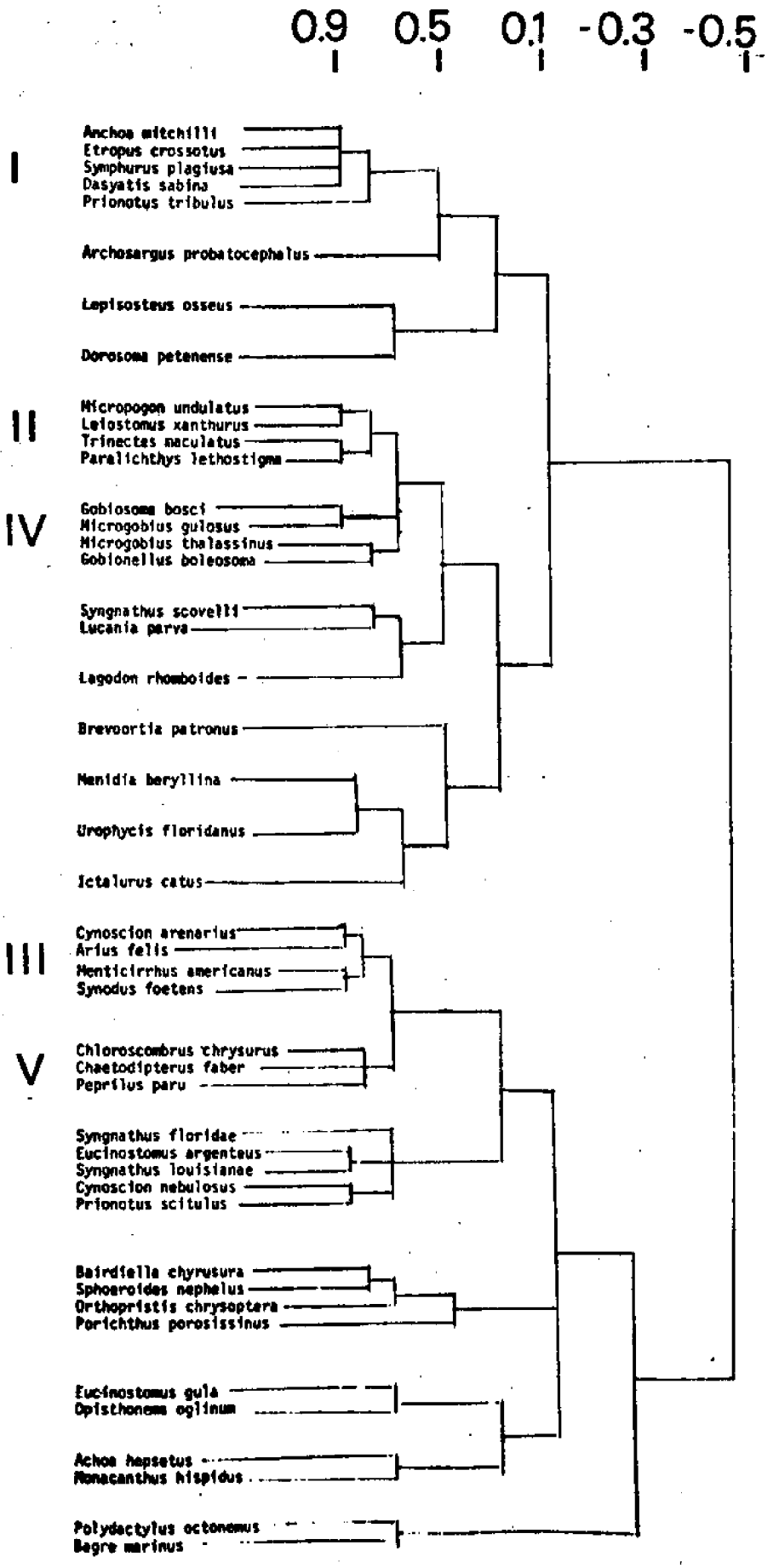
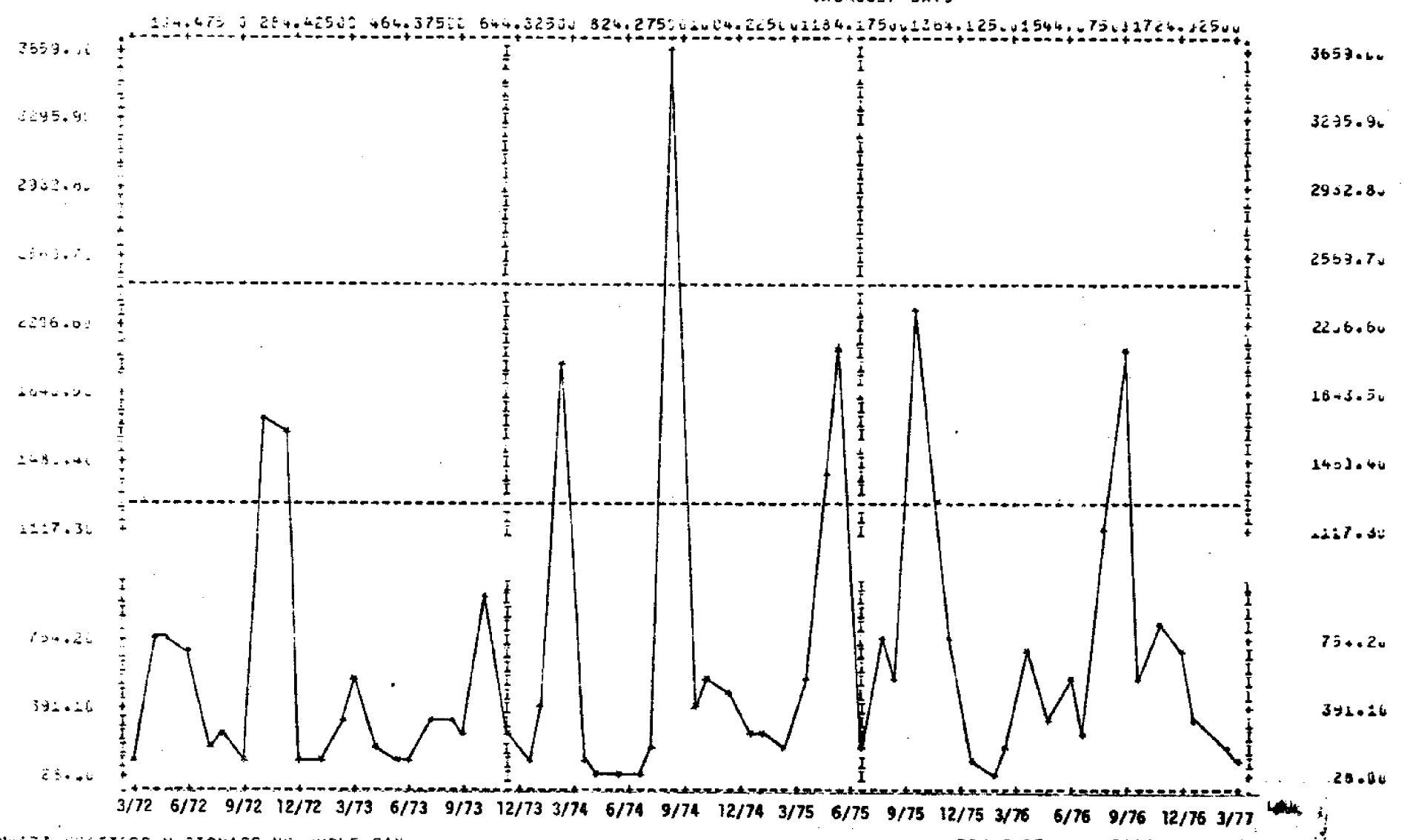


Fig. 9: Dendogram representing temporal associations of fishes taken in the Apalachicola Estuary from March, 1972 to February, 1974. Only the top 45 species (in terms of total numbers of individuals) are shown. Clusters show those species which co-occur on a monthly basis from one year to the next.

Fig. 10: Total numbers of epibenthic invertebrates taken monthly in the Apalachicola Estuary (Stations L, 1A, 1B, 1C, 2, 3, 4, 5, 5A, 6) From March, 1972 to March, 1977.

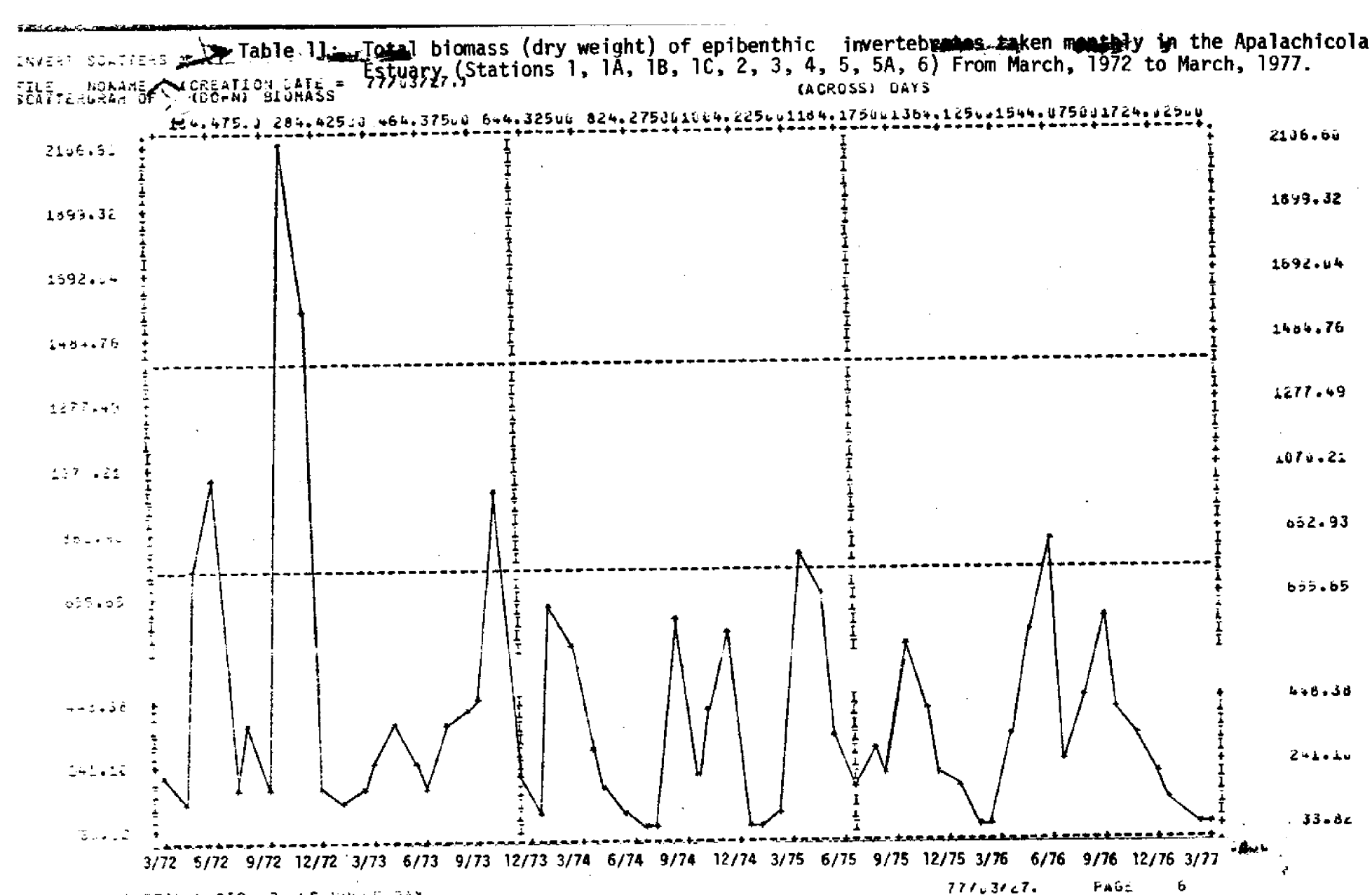


INVERT SCATTERS N,BIOMASS,NS WHOLE BAY 77/03/27. PAGE 4

STATISTICS..

CORRELATION (R) -	.00518	R SQUARED -	.00106	SIGNIFICANCE R -	.21191
STD ERR OF EST -	698.76292	INTERCEPT (A) -	499.21011	STD ERROR OF A -	180.31178
SIGNIFICANCE A -	.0677	SLOPE (B) -	.03785	STD ERROR OF B -	.17113
SIGNIFICANCE B -	.21191				
NUMBER OF VALUES -	60.	EXCLUDED VALUES-	0	MISSING VALUES -	0

Table 11. Total biomass (dry weight) of epibenthic invertebrates taken monthly in the Apalachicola Estuary (Stations 1, 1A, 1B, 1C, 2, 3, 4, 5, 5A, 6) From March, 1972 to March, 1977.



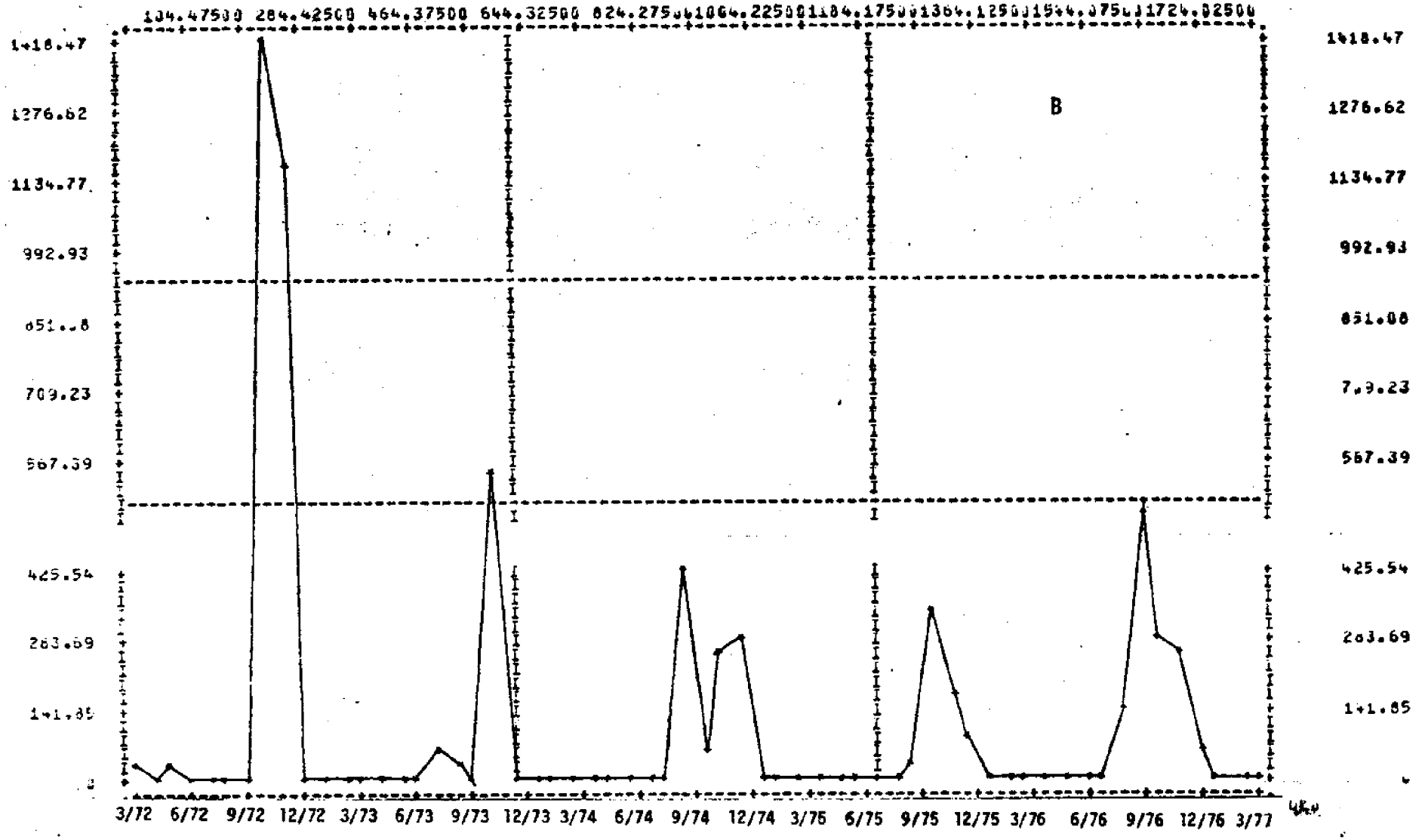
INVERT QUARTERS N.BIOM.SCATTERGRAM WHOLE BAY

REGRESSION

CORRELATION (R) =	-.23598	R SQUARED =	.05569	SIGNIFICANCE R =	.0475
STD ERR OF EST =	363.56198	INTERCEPT (A) =	531.3.557	STD ERROR OF A =	93.81483
SIG SIGNIFICANCE R =	.0004	SLOPE (B) =	-.16467	STD ERROR OF B =	.0894
[illegible] =	-.0479				
[illegible] =	0	[illegible] =		MISSING VALUES =	0

Scatterplots in the Apalachicola Estuary: Regions I, II, III, and IV From March, 1972 through February, 1977.

FILE NONAME (CREATION DATE = 77/03/27.)
SCATTERGRAM OF (DOWN) PENSET (ACROSS) DAYS

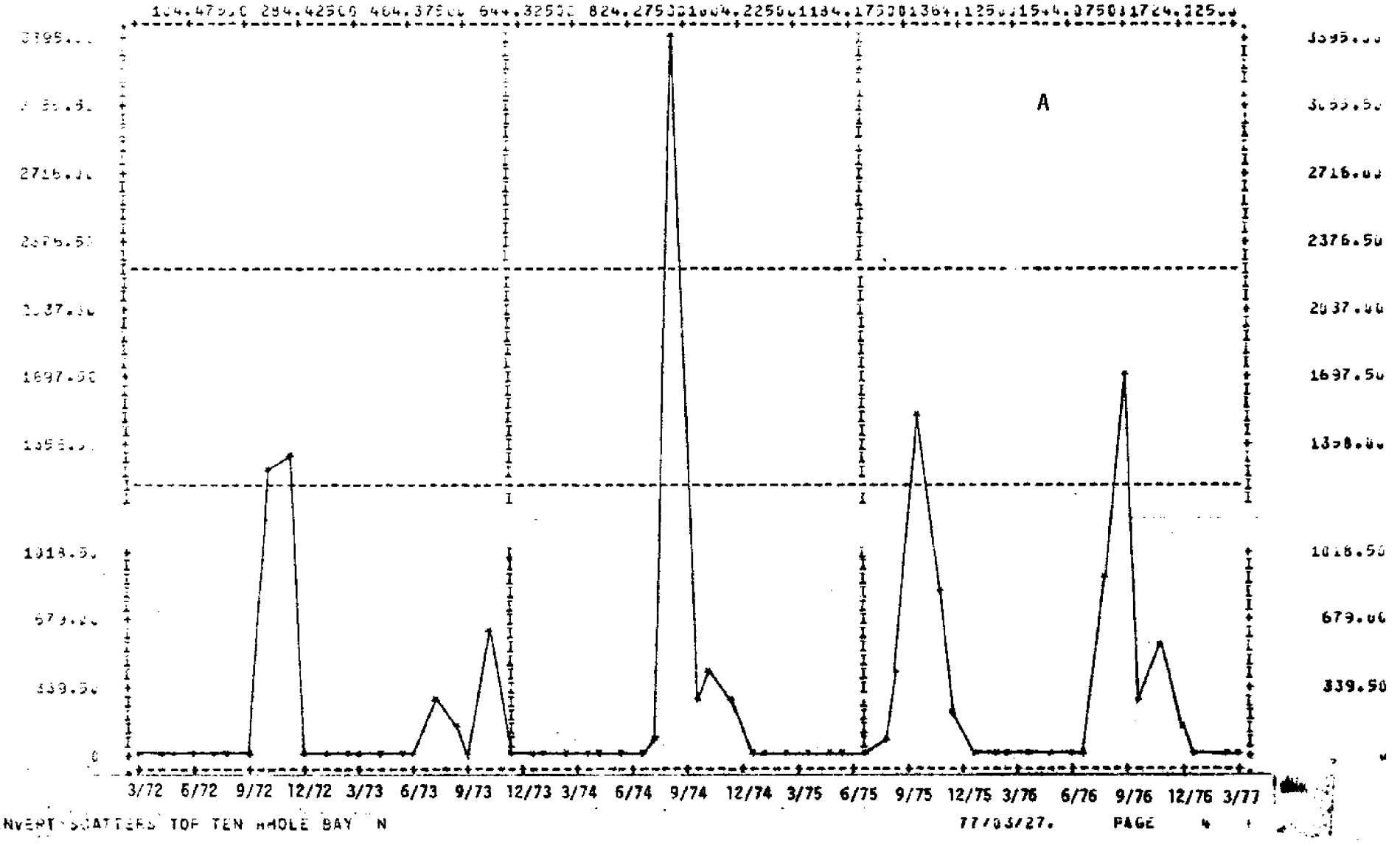


STATISTICS..

CORRELATION (R) =	-.110401	R SQUARED =	.01182	SIGNIFICANCE R =	.21451
STD ERR OF EST =	258.72496	INTERCEPT (A) =	155.14487	STD ERROR OF A =	56.76146
SIGNIFICANCE A =	.01183	SLOPE (B) =	-.05647	STD ERROR OF B =	.06336
SIGNIFICANCE B =	.2145.				
PLOTTED VALUES =	61	EXCLUDED VALUES=	0	MISSING VALUES =	0

******** END OF COEFFICIENT FORMAT OF OUTPUT ********

(ACROSS) DAYS



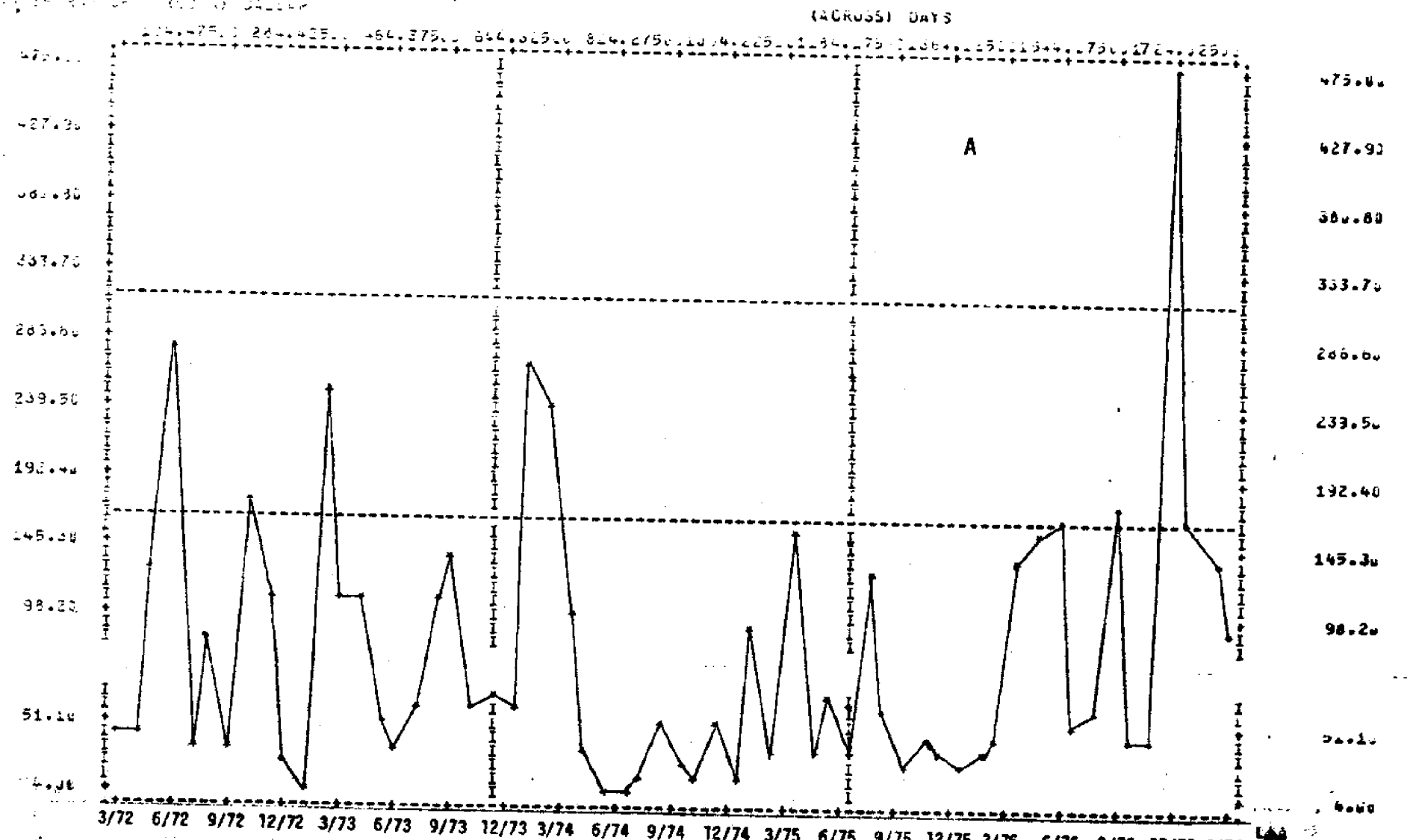
INVERT SCATTERS TOP TEN WHOLE BAY N 77/03/27. PAGE 4

STATISTICS..

CORRELATION (R) -	.49316	R SQUARED -	.03867	SIGNIFICANCE R -	.23963
STD ERR OF EST -	575.55048	INTERCEPT (A) -	169.57848	STD ERROR OF A -	148.51751
SIGNIFICANCE A -	.12911	SLOPE (B) -	.14637	STD ERROR OF B -	.14696
SIGNIFICANCE B -	.23963				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

1, 2, 3, 4, 5, 6, 7A, 7B, 7C, 5A) From March, 1972 through February, 1977.

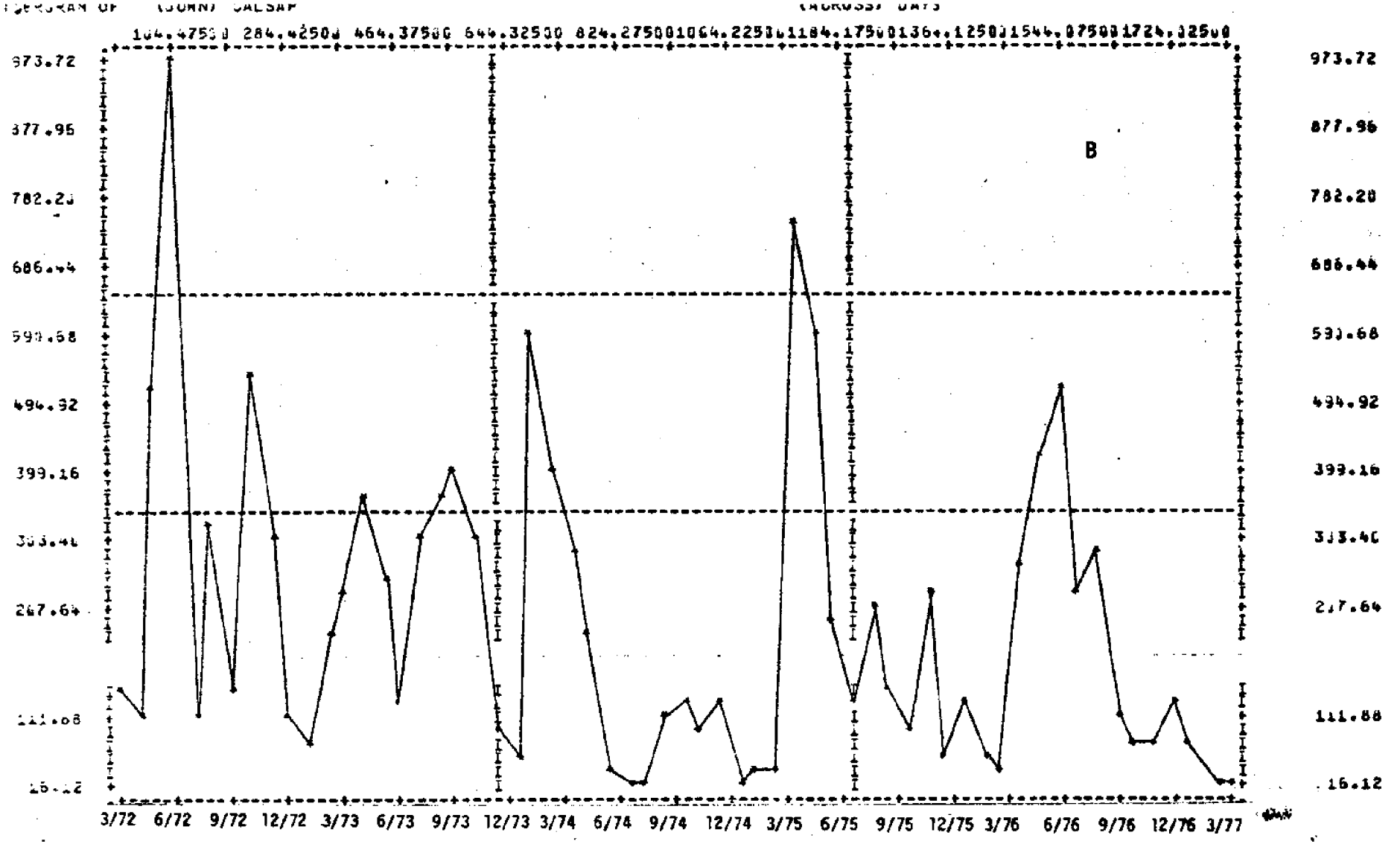


INVERT SCATTERS TOP TEN WHOLE BAY N

STATISTICS..

CORRELATION (R) -	.06450	R SQUARED -	.00416	SIGNIFICANCE R -	.31220
STD ERR OF EST -	84.90591	INTERCEPT (A) -	82.86179	STD ERROR OF A -	21.9099+8
SIGNIFICANCE A -	.0019	SLOPE (B) -	.01424	STD ERROR OF B -	.02679
SIGNIFICANCE B -	.31220				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

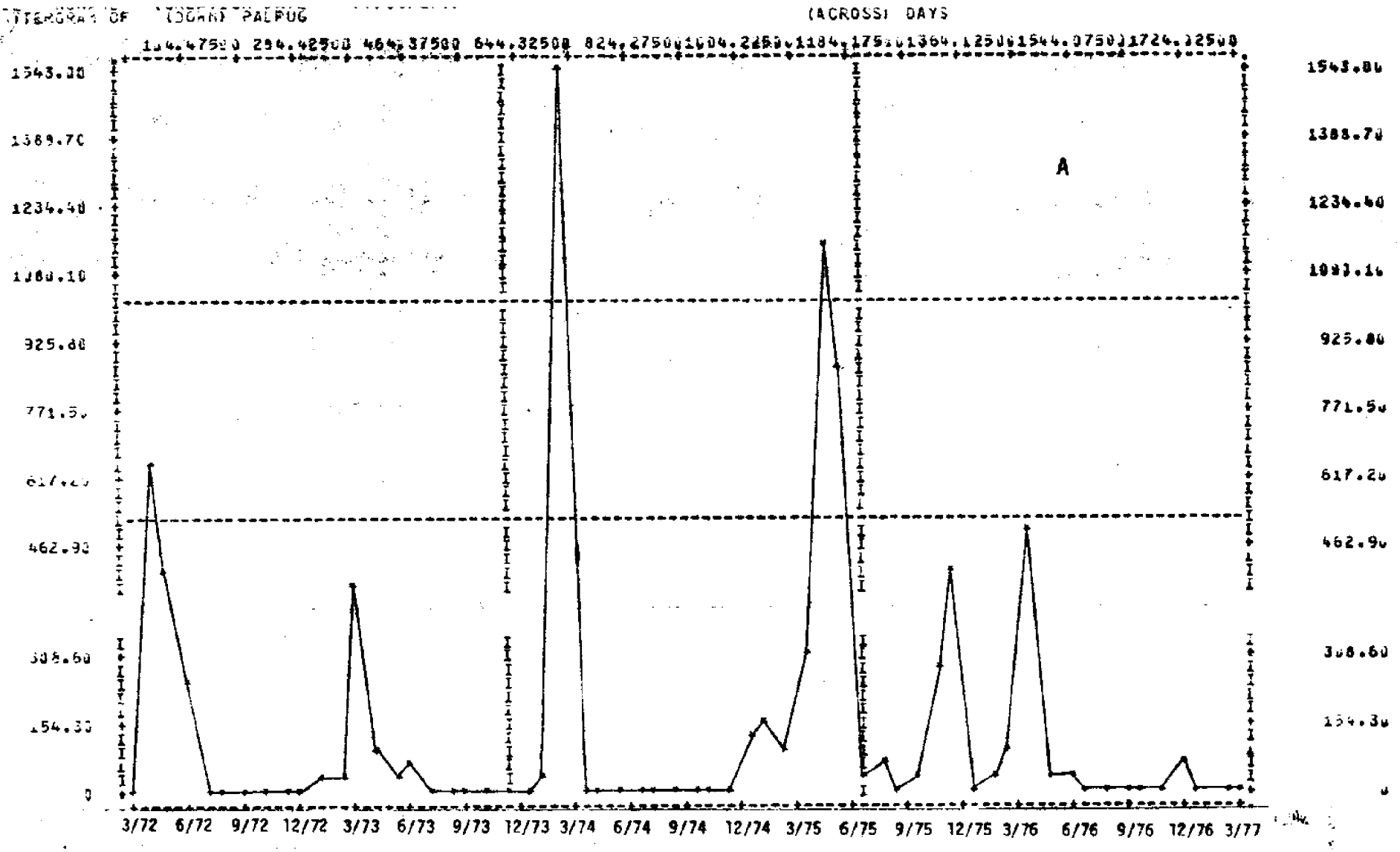
******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.



TATISTICS..

CORRELATION (R) -	-.27992	R SQUARED -	.07836	SIGNIFICANCE R -	.01515
STD ERR OF EST -	189.87695	INTERCEPT (A) -	317.53456	STD ERROR OF A -	48.73862
SIGNIFICANCE A -	.06001	SLOPE (B) -	-.13272	STD ERROR OF B -	.04626
SIGNIFICANCE B -	.01915				
PLOTTED VALUES -	60	EXCLUDED VALUES -	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.



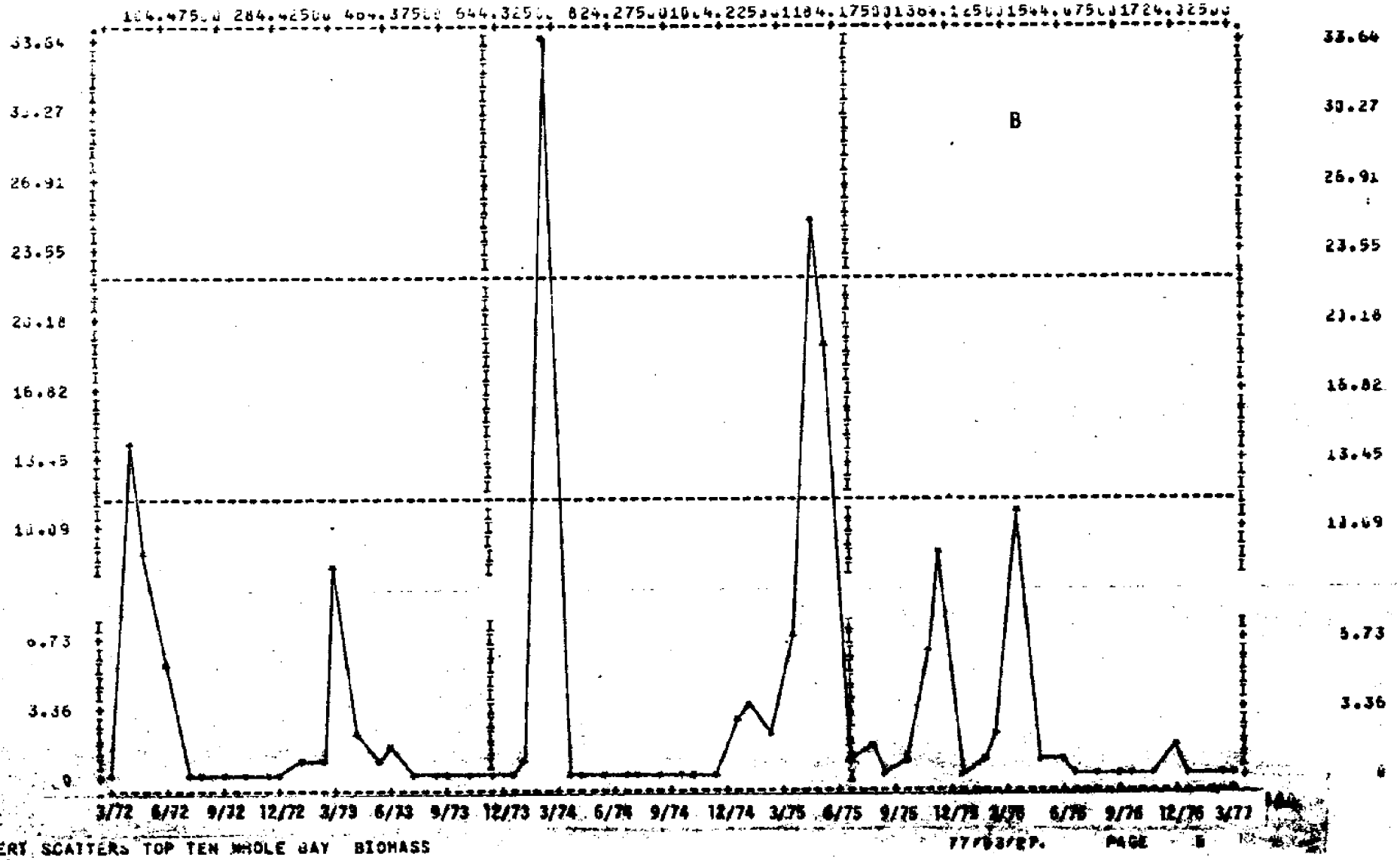
NVERT SCATTERS TOP TEN WHOLE BAY N 77/03/27. PAGE 6

TATISTICS..

CORRELATION (R)-	-..3353	R SQUARED -	.03112	SIGNIFICANCE R -	.39961
STD ERR OF EST -	25[illegible].63737	INTERCEPT (A) -	155.31994	STD ERROR OF A -	74.99731
SIGNIFICANCE A -	..2142	SLOPE (B) -	-.01819	STD ERROR OF B -	.07118
SIGNIFICANCE B -	.39961				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

FILE NONAME (CREATION DATE = 77/03/27.)
SCATTERGRAM OF (DOWN) PALPUG (ACROSS) DAYS



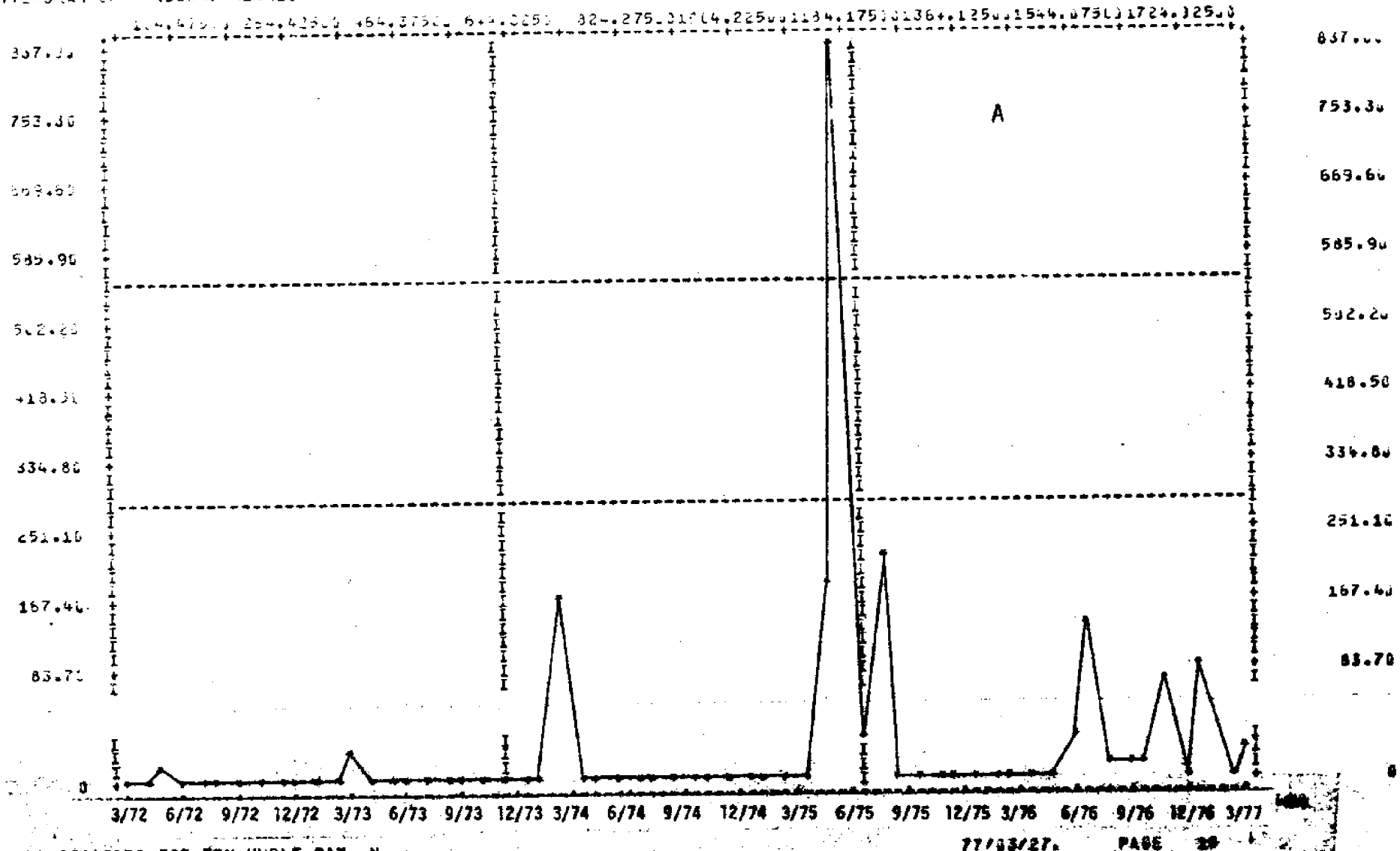
INVERT SCATTERS TOP TEN WHOLE DAY BIOMASS 77/03/27. PAGE 6

STATISTICS..

CORRELATION (R) -	-.03353	R SQUARED -	.0011 2	SIGNIFICANCE R -	.39962
STD ERR OF EST -	6.33535	INTERCEPT (A) -	3.38688	STD ERROR OF A -	1.63480
SIGNIFICANCE A -	.0 2137	SLOPE (B) -	-.00040	STD ERROR OF B -	.00159
SIGNIFICANCE B -	.0 9962				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

ALL NONAME (CREATION DATE = 77/03/27.)
SCATTERGRAM OF (DOWN) NEWREG (ACROSS) DAYS



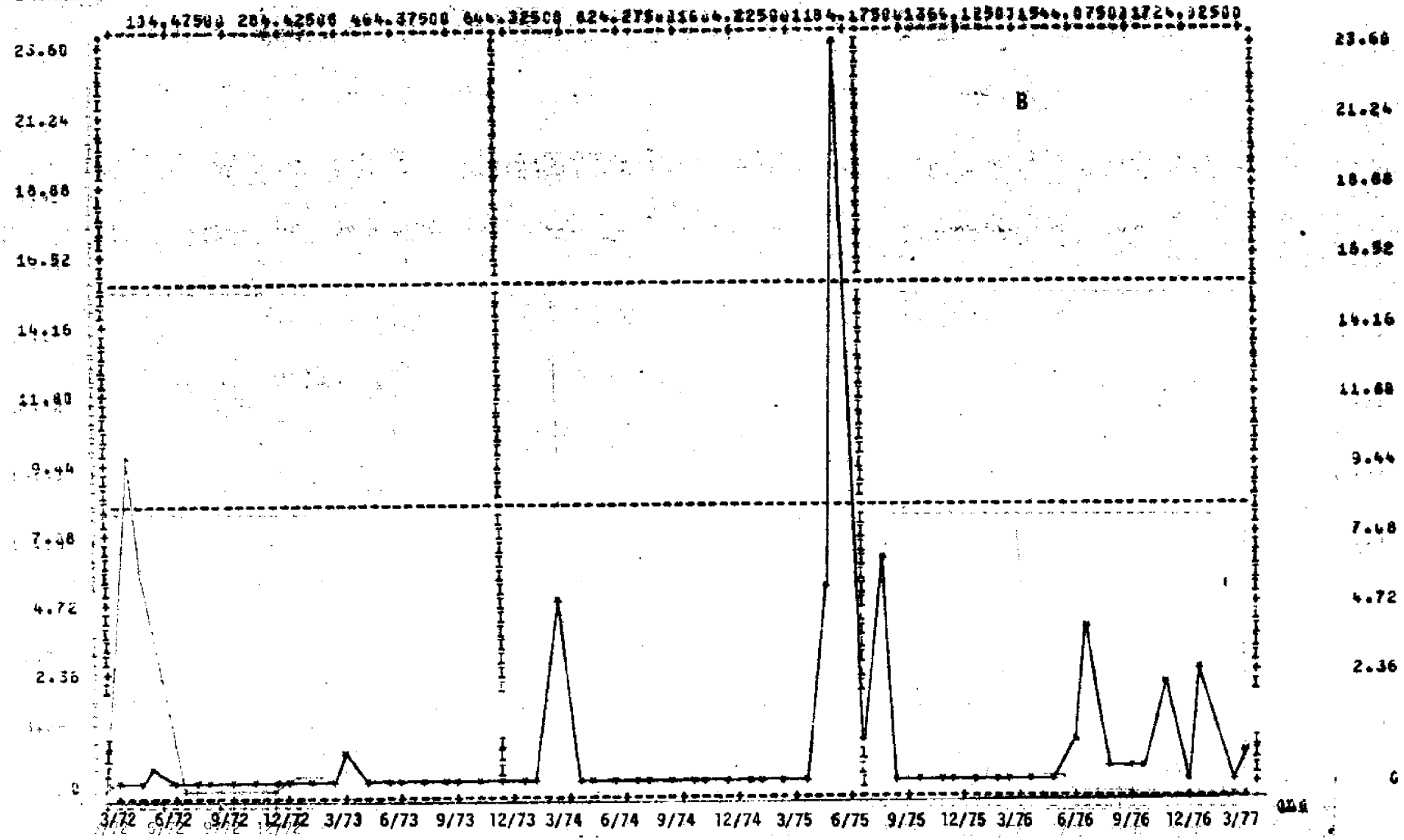
INVERT SCATTERS TOP TEN WHOLE BAY N 77/03/27. PAGE 20

STATISTICS..

CORRELATION (R) -	.17775	R SQUARED -	.03160	SIGNIFICANCE R -	.08711
STD ERR OF EST -	114.55526	INTERCEPT (A) -	1.05766	STD ERROR OF A -	29.56033
SIGNIFICANCE A -	.48579	SLOPE (B) -	.03859	STD ERROR OF B -	.02006
SIGNIFICANCE B -	.08711				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

FILE NONAME (CREATION DATE = 77/03/27.)
SCATTERGRAM OF (DOWN) NERREC (ACROSS) DAYS

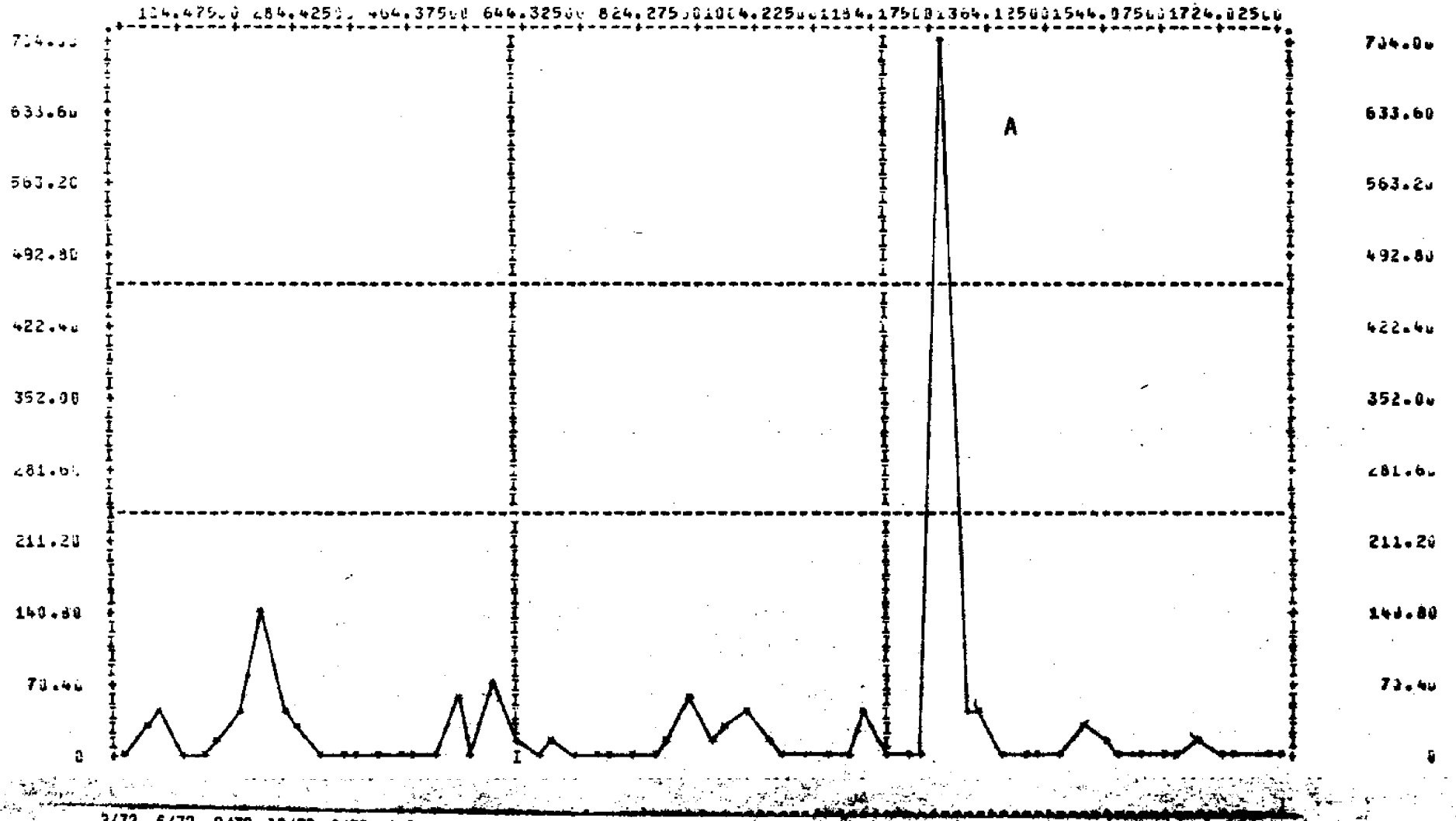


STATISTICS,.

CORRELATION (R) -	.17776	R SQUARED -	.03160	SIGNIFICANCE R -	.08710
STD ERR OF EST. -	3.03641	INTERCEPT (A) -	.82992	STD ERROR OF A -	.83359
SIGNIFICANCE A -	.46582	SLOPE (B) -	.01109	STD ERROR OF B -	.00679
SIGNIFICANCE B -	.08710				
PLOTTED VALUES -	80	EXCLUDED VALUES-	0	MISSING VALUES -	0

******* IS THE RATIO OF A TOLERANCE LIMIT TO SURFACE.

FILE NONAME (CREATION DATE = 77/ 3/27.)
SCATTERGRAM OF (DOWN) PENUDO (ACROSS) DAYS



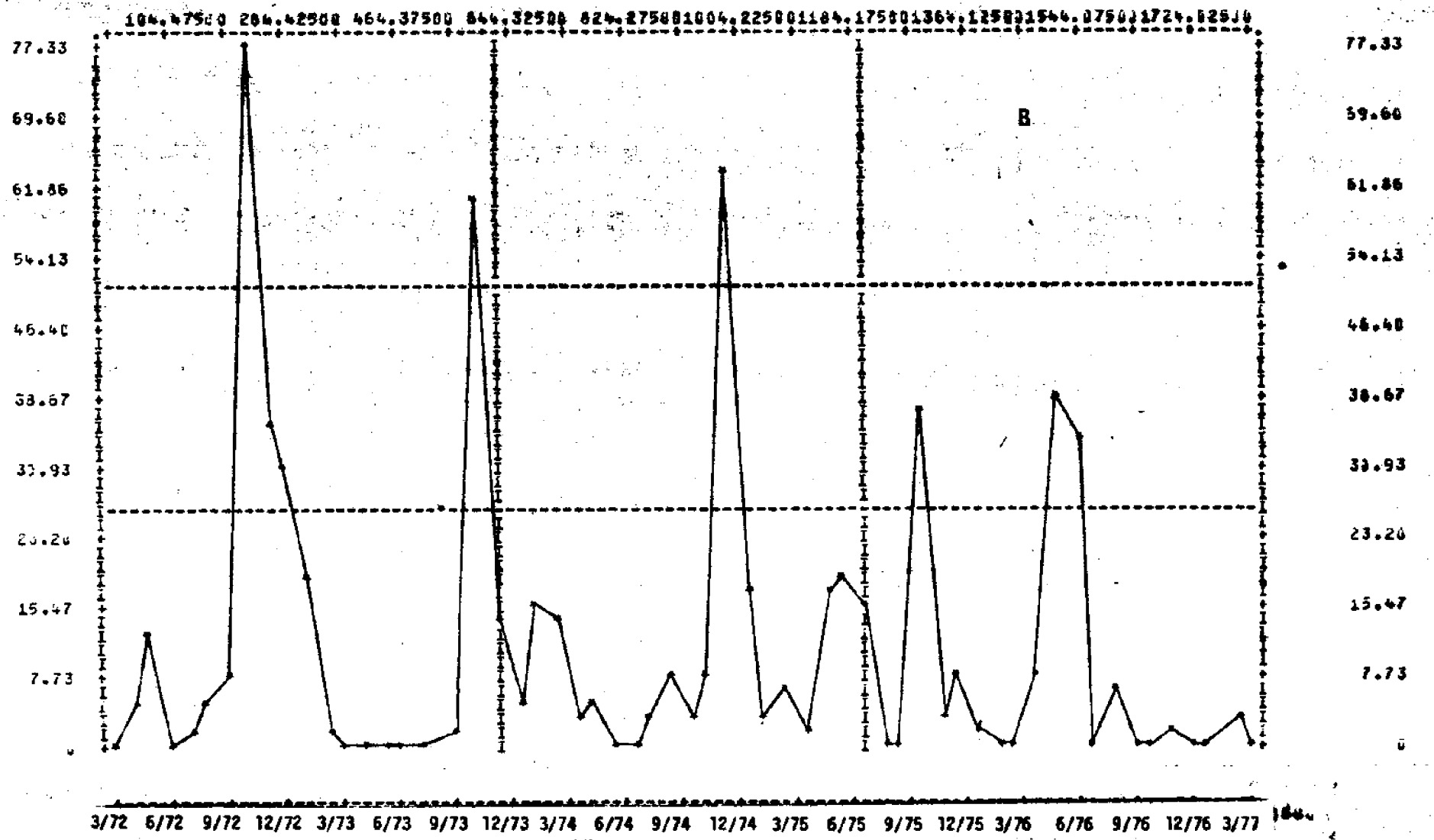
INVERT SCATTERS TOP TEN WHOLE DAY N 77/03/27. PAGE 380

STATISTICS..

CORRELATION (R)-	.01926	R SQUARED -	.00037	SIGNIFICANCE R -	.44194
STD ERR OF EST -	94.02139	INTERCEPT (A) -	28.49125	STD ERROR OF A -	24.88364
SIGNIFICANCE A -	.12637	SLOPE (B) -	.00234	STD ERROR OF B -	.02278
SIGNIFICANCE B -	.44194				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

ILE NONAME (CREATION DATE = 77/03/27.)
SCATTERGRAM OF (DOWN) PENDUO (ACROSS) DAYS



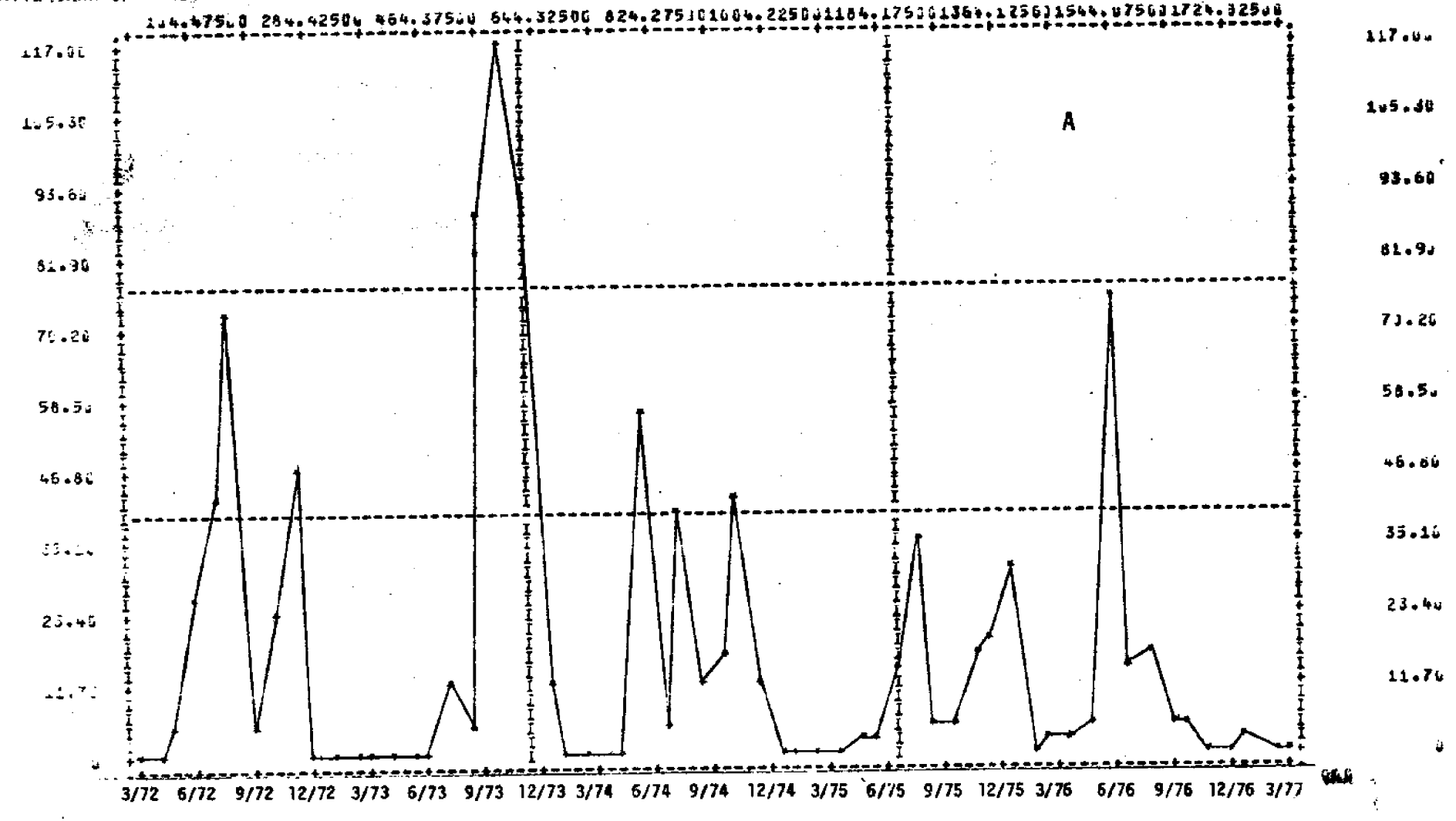
STATISTICS..

CORRELATION (R) -	-.14069	R SQUARED -	.01903	SIGNIFICANCE R -	.14285
STD ERR OF EST -	16.73231	INTERCEPT (A) -	15.43564	STD ERROR OF A -	4.31768
SIGNIFICANCE A -	.0036	SLOPE (B) -	-.03442	STD ERROR OF B -	.0410
SIGNIFICANCE B -	.1486				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

(CREATION DATE = 77/03/27.)
ATTERGRAM OF (JOHN) LOLBRE

(ACROSS) DAYS



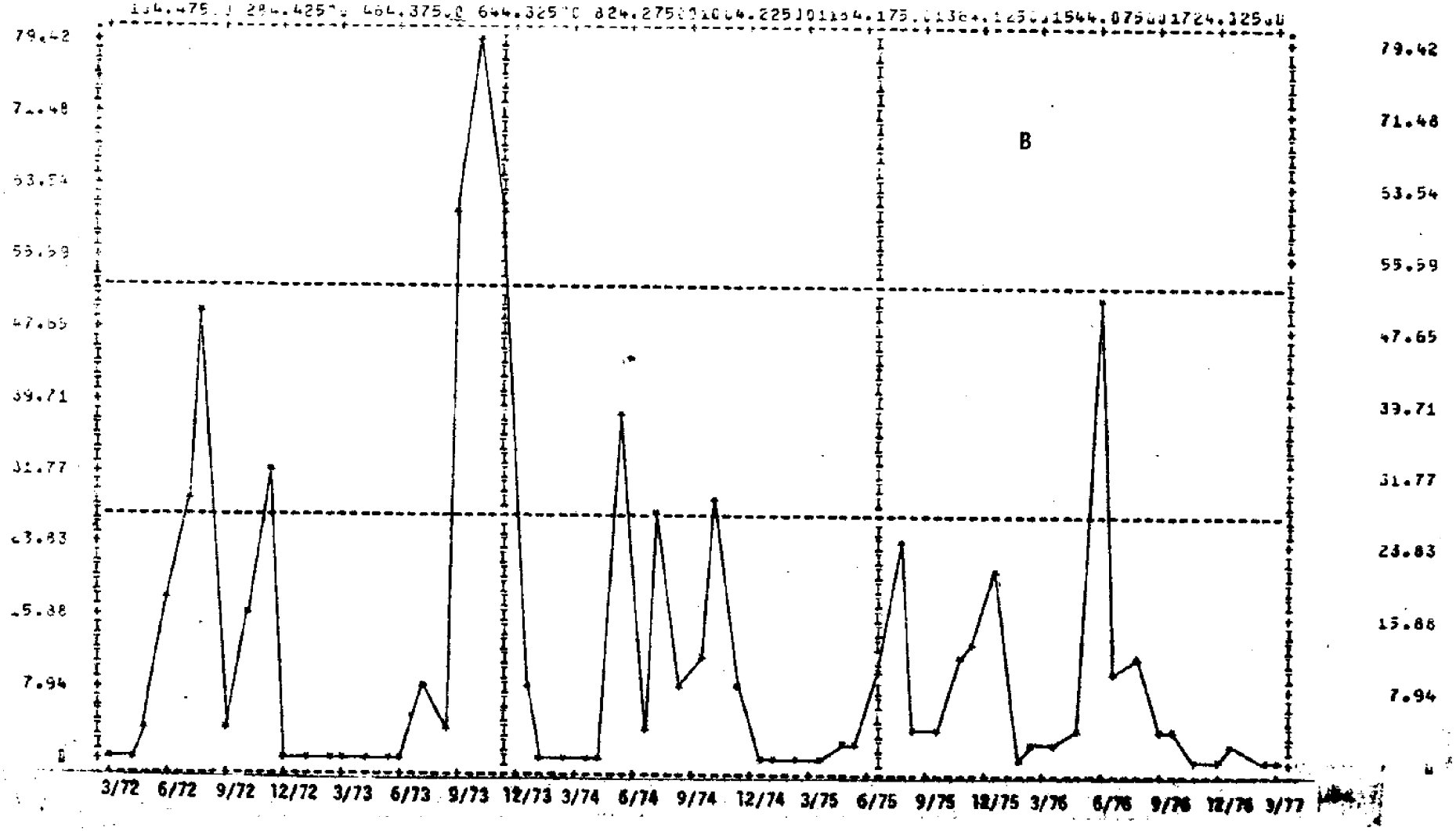
77/03/27. PAGE 14

TATISTICS..

CORRELATION (R)-	-.16372	R SQUARED -	.02680	SIGNIFICANCE R -	.15566
STD ERR OF EST -	26.23556	INTERCEPT (A) -	24.89192	STD ERROR OF A -	6.76932
SIGNIFICANCE A -	.0045	SLOPE (B) -	-.03012	STD ERROR OF B -	.0208
SIGNIFICANCE B -	.15566				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

.....COMPUTED.

(GROSS) DAYS



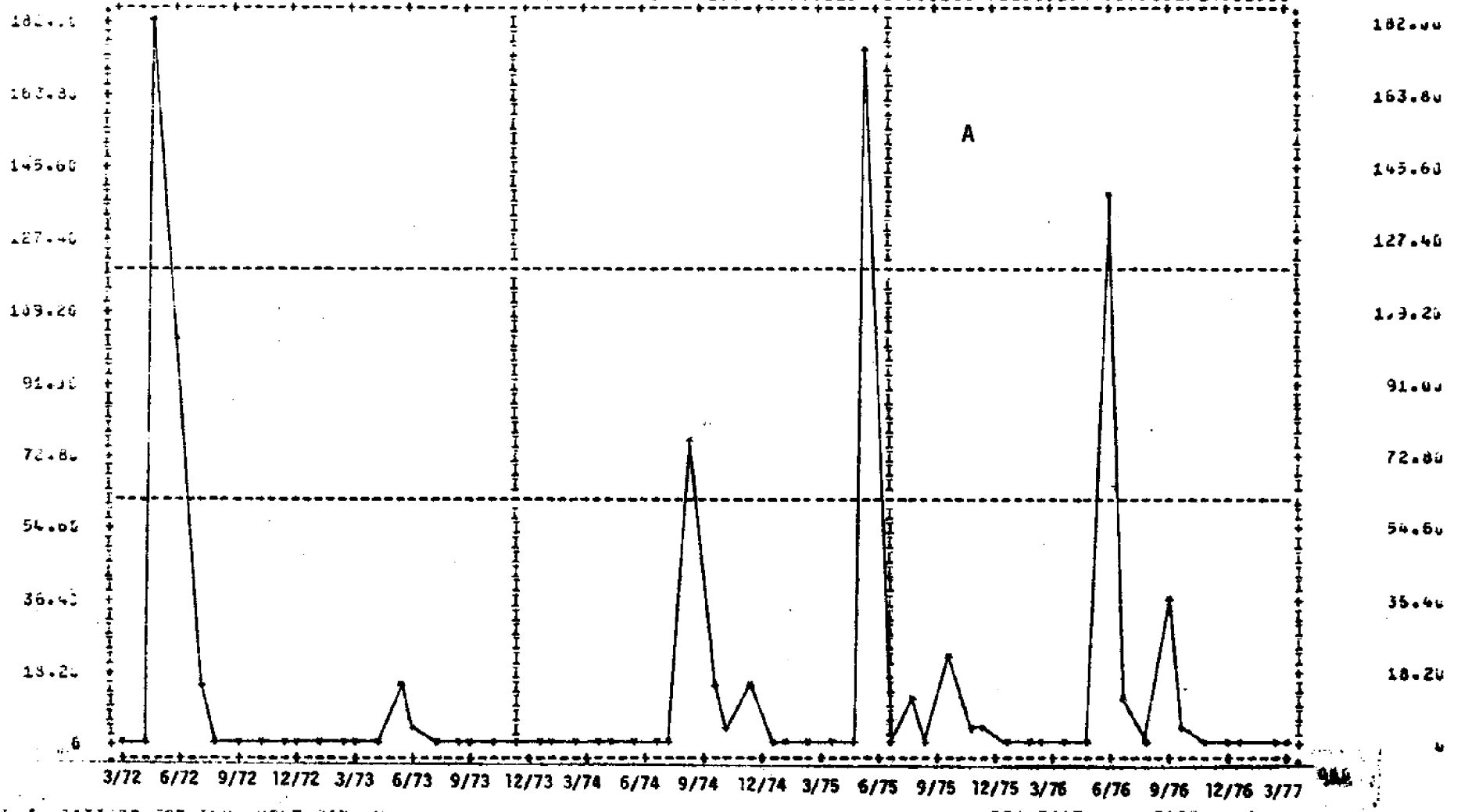
NVERT SCATTER. TOP TEN WHOLE BAY BIOMASS 77/03/27. PAGE 14

TATISTICS..

CORRELATION (R) -	-.16372	R SQUARED -	.02680	SIGNIFICANCE R -	.18567
STD ERR OF EST -	17.80865	INTERCEPT (A) -	16.89664	STD ERROR OF A -	4.59542
SIGNIFICANCE A -	.00026	SLOPE (B) -	-.01551	STD ERROR OF B -	.00436
SIGNIFICANCE B -	.10567				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** AS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

(ACROSS) DAYS



INVERT SCATTERS FOR TEN WHOLE BAY N 77/03/27. PAGE 16

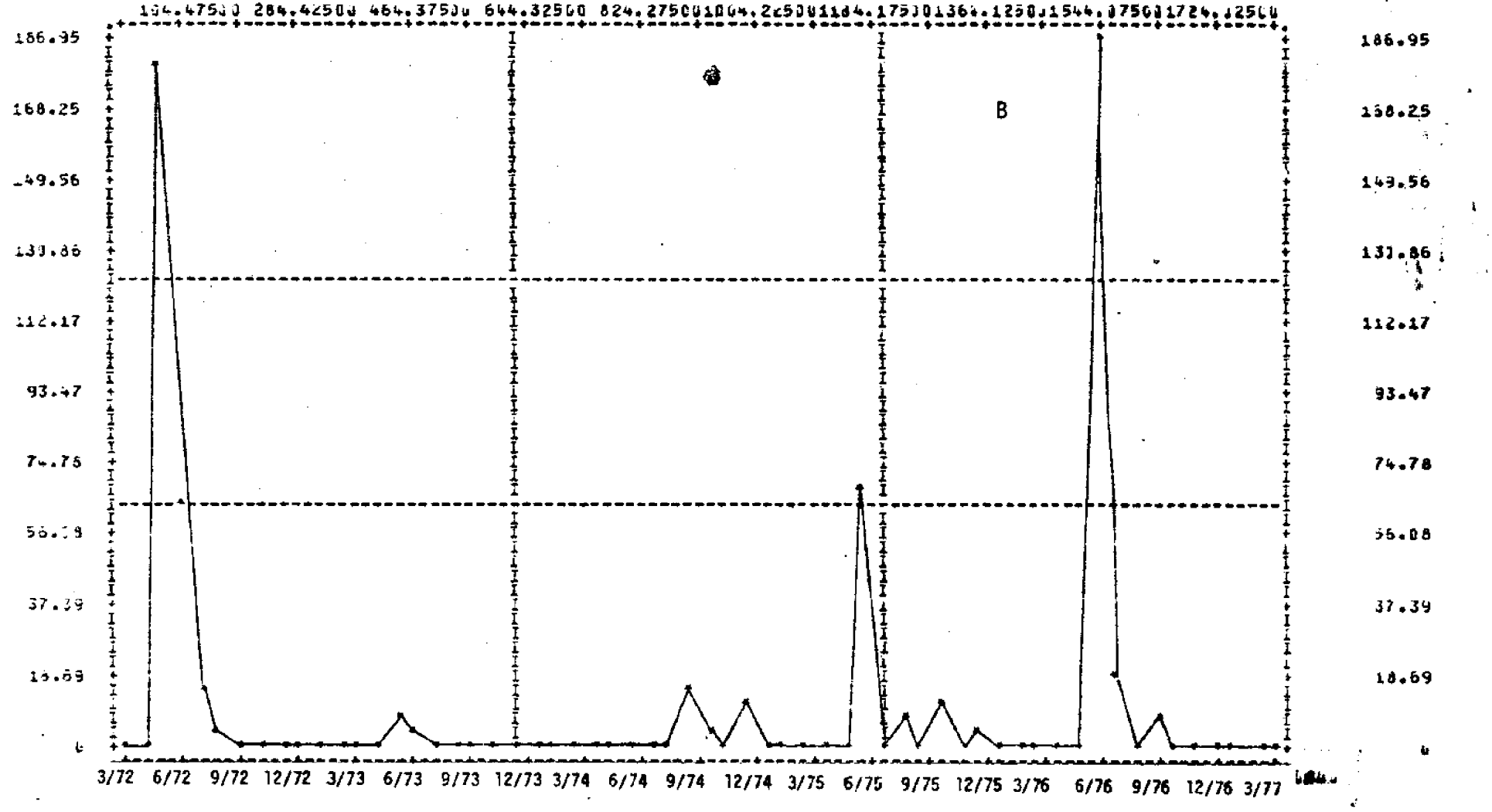
STATISTICS..

CORRELATION (R)-	-.05440	R SQUARED -	.00296	SIGNIFICANCE R -	.33987
STD ERR OF EST -	39.47110	INTERCEPT (A) -	18.49254	STD ERROR OF A -	10.16529
SIGNIFICANCE A -	.03730	SLOPE (B) -	-.00401	STD ERROR OF B -	.00987
SIGNIFICANCE B -	.33987				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

FILE NONAME (CREATION DATE = 77/03/27.)
SCATTERGRAM OF (COMM) PENAZT

(ACROSS) DAYS



385.

PAGE 16

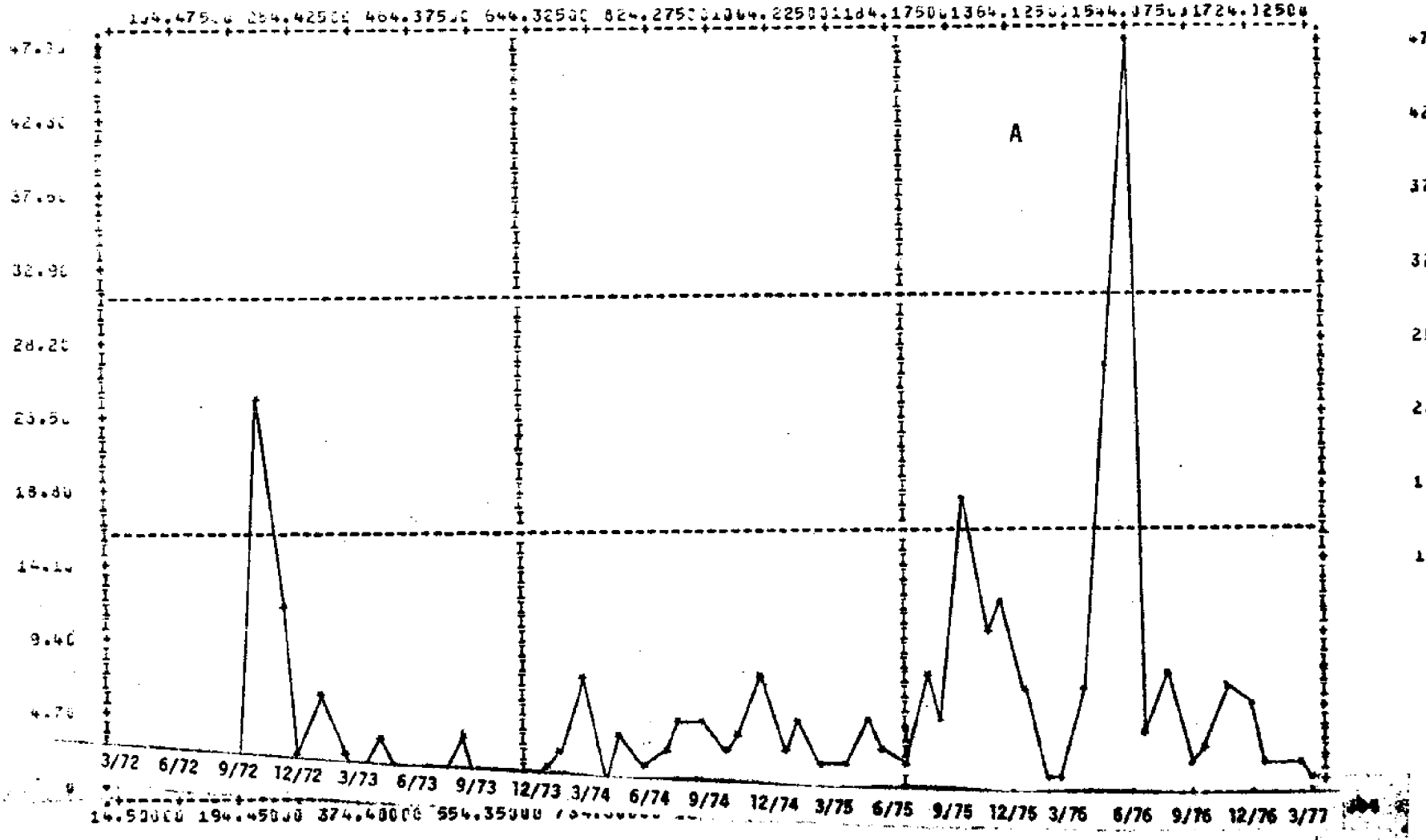
STATISTICS..

CORRELATION (R) -	-.3384	R SQUARED -	.1145	SIGNIFICANCE R -	.34143
STD ERR OF EST -	34.07985	INTERCEPT (A) -	14.41799	STD ERROR OF A -	9.00055
SIGNIFICANCE A -	.1873	SLOPE (B) -	-.21351	STD ERROR OF B -	.20834
SIGNIFICANCE B -	.34143				
PLOTTED VALUES -	60	EXCLUDED VALUES-	1	MISSING VALUES -	0

******** [illegible] CANNOT BE COMPUTED.

(DAYS (CREATION DATE = 77/03/27.)
DIFFERENCE OF (DAYS) CALSIM

(ACROSS) DAYS

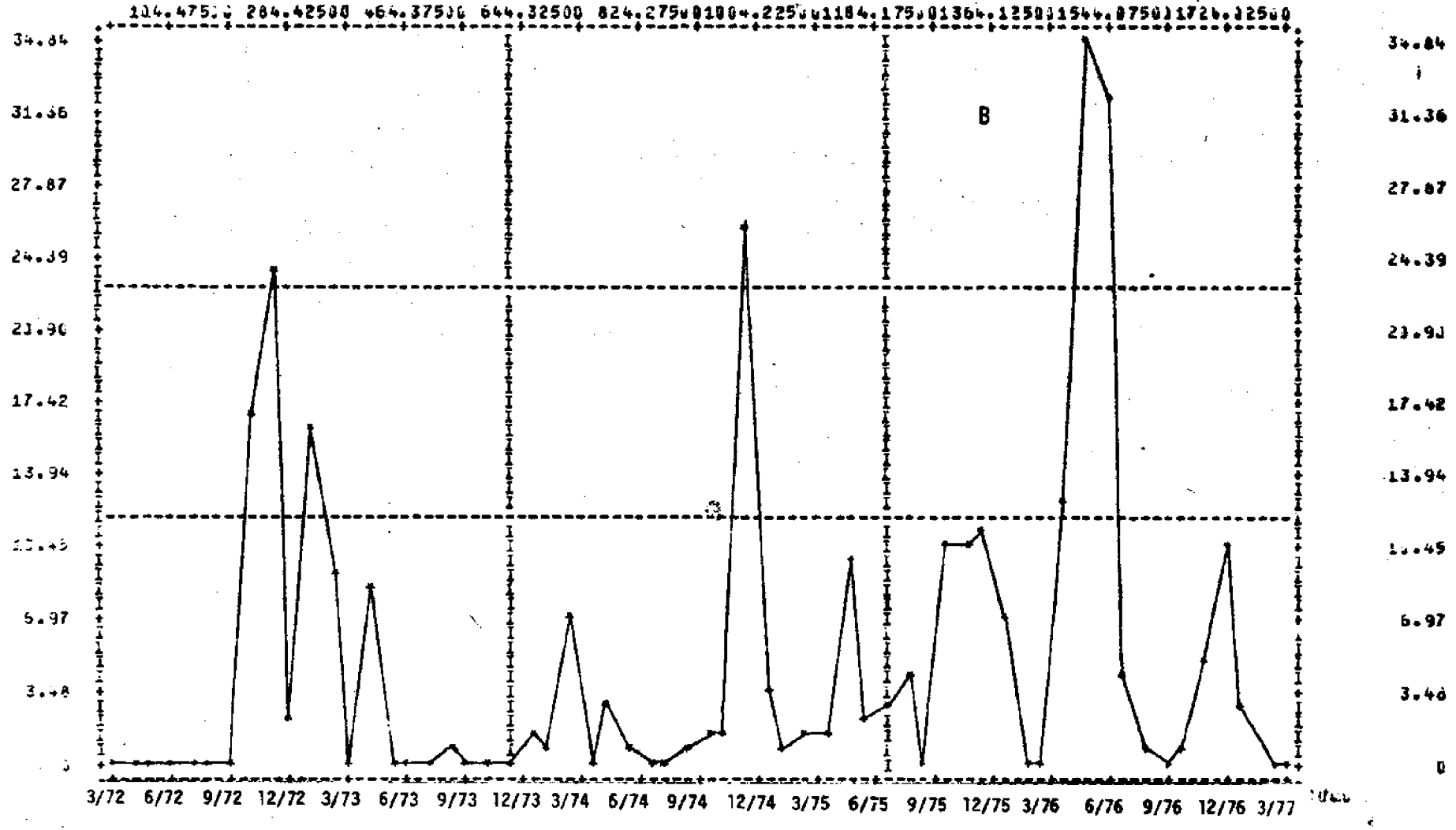


STATISTICS..

CORRELATION (R) -	.23221	R SQUARED -	.05392	SIGNIFICANCE R -	.03710
STD ERR OF EST -	7.67254	INTERCEPT (A) -	1.34989	STD ERROR OF A -	1.97986
SIGNIFICANCE A -	.24904	SLOPE (B) -	.01342	STD ERROR OF B -	.00588
SIGNIFICANCE B -	.03710				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

FILE NONAME (CREATION DATE = 77/03/27.)
SCATTERGRAM OF (JOHN) CALSIM (ACROSS) DAYS

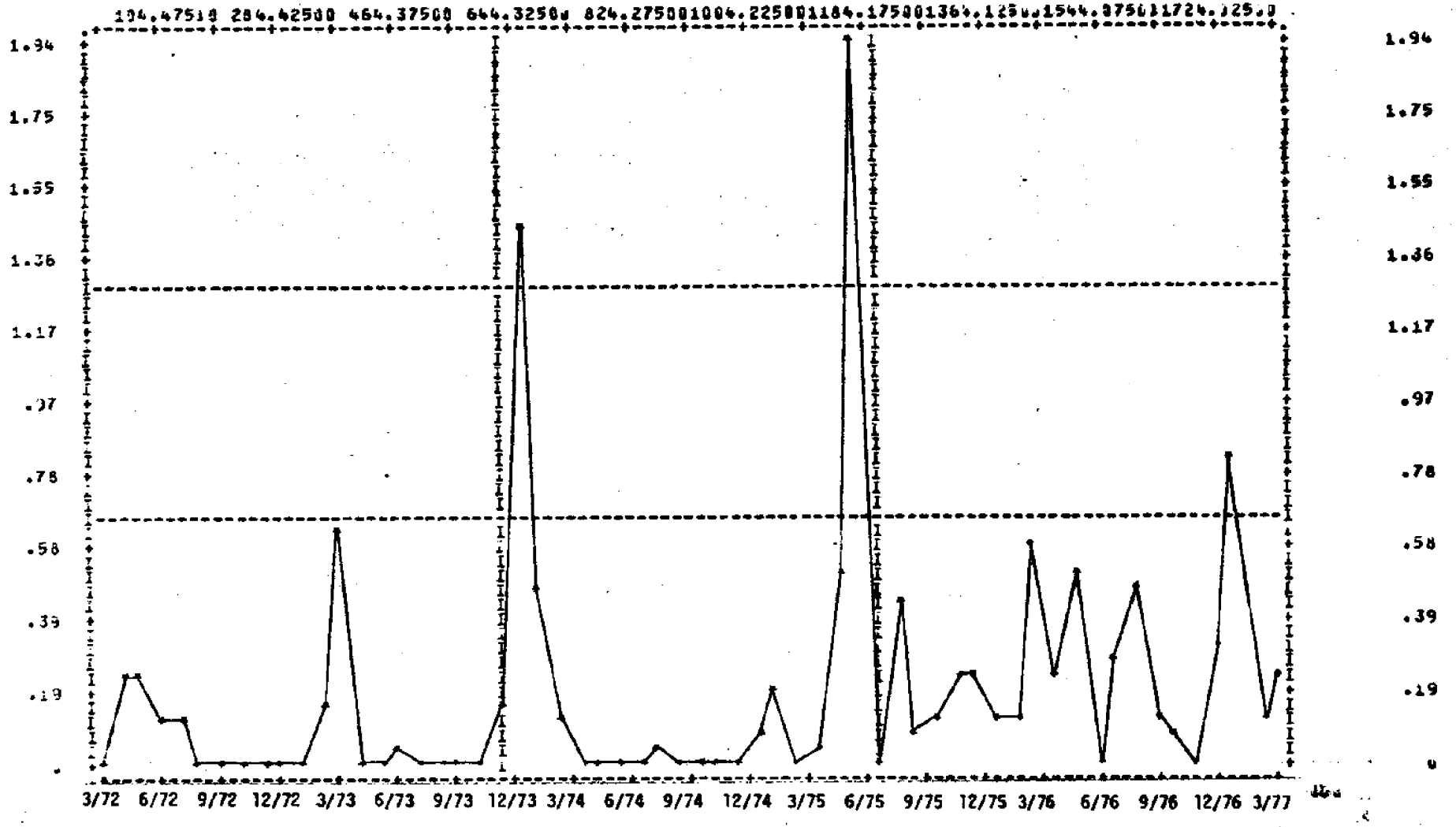


INVERT SCATTERS TOP TEN WHOLE BAY BIOMASS 77/03/27. PAGE 18

STATISTICS..

CORRELATION (R)=	.16481	R SQUARED =	.02716	SIGNIFICANCE R =	.28413
STD ERR OF EST =	7.81328	INTERCEPT (A) =	2.77829	STD ERROR OF A =	2.04196
SIGNIFICANCE A =	.18945	SLOPE (B) =	.00247	STD ERROR OF B =	.00194
SIGNIFICANCE B =	.10413				
PLOTTED VALUES =	60	EXCLUDED VALUES=	0	MISSING VALUES =	0

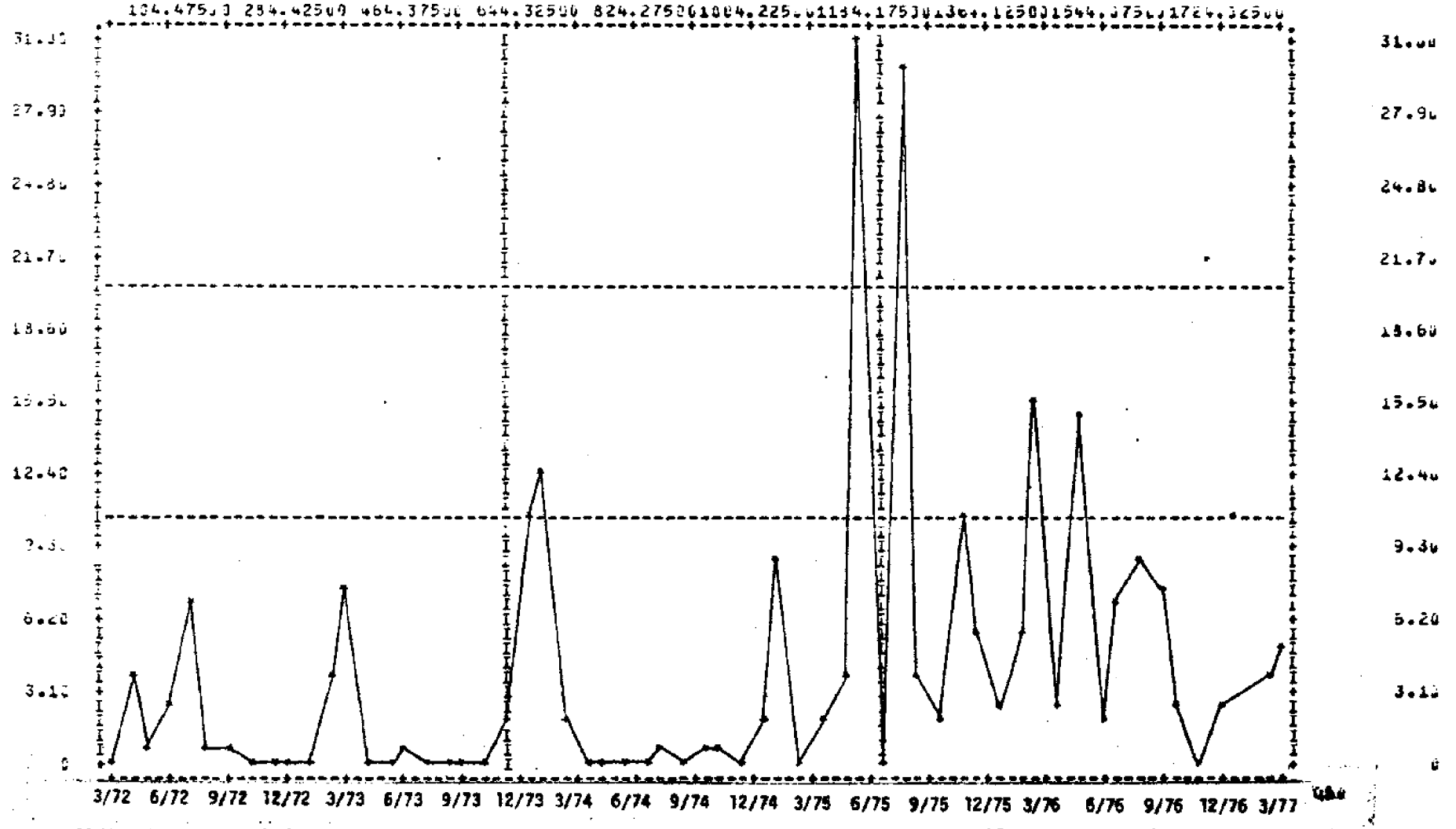
ILE NONAME (CREATION DATE = 77/03/27.)
CATTERGRAM OF (DOWN) RMINAR (ACROSS) DAYS



TATISTICS..

CORRELATION (R) -	.22554	R SQUARED -	.05087	SIGNIFICANCE R -	.04158
STD ERR OF EST -	.33945	INTERCEPT (A) -	.87237	STD ERROR OF A -	.08759
SIGNIFICANCE A -	.26695	SLOPE (B) -	.00015	STD ERROR OF B -	.00008
SIGNIFICANCE B -	.04158				
[illegible] VALUES -	96.	EXCLUDED VALUES-	0	MISSING VALUES -	0

(ACROSS) DAYS



STATISTICS..

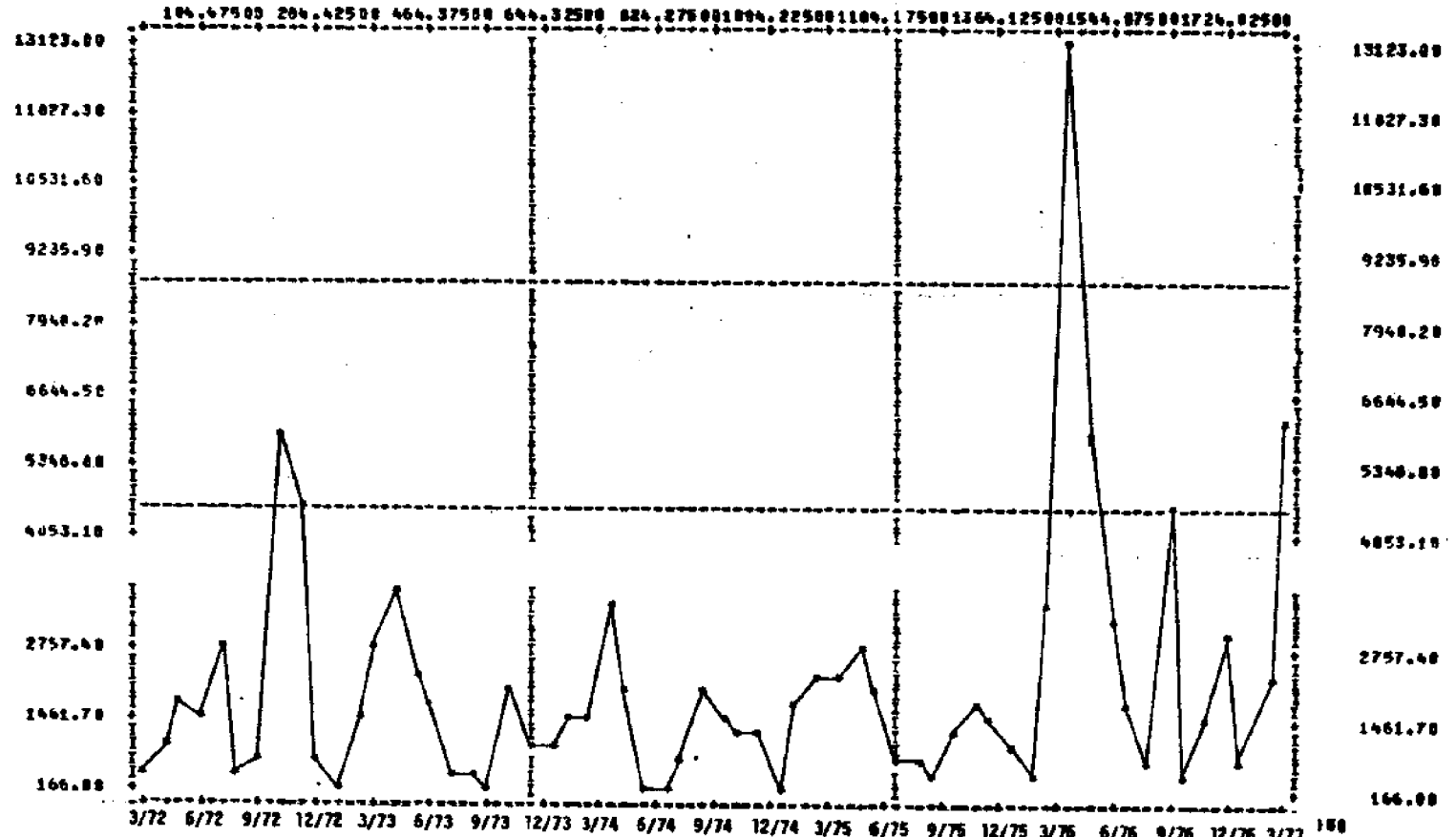
CORRELATION (R) -	.32582	R SQUARED -	.10616	SIGNIFICANCE R -	.00554
STD ERR OF EST -	6.09961	INTERCEPT (A) -	.71652	STD ERROR OF A -	1.57397
SIGNIFICANCE A -	.32760	SLOPE (B) -	.6.392	STD ERROR OF B -	.00149
SIGNIFICANCE B -	.00554				

PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******* = POINT IS A COINCIDENT CANNOT BE COMPUTED.

SCATTERGRAMS N,BIOMASS,NS 001,002,003,004,005,006,01A,01B,01C,0 77/03/22. PAGE 3

FILE NONAME (CREATION DATE = 77/03/22.)
SCATTERGRAM OF (COLS) N (ACROSS) DAYS



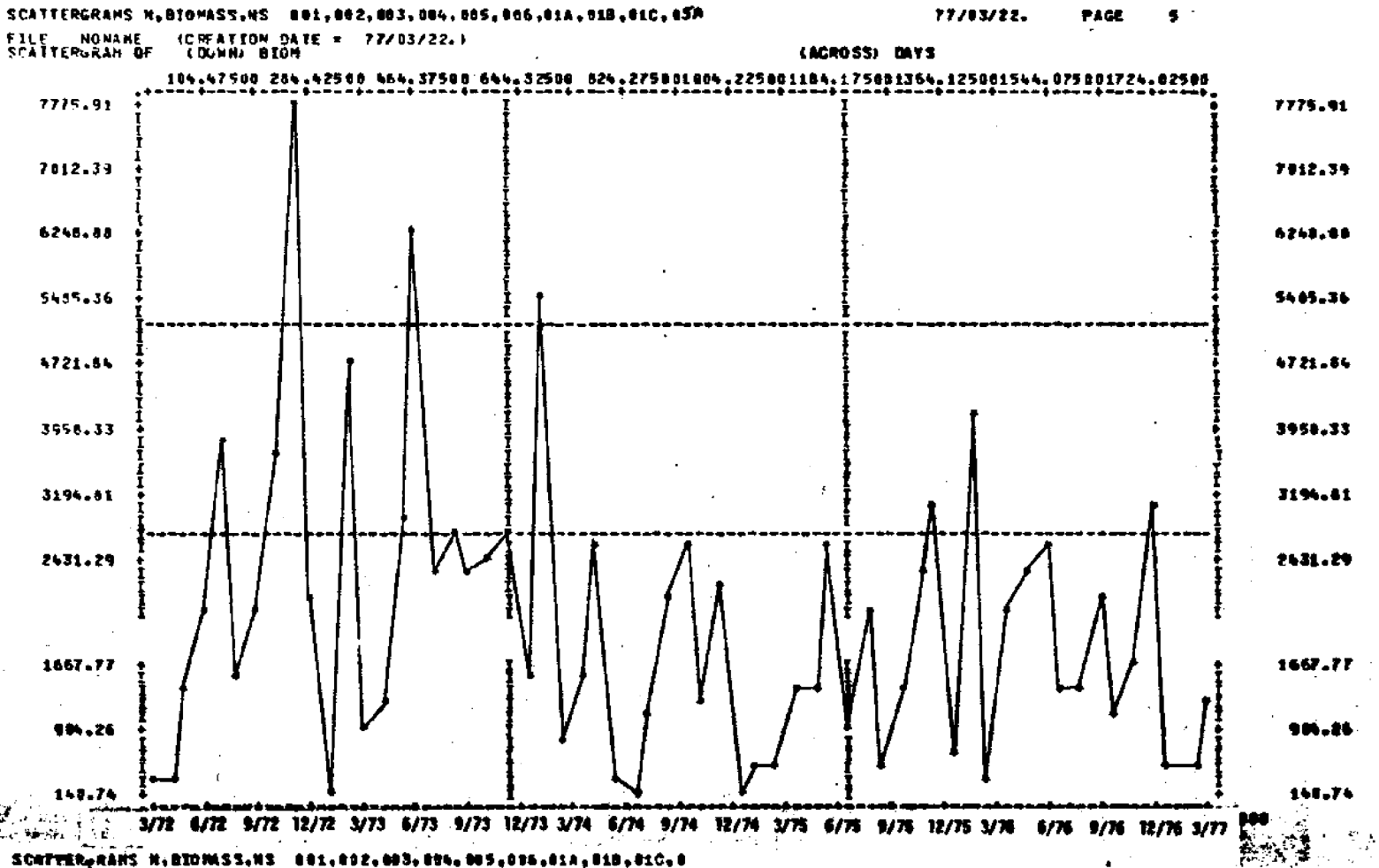
SCATTERGRAMS N,BIOMASS,NS 001,002,003,004,005,006,01A,01B,01C,0

STATISTICS..

CORRELATION (R)-	.20786	R SQUARED -	.04321	SIGNIFICANCE R -	.05550
STD ERR OF EST -	2028.19342	INTERCEPT (A) -	1347.98851	STD ERROR OF A -	521.29937
SIGNIFICANCE A -	.00612	SLOPE (B) -	.00072	STD ERROR OF B -	.00476
SIGNIFICANCE B -	.05550				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 21: Total biomass (dry weight) of fishes taken monthly in the Apalachicola Estuary (Stations 1, 1A, 1B, 1C, 2, 3, 4, 5, 5A, 6) From March, 1972 to March, 1977.



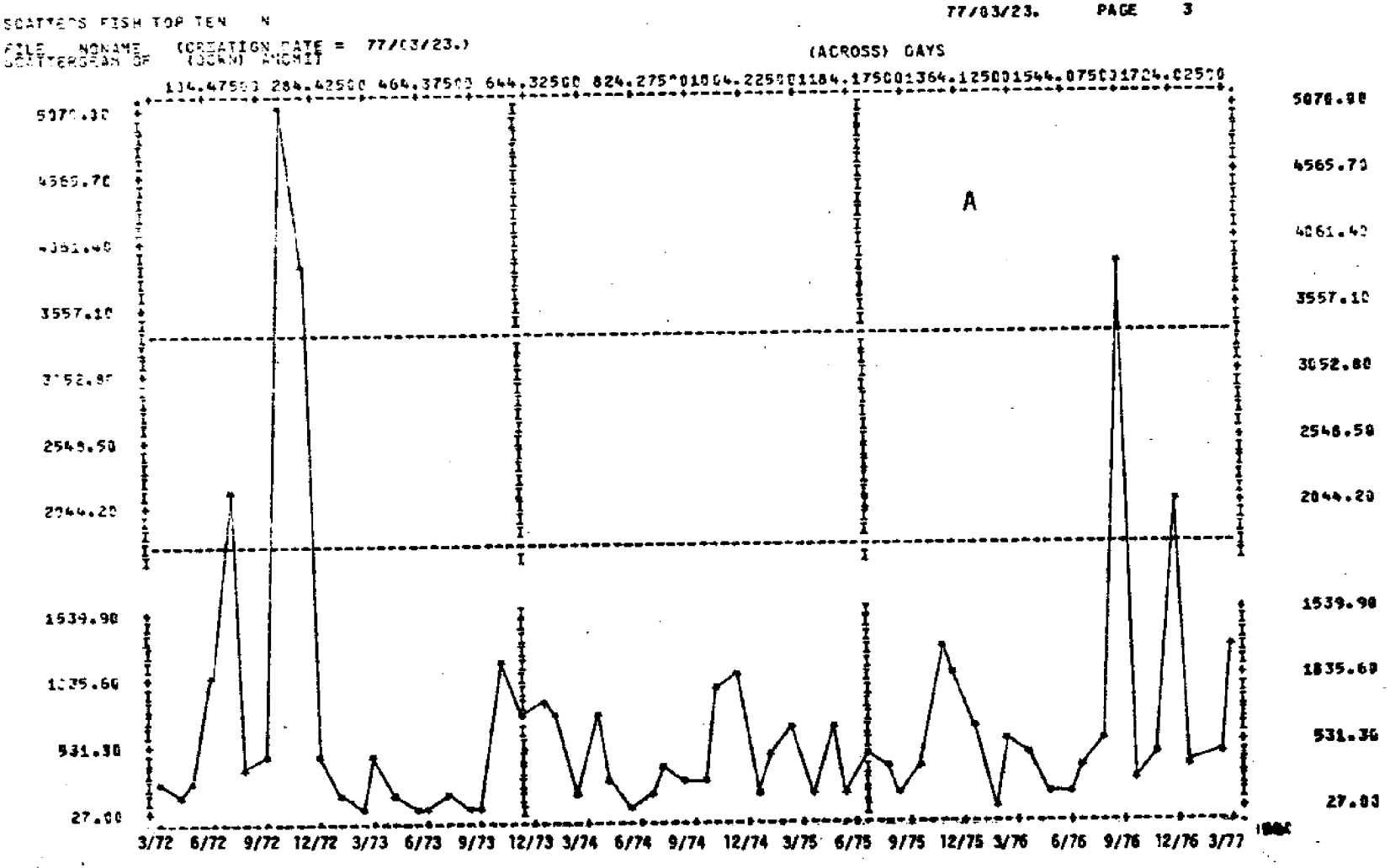
SCATTERGRAMS N,BIOMASS,NS 001,002,003,004,005,006,01A,01B,01C,0

STATISTICS..

CORRELATION (R)-	-.22694	R SQUARED -	.05150	SIGNIFICANCE R -	.04868
STD ERR OF EST -	1472.35163	INTERCEPT (A) -	2565.96885	STD ERROR OF A -	379.93193
SIGNIFICANCE A -	.00861	SLOPE (B) -	-.63991	STD ERROR OF B -	.36859
SIGNIFICANCE B -	.04868				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 22: Numbers (A) and Biomass (B) of Anchoa mitchilli in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March 1972 through February, 1977.



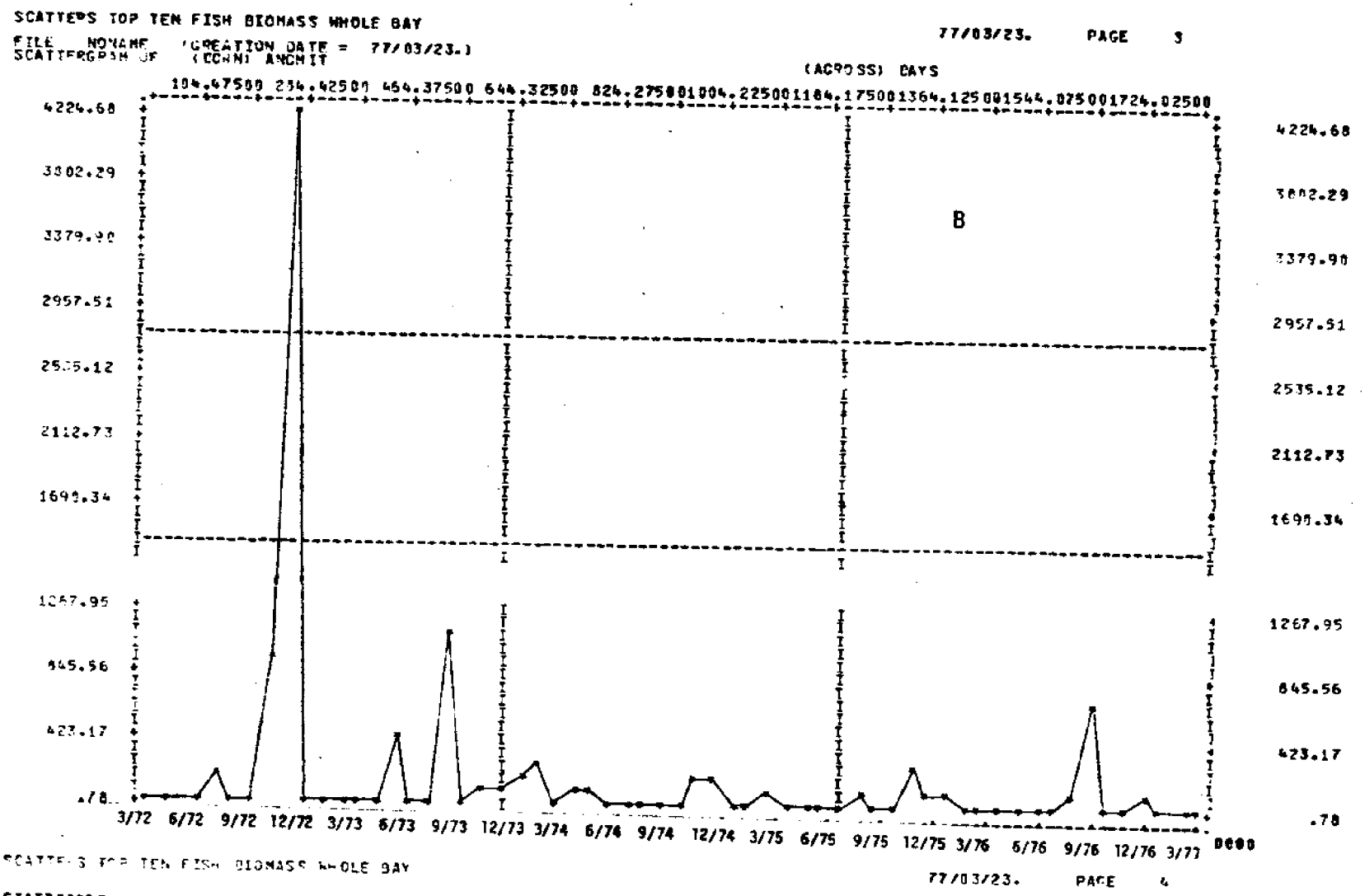
SCATTERS FISH TOP TEN N

STATISTICS..

CORRELATION (R) -	-.04205	R SQUARED -	.00177	SIGNIFICANCE R -	.37486
STD ERR OF EST -	960.42015	INTERCEPT (A) -	764.39783	STD ERROR OF A -	247.63093
SIGNIFICANCE A -	.00156	SLOPE (B) -	-.07539	STD ERROR OF B -	.23521
SIGNIFICANCE B -	.37486				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 22, continued



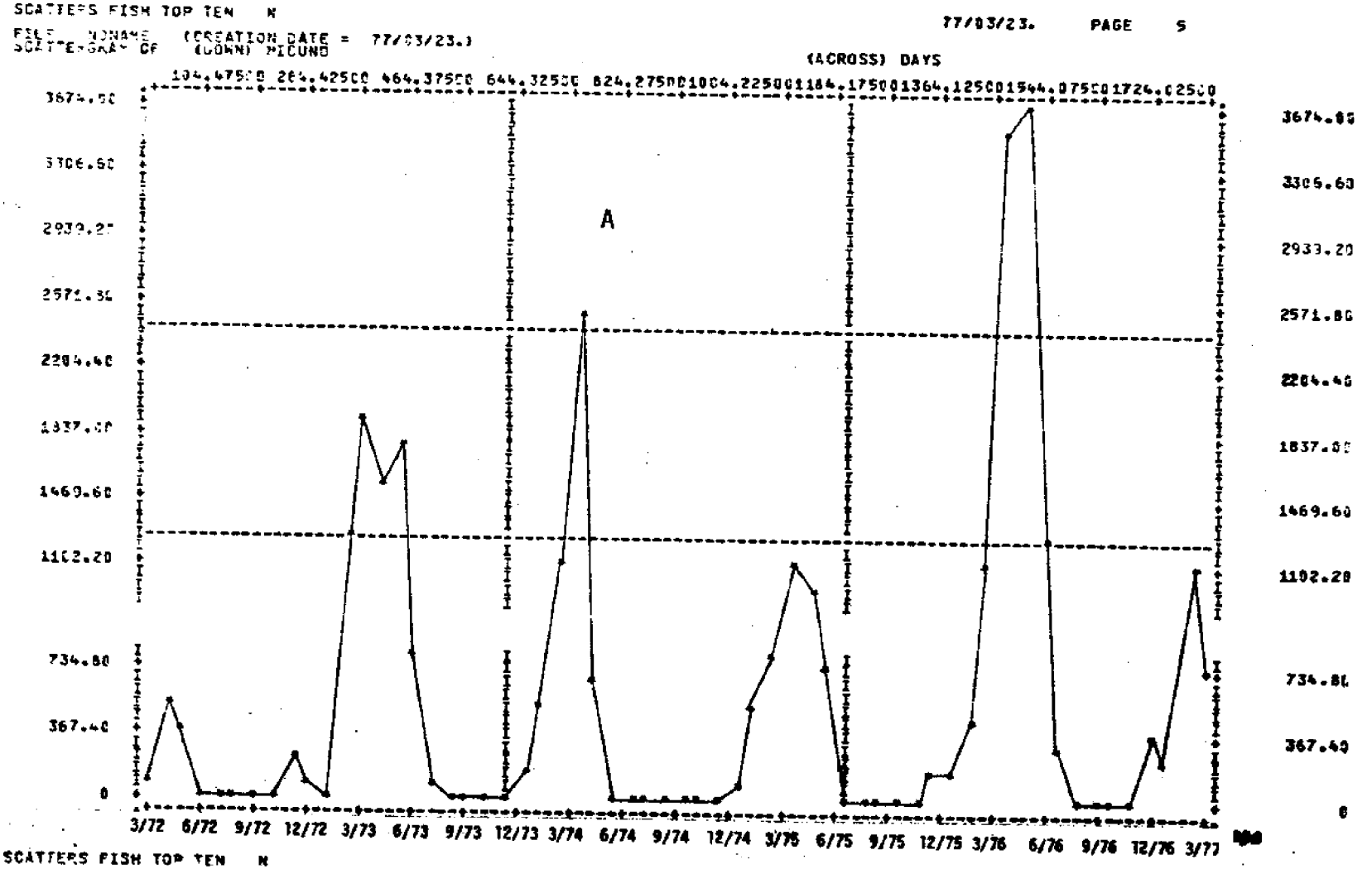
SCATTERS FOR TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 4

STATISTICS..

CORRELATION (R) =	-.19181	R SQUARED =	.03679	SIGNIFICANCE R =	.07103
STD ERR OF EST =	542.72168	INTERCEPT (A) =	381.60938	STD ERROR OF A =	145.10390
SIGNIFICANCE A =	.00546	SLOPE (B) =	-.21498	STD ERROR OF B =	.11772
SIGNIFICANCE B =	.07103				
[illegible] =	[illegible]	[illegible] VALUES =	[illegible]	MISSING VALUES =	0

[illegible] IS OUTSIDE OF A [illegible]

Figure 23: Numbers (A) and Biomass (B) of Micropogon undulatus in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.



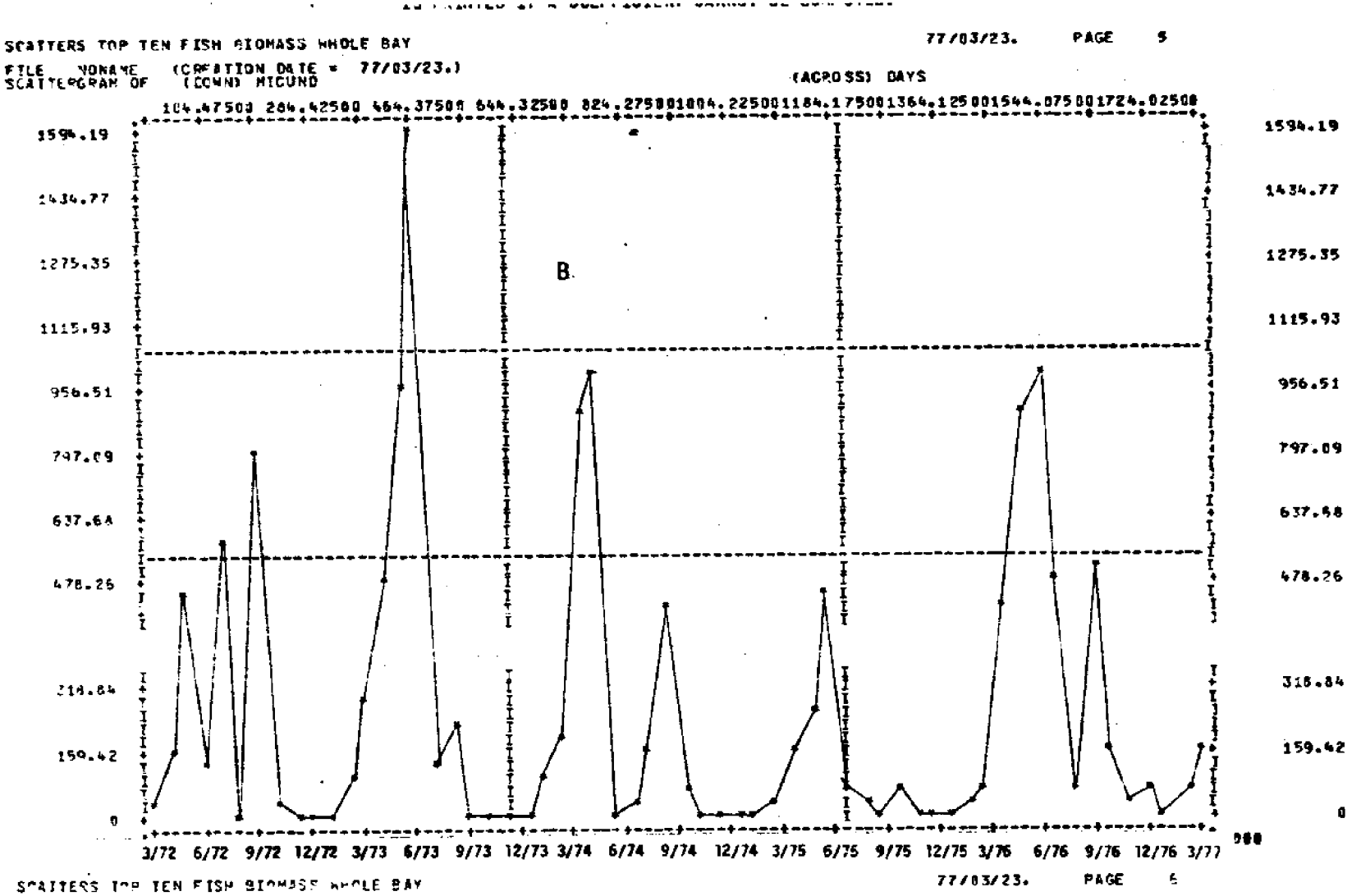
SCATTERS FISH TOP TEN N

STATISTICS..

CORRELATION (R) =	.13632	R SQUARED =	.01858	SIGNIFICANCE R =	.14950
STD ERR OF EST =	815.75657	INTERCEPT (A) =	345.84621	STD ERROR OF A =	210.58132
SIGNIFICANCE A =	.05330	SLOPE (B) =	.23937	STD ERROR OF B =	.19976
SIGNIFICANCE B =	.14950				
PLOTTED VALUES =	60	EXCLUDED VALUES=	0	MISSING VALUES =	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 23, continued

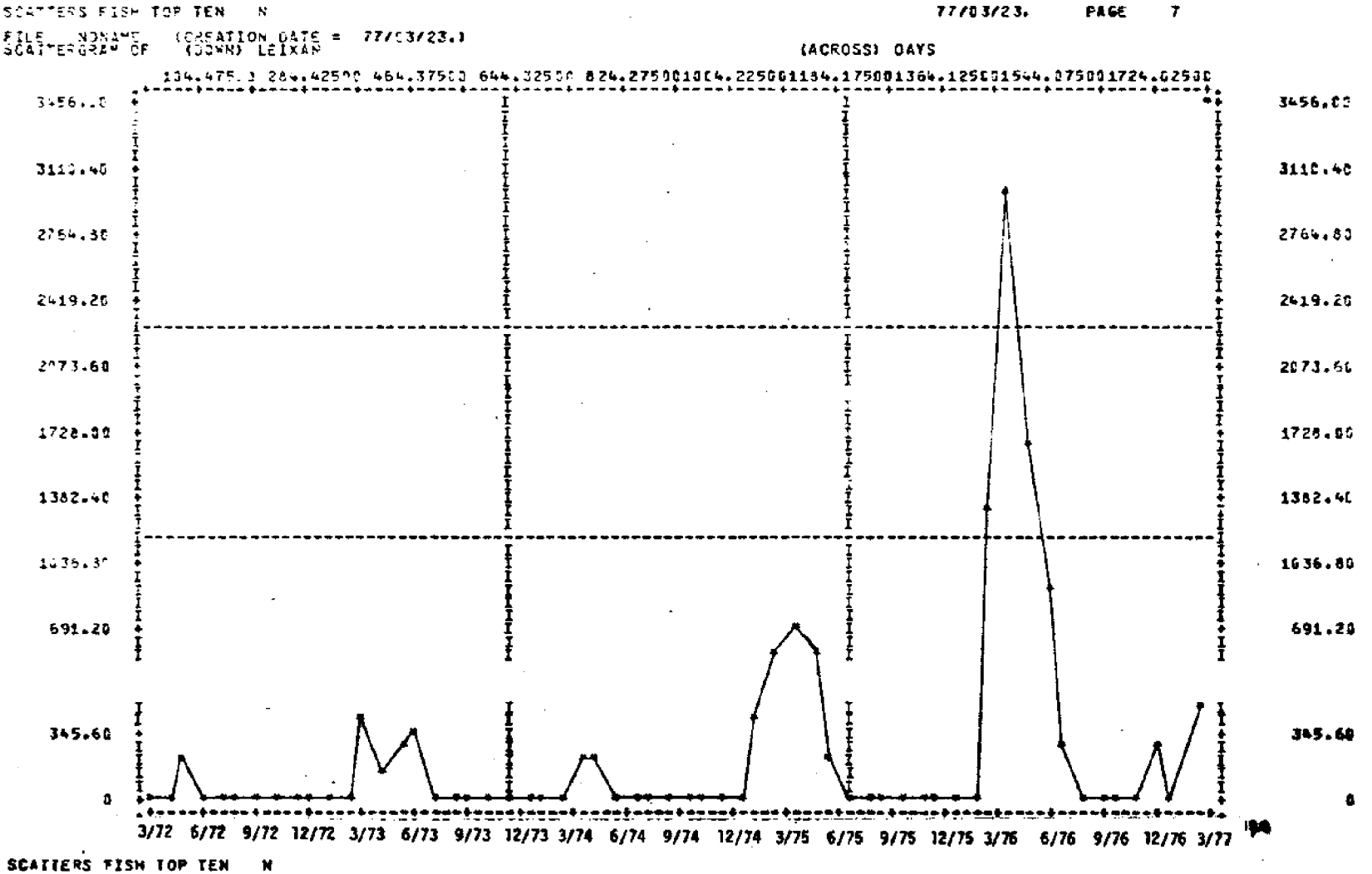


SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 6

STATISTICS..

CORRELATION (R) -	-.09850	R SQUARED -	.00970	SIGNIFICANCE R -	.22700
STD ERR OF EST -	339.56028	INTERCEPT (A) -	360.48733	STD ERROR OF A -	87.62159
SIGNIFICANCE F -	.08056	SLOPE (B) -	-.06269	STD ERROR OF B -	.08316
[illegible] -	[illegible]				
PLOTTED VALUES -	69	EXCLUDED VALUES-	0	MISSING VALUES -	0

Figure 24: Numbers (A) and Biomass (B) of Leiostomus xanthurus in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.



SCATTERS FISH TOP TEN N

STATISTICS..

CORRELATION (R) -	.37517	R SQUARED -	.14076	SIGNIFICANCE R -	.00157
STD ERR OF EST -	600.31222	INTERCEPT (A) -	-136.31498	STD ERROR OF A -	154.98714
SIGNIFICANCE A -	.19125	SLOPE (B) -	.45318	STD ERROR OF B -	.14702
SIGNIFICANCE B -	.00157				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 24, continued

B

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 7

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (DOWN) LETKAN (ACROSS) DAYS

104.47500 284.42500 464.37500 644.32500 824.27500 1004.22500 1184.17500 1364.12500 1544.07500 1724.02500

1172.66
1055.39
938.13
820.86
703.60
586.33
469.06
351.80
234.53
117.27
0

3/72 6/72 9/72 12/72 3/73 6/73 9/73 12/73 3/74 6/74 9/74 12/74 3/75 6/75 9/75 12/75 3/76 6/76 9/76 12/76 3/77

388

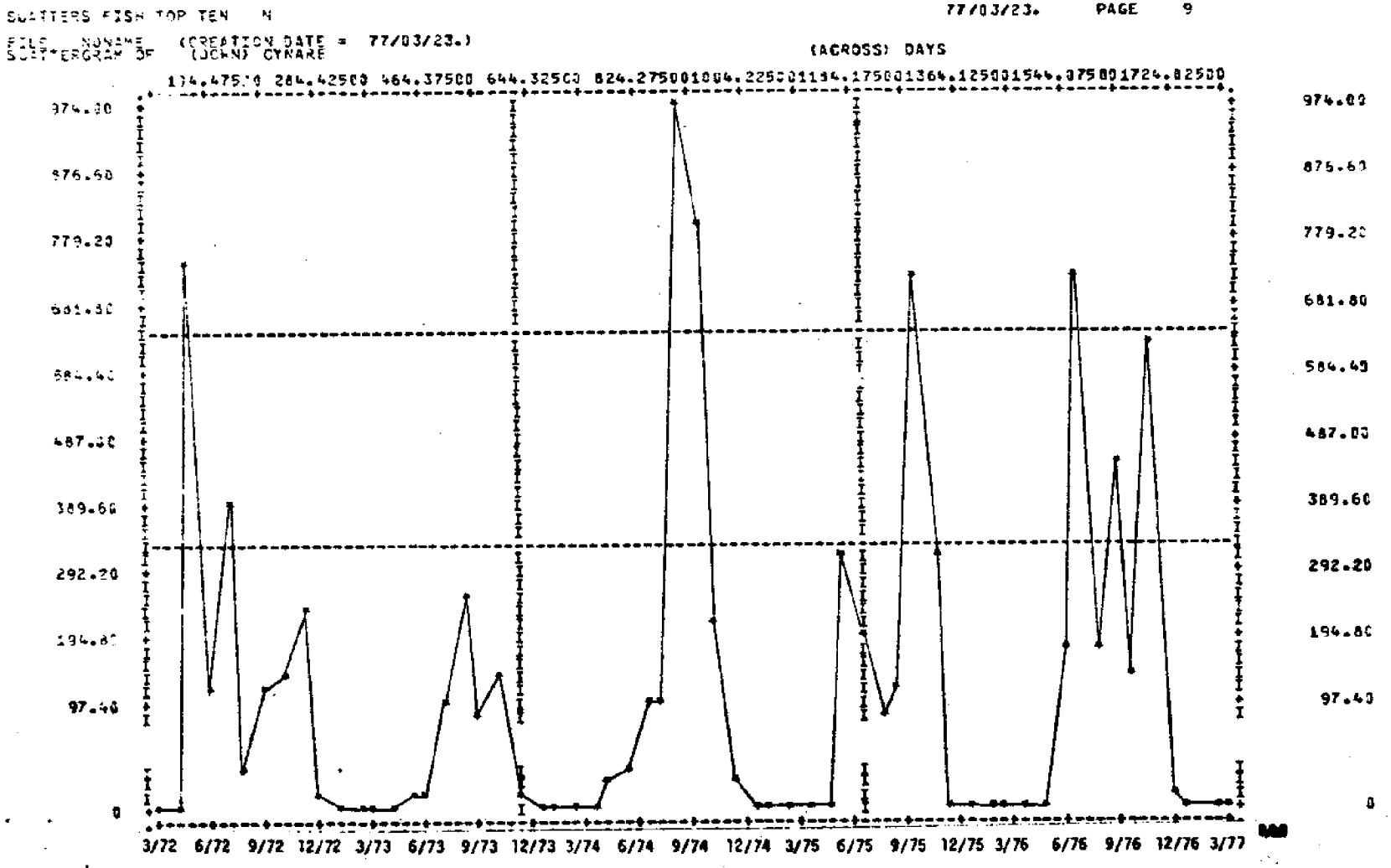
SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 8

STATISTICS..

CORRELATION (R)=	.18606	R SQUARED =	.03462	SIGNIFICANCE R =	.07732
STD ERR OF EST =	201.58026	INTERCEPT (A) =	59.43288	STD ERROR OF A =	32.53504
SIGNIFICANCE A =	.13129	SLOPE (B) =	.07191	STD ERROR OF B =	.04145
SIGNIFICANCE B =	.07732				
PLOTTED VALUES =	62	EXCLUDED VALUES=	0	MISSING VALUES =	0

******* IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 25: Numbers (A) and Biomass (B) of Cynoscion arenarius in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.



SCATTERS FISH TOP TEN N

STATISTICS..

CORRELATION (R) -	.07867	R SQUARED -	.00619	SIGNIFICANCE R -	.27518
STD ERR OF EST -	236.57810	INTERCEPT (A) -	122.86655	STD ERROR OF A -	61.04763
SIGNIFICANCE A -	.02512	SLOPE (B) -	.03402	STD ERROR OF B -	.05794
SIGNIFICANCE B -	.27510				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

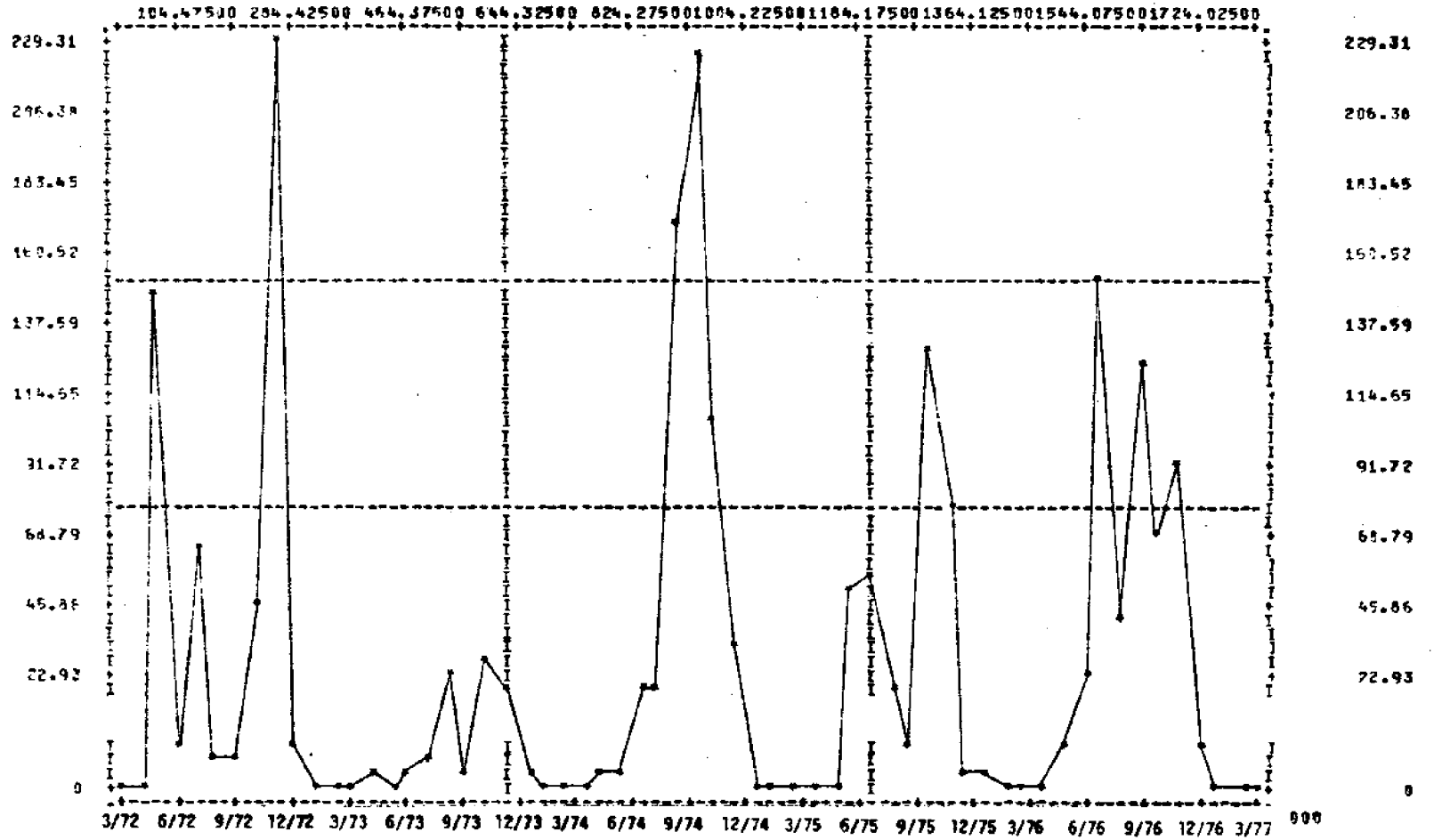
******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 25, continued

A

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 9

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (CONN) CYNARE (ACROSS) DAYS



SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 10

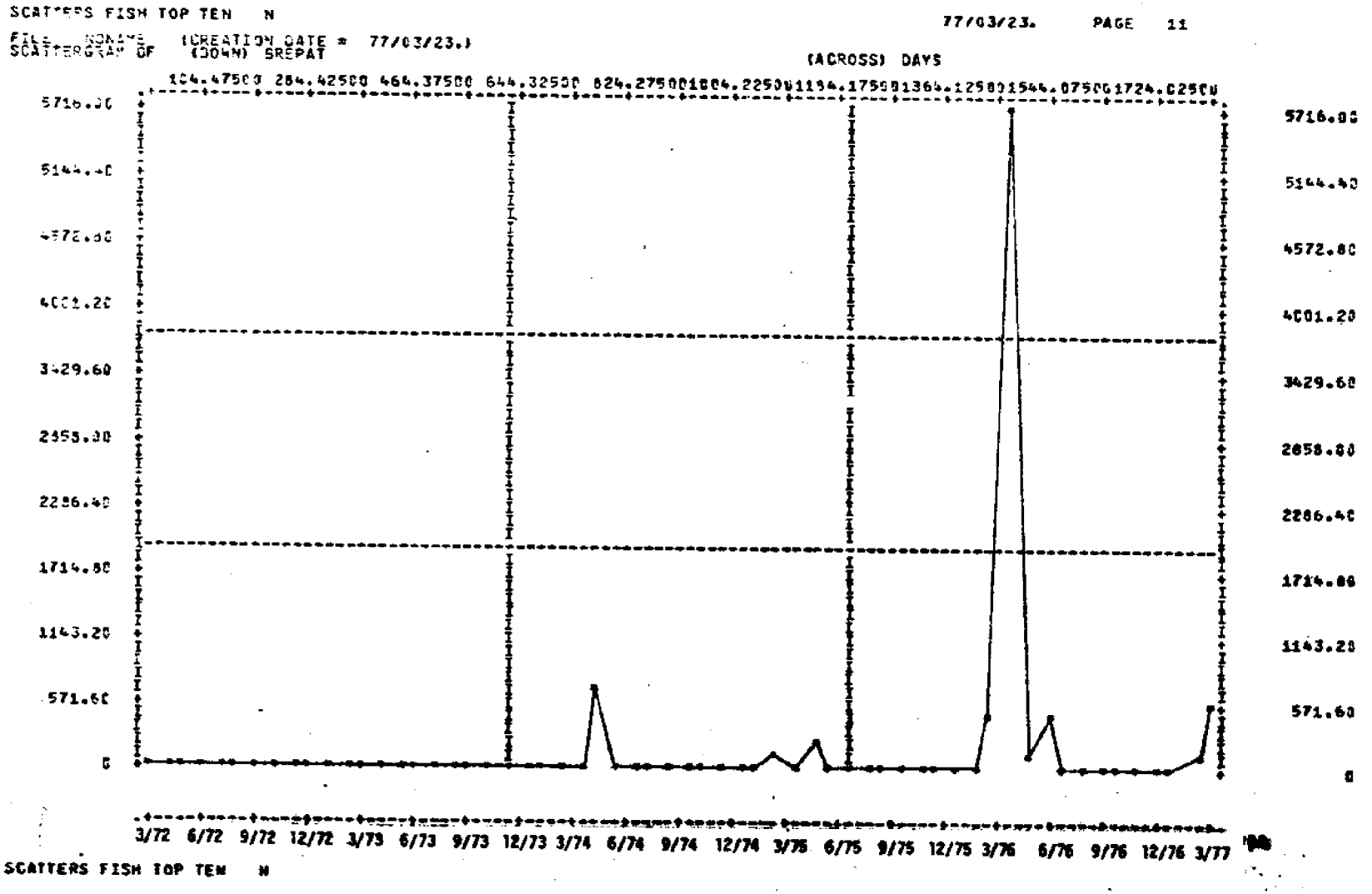
STATISTICS..

CORRELATION (R)-	.25099	R SQUARED -	.00260	SIGNIFICANCE R -	.34942
STD ERR OF EST -	56.54848	INTERCEPT (A) -	31.59732	STD ERROR OF A -	14.59281
SIGNIFICANCE A -	.01724	SLOPE (B) -	.00538	STD ERROR OF B -	.01185
SIGNIFICANCE B -	.34942				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

**** NOTE *** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 26: Numbers (A) and Biomass (B) of Brevoortia patronus in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.

A



SCATTERS FISH TOP TEN N

STATISTICS..

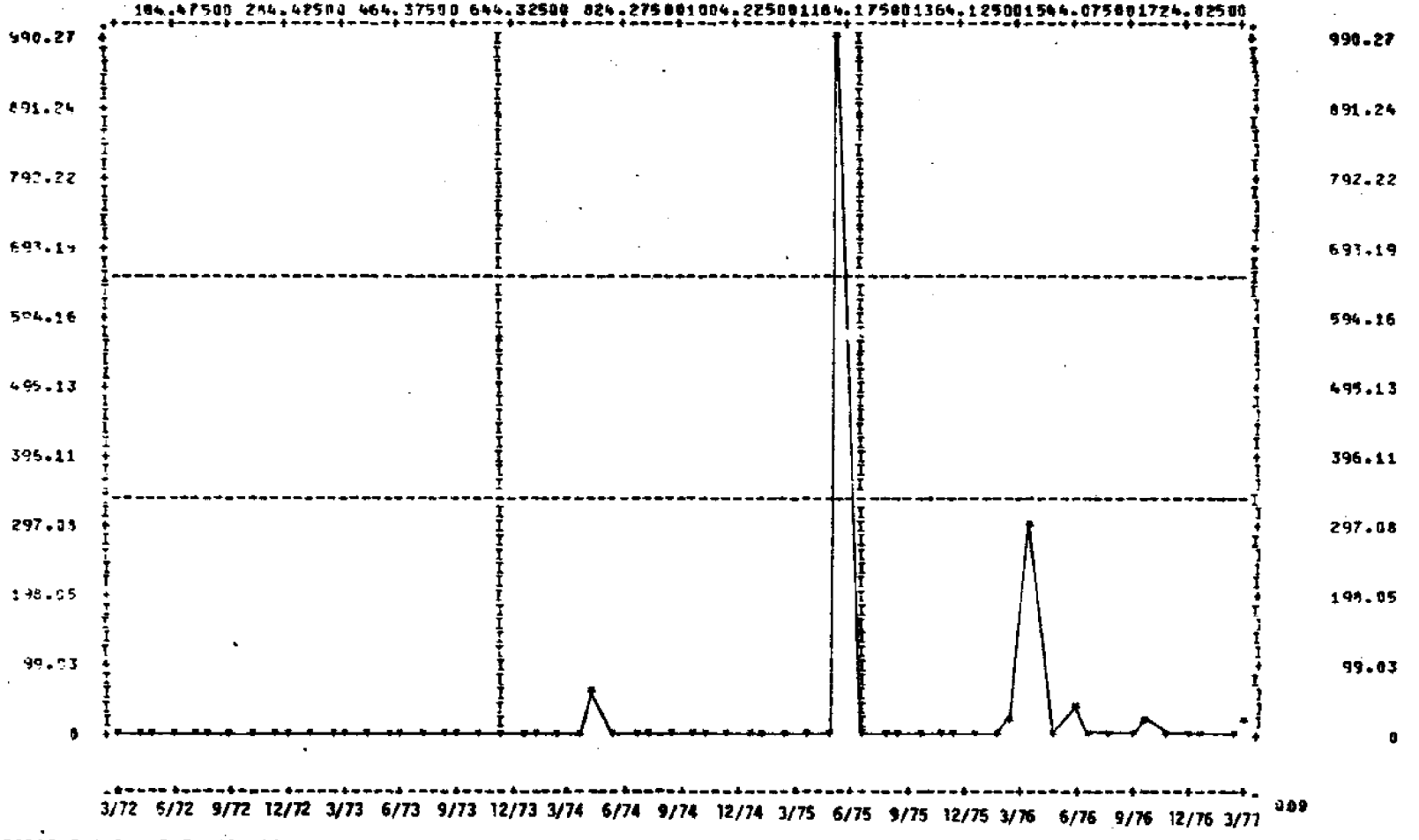
CORRELATION (R)-	.19621	R SQUARED -	.03850	SIGNIFICANCE R -	.06649
STD ERR OF EST -	738.68993	INTERCEPT (A) -	-181.12298	STD ERROR OF A -	190.61472
SIGNIFICANCE A -	.29889	SLOPE (B) -	.27968	STD ERROR OF B -	.18091
SIGNIFICANCE B -	.06649				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 26, continued

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 11

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (DOWN) BREPAT (ACROSS) DAYS



SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 12

STATISTICS..

CORRELATION (R) -	.12657	R SQUARED -	.01602	SIGNIFICANCE R -	.16761
STD ERR OF EST -	137.27621	INTERCEPT (A) -	-3.09816	STD ERROR OF A -	34.39116
SIGNIFICANCE A -	.46426	SLOPE (B) -	.03172	STD ERROR OF B -	.03264
SIGNIFICANCE B -	.16761				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

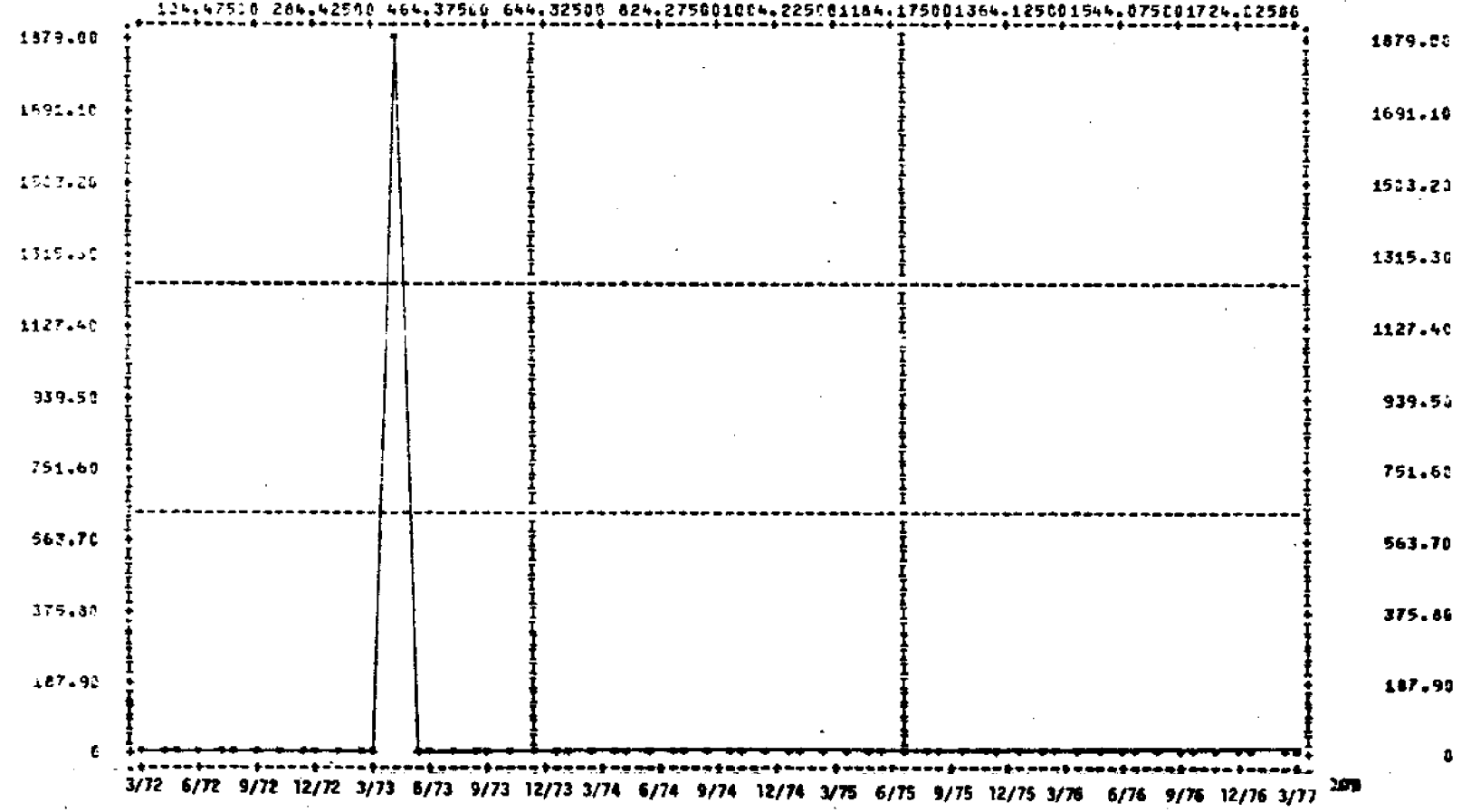
******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

A

Figure 27: Numbers (A) and Biomass (B) of Harengula pensacolae in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.

SCATTERS FISH TOP TEN N 77/03/23. PAGE 13

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (DOWN) HARPEN (ACROSS) DAYS



SCATTERS FISH TOP TEN N 77/03/23. PAGE 14

STATISTICS..

CORRELATION (R)-	-.12428	R SQUARED -	.01545	SIGNIFICANCE R -	.17205
STD ERR OF EST -	242.75299	INTERCEPT (A) -	83.13589	STD ERROR OF A -	62.64182
SIGNIFICANCE A -	.09482	SLOPE (B) -	-.05671	STD ERROR OF B -	.05945
SIGNIFICANCE B -	.17205				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

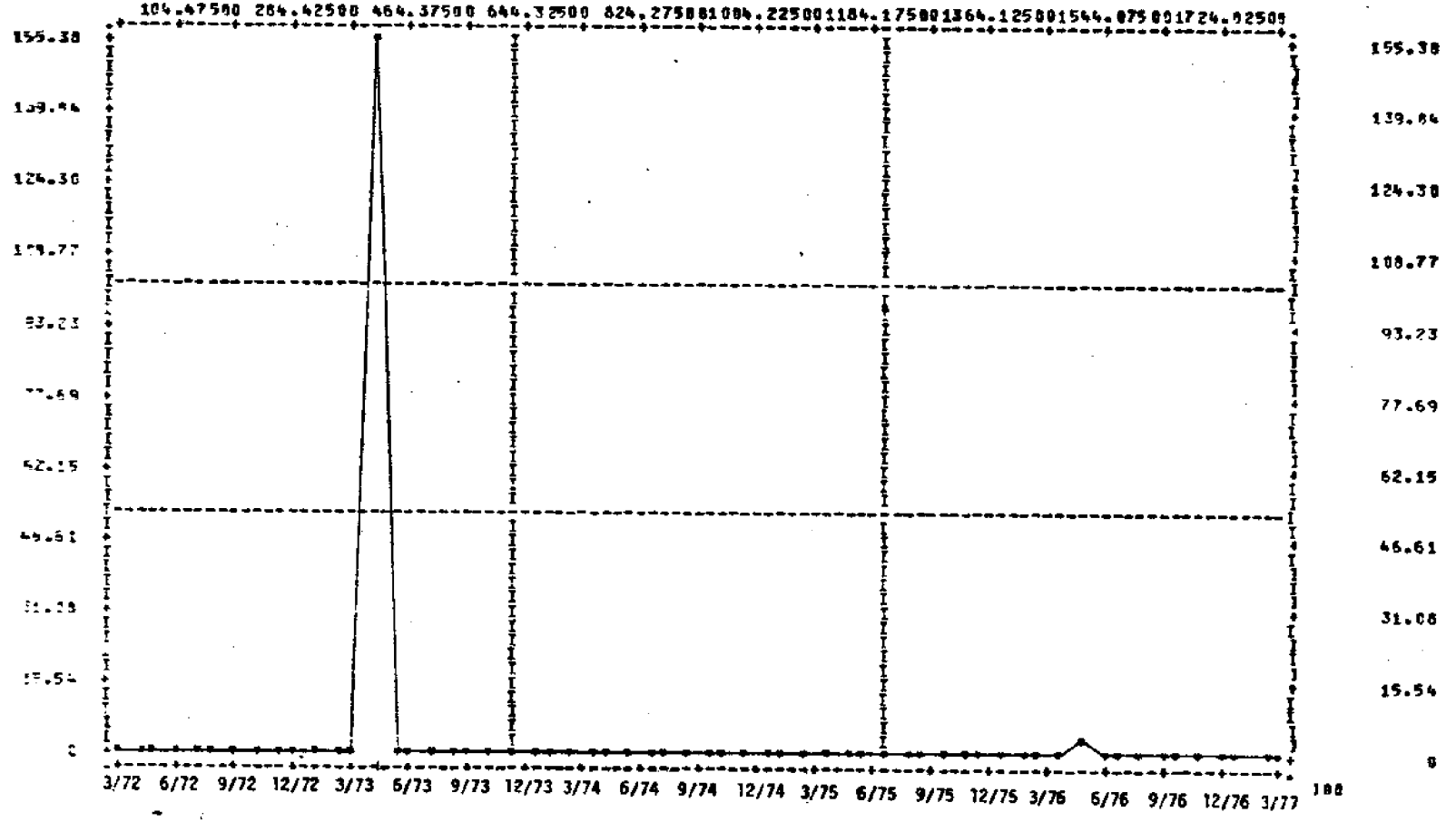
Figure 27, continued

B

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 13

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (DOWN) HARPEN

(ACROSS) DAYS



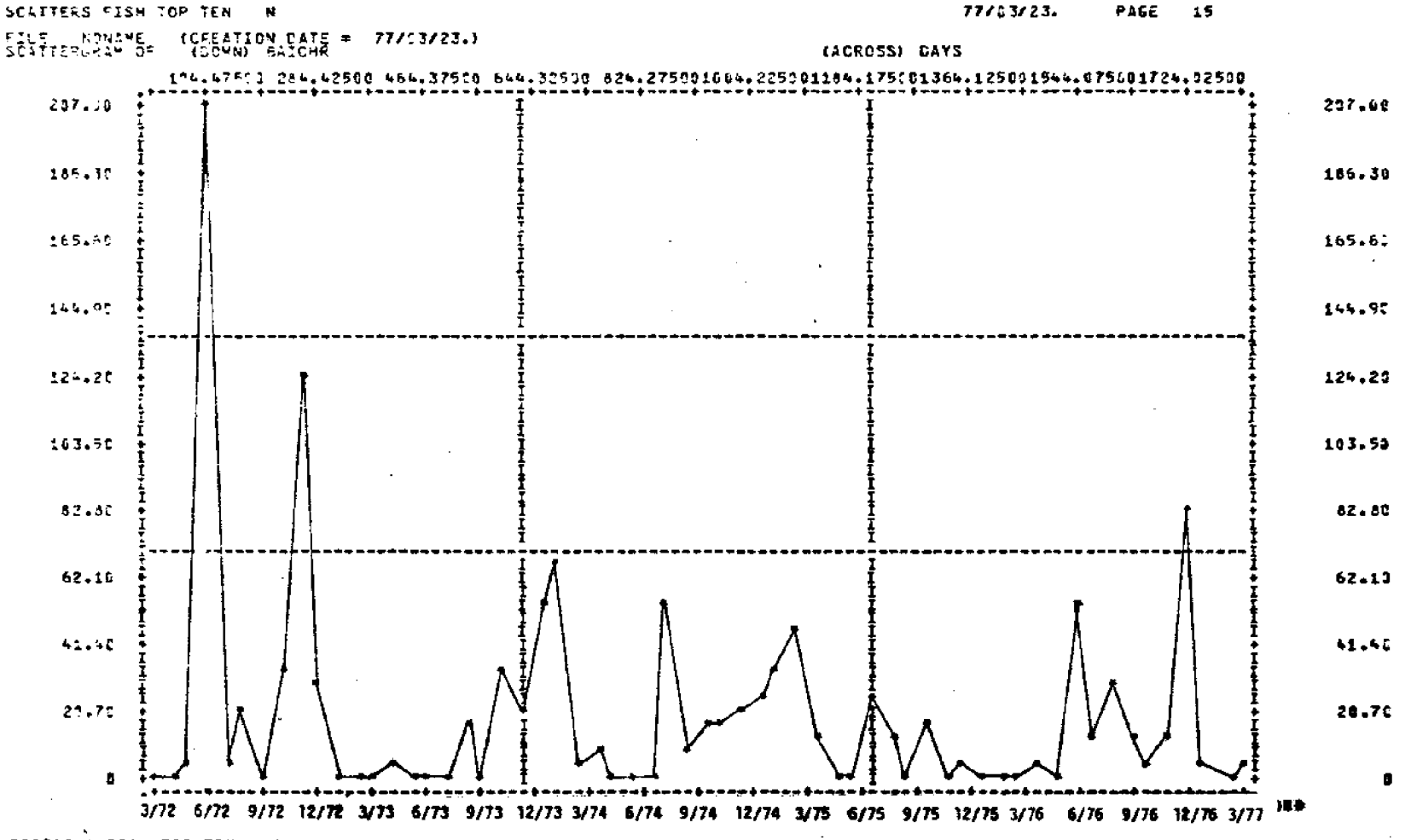
SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 14

STATISTICS..

CORRELATION (R)=	-.12061	R SQUARED =	.01455	SIGNIFICANCE R =	.17932
STD ERR OF EST =	20.03122	INTERCEPT (A) =	6.81057	STD ERROR OF A =	5.15184
[illegible] =	.09696	SLOPE (B) =	-.00455	STD ERROR OF B =	.00342
SIGNIFICANCE B =	.17932				
[illegible] =	61	EXCLUDED VALUES=	0	MISSING VALUES =	0

[illegible] IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 28: Numbers (A) and Biomass (B) of Bairdiella chrysura in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.



SCATTERS FISH TOP TEN N

STATISTICS..

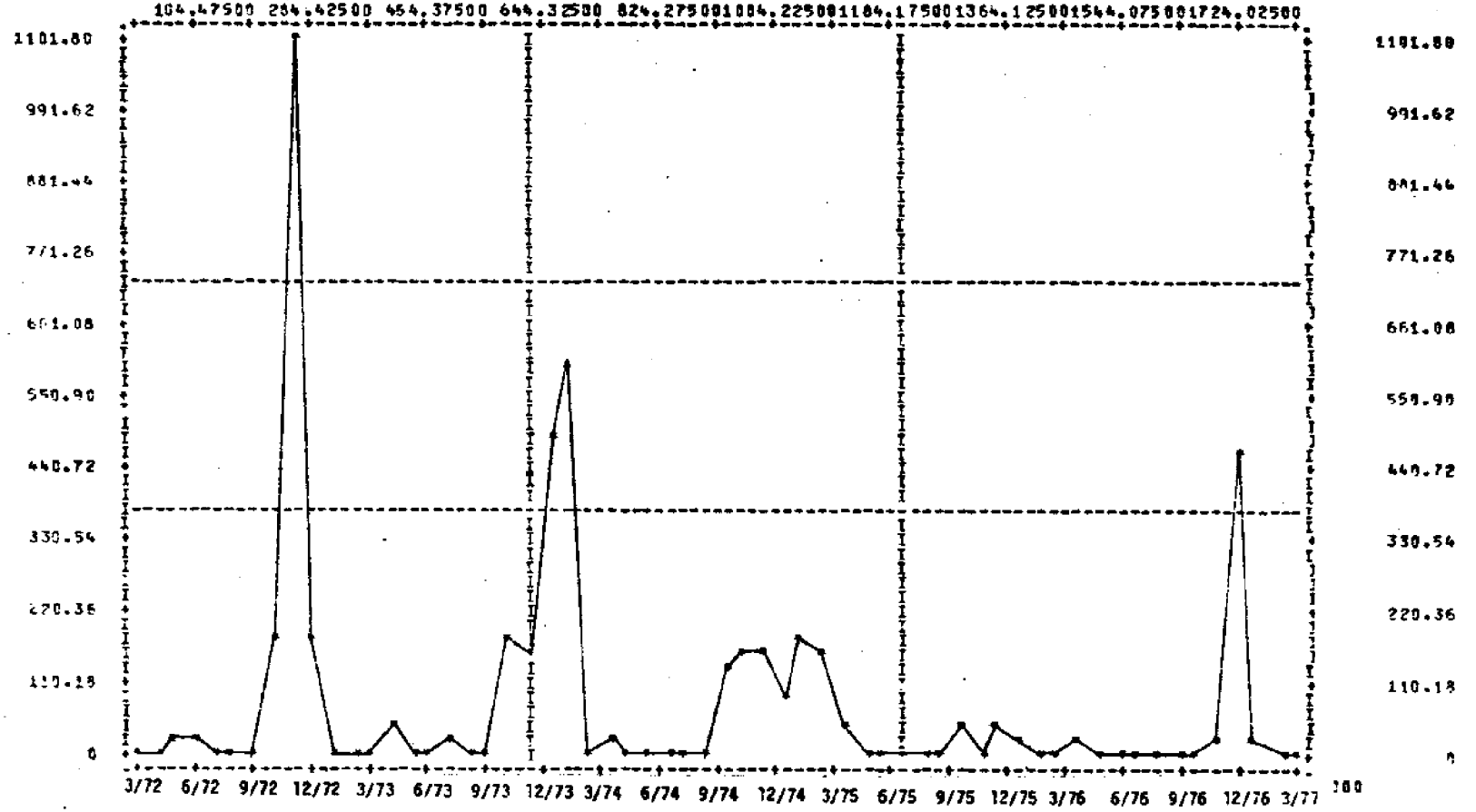
CORRELATION (R) -	-.16050	R SQUARED -	.02576	SIGNIFICANCE R -	.11028
STD ERR OF EST -	33.82285	INTERCEPT (A) -	30.15662	STD ERROR OF A -	8.72779
SIGNIFICANCE A -	.00052	SLOPE (B) -	-.01026	STD ERROR OF B -	.00628
SIGNIFICANCE B -	.11028				
PLOTTED VALUES -	69	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 28, continued.

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 15

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (COMM) BAICMR (ACROSS) DAYS



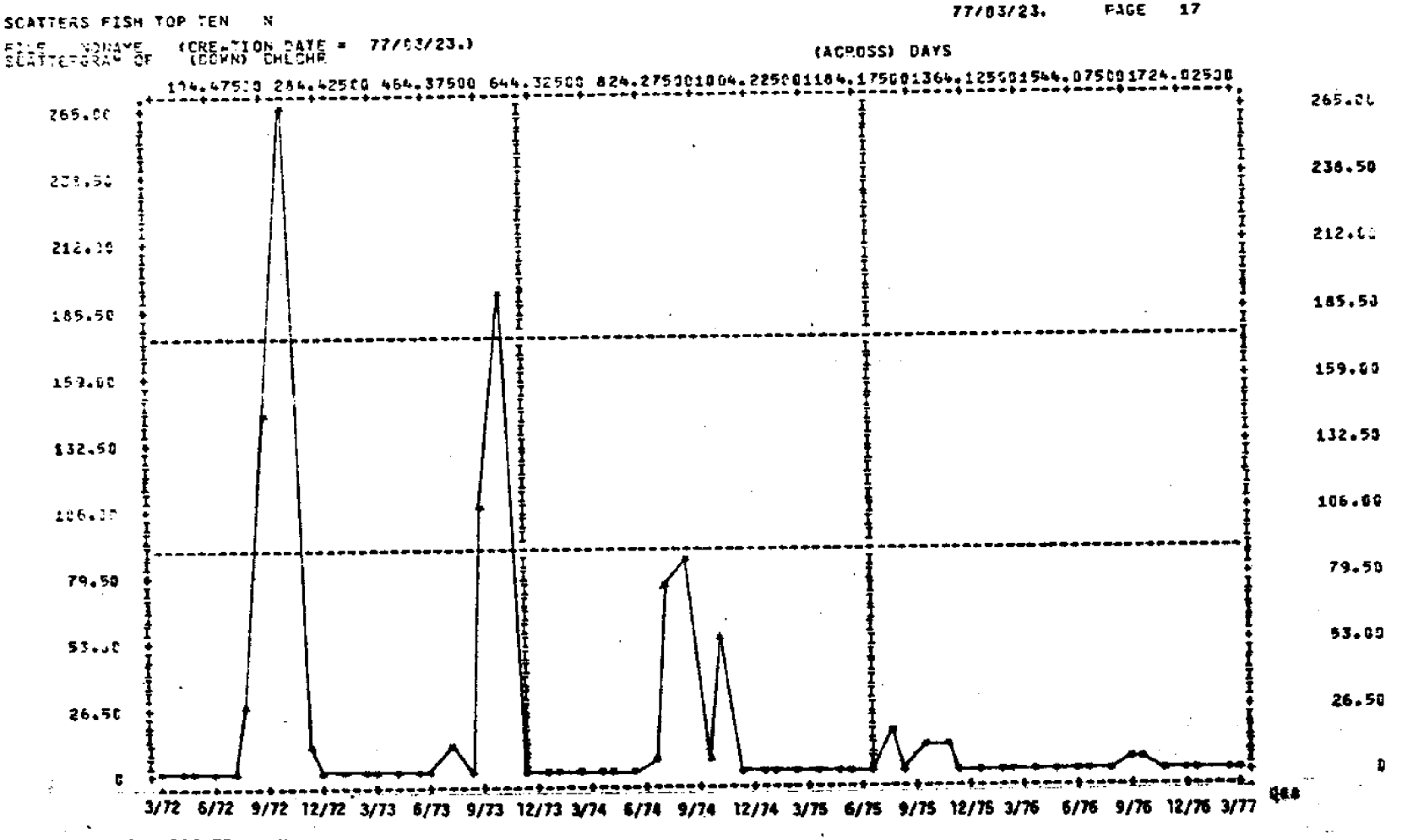
SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 15

STATISTICS..

CORRELATION (R)=	-.14471	R SQUARED =	.02094	SIGNIFICANCE R =	.13499
STD ERR OF EST =	180.74334	INTERCEPT (A) =	128.81507	STD ERROR OF A =	46.63994
SIGNIFICANCE A =	.01634	SLOPE (B) =	-.04937	STD ERROR OF B =	.01427
ST DEVIATION Y =	.13+49				
PLOTTED VALUES =	59	EXCLUDED VALUES=	0	MISSING VALUES =	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 29: Numbers (A) and Biomass (B) of Chloroscombrus chrysurus in the Apalachicola Estuary Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.



SCATTERS FISH TOP TEN N

STATISTICS..

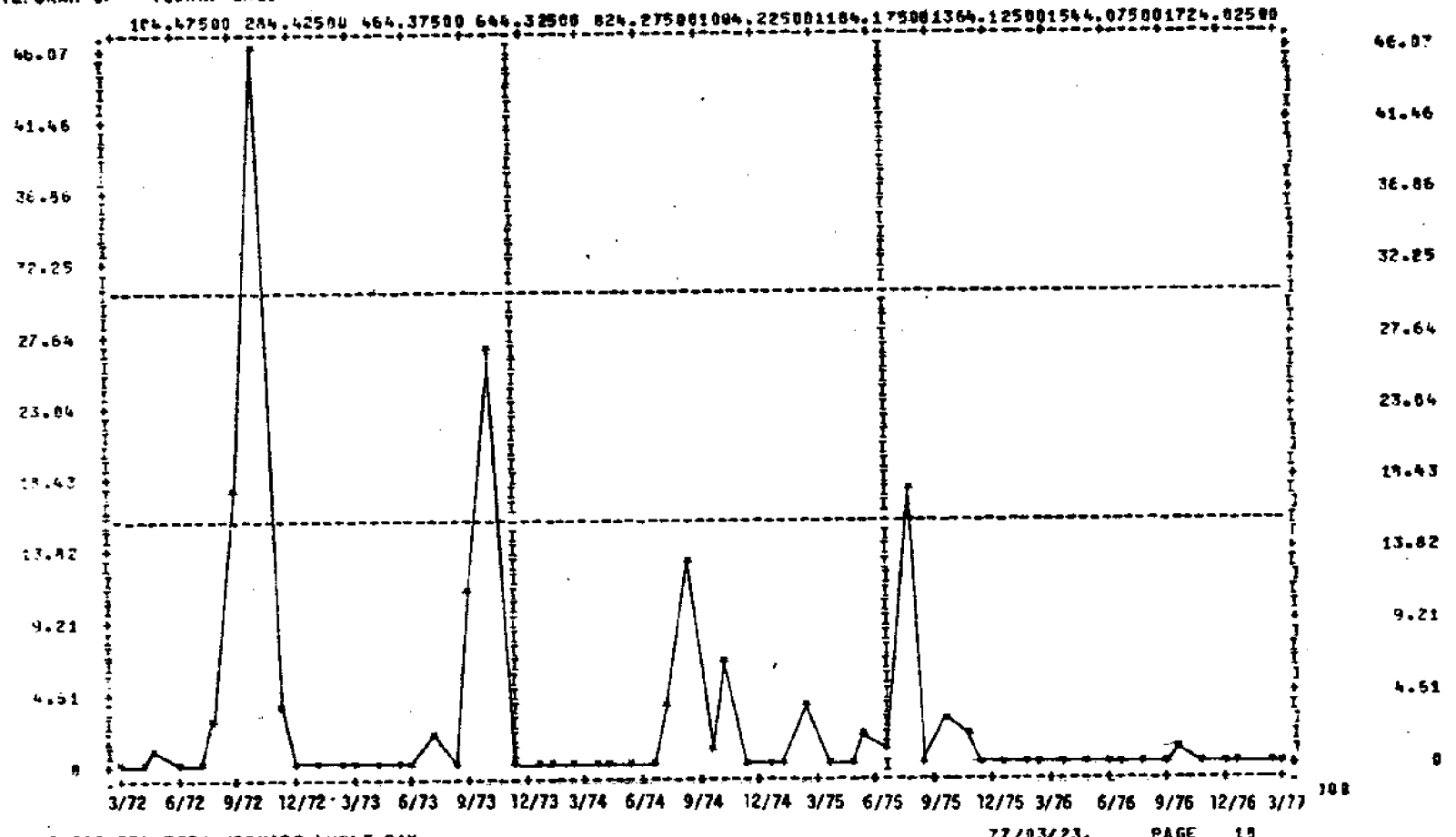
CORRELATION (R)-	-.26217	R SQUARED -	.06873	SIGNIFICANCE R -	.02151
STD ERR OF EST -	47.20457	INTERCEPT (A) -	39.70446	STD ERROR OF A -	12.10087
SIGNIFICANCE A -	.00093	SLOPE (B) -	-.02392	STD ERROR OF B -	.01156
SIGNIFICANCE B -	.02151				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Figure 29, continued

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 17

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (CORN) CHLCHR (ACROSS) DAYS



SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 18

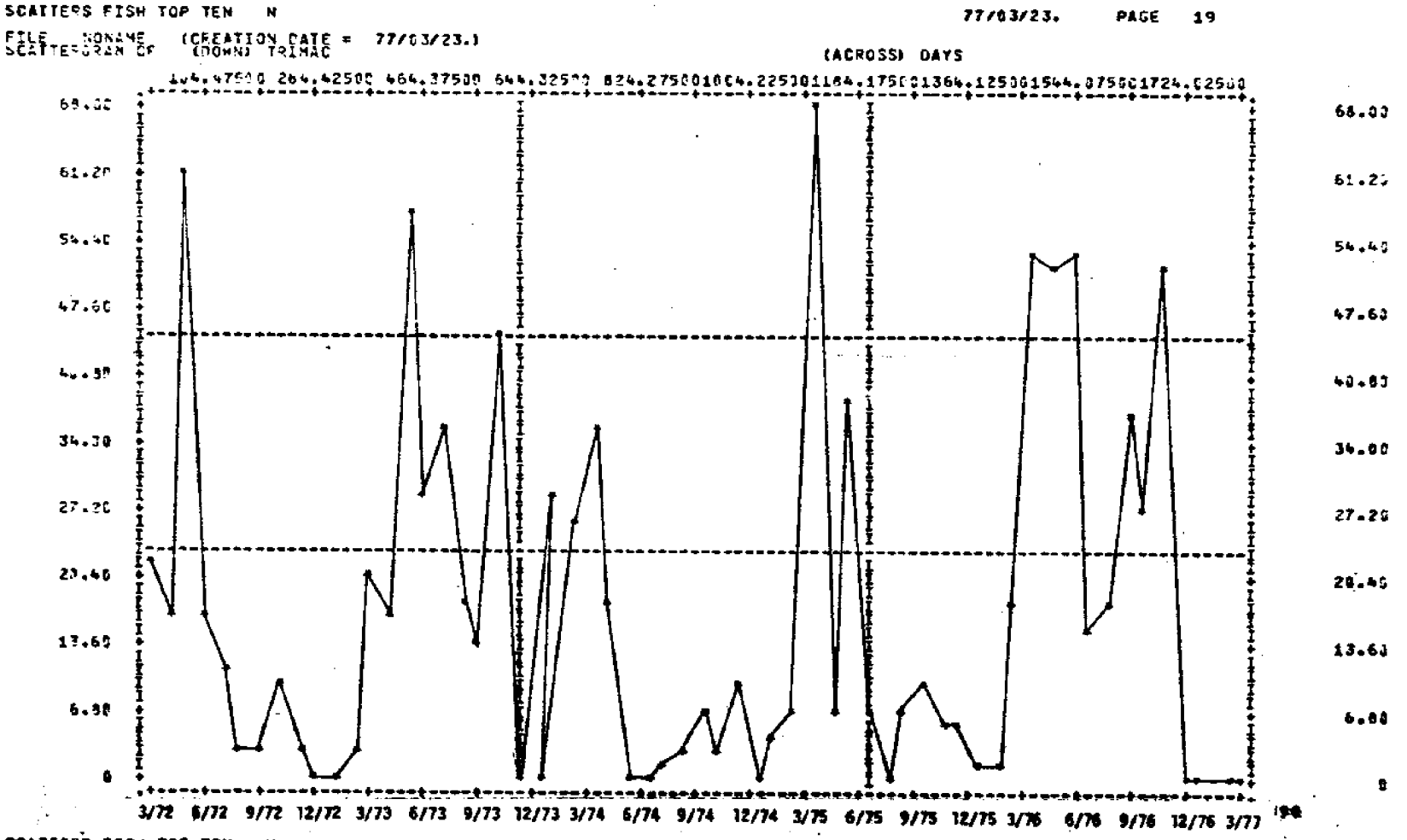
STATISTICS..

CORRELATION (R) -	-.22475	R SQUARED -	.05051	SIGNIFICANCE P -	.04214
STD ERR OF EST -	7.49597	INTERCEPT (A) -	5.87623	STD ERROR OF A -	1.93429
SIGNIFICANCE A -	.00176	SLOPE (B) -	-.00322	STD ERROR OF B -	.00154
SIGNIFICANCE B -	.04214				
PLOTTED VALUES -	50	EXCLUDED VALUES-	0	MISSING VALUES -	0

******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

A

Figure 30: Numbers (A) and Biomass (B) of Trinectes maculatus in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.



SCATTERS FISH TOP TEN N

STATISTICS..

CORRELATION (R)-	.02229	R SQUARED -	.00049	SIGNIFICANCE R -	.43316
STD ERR OF EST -	18.98059	INTERCEPT (A) -	16.48600	STD ERROR OF A -	4.87718
SIGNIFICANCE A -	.00065	SLOPE (B) -	.00078	STD ERROR OF B -	.00463
SIGNIFICANCE B -	.43316				
PLOTTED VALUES -	63	EXCLUDED VALUES-	0	MISSING VALUES -	0

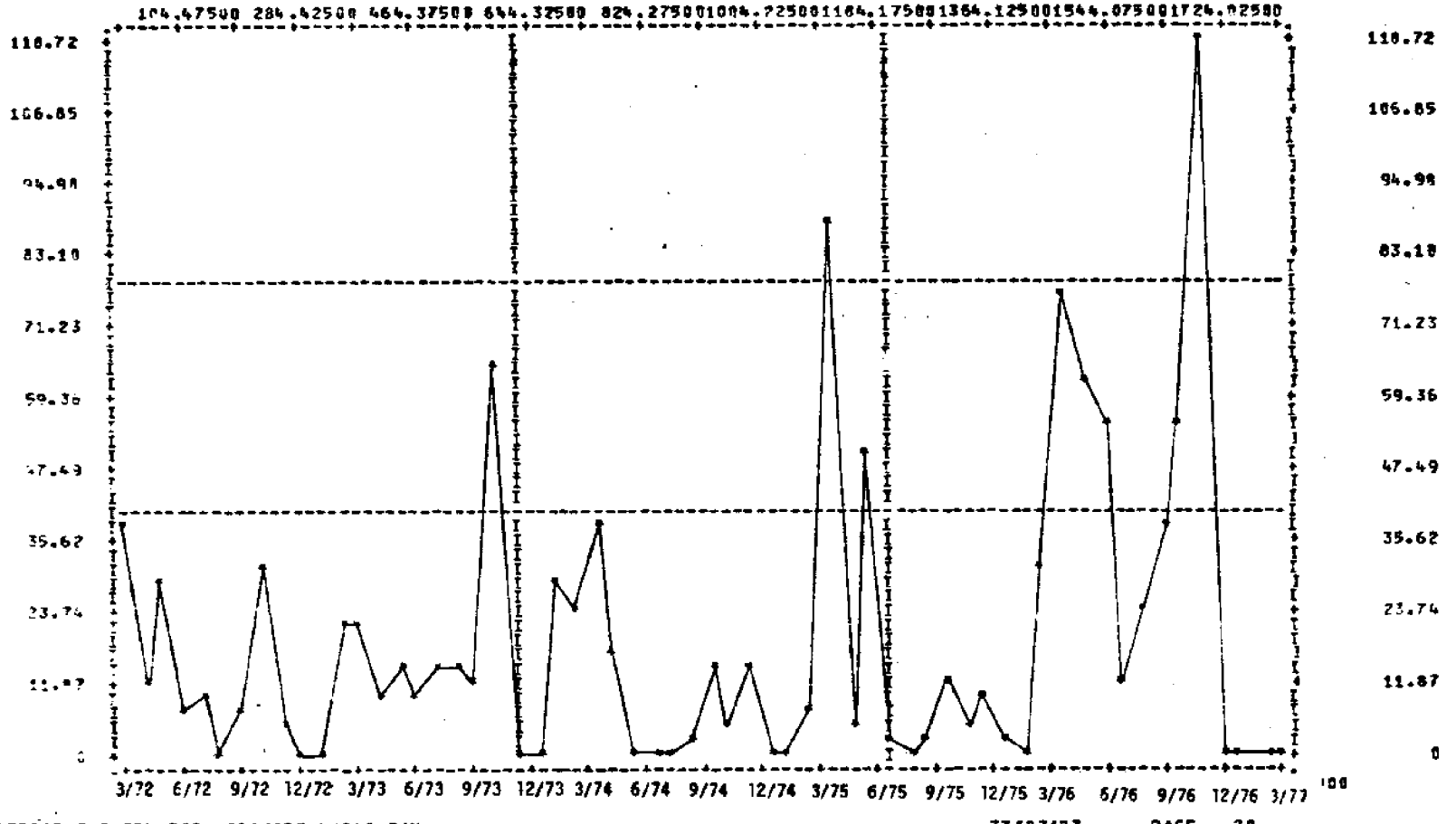
******** IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

B

Figure 30: continued

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 19

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (DOWN) TRIMAC (ACROSS) DAYS



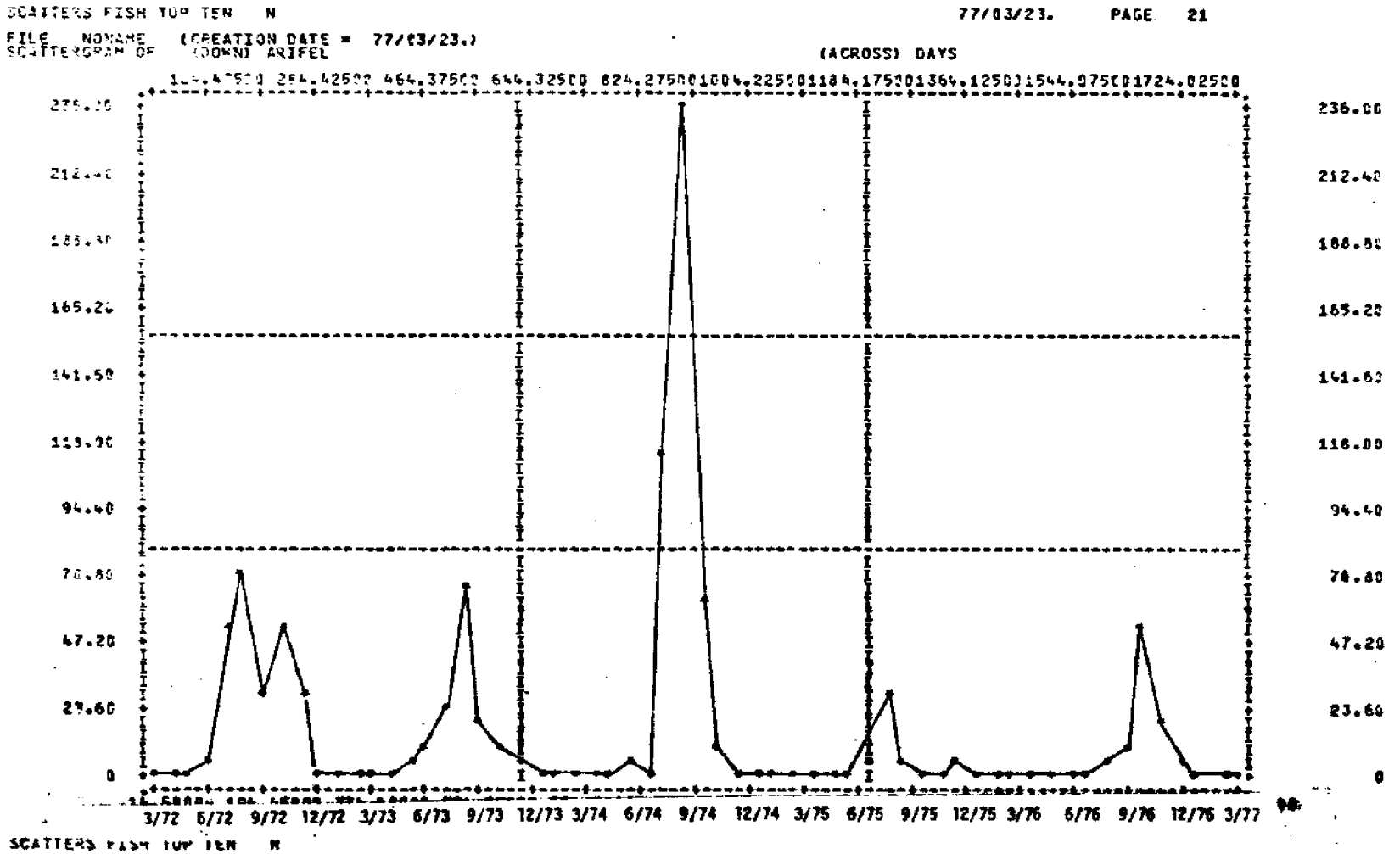
SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 20

STATISTICS..

CORRELATION (R) =	.19559	R SQUARED	=	.03825	SIGNIFICANCE R = .06712
STD ERR OF EST =	24.55102	INTERCEPT (A)	=	11.24572	STD ERROR OF A = 5.31203
SIGNIFICANCE A =	.74052	SLOPE (B)	=	.00910	STD ERROR OF B = .00599
SIGNIFICANCE B =	.06712				
[illegible] =		LAGGED VALUES =			MISSING VALUES = 0

******** THE REGRESSION IS A DEGENERATE CANNOT BE COMPUTED.

Figure 31: Numbers (A) and Biomass (B) of Arius felis in the Apalachicola Estuary (Stations 1, 2, 3, 4, 5, 6, 1A, 1B, 1C, 5A) From March, 1972 through February, 1977.



SCATTERS FISH TOP TEN N

STATISTICS..

CORRELATION (R) -	-.13111	R SQUARED -	.01719	SIGNIFICANCE R -	.15902
STD ERR OF EST -	36.82515	INTERCEPT (A) -	25.42817	STD ERROR OF A -	9.50252
SIGNIFICANCE A -	.00485	SLOPE (B) -	-.00906	STD ERROR OF B -	.00902
SIGNIFICANCE B -	.15912				
PLOTTED VALUES -	60	EXCLUDED VALUES-	0	MISSING VALUES -	0

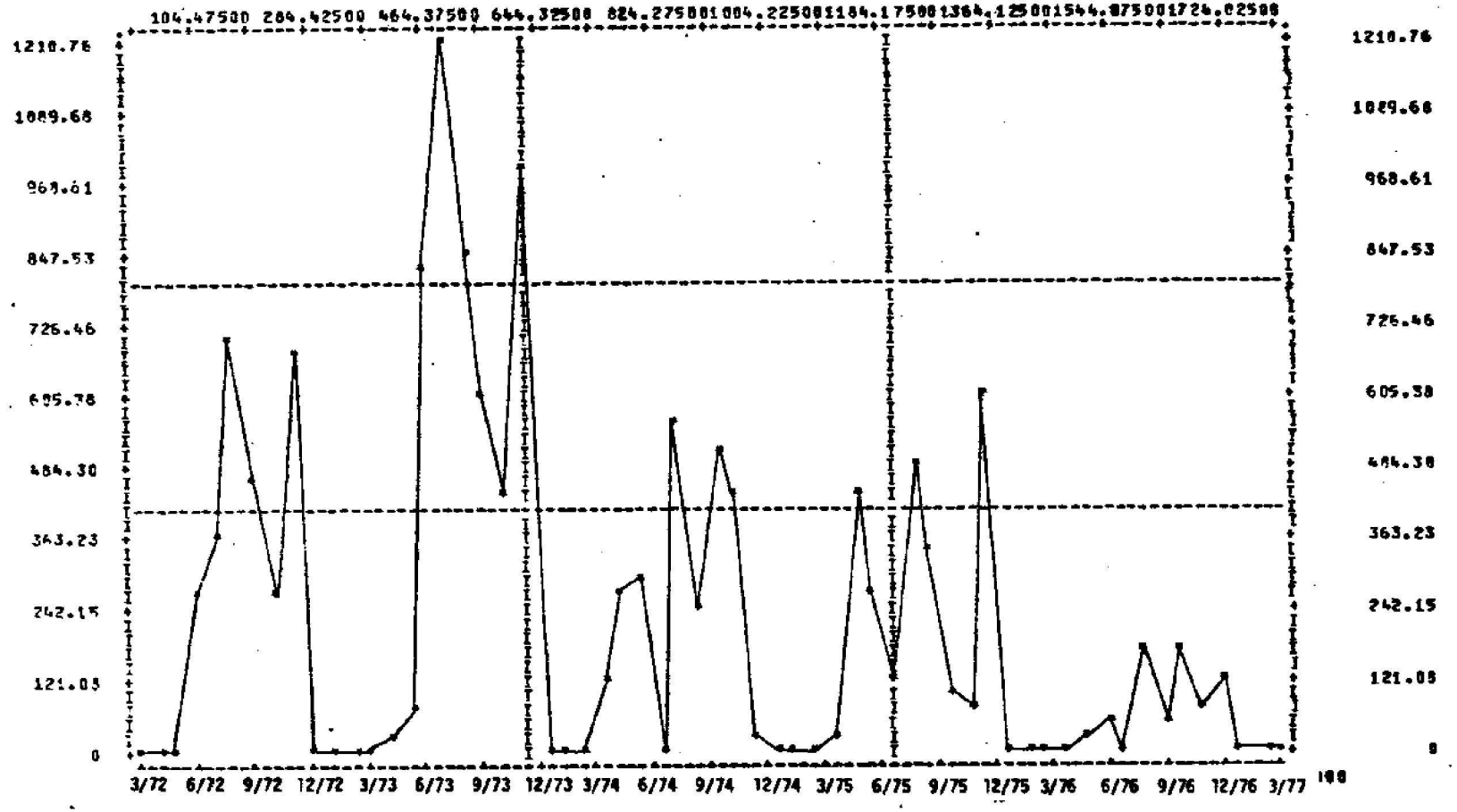
Figure 31: continued

A

SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 21

FILE NONAME (CREATION DATE = 77/03/23.)
SCATTERGRAM OF (COMN) ARIFEL

(ACROSS) DAYS



SCATTERS TOP TEN FISH BIOMASS WHOLE BAY 77/03/23. PAGE 22

STATISTICS..

CORRELATION (R) -	-.28619	R SQUARED -	.08305	SIGNIFICANCE R -	.01278
STD ERR OF EST -	283.98325	INTERCEPT (A) -	373.33455	STD ERROR OF A -	72.50612
SIGNIFICANCE A -	.00001	SLOPE (B) -	-.15772	STD ERROR OF B -	.05481
SIGNIFICANCE B -	.01274				
PLOTTED VALUES -	69	EXCLUDED VALUES -	1	MISSING VALUES -	1

XII. Trophic resource partitioning among juvenile fishes

Introduction

Estuarine areas provide a nursery ground for juveniles of many species of fish. The Apalachicola Estuary is characterized by the dominance of a small number of juvenile fish species: Anchoa mitchilli, Micropogon undulatus, Leiostomus xanthurus, and Cynoscion arenarius (in decreasing order of abundance). Seasonal and long-term fluctuations of these fishes have been documented (Livingston et al., 1976) and observations are continuing. Generally, seasonal peaks of abundance do not coincide, with the exception of M. undulatus, and L. xanthurus. Anchoa mitchillé is usually most abundant in fall-early winter, M. undulatus and L. xanthurus peak in winter-spring, and C. arenarius peaks in summer-early fall. Analyses of the seasonal fluctuations of these species indicate that physico-chemical factors (including salinity and temperature) may not be as critical in determining the fishes' distribution as biological characteristics such as feeding and reproduction. The present study was designed to examine the food habits of these four species and to relate their seasonal utilization of the estuary to the seasonal availability of their food sources. Such aspects as trophic resource partitioning, interspeciefic competition, and utilization of abundant, commercially important macroinvertebrates are the subject of this study.

Materials and Methods

Fishes were collected by monthly trawling in various areas of the Apalachicola estuary (see Livingston et al., 1976, or other portions of this report for description and details of field methods). After field preservation in 10% formalin, fishes were washed and stored in 40% isopropanol until analysis. At such time, fishes were sorted into 10mm SL size classes (e.g. 10-19mm,

20-29mm, etc.). Stomachs of up to 25 individuals (50 individuals in 10-19 class) from each size class were dissected and their pooled contents stored in 40% isopropanol. Stomach contents were then analyzed concerning percent composition by a gravimetric procedure using a series of 76mm diameter sieves (2000, 850, 425, 250, 150, and 75 μ mesh) as described by Carr and Adams (1972; 1973). Large food items were separated, identified by genus and species when possible, and dried individually. Smaller items were separated into fractions of similar particle size with the sieves. After determining the percent composition of each fraction by subsampling, (enumerating and classifying 100-300 particles with a dissecting microscope), each fraction, as well as the larger items, was placed in preweighed aluminum tins and dried overnight at 90-100 ^{o}C in an oven. Samples were then weighed to the nearest 0.1 mg on a microbalance. Percent composition was determined by multiplying the numerical percentage of each food type in a sieve fraction by the dry weight of that fraction, then summing the values of each food type over all fractions.

Data analysis was conducted using various combinations of similarity indices and clustering strategies. For continuous data such as biomass, three similarity coefficients and two clustering strategies were used. The similarity coefficients included:

1) complement of the Bray-Curtis measure,
$$1 - \left[\sum_{i=1}^{m} |x_i - y_i| \Big/ \sum_{i=1}^{m} (x_i + y_i)\right] \quad ;$$
2) complement of the Canberra metric,
$$1 - \left(\left[\sum_{i=1}^{m} |x_i - y_i| / (x_i + y_i)\right] / N\right) \quad ;$$
3) Rho
$$\sum_{i=1}^{n} (P_{x_i} P_{y_i})^{1/2} \quad ;$$

The clustering strategies included the following:

1) group average,

$$D(IJ,k) = \frac{n_1}{n_1+n_2} D(I,K) + \frac{n_2}{n_1+n_2} D(J,k);$$

2) flexible grouping,

$$D(IJ,k) = \frac{1-\beta}{2}[D(I,K) + D(J,k)] + \beta D(I,J),$$

where x = biomass of i^{th} food item in sample x,

y = biomass of i^{th} food item in sample y,

N = total number of food items in samples x + y,

P = $x_i / \sum_{i=1}^{n} x_i$ = proportion of biomass of the food item in total biomass of sample x,

P = $y_i / \sum_{i=1}^{n} y_i$ = proportion of biomass of the food item in total biomass of sample y,

h_1 = number of samples in cluster 1

h_2 = number of samples in cluster 2

I, J, K = unit clusters (single entities)

IJ = fused cluster

D(A,B) = distance generated by similarity index matrix between samples A and B

β = clustering intensity coefficient (-1 to 1).

The choice of these similarity indices and clustering strategies were based on discussions of methods in Sneath and Sokal (1973) and Clifford and Stephenson (1975). The rho index is discussed by van Belle and Ahmed (1974).

Results and Discussion

Anchoa mitchilli

A total of 3,448 A. mitchilli stomachs were examined, forming 276 station x date x size class (SDS) combinations. Stomach contents are summarized by size class, over all stations, and months in Table 1. Larger, identifiable organisms are presented in Table 2.

Calanoid copepods, probably Acartia sp., are the major food item for A. Mitchilli, although dependence upon copepods decreases from 97.8% in the 10-19mm class to 49.3% in the 60-69mm class. The change in diet is mainly due to increased consumption of mysids (up to 17%), insect larvae (up to 12%), and juvenile fishes (up to 6.7%). Seasonally, copepods are usually the main food item for spring through fall for fishes 49mm SL. Larger fishes utilize copepods mainly during spring and summer. Mysids become important in the fall and occasionally in the spring. Winter feeding encompasses a wide variety of organisms, including copepods, insect larvae, cladocerans, barnacle nauplii, and plant matter. Although detrital matter was not found to any extent in Anchoa stomachs (<2.6%), anchovies do utilize the detrital food web as they switch from copepods to epibenthic and benthic organisms such as mysids and insect larvae.

Micropogon undulatus

A total of 2,215 Micropogon undulatus stomachs were examined, forming 165 SDS combinations. Stomach contents are summarized by size class, over all stations and months, in Table 3. Larger, identifiable food items are presented in Table 4.

Polychaetes form the basis of M. undulatus' diet, averaging 34.1% over all size classes examined (10-159mm SL). The main species of polychaetes encountered were Parapriponospio pennata and Glycinde solitaria in outer bay stations, and Amphicteis gunneri in inner bay stations. Other important food items include detritus (13.6%0), shrimp (10.4%), mainly Ogyrides limicola), and juvenile fishes (8.5%). Across the range of size classes, smaller fishes (10-39mm) consumed relatively larger amounts of insect larvae, mid-range fishes (40-99mm) consumed relatively more detritus, mysids and isopods, while larger fish (<100mm) increased intake of juvenile fishes, crabs, and infaunal

shrimp. Commerically important shrimp, Penaeus spp., were rarely found, and blue crabs, Callinectes sapidus, were not found at all. Of the fishes eaten, 40% were identified as juvenile Micropogon, indicating some degree of cannibalism.

Leiostomus xanthurus

A total of 903 Leiostomus xanthurus stomachs were examined, forming 81 SDS combinations. Stomach contents are summarized by size class, over all stations, and dates in Table 5. Larger identifiable food items are presented in Table 6.

Generally Leiostomus does not depend heavily on one or two main food items, as do the other species examined. Detritus (22.5%), harpacticoid copepods (18.2%), polychaetes (18%), insect larvae (12.4%), and bivalves (12%) are the main food sources. Trends across size classes are not as clear as those determined for other species. Insect larvae are most important to the middle size classes (40-69mm). Detritus and polychaetes are relatively more abundant in fish 70-89mm, while bivalves become important to the 90-109mm individuals. Harpacticoid copepods are quite variable.

Cynoscion arenarius

A total of 1,545 Cynoscion arenarius stomachs were examined, forming 122 SDS combinations. Stomach contents are summarized by size class over all stations and dates in Table 7. Larger identifiable food items are presented in Table 8.

Cynoscion feeds mainly on fishes (62%) and mysids (25.7%). Smaller size classes depend heavily upon mysids (73% in the 10-19mm class) and to a lesser extent upon calanoid copepods (48%). There is aclear trend in the reduction of mysids and copepods, and a rapid, concurrent change to juvenile fish as the main food item. Juvenile fish become dominant by the 40-49mm class and reach 100% by the 80-89mm class. Of the fishes consumed, Anchoa

mitchilli represented 78% of those identified. Generally, shrimp, particularly Penaeus spp., and blue crabs which are seasonally very abundant in the bay are not heavily preyed upon.

Preliminary results of cluster analyses

Initial investigations concerning the similarity coefficient clustering strategy to be used for the final data analysis were conducted with the data for Micropogon undulatus as given in Table 3. In a comparison of group averaging vs. flexible grouping (β = -0.25) and concurrent comparisons of Bray-Curtis vs. Canberra metric vs. rho, group average clustering appeared to form weaker clusters with a higher degree of chaining than did flexible grouping over all similarity coefficients. Of the similarity coefficients, rho appeared to give the most obvious and strongest clusters in terms of interpretable biological information concerning Micropogon size classes. The apparent "best" choices were rho combined with flexible grouping, although further analyses will be conducted.

Secondary investigations considered the choice of β values (clustering intensity coefficient) used in flexible grouping. Four values of B (0.25, 0.00, -0.25, -0.50) were compared using the Micropogon data, rho, and flexible grouping. Compaction of clusters increased as β increased from -0.25 to 0.25, while negative values in the similarity matrix occurred with β = -0.50. Thus, the best performance was chosen for β = -0.25 in flexible grouping, as has been noted by others (Sneath and Sokal, 1973).

The final stage in these preliminary analyses was to use the data in Tables 1,3,5 and 7 in conjunction with rho and flexible grouping (β = -0.25) to investigate the dietary similarity of size classes within each species (Figure 1), and to examine station similarities with respect to food availability to each species (Figure 2). Anchoa mitchilli size classes were highly interrelated but seemed to form two distinct clusters; the 10-39mm group,

characterized by the largest intake of copepods, and the 40-69mm group, characterized by decreased consumption of copepods and increased consumption of larger food items such as mysids and juvenile fish. Micropogon undulatus size classes also formed two clusters: an intense cluster of 10-69mm fish, whose diet included > 50% polychaetes, detritus, and insect larvae, and a loose cluster of 70-159mm fish, whose diet was composed of polychaetes, shrimp, crabs, or fish, usually with one of these items predominating. These two clusters were only weakly linked. Leiostomus xanthurus size classes formed three clusters: a relatively intense cluster of 20-69mm fish, whose diet was composed of insect larvae, polychaetes, harpacticoid copepods, and detritus; a more intense cluster of 70-99mm fish, whose diet was mainly detritus, harpacticoid copepods, and polychaetes; and a unit cluster of 100-109mm fish, whose main dietary item was bivalves. The first two clusters were relatively closely related, while the third was only loosely associated with the others. Cynoscion arenarius formed two main clusters which were distantly related: the 10-49mm fish appeared to be a loose grouping of two intense clusters, the 10-29mm class, consuming mainly mysids, and the 30-49mm class, consuming a mixture of mysids and fish. The second main cluster was 50-89mm fish, whose main food item was juvenile fish. The results of the cluster analysis thus appear to agree with the biological results.

Cluster analysis by station for each species (Figure 2) indicated the variety of food found in various areas in the bay. Water column feeders such as Anchoa mitchilli do not seem to have different food habits with respect to location, since all stations appear to be relatively tightly clustered. It was expected that Cynoscion arenarius, also a water-column feeder, would behave similarly, but two loosely related station clusters appeared. However, when the original data were scanned, it was noted that Cynoscion consistently consumed more fish at stations 5,1A,1B, and 1C than at stations

2,6,1,4,5A, and 3. Distinct station-to-station differences were noted for the bottom-feeding Micropogon undulatus and Leiostomus xanthurus. Micropogon clusters into three groups, stations 3-5-5A-6, 1-4-1A-1C, and 2-1B. Leiostomus clusters into two groups, stations 3-5-5A-6 and 1A-1B-1-4-2-1C. The distinctions in these cases probably are related to station characteristics. Thus, the cluster of stations 3-5-5A-6, occurring for both species are characterized as shallow, low salinity areas with nearby beds of benthic macrophytes, while the other stations are relatively remote from land and have, in general, higher salinities and muddy bottoms with little or no macrophyte development.

Resource Partitioning and Competition

The general evidence presented above indicates that the various resources of Apalachicola Bay are well partitioned among the fish species. The most commonly examined resource dimensions are habitat, food, and time. In this case, habitat has not yet been examined in detail. Temporal partitioning has already been documented, with the four main species generally occurring in peak abundances during different seasons, the exception being Micropogon and Leiostomus (Livingston et al., 1976). Food resources appear also to be well divided among the species: Cynoscion feeds on mysids and juvenile fishes, Anchoa on calanoid copepods, and polychaetes. The obvious competitive interactions would, on a temporal basis, appear to be between Micropogon and Leiostomus. However, competition is ameliorated between these two benthic feeders via differentiated food habits as demonstrated above.

Future analyses

A number of important aspects have yet to be considered. These include: 1) the extent to which spatial and temporal differences in food availability affect the observed variability in food habits of each species, 2) the extent

of competition among the species when smaller size classes co-occur (this may have been obscured by the preliminary examination of average food consumption per size class), 3) the relationship between the temporal occurrence of each species and the abundance patterns of the prey organisms (data collected by other investigators but not yet available for analysis), 4) possible habitat partitioning by these fish species, particularly Leiostomus and Micropogon, and 5) possible reasons for the apparent exclusion of commercially important invertebrates from the diets of the four fish studied. These aspects will be considered in future work.

In addition, further analysis will include a multivariate treatment of the potential interactions of key forcing functions such as river flow with some of the trophic relationships detailed above. It appears that detritivorous groups have well timed migrations into the bay which could be associated with river-borne influxes of detritus during certain times of the year.

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Table 1. Stomach contents (% of total dry weight) of Anchoa mitchilli, summed by size class.

Food Item	Size (mm) 10-99	20-29	30-39	40-49	50-59	60-69	Avgr. 10-69
Sand Grains			<.1	<.1	0.1	0.1	<.1
Detritus		2.2		2.5	2.3	2.4	1.6
Diatoms		0.7	1.0	0.8	0.4	0.2	0.5
Plant remains		<.1	0.7	0.2	1.0	0.5	0.4
Scyphozoans				<.1		<.1	<.1
Polychaetes - larval	1.1	0.3	0.2	0.3	0.3	0.3	0.4
- juv./adult		0.2		0.2	2.2	0.3	0.5
Gastropod veligers		<.1		0.4	0.2	0.2	0.1
Gastropods		<.1	0.4	1.2	1.0	1.6	0.7
Bivalve veligers		0.3	0.5	0.8	0.6	0.8	0.5
Bivalves		1.3	<.1	0.3	0.4	0.2	0.4
Unassigned mollusc larvae					<.1	0.1	<.1
Hydracarinids			<.1		<.1		<.1
Cladocerans		2.8	3.9	1.5	0.8	3.1	2.0
Ostracods		0.4	1.0	0.9	1.8	2.6	1.1
Calanoid copepods	97.8	82.3	72.7	60.6	52.7	49.3	69.2
Cirripede nauplii		0.2	4.8	4.2	1.2	0.6	1.8
Cumaceans		<.1	<.1	0.2	0.1	0.2	<.1
Isopods			<.1		<.1		<.1
Amphipods		<.1	0.5	1.3	1.0	0.7	0.6
Mysids	1.1	1.7	3.1	17.0	16.5	15.3	9.1
Shrimp - zoeal			0.2	0.5	0.4	0.4	0.2
- postlarval		2.1	1.6	0.4	0.2		0.7
- juv./adult			0.2	0.3	2.3	0.7	0.6
Crabs - zoeal		0.2	0.4	0.9	0.5		0.3
- megalopal				<.1	2.1		0.4
Unassigned decapod larval		0.4	0.6	0.5	0.4	0.3	0.4
Insects - larval		4.5	2.6	2.2	4.3	12.0	4.3
- adult		0.4	<.1	<.1		<.1	<.1
Chaetognaths					0.6		0.1
Invertebrate eggs		2.0	3.2	2.1	1.5	0.6	1.6
Fish - eggs			0.1	0.4	1.0	0.6	0.4
- larval					1.0		<.1
- juvenile				0.2	2.6	6.7	1.6

Table 2. Identified food items in stomachs of Anchoa mitchilli (276 sets of samples)

AMPHIPODS (20/276 occurrences)	# of occurrences
Gammarus sp. 1	3
Grandidierella bonnieroides	3
Cerapus sp.	2
Corophium louisianum	1

MYSIDS (52/276) occurrences	
Mysidopis bahia	18
Mysidopsis bigelowi	3
Mysidopsis almyra	3
Taphromysis bowmani	2

Shrimp (12/276)	# of occurrences
Ogyrides limicola	5
Lucifer faxoni	4

Fish (4/276)	
Anchoa mitchilli	1
Cynoscion Arenarius	1
Syngnathus sp.	1

Table 3: Stomach contents (% of total dry weight) of Micropogon undulatus, summed by size class.

Food Item	Size (mm) 10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109
Sand Grains		<.1			<.1	0.2	0.2		0.3	<.1
Sediment masses			0.2	2.4	1.5	3.3	3.3	8.2		
Detritus	7.1	6.5	12.9	10.4	17.5	19.2	19.0	15.0	19.5	10.3
Plant remains		<.1	0.3	0.4	<.1	0.4	0.1	<.1	0.6	0.7
Nematodes	0.8	0.4	<0.1	<.1	<.1	<.1	<.1			
Polychaetes - larval		<.1	<.1							
- juv./ adult	26.2	31.5	35.6	36.6	29.6	31.7	28.1	48.4	64.7	32.8
Gastropods				<.1	<.1	0.3				
Bivalve siphons			1.5	2.8	3.7	3.1	3.0	1.2	3.2	
Bivalves	0.8	1.0	0.9	0.6	0.1	0.3	0.1			
Cladocerans		<.1	<.1	<.1		<.1				
Ostracods	0.2	0.2	<.1	<.1		<.1	<.1			
Calanoid copepods	10.0	7.1	4.2	6.0	9.1	7.8	7.1	1.6	2.1	<.1
Harpacticoid copepods	12.2	8.6	2.7	1.9	4.3	2.4	0.7	0.1		
Cumaceans	1.4	0.6	0.4	0.2	0.1	<.1	<.1	<.1		
Isopods			0.2	0.7	3.6	2.9	0.9	0.1		
Amphipods	5.3	16.9	13.6	6.8	3.7	4.6	3.8	2.3	0.3	0.1
Mysids	8.0	5.7	5.0	8.2	10.4	11.3	11.0	2.3	5.6	
Shrimp - postlarval			<.1		<.1					
- jub./adult		0.1	1.4	0.9	2.9	4.8	10.3	10.1	2.1	1.8
- juv./adult					0.8	0.6	0.4			0.5
Unassigned decapod larva				<.1						
Insect larvae	27.9	20.9	20.8	11.6	11.9	5.0	0.5	0.2		
Ophiuroids							1.0			
Unassigned invertebrate eggs	0.1		<.1		<.1		<.1	<.1		
Fish - eggs				<.1	<.1					
- larval		0.3	0.3	1.2						
- juvenile					0.5	0.8	10.3	10.4	1.8	53.7
- bones, scales				<.1		1.2				

Table 3: continued.

110-119	120-129	150-159	Avg. 10-159
2.1			0.2
			1.4
6.8	14.1	9.7	13.6
<.1		0.3	0.2
2.1			0.3
			<.1
4.4	40.1	34.0	34.1
			<.1
			1.4
			0.3
			<.1
			<.1
0.1			4.2
<.1			2.5
			0.2
			0.6
1.8	0.2		4.6
2.7	2.2		5.6
			<.1
46.0	43.3	10.9	10.4
		45.1	3.6
			<.1
1.2			7.7
			<.1
			<.1
			<.1
			0.1
32.7			8.5
			<.1

Table 4: Identified food items in stomachs of *Micropogon undulatus* (165 sets of samples)

Polychaetes (127/165 total occurrences)	# of occurrences
Paraprionospio pinnata	20
Amphicteis gunneri	20
Glycinde solitaria	19
Laeonereis culveri	5
Neanthes succinea	4
Capitellid sp.	3
Loandalia americana	2
Streblospio benedicti	1
Haploscolopios fragilis	1
Sigambra bassi	1
Mysids (95/165 total occurrences)	
Mysidopsis bahia	15
Taphromysis bowmani	10
Mysidopsis almyra	1
Mysidopsis bigelowi	1

Amphipods (99/165 occurrences)	# of occurrences
Grandidiereua bonnieroides	39
Gammarus sp. 1	27
Cerapus sp.	12
Haustoriid sp.	10
Ampelisca vadorum	7
Corophium louisianum	4
Gammarus macronatus	4
Melita sp.	3
Gammarus sp. 2	3
Cymadusa compta	1
Caprellid sp.	1
Isopods (20/165 occurrences)	
Cyathura polita	18
Edotea montosa	8
Cassidinidea ovalis	2

Shrimp (45/165 occurrences)
Ogyrides limicola
Callianassa Jamaicense
Penaeus spp
Alpheus heterochaelis
Crabs (5/165 occurrences)
Rhithropanopeus harrisii
Fish (13/165 occurrences)
Micropogon undulatus
Anchoa mitchilli
Cynoscion arenarius
Microgobius gulosus
Leptocephalus

Table 4: continued.

# of occurences
22
8
2
1
5
4
2
2
1
1

Table 5. Stomach contents (% of total dry weight) of Leiostomus xanthurus, summed by size classes.

Food Item	Size (mm) 20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	Avg. 20-109
Sand grains	0.3		0.2	0.2		0.3	2.1	1.6	0.3	0.7
Sediment masses					0.1	<.1				<.1
Detritus	19.7	21.4	14.5	12.5	11.8	27.2	33.4	33.0	14.4	22.5
Plant remains					<.1					<.1
Rhychocoels		<.1								<.1
Nematodes	8.8	12.6	9.6	8.3	7.1	8.2	7.2	4.3	3.0	7.8
Polychaetes	37.2	12.4	12.3	12.4	15.6	23.2	22.6	17.4		18.1
Gastropods				0.3	0.4					<.1
Bivalve siphons			0.7	0.1						<.1
Bivalves		5.8	12.5	11.5	2.4	8.8	8.7	21.3	69.9	12.1
Cladocerans	0.2	<.1		<.1						<.1
Ostracodis					<.1					<.1
Calanoid Copepods	5.2	5.6	1.1	3.6	5.1	3.8	7.0			3.8
Harpacticoid copepods	8.3	20.4	11.9	15.5	25.2	22.8	15.1	19.9	6.9	18.3
Cumaceans	0.2			0.3	0.6	0.4	1.4			0.4
Isopods		0.2	0.1	0.3	<.1					<.1
Amphipods	0.8	3.6	2.2	0.5	1.2	0.1	<.1		4.6	1.0
Mysids		3.2	1.4	5.4	1.3	3.0	2.1	2.2	0.8	2.6
Shrimp zoea					<.1					<.1
Crabs - zoeal			<.1		<.1					<.1
- megalopal			<.1							<.1
Insects - larval	19.3	12.9	32.8	28.8	28.3	2.0	0.6	0.2		12.4
- adult			0.1	<.1						<.1
Invertebrate eggs		<.1	<.1	<.1						<.1
Fish eggs			<.1	<.1	<.1					

Table 6: Identified food items in stomachs of Leiostomus xanthurus (81 sets of samples)

Polychaetes (52/81 occ.)	# of occurrences
Amphicteis gunneri	13
Glycinde solitaria	13
Capitellid sp.	6
Paraprionospid pinnata	5
Neanthes succinea	2
Laeonereis culveri	1
Loandalia americana	2
Sigambra bassi	1
Isopods (8/81 occ.)	
Edotea montosa	3
Munna reynoldsi	3
Cyathura polita	1
Mysids (25/81 occ.)	
Mysidopsis bigelowi	4
Taphromysis bowmani	3
Mysicopsis bahia	1

Amphipods (30/81 occ.)	# of occurrences
Gammarus sp. 1	7
Melita sp.	3
Grandidierella bonnieroides	3
Haustoriid sp.	2
Cerapus sp.	2
Corophium louisianum	1

Table 7: Stomach contents (% of total dry weight) of Cynoscion arenarius

Food Item	Size (mm) 10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	Avg. 10-89
Detritus			<.1						<.1
Polychaetes			<.1						<.1
Calanoid copepods	18.7	14.7	6.1	2.9	0.8	0.2			2.9
Parasitic copepods			0.1		<.1		0.3		<.1
Isopods			<.1	<.1	0.2				<.1
Amphipods		1.7	1.4	1.5	1.2	0.5	0.3		1.1
Mysids	72.9	65.3	46.0	33.1	14.2	10.7	7.8		25.7
Shrimp - zoeal		0.2	0.8	1.7	0.3	0.2			0.6
- postlarval	8.4	0.9	3.2	0.6	0.3	0.2			0.8
- juv./adult			3.4	3.1	7.9	2.7			4.0
Crabs - zoeal		0.9	3.6	4.2	1.4	0.6			2.0
- megalopal			0.1	<.1	0.2	<.1	0.6		0.1
- jub./adult			<.1	0.3	0.2	<.1			0.2
Decapod larvae		<.1							<.1
Insects - larval		<.1	0.3	0.2	<.1				0.1
- adult				0.1	<.1				<.1
Fish - larval		0.2	<.1	<.1					<.3
- juvenile		16.2	34.2	52.0	73.3	84.9	91.0	100.0	62.1

Table 8: Identified food items in stomachs of Cynoscion arenarius (122 sets of samples)

Isopods (4/122 occurrences)	# of occurrences
Cyathura polita	1
Edotea montosa	1
Erichsonella filiformis	1
Parasitic isopod	1
Amphipods (42/122 occ.)	
Gammarus sp. 1	27
Grandidierella bonnieroides	9
Corophium louisianum	7
Cerapus sp.	6
Gammarus sp. 2	2
Ampelisca vadorum	1
Haustoriid sp.	1
Mysids (118/122 occ.)	
Mysidopsis bahia	39
Mysidopsis bigelowi	16
Mysidopsis almyra	16
Taphromysis bowmani	7

Shrimp	# of occurrences
Zoeal (14/122 occ.)	
Callianassa sp.	5
Palaemonetes sp.	1
Postlarval (19/122 occ.)	
Palaemonetes sp.	1
Juv./adult (16/122 occ.)	
Penaeus spp.	7
Callianassa sp.	3
Aetes americanus	3
Palaemonetes sp.	2
Ogyrides limicola	1
Crabs	
Zoeal (13/122 occ.)	
Rhithropanopeus harrisii	5
Juv./adult (5/122)	
Callinectes sapidus	5

Fish (79/122 occurrences)	# of occurrences
Anchoa mitchilli	25
Cynoscion arenarius	5
Micropogon undulatus	1
Microgobius sp.	1

FIGURE 1. RESULTS OF CLUSTER ANALYSES OF FOUR SPECIES OF FISH FROM APALACHICOLA BAY, BY SIZE CLASS.

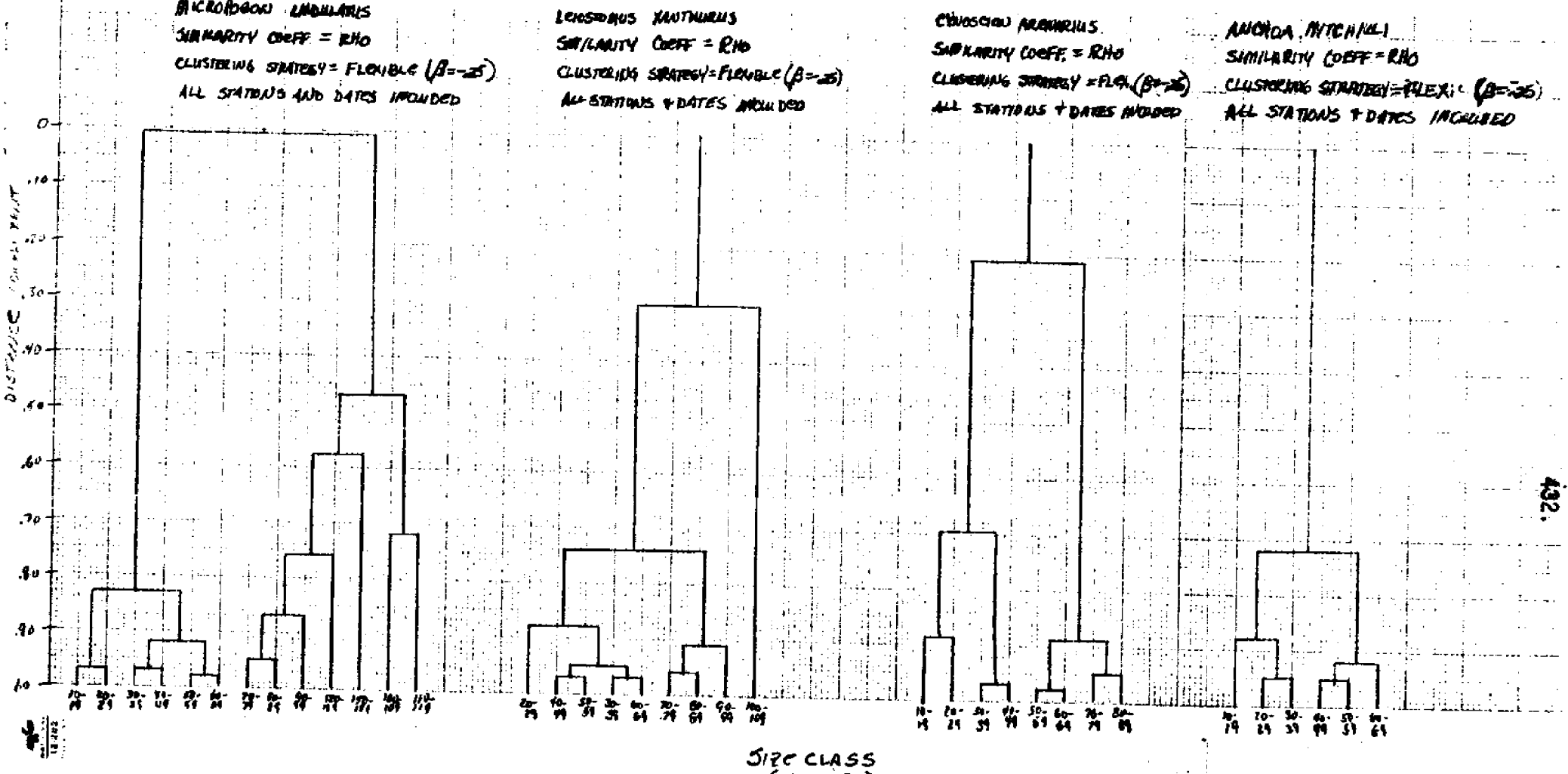
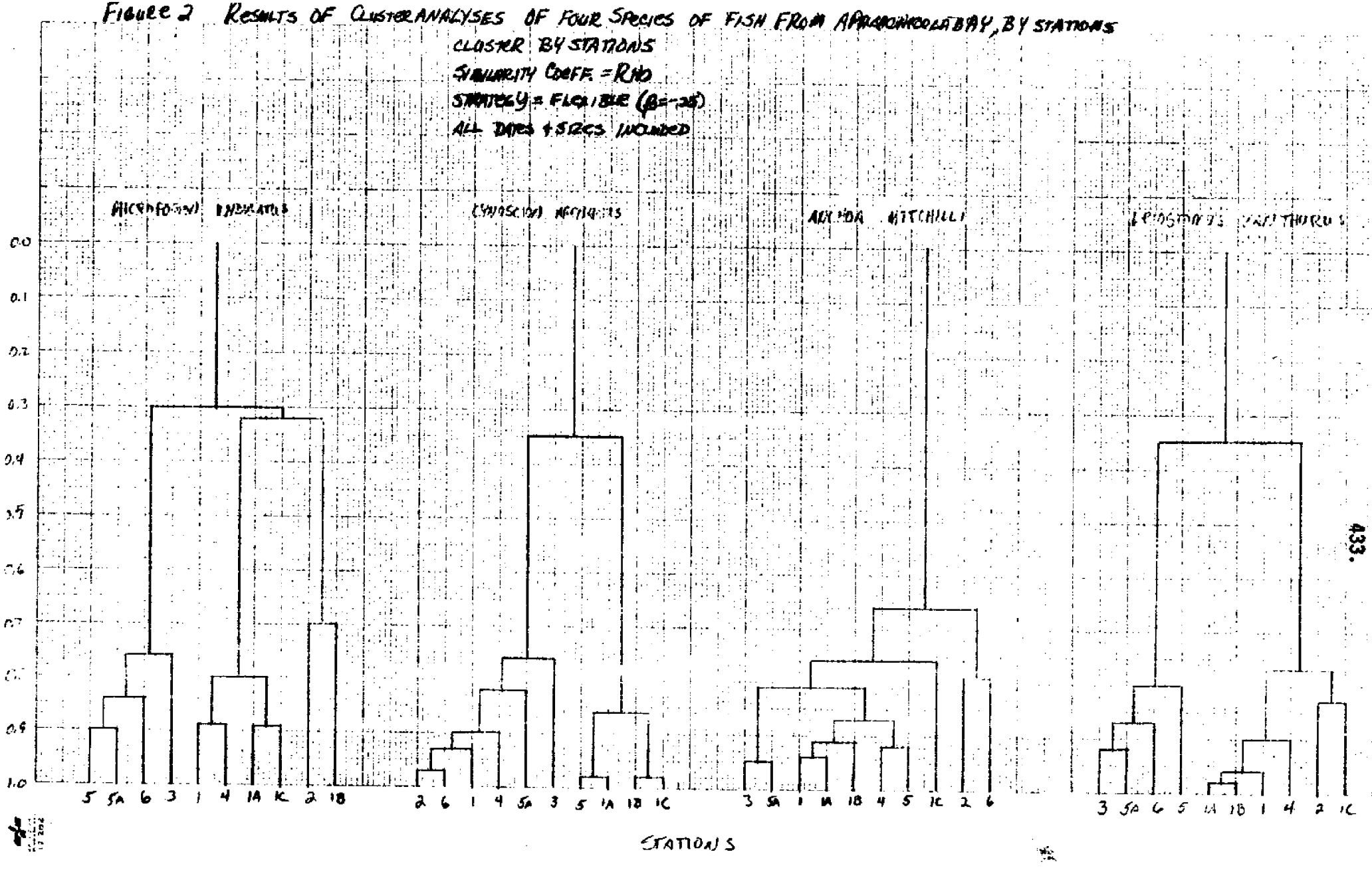


FIGURE 2 RESULTS OF CLUSTER ANALYSES OF FOUR SPECIES OF FISH FROM APALACHICOLA BAY, BY STATIONS

CLUSTER BY STATIONS
SIMILARITY COEFF. = RHO
STRATEGY = FLEXIBLE (β=-.25)
ALL DATES + SIZES INCLUDED



XIV. PLANNING AND MANAGEMENT: APPLICATION OF SCIENTIFIC DATA

It is appropriate that objective scientific information should form the basis of planning and management criteria in environmental matters. The data generated in this Sea Grant Project have been applied in various ways to promote constructive interactions among local fishermen, upland developmental interests, elected officials, state and federal agencies, and professional planners. This effort has been documented in a series of papers (Livingston, 1975, 1976, 1977; Livingston et al., 1974; Livingston and Joyce, 1977).

1. In response to the Franklin County Board of Commissioners and commercial fishing interests in the area, a project was initiated to determine the impact on the bay of upland clearcutting and draining practices in Tate's Hell Swamp. The combined field and laboratory program, supported by the Board of Franklin County Commissioners, the Buckeye Cellulose Corporation, and the Florida Department of Environmental Regulation, includes day/night field collections of infauna and epifauna, physico-chemical monitoring, and field experiments in areas of interest. This has developed into a full Sea Grant project which is a joint effort by Florida Sea Grant investigators, federal, state, and county agencies, and private pulp mill interests. The primary aim is to determine the feasibility of management practices for upland runoff due to clearcutting practices.

2. During the past year, project personnel have continued to work with the Florida Department of Natural Resources with regard to the purchase of sensitive wetlands areas of the lower Apalachicola River as

part of the state's Environmentally Endangered Lands Plan. A total of more than 28,000 acres at a cost exceeding 8 million dollars has now been purchased. This purchase was defined and qualified by scientific data generated by the Apalachicola Sea Grant project. Further involvement of this project in the proposed management of such lands is anticipated. In addition, baseline data generated by this Sea Grant Project have been used in decisions by state officials to buy portions of St. George Island and Little St. George Island, an investment exceeding $10 million. Thus, sensitive portions of the Apalachicola Drainage System have been identified and appropriate steps toward preservation of such areas have been taken.

3. Baseline data from the Sea Grant project have also been used to generate interest in the development of a basin-wide management plan through the coordinated action of a number of state and federal agencies, county commissions, and private interests in the Apalachicola Valley. The principal investigator, together with the Florida Department of Natural Resources, has generated a published compendium of knowledge (Livingston and Joyce, 1977) concerning scientific, economic, legal, and managerial considerations in the Apalachicola Drainage System. This includes papers written by 28 experts in various fields and is now serving as a multi-disciplinary base of information to be used in future planning and management decisions. This has provided the impetus for various related activities, and is viewed as an important step in promoting an objective translation of scientific data for use in planned development.

4. The principal investigator has served as an advisor to the Franklin County Board of Commissioners with regard to zoning regulations, local planning programs for St. George Island, water hyacinth control in

the lower Apalachicola Drainage, and the development of efficient decision-making processes at the local level. Through a series of lectures and briefings, this project has contributed scientific input to the Florida Division of State Planning with respect to the development and coordination of a resource management and planning program for the entire Apalachicola Drainage System. Close contacts have been maintained with various local groups and elected county officials. High school and university students have been taken out on our boats and trained as marine biologists in a continuing effort to operate on a grass roots level. The principal investigator has periodically written a column in the local newspaper, translating scientific facts about the bay into everyday language. Consequently, decisions have been made at the local level which have opened the way for the development of constructive planning programs throughout the area.

5. There has been close coordination of this Sea Grant project with researchers of the Fish and Wildlife Service in their ongoing and proposed studies of the Apalachicola wetlands. Data from the Sea Grant project has been used to initiate preliminary efforts of the Environmental Protection Agency and the National Aeronautics and Space Administration to develop remote sensing as a management tool in this area. Information has also been used by the Florida Department of Environmental Regulation and the U.S. Army Corps of Engineers in their activities in the Apalachicola Drainage System. Data from the Apalachicola Sea Grant project provided the impetus for the possible designation of the Apalachicola Bay System as a National Estuarine Sanctuary in the Gulf of Mexico under the Coastal Zone Management Act of 1972. This represents, if successful, the direct application of Sea Grant research data to the implementation of coastal zone management on a national scale. Pursuant to this activity,

The Conservation Foundation of Washington, D.C. has initiated a series of meetings among local, state, and federal agencies to develop an organized setting for coordinated research and management processes in the Apalachicola Valley. In short, the Apalachicola Bay Sea Grant research is now serving as a nucleus for what could eventually become a national model for the integration of research and planning techniques in important natural drainage systems.

Literature Cited

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United States Department of the Interior
FISH AND WILDLIFE SERVICE
17 EXECUTIVE PARK DRIVE, N. E.
ATLANTA, GEORGIA 30329

September 10, 1975

Dr. Robert J. Livingston
Dept. of Biological Sciences
Florida State Universtiy
Tallahassee, Florida 32306

Dear Dr. Livingston:

I sincerely enjoyed our telephone conversation of this date, and appreciate your enthusiastic response to possibilities for cooperative efforts in fishery work which we might initiate in the Apalachicola River System in the future.

As a result of phasing out our study of striped bass stocking in the Choctawhatchee River System, Florida, we have potential to divert limited effort to fishery studies in the Apalachicola. Our immediate interest is in formulating a project proposal which addresses the broadest possible range of interests and improves our efficiency in generating that data which is most meaningful to the resources. As mentioned, the September 18, 1975 Meeting with representatives from several State agencies is toward this end. We regret very much that other commitments preclude your meeting with us, however, you may rest assured that we will be visiting you in the near future for your input prior to finalizing our proposal.

It is our firm intent to coordinate and interact with you and your work under the Sea Grant Program to the fullest possible degree in any study effort which we contemplate in the Apalachicola River. Your concurrence in such interaction and cooperation toward avoiding duplication and maximizing the returns for the efforts expended is solicited.

I wish to thank you for the information which you provided in our brief discussion. I will look forward to meeting with you personally at some future date to discuss the River and your work in the Bay in more detail.

Sincerely,

Alex B. Montgomery

Alex B. Montgomery
Regional Supervisor
Division of Fishery Services

Save Energy and You Serve America!

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
RESEARCH AND DEVELOPMENT

Dr. Robert J. Livingston
Florida State University
Department of Biological Science
Tallahassee, Florida 32306

Dear Dr. Livingston:

The Office of Monitoring and Technical Support (Environmental Protection Agency (EPA) Headquarters), the EPA Region IV, and the Environmental Monitoring and Support Laboratory, Las Vegas (EMSL-LV) wish to thank you for your highly valuable assistance in the collection of ground truth data during the recent remote sensing (satellite and aircraft) effort with National Aeronautics and Space Administration over the Apalachicola Bay area.

Such joint efforts, that combine the actual needs of the user community with the prospective agencies, produce the encouraging environmental goals that we so gravely need. The work that you helped us complete will hopefully serve as a milestone in any future efforts to monitor environmental stress in our coastal zone around the Nation. Once the final report is completed, two copies will be sent to you.

We are looking forward to receiving your helicopter photographs, as well as the vital water quality ground truth, background data reports and oyster bed maps. I hope to visit with you personally during my next visit to the area. Thank you again for your cooperation.

Sincerely yours,

John D. Koutsandreas

John Koutsandreas, Senior Advisor
Advanced Monitoring Program
Monitoring Technology Division
Office of Monitoring and Technical Support (RD-680

cc: John M. Hill (RD680)
Dr. Harvey Melfi (EMSLLV)

DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2288
MOBILE, ALABAMA 36628

REPLY TO
ATTENTION OF: SAMPD-N

24 May 1976

Dr. Robert J. Livingston
Florida State University
Tallahassee, Florida 32306

Dear Dr. Livingston:

I have recently received a copy of comments attributed to you in a 26 April 1976 edition of the Herald Tribune regarding development on the Apalachicola River.

I note from your statements that you do not totally oppose use of the Apalachicola River for navigation purposes, but support a multiple use plan which would permit such use in conjunction with preserving fundamental environmental values. In this respect your views are not basically different from the objectives of the Corps of Engineers' planning efforts.

As you are aware, the Corps of Engineers has been directed by Congress to investigate alternatives that will better maintain the authorized 9-foot navigation channel on the Apalachicola River. While our study directive is to investigate improvements for navigation, the Corps of Engineers' planning criteria use a framework established in the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources," which requires the systematic preparation and evaluation of alternative solutions that will maximize contributions to the two national planning objectives of "Environmental Quality" (EQ) and "National Economic Development" (NED). The process also requires that the impacts of proposed actions be evaluated and measured to the fullest extent possible. Within this planning concept we are not only unconstrained, but charged to develop multiple use plans for water resource developments that achieve the best overall balance in contributions to both EQ and NED.

Our study on the Apalachicola River has been inactive for the past year due to lack of funds; however, it is scheduled to be actively resumed in the forthcoming fiscal year. In an endeavor to achieve a better understanding of the planning objectives, we are proposing a series of

SAMPD-N 24 May 1976
Dr. Robert J. Livingston

informal workshop meetings with agencies and affected interests knowledgeable of both economic and environmental needs of the area. Through this effort we would hope to develop an overall plan to meet navigation and other needs while also utilizing the economic and environmental values of the river. In this endeavor we would appreciate any suggestions you may have regarding our approach at this time and solicit your participation in our forthcoming meetings. We will advise you further of our proposed meetings when we have firmed up a schedule.

If you desire further information regarding our study plans, please contact Mr. Walter Burdin of my staff at telephone (205) 690-2772.

Sincerely yours,

DRAKE WILSON
Brigadier General, USA
District Engineer

State of Florida

DEPARTMENT OF NATURAL RESOURCES

HARMON W. SHIELDS
Executive Director

CROWN BUILDING / 202 BLOUNT STREET / TALLAHASSEE 32304

REUBIN O'D. ASKEW
Governor
BRUCE A. SMATHERS
Secretary of State
ROBERT L. SHEVIN
Attorney General
GERALD A. LEWIS
Comptroller
PHILIP F. ASHLER
Treasurer
DOYLE CONNER
Commissioner of Agriculture
RALPH D. TURLINGTON
Commissioner of Education

December 28, 1976

Dr. Robert J. Livingston
Associate Professor
Department of Biological Sciences
Conradi Building
Florida State University
Tallahassee, Florida 32306

Dear Dr. Livingston:

As you know, the State of Florida recently authorized the acquisition of 12,869 additional acres within the Lower Apalachicola River endangered lands project. This brings the total acquired so far to more than 28,000 acres, or better than 90% of the proposed acquisition.

The scientific knowledge generated through your on-going studies, and your generous sharing of that information with us, has enabled the State to define an optimum purchase boundary which will reap public dividends far in excess of the 8 million dollars we have so far invested in the Lower Apalachicola land purchase. We would hope that your work will continue so that we might even further sharpen our focus on the most critical environmental needs of this estuarine complex.

Now that our initial land purchase in the Lower Apalachicola is nearly completed, we are working towards finalizing a management plan for the area. Enclosed you will find a draft management concept outlining the essential elements of that management plan. In view of your long-standing interest and involvement with this state acquisition, we would invite your comments and criticisms on the draft.

Once again, may I express our deepest appreciation for your invaluable assistance to the State of Florida over the more than

three years in which the Lower Apalachicola purchase has been developed. We look forward to your further advice on the matter of its future management.

Sincerely,

James W. Pearce

James W. Pearce, Chief
Bureau of Plans, Programs, and Services
Division of Recreation and Parks

JWP/am
Enclosure

Law Offices
J. Michael Carter, Esquire

(CRAWFORDVILLE OFFICE)
COURTHOUSE SQUARE
P. O. BOX 566
CRAWFORDVILLE, FLORIDA 32327
(904) 926-3647

June 11, 1976

(TALLAHASSEE OFFICE)
836 EAST LAFAYETTE STREET
TALLAHASSEE, FLORIDA 32301
(904) 878-2183

Dr. Robert J. Livingston
Biology Department
Florida State University
Conradi Building
Tallahassee, Florida 32313

Subject: Optimist Program

Dear Dr. Livingston:

The response from your presentation of the Blue Crab habits and ecological effects if the Apalachicola River is altered by Alabama and Georgia interest was tremendous. I feel sure Ray Wheeler, Program Chairman for the Wakulla Chamber of Commerce, will contact you for a presentation before that association, since the survival of the blue crab directly affects 27% of the work force in the county.

I look forward to receiving the advance copy of your group's study, the past and future newspaper articles, and further communication in this respect.

Enclosed is a copy of the Blue Crab Festival program similar to that which we will use this year and any article explaining your research will be appreciated and well distributed.

Please stop by to see me if you are in Crawfordville and again, thank you in behalf of the Optimist Club.

Sincerely,

J. Michael Carter
Optimist Club Program Committeeman

JMC/hmt

cc: Mr. Bob Morgan, Optimist President
Mr. John Burke, Program Chairman
Mr. Walter Dodson, Wakulla Chamber of Commerce President
Wakulla News
Mr. Ray Wheeler, Wakulla Chamber of Commerce
Program Chairman

CHATTAHOOCHEE ROTARY CLUB

Charter No. 4548

CHATTAHOOCHEE, FLORIDA
U. S. A.

December 13, 1976

Dr. R. J. Livingston
Bradfordville Road
Tallahassee, Florida

Dear Dr. Livingston:

Our local Rotary Club is very interested in the proposed dam site that would be located at Blountstown, Florida. We have heard many points that lean towards having the dam. I have read in the paper many times of your concern over the propects of having another dam on the Apalachicola River.

I would like to hear your comments and many of our members would also. We plan on having two programs on this subject and would appreciate your being part of this series. Would you please see if you could meet with our Club on January 17 or January 24? These dates are Monday. We have a luncheon meeting at 1:00 PM at the Gate Resturant here in Chattahoochee. We would like you to present us with a 30 minute program if you could.

Would you inform me if you could meet with us on Monday, January 17?

Thanking you in advance,

Norman S. James, Jr., President
Chattahoochee Rotary Club
Chattahoochee, Florida

663-7561

Home

GATE RESTAURANT - 663-4900

WORK 663-7565

FLORIDA GAME AND FRESH WATER FISH COMMISSION

P.O. Box 128
DeFuniak Springs, Florida
32433

December 20, 1976

Dr. Robert J. Livingston
Florida State University
Department of Biological Science
Tallahassee, Florida 32306

Dear Dr. Livingston:

I received your letter of December 17, 1976, concerning the hyacinth problem in Apalachicola Bay.

We are of the opinion that our spring spraying of the creeks is not a loss of breeding habitat. I have tried to make clear that hyacinths are detrimental in these areas and we want to maintain them, both to insure quality habitat and quality recreation potential.

I have come to regard the marsh area as too complex a system for us to infringe upon and believe if we concentrate our efforts on the area above the marsh we can accomplish the desired objectives. I believe I showed you enough information on the herbicide 2,4-D to adequately demonstrate that our use on hyacinths upstream would have no direct effect on invertebrates in the marsh. This is why I believe we could have a program in these upstream creeks in September and October. I would like your opinion on this point.

The County Commission felt obligated to speak for the fishermen when they requested we not spray the creeks in the spring. I am asking they reconsider whether the fishermen wish us to cease our program. We cannot spray in February before the fishing season as they suggested.

As for a specific program, we would like to spray as needed any of the creeks along the Jackson River from Lake Wimico to the Apalachicola River. Other upland creeks which would need very little "touch up" maintenance spraying are Upper Chipley Creek, Big St. Mark's (above tressel), East River and East River Cutoff (above tressel). As I stated in last year's proposal we can accomplish our objectives and never spray on the marsh side of the railroad tressel.

We feel that keeping the hyacinths under control at these times will keep down the rafts of hyacinths in the marsh and bay in the summer.

We would like to spray these creeks described above in February, March and April and in September and October. Our spray schedule would probably be only two days per week and we could work this out more definitely if you felt it necessary. We do usually try to not spray when the fish are bedding and would certainly feel proud if we could satisfy ourselves that we put the hyacinths on maintenance in some creeks before April, but as you are well aware, it takes time to work on this problem.

Last year you seemed satisfied that our operations and 2,4-D were not directly harmful to the commercial fishery and that restricting our efforts to help sport fishermen, if unwarranted, was not necessary. However, the Franklin County Commission was never convinced of this. If we are going to spray at all we will want to intelligently strive to be effective, as outlined by creeks and seasons. If we are going to spray I need to coordinate with you and the County Commission and plan now, otherwise our spray operation will be less effective. If we are not going to spray at all, it would be best to determine that at this time also.

I look forward to your reply and to working together on this matter.

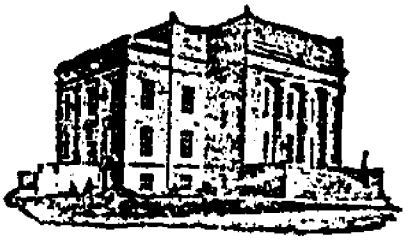
Sincerely,

Jerry Krummrich/bsp

Jerry T. Krummrich
Regional Aquatic Botanist

JTK/bsp

cc: Franklin County Commission
Clayton Phillippy



ROBERT L. HOWELL
Clerk Circuit Court

FRANKLIN COUNTY

APALACHICOLA FLORIDA 32320

December 22, 1976

Florida Game and Fresh Water
Fish Commission
P. O. Box 128
DeFuniak Springs, Florida 32433

Attention: Jerry T. Krummrich
Regional Aquatic Botanist

Dear Mr. Krummrich:

I presented your letter of 13 December 1976 to the Board of County Commissioners pertaining to the spraying of hyacinths in the creeks along Jackson River. I also presented your copy of a letter to Dr. Robert J. Livingston dated 20 December 1976 pertaining to the same subject.

It is the desire of the Board of County Commissioners that you spray and control the hyacinths in the area as stated in your letter of 13 December but would you work out the schedule with Dr. Livingston. Any schedule he works out will be satisfactory to the Board of County Commissioners.

Sincerely,

Robert L. Howell/mmj

Robert L. Howell
Clerk Circuit Court
Franklin County, Florida

RLH:mmj

cc: Dr. Robert J. Livingston

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway - IBM Building

TALLAHASSEE

32304

(904) 488-4925

Reubin O'D. Askew
GOVERNOR

R.G. Whittle, Jr.
STATE PLANNING DIRECTOR

Lt. Gov. J. H. "Jim" Williams
SECRETARY OF ADMINISTRATION

January 12, 1977

Dr. Robert J. Livingston
Department of Biological Sciences
Florida State University
Tallahassee, Florida 32306

Dear Skip:

I want to confirm the briefing we discussed during our telephone conversation of January 11. I would like you to brief the Director, Assistant Director and Bureau Chiefs of the Division of State Planning on the status of your research in the Apalachicola River basin. We will meet on Friday, January 21, at 10:00 A.M. in our third floor conference room.

I also want to tell you how much I enjoyed your presentation to the Conservation Foundation in Washington, D.C. last week. Your research and your hard earned contacts in the basin should prove invaluable to our Apalachicola River and Bay Resource Management and Planning Program. Hopefully, you will continue to work with us to protect these valuable resources and to assist the people of the basin to meet their own socio-economic needs.

Sincerely,

Eastern W. Tin
Chief, Bureau of Land
and Water Management

EWT/SF/kb

STATE OF FLORIDA

Department of Administration

Division of State Planning

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Reubin O'D. Askew
GOVERNOR

R.G. Whittle, Jr.
STATE PLANNING DIRECTOR

Lt. Gov. J. H. "Jim" Williams
SECRETARY OF ADMINISTRATION

February 1, 1977

Dr. Robert J. Livingston
Department of Biological Sciences
Florida State University
Tallahassee, Florida 32306

Dear Skip:

I want to confirm your rescheduled briefing to the Division of State Planning on the Apalachicola River basin. The new meeting is now set for Wednesday, February 2, 1977, at 9 a.m. in our third floor conference room.

Sincerely,

Eastern W. Tin,
Chief, Bureau of Land
and Water Management

EWT/SF/kb

RANDY WHITTLE
DIRECTOR

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway · IBM Building

TALLAHASSEE

32304

(904) 488-1115

Reubin O'D. Askew
GOVERNOR

R. G. Whittle, Jr.
STATE PLANNING DIRECTOR

Lt. Gov. J. H. "Jim" Williams
SECRETARY OF ADMINISTRATION

January 17, 1977

Dr. Gib DeBusk
Chairman
Department of Biological Sciences
212 Conradi Building
The Florida State University
Tallahassee, Florida 32306

Dear Dr. DeBusk:

I have invited Dr. Robert J. Livingston of your department to meet with representatives of each of the bureaus of the Division of State Planning in a division-wide meeting on Friday, January 21 at 10:00 a.m. The Division of State Planning is going to be coordinating a Resource Management and Planning Program for the Apalachicola River and Bay and we feel that Dr. Livingston's attendance at this meeting is of crucial importance.

Sincerely,

R. G. Whittle, Jr.
State Planning Director

RGWjr/EL/km

bc: Dr. Robert J. Livingston

State of Florida

DEPARTMENT OF NATURAL RESOURCES

HARMON W. SHIELDS
Executive Director

CROWN BUILDING / 202 BLOUNT STREET / TALLAHASSEE 32304

REUBIN O'D. ASKEW
Governor
BRUCE A. SMATHERS
Secretary of State
ROBERT L. SHEVIN
Attorney General
GERALD A. LEWIS
Comptroller
PHILIP F. ASHLER
Treasurer
DOYLE CONNER
Commissioner of Agriculture
RALPH D. TURLINGTON
Commissioner of Education

September 11, 1975

Dr. Robert J. Livingston
Biology Department
Conradi Building
Florida State University
Tallahassee, Florida 32306

Dear Skip:

As one of my first duties as newly appointed Research Coordinator for the Bureau of Coastal Zone Planning, I am happy to acknowledge receipt of a copy of the compilation of the results of your field and laboratory studies (Sea Grant Project #R/EM-1). The delay in response reflects the lack of an encumbent in my position; Bruce judged it best that the new Coordinator restore our close relations. It will certainly be my pleasure to resume and maintain a close working relationship, for your efforts have been the best representation of the letter and spirit of the Sea Grant Program.

Hope to see you soon.

Sincerely,

Tom Savage
Research Coordinator
Bureau of Coastal Zone
Planning

TS/ses

cc: Bruce Johnson

LAWTON CHILES
FLORIDA

COMMITTEES:
APPROPRIATIONS
BUDGET
GOVERNMENT OPERATIONS
SPECIAL COMMITTEE ON AGING
JOINT COMMITTEE ON CONGRESSIONAL OPERATIONS
DEMOCRATIC STEERING COMMITTEE

United States Senate

WASHINGTON, D.C. 20510

October 5, 1976

Dr. Robert J. Livingston
Department of Biological Science
Florida State University
Tallahassee, Florida 32306

Dear Dr. Livingston:

Just a note to let you know I appreciate your sending me a copy of the transcript of the Conference on the Apalachicola Drainage System from earlier this year. I hope to have the opportunity to read the study in its entirety and will certainly give this research thorough consideration in my future dealings with planners from the Army Corps of Engineers.

Once again, your thoughtfulness is most appreciated.

Sincerely yours,

LAWTON CHILES

LC/dr/SF4e-3/H

State of Florida

DEPARTMENT OF NATURAL RESOURCES

HARMON W. SHIELDS
Executive Director

CROWN BUILDING / 202 BLOUNT STREET / TALLAHASSEE 32304

REUBEN O'D. ASKEW
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Attorney General
GERALD A. LEWIS
Comptroller
PHILIP F. ASHLER
Treasurer
DOYLE CONNER
Commissioner of Agriculture
RALPH D. TURLINGTON
Commissioner of Education

December 15, 1976

Dr. Robert J. Livingston
Associate Professor
Department of Biological Science
Florida State University
Tallahassee, Florida 32306

Dear Skip:

Thanks very much for your letter of November 30, 1976 offering your services for aiding in designating Apalachicola Bay and environs as an estuarine sanctuary. We very much appreciate your offer and we never take significant action involving this area without consulting with you.

Pursuant thereto, please find enclosed a 1st draft of a preliminary preapplication to OCZM for such a sanctuary. Your comments or advice are solicited. We are expecting Bob Kifer from OCZM down here shortly and if convenient, would like to have you with us when we meet on this subject. We will keep you advised.

Sincerely,

Bruce Johnson, Chief
Bureau of Coastal Zone Planning

BJ/rh
enclosure
cc: Harry McGinnis

State of Florida

DEPARTMENT OF NATURAL RESOURCES

HARMON W. SHIELDS
Executive Director

CROWN BUILDING / 202 BLOUNT STREET / TALLAHASSEE 32304

REUBIN O'D. ASKEW
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GERALD A. LEWIS
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PHILIP F. ASHLER
Treasurer
DOYLE CONNER
Commissioner of Agriculture
RALPH D. TURLINGTON
Commissioner of Education

January 28, 1977

Dr. Robert J. Livingston
Department of Biological Science
Florida State University
Room 213, Conradi Building
Tallahassee, Florida 32601

Dear Skip:

On February 3 and 4, Dr. Robert Kifer and Mr. Richard Gardner, of NOAA will be in Tallahassee to discuss the proposal for the designation of the Apalachicola River-Bay System as a Louisianian National Estuarine Sanctuary.

We wish to thank you for your offer to serve as tour guide and especially for providing a boat for a field trip of the River and Bay system on Thursday afternoon, February 3. Also, we would like to request that you serve as our tour guide for an aerial field trip of the area on Friday morning, February 4, from 8 a.m. until 12 noon if this is convenient to your schedule.

Many thanks again for your help in this matter.

With best regards,

Bruce

Bruce Johnson, Chief
Bureau of Coastal Zone Planning

BJ/hmg
Attachment
cc: Charles M. Sanders
Charles Futch
David R. Worley
Harry McGinnis

1717 Massachusetts Avenue, N.W., Washington, D.C. 20036
Telephone (202)797-4300 Cable CONSERVIT

December 20, 1976

Mr. Robert Knecht, Administrator
Office of Coastal Zone Management
National Oceanic and Atmospheric
Administration
3300 Whitehaven Street, N.W.
Washington, D.C. 20235

Dear Bob:

On behalf of the Conservation Foundation, I am inviting you to a one-day forum on the national stake in the resources of the Apalachicola River Basin, in the panhandle area of North Florida. We will be meeting January 7, beginning at 9:30 a.m. at the Foundation. Lunch and a short cocktail period at the end of the day will break up the working agenda. I hope you can join a small group of local, state and Federal officials interested in research and management priorities for this valuable ecosystem.

Both state and federal governments have important land holdings in this area. The ecosystem is intact and contributes to the livelihood of local oystermen and growing agricultural operations. Industrialization and recreational development have yet to exert strong pressure in the area, though St. George's Island, a barrier island at the mouth of the estuary has been the subject of disputes over second home development.

The recent decision by the Florida Governor and Cabinet opposing the cross-Florida barge canal project suggests a reexamination of the longer term agenda for the Apalachicola The state is also making efforts to implement coastal management objectives with a new state task force. The ecosystem's complex relationships between fresh and salt waters afford an opportunity to address both values. The Apalachicola will be an early priority for significant management decisions.

The opportunity for setting a coordinated research and management agenda exists now. This meeting between state, federal and local interests can take place before confrontation has made dialogue and some measure of consensus

impossible. I look forward to discussing possible goals and directions informally at this early stage in the area's growth process.

Please let us know whether or not you plan to join us on the seventh by calling Laura O'Sullivan at (202) 797-4362.

With best wishes for the holiday season,

Sincerely,

William K. Reilly
President

Encl.

The Conservation Foundation
1717 Massachusetts Avenue, N.W., Washington, D.C. 2003
Telephone (202)797-4300 Cable CONSERVIT

APALACHICOLA MEETING

January 7, 1976

CF Conference Room

Preliminary Agenda

9:30 AM — State and Local Needs and Priorities

- Overview and Slide Presentation on Ecosystem -- Robert J. Livingston
- Franklin County
- Apalachicola River Basin
  - -- Regional Interest
  - -- State Perspective

12:00 Noon — Lunch

1:30 PM — The National Stake in the Apalachicola

- Open questions on the research needs and management objectives for the Apalachicola system. Round table discussion with Federal representatives.

4:15 PM Cocktails

John Clark
Convenor

Lt. Col. John Hill
Office of the Chief of Engineers
Department of the Army
Forrestal Building Room 4G065
1000 Independence Avenue
Washington, D.C. 20314

693-7093

Dr. Allan Hirsch, Chief
Office of Biological Services
Fish and Wildlife Service
Department of the Interior
Washington, D.C. 20240

343-8095

OK Chapman

Vance Hughes
Environmental Protection Agency
401 M Street, S.W.
Room 737, East Tower WH551
Washington, D.C. 20460

426-2704

Robert Knecht, Administrator
Office of Coastal Zone Management
National Oceanic and Atmospheric
Administration
3300 Whitehaven Street, N.W.
Washington, D.C. 20235

634-4232

Richard Krimm
Assistant Administrator for Flood Insurance
Federal Insurance Administration
451 Seventh Street, S.W.
Room 5266
Washington, D.C. 20410

OK — Tim Haywalt
755-5581

Jay Landers
Secretary, Department of Environmental
Regulation
2562 Executive Center Circle East
Tallahassee, Florida 32301

✓Victoria Tschinkel
Asst. to Sec.
904 488-4807

B/Gen. Kenneth E. MacIntyre
Division Engineer
Corps of Engineers
510 Title Building
30 Pryor Street, S.W.
Atlanta, Georgia 30303

Arrive late +5

404-221-6711

INVITEES - APALACHICOLA MEETING

F. Leroy Bond
Associate Deputy Chief
U.S. Forest Service
Department of Agriculture
South Building
12th and Independence Avenue, S.W.
Washington, D.C. 20250

Mr. William Butcher
Director
Office of Water Research and Technology
Departmentof the Interior
Washington, D.C. 20240
343-5975

Robert Eastman
Chief, Division of Resource Area Studies
Bureau of Outdoor Recreation
Department of the Interior
1950 Constitution Avenue, N.W.
Washington, D.C. 20240
343-5772

Richard Gardner
Deputy Assistant Administrator
Office of Coastal Zone Management
National Oceanic and Atmospheric
Administration
3300 Whitehaven Street, N.W.
Washington, D.C. 20235
634-4241

Lynn A. Greenwalt
Directo
U.S. Fish and Wildlife Service
Department of the Interior
Washington, D.C. 20240
343-4717

Rebecca Hammer,
Director, Office of Federal Activities
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

William McCartney
Executive Director
Northwest Florida Water Management District
325 John Knox Road
Tallahassee, Florida 32303

Dr. Ralph J. McCracken
Associate Administrator
Agricultural Research Service
U.S. Department of Agriculture
Washington, D.C. 20250

447-3658

Peter Ramatowski
Assistant Director
Planning and Assessmet
Water Resources Council
2120 L Street, N.W.
Washington, D.C. 20037

254-6442

Robert Shevin, Esquire
Attorney General
The Capitol
Tallahassee, Florida 32304

b.c. OK Kendrick Tucker Asst.

904-488-4906

Slevin → 488-5861

Harmon Shields
Department of Natural Resources
Crown Building
202 Blount Street
Tallahassee, Florida 32304

904-488-1555

Eastern Tin
Chief, Bureau of Land and Water Management
Division of State Planning
Department of Administration
660 Apalachee Parkway
Tallahassee, Florida 32304

904-488-4925

Cecil Varnes
Chairman, County Commission
Franklin County
Apalachicola, Florida 32320

904-653-9558
Ticket

Kenneth Woodburn
Environmental Advisor
Office of the Governor
The Capitol
Tallahassee, Florida 32304

904-488-2631

Attendance List

Forum on Apalachicola River

Name	Organization	Phone
Ann H. Berger	OCZM	634-4235
Frank T. Carlson	OWRT-DOI	343-2101
Lillian F. Dean	The Research Group	(404)577-1341
Thomas S. Talley	USFWS-DOI	(904)769-0552
Lawrence R. Green	COE - Mobile	(205)690-2777
Hugh A . McClellan	COE - Mobile	(205)690-2724
William Simms	COE-Wash., D.C.	0X3-1590
Rice Odell	CF	797-4351
Jeff Zinn	CF	797-4342
Cdr. Phillip C. Johnson	OCZM- Marine Sanctuaries	(202)634-4243
Tim Maywalt	HUD-FIA	(202)426-1891
Michelle Lodge	Apalachicola Times	(904)653-8868
Robert L. Eastman	Bur. of Outdoor Rec.	(202)343-4793
R.M. Housley	Forest Service	(202)447-7465
Ken Tucker	FIA Attorney General's Office	(904)488-7033
Dan Dunford	Fla. Game &Freshwater Fish Comm.	(904)488-6661
Vicki Tschinkel	Fla. Department Env. Regulation	(904)488-4807
Margarita Castellon.	Treasurer of Fla.	(904)488-5796
Charles R. Futch	Fla. Dept. of Natural Resources	(904)487-1715
Eastern W. Tin	Fla., Bur. of Land & Water Mgt.	(904)488-4925
Charles L. Blalock	COE	(605)690-2511
John R. Hill, Jr.	Office, Chief of Eng.	(202)693-7093
Louis J. Atkins	NW Fla. Water Mgt. Distirct	(904)487-1770
Allan Hersch	FWS	343-8095
Joe Yovino	FWS, Atlanta, Ga.	(404)881-5781
Richard Gardner	OCZM/NOAA	634-4241
John Banta	CF	797-4337
John Clark	CF	797-4360
Robert J. Livingston	Fla. State Univ.	(904)644-1466
T.T. (Trux) Moebs	EPA Region 4	(404)881-4727
Vance Hughes	EPA, Wash., D.C.	(202)426-2704
Robert L. Howell	Franklin County, Fla.	(904)653-8861
Bill Millhouser	OCZM-NOAA	634-4235

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Coastal Zone Management Advisory Committee
3300 Whitehaven Street, N.W.
Washington, D.C. 20235
202/634-6791

February 1, 1977

Dr. Robert Livingston
Associate Professor
Biological Sciences
Conradi Building, Room 213
Florida State University
Tallahassee, Florida 32306

Dear Dr. Livingston:

This is to confirm your recent phone conversation with members of the Office of Coastal Zone Management staff requesting you to address the Coastal Zone Management Advisory Committee at its next meeting in Tallahassee. We are pleased that you will be able to join us on February 23 and welcome you to attend the entire meeting.

We are interested in hearing your presentation on the proposed Corps of Engineers' dam project along the Apalachicola River.

Enclosed for your information are an agenda and a list of the Committee membership.

Thank you for your assistance. We look forward to a productive meeting. The Committee staff will be in touch with you regarding final arrangements.

Sincerely,

William C. Brewer
NOAA General Counsel
Chairman, CZM Advisory Committee

Enclosures