ECOLOGIC AND HYDROGRAPHIC STUDIES OF ELKHORN SLOUGH MOSS LANDING HARBOR AND NEARSHORE COASTAL WATERS JULY 1974 TO JUNE 1976

James Nybakken
Gregor Cailliet
William Broenkow

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Moss Landing Marine Laboratories
Moss Landing, California 95039

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PREFACE

In July 1974, we began a two-year baseline study of the Moss Landing-Elkhorn Slough marine environment for Pacific Gas and Electric Company as mandated by the Coastal Commission. The original proposal included strong recommendations for more complete oceanographic studies and a third year of data collection. These further studies were not funded. This report is divided into three sections: oceanography, benthic invertebrate ecology and fish and zooplankton ecology.

This is a final report in the sense that it presents all of the data gathered under the two-year funding by PG&E. It cannot, however, be construed as a definitive study of the ecology and oceanography of Elkhorn Slough and Moss Landing marine environment. Such a study would take several more years of intensive work. In a very real way, we have but established a baseline from which further work is to be done and have raised additional questions to be answered. Thus, the present report does not cover competitive interactions among benthic invertebrates, animal-sediment relationships, larval settling and recruitment, recolonization, quantitative assessment of subtidal benthic invertebrates, food chain relationships, primary productivity, predator-prey relationships and the role of mammals and birds. Fundamentally, this report merely establishes the species of animals present in Elkhorn Slough and surrounding water and quantifies their changes at selected stations over a two-year period -- nothing more. It cannot be used to make long-term predictions of changes in animal abundance or composition, even at those stations which have been sampled. Such predictions cannot be estimated without further studies of the type listed above as unanswered in this report. We would urge further such studies to enhance our understanding of the slough and hence, our ability to make predictions. In this respect, it is particularly regrettable that PG&E did not deem it fitting to support at least the third year of this study.

It is our intention to continue certain aspects of this work under other funding and for our own interests. When more of this work is finished, we would hope to integrate it with the data in this report and other data not analyzed, and to publish it in a referenced journal as a more definitive study.

James Nybakken
Gregor Cailliet
William Broenkow

SCIENTIFIC PERSONNEL

Dave Ambrose	Research Assistant	(Fish)
Brooke Antrim	Research Assistant	(Fish)
William Broenkow	Principal Investigator	(Hydrography)
Gregor Cailliet	Principal Investigator	(Fish, Zooplankton)
Terry Eckhardt	Research Assistant	(Benthic)
Larry Hulberg	Research Assistant	(Offshore Benthos)
Dan Ituarte	Research Assistant	(Benthic)
Chris Jong	Research Assistant	(Benthic)
Steven Lasley	Research Assistant	(Hydrography)
James Nybakken	Principal Investigator	(Benthic)
James Oakden	Research Assistant	(Sandy Beach)
Steve Pace	Research Assistant	(Zooplankton)
Paul Reilley	Research Assistant	(Hydrography)
Evelyn Shumaker	Research Assistant	(Foraminifera)
Mark Silberstein	Research Assistant	(Benthic)
Marty Stevenson	Research Assistant	(Larval Fish)
Daniel Watson	Research Assistant	(Hydrography)

BENTHIC INVERTEBRATE BASELINE STUDIES OF THE MOSS LANDING-ELKHORN SLOUGH ENVIRONMENT

Prepared by
James Nybakken and Christine Jong

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I. INTRODUCTION

This section of the report summarizes the qualitative and quantitative data with respect to benthic marine invertebrate communities of the Elkhorn Slough and the adjacent shallow waters of Monterey Bay.

Previous quantitative benthic community work in the Moss Landing area has all been conducted offshore. The most extensive study of the offshore area was carried out for the Association of Monterey Bay Area Governments by the Moss Landing Marine Laboratories with joint funding by AMBAG and Sea Grant. This program involved sampling ten stations in the north half of Monterey Bay for a period of eighteen months (Hodgson and Nybakken, 1973). Although most of these stations lay in water less than thirty meters deep, none were closer than three miles to Moss Landing. The best and most long-term quantitative study of the nearshore benthic environment has been conducted by Oliver and Slattery since 1971 and has just recently been concluded (Oliver, Slattery, Hulberg and Nybakken, 1976). Their study has produced the most detailed knowledge available concerning variation in natural communities in shallow subtidal areas south of the Monterey Submarine Canyon. The Moss Landing Marine Laboratories have also conducted a research program for Kaiser Industries for several years which has produced quantitative benthic data for three sites in and around their new outfall in Monterey Bay.

Other studies of the offshore environment near Moss Landing have been conducted for Pacific Gas and Electric Company by personnel of the Moss Landing Marine Laboratories as well as private firms. Most of the data generated in these studies which have been made available to the staff of the

Laboratories, have been inadquate in a quantitative sense. This inadequacy is due in most cases to problems of varying sample size, inconsistent sampling times and identifications, insufficient replication and inadequate time intervals for the conduct of the sampling program.

The most ambitious benthic sampling program yet undertaken in Monterey Bay was the joint effort of Hopkins Marine Station and the U.S. Naval Postgraduate School several years ago under the direction of Dr. Eugene Haderlie and Dr. Welton Lee. These agencies monitored a total of thirty-seven stations in the southern half of Monterey Bay over a twenty-four month period. Unfortunately, none of their stations lay close to Moss Landing. The northernmost stations were at the Salinas River mouth. To date, the data accumulated in the study have not been made available in published form.

Other smaller, incidental studies of the benthos have been carried out in Monterey Bay. The few that were conducted in the area in question suffer from one inadequacy or another for the purposes outlined by the Coastal Commission resolution.

Although Elkhorn Slough is well known among Pacific Coast Marine biologists because of the classic paper of MacGinitie (1935), there appear to be no other extensive published studies of its invertebrate fauna. Unfortunately, the MacGinitie paper is not a quantitative study and hence, we are left with the situation that no published quantitative studies of Elkhorn Slough exist.

It has been the object of this study then to attempt to sample quantitatively selected benthic areas in both Elkhorn Slough and the adjacent shallow waters of Monterey Bay such that we may attempt to assess the community structure and its natural variability with time. An important second objective is to establish as complete an invertebrate species list for the Elkhorn Slough area as possible.

Initially, we had hoped to sample at least three intertidal areas in Elkhorn Slough, two subtidal stations in Elkhorn Slough, three subtidal stations offshore in the vicinity of the tanker anchorage and two stations on the open sand beaches. We discovered, once we had begun work, that number of stations was greater than we could handle effectively, especially at the two-month sampling interval we had originally suggested. We further discovered in conversations with Dr. Adrian Wenner of the University of California that certain macrofaunal organisms of the open sand beaches move constantly, making it virtually impossible to sample them adequately. As a result, we decided to drop sampling of the open intertidal sand beaches. This decision not to sample the open sand beach was re-evaluated in August 1975, when representatives from PG&E requested that at least an attempt to sample this area be made. We subsequently did sample the sand beach in front of the laboratory during the second year. That report is included here.

Also, in the second year, we added a new intertidal station between the Vierra station and Kirby Park. This station was added to fill a large void in the mud-slough area, and also at the request of the people sampling the fish.

Initial work with species/area curves suggested that the eight to ten replicate samples were excessive and hence, we reduced the number of replicates to six or, in some cases, fewer. For most of the study, we sampled bimonthly in Elkhorn Slough in the first year, but changed to quarterly in the second year, to enable us to add sandy beaches to our sampling scheme and to add the fourth intertidal station in the Slough. In the offshore stations, based on work by Oliver and Slattery (personal communication), we sampled first at monthly intervals but later only quarterly. Similarly, the subtidal areas in the harbor were monitored first at monthly intervals and later quarterly.

Our intertidal station at Kirby Park presented us with a considerable unanticipated problem. This station has by far the greatest amount of organic debris in it. As a result, the samples of the original size (.018 m^2) took an excessive amount of time to screen. Furthermore, much debris remained after screening, such that it was extremely time-consuming to pick out the organisms. (It was taking up to 200 hours to do samples.) As a result, we experimented with different sized samples and finally settled on one which was much smaller than the three-pound coffee can. This enabled us to still take samples at Kirby Park and also to be able to process them. The final sampler used at Kirby Park took a sample of .005 m^2.

It should also be noted that the first set of samples taken at the intertidal stations in Elkhorn Slough (Skippers, Vierra, Kirby Park) in July 1974 were taken on a vertical transect through the intertidal rather than horizontally at a single tide level, as were all subsequent samples. This undoubtedly has biased those samples, most probably by giving higher numbers of species than would be found at one tide level.

Certain groups were not considered in the analysis of the quantitative data. This was because we could not obtain valid species identifications. The major groups here excluded were Nematoda, Nemertinea and Oligochaeta. Hence, most of our quantitative data deal with three abundant macrofauna groups: Crustacea, Polychaeta and Bivalvia.

Qualitative sampling was also initiated in the spring of 1975. We embarked on this program primarily to obtain a better feeling for the invertebrate fauna of the slough as a whole and to insure that our species list would be more valid. The most important section of the qualitative sampling thus far has been the diving survey in the channel.

II. MATERIAL AND METHODS (QUANTITATIVE)

A. Intertidal Sampling (Elkhorn Slough)

Benthic infaunal invertebrates were sampled with cores placed randomly along a thirty-meter transect line at about the -0.5 foot tide level at four stations in Elkhorn Slough (Figures 1 and 2). Preliminary samples were taken in July 1974, bimonthly samples taken from October 1974 to June 1975 and quarterly samples taken from August 1975 to May 1976. Table 1 lists the sampling dates and number of replicates taken at each station.

Skippers, Vierras and the Dairy stations were sampled with can cores (area = 0.018 m^2; height = 17 cm). Kirby Park was sampled with smaller cores (area = 0.005 m^2; height = 19.5 cm).

Each core was emptied into a bucket of seawater and washed into stacking screens consisting of a 1 mm square mesh above a 0.5 mm square mesh. All large and obvious animals were picked from the screens and relaxed in a dilute solution of propylene phenoxetol in seawater (McKay and Hartzband, 1970). These animals and the remaining material on the screens were preserved in 10% formalin for at least twenty-four hours. Samples were then rinsed with freshwater and stored in a solution of 70% ethanol with rose bengal. The rose bengal was added to stain the animals prior to sorting.

Benthic infaunal invertebrates were separated from the remaining debris, enumerated and identified to the lowest possible taxon with the use of dissecting and compound microscopes. The sorted and identified animals were placed in labeled vials and preserved in 70% ethanol. A reference col-

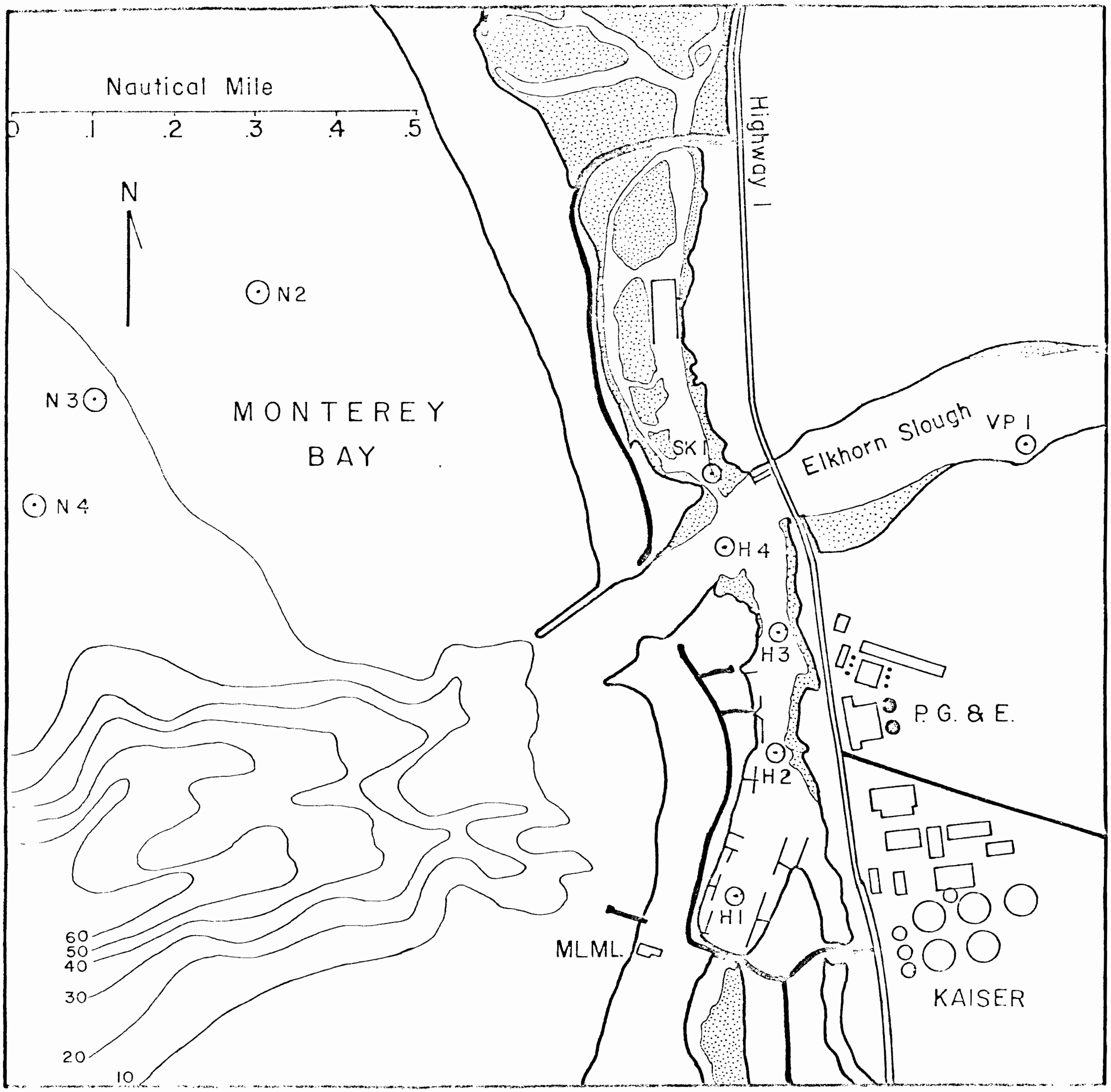

FIGURE 1. Map of Moss Landing Harbor area showing benthic sampling stations

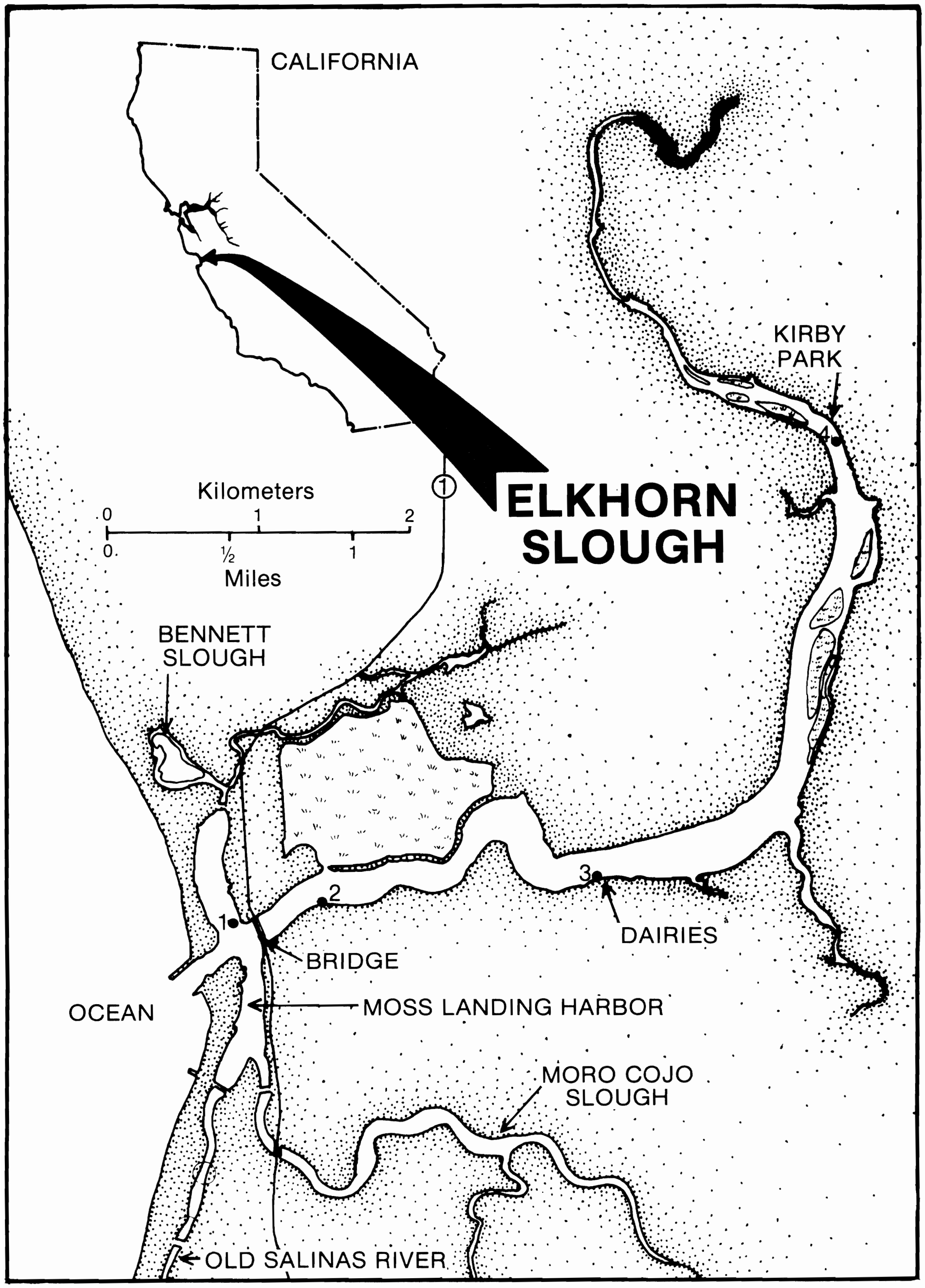

FIGURE 2. Map of Elkhorn Slough locating benthic sampling stations. Stations 1 and 2 refer to Skippers and Vierras.

Table 1

Sampling schedule for Benthic Intertidal Stations SK (Skippers), VR (Vierras), DA (Dairy) and KP (Kirby Park) in Elkhorn Slough. Number in parentheses indicates number of replicates taken at each station.

Date	Station
20 July 1974	SK (10), VR (10)
15 Oct. 1974	SK (8), VR (8)
12 Nov. 1974	KP (8)
10 Dec. 1974	SK (8), KP (8)
11 Dec. 1974	VR (8)
22 Feb. 1975	SK (8), KP (8)
24 Feb. 1975	VR (8)
27 Apr. 1975	SK (6), VR (8), KP (8)
11 June 1975	SK (6), VR (6), KP (8)
8 Aug. 1975	SK (6), VR (6), DA (6), KP (8)
2 Nov. 1975	SK (6), VR (6), DA (6), KP (8)
13 Feb. 1976	SK (6), VR (6), DA (6), KP (8)
17 May 1976	SK (6), VR (6), DA (6), KP (8)

lection of all identified species found in Elkhorn Slough has been compiled and is deposited in the Moss Landing Marine Laboratories Museum.

Three additional replicate cores (area 9.6 cm^2; height 17 cm) were taken at each Slough station during each sampling period in order to define physical properties of the sediment. These cores were kept frozen until the laboratory analysis could be made. Subsample scrapings were taken along the length of each core, homogenized and wet-sieved through a 64 μ Tyler screen. The coarse fraction (> 64 μ) was oven-dried, weighed and submitted to a settling tube analysis (Emery, 1938).

The silt and clay fraction (< 64 μ) was rinsed into a 1000 ml graduated cylinder for pipette analysis (Krumbein and Pettijohn, 1938), which covers those particle sizes ranging from 4.5 ϕ to 11.0 ϕ. Since the silt and clay fraction could not be disaggregated after drying, the weight of this fine fraction was determined by weighing a subsample from the graduated cylinder.

The weights and fractional percentages from the Emery tube and pipette analyses were combined to generate a total cumulative curve. Values were taken from this curve to calculate mean and median particle sizes, skewness, kurtosis and sorting coefficients for the sediments (Table 4) according to the equations of Folk and Ward (1957).

Unfortunately, not all species of invertabrates occurred at each sampling site at each sampling date. This made it virtually impossible to make meaningful statistical comparisons among all the stations for all samping dates with respect to the whole array of species. In other words, most non-parametric statistical methods require that each species be present at each sampling time, such that a value may be assigned and subsequently evaluated. In the absence of such consistency, we had to make comparisons of total numbers of species and individuals based on means from the replicates. Both parametric and non-parametric statistical methods were used in testing the data.

B. Subtidal Sampling (Offshore and Harbor)

All sampling and field observations were accomplished by divers using SCUBA. Most benthic infaunal samples were taken with driver-held corers. The standard corer was, as in the intertidal, a three-pound coffee can with both ends removed (area = 0.18 m^2; height = 17 cm). Careful diver implacement and snap-on plastic lids allowed the procurement of bottom cores with minimal disturbance and animal loss. Corers were loaded into a rack and transferred to the water surface by means of an air-filled lift bag. Each core was washed over a screen with 0.5 mm square openings. The screen residue was fixed in buffered 10% formalin with rose bengal. Animals were sorted under dissecting microscopes, transferred to a 70% ethanol and 5% glycerin solution and identified to the lowest possible taxon.

Core samples were taken at all stations at varying intervals between July 1974 and February 1976 (Tables 2 and 3). Most of the stations were sampled at the same time, but some were visited more often than others. The tables and graphs which occur in the text indicate the number of replicate core samples involved in the various calculations.

Table 2

Sampling schedule for Harbor Stations H-1, H-2, H-3 and H-4. Number in parentheses indicates number of replicates taken at each station.

Date	Station
2 July 1974	H-1 (4), H-4 (4)*
12 Aug. 1974	H-2 (3), H-3 (4)
25 Sept 1974	H-1 (4), H-3 (4), H-4 (4)*
27 Sept 1974	H-2 (4)
13 Nov. 1974	H-2 (2), H-3 (4)
15 Nov. 1974	H-1 (4)
19 Dec. 1974	H-1 (4), H-2 (4), H-3 (4)
31 Dec. 1974	H-4 (4)*
12 Feb. 1975	H-3 (4)
17 Feb. 1975	H-1 (4), H-2 (4)
4 Apr. 1975	H-4 (4)*
1 May 1975	H-1 (4), H-2 (4), H-3 (4)
17 Sept 1975	H-1 (4), H-2 (4), H-3 (4), H-4 (4)*

*Polychaete data unavailable at this time.

Table 3

Sampling schedule for Offshore Stations N-2, N-3 and N-4. Number in parentheses indicates number of replicates taken at a station.

Date	Station
29 Aug. 1974	N-2 (4), N-4 (4)
30 Aug. 1974	N-3 (4)
23, 27 Sept 1974	N-2 (2), N-3 (2), N-4 (2)
3 Nov. 1974	N-3 (5)
5 Nov. 1974	N-4 (5)
14, 18, 20 Nov. 1974	N-2 (5)
5 Jan. 1975	N-4 (3)
11 Jan. 1975	N-2 (3)
16 Jan. 1975	N-3 (3)
2 Apr. 1975	N-2 (3), N-4 (3)
5 Apr. 1975	N-3 (3)
23 Feb. 1976	N-3 (3), N-4 (3)
17 June 1976	N-2 (3), N-3 (3)
19 June 1976	N-4 (3)
16 Sept 1976	N-2 (3), N-3 (3), N-4 (3)

Table 4

Sediment parameters for the intertidal Elkhorn Slough stations for each sampling date based on the equations of Folk and Ward (1957). Values for the mean ($\bar{X}$), standard deviation (S) and standard error ($S_{\bar{X}}$) are based on three replicates.

	MEAN			MEDIAN			SORTING			SKEWNESS			KURTOSIS		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Skippers															
July 74	2.95	0.09	0.05	2.99	0.76	0.04	1.12	0.08	0.04	0.01	0.08	0.05	0.95	0.00	0.04
Oct. 74	3.20	0.19	0.11	3.25	0.20	0.11	0.93	0.08	0.05	-0.07	0.11	0.06	1.04	0.02	0.02
Dec. 74	2.67	0.21	0.12	2.78	0.16	0.90	1.21	0.30	0.17	-0.09	0.10	0.06	0.97	0.14	0.08
Feb. 75	2.72	0.40	0.23	2.10	1.53	0.88	0.78	0.05	0.03	0.98	1.91	1.10	1.09	0.15	0.87
Apr. 75	3.03	0.36	0.21	3.01	0.26	0.15	1.08	0.11	0.62	0.11	0.12	0.07	1.22	0.16	0.09
June 75	3.09	0.26	0.15	3.10	0.23	0.13	0.98	0.13	0.08	-0.01	0.06	0.03	1.10	0.11	0.67
Aug. 75	3.30	0.21	0.12	3.31	0.16	0.90	0.70	0.46	0.26	-0.01	0.09	0.50	1.06	0.14	0.83
Nov. 75	3.32	0.39	0.23	3.31	0.34	0.20	0.83	0.16	0.94	0.04	0.08	0.04	0.99	0.11	0.06
Feb. 76	3.22	0.25	0.14	3.29	0.21	0.12	0.85	0.08	0.47	-0.09	0.05	0.03	1.09	0.02	0.01
May 76	3.41	0.60	0.35	3.37	0.10	0.05	0.94	0.01	0.07	0.08	0.07	0.04	1.14	0.12	0.07
Vierras															
July 74	4.80	0.44	0.26	4.42	0.16	0.92	1.57	0.61	0.35	0.38	0.25	0.15	1.46	0.36	0.21
Oct. 74	5.68	0.68	0.39	4.98	0.60	0.43	2.26	0.09	0.51	0.54	0.02	0.14	1.36	0.23	0.13
Dec. 74	4.79	0.66	0.38	4.19	0.38	0.22	1.95	0.38	0.22	0.59	0.04	0.02	1.81	0.46	0.27
Feb. 75	5.21	0.51	0.29	4.60	0.36	0.20	2.15	0.38	0.22	0.49	0.05	0.31	1.48	0.57	0.33
Apr. 75	5.50	0.45	0.26	4.59	0.42	0.24	2.43	0.14	0.08	0.62	0.00	0.00	1.26	0.14	0.08
June 75	4.82	0.36	0.21	4.25	0.15	0.84	2.02	0.34	0.20	0.62	0.02	0.01	2.34	0.82	0.47
Aug. 75	5.69	0.24	0.14	4.88	0.34	0.20	2.32	0.18	0.10	0.54	0.11	0.06	1.05	0.03	0.02
Nov. 75	5.62	0.38	0.22	4.63	0.14	0.08	2.54	0.13	0.74	0.64	0.04	0.02	1.37	0.53	0.16
Feb. 76	5.53	0.10	0.06	4.43	0.54	0.31	2.68	0.32	0.19	0.67	0.16	0.09	1.51	0.30	0.17
May 76	5.09	0.44	0.26	4.23	0.17	0.10	2.33	0.44	0.26	0.68	0.03	0.02	2.00	0.63	0.36
Dairy															
Aug. 75	9.21	0.53	0.31	9.02	0.58	0.34	2.84	0.12	0.71	0.09	0.03	0.15	0.89	0.06	0.03
Nov. 75	9.28	0.34	0.20	9.02	0.26	0.15	2.89	0.28	0.16	0.14	0.07	0.41	0.91	0.06	0.03
Feb. 76	8.93	0.23	0.13	8.85	0.16	0.09	2.93	0.61	0.35	0.05	0.13	0.73	0.94	0.12	0.71
May 76	9.03	0.36	0.21	8.71	0.20	0.12	2.90	0.16	0.09	0.20	0.06	0.03	0.89	0.05	0.31
Kirby Park															
July 74	8.47	0.98	0.57	8.08	0.83	0.48	2.81	0.43	0.25	0.24	0.16	0.09	0.91	0.12	0.07
Oct. 74	7.29	1.18	0.68	6.77	1.43	0.82	3.00	0.58	0.34	0.26	0.16	0.09	0.92	0.06	0.03
Feb. 75	10.00	1.04	0.60	9.79	0.98	0.57	3.28	0.37	0.21	0.08	0.02	0.01	0.97	0.04	0.02
Apr. 75	9.06	1.07	0.62	8.97	1.32	0.76	2.85	0.35	0.20	0.07	0.15	0.09	0.93	0.06	0.03
June 75	9.66	0.56	0.32	9.51	0.60	0.35	3.30	0.27	0.16	0.08	0.04	0.02	0.96	0.02	0.01
Aug. 75	9.98	0.02	0.01	9.95	0.06	0.04	2.82	0.28	0.16	0.04	0.04	0.02	0.94	0.01	0.67
Nov. 75	10.49	0.30	0.17	10.46	0.04	0.02	2.95	0.50	0.29	0.02	0.14	0.83	0.91	0.00	0.00
Feb. 76	10.63	0.72	0.42	10.94	0.62	0.36	2.87	0.34	0.20	-0.11	0.11	0.64	0.96	0.12	0.68
May 76	10.03	0.29	0.17	9.97	0.36	0.21	3.14	0.16	0.90	0.04	0.05	0.03	0.97	0.04	0.02

III. RESULTS

A. Species Composition and Temporal Changes in Elkhorn Slough Intertidal

Three classes, Polychaeta, Bivalvia and Crustacea, dominate the intertidal benthic invertebrate fauna in Elkhorn Slough, as they do also in the subtidal areas offshore in Monterey Bay. Since these three classes dominate and are the only ones for which we have good identifications, they will be the only groups discussed herein.

Polychaetes belonging to the families Capitellidae and Spionidae were numerically dominant at all four stations in the Slough during all sampling periods. The capitellids *Capitella capitata* and *Notomastus tenuis*, the spionid *Streblospio benedicti* and the opheliid *Armandia brevis* were among the most abundant species present at Skippers, Vierras and the Dairy stations throughout the year (Tables 5 - 7). At Kirby Park, the spionids *Streblospio benedicti*, *Pseudopolydora paucibranchiata* and *Polydora ligni* were abundant along with high densities of small polychaetes belonging to the family *Ctenodrilidae*, *Ctenodrilus serratus*, and the family Syllidae, *Exogone lourei* (Table 8).

A few species of pericarideans dominated the crustacean fraction of the samples identified (Tables 5 - 8). Two species of the amphipod genus *Corophium*, *C. acherusicum* and *C. insidiosum*, were commonly found in differing abundances at all stations at all times. Adult males of the two *Corophium* species were distinguishable, but females and immature species were so similar they could not be accurately identified beyond the generic level. Therefore, in tabulating the data, we have chosen not to separate counts for the

Table 5. SKIPPERS STATION

Principal species and their statistical parameters by sampling date.

	July 1974			October 1974			December 1974			February 1975			April 1975		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Polychaeta															
Capitella capitata	--	--	--	154.00	134.95	47.71	38.88	28.32	10.01	6.75	5.31	1.88	5.00	4.15	1.69
Mediomastus californiensis	13.20	82.26	9.07	5.50	4.11	1.45	10.75	10.82	3.83	15.50	12.01	4.25	9.67	3.78	1.54
Notomastus tenuis	10.40	6.62	2.09	5.25	5.55	1.96	7.75	6.63	2.34	2.62	2.92	1.03	5.67	6.56	2.68
Nephtys cornuta franciscana	0.50	0.71	0.22	1.00	0.93	0.33	2.25	2.31	0.82	0.75	0.71	0.25	4.17	2.86	1.17
Armandia brevis	0.50	0.71	0.22	101.13	52.93	18.71	275.50	155.64	55.03	64.00	51.53	18.22	15.83	11.00	4.49
Prionospio cirrifera	1.20	1.87	0.59	1.25	1.75	0.62	5.25	8.22	2.91	2.75	2.25	0.80	0.50	0.55	0.22
Prionospio pygmaea	0.20	0.42	0.13	0.63	0.74	0.26	4.25	4.59	1.62	3.88	2.95	1.04	4.33	2.25	0.92
Streblospio benedicti	84.00	50.65	16.02	29.63	48.50	17.15	14.75	25.14	8.89	1.25	1.58	0.56	2.67	2.50	1.02
Exogone lourei	1.30	1.49	0.47	3.00	3.30	1.16	1.50	1.51	0.53	0.63	0.92	0.32	0.50	1.22	0.50
Crustacea															
Allorchestes angusta	2.30	4.69	1.48	--	--	--	0.63	0.74	0.26	1.62	2.06	0.73	0.17	0.41	0.17
Corophium spp.	23.80	20.94	6.62	1.00	0.93	0.33	0.25	0.46	0.16	0.63	1.06	0.38	0.33	0.82	0.33
Cyclaspis sp.	45.90	22.92	7.25	1.00	1.41	0.50	1.88	2.30	0.81	7.88	6.03	2.13	20.83	7.57	3.09
Leptochelia dubia	9.60	9.73	3.68	5.75	3.06	1.08	2.13	1.13	0.40	7.25	5.44	1.92	25.17	18.23	7.44
Mollusca															
Macoma nasuta	4.10	4.80	1.52	6.00	2.62	0.93	10.88	5.82	2.06	3.12	2.36	0.83	8.00	3.85	1.57
Tellina modesta	0.60	1.07	0.34	0.50	0.53	0.19	0.13	0.35	0.13	--	--	--	0.67	0.82	0.33
Cryptomya californica	0.50	0.53	0.17	0.13	0.35	0.13	0.25	0.71	0.25	3.38	8.75	3.09	0.17	0.41	0.17
Protothaca staminea	2.50	2.92	0.92	1.12	0.99	0.35	0.88	0.99	0.35	--	--	--	--	--	--
Number polychaete individuals	121.00	57.80	18.28	308.88	114.69	40.55	366.00	178.67	63.17	102.88	56.91	20.12	52.17	15.12	6.17
Number polychaete species	11.00	3.33	1.05	12.00	2.14	0.76	11.13	2.59	0.91	9.50	3.38	1.20	10.00	2.10	0.86
Number crustacean individuals	82.70	34.09	10.78	8.88	2.03	0.72	5.88	3.14	1.11	19.25	6.65	2.35	47.50	21.66	8.84
Number crustacean species	4.30	1.57	0.50	3.00	0.93	0.33	3.13	1.73	0.61	4.38	1.41	0.50	3.00	0.89	0.87
Number mollusc individuals	13.60	9.36	2.96	8.87	2.64	0.93	14.50	5.90	2.09	8.13	10.01	3.54	13.00	6.99	2.85
Number mollusc species	4.40	1.58	0.50	3.25	1.58	0.56	3.38	1.19	0.42	2.13	0.99	0.35	4.33	1.03	0.42
Total number individuals	217.30	69.64	22.02	326.62	115.44	40.81	389.63	183.16	64.76	132.38	59.76	21.13	112.67	37.96	15.50
Total number species	19.70	4.81	1.52	18.25	3.20	1.13	17.75	3.45	1.22	17.13	5.11	1.81	17.33	2.25	0.92
Oligochaeta	43.10	32.46	10.26	139.88	105.86	37.43	58.50	45.31	16.02	140.25	98.36	34.77	95.33	50.53	20.63
Nemertea	7.80	13.27	4.20	5.83	2.93	1.19	6.38	3.89	1.38	1.50	1.31	0.46	2.00	1.41	0.58
Phoronida	3.70	4.03	1.27	1.00	1.69	0.60	8.00	14.02	4.96	0.63	0.74	0.26	1.00	0.63	0.26

Table 5. SKIPPERS STATION continued

	June 1975			August 1975			November 1975			February 1976			May 1976		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Polychaeta															
Capitella capitata	4.50	4.72	1.93	1.50	1.22	0.50	75.17	22.22	9.07	26.67	18.04	7.37	23.33	6.83	5.00
Mediomastus californiensis	8.66	5.75	2.35	9.83	10.03	4.12	10.00	7.77	3.17	15.33	11.09	4.53	6.83	5.81	2.37
Notomastus tenuis	7.16	5.81	2.37	8.00	4.34	1.77	7.83	4.45	1.82	10.67	12.96	5.29	5.00	5.29	2.16
Nephtys cornuta franciscana	2.00	1.41	0.58	1.00	1.55	0.63	0.33	0.52	0.21	0.17	0.41	0.17	0.50	0.55	0.22
Armandia brevis	1.67	1.97	0.80	31.00	21.15	8.63	39.00	14.00	5.72	16.83	20.93	8.55	10.33	7.00	2.86
Prionospio cirrifera	1.33	1.75	0.71	1.50	1.38	0.56	2.33	3.14	1.28	0.50	0.84	0.34	0.33	0.82	0.33
Prionospio pygmaea	2.00	1.79	0.73	2.67	2.07	0.84	1.33	1.03	0.42	1.67	0.82	0.33	5.17	2.56	1.05
Streblospio benedicti	3.33	2.06	0.84	2.00	1.55	0.63	11.17	11.30	4.61	21.50	37.06	15.13	7.50	8.87	3.62
Exogone lourei	0.67	1.03	0.42	0.50	0.55	0.22	3.67	2.66	1.09	1.33	0.82	0.33	6.50	8.09	3.30
Crustacea															
Allorchestes angusta	--	--	--	2.17	2.14	0.87	0.17	0.41	0.17	--	--	--	0.17	0.41	0.17
Corophium spp.	0.67	0.82	0.33	1.00	1.26	0.52	119.50	115.69	47.23	0.50	0.55	0.22	5.33	5.92	2.42
Cyclaspis sp.	25.83	8.13	3.32	17.67	22.21	9.07	32.33	15.37	6.28	9.17	6.52	2.66	27.67	11.47	4.68
Leptochelia dubia	19.00	11.45	4.67	7.83	2.64	1.08	98.33	36.23	14.79	74.50	23.75	9.69	391.17	291.63	119.06
Mollusca															
Macoma nasuta	5.50	3.21	1.31	8.67	2.25	0.92	10.83	2.56	1.05	12.33	2.88	1.17	7.83	3.13	1.28
Tellina modesta	--	--	--	2.17	2.64	1.08	3.83	2.99	1.22	1.17	1.17	0.48	0.33	0.52	0.21
Cryptomya californica	--	--	--	0.33	0.82	0.33	3.50	3.83	1.57	--	--	--	--	--	--
Protothaca staminea	0.17	0.41	0.17	--	--	--	4.17	3.92	1.60	0.50	0.84	0.34	0.33	0.52	0.21
Number polychaete individuals	32.33	15.19	6.20	62.50	20.78	8.48	156.00	26.88	10.98	100.67	32.56	13.29	74.00	21.48	8.77
Number polychaeta species	9.00	2.53	1.03	10.67	2.94	1.20	11.17	2.23	0.91	10.17	0.98	0.40	10.00	1.26	0.52
Number crustacean individuals	45.83	17.00	6.94	30.33	23.89	9.75	251.67	141.42	57.73	86.00	22.42	9.15	424.67	305.49	124.72
Number crustacean species	3.00	1.26	0.52	4.33	1.51	0.61	6.33	1.86	0.76	4.33	1.37	0.56	4.00	1.26	0.52
Number mollusc individuals	12.67	5.09	2.08	12.83	2.93	1.19	22.33	4.46	1.82	16.50	3.39	1.38	9.83	3.87	1.58
Number mollusc species	4.00	0.89	0.37	3.17	0.98	0.40	5.17	1.17	0.48	3.83	1.47	0.60	2.33	0.82	0.33
Total number individuals	88.17	27.75	11.33	106.67	22.04	9.00	430.67	145.34	59.33	203.50	42.52	17.36	508.50	313.07	127.81
Total number species	16.33	3.72	1.52	18.67	4.23	1.73	23.00	3.58	1.46	18.67	2.42	0.99	16.33	1.75	0.71
Oligochaeta	17.17	7.08	2.89	27.17	36.23	14.81	194.50	102.65	41.91	161.83	142.66	58.24	117.50	93.64	38.23
Nemertea	2.83	1.47	0.60	1.83	0.98	0.40	3.50	1.38	0.56	5.33	1.86	0.76	2.17	2.14	0.87
Phoronida	0.33	0.52	0.21	1.00	1.26	0.52	0.33	0.52	0.21	0.33	0.52	0.21	0.33	0.82	0.33

Table 6. VIERRAS STATION

Principal species and their statistical parameters by sampling date.

	July 1974			October 1974			December 1974			February 1975			April 1975		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Polychaeta															
Capitella capitata	2.60	2.88	0.91	89.75	61.63	21.79	16.50	25.55	9.03	22.63	23.93	8.46	40.38	22.41	7.92
Mediomastus californiensis	0.30	0.68	0.21	0.38	0.52	0.18	0.13	0.35	0.13	0.75	1.04	0.37	2.50	1.77	0.63
Notomastus tenuis	1.50	4.40	1.39	0.38	0.52	0.18	0.63	0.92	0.32	0.38	1.06	0.38	21.25	10.42	3.68
Armandia brevis	0.13	0.35	0.13	11.50	6.50	2.30	232.88	67.35	23.81	13.63	12.98	4.59	2.25	1.39	0.49
Platynereis bicanaliculata	8.50	5.44	1.72	0.38	0.52	0.18	1.63	1.77	0.63	2.25	2.87	1.01	0.88	0.83	0.30
Exogone lourei	0.20	0.42	0.13	0.38	0.52	0.18	0.13	0.35	0.13	0.25	0.46	0.17	0.75	0.89	0.31
Prionospio cirrifera	0.40	0.97	0.31	0.50	0.76	0.27	0.50	0.76	0.27	3.25	3.45	1.22	0.38	0.52	0.18
Prionospio pygmaea	--	--	--	--	--	--	0.63	0.74	0.26	--	--	--	0.13	0.35	0.13
Streblospio benedicti	0.80	1.23	0.39	1.38	1.60	0.56	1.00	1.07	0.38	1.63	1.60	0.57	3.63	3.11	1.10
Crustacea															
Aoroides columbiae	0.90	0.99	0.31	0.13	0.35	0.13	0.25	0.71	0.25	0.38	0.74	0.26	0.13	0.35	0.13
Corophium spp.	1.20	2.30	0.73	--	--	--	10.38	11.33	4.00	0.38	0.74	0.26	0.13	0.35	0.13
Cyclaspis sp.	0.50	1.27	0.40	0.38	0.52	0.18	0.50	0.76	0.27	4.50	8.37	2.96	11.88	7.74	2.73
Nebalia pugettensis	--	--	--	1.13	1.73	0.61	0.13	0.35	0.13	0.25	0.71	0.25	--	--	--
Mollusca															
Macoma nasuta	3.70	2.16	0.68	1.38	1.19	0.42	2.50	2.20	0.78	2.63	1.92	0.68	1.50	1.20	0.42
Protothaca staminea	0.10	0.32	0.10	--	--	--	--	--	--	--	--	--	0.13	0.35	0.13
?Musculus sp.	0.40	0.70	0.22	0.38	0.52	0.18	0.25	0.46	0.16	0.50	1.07	0.38	0.38	0.52	0.18
Mysella sp.	0.60	0.84	0.27	0.50	0.76	0.27	0.13	0.35	0.13	0.13	0.35	0.13	--	--	--
Cryptomya californica	0.10	0.32	0.10	0.25	0.46	0.16	0.13	0.35	0.13	1.25	1.49	0.53	--	--	--
?Mactra sp.	--	--	--	--	--	--	--	--	--	13.88	11.26	3.98	1.00	1.07	0.38
Number polychaete individuals	15.20	8.43	2.67	106.13	57.92	20.48	256.75	78.15	27.63	46.13	23.19	8.20	76.38	26.91	9.51
Number polychaete species	3.80	1.93	0.61	5.63	1.41	0.50	7.38	1.06	0.38	6.50	1.41	0.50	9.13	1.89	0.67
Number crustacean individuals	7.90	6.51	2.06	1.63	1.60	0.56	2.38	3.96	1.40	5.50	8.59	3.04	12.38	7.67	2.71
Number crustacean species	2.80	3.28	1.81	1.00	0.76	0.27	1.13	0.99	0.35	1.50	1.20	0.42	1.50	0.76	0.27
Number mollusc individuals	4.70	2.98	0.94	2.63	2.28	1.51	3.25	2.55	0.90	20.00	12.54	4.43	3.13	2.10	0.74
Number mollusc species	1.70	1.42	0.45	1.75	1.16	0.41	1.50	1.41	0.50	3.63	0.74	0.26	1.75	1.28	0.45
Total number individuals	32.20	17.66	5.58	111.00	59.67	21.10	262.38	78.00	27.58	71.63	32.74	11.58	91.88	26.10	9.23
Total number species	9.80	5.77	1.82	8.75	2.82	1.00	10.00	2.20	0.78	11.63	1.77	0.63	12.38	1.51	0.53
Oligochaeta	66.70	75.87	23.99	124.13	44.82	15.85	97.38	98.47	34.81	59.13	60.16	21.27	19.75	10.59	3.75
Nemertea	0.90	0.99	0.31	0.88	0.83	0.30	1.50	0.76	0.27	2.00	3.42	1.21	3.63	2.72	0.96
Phoronida	26.50	49.41	15.62	6.75	8.12	2.87	18.00	26.15	9.25	2.50	5.18	1.83	41.88	22.36	7.91

Table 6. VIERRAS STATION continued

	June 1975			August 1975			November 1975			February 1976			May 1976		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Polychaeta															
Capitella capitata	9.00	5.22	2.13	9.83	8.30	3.39	7.33	3.39	1.38	18.67	14.57	5.95	3.17	3.13	1.28
Mediomastus californiensis	1.67	1.03	0.42	0.33	0.82	0.33	0.17	0.41	0.17	1.17	1.47	0.60	1.00	1.10	0.45
Notomastus tenuis	10.67	10.68	4.36	2.17	3.06	1.25	7.33	11.88	4.85	8.33	9.29	3.79	7.17	13.42	5.48
Armandia brevis	0.17	0.41	0.17	0.17	0.41	0.17	16.17	10.72	4.38	40.00	31.72	12.95	10.00	5.06	2.07
Platynereis bicanaliculata	--	--	--	1.17	0.98	0.40	0.17	0.41	0.17	5.17	4.75	1.94	0.50	0.84	0.34
Exogone lourei	0.83	1.17	0.48	--	--	--	0.17	0.41	0.17	1.17	0.98	0.40	0.67	0.52	0.21
Prionospio cirrifera	1.17	0.75	0.31	0.17	0.41	0.17	--	--	--	0.33	0.52	0.21	0.33	0.52	0.21
Prionospio pygmaea	0.17	0.41	0.17	--	--	--	0.33	0.52	0.21	--	--	--	2.50	1.38	0.56
Streblospio benedicti	3.83	3.31	1.35	0.17	0.41	0.17	0.33	0.52	0.21	0.50	0.55	0.22	2.50	1.52	0.62
Crustacea															
Aoroides columbiae	--	--	--	0.67	0.82	0.33	0.17	0.41	0.17	8.67	10.03	4.10	0.17	0.41	0.17
Corophium spp.	0.67	1.21	0.49	1.00	2.00	0.82	7.50	5.89	2.40	0.83	0.41	0.17	2.00	1.26	0.52
Cyclaspis sp.	19.50	16.40	6.70	--	--	--	6.67	5.61	2.29	5.50	5.17	2.11	14.17	12.07	4.93
Nebalia pugettensis	--	--	--	0.67	1.21	0.49	--	--	--	0.17	0.41	0.17	0.33	0.82	0.33
Mollusca															
Macoma nasuta	8.17	3.97	1.62	4.50	2.66	1.09	3.33	2.07	0.84	6.33	4.18	1.71	3.50	1.64	0.67
Protothaca staminea	--	--	--	--	--	--	1.50	1.76	0.72	0.50	1.22	0.50	--	--	--
?Musculus sp.	--	--	--	0.83	0.75	0.31	0.50	0.55	0.22	0.17	0.41	0.17	0.17	0.41	0.17
Mysella sp.	0.17	0.41	0.17	--	--	--	0.17	0.41	0.17	1.33	1.03	0.42	1.17	1.60	0.65
Cryptomya californica	--	--	--	0.17	0.41	0.17	--	--	--	0.17	0.41	0.17	0.17	0.41	0.17
?Mactra sp.	--	--	--	--	--	--	1.00	1.55	0.63	0.17	0.41	0.17	--	--	--
Number polychaete individuals	28.67	13.49	5.51	14.50	12.00	4.90	34.50	24.94	10.18	81.67	48.43	19.77	31.17	12.29	5.02
Number polychaete species	6.67	1.03	0.42	3.30	1.86	0.76	6.33	3.14	1.28	9.67	3.01	1.23	8.67	2.58	1.05
Number crustacean individuals	20.33	17.49	7.14	9.67	8.52	3.48	14.83	8.73	3.56	22.00	17.44	7.12	20.17	10.82	4.42
Number crustacean species	1.50	0.84	0.34	3.00	1.41	0.58	3.67	0.82	0.33	5.00	2.00	0.82	4.50	2.26	0.92
Number mollusc individuals	8.67	4.27	1.74	5.67	2.94	1.20	8.17	4.17	1.70	9.17	4.54	1.85	5.17	3.13	1.28
Number mollusc species	1.50	0.84	0.34	2.00	0.89	0.37	3.83	1.72	0.70	3.00	0.89	0.37	2.00	1.26	0.52
Total number individuals	78.17	56.08	22.89	56.17	22.27	9.09	91.83	37.36	15.25	180.00	99.34	40.56	73.00	30.81	12.58
Total number species	10.67	1.63	0.67	9.17	2.32	0.95	14.83	4.71	1.92	18.67	4.97	2.03	16.17	3.31	1.35
Oligochaeta	47.83	63.21	25.81	6.33	5.65	2.30	15.00	9.32	3.80	34.33	29.78	12.16	27.67	11.57	4.72
Nemertea	6.50	6.98	2.85	7.67	3.78	1.54	3.67	3.72	1.52	8.50	10.78	4.40	3.33	2.50	1.02
Phoronida	20.33	33.99	13.88	26.33	23.55	9.61	34.33	16.59	6.77	67.83	54.08	22.08	16.50	21.23	8.67

Table 7. DAIRY STATION

Principal species and their statistical parameters by sampling date.

	August 1975			November 1975			February 1976			May 1976		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Polychaeta												
Capitella capitata	5.00	6.42	2.62	19.17	13.51	5.52	5.00	5.66	2.31	5.17	2.64	1.08
Mediomastus californiensis	0.83	1.33	0.54	0.33	0.52	0.21	0.17	0.17	0.41	1.17	0.75	0.31
Notomastus tenuis	4.50	6.98	2.85	1.17	1.60	0.65	1.33	3.88	1.97	1.50	2.74	1.12
Armandia brevis	6.00	3.16	1.29	0.67	0.52	0.21	1.67	5.06	2.25	0.33	0.52	0.21
Streblospio benedicti	44.67	20.04	8.18	109.67	40.94	16.71	130.17	73.42	29.97	128.50	32.27	13.17
Crustacea												
Allorchestes angusta	30.00	19.69	8.04	--	--	--	2.67	3.50	1.43	0.17	0.41	0.17
Aoroides columbiae	1.33	1.37	0.56	--	--	--	0.67	1.21	0.49	--	--	--
Corophium spp.	5.50	2.88	1.18	0.67	0.82	0.33	13.00	10.60	4.33	17.17	13.60	5.55
Cyclaspis sp.	2.50	2.17	0.89	2.17	1.60	0.65	54.67	37.49	15.31	68.17	29.98	12.24
Leptochelia dubia	1.33	1.21	0.49	--	--	--	2.17	2.32	0.95	18.17	5.91	2.41
Nebalia pugettensis	14.67	12.43	5.10	--	--	--	--	--	--	--	--	--
Mollusca												
Macoma nasuta	2.17	2.56	1.05	3.17	2.86	1.17	4.83	2.79	1.14	12.50	5.75	2.35
Mactridae	0.33	0.52	0.21	--	--	--	--	--	--	--	--	--
Protothaca sp.	0.17	0.41	0.17	--	--	--	0.17	0.41	0.17	0.17	0.41	0.17
Zirfaca pilsbryi	--	--	--	0.17	0.41	0.17	0.17	0.41	0.17	1.00	2.45	1.00
Number polychaete individuals	65.50	23.20	9.47	133.17	38.07	15.54	143.67	79.64	32.51	140.17	30.62	12.50
Number polychaete species	6.83	2.23	0.91	5.33	1.37	0.56	6.67	2.16	0.88	6.17	1.72	0.70
Number crustacean individuals	55.67	29.38	12.00	3.17	1.60	0.65	74.33	51.99	21.23	104.17	41.78	17.06
Number crustacean species	6.83	0.75	0.31	2.00	0.89	0.37	6.50	2.59	1.06	5.33	0.82	0.33
Number mollusc individuals	3.33	2.66	1.09	3.67	2.88	1.17	6.17	3.31	1.35	14.67	6.44	2.63
Number mollusc species	1.83	0.98	0.40	1.17	0.41	0.17	2.50	1.05	0.43	2.00	0.89	0.37
Total number individuals	124.50	24.95	10.18	141.00	38.68	15.79	224.50	110.51	45.12	259.00	53.26	21.74
Total number species	15.50	2.43	0.99	9.17	1.47	0.60	15.83	3.97	1.62	13.50	2.07	0.85
Oligochaeta	115.00	94.52	38.59	260.67	198.15	80.89	174.50	107.50	43.89	133.50	57.14	23.33
Nemertea	1.50	2.07	0.85	1.00	0.63	0.26	1.00	0.89	0.37	2.50	3.83	1.57
Phoronida	0.33	0.52	0.21	0.83	1.17	0.48	0.17	0.41	0.17	0.17	0.41	0.17

Table 8. KIRBY PARK STATION

Principal species and their statistical parameters by sampling date.

	November 1974			December 1974			February 1975			April 1975			June 1975		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Polychaeta															
Capitella capitata	--	--	--	0.63	0.92	0.32	3.25	3.37	1.19	6.94	6.29	1.57	1.75	1.75	0.62
Ctenodrilus serratus	0.38	0.74	0.26	9.25	9.77	3.45	15.25	12.36	4.37	1.63	3.22	0.81	11.75	6.80	2.40
Eteone longa californica	--	--	--	0.13	0.35	0.13	1.38	1.30	0.46	1.06	1.12	0.28	1.12	0.84	0.30
Exogone lourei	4.38	1.41	0.50	3.75	1.98	0.70	8.25	6.92	2.45	10.13	6.97	1.74	25.50	6.52	2.31
Polydora ligni	1.00	0.93	0.33	5.25	4.17	1.47	4.38	4.37	1.55	7.19	6.54	1.64	8.63	4.07	1.44
Pseudopolydora paucibranchiata	0.13	0.35	0.13	0.38	0.74	0.26	0.50	0.76	0.27	4.88	3.69	0.92	4.63	2.67	0.94
Streblospio benedicti	17.00	9.91	3.50	30.25	11.45	4.05	15.63	9.53	3.37	12.25	4.82	1.21	33.50	12.90	4.56
Boccardia hamata	0.13	0.35	0.13	--	--	--	--	--	--	--	--	--	0.13	0.35	0.13
Armandia brevis	0.25	0.46	0.16	--	--	--	0.88	1.13	0.40	--	--	--	--	--	--
Crustacea															
Allorchestes angusta	--	--	--	0.38	0.52	0.18	4.00	2.73	0.96	3.56	3.05	0.76	2.88	1.25	0.44
Anisogammarus confervicolus	--	--	--	--	--	--	--	--	--	1.25	1.39	0.35	2.38	3.16	1.12
Aoroides columbiae	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Corophium spp.	25.50	10.18	3.60	7.00	3.07	1.09	7.00	5.73	2.03	11.63	6.66	1.67	102.00	31.96	11.30
Melita sp.	0.25	0.71	0.25	0.38	1.06	0.38	--	--	--	--	--	--	0.75	1.49	0.53
Cyclaspis sp.	13.25	7.09	2.51	64.13	32.81	11.60	245.38	137.86	48.74	246.94	160.65	40.16	156.63	74.84	26.46
Leptochelia dubia	--	--	--	--	--	--	--	--	--	0.38	0.72	0.18	0.25	0.71	0.25
Podocopid ostracod	0.25	0.46	0.16	0.38	0.74	0.26	0.13	0.35	0.13	--	--	--	0.50	0.76	0.27
Mollusca															
Macoma nasuta	--	--	--	--	--	--	--	--	--	0.06	0.25	0.06	--	--	--
Gemma gemma	5.75	6.52	2.31	36.75	33.36	11.79	4.88	4.55	1.61	6.19	3.90	0.98	3.63	2.50	0.89
Number polychaete individuals	22.88	11.73	4.15	54.63	10.68	3.77	50.88	21.03	7.44	44.38	17.59	4.40	87.88	11.79	4.17
Number polychaete species	3.38	0.92	0.32	6.00	36.88	33.26	7.00	1.41	0.50	5.88	1.45	0.36	7.38	1.19	0.42
Number crustacean individuals	39.00	14.34	5.07	72.63	35.30	12.48	256.88	142.97	50.55	6.31	3.98	0.99	266.38	94.26	33.33
Number crustacean species	2.13	0.35	0.13	4.50	1.20	0.42	4.38	1.51	0.53	1.50	0.52	0.13	5.25	0.71	0.25
Number mollusc individuals	6.00	6.46	2.28	36.88	33.26	11.76	5.00	4.60	1.63	258.38	157.42	39.35	4.25	2.31	0.82
Number mollusc species	1.00	0.53	.0.19	1.13	0.35	0.13	1.00	0.53	0.19	2.56	0.73	0.18	1.63	0.74	0.26
Total number individuals	67.88	25.37	8.97	162.88	60.30	21.32	312.75	154.48	54.62	309.06	166.27	41.72	358.50	98.79	34.93
Total number species	6.50	1.41	0.50	11.63	1.60	0.56	12.38	2.07	0.73	9.50	1.67	0.42	14.25	1.58	0.56
Oligochaeta	28.63	51.44	18.19	79.13	41.99	14.84	142.00	116.63	41.24	72.00	64.89	16.22	30.63	24.55	8.68
Nemertea	0.13	0.35	0.13	0.50	0.76	0.27	0.13	0.35	0.13	0.81	1.64	0.41	0.75	1.49	0.53

	August 1975			November 1975			February 1976			May 1976		
	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$	$\bar{X}$	S	$S_{\bar{X}}$
Polychaeta												
Capitella capitata	0.13	0.35	0.13	0.38	0.52	0.18	2.00	2.27	0.80	0.25	0.46	0.16
Ctenodrilus serratus	0.13	0.35	0.13	--	--	--	1.75	2.76	0.98	--	--	--
Eteone longa californica	0.63	0.52	0.18	0.13	0.35	0.13	1.38	1.85	0.65	0.13	0.35	0.13
Exogone lourei	44.00	22.03	7.79	82.50	45.03	15.92	134.25	63.51	22.45	49.25	15.07	5.33
Polydora ligni	2.00	0.76	0.27	1.75	2.38	0.84	0.13	0.35	0.13	1.00	1.60	0.57
Pseudopolydora paucibranchiata	10.25	15.38	5.44	0.75	0.89	0.31	0.63	1.06	0.38	0.13	0.35	0.13
Streblospio benedicti	32.75	12.63	4.47	33.63	29.01	10.26	35.50	22.43	7.93	38.88	10.86	3.84
Boccardia hamata	0.25	0.46	0.16	0.38	0.52	0.18	0.88	1.13	0.40	0.38	0.52	0.18
Armandia brevis	0.38	0.74	0.26	0.13	0.35	0.13	0.25	0.46	0.16	--	--	--
Crustacea												
Allorchestes angusta	2.50	2.00	0.71	--	--	--	2.63	3.25	1.15	0.50	0.76	0.27
Anisogammarus confervicolus	--	--	--	--	--	--	--	--	--	0.75	0.71	0.25
Aoroides columbiae	--	--	--	0.63	1.41	0.50	1.63	2.39	0.84	7.25	7.78	2.75
Crrophium spp.	53.13	25.90	9.16	1.88	2.80	0.99	4.38	4.17	1.48	22.00	13.54	4.78
Melita sp.	0.13	0.35	0.13	0.38	0.74	0.26	--	--	--	--	--	--
Cyclaspis sp.	18.75	11.26	3.98	2.50	1.60	0.57	65.88	55.06	19.47	35.13	49.10	17.36
Leptochelia dubia	--	--	--	0.13	0.35	0.13	0.13	0.35	0.13	0.88	17.27	6.11
Podocopid ostracod	--	--	--	--	--	--	--	--	--	0.13	0.35	0.13
Mollusca												
Macoma nasuta	--	--	--	0.25	0.46	0.16	--	--	--	--	--	--
Gemma gemma	54.63	42.26	14.94	1.50	1.69	0.60	1.50	1.41	0.50	0.13	0.35	0.13
Number polychaete individuals	90.88	19.10	6.75	119.88	44.26	15.65	177.00	64.03	22.64	89.60	17.20	6.10
Number polychaete species	5.75	1.49	0.53	4.38	1.30	0.46	5.38	1.30	0.46	3.40	0.74	0.26
Number crustacean individuals	74.50	35.28	1.07	6.00	5.10	1.80	74.88	57.44	20.31	67.60	54.10	1.50
Number crustacean species	5.50	1.07	0.38	3.00	2.20	0.78	4.75	2.55	0.90	8.00	19.10	0.50
Number mollusc individuals	55.00	42.57	15.05	1.75	1.67	0.59	2.13	1.46	0.52	--	--	--
Number mollusc species	1.38	0.52	0.18	1.00	0.76	0.27	1.38	0.52	0.18	--	--	--
Total number individuals	220.38	63.51	22.45	127.63	48.01	16.97	246.33	122.41	43.28	157.40	52.20	18.50
Total number species	12.63	2.45	0.86	8.38	2.92	1.03	11.50	3.42	1.21	11.60	2.00	0.70
Oligochaeta	81.63	87.48	30.93	23.75	22.90	8.09	44.63	34.81	12.31	15.75	12.36	4.37
Nemertea	0.50	0.53	0.19	0.25	0.46	0.16	--	--	--	--	--	--

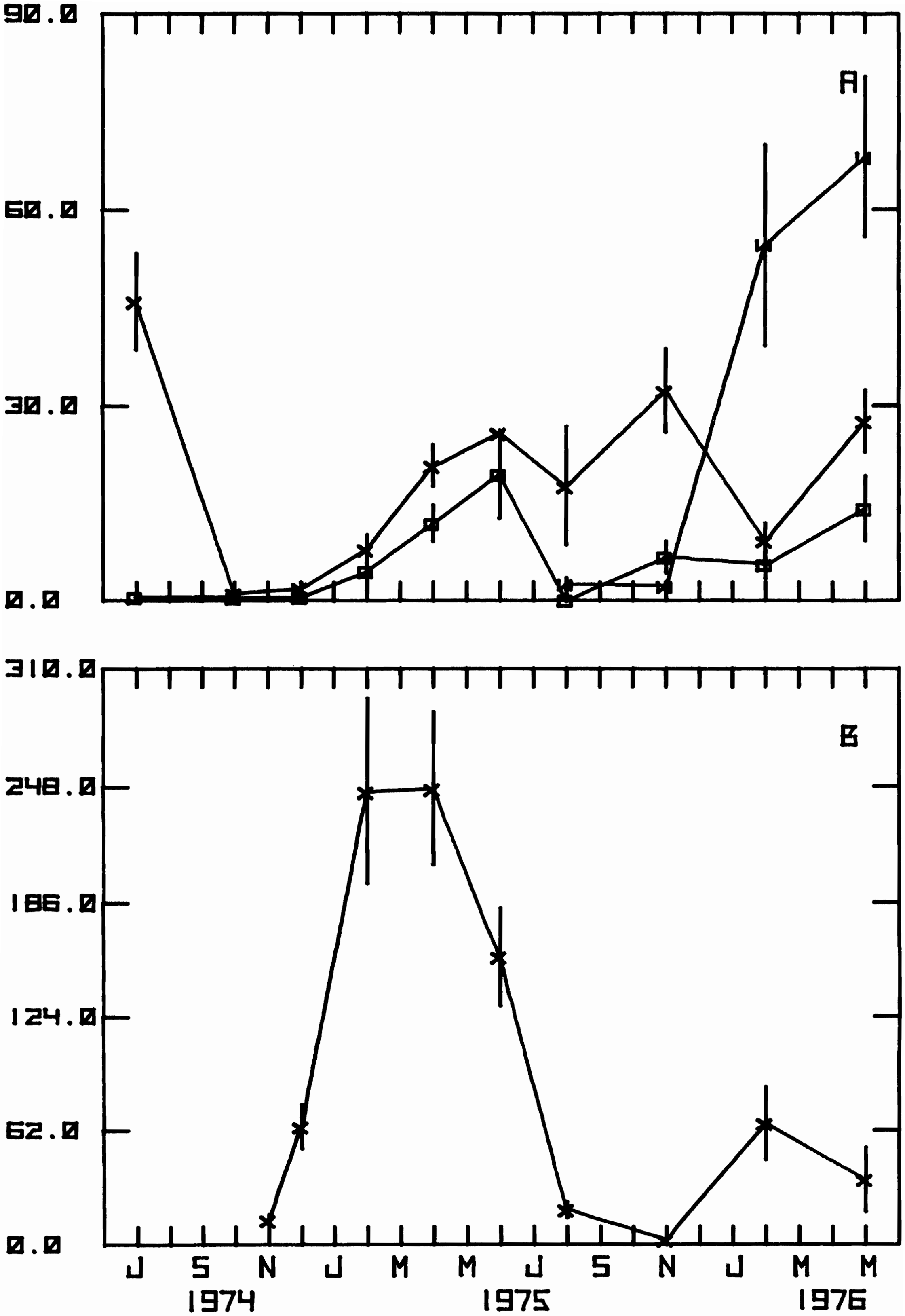

FIGURE 3. Mean numbers of individuals of Cyclaspis sp. per core at: A. Skippers (X), Vierras (O) and The Dairy (W), and B. Kirby Park. Vertical lines represent the standard error.

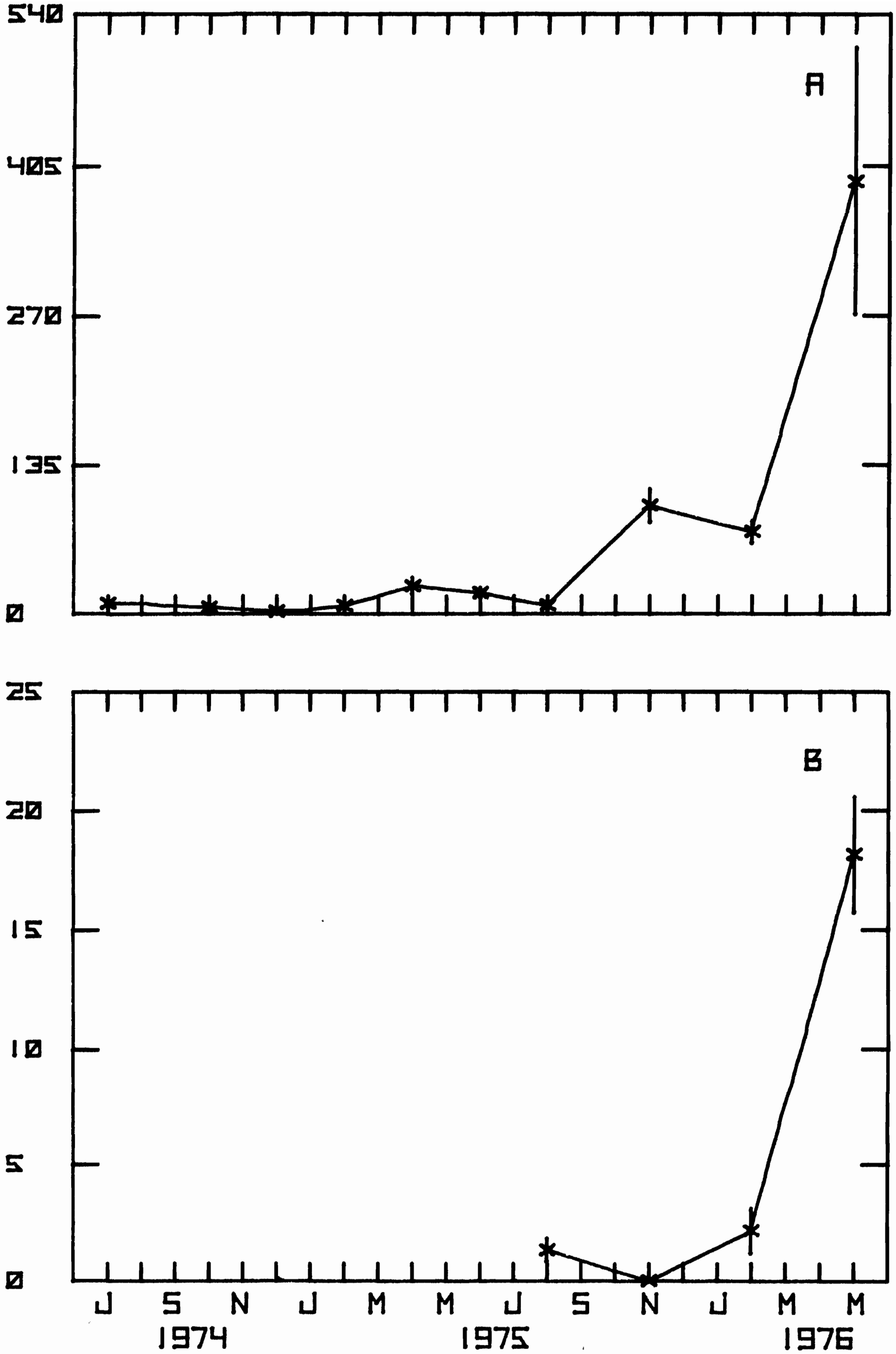

FIGURE 4. Mean numbers of individuals of Leptochelia dubia per core at: A. Skippers, and B. The Dairy. Vertical lines represent the standard error.

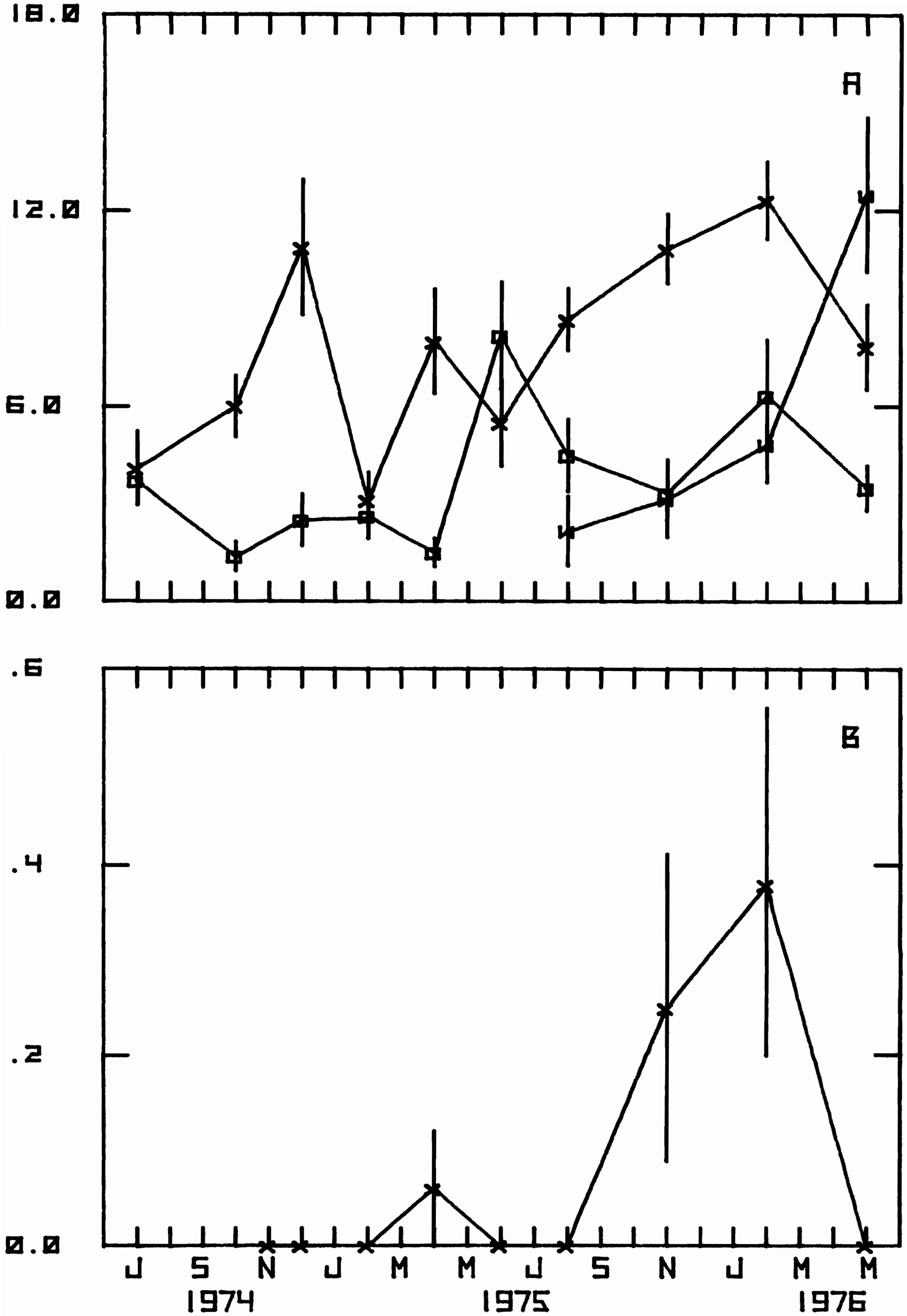

FIGURE 5. Mean numbers of individuals of Macoma nasuta per core at: A. Skippers (X), Vierras (O) and The Dairy (W), and B. Kirby Park. Vertical lines represent standard errors.

two species and refer to them collectively under the generic category Corophium spp.

A species of the cumacean genus Cyclaspis was often the most abundant crustacean present at each of the four stations (Figures 3-A and 3-B). Leptochelia dubia, a tanaidacean, was also seen at various times at all stations, but was more abundant at Skippers and the Dairy stations, with particularly high numbers observed in May 1976 (Figures 4-A and 4-B). Generally, the highest densities of crustaceans were present at Kirby Park, while the lowest numbers of crustaceans were found at Vierras.

The molluscan fauna at all stations consisted primarily of bivalves. Skippers, Vierras and the Dairy were dominated by the deposit-feeding tellinid Macoma nasuta (Tables 5 - 7, Figures 5-A and 5-B). Low abundances of other clams were seen at these stations, but none were consistently present throughout the year. At Kirby Park, the suspension-feeding venerid Gemma gemma was abundant and was often the only clam found there.

Considering first the mean numbers of total polychaete, mollusc and crustacean individuals per core at Skippers, large fluctuations were seen between several of the sampling dates (Figure 6-A). The number of individuals rose steadily to a peak in December 1974, then dropped off to a significant low in February 1975 ($P < 0.05$, Mann-Whitney U-test). The change in mean number of individuals per core was not significantly different in April 1975 ($P > 0.5$, t-test), but did drop significantly again in June 1975 ($P < 0.01$, t-test). After this time, the number of individuals rose to another peak in November 1975, which was followed by a significant decrease three months later ($P < 0.05$, Mann-Whitney U-test). During the interval between February 1976 and May 1976, the mean number of individuals again rose to a statistically significant level ($P < 0.05$, Mann-Whitney U-test). All this suggests a trend of high numbers in the fall and winter and fewer individuals in the spring and summer.

The high number of individuals of all three invertebrate classes at Skippers in December 1974 was primarily due to the rise in the number of polychaetes at that time (Figure 6-B), since there was no significant change in the mean number of individual molluscs during this same time period ($P > 0.5$, Mann-Whitney U-test, Figure 7-A) and the number of crustaceans actually decreased significantly from July to December 1974 ($P < 0.005$, Mann-Whitney U-test, Figure 7-B).

This winter peak in 1974 was due in part to the settlement, probably in later summer or early fall, of considerable numbers of the opportunistic polychaete species *Armandia brevis* (Figure 10-A). There was also a contribution to the increase in total numbers by the settlement of large numbers of another opportunistic polychaete *Capitella capitata*, which was not present in the July 1974 samples but had a significant mean abundance of 154.00 ±47.71 individuals/core in October 1974 and 38.88 ±10.01 individuals/core in December 1974 (Figure 11-A). These two species both declined steeply in abundance in February 1975 and were primarily responsible for the statistically significant decrease in total numbers of individuals seen between December 1974 and April 1975.

Between June and November 1975, at Skippers, each of the three invertebrate classes showed significant increases in numbers of individuals ($P << 0.001$, t-test). Like the previous year, there was a rise in the numbers of the polychaetes *Capitalla capitata* and *Armandia brevis* between August and November 1975. But unlike the previous fall, there were significant increases in the numbers of molluscs and crustaceans as well ($P < 0.01$, t-test). Macoma nasuta was the major clam species contributing to the increased number of molluscs during this period ($P < 0.005$, Mann-Whitney U-test; Figure 5-A). Cyclaspis sp., Corophium spp. and Leptochelia dubia were the principal contributors to increases in the number of crustacean individuals in November 1975.

The numbers of individual polychaetes, molluscs and crustacea at Skippers all dropped off significantly in February 1976. During the following sampling period in May 1976, the number of polychaetes remained relatively the same ($P > 0.2$, t-test), while the number of molluscs decreased ($P \ll 0.001$, t-test) and the number of crustaceans increased ($P < 0.01$, Mann-Whitney U-test). The decrease in molluscs following a fall peak was similar to that seen the previous year. The magnitude of increase in the number of crustaceans was much greater in May 1976 than that occurring during the same season in 1975. The high abundance of the tanaid Leptochelia dubia in May 1976 (391.17 ±119.06 individuals/core) accounted for much of the increase in crustacean numbers.

The total number of species of polychaeta, mollusca and crustacea per core at Skippers showed a slight downward trend from July 1974 to June 1975 (Figure 8-A). The mean numbers of species between December 1974 and June 1975 were not significantly different ($P > .01$, t-test), but were all significantly lower than the value for July 1974 ($P < 0.025$, t-test). From June to November 1975, there was a significant rise in the number of species present ($P \ll 0.001$, t-test), followed by another statistically significant decline through May 1976 ($P \ll 0.001$, t-test).

Looking at the number of polychaete species at Skippers (Figure 8-B), there was a significant rise in the number of species in October 1974 ($P < 0.01$, t-test) not observed when considering changes in the total number of species for all three invertebrate classes. This was followed by a decline through February 1975 ($P < 0.01$, t-test). The number of polychaete species then remained about the same until August 1975, when there was a statistically significant rise ($P < 0.025$, t-test). This rise leveled off without a significant change through November 1975, until February 1976, when there was a significant downward trend ($P < 0.025$, t-test). No significant change was observed during the last sampling period in May 1976 ($P > 0.25$, t-test).

There were fewer species of molluscs at Skippers at all times than there were polychaete species. There appeared to be more variation in the numbers of mollusc species present from one sampling date to the next (Figure 9-A). Again, there was a downward trend in number of species after the initial sampling period to a low during February 1975 ($P \ll 0.001$, t-test). A rise in the number of mollusc species in April 1975 was followed by a decline through August 1975. In November 1975, there was a statistically significant rise in the number of mollusc species ($P \ll 0.001$, t-test) followed by a decline through May 1976 ($P \ll 0.005$, t-test). The number of mollusc species was generally so low that the presence or absence of only one or two species was enough to cause a statistically significant change.

The crustacean species at Skippers, like the molluscs, were far fewer in number than the polychaetes (Figure 9-B). The number of crustacean species per core, as with the polychaetes and molluscs, dropped significantly following the initial sampling period ($P < 0.001$, t-test). But unlike the other two classes of invertebrates, the number of crustacean species increased rather than decreased in February 1975 ($P << 0.001$, t-test), followed by a decline in April 1975 ($P < 0.001$, t-test). Between August and November 1975, there was a steady increase in the number of crustacean species found ($P < 0.005$, t-test), followed by a decrease very similar to the pattern observed for the molluscs.

Because diversity and diversity indices reflect variations in two parameters, species richness and the "evenness" with which individuals are distributed among the species, they are often used to explain changes occurring in biological systems. Considerable controversy exists regarding the proper use of these indices at the present time. Nevertheless, we report diversity here and we use the Shannon-Weaver equation for calculation (Pielou, 1966). At Skippers, the total diversity H', as calculated for molluscs, polychaetes and crustacea, showed a significant decline from July to December 1974 ($P << 0.001$, t-test; Figure 12-A). The decline can be attributed primarily to the great influx of individuals of Armandia brevis and Capitella capitata, which significantly reduced the evenness component of diversity and, hence, the index value (see Figure 12-B) and to the declining H' value for molluscs (Figure 13-A). The diversity index for crustaceans did not change significantly during this same time period ($P > .05$, t-test; Figure 13-B).

From December 1974 to April 1975, the total species diversity index rose at Skippers after the two dominant species, Armandia and Capitella,

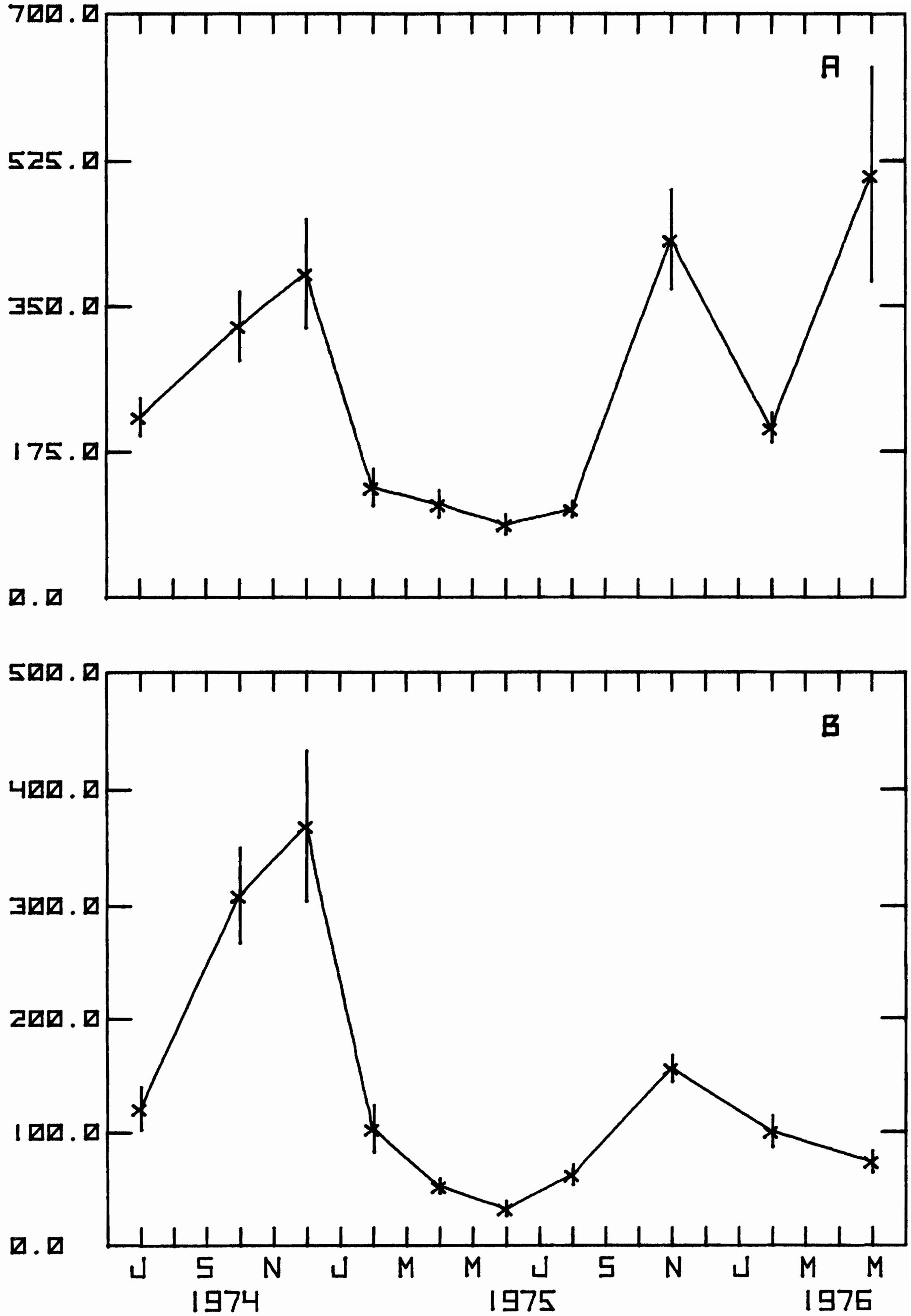

FIGURE 6. A. Mean numbers of individuals of all species per core, Skippers. B. Mean number of polychaete individuals at Skippers. Vertical lines represent standard errors.

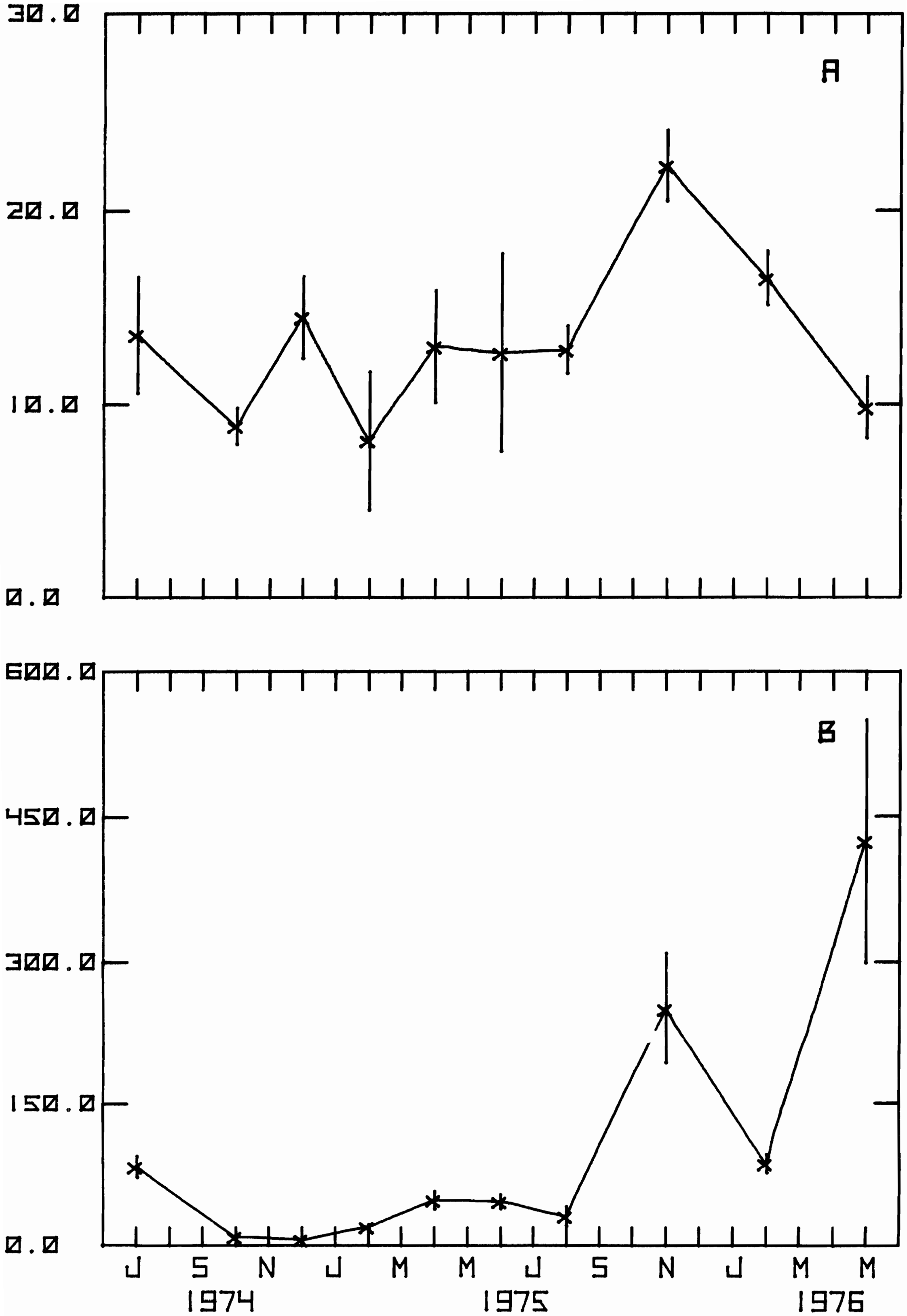

FIGURE 7. A. Mean number of mollusc individuals per core at Skippers. B. Mean number of crustacean individuals per core at Skippers. Vertical lines represent standard errors.

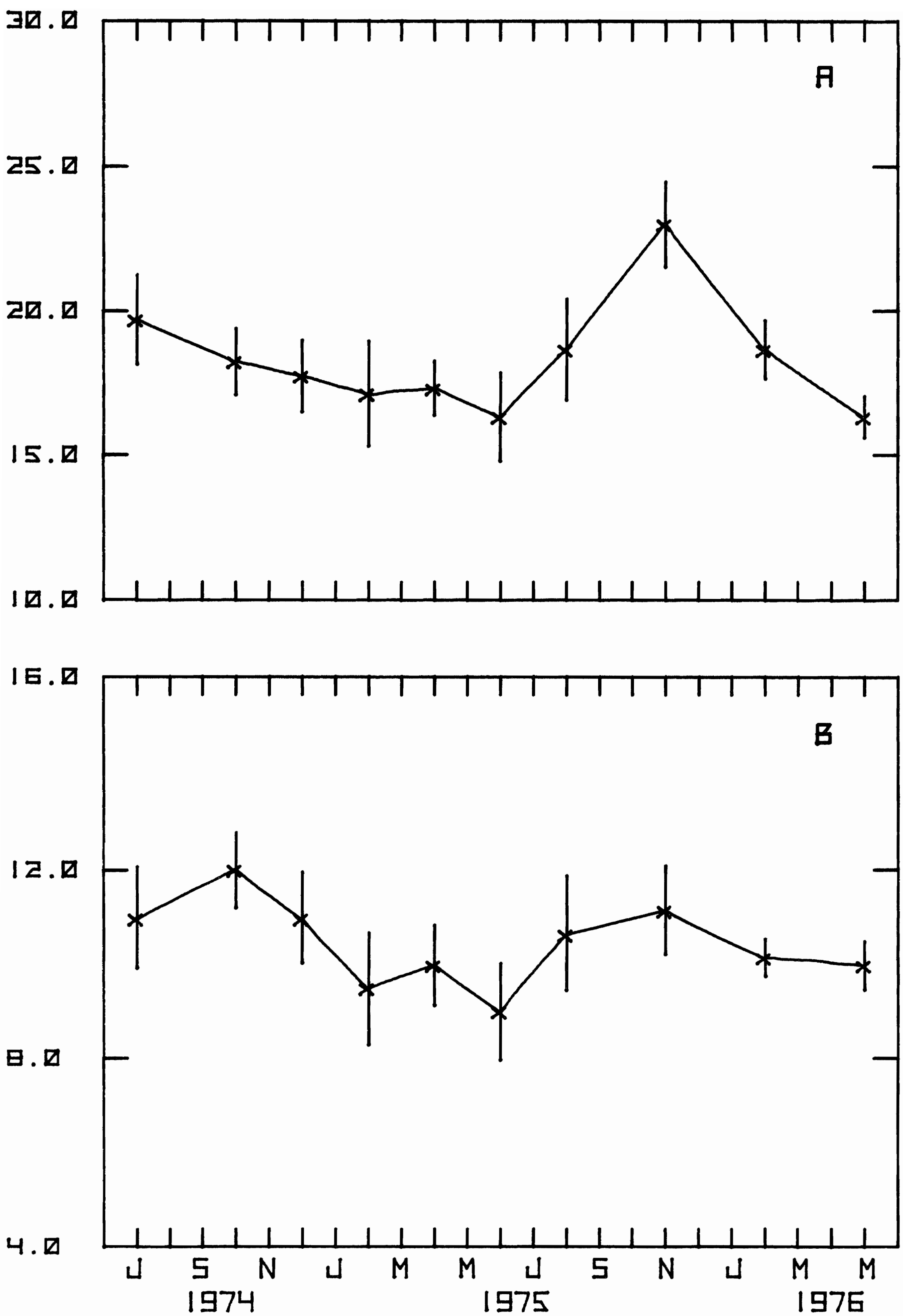

FIGURE 8. A. Mean number of species per core, all groups, Skippers.
B. Mean number of polychaete species per core, Skippers.
Vertical lines represent standard error.

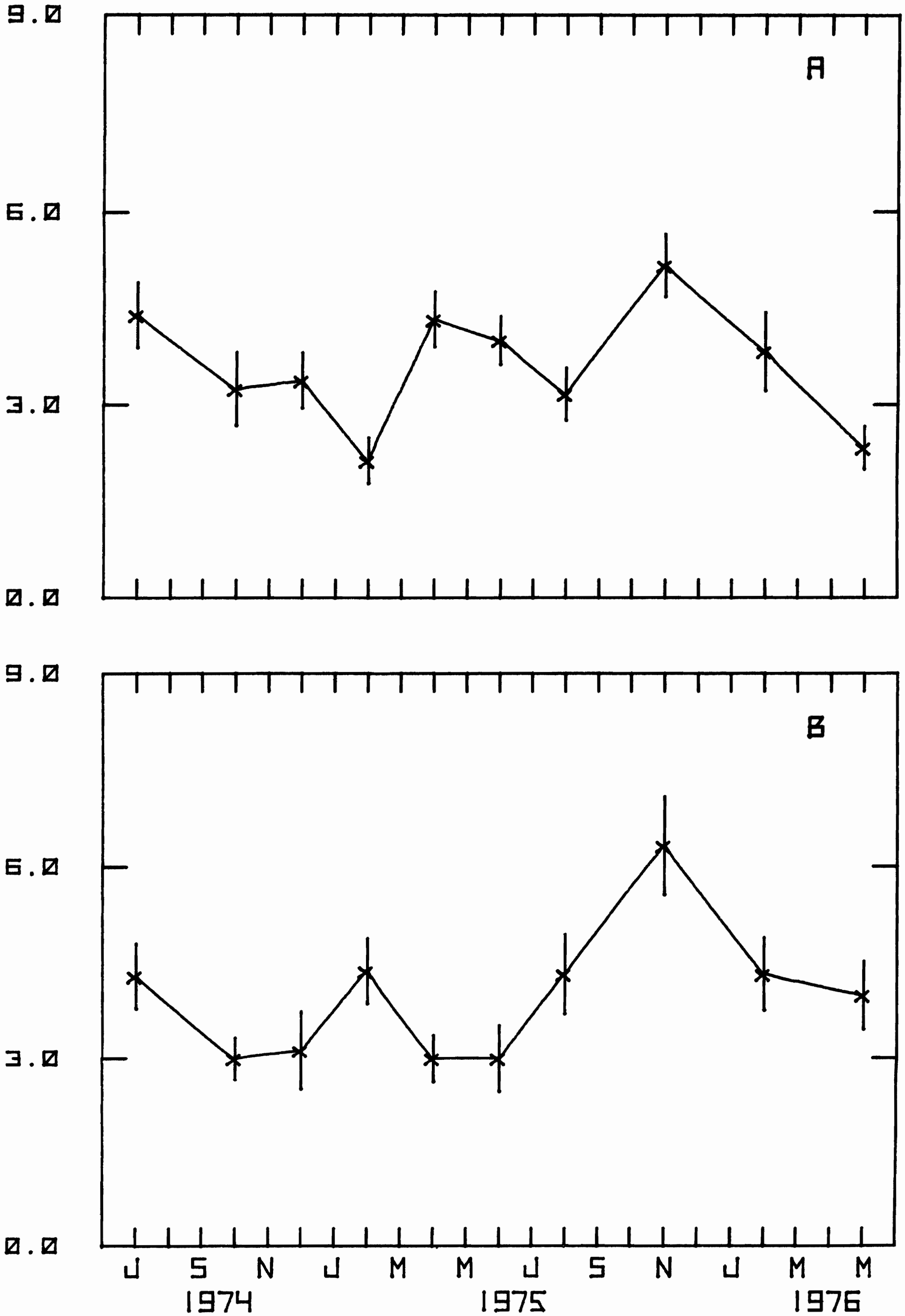

FIGURE 9. A. Mean number of mollusc species per core, Skippers.
B. Mean number of crustacean species per core, Skippers.
Vertical lines represent standard error.

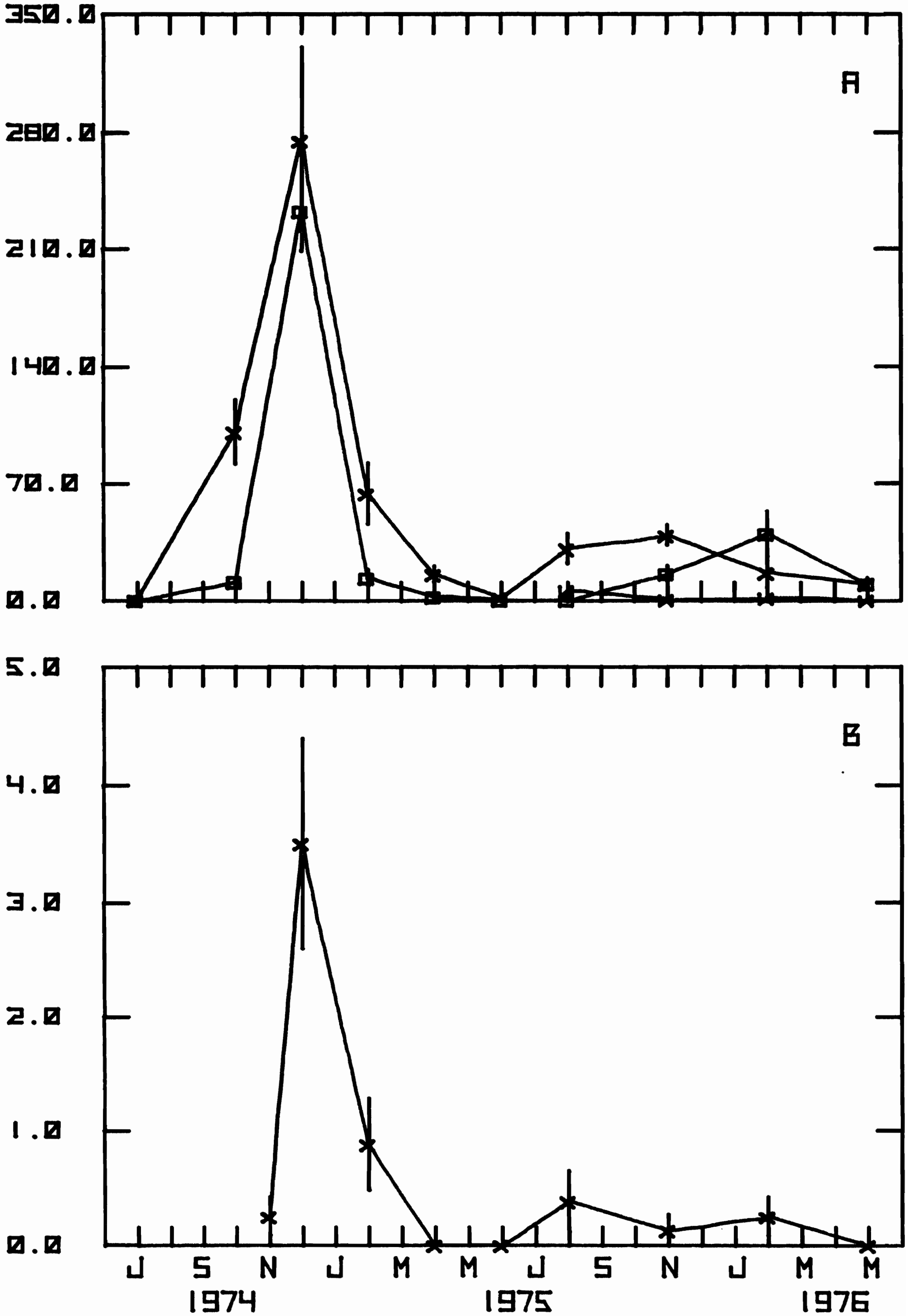

FIGURE 10. Mean number of individuals per core of Armandia brevis at: A. Skippers (X), Vierras (O) and The Dairy (W), and B. Kirby Park. Vertical lines represent standard error.

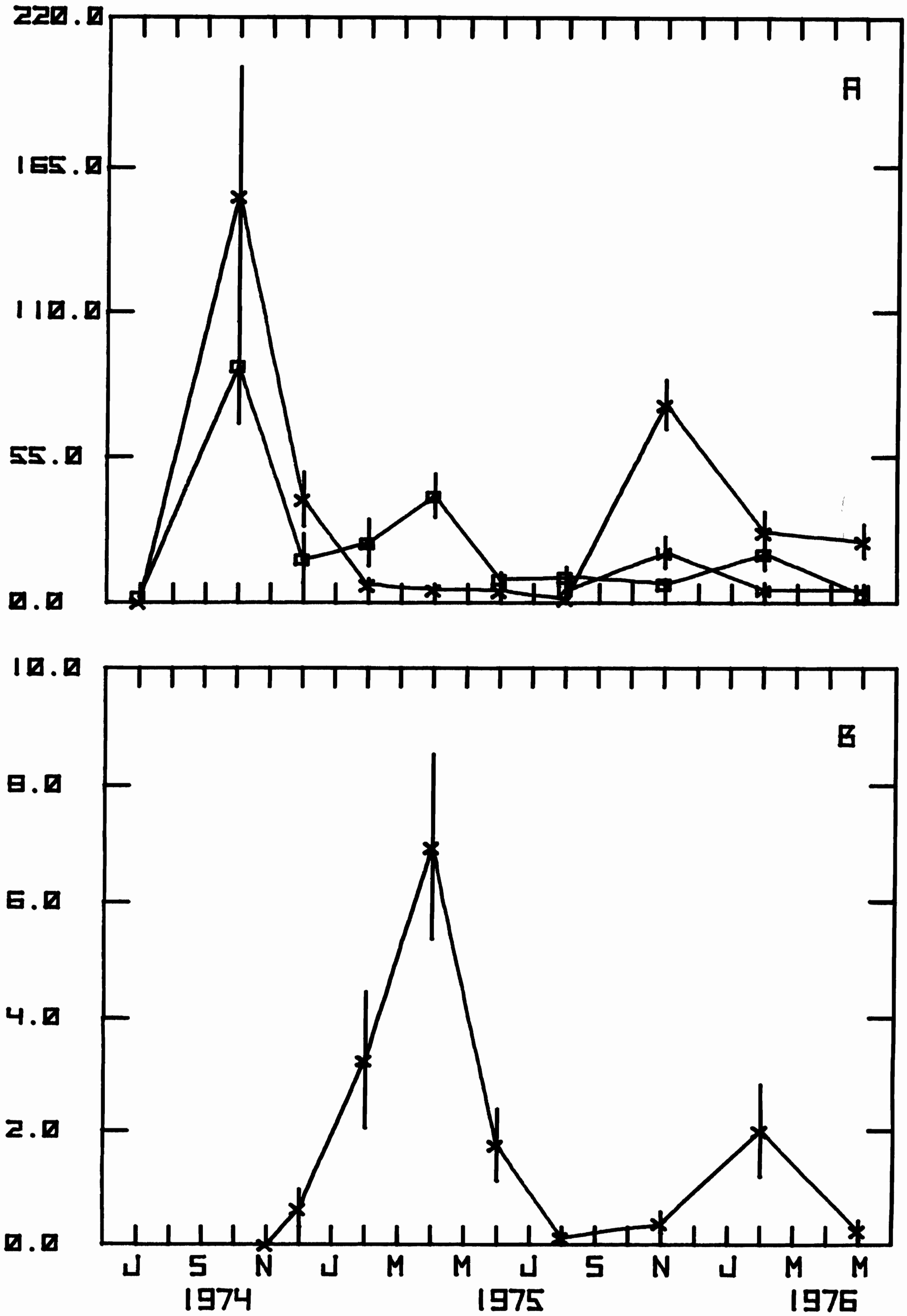

FIGURE 11. Mean number of individuals per core of Capitella capitata at: A. Skippers (X), Vierras (O) and The Dairy (W); and B. Kirby Park. Vertical lines represent standard error.

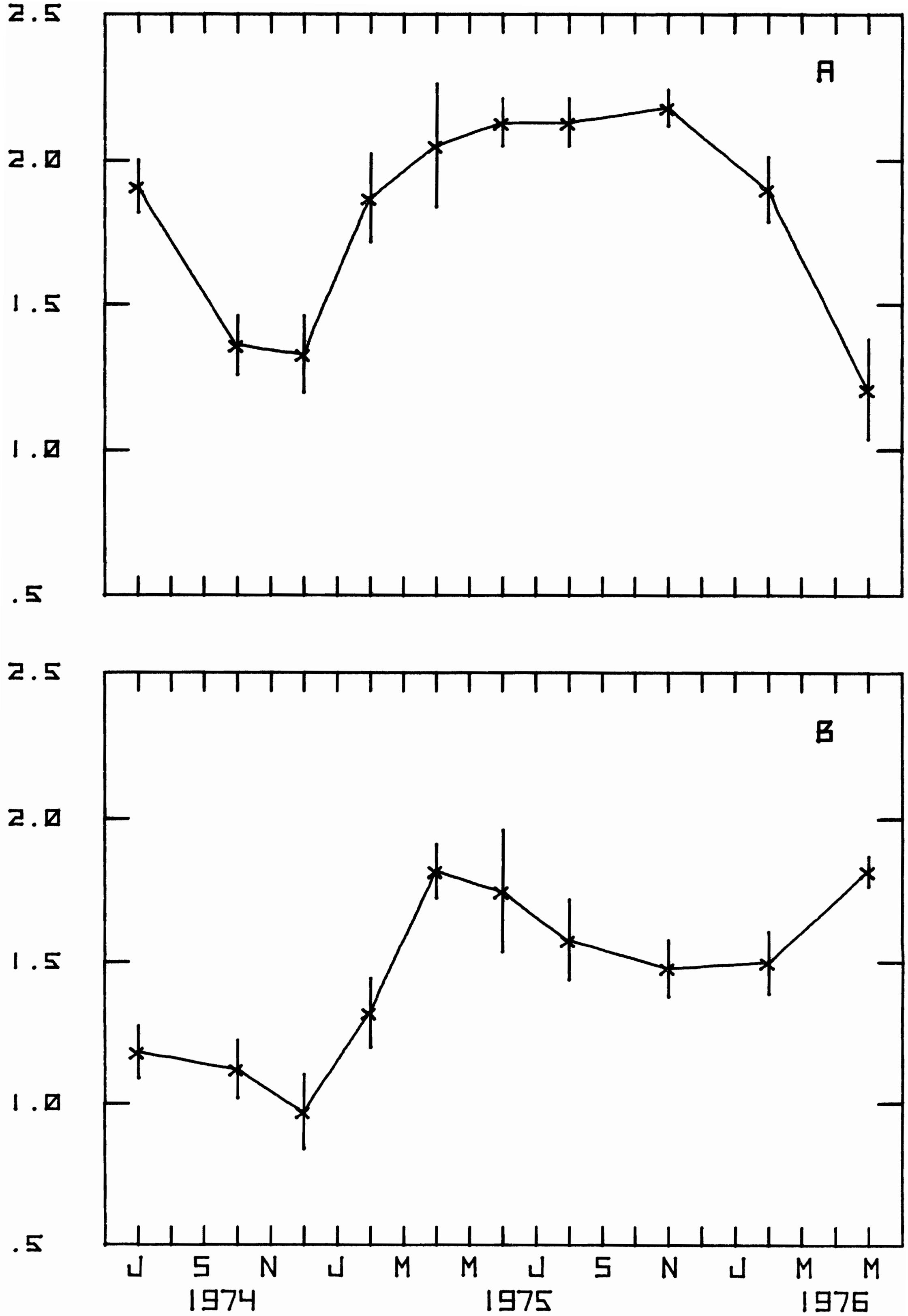

FIGURE 12. A. Mean total diversity, H', per core at Skippers.
B. Mean polychaete diversity, H', per core at Skippers.
Vertical lines represent standard error.

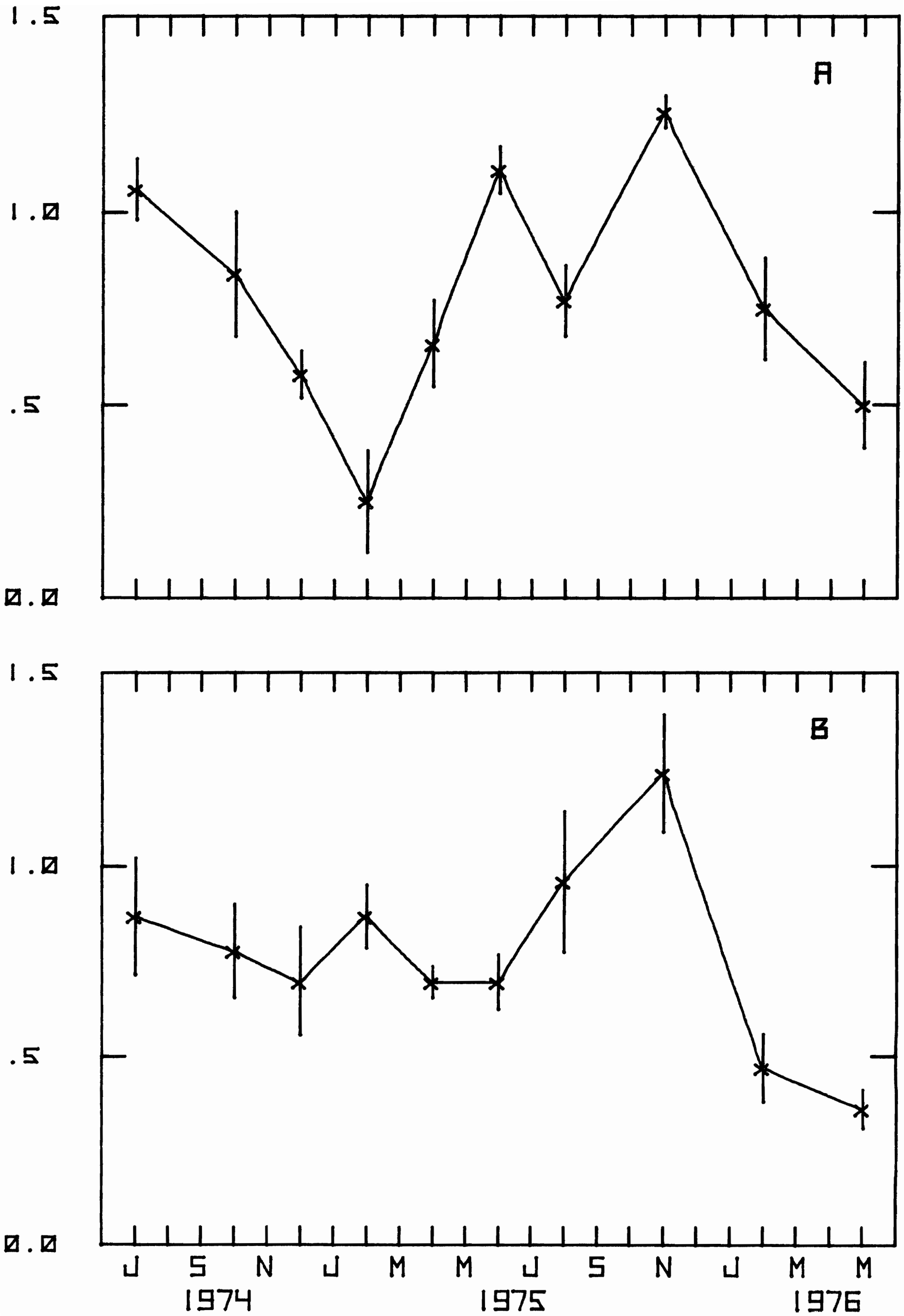

FIGURE 13. A. Mean mollusc diversity, H', per core at Skippers.
B. Mean crustacean diversity, H', at Skippers.
Vertical lines represent standard error.

declined. (See Figures 10-A, 11-A and 12-A.) The values for total diversity, H', then remained relatively stable until February 1976, when there was a significant decline ($P << 0.001$, t-test), which continued through May 1976.

This decline was greatly influenced by both the molluscs and crustaceans ($P << 0.001$, t-test; Figures 13-A and 13-B). The numbers of mollusc species appearing in the February and May 1976 samples declined. The higher numbers of _Macoma nasuta_ relative to the remaining clam species had a significant effect in lowering the calculated H' values. High numbers of the crustaceans _Cyclaspis_ sp. (Figure 3-A) and particularly _Leptochelia dubia_ (Figure 4-A) also caused the diversity index to decrease.

Considering the Vierras station next, the polychaetes found there were much higher in number of individuals than either the molluscs or crustaceans (Table 6). As a result, significant changes in the total number of individuals at this station were almost entirely due to fluctuations in the abundance of polychaetes. (See Figures 14-A and 14-B.) The total number of individuals peaked in December 1974 and declined sharply in February 1975 in a pattern similar to that seen at Skippers. Again, this rise and fall can be attributed mostly to changes in the numbers of _Armandia brevis_ and _Capitella capitata_ (Figures 10-A and 11-A).

Between December 1974 and February 1975, there was actually a significant increase in the number of molluscs ($P < 0.001$, Mann-Whitney U-test; Figure 15-A) attributed to the appearance of juvenile mactrid clams, but the magnitude of declining polychaete numbers masked this occurrence, when looking at changes in total numbers of individuals. The number of crustaceans collected during the same time period did not change significantly from the December 1975 samples ($P > 0.05$, Mann-Whitney U-test).

There was a slight but statistically significant rise in total numbers of individuals at Vierras in April 1975, caused by increased abundance of the polychaetes and crustaceans ($P < 0.005$, t-test). There was no significant change in the total numbers of individuals at Skippers at this same time. At Vierras, the opportunistic polychaeta *Capitella capitata* again significantly increased in numbers ($P < 0.005$, t-test), along with another capitellid, *Notomastus tenuis*. The abundance of the small cumacean *Cyclaspis* sp. also contributed to the April 1975 increase and was primarily responsible for the crustacean peak in June 1975 (Figure 15-B).

The total number of individuals at Vierras fell to a low in August 1975, as each of the three invertebrate classes decreased significantly in numbers. A similar decreasing trend was also seen in the Skippers samples at this time. The next sampling period at Vierras in November 1975 showed an increase in numbers of individuals, but peak abundances were not reached until February 1976 (Figure 14-A).

The cause of the February 1976 peak in numbers of individuals at Vierras was again due primarily to the two opportunistic polychaete species, although the numbers of crustaceans and molluscs did increase significantly as well (Figures 14-B, 15-A and 15-B). The blooms of *Capitella* and *Armandia* were much smaller in magnitude than in the previous year and were not entirely coincident with the polychaete blooms at Skippers, which were apparent during the sampling period three months earlier in November 1975.

The total number of species present at Vierras was generally lower than that found at Skippers. From July to October 1974, there was no significant change in the total number of species ($P > 0.1$, Mann-Whitney U-test), an increase in polychaete species being offset by decreases in crustacean species and no change in the number of mollusc species (Figures 16-A, 16-B, 17-A and 17-B). From October 1974 to April 1975, there was a slight upward trend in the total number of species. This trend was not observed at Skippers. While the abundance of crustacean species did not change significantly during this time interval, the number of mollusc species peaked in February 1975 and fell in April 1975, while the number of polychaete species dropped slightly in February 1975 and rose to a peak in April 1975.

At Vierras, a gradual decrease to a low in numbers of species was observed from April to August 1975, influenced primarily by a significant drop in the number of polychaete species ($P < 0.001$, t-test; Figures 16-A and 16-B). The low numbers of crustacean and mollusc species were actually beginning to rise (Figures 17-A and 17-B), but had little overall effect on the total change in numbers. The highest number of species was seen in February 1976 (Figure 16-A). The polychaetes and crustaceans rose steadily to this peak while the number of mollusc species peaked earlier in November 1975 and was dropping in February 1976. The mollusc species again peaked in number, three months earlier than the polychaetes.

The depression in diversity index values at Vierras from July to December 1974 can be attributed to the dominating presence of large numbers of the two opportunistic polychaetes similar to the occurrence at Skippers

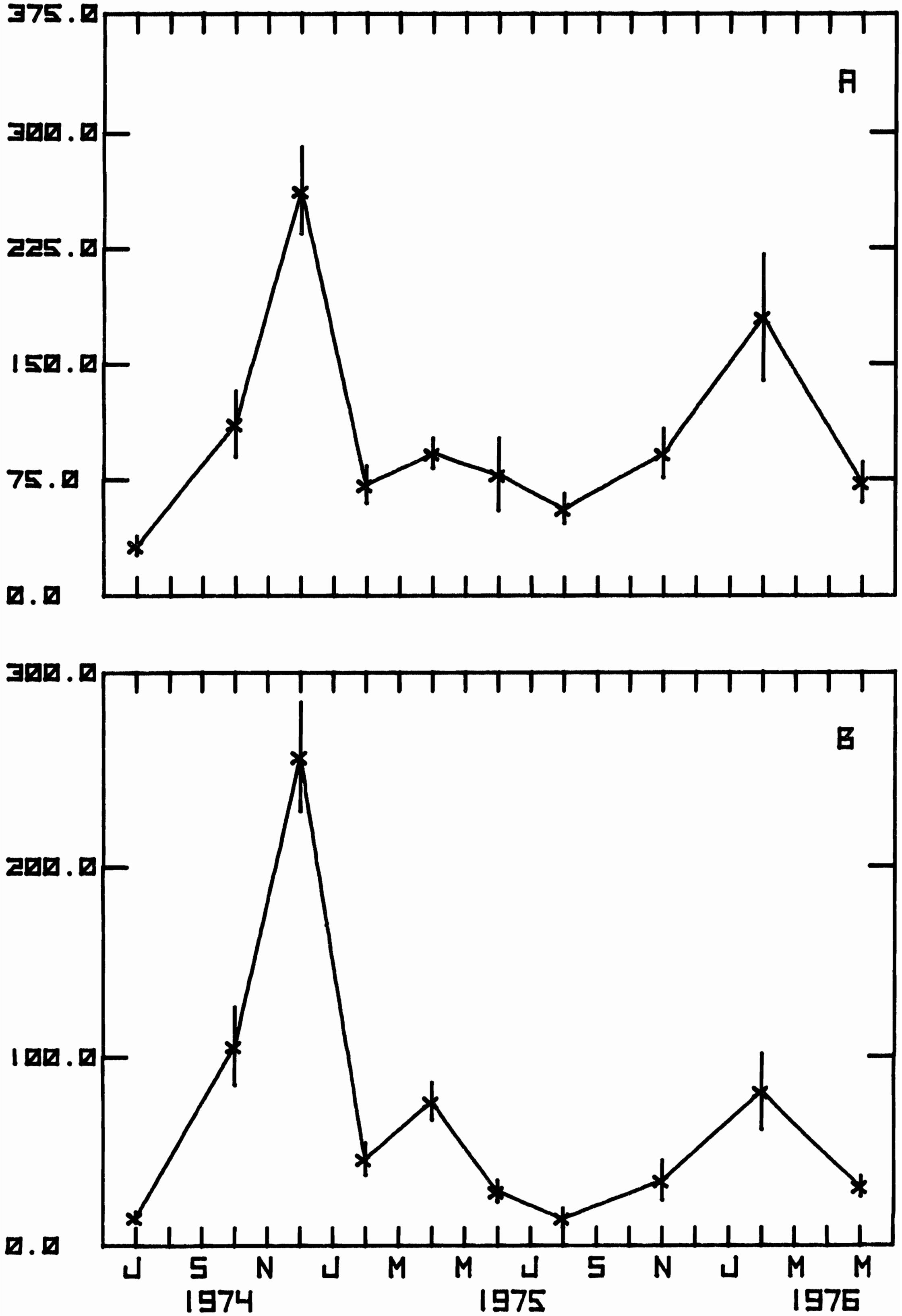

FIGURE 14. A. Mean numbers of individuals per core of all groups, Vierras. B. Mean numbers of polychaete individuals per core, Vierras. Vertical lines represent standard error.

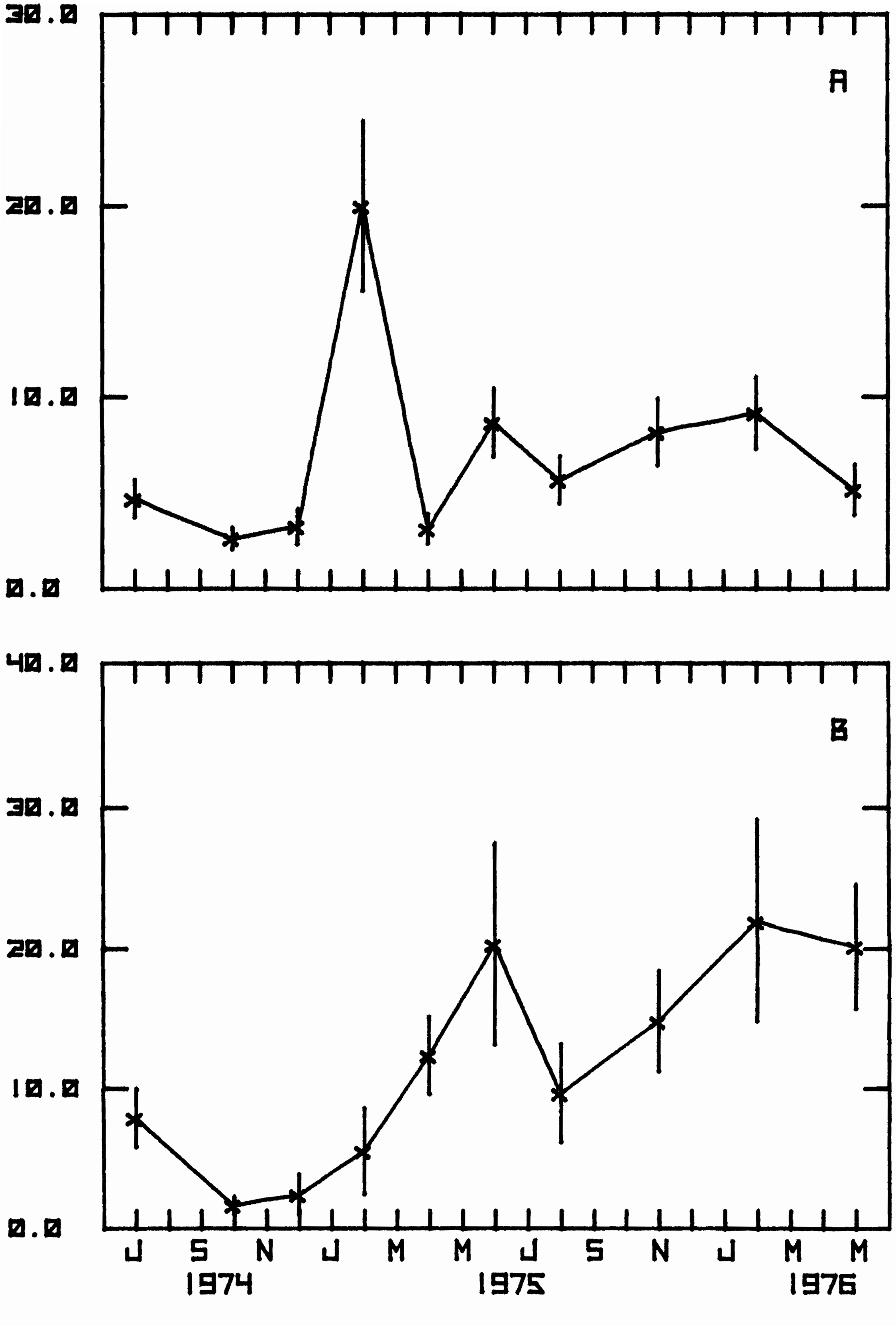

FIGURE 15. A. Mean numbers of mollusc individuals per core, Vierras.
B. Mean number of crustacean individuals per core, Vierras. Vertical lines represent standard error.

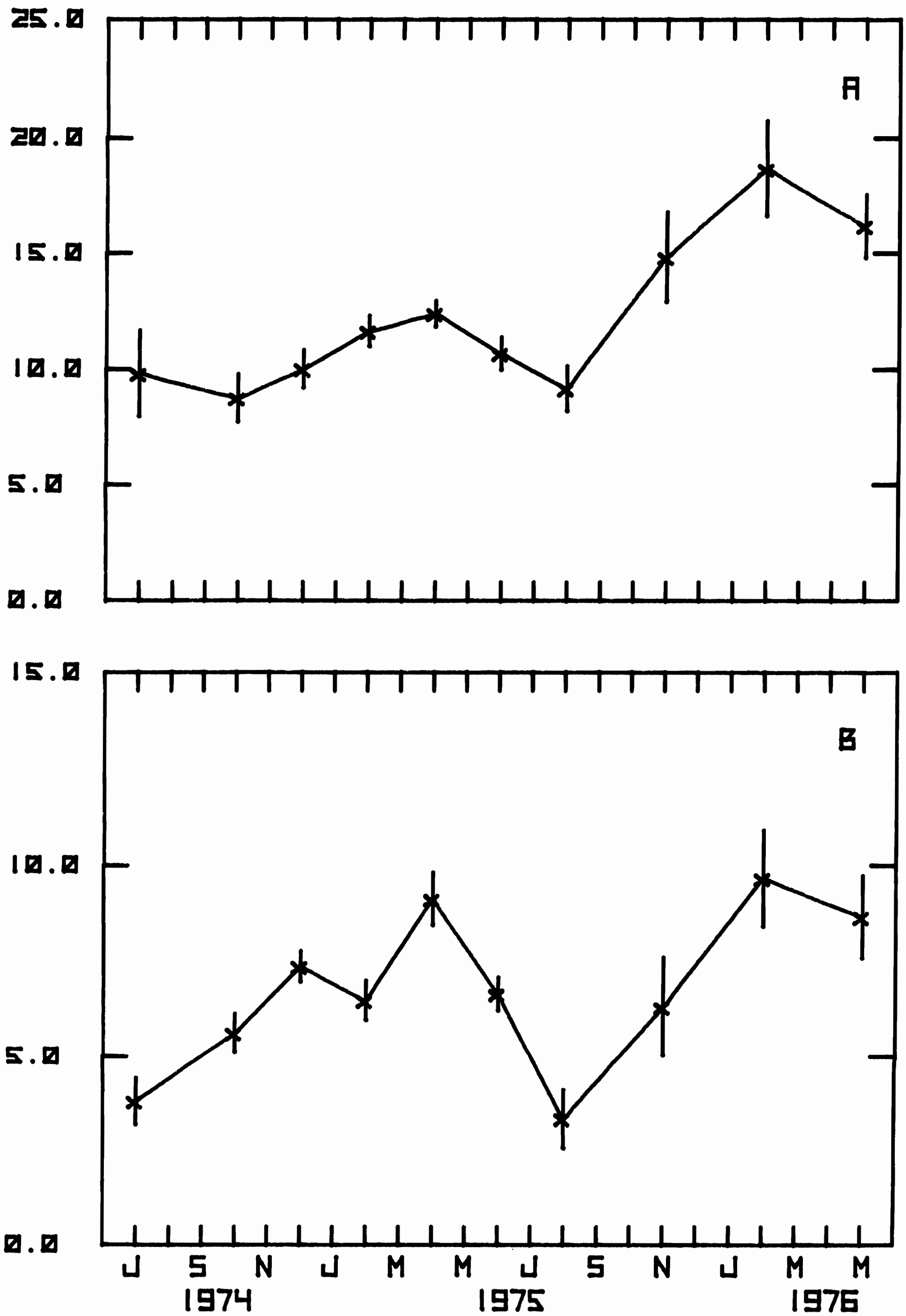

FIGURE 16. A. Mean number of species of all groups per core, Vierras.
B. Mean number of polychaete species per core, Vierras.
Vertical lines represent standard error.

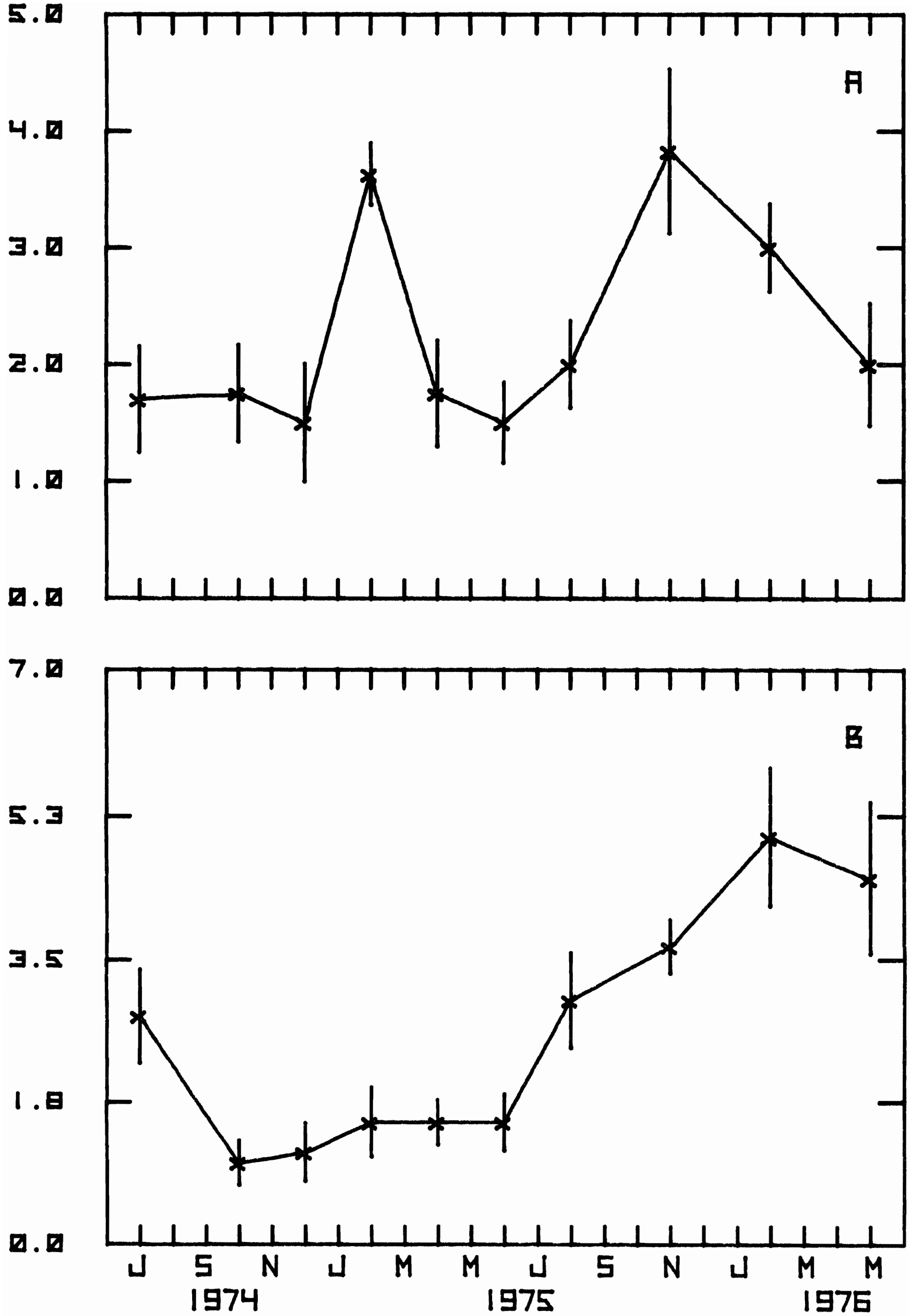

FIGURE 17. A. Mean number of mollusc species per core, Vierras.
B. Mean number of crustacean species per core, Vierras.
Vertical lines represent standard error.

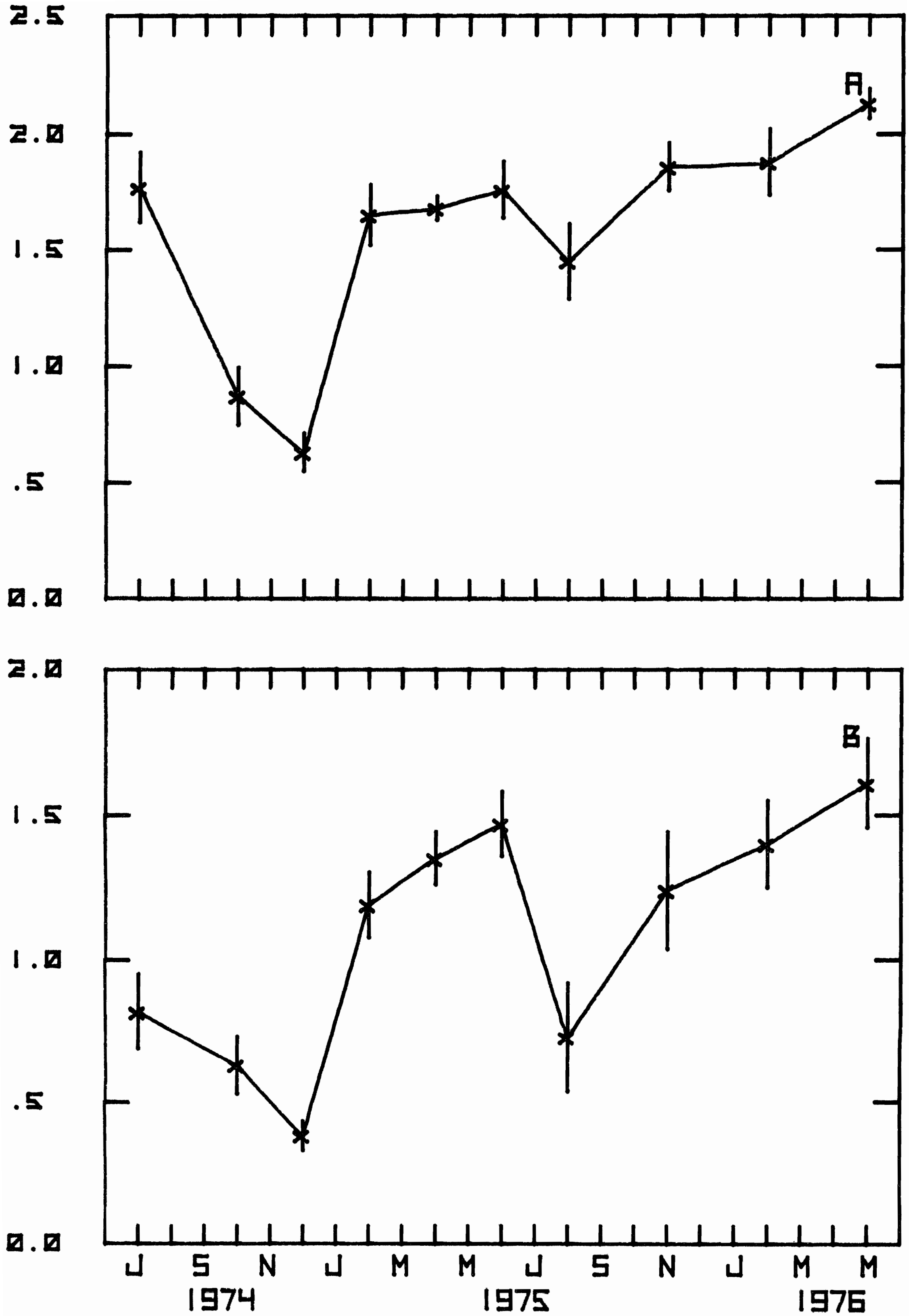

FIGURE 18. A. Mean total diversity, H', per core for all species, Vierras. B. Mean polychaete diversity, H', per core, Vierras. Vertical lines represent standard error.

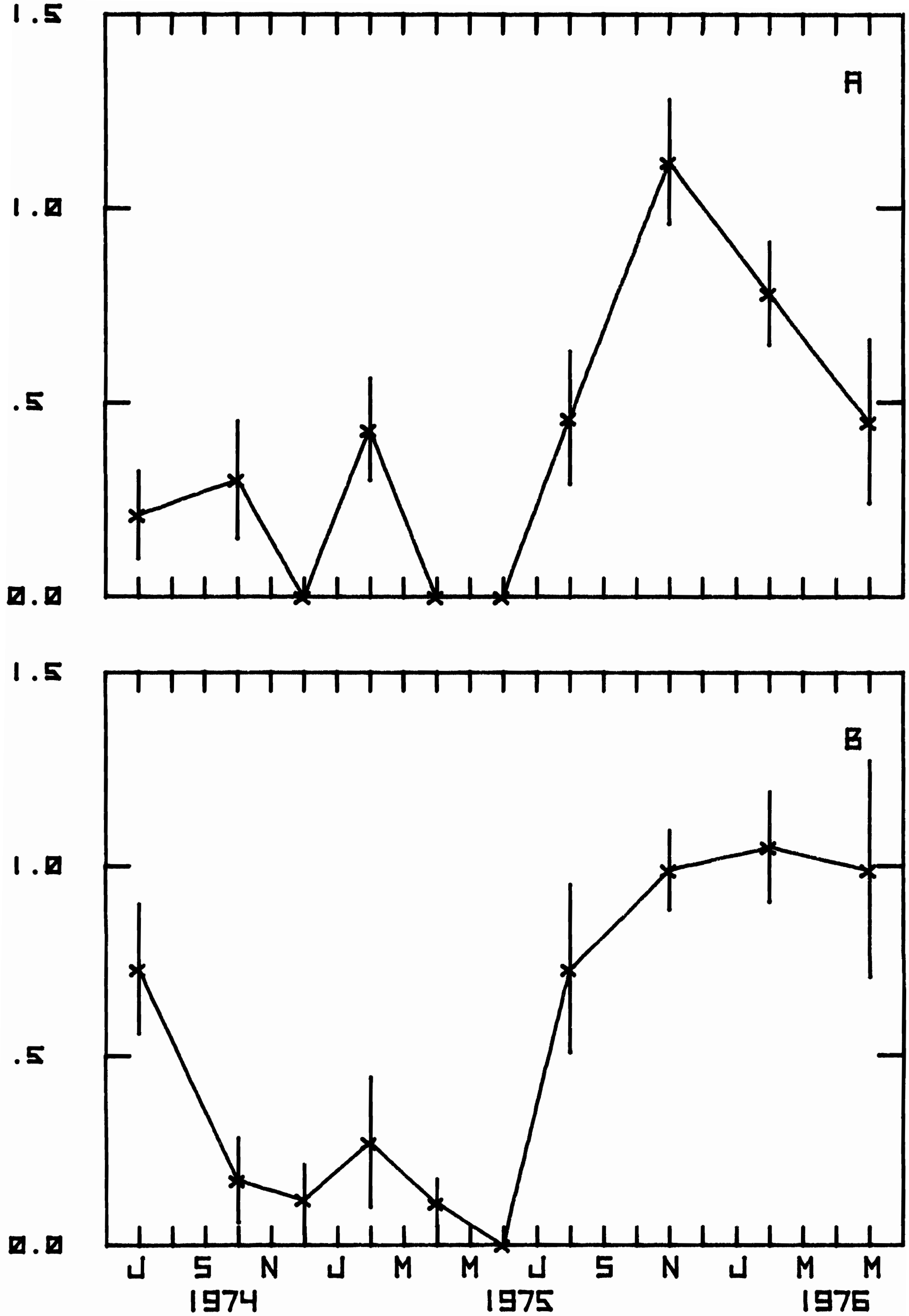

FIGURE 19. A. Mean molluscan diversity, H', per core, Vierras.
B. Mean crustacean diversity, H', per core, Vierras.
Vertical lines represent standard error.

(Figure 18-B). The total H' value subsequently rose again as the high numbers of Armandia brevis significantly decreased from a mean of 232.88 ±23.81 individuals/core in December 1974 to 13.63 ±4.59 individuals/core in February 1975.

The total diversity index at Vierras remained relatively stable from February 1975 through the summer until August 1975, when there was a statistically significant drop ($P < 0.005$, t-test; Figure 18-A). The H' value at this time mostly reflected the lowered numbers of polychaete species and individuals, since the diversity index for the molluscs and crustacea was beginning to increase (Figures 18-B, 19-A and 19-B).

The last significant change observed in the total diversity index occurred in November 1975, when the H' value of each of the three invertebrate classes rose. Whereas the diversity index at Skippers was significantly reduced in May 1976 by very high numbers of a few crustacean species, this did not occur at Vierras. The numbers of the cumacean Cyclaspis sp. did increase at Vierras, but the crustacea counted as a whole were still relatively low and the variance too high to show any significant change from the previous sampling period.

The phoronid Phoronopsis viridis, not discussed here, was often very abundant at Vierras and not at any of the other stations sampled. The presence of these tube-dwelling phoronids may have significantly affected the numbers of individuals and diversity of the infauna appearing at this station.

The Dairy station, located further up the slough, was added during the second year of study and was sampled four times during the nine-month period between August 1975 and May 1976. Polychaetes were again more abundant here than molluscs and crustaceans, but unlike Vierras, the number of crustaceans was high enough to affect changes in the total numbers of individuals.

Considering total abundances first, there was a slight increase from August to November 1975 at the Dairy station ($P < 0.05$, t-test; Figure 20-A). The polychaetes increased significantly in number during this time ($P << 0.001$, t-test; Figure 20-B). Rising abundances of *Capitella capitata* and particularly the spionid *Streblospio benedicti* were the primary cause of the change in polychaete numbers. *Streblospio benedicti* was also the numerically dominant polychaete at this station at all times. Crustacean numbers dropped significantly in November 1975, the absence of the amphipod *Allorchestes angusta* and the leptostracan *Nebalia pugettensis* drastically affecting the crustacean total ($P < 0.001$, Mann-Whitney U-test; Figure 21-B). The number of molluscs did not change significantly at this same time ($P > 0.25$, t-test; Figure 21-A).

In February 1975, the total number of individuals at the Dairy apparently increased, but this observation was not supported statistically ($P > 0.05$, Mann-Whitney U-test). The numbers of polychaetes did not change significantly due to the large variance surrounding the mean of the counts. The crustaceans increased significantly ($P < 0.005$, Mann-Whitney U-test) due primarily to higher numbers of *Cyclaspis* sp. and *Corophium* spp. The abundance of molluscs increased significantly ($P < 0.01$, t-test), primarily because of an increase in numbers of the bivalve *Macoma nasuta*, but the total number of molluscs was still very low in relation to the polychaetes and crustacea.

The mean total numbe— — mollusc individuals at the Dairy in May 1976 appeared to rise, but ag was not statistically different from the previous sampling date (P > 0.05, t-test; Figure 21-A). The numbers of Macoma nasuta continued to increase (P < 0.001, t-test; Figure 5-A), but were still not high enough to affect the total for all three classes of invertebrates. The number of crustaceans increased significantly in May 1976 (P < 0.025, t-test) when the numbers of the tanaid Leptochelia dubia were added to already high abundances of Cyclaspis sp. and Corophium spp. The rise in numbers of Leptochelia coincided with the same phenomenon at Skippers (Figure 4-A). Numbers of polychaetes in May 1976 show no significant change from the previous sampling period in February 1976 (P > 0.1, Mann-Whitney U-test).

The total number of species at the Dairy dropped to a low in November 1975 (P << 0.001, t-test; Figure 23-A), unlike the Skippers and Vierras stations, which were lowest in numbers of species in August 1975. Only the polychaetes and crustaceans influenced this reduction (Figures 22-B and 23-B). In February 1976, the mean total number of species was higher, but not statistically different (P > 0.05, Mann-Whitney U-test). The polychaete and crustacean species did increase significantly at this time, while the number of mollusc species did not (Figures 22-B, 23-A and 23-B). During the last sampling period in May 1976, there was a drop in the total number of species (P < 0.01, t-test), as was the trend at Skippers and Vierras. The only statistically significant change at this time was the lowered numbers of mollusc species.

Looking next at the species diversity index H', there was considerable fluctuation among the four sampling periods at the Dairy (Figure 24-A). The H' value for all three invertebrate classes dropped off steeply in November 1975 (Figures 24-B, 25-A and 25-B), due to a combination of fewer numbers of species and high numbers of one or two species present in each class. Streblespio benedicti and Capitella capitata numerically dominated the polychaetes, while Macoma nasuta and Cyclaspis sp. dominated the molluscs and crustaceans, respectively.

From February through May 1976, the diversity index for polychaetes continued to drop at the Dairy as high numbers of Streblospio benedicti dominated this class. The opportunistic polychaete Armandia brevis did not settle in high densities relative to the remaining polychaete species (Figure 10-A). Capitella capitata did peak in numbers in November 1975 (Figure 11-A), coincident with the rise at Skippers, but occurred in far fewer numbers than Streblospio benedicti.

There were very few mollusc species occurring at the Dairy; therefore, the diversity index for this class remains relatively low and, in some cases, simply was meaningless to calculate. Because there were so few species, the complete absence of one or two species out of three or four caused a significant change. This happened in November 1975, when there were so few species. The mean H' value was zero (Figure 25-A). In February 1976, the H' value increased significantly, as several clam species appeared again in very low numbers. During the next sampling period in May 1976, the mean abundance of the numerically dominant clam Macoma nasuta rose from 4.83 ±1.14 individuals/core to 12.50 ±2.35 individuals/core (Figure 5-A), which forced

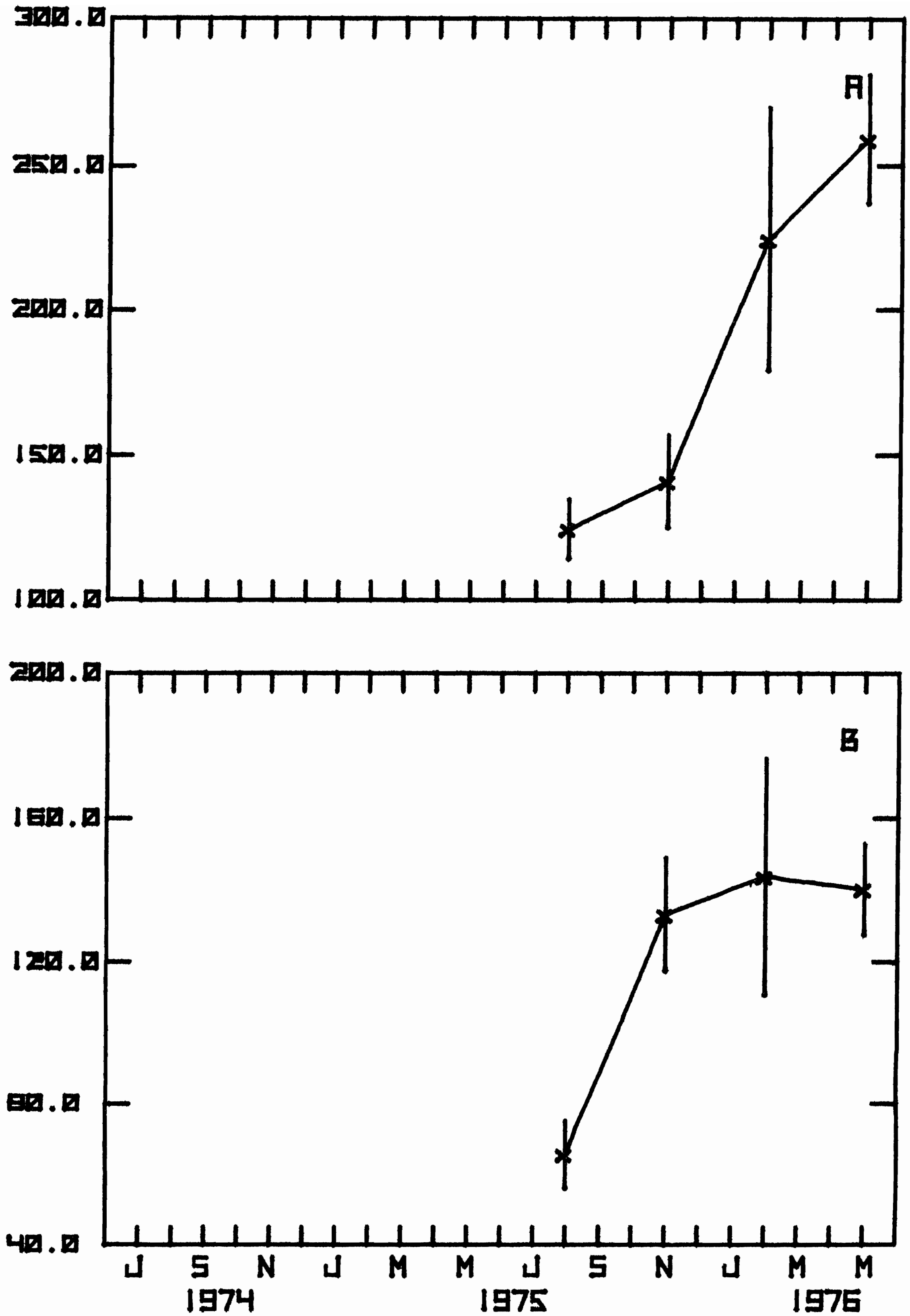

FIGURE 20. A. Mean number of individuals per core of all groups, The Dairy. B. Mean numbers of polychaete individuals per core, The Dairy. Vertical lines represent standard error.

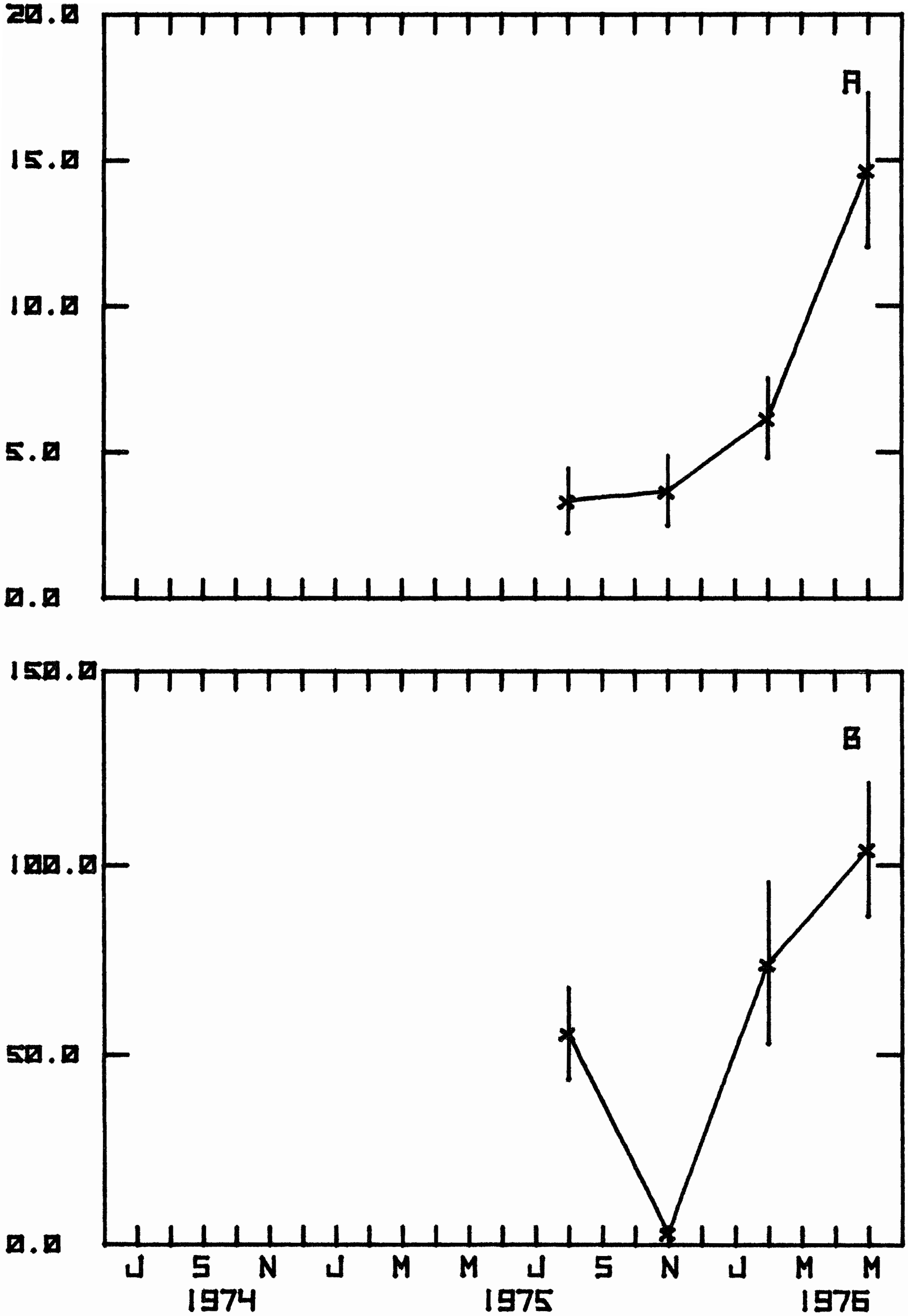

FIGURE 21. A. Mean number of mollusc individuals per core, The Dairy. B. Mean number of crustacean individuals per core, The Dairy. Vertical lines represent standard error.

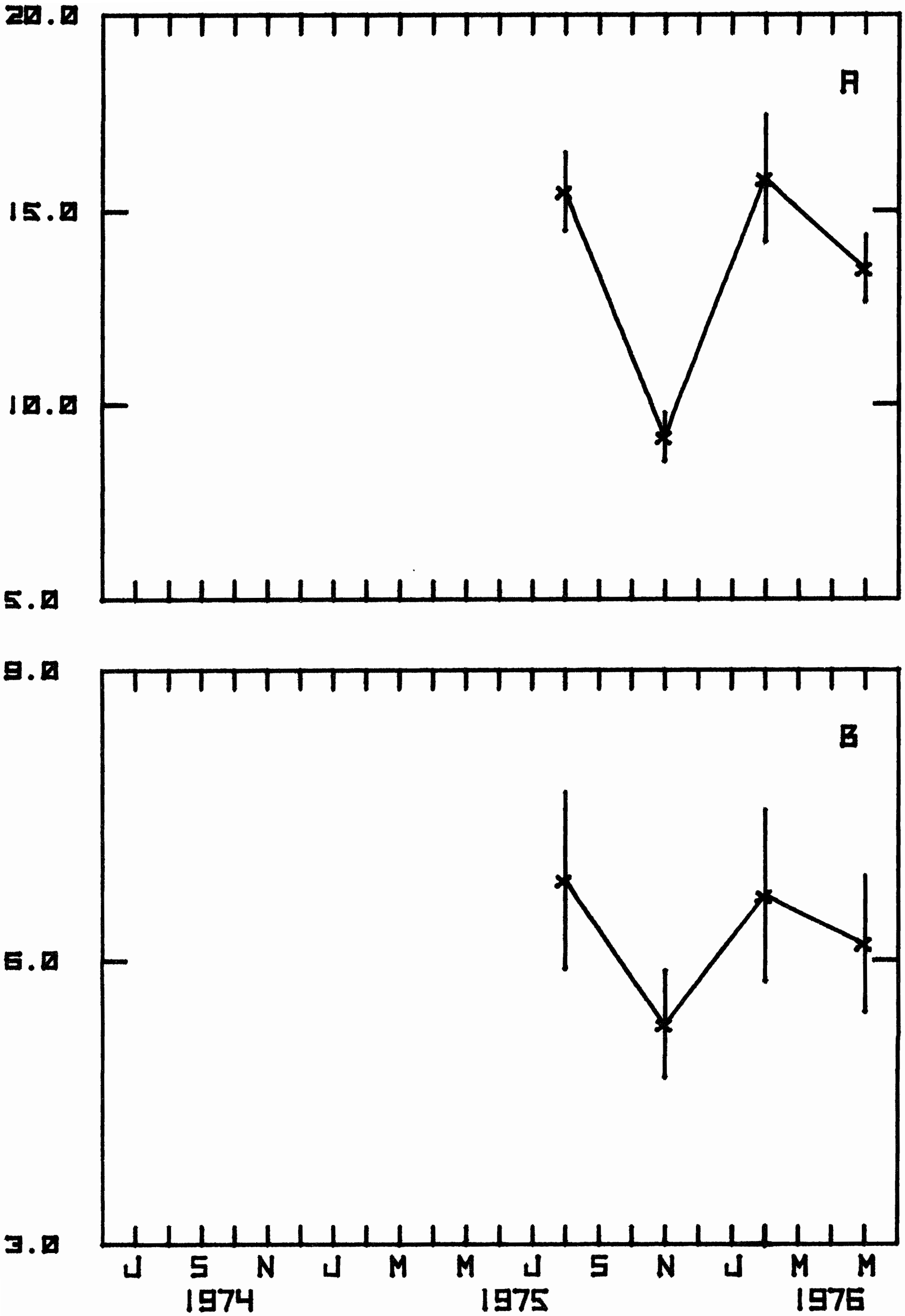

FIGURE 22. A. Mean number of species per core of all groups, The Dairy. B. Mean number of polychaete species per core, The Dairy. Vertical lines represent standard error.

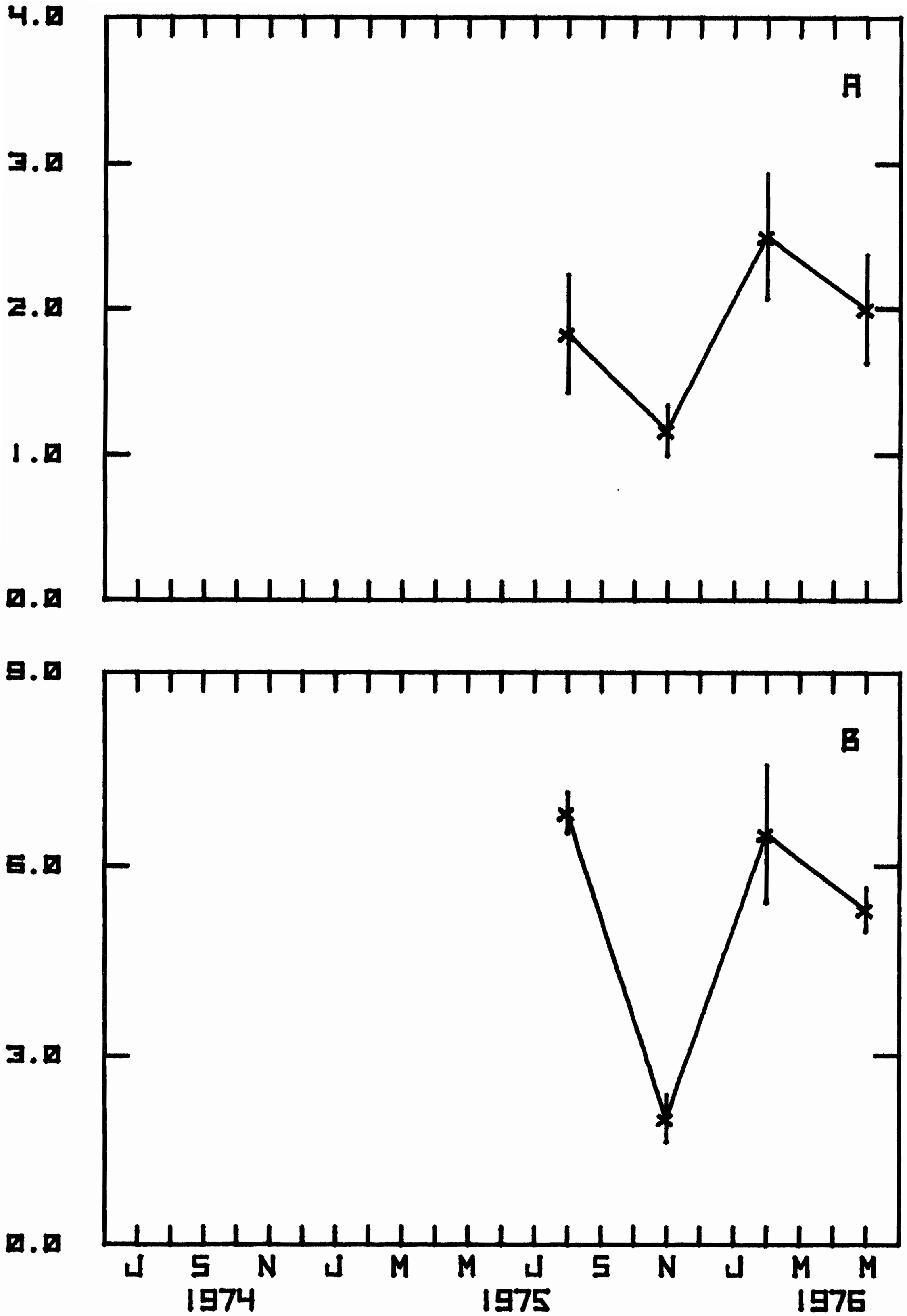

FIGURE 23. A. Mean number of mollusc species per core, The Dairy.
B. Mean number of crustacean species per core, The Dairy.
Vertical lines represent standard error.

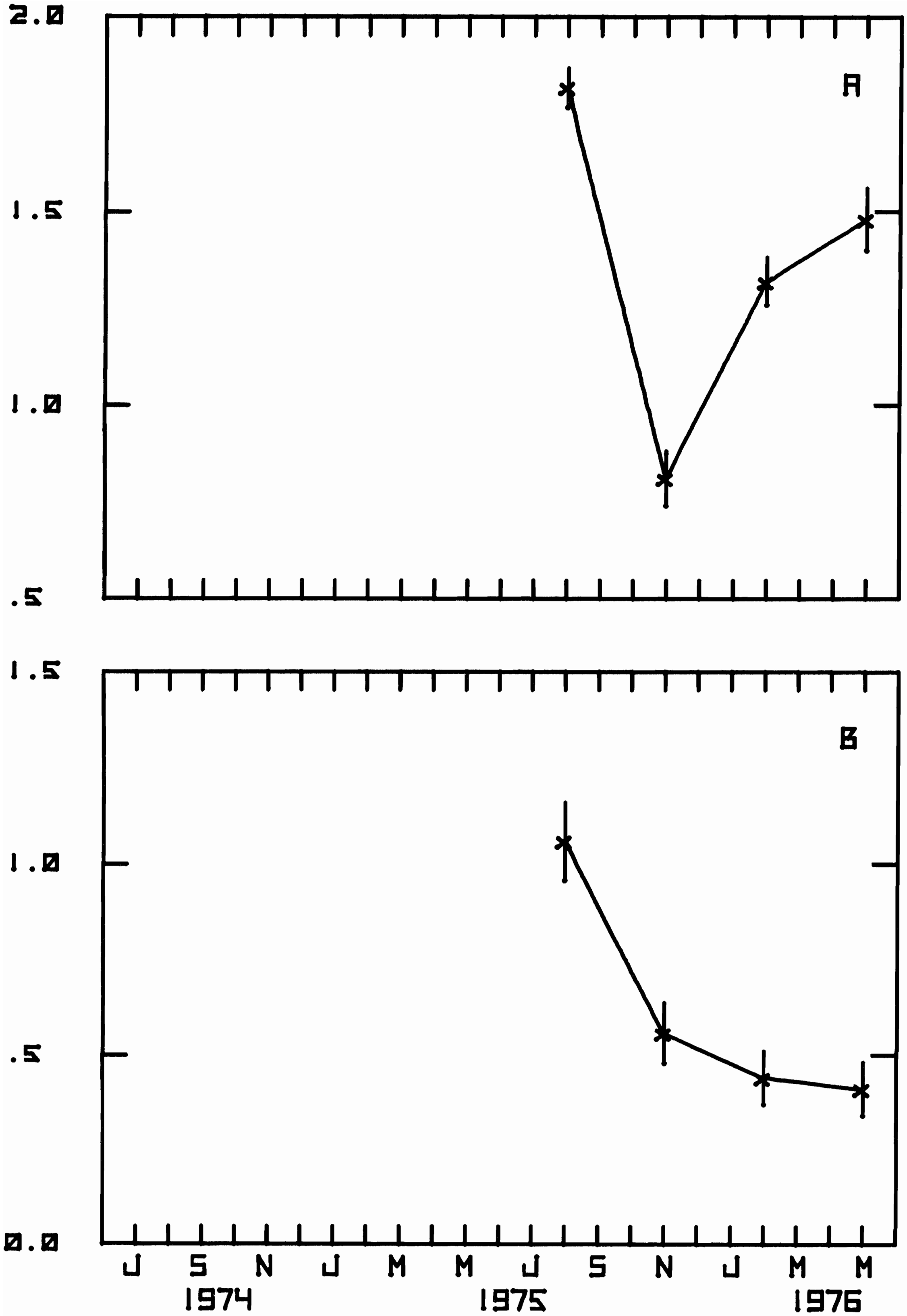

FIGURE 24. A. Mean total diversity, H', per core at The Dairy.
B. Mean polychaete diversity, H', per core at The Dairy.
Vertical lines represent standard error.

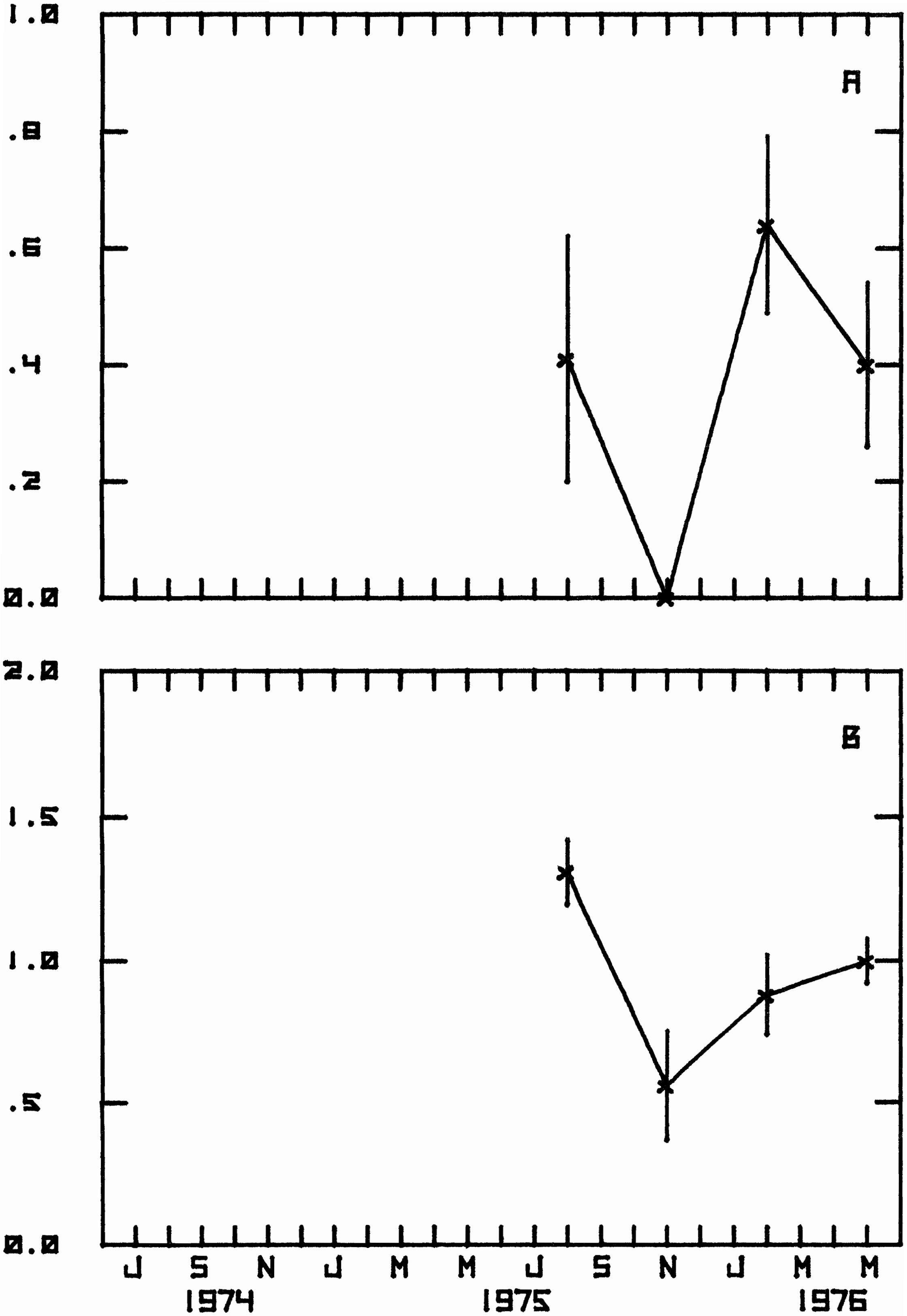

FIGURE 25. A. Mean mollusc diversity, H', per core at The Dairy.
B. Mean crustacean diversity, H', per core at The Dairy.
Vertical lines represent standard error.

the calculated H' value down through reduction of the evenness component of diversity.

Crustacean numbers and species at the Dairy were generally higher than for the polychaetes and molluscs; therefore, the trends of the total diversity index, calculated for all three classes, directly reflected changes in the crustacean fraction (Figures 24-A and 25-B). Many crustacean species found in August 1975 were absent in November 1975, causing a significant decrease in the H' values ($P < 0.001$, t-test). The diversity index increased in February 1976, aided by the reappearance of two amphipod species and a tanaid found in the August 1975 samples, but absent in November 1975. High densities of Cyclaspis sp. were observed in February and May 1976 (Figure 3-A), but other crustaceans, most notably Corophium spp. and Leptochelia dubia, were also abundant at these times, so the diversity index did not change significantly ($P > 0.5$, t-test).

Crustaceans were generally the numerical dominants at Kirby Park, rather than the polychaetes. Changes in the high densities of all three classes reflected this dominance (Figures 26-A and 27-B). From November 1974 to February 1975, there was a very significant rise in total numbers of individuals caused by the crustaceans and, in particular, high densities of the cumacean Cyclaspis sp. (245.38 ±48.74 individuals/core; Figure 3-B).

There was an increase in abundance of polychaetes between November 1974 and December 1974 at Kirby Park ($P < 0.01$, Mann-Whitney U-test), due to higher numbers of the spionids Streblospio benedicti and Polydora ligni and the ctenodrilid, Ctenodrilus serratus (Figure 26-B). No change in the number of polychaetes was observed in February 1975. As with the polychaetes, the molluscs rose in numbers of individuals in December 1974, due almost entirely to increased numbers of the dominant clam at Kirby Park, Gemma gemma ($P < 0.005$, Mann-Whitney U-test; Figure 28-A).

No significant changes were observed in numbers of individuals/core between February and April 1975 at Kirby Park. In June 1975, there was a slight increase in the total abundance, due to an increase in the number of polychaetes ($P << 0.001$, t-test). The mean numbers per core of the polychaetes Streblospio benedicti, Exogone lourei and Ctenodrilus serratus all rose from the previous values two months earlier.

Toward the end of the summer, August 1975, the number of crustaceans at Kirby Park dropped steeply, especially the numbers of Cyclaspis sp. and Corophium ssp., a trend similar to that seen at the other stations. A peak in the numbers of the clam Gemma gemma was reached at the same time, while no significant change in the polychaete abundance was observed ($P > 0.1$, t-test).

The total number of individuals of all groups dropped significantly in November 1975 ($P << 0.001$, t-test), primarily due to decreased numbers of molluscs and crustaceans, as no change was observed for the polychaetes ($P > 0.05$, Mann-Whitney U-test). The abundances of the crustaceans Cyclaspis and Corophium continued to fall downward at this time. The numbers of Gemma gemma dropped from 54.63 ±14.94 individuals/core in August 1975 to 1.50 ±0.50 individuals/core in November 1975, and remained low without significant change through May 1976.

In February 1976, the total number of individuals of the three invertebrate classes at Kirby Park rose significantly, due to increased numbers of polychaetes and crustacea. The rise in crustaceans was due primarily to increased numbers of *Cyclaspis* (Figure 3-B). Higher densities of *Exogone lourei* than at any of the other stations accounted for much of the increase in the polychaete fraction at this time (Figures 28-A and 28-B). Although *Capitella capitata* and *Armandia brevis* were present at Kirby Park (Figures 10-B and 11-B), their abundances were low and the blooms of these opportunistic species which dominated other stations were not influential here on the total number of individuals.

During the last sampling period in May 1976, the number of individuals dropped again, due this time to the polychaetes, since the abundances of molluscs and crustaceans did not change significantly. The fall in numbers of polychaetes could be attributed again to a change in the numbers of the syllid *Exogone lourei* (Figure 28-B). *Leptochelia dubia*, the tanaid so abundant at Skippers and the Dairy in May 1976, was very low in abundance at all times at Kirby Park (Figure 4-B).

The total number of species present at Kirby Park changed significantly between each sampling period except the last (Figure 29-A). The polychaetes and crustaceans influenced these changes, since the molluscs comprised so few species (Figure 29-B, 30-A and 30-B). Between November 1974 and February 1975, there were increased numbers of polychaete and crustacean species. A decline began in April 1975. At the beginning of the summer, all three classes of invertebrates increased in number of species present to the highest mean value seen at Kirby Park, 14.25 ±0.56 species/core ($P < 0.001$, t-test).

In November 1975, the total number of species at Kirby Park decreased to another low in a trend similar to that seen in the previous year. This decrease was strongly influenced by the crustaceans and particularly the absence of some amphipod species. The reduction in crustacean species coincided with a similar decrease at the Dairy station. The total number of species in May 1976 showed no significant change ($P > 0.25$, t-test; Figure 29-A). This was the result of reduced numbers of mollusc and polychaete species being offset by increased numbers of crustacean species (Figures 29-B, 30-A and 30-B).

The calculated species diversity index H' showed considerable fluctuation at Kirby Park during the entire sampling period (Figure 31-A). The values for mollusca were low or not calculatable, due to the presence of few species. Changes in the molluscan diversity index could at all times be directly related to changes in the dominance of the clam *Gemma gemma*. The H' value of polychaetes and crustaceans directly opposed each other between November 1974 and April 1975. The polychaete diversity index increased during this period (Figure 31-B), while the crustacean diversity index fell to a low in April 1975, due to domination by high numbers of *Cyclaspis* sp. and *Corophium* spp. (Figure 32-B).

A downward trend occurred in the polychaete H' value between June 1975 and November 1975, when there were fewer species present and *Streblospio benedicti* and *Exogone lourei* were dominant. The crustacean diversity index peaked in August 1975 ($P << 0.001$, t-test) as the numbers of *Cyclaspis* and *Corophium* were lower and less dominant. This crustacean peak fell to a low point along with the polychaetes during the next sampling period in November 1975.

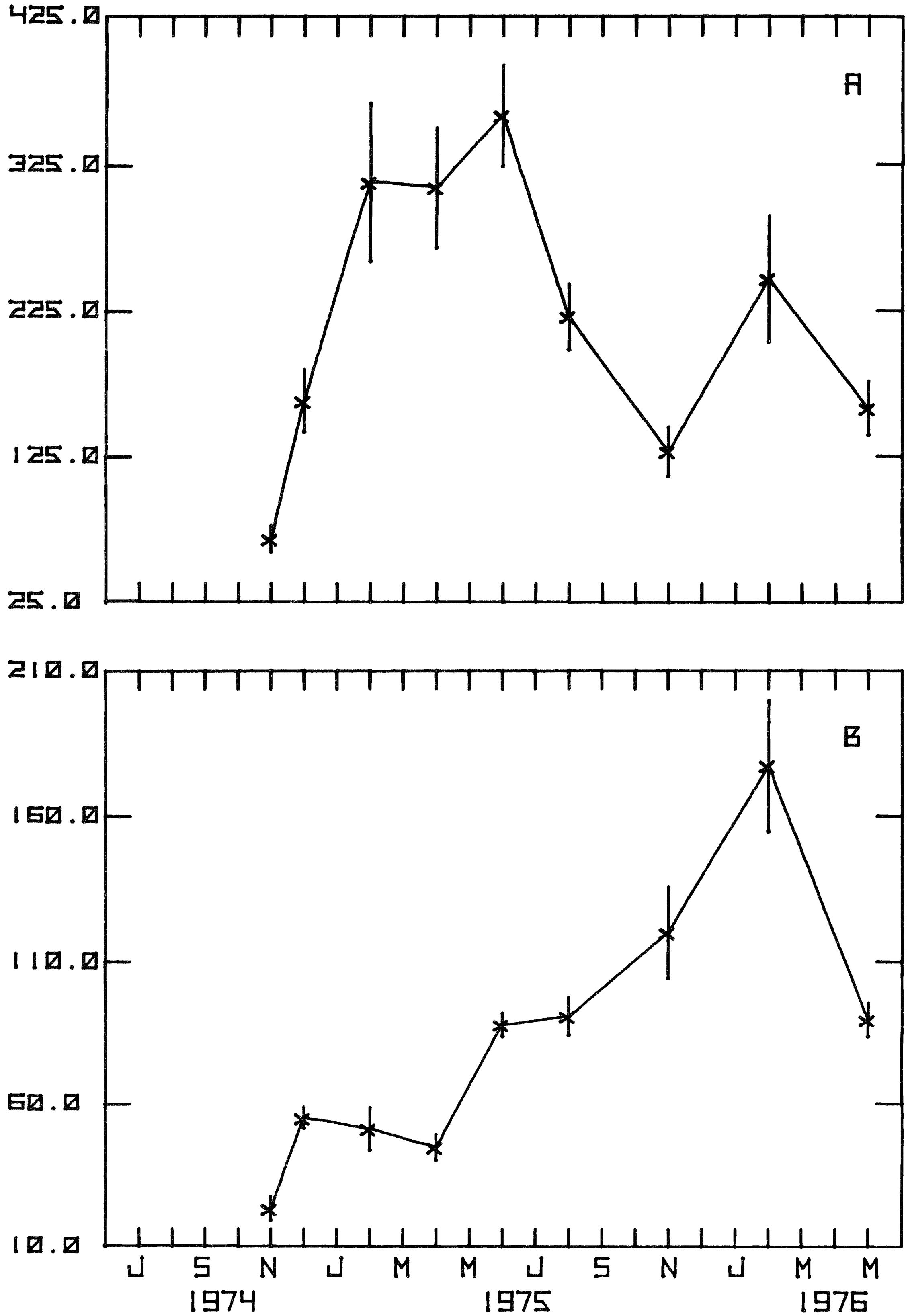

FIGURE 26. A. Mean total number of individuals per core, Kirby Park. B. Mean number of polychaete individuals per core, Kirby Park. Vertical lines represent standard error.

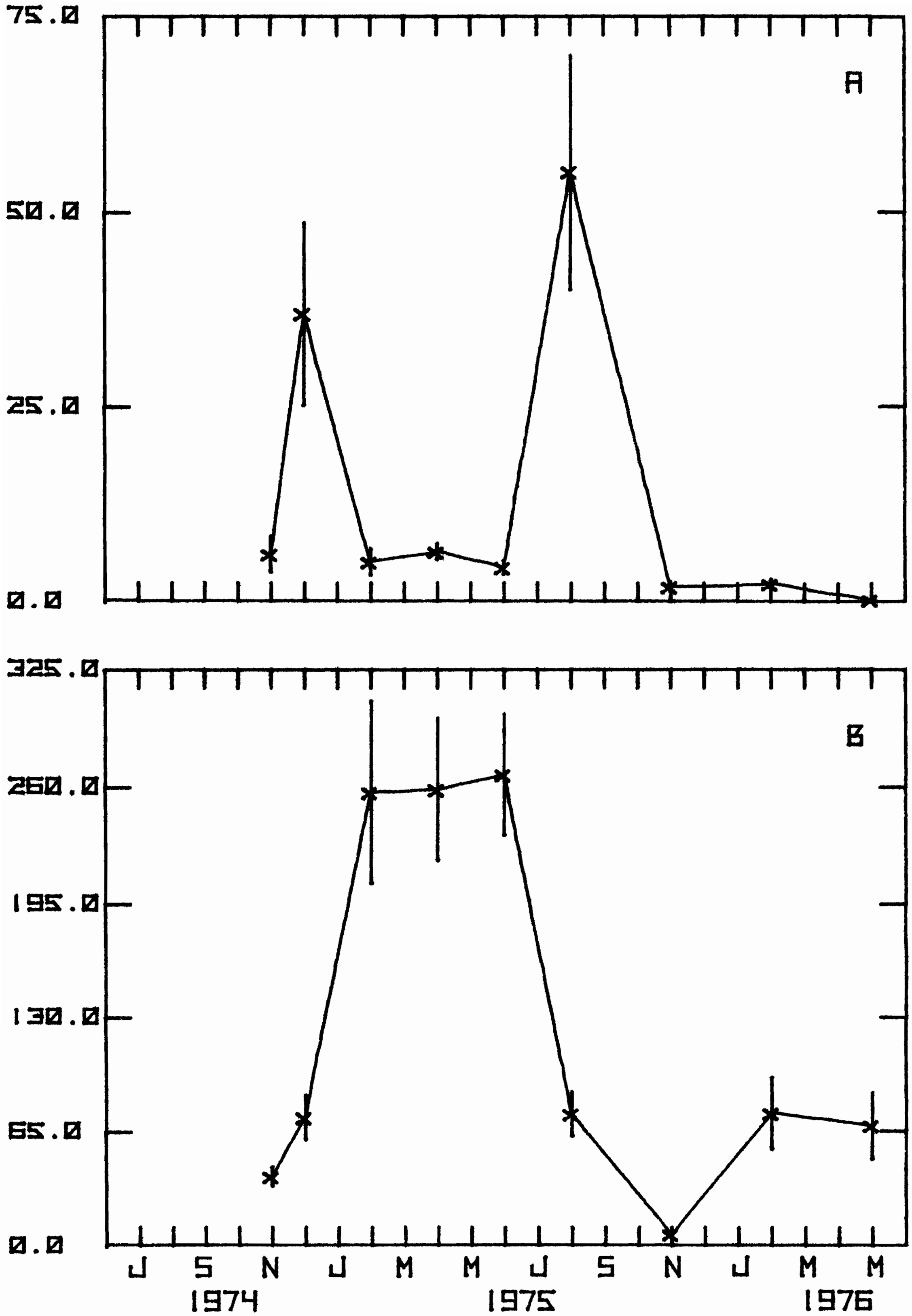

FIGURE 27. A. Mean number of mollusc individuals per core, Kirby Park. B. Mean number of crustacean individuals per core, Kirby Park. Vertical lines represent standard error.

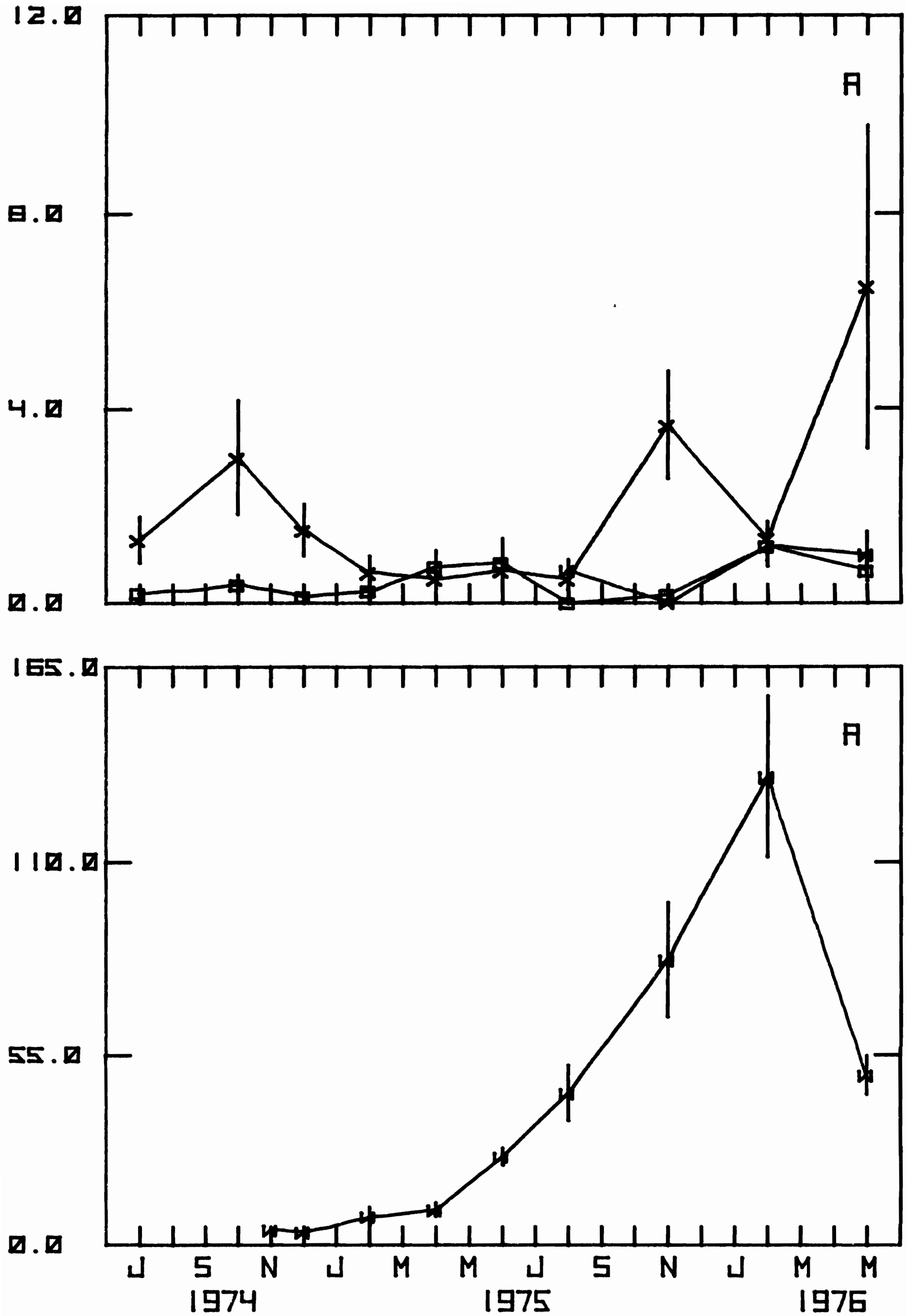

FIGURE 28. Mean numbers of individuals of <u>Exogone lourei</u> per core at: <u>A</u>. Skippers (X), Vierras (O), The Dairy (W), and <u>B</u>. Kirby Park. Vertical lines represent standard error.

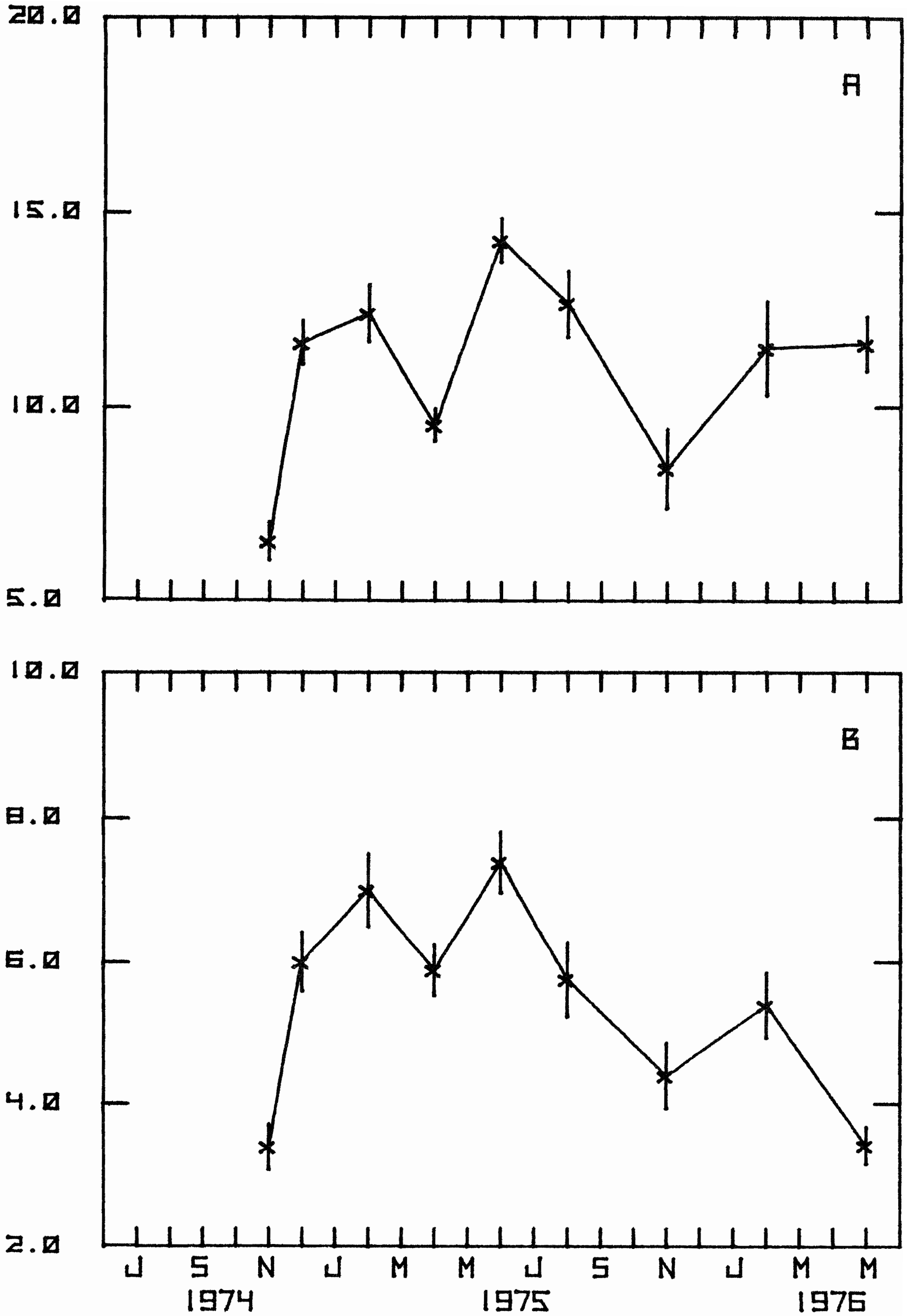

FIGURE 29. A. Mean total number of species per core, all groups, Kirby Park. B. Mean number of polychaete species per core, Kirby Park. Vertical lines represent standard error.

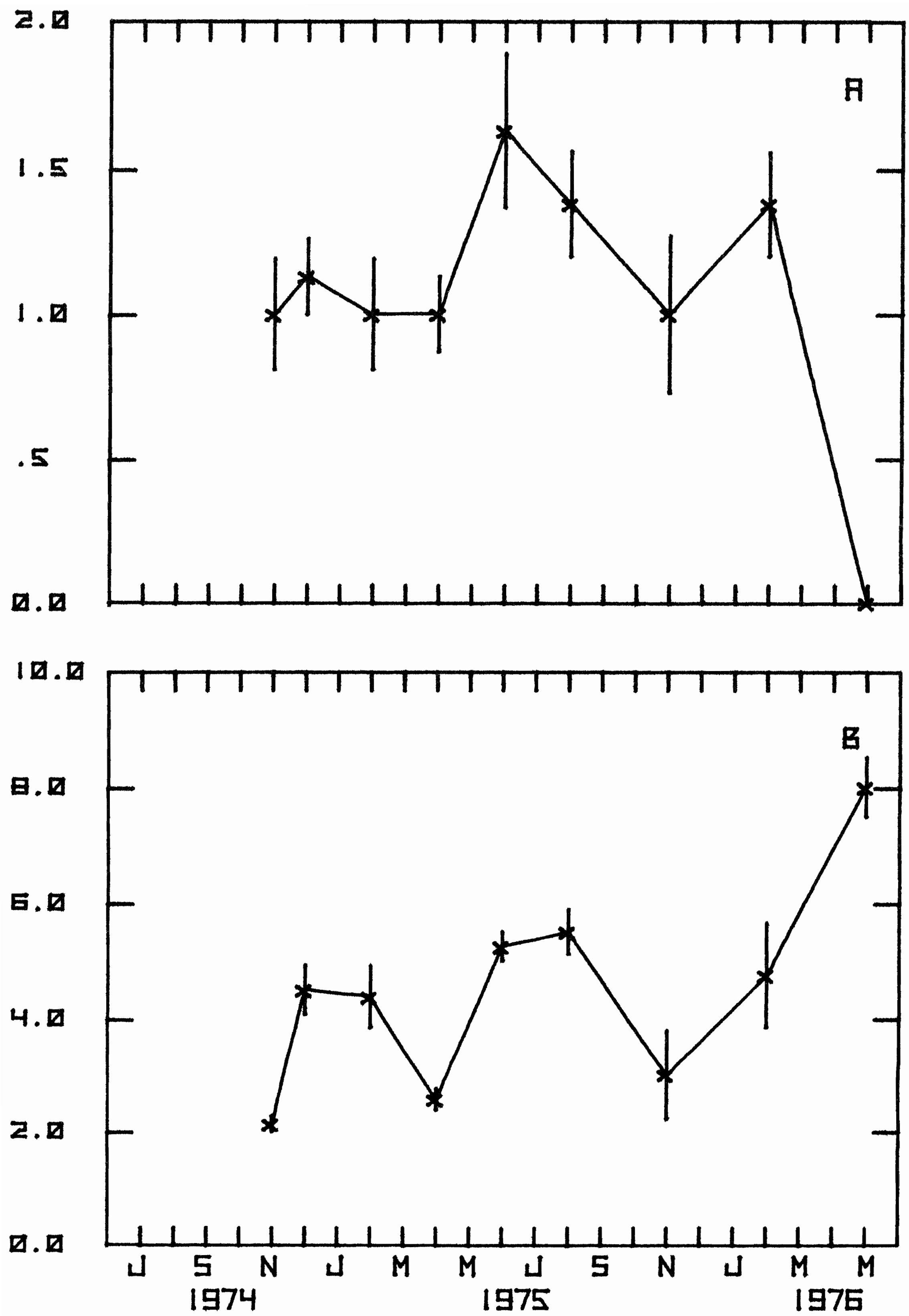

FIGURE 30. A. Mean number of mollusc species per core, Kirby Park. B. Mean number of crustacean species per core, Kirby Park. Vertical lines represent standard error.

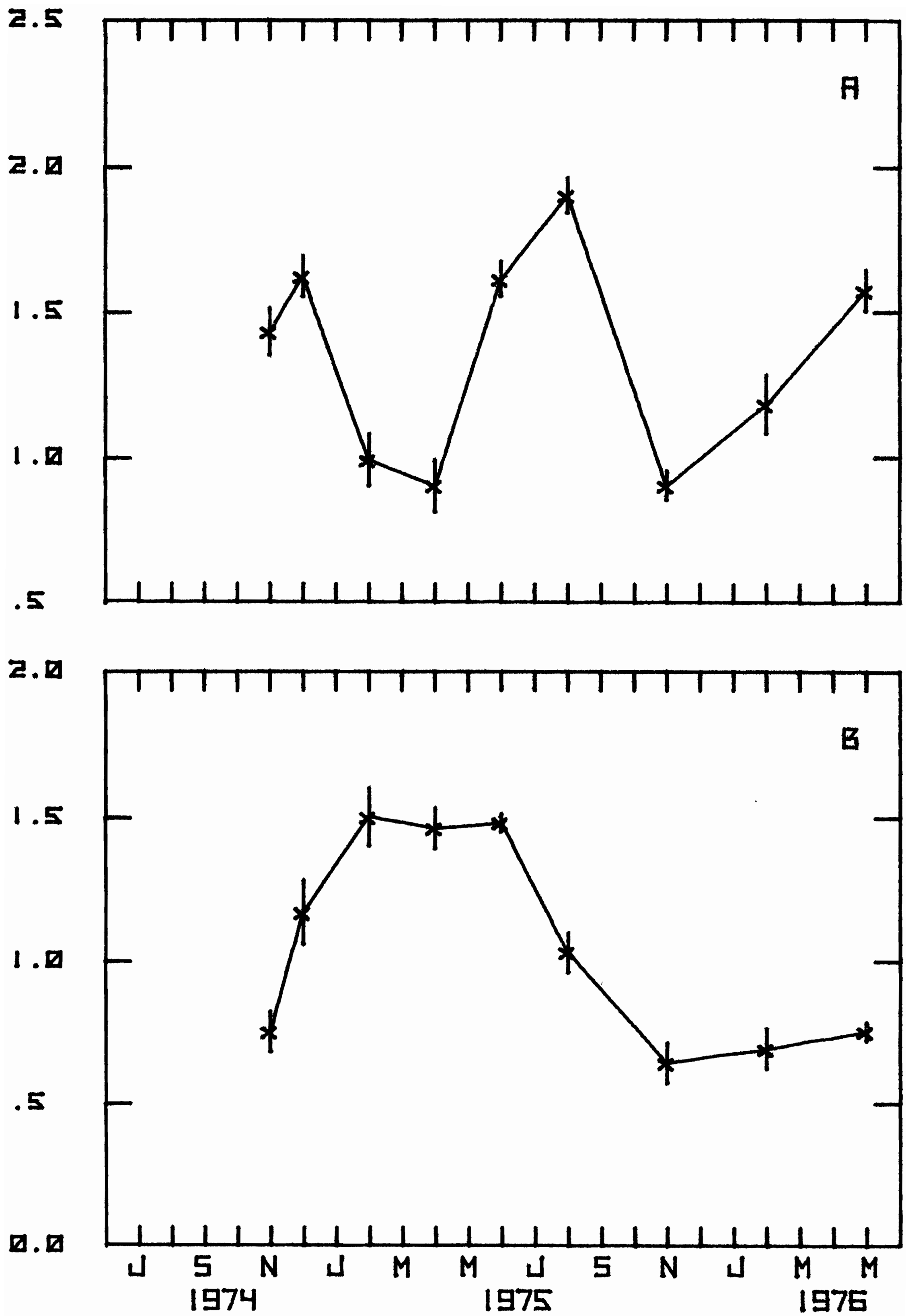

FIGURE 31. A. Mean total diversity, H', per core at Kirby Park.
B. Mean polychaete diversity per core at Kirby Park.
Vertical lines represent standard error.

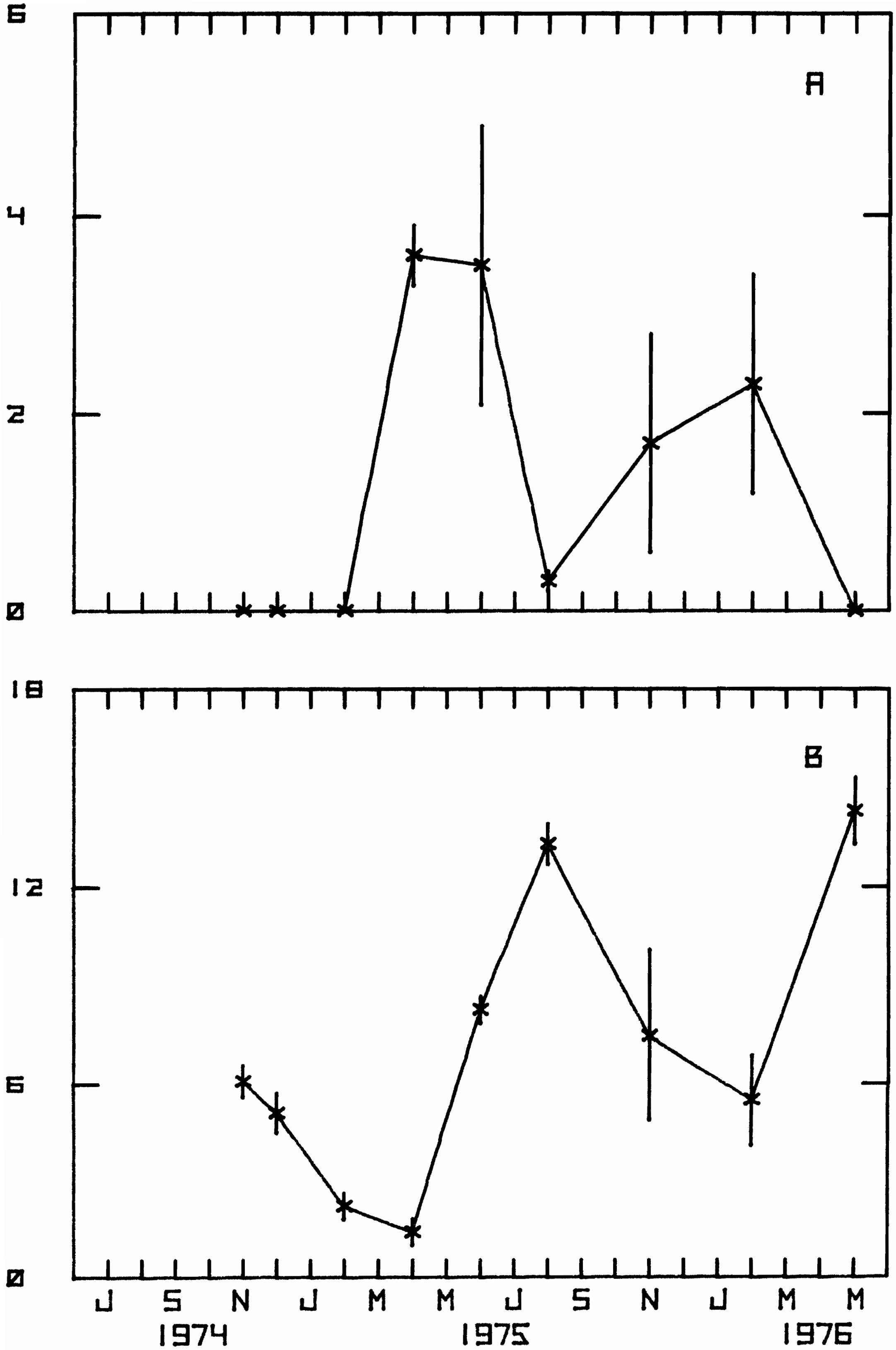

FIGURE 32. A. Mean mollusc diversity, H', per core at Kirby Park. B. Mean crustacean diversity per core at Kirby Park. Vertical lines represent standard error.

Samples taken in February 1976 showed the diversity index apparently falling again, but the change was not significant (P > 0.05, t-test). The polychaete H' value did not change significantly at this time either (P > 0.1, t-test). During the last sampling period in May 1976, the polychaete diversity index again did not change significantly (P > 0.1, Mann-Whitney U-test), while there was a very significant rise in the crustacean H' value (P << 0.001, t-test). This increase was caused by the presence of additional amphipod and tanaid species and fewer numbers of the dominant Cyclaspis, a trend similar to that seen in the crustacean fraction between April and June of the previous year.

In summary, the numbers of individuals and the diversity index at Skippers and Vierras were greatly influenced by winter peaks in the numbers of the opportunistic polychaetes Capitella capitata and Armandia brevis. These peaks were less important at the Dairy and insignificant at Kirby Park.

Both crustaceans and polychaetes influenced the total abundances of invertebrates and the diversity index at Skippers, the Dairy and Kirby Park. The highest densities of crustaceans were found at Kirby Park, where the dominants were the amphipod Corophium spp. and the cumacean Cyclaspis sp. These same crustaceans, together with the tanaid Leptochelia dubia, were also important during the second year of study at Skippers and the Dairy. There was a general trend towards peak numbers of crustaceans occurring in late spring and early summer at all stations.

In addition to the opportunistic polychaete species at Skippers, there were also significant numbers of several other spionid and capitellid species

(Table 5). At the Dairy and Kirby Park stations, one spionid species in particular, Streblospio benedicti, dominated in numbers relative to other species. The syllid Exogone lourei was another numerically dominant polychaete at Kirby Park, but not so elsewhere.

The molluscs throughout the slough were lower in abundance and much less diverse in number of species present than the other two invertebrate classes. Few molluscs other than relatively small clams and undetermined juvenile species were sampled by our cores. The deposit-feeding tellinid Macoma nasuta was the most abundant clam found at Skippers, Vierras and the Dairy stations. At Kirby Park, the suspension-feeding clam Gemma gemma was clearly the dominant mollusc.

Since smaller cores were used at Kirby Park than at the other three stations, strict comparisons between numbers of species or individuals per core at the various sampling sites are difficult to make. Very generally speaking, then, there were higher numbers of species and diversity index values at Skippers than at any other station. The trend towards fewer species and lower diversity index values continued inland from the mouth of the slough, the extreme example of this occurring at Kirby Park, which was dominated by high numbers of a few species. Finally, the numbers of polychaetes were important to the total abundances at all stations, while the number of molluscs contributed less in this regard. Numbers of crustaceans fluctuated rather widely and there was no clear trend from station to station as to their importance at times, but crustaceans were very significant in occurrence most of the year at Kirby Park. Cyclic trends in abundance of any of the species observed might be better defined by a longer term study. Certainly, we do not at this time have a handle on the seasonal or annual trends in the populations of the dominant invertebrate species in Elkhorn Slough.

B. Subtidal Quantitative Studies in Moss Landing Harbor

The stations H-1, H-2, H-3 and H-4 indicated on Figure 1 represent the stations for which we presently have quantitative samples. All of these stations lie in the present boat channel and all are, therefore, dredged regularly in routine maintenance dredging of the harbor. These stations serve then as a monitor of recolonization patterns of benthic communities and give an indication of the types of changes which might be expected. These stations have been sampled and analyzed by personnel working on another project and it is only because of this that we have data for these stations.

The harbor channel was most recently dredged in the summer of 1974 at about the time of initiation of these studies. However, we do have data on certain of these stations extending back to 1971 (not included here), when the last dredging occurred. Before dredging, the bottom at H-3 and H-4 stations was poorly sorted sand with a five to ten percent silt fraction. Benthic algae, Gracilaria sp. and Enteromorpha sp., covered approximately ten to fifteen percent of the bottom and probably helped to trap and stabilize the finer fraction of the sediment. The pre-dredging assemblage was characterized by capitellid polychaetes, Notomastus tenuis, Heteromastus filobranchus, Mediomastus californiensis, several oligochaetes and bivalves of the genus Macoma. Capitella capitata was also present at the 1974 site, H-3.

Table 9. STATION H-1

Principal species and their statistical parameters by sampling date.

	2 July 1974 (4 replicates)				25 September 1974 (4 replicates)				15 November 1974 (4 replicates)				19 December 1974 (4 replicates)			
	N	$\bar{X}$/CORE	S^2	$S_{\bar{X}}$	N	$\bar{X}$/CORE	S^2	$S_{\bar{X}}$	N	$\bar{X}$/CORE	S^2	$S_{\bar{X}}$	N	$\bar{X}$/CORE	S^2	$S_{\bar{X}}$
Number polychaete individuals	93	23.25	20.92	2.29	53	13.25	25.58	2.53	1709	427.25	11476.92	53.56	1947	486.75	39486.25	99.36
Armandia brevis					18	4.50	1.67	0.64	1080	270.00	3736.00	30.56	1697	424.25	30902.92	87.90
Capitella capitata					22	5.50	13.67	1.85	408	102.00	1672.67	20.45	122	30.50	29.67	2.72
Gyptis brevipalpa	9	2.25	4.92	1.11												
Streblospio benedicti	59	14.75	27.58	2.63					139	34.75	121.58	5.51	80	20.00	368.67	9.60
Number crustacean individuals	1	0.25	0.25	0.25	2	0.50	1.00	0.50	3	0.75	0.25	0.25				
Number mollusc individuals	6	1.50	3.00	0.87	2	0.50	0.33	0.29	2	0.50	0.33	0.29	4	1.00	0.00	0.00
Total number PCM individuals	100	25.00	36.67	3.03	57	14.25	30.92	2.78					1951	487.75	39486.25	99.36
Number polychaete species		5.75	0.92	0.48		4.20	4.20	1.00		10.00	4.67	1.08		8.25	2.25	0.75
Number crustacean species		8.33	208.33	8.33		0.50	1.00	0.50		0.75	0.25	0.25				
Number mollusc species		1.25	1.58	0.63		0.50	0.30	0.30		0.50	0.33	0.29		1.00	0.00	0.01
Total number PCM species		13.25	143.58	5.99		5.20	7.60	1.40		11.25	6.25	1.25		9.20	1.50	0.80
Diversity (H')		1.37	0.02	0.08		1.30	0.21	0.23		1.06	0.00	0.02		0.56	0.00	0.02
Evenness (J')		0.70	0.00	0.04		0.87	0.01	0.04		0.44	0.00	0.02		0.25	0.00	0.00
Oligochaeta	848	212.00	1746.00	20.89	5	1.20	3.50	0.90	96	24.00	70.67	4.20				

Table 9. STATION H-1 continued

	17 February 1975 (4 replicates)				1 May 1975 (4 replicates)				17 September 1975 (4 replicates)			
	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$
Number polychaete individuals	858	214.50	26375.00	81.20	1172	293.00	31504.67	88.75	188	47.00	81.33	4.51
Armandia brevis	120	30.00	896.67	14.97					32	8.00	14.00	1.87
Capitella capitata	373	93.25	12568.25	56.05	918	229.50	20721.67	71.98	142	35.50	108.33	5.20
Gyptis brevipalpa												
Streblospio benedicti	308	77.00	4920.00	35.07	234	58.50	1020.33	15.97				
Number crustacean individuals	7	1.75	4.25	1.03	2	0.50	0.33	0.29	3	0.75	2.25	0.75
Number mollusc individuals	8	2.00	1.33	0.58	3	0.75	0.25	0.25	8	2.00	3.33	0.91
Total number PCM individuals	873	218.25	26858.25	81.94	1177	294.25	31364.92	88.55	199	49.75	102.92	5.07
Number polychaete species		9.75	7.58	1.38		6.00	2.00	0.71		4.25	0.92	0.48
Number crustacean species		1.25	2.25	0.75		0.50	0.33	0.29		1.00	2.00	0.71
Number mollusc species		1.75	0.92	0.48		0.75	0.25	0.25		1.50	1.67	0.65
Total number PCM species		12.25	8.25	1.44		7.25	0.92	0.48		6.75	6.92	1.32
Diversity (H')		1.31	0.04	0.10		0.67	0.01	0.05		0.96	0.07	0.13
Evenness (J')		0.54	0.01	0.06		0.34	0.00	0.04		0.53	0.01	0.04
Oligochaeta												

Table 10. STATION H-2

Principal species and their statistical parameters by sampling date.

	12 August 1974 (3 replicates)				27 September 1974 (4 replicates)				14 November 1974 (2 replicates)				19 December 1974 (4 replicates)			
	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$
Number polychaete individuals	270	90.00	2479.00	28.75	1228	307.00	46906.00	108.29	702	351.00	4608.00	48.00	2103	525.75	11990.92	54.75
Armandia brevis	17	5.67	22.33	2.73	480	120.00	19182.00	69.25	212	106.00	7688.00	62.00	1270	317.50	12179.00	55.18
Capitella capitata					607	151.75	4388.92	33.12	405	202.50	1012.50	22.50	740	185.00	2790.00	26.41
Cossura sp.	11	3.67	30.33	3.18	10	2.50	8.33	1.44								
Eteone longa californica																
Eumida tubiformis													12	3.00	2.00	0.71
Gyptis brevipalpa									4	2.00	2.00	1.00				
Harmothoe lunulata																
Heteromastus filobranchus	135	45.00	661.00	14.84	71	17.75	40.92	3.20	59	29.50	12.50	2.50	20	5.00	0.67	0.41
Mediomastus californiensis	88	29.33	170.33	7.54	43	10.75	25.58	2.53								
Nephtys cornuta franciscana									14	7.00	50.00	5.00	35	8.75	9.58	1.55
Platynereis bicanaliculata													8	2.00	4.67	1.08
Streblospio benedicti	10	3.33	10.33	1.86												
Number crustacean individuals	2	0.67	0.33	0.33	4	1.00	4.00	1.00					3	0.75	0.92	0.48
Number mollusc individuals	11	3.67	4.33	1.20	17	4.25	14.25	1.89	23	11.50	12.50	2.50	29	7.25	0.92	0.48
Macoma nasuta													8	2.00	1.33	0.58
Macoma spp.									8	4.00	2.00	1.00				
Modiolus spp.																
Siliqua spp.																
Tellina modesta									11	5.50	4.50	1.50	19	4.75	4.25	1.03
Total number PCM individuals	283	94.33	2700.33	30.00	1249	312.25	48158.25	109.72	725	362.50	5100.50	50.50	2135	533.75	11952.25	54.66
Number polychaete species		7.33	1.33	0.67		7.75	2.25	0.75		8.00	0.00	0.00		8.25	3.58	0.95
Number crustacean species		0.67	0.33	0.33		0.75	2.25	0.75		0.00	0.00	0.00		0.75	0.92	0.48
Number mollusc species		3.00	3.00	1.00		1.50	1.67	0.65		4.00	0.00	0.00		2.50	0.33	0.29
Total number PCM species		11.00	1.00	0.58		10.00	8.00	1.41		12.00	0.00	0.00		11.50	3.00	0.87
Diversity (H')		1.44	0.03	0.11		1.11	0.02	0.07		1.13	0.04	0.14		0.95	0.01	0.05
Evenness (J')		0.60	0.00	0.04		0.50	0.00	0.02		0.45	0.01	0.06		0.39	0.00	0.02

Table 10. STATION H-2 continued

	17 February 1975 (4 replicates)				1 May 1975 (4 replicates)							
	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$
Number polychaete individuals	6393	1598.25	2299562.92	758.22	1562	390.50	230883.67	240.25	271	67.75	622.92	12.48
Armandia brevis	2405	601.25	231348.25	240.49	17	4.25	12.92	1.80	193	48.25	1438.25	18.96
Capitella capitata	3357	839.25	974108.25	493.49	1359	339.75	220794.25	234.94	36	9.00	66.00	4.06
Cossura sp.												
Eteone longa californica	11	2.75	4.92	1.11								
Eumida tubiformis	219	54.75	3108.92	27.88								
Gyptis brevipalpa	17	4.25	16.25	2.02								
Harmothoe lunulata	14	3.50	1.00	0.50								
Heteromastus filobranchus	166	41.50	460.33	10.73	161	40.25	334.92	9.15	83	20.75	130.25	5.71
Mediomastus californiensis												
Nephtys cornuta franciscana	150	37.50	797.67	14.12					21	5.25	4.92	1.11
Platynereis bicanaliculata	26	6.50	51.67	3.59								
Streblospio benedicti	17	4.25	6.25	1.25								
Number crustacean individuals	10	2.50	1.67	0.65	6	1.50	5.67	1.19	3	0.75	2.25	0.75
Number mollusc individuals	37	9.25	46.92	3.43	19	4.75	4.92	1.11	84	21.00	38.00	3.08
Macoma nasuta	8	2.00	4.67	1.08								
Macoma spp.									8	2.00	2.00	0.71
Modiolus spp.									16	4.00	4.67	1.08
Siliqua spp.	11	2.75	12.92	1.80								
Tellina modesta	13	3.25	4.92	1.11					48	12.00	22.00	2.35
Total number PCM individuals	6440	1610.00	2322734.00	762.03	1587	396.75	231170.92	240.40	358	89.50	356.33	9.44
Number polychaete species		11.50	3.67	0.96		6.50	4.33	1.04		5.50	0.33	0.29
Number crustacean species		2.25	0.92	0.48		0.50	0.33	0.29		0.50	1.00	0.50
Number mollusc species		3.50	3.00	0.87		3.00	0.67	0.41		4.50	1.66	0.65
Total number PCM species		17.25	12.25	1.75		10.00	8.67	1.47		10.50	2.99	0.87
Diversity (H')		1.13	0.01	0.05		0.94	0.28	0.26		1.74	0.08	0.14
Evenness (J')		0.40	0.00	0.03		0.40	0.04	0.10		0.74	0.01	0.04

Table 11. STATION H-3

Principal species and their statistical parameters by sampling date.

	12 August 1974 (4 replicates)				25 September 1974 (4 replicates)				13 November 1974 (4 replicates)				19 December 1974 (4 replicates)			
	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$
Number polychaete individuals	351	87.75	2650.25	25.74	1610	402.50	9363.00	48.38	1768	442.00	13627.33	58.37	6755	1688.75	341987.58	292.40
Armandia brevis	66	16.50	629.67	12.55	1276	319.00	5304.00	36.41	148	37.00	1974.00	22.22	5633	1408.25	304020.92	275.69
Capitella capitata	132	33.00	544.67	11.67	251	62.75	693.58	13.17	1546	386.50	6575.00	40.54	644	161.00	6598.67	40.62
Eteone longa californica													20	5.00	12.67	1.78
Eumida tubiformis													153	38.25	156.25	6.29
Exogone lourei																
Glycera spp.																
Gyptis brevipalpa													62	15.50	23.00	2.40
Harmothoe sp.													10	2.50	7.00	1.32
Heteromastus filobranchus																
Mediomastus californiensis	35	8.75	36.25	3.01												
Nephtys cornuta franciscana									9	2.25	10.25	1.60	75	18.75	89.58	4.73
Notomastus tenuis	44	11.00	122.00	5.52												
Phyllodocidae					19	4.75	1.58	0.63								
Platynereis bicanaliculata	12	3.00	28.67	2.68	28	7.00	75.33	4.34	31	7.75	121.58	5.51	134	33.50	332.33	9.12
Prionospio cirrifera	12	3.00	28.67	2.68												
Prionospio pygmaea	11	2.75	4.92	1.11	8	2.00	2.67	0.82								
Number crustacean individuals	10	2.50	3.00	0.87	24	6.00	11.33	1.68	7	1.75	12.25	1.75	32	8.00	18.00	2.12
Aoroides columbiae													8	2.00	6.00	1.22
Cancer jordani																
Ischyrocerus sp. juv.					9	2.25	0.92	0.48								
Number mollusc individuals	141	35.25	80.25	4.48	8	2.00	1.33	0.58	42	10.50	67.67	4.11	175	43.75	672.92	12.97
Unidentified Bivalve sp. A																
?Cryptomya sp. juv.													154	38.50	563.67	11.87
Macoma nasuta	82	20.50	46.33	3.40												
Macoma sp.									13	3.25	26.92	2.59	11	2.75	4.25	1.03
Macoma sp. juv. (nasuta?)	11	2.75	3.58	0.95												
Modiolus spp.																
Mysella sp.																
Protothaca staminea																
Siliqua spp.																
?Siliqua spp. juv.	11	2.75	4.92	1.11												
Tellina modesta	21	5.25	8.25	1.44					15	3.75	11.58	1.70				
Trachycardium quadragenarium																
?Tresus sp.																
Total number PCM individuals	502	125.50	2993.67	27.36	1642	410.50	9270.33	48.14	1813	453.25	15644.25	62.54	6962	1740.50	368541.67	303.54
Number polychaete species		14.00	2.00	0.71		9.25	1.58	0.63		9.00	6.67	1.29		11.00	0.00	0.01
Number crustacean species		1.75	2.25	0.75		4.25	4.92	1.11		0.50	1.00	0.50		6.00	11.33	1.68
Number mollusc species		6.25	2.92	0.85		1.50	1.00	0.50		4.75	2.92	0.85		4.25	1.58	0.63
Total number PCM species		22.00	4.67	1.08		15.00	7.33	1.35		14.25	24.92	2.50		21.25	12.92	1.80
Diversity (H')		2.33	0.10	0.16		0.81	0.00	0.02		0.58	0.06	0.12		0.83	0.02	0.08
Evenness (J')		0.76	0.01	0.05		0.30	0.00	0.01		0.22	0.01	0.04		0.27	0.00	0.12

Table 11. STATION H-3 continued

	12 February 1975 (4 replicates)				1 May 1975 (4 replicates)				17 September 1975 (4 replicates)			
	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$
Number polychaete individuals	3078	769.50	24915.00	78.92	1421	355.25	13218.92	57.49	344	66.00	974.06	15.60
Armandia brevis	2631	657.75	14126.92	59.43	73	18.25	182.92	6.76	246	61.50	1031.00	16.06
Capitella capitata	51	12.75	65.58	4.05	1269	317.25	12568.25	56.05				
Eteone longa californica												
Eumida tubiformis	60	15.00	44.67	3.34								
Exogone lourei					9	2.25	8.25	1.44				
Glycera spp.	8	2.00	2.00	0.71								
Gyptis brevipalpa	27	6.75	68.25	4.13								
Harmothoe sp.												
Heteromastus filobranchus					10	2.50	1.67	0.64				
Mediomastus californiensis	10	2.50	7.00	1.32	22	5.50	15.00	1.94				
Nephtys cornuta franciscana									20	5.00	3.33	0.91
Notomastus tenuis												
Phyllodocidae												
Platynereis bicanaliculata	260	65.00	646.67	12.72	9	2.25	10.92	1.65				
Prionospio cirrifera												
Prionospio pygmaea									34	8.50	9.00	1.50
Number crustacean individuals	15	3.75	11.58	1.70	9	2.25	2.25	0.75	11	2.75	7.58	1.38
Aoroides columbiae												
Cancer jordani	12	3.00	10.00	1.58								
Ischyrocerus sp. juv.												
Number mollusc individuals	88	22.00	222.00	7.45	97	24.25	38.92	3.12	648	162.00	304.67	8.73
Unidentified Bivalve sp. A									25	6.25	14.25	1.89
?Cryptomya sp. juv.												
Macoma nasuta	11	2.75	4.92	1.11	22	5.50	4.33	1.04				
Macoma sp.									63	15.75	6.25	1.25
Macoma sp. juv. (nasuta?)												
Modiolus spp.					16	4.00	8.67	1.47	8	2.00	7.33	1.35
Mysella sp.									8	2.00	2.00	0.71
Protothaca staminea									26	6.50	9.67	1.56
Siliqua spp.	51	12.75	124.92	5.59	38	9.50	16.33	2.02				
?Siliqua spp. juv.												
Tellina modesta									457	114.25	472.25	10.87
Trachycardium quadragenarium									32	8.00	6.00	1.22
?Tresus sp.									14	3.50	16.33	2.02
Total number PCM individuals	3181	795.25	25537.58	79.90	1527	381.75	11962.92	54.69	1003	250.75	406.92	10.09
Number polychaete species		12.50	8.33	1.44		10.75	4.25	1.03		10.25	2.92	0.85
Number crustacean species		1.50	0.33	0.29		1.50	0.33	0.29		2.00	3.33	0.91
Number mollusc species		5.50	9.67	1.56		6.25	2.25	0.75		9.50	7.00	1.32
Total number PCM species		19.50	30.33	2.75		18.50	4.33	1.04		21.75	16.25	2.02
Diversity (H')		0.77	0.03	0.08		0.88	0.08	0.14		1.79	0.24	0.08
Evenness (J')		0.26	0.00	0.02		0.30	0.01	0.05		0.58	0.00	0.01

Table 12. STATION H-4

Principal species and their statistical parameters by sampling date.

	2 July 1974 (4 replicates)				25 September 1974 (4 replicates)				31 December 1974 (4 replicates)				4 April 1975 (4 replicates)			
	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$
Number polychaete individuals					790	197.50	8203.00	45.28								
Armandia brevis					391	97.75	4802.92	34.65								
Capitella capitata					260	65.00	4167.33	32.28								
Heteromastus filobranchus					14	3.50	19.67	2.22								
Mediomastus californiensis					25	6.25	10.92	1.65								
Nephtys cornuta franciscana					9	2.25	2.92	0.85								
Notomastus tenuis					10	2.50	7.00	1.32								
Platynereis bicanaliculata					24	6.00	58.67	3.83								
Prionospio pygmaea					27	6.75	31.58	2.81								
Number crustacean individuals	10	1.25	2.25	0.75	25	6.25	84.25	4.59	1	0.25	0.25	0.25	14	3.50	12.33	1.76
Cancer jordani													8	2.00	5.33	1.16
Caprella californica																
Caprella mendax					10	2.50	19.00	2.18								
Cyclaspis nubila	7	1.75	2.25	0.75												
Number mollusc individuals	76	23.00	102.00	5.05	95	22.25	31.58	2.81	54	13.50	51.67	3.59	39	9.75	4.25	1.03
Macoma nasuta	24	6.00	0.67	0.41	35	8.75	4.25	1.03	25	6.25	11.58	1.70	22	5.50	3.00	0.87
Macoma sp. juv. (*nasuta*?)									8	2.00	11.33	1.68				
Modiolus spp.																
Mya arenaria	34	8.50	32.33	2.84	12	3.00	12.67	1.78								
Mysella aleutica																
Protothaca staminea	9	2.25	1.58	0.63												
Tellina modesta					11	2.75	4.92	1.11								
?*Tresus* sp.																
Total number PCM individuals					905	226.25	9834.92	49.59								
Number polychaete species						12.50	3.67	0.96								
Number crustacean species		1.00	1.33	0.58		2.50	5.67	1.19		0.25	0.25	0.25		2.00	3.33	0.91
Number mollusc species		6.50	3.00	0.87		7.50	5.67	1.19		5.25	0.92	0.48		4.50	3.67	0.96
Total number PCM species						22.50	25.67	2.53								
Diversity (H')						1.68	0.08	0.14								
Evenness (J')						0.54	0.01	0.05								

Table 12. STATION H-4 continued

	17 September 1975 (4 replicates)			
	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$
Number polychaete individuals				
Armandia brevis				
Capitella capitata				
Heteromastus filobranchus				
Mediomastus californiensis				
Nephtys cornuta franciscana				
Notomastus tenuis				
Platynereis bicanaliculata				
Prionospio pygmaea				
Number crustacean individuals	20	5.00	100.00	5.00
Cancer jordani				
Caprella californica	9	2.25	20.25	2.25
Caprella mendax				
Cyclaspis nubila				
Number mollusc individuals	197	49.25	610.92	12.36
Macoma nasuta	33	8.25	10.92	1.65
Macoma sp. juv. (nasuta?)				
Modiolus spp.	39	9.75	46.92	3.42
Mya arenaria				
Mysella aleutica	25	6.25	28.25	2.66
Protothaca staminea	10	2.50	3.00	0.87
Tellina modesta	74	18.50	89.67	4.74
?Tresus sp.	16	4.00	8.67	1.47
Total number PCM individuals				
Number polychaete species				
Number crustacean species		1.25	6.25	1.25
Number mollusc species		9.00	8.00	1.41
Total number PCM species				
Diversity (H')				
Evenness (J')				

Observations of recolonization of harbor station H-4 after dredging in 1971 were described by Oliver *et al* (1976). The early phase of recovery was characterized first by an increase and then a decline in the numbers of the opportunistic polychaetes, *Capitella capitata* and *Armandia brevis*. In March 1972, there was a large settlement of the phoronid worm, *Phoronopsis viridis*. Over the next twelve-month period, there was a marked decline in the number of phoronids. The nudibranch, *Hermissenda crassicornis*, settled or migrated into the disturbed area in large numbers during the summer of 1972. All of the individuals observed were quite large for the species. *Hermissenda crassicornis* preys on phoronids and may have caused the large decline in their numbers between the summer and fall of 1972.

Phoronopsis viridis breeds between March and May (Rattenbury, 1953) and during the following reproductive season, in April 1973, there was a second successful recruitment of young phoronids. The first recruitment episode (1972) was three times larger than the second (1973). During the second year, mortality was higher and only a few adults remained by the following winter (December 1973). During the third breeding season (spring 1974) there was even lower recruitment and survival. Thus, the pre-dredging deposit feeding assemblage of polychaetes and bivalves was replaced by a tube-dwelling suspension feeder, *P. viridis*. Since April 1973, however, there has been a marked decline in the *P. viridis* population and a gradual return to the pre-dredging assemblage (Figure 33-A).

Settlement of a number of bivalve species occurred throughout the study period at station H-4. In most cases, a peak in abundance of juveniles was followed by almost complete mortality. The only exception was a member of the pre-dredging fauna, *Macoma nasuta*, which was commonly abundant. The crustaceans were not numerically important colonists.

Variations in the total number of individuals were dominated by *Phoronopsis viridis* during early succession. Changes in the total density (polychaete, crustacean and mollusc) were dominated by the polychaetes (Figures 33-A and 33-B). The highest number of species was observed when the phoronid patch was maximally developed (June 1972) and remained relatively high thereafter (Figure 34). Most of the species were present in low abundances. Decreases in species diversity or heterogeneity (H') and species evenness (J) primarily reflected the numerical dominance of one or a few species (data on file and Table 12).

Most of the variation in total density at station H-3 was caused by the polychaetes (Figures 35-A and 35-B). The 1974 dredging at H-3 was followed by an increase in the same opportunitsts, *Capitella capitata* and *Armandia brevis* (Table 11). In 1971, *C. capitata* settled first and its decline was coincident with an increase in the number of *A. brevis*. Oliver and Slattery (1972) speculated that the decline may have been the result of negative interaction with *A. brevis*. Surprisingly, Figures 36-A and 36-B show that the larger peaks in abundance of the two opportunistic species were non-complementary in 1974 - 1975. Gause (1934) showed that conditions can be varied in the laboratory which will first favor one and then the other species in a competitive interaction, but it is unknown whether these two polychaete species actually compete in nature.

An alternative explanation concerning the occurrence of *Armandia* and *Capitella* involves only the life history characteristics of each species.

Both species settle and grow fast; young can be produced within a single month (Dr. Reish, personal communication, personal observation). A species may settle in large numbers within a short period of time, grow to maturity, release young that are transported to some other region and subsequently die. Their death could, in itself, be considered a disturbance and might be attractive to another opportunist. Grassle and Grassle (1976) state that sibling species of Capitella are capable both of producing pelagic larvae and of brooding young that directly colonize the bottom. An ability to suppress the dispersal stage may allow the opportunist to fully exploit an available habitat (Gassle and Gassle, 1974). Local population explosions and crashes of Capitella capitata and Armandia brevis have also been observed in the intertidal sample stations of the Elkhorn Slough and roughly at the same time. However, in these intertidal cases, settlement occurred into existing communities, not into fresh, unpopulated sediment.

The numbers of Armandia brevis and Capitella capitata at H-3 decreased to pre-dredging levels by May 1975 and September 1975, respectively. Although oligochaetes and the capitellid polychaetes Notomastus tenuis, Mediomastus californiensis and Heteromastus filobranchus were found after the August 1974 dredging, their numbers did not recover to the same level of high abundance seen before dredging occurred.

There was a gradual increase in the number of bivalves at H-3, until a large settlement of several species occurred in September 1975 (Figure 37-A). The most abundant of these was Tellina modesta, which often settles in great numbers in the area and subsequently incurs extremely high mortality. In contrast, _Macoma_ spp. increased at a very steady rate, but had not reached the pre-dredging level by September 1975. Compared to the polychaetes and molluscs, changes in the number of crustaceans did not significantly affect the variation in total invertebrate density (Figure 37-B).

Changes in the number of species present at H-3 were dominated by the polychaetes (Figures 38-A, 38-B, 39-A and 39-B). The slight increase from May to September 1975 was due to the bivalves. The species diversity index (H') decreased following the dredging, due to numerical domination by a few species (Figures 40-A, 40-B, 41-A and 41-B). Both diversity and evenness increased with time, but failed to reach pre-dredging levels.

Thus, at H-3, the early phase of recovery involved the settlement of several polychaetes. _Armandia brevis_ and _Capitella capitata_ periodically settled in large numbers until May 1975, while some other polychaete species settled and subsequently disappeared, presumably due to relatively high mortality rates. Although many _Tellina modesta_ individuals were seen in September 1975, previously observed patterns suggest they probably survived only a short while. The pre-dredging polychaete, oligochaete and bivalve populations were not re-established during the year after the dredging.

Considering the H-2 station next, the dredging here in August 1974 was not as complete as that at H-3. Consequently, more animals survived the disturbance and were present in more patchy distributions (Table 10). Nevertheless, the early phase of succession was similar to station H-3. The changes in total number of individuals was again due primarily to the polychaetes (Figures 42-A and 42-B). The highest density of individuals observed in February 1975 was due primarily to high numbers of both Armandia brevis and Capitella capitata. The former species decreased to a very low population size in May 1975, while the latter reached a similar low in September 1975. This pattern of decline was also observed at H-3.

As an example of the patchiness of the dredging at H-2, a fair number of the polychaete Heteromastus filobranchus was present in the first post-dredging samples and within several months reached pre-dredging densities. Other principal polychaete species were essentially re-established between May 1975 and September 1975.

Several bivalve species settled at H-2 in September 1975. The number of individuals involved was much fewer than the corresponding H-3 settlement (approximately 1/10 as many individuals, Figure 43-A). Judging from previously observed patterns, few of these juvenile bivalves probably survived. Very low numbers of crustaceans were observed, their densities being even lower than that observed at H-3 (Figure 43-B).

Variations in the total number of species at H-2 were primarily due to the polychaete species, except in September 1975, when a high number of bivalve species appeared (Figures 44-A, 44-B, 45-A and 45-B). The species diversity index did not follow any simple trend that could be easily related to the general pattern of succession (Figures 46-A, 46-B, 47-A and 47-B). The low value of H' in May was due to high numbers of C. capitata in one core. The high value in September 1975 was due to fewer polychaetes and high numbers of a few bivalve species.

Thus, the early phase of succession involved the same species of polychaetes at both H-2 and H-3. A later settlement of bivalves was also observed at both stations, though the abundances seen at H-2 were much reduced in comparison. In contrast to H-3, the pre-dredging assemblage at H-2 had essentially recovered between May and September 1975.

The back harbor area (H-1) had the least complex bottom community prior to dredging. The polychaetes, Streblospio benedicti and Schistomeringos sp. were commonly found only at this station. Some of the same capitellid and other polychaete species were present at H-1, but in much lower numbers than at the other harbor stations (Table 9, Figures 48-A and 48-B). Oligochaetes and nematodes were as abundant as they were at H-3, but bivalves and crustaceans were rare (Figures 49-A and 49-B).

The early phase of succession at H-1 was numerically dominated by A. brevis and C. capitata. A few other polychaetes settled, but were very low in abundance by September 1975. The peak in numbers of A. brevis was greater and preceded that of C. capitata. This pattern was similar to that at H-3; however, the major settlement occurred later and involved fewer individuals at H-1 (Figures 36-A and 36-B).

Except for the presence of A. brevis and C. capitata, the pre-disturbance polychaete fauna was re-established in several months. On the other hand, the abundance of oligochaetes and nematodes in September 1975 was much lower than the pre-disturbance levels. The number of species of polychaetes, molluscs and crustaceans recovered within several months (Figures 50-A, 50-B, 51-A and 51-B), although there was no simple pattern in the indices of species diversity (Figures 52-A, 52-B, 53-A and 53-B). Thus, the general succession appeared to be completed sometime between May and September 1975.

Recovery following the 1971 and 1974 disturbances in the outer harbor was similar in several respects. The same group of early polychaete colonists characterized each succession, although their order of occurrence and subsequent mortality rates were somewhat different. In addition, the pattern of settlement and subsequent high mortality of most bivalve species was similar. Finally, the later recovery phase involved the re-establishment of similar pre-disturbance dominants. This phase was only beginning at H-3 one year after the 1974 disturbance and it was retarded at H-4 by the establishment of a phoronid patch.

The two successions differed in one major concern. A large patch of *Phoronopsis viridis* was established and maintained for more than a year at H-4, but *P. viridis* was never abundant at H-3. The eventual break-up of the patch was probably caused by at least one significant nudibranch predator, *Hermissenda crassicornis*. After the decline in the *P. viridis* population, the pattern of succession at H-4 was similar to that observed after the initial disturbance in August 1971.

We do not know why a dense patch of phoronids did not form at H-3 in 1975, but it may have been related to differences in the initial disturbance. The excavated site at H-3 was smaller and closer to undredged areas of potential slumping than at H-4. *Phoronopsis viridis* may prefer not to settle in locations where large deposit feeders are nearby. In contrast, at H-4 a large area was essentially defaunated and the only animals present were small surface deposit feeders. The absence of *P. viridis* at H-3 may also have been related to the proximity of industrial water intake pumps. Their net effect might be to isolate this area from the central slough, where

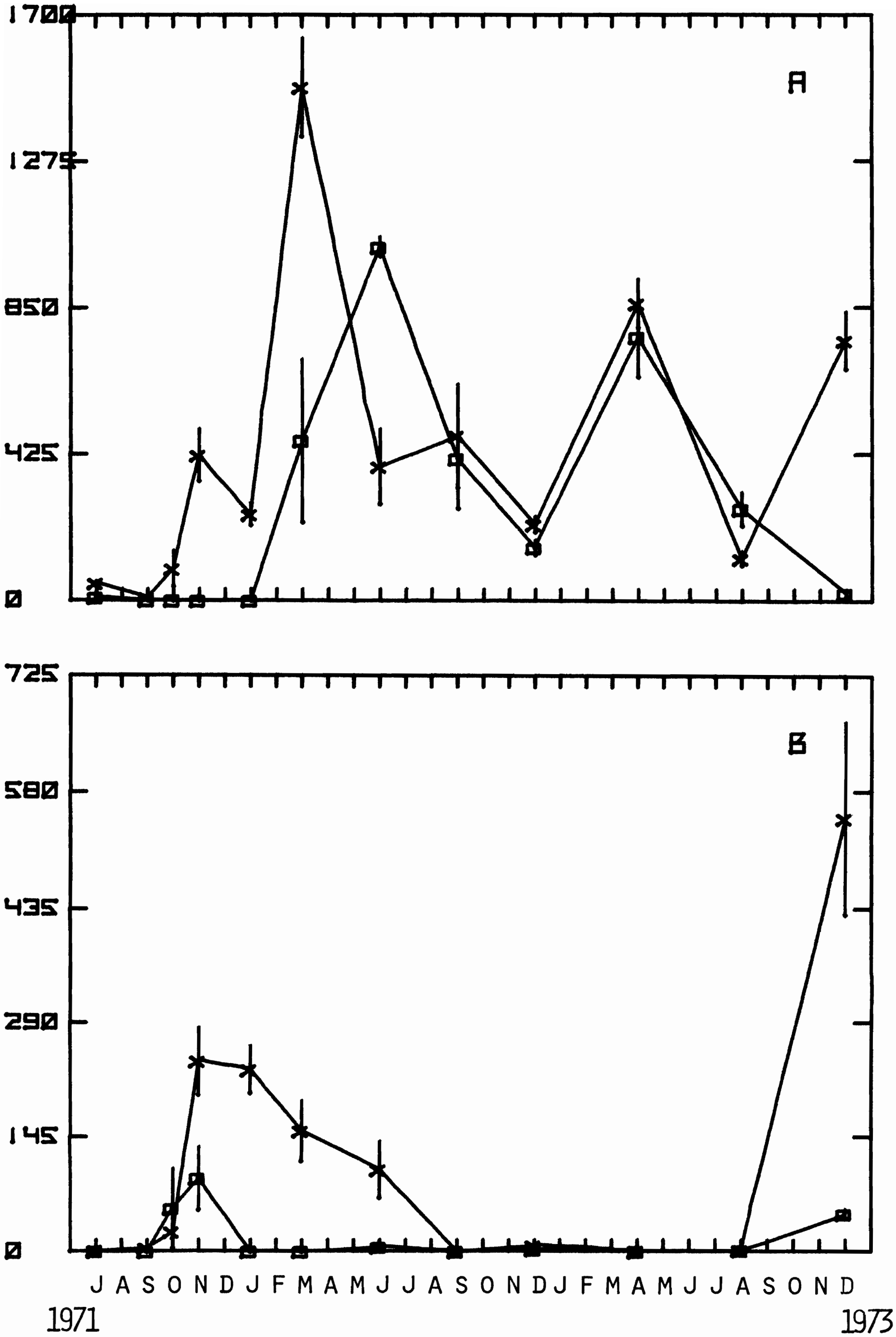

FIGURE 33. A. Mean number of individuals of all groups per core (X) and mean number of individuals of Phoronopsis viridis (0) per core at H-4. B. Mean number of individuals of Armandia brevis (X) and Capitella capitata (0) per core at H-4. Vertical lines represent standard error.

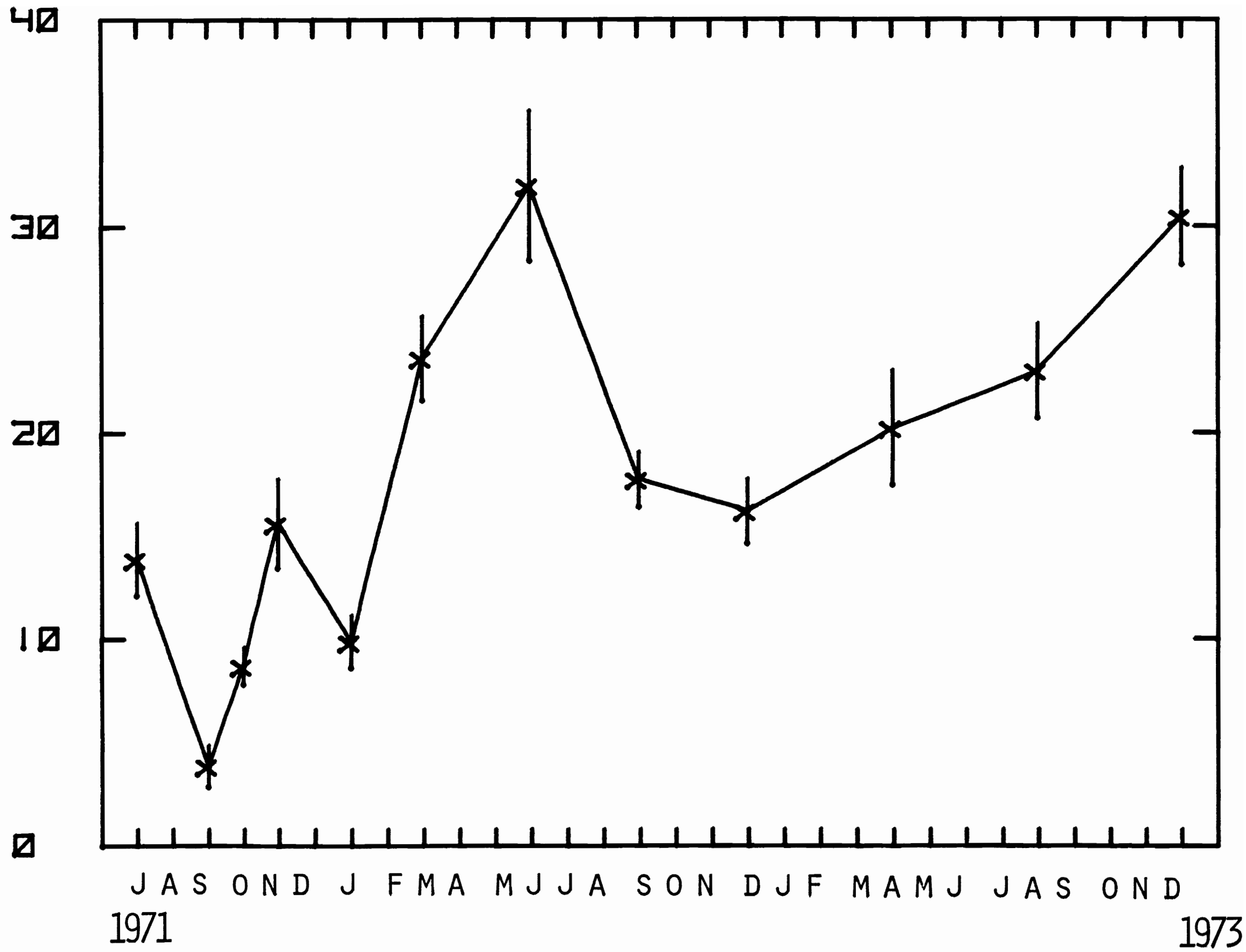

FIGURE 34. Mean number of species per core of all groups, H-4. Vertical lines represent standard error.

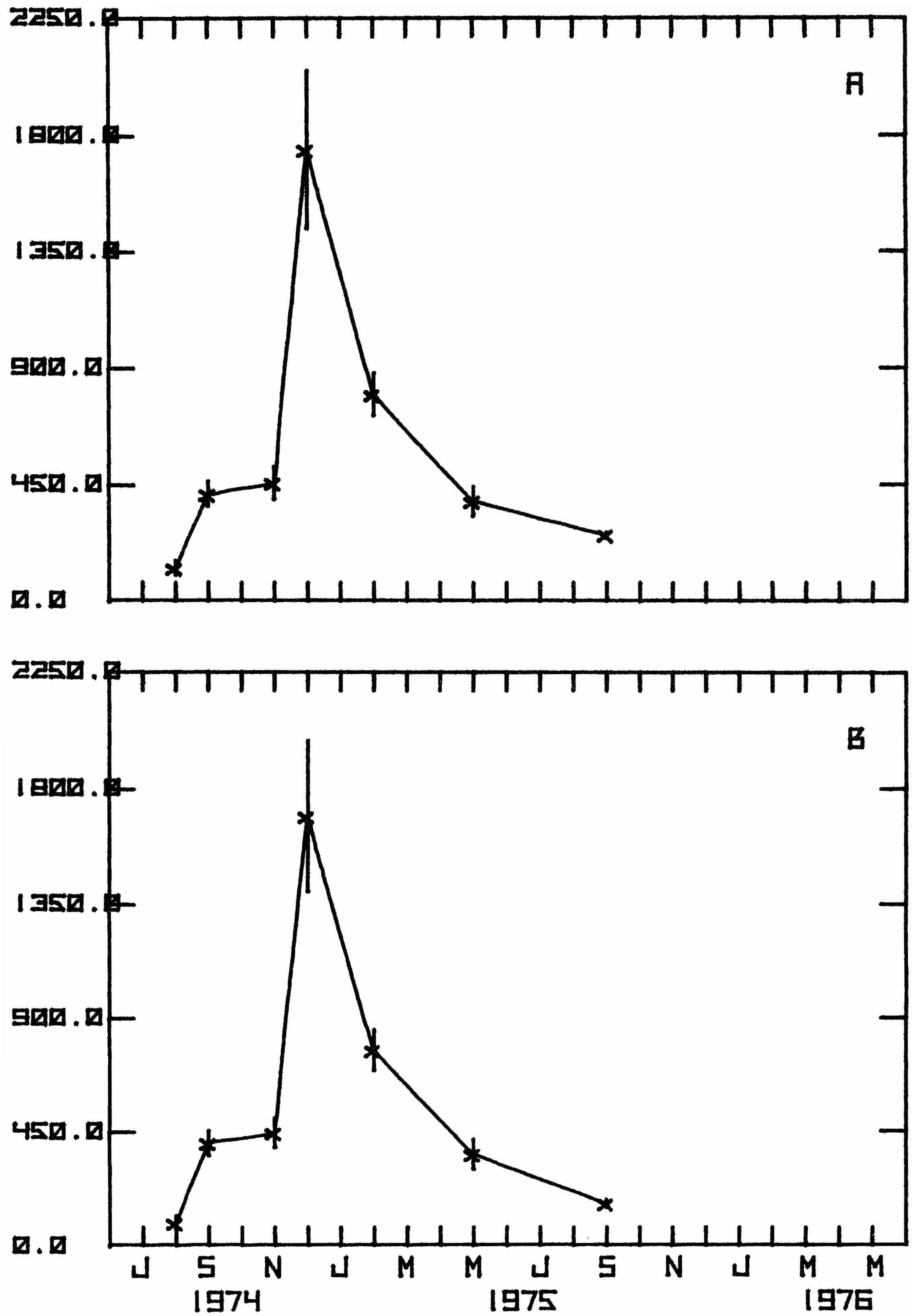

FIGURE 35. A. Mean numbers of individuals of all groups per core, H-3. B. Mean number of polychaete individuals per core, H-3. Vertical lines represent standard error.

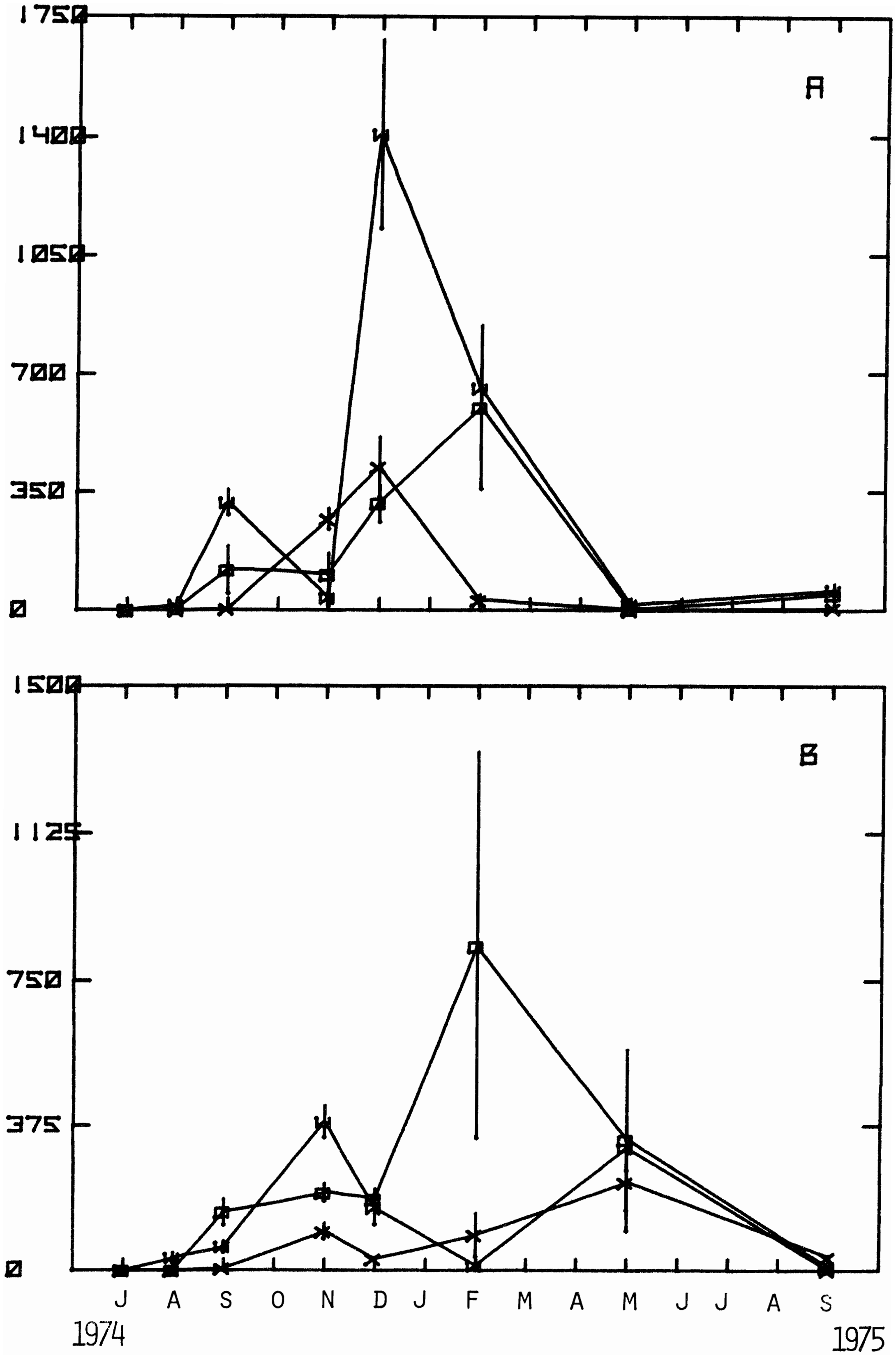

FIGURE 36. A. Mean number of Armandia brevis per core at H-l (X), H-2 (O) and H-3 (W). Mean number of Capitella capitata per core at H-l (X), H-2 (O) and H-3 (W). Vertical lines represent standard error.

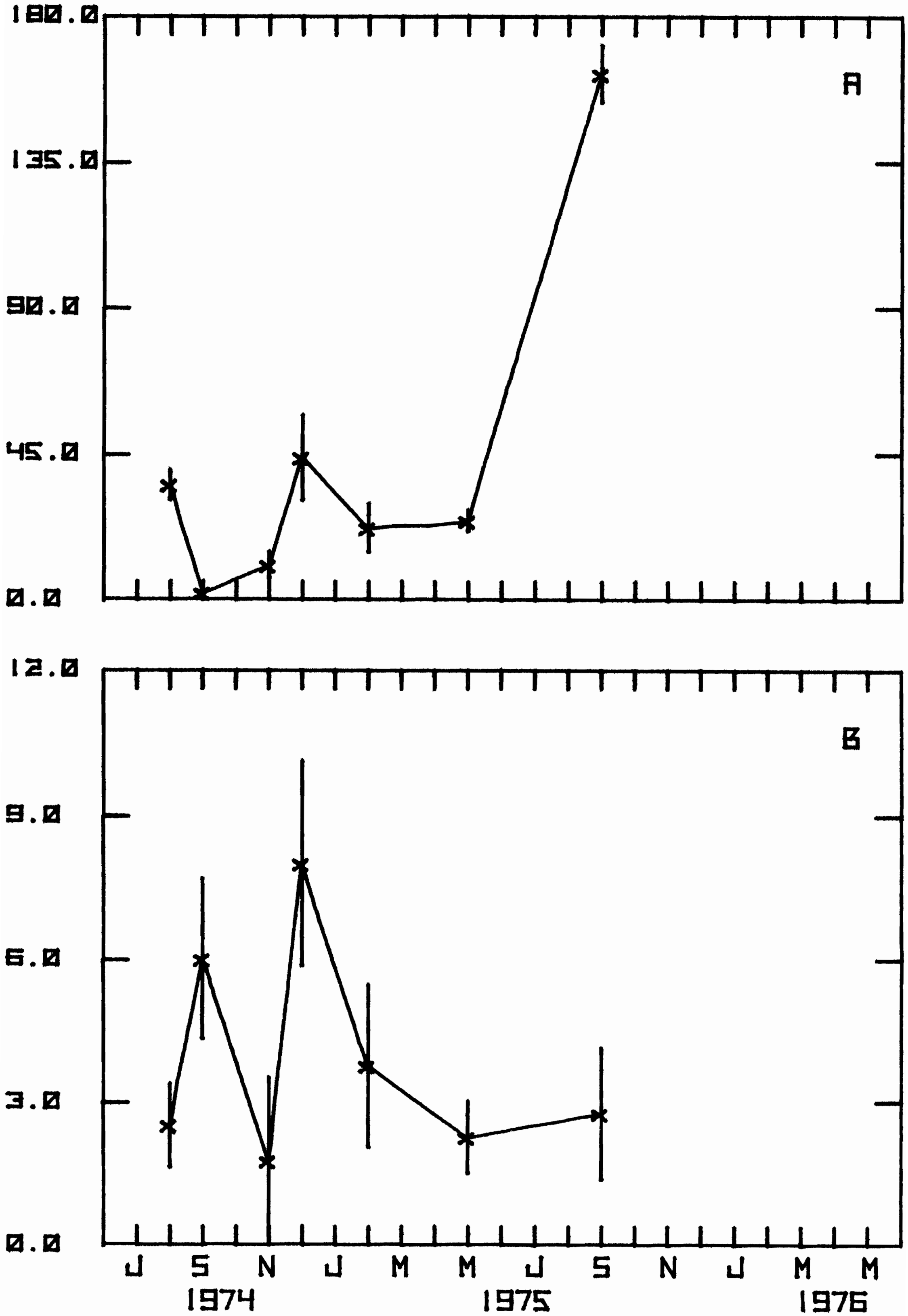

FIGURE 37. A. Mean number of mollusc individuals per core, H-3.
B. Mean number of crustacean individuals per core, H-3.
Vertical lines represent standard error.

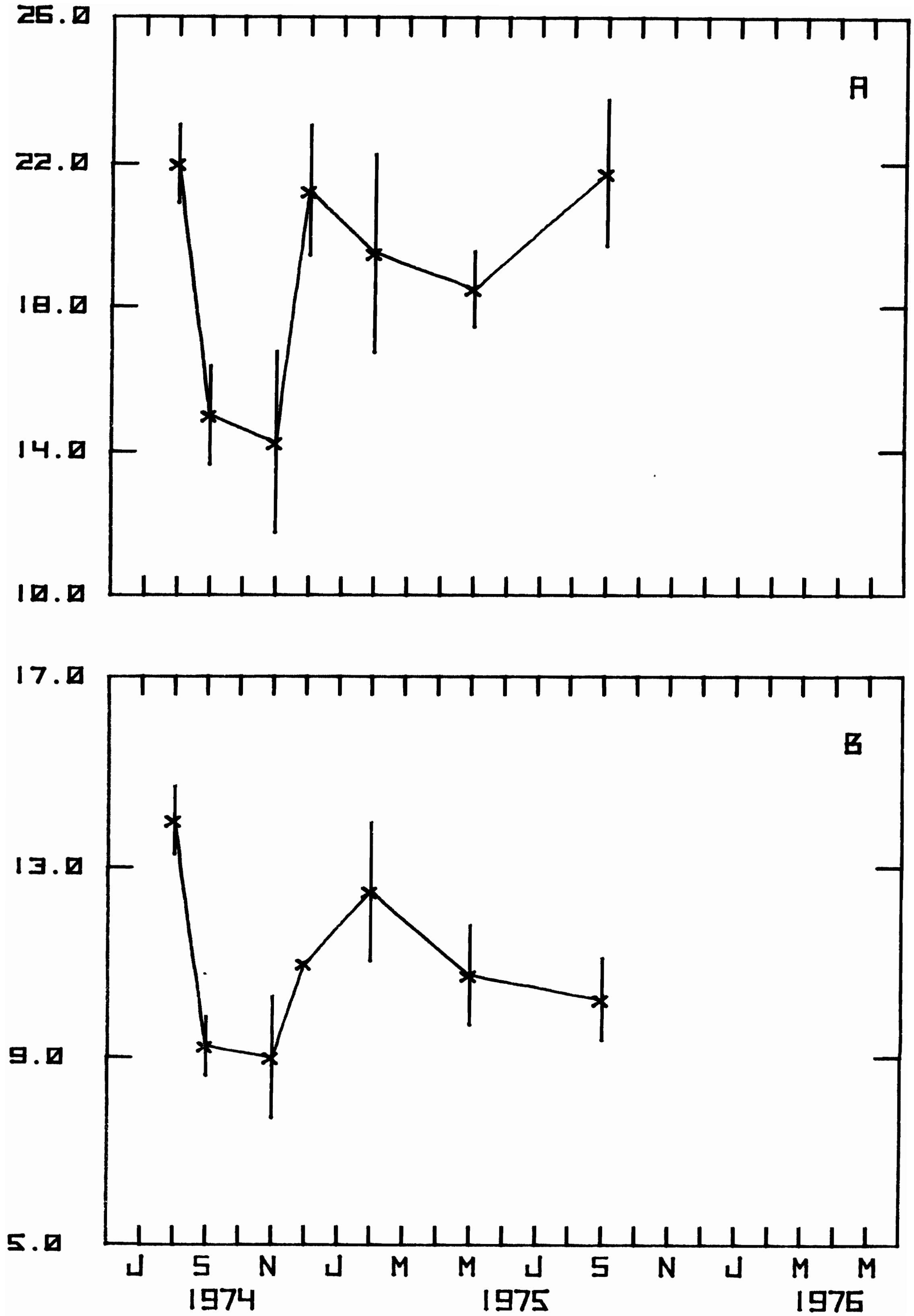

FIGURE 38. A. Mean number of species per core, all groups, H-3.
B. Mean number of polychaete species per core, H-3.
Vertical lines represent standard error.

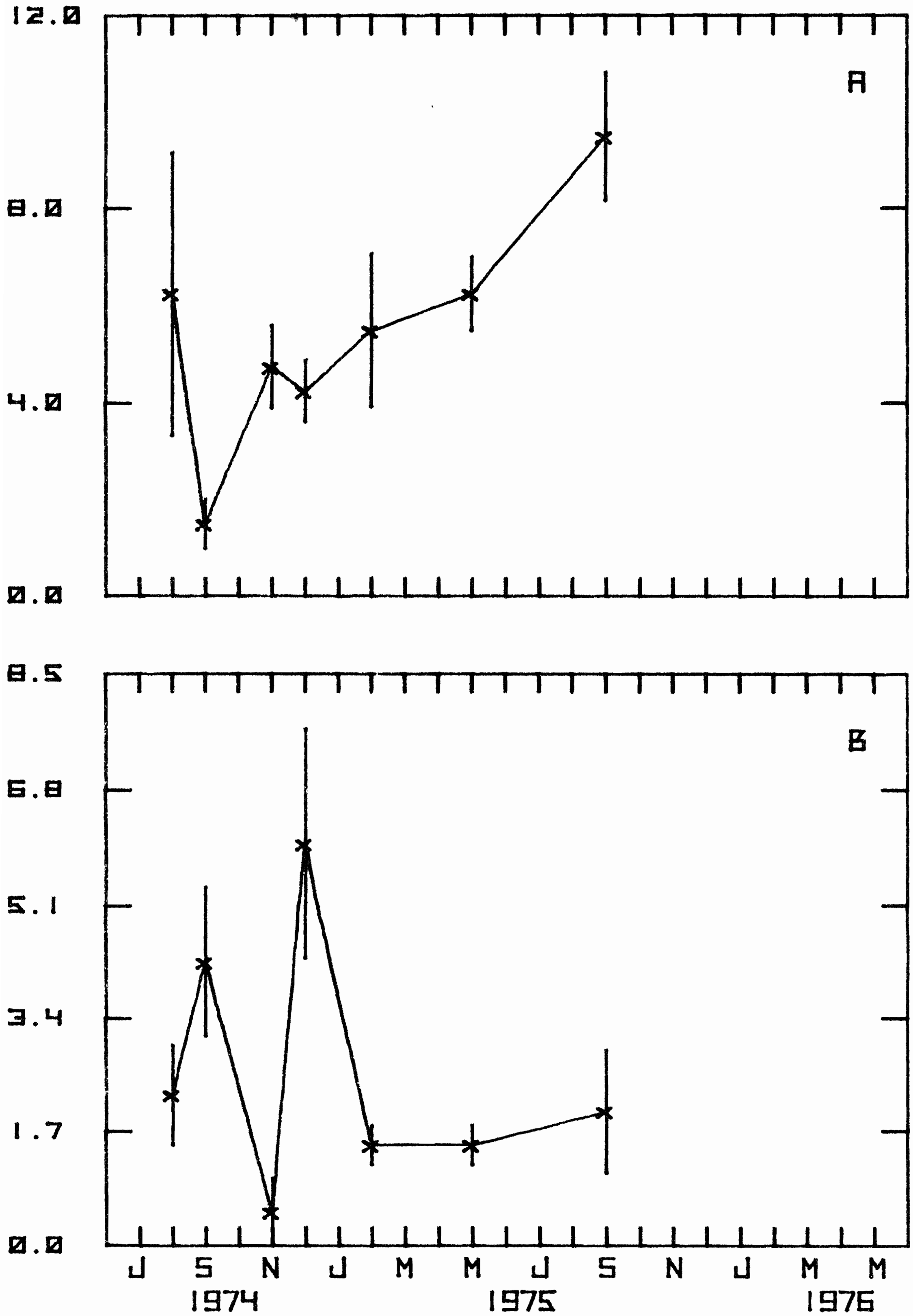

FIGURE 39. A. Mean number of molluscs species per core, H-3. B. Mean number of crustacean species per core, H-3. Vertical lines represent standard error.

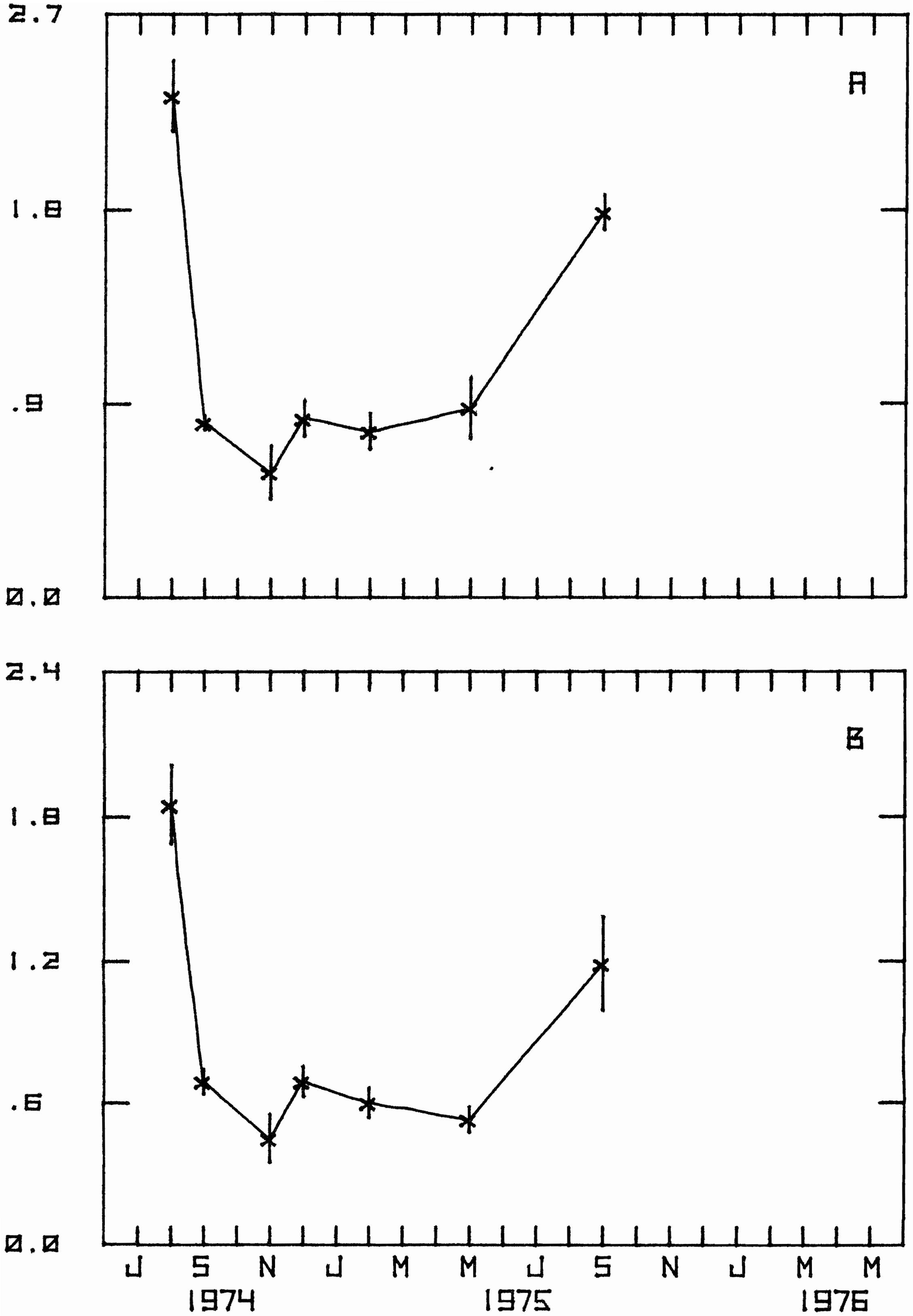

FIGURE 40. A. Mean total diversity, H', per core, all groups, H-3.
B. Mean polychaete diversity, H', per core, H-3. Vertical lines represent standard error.

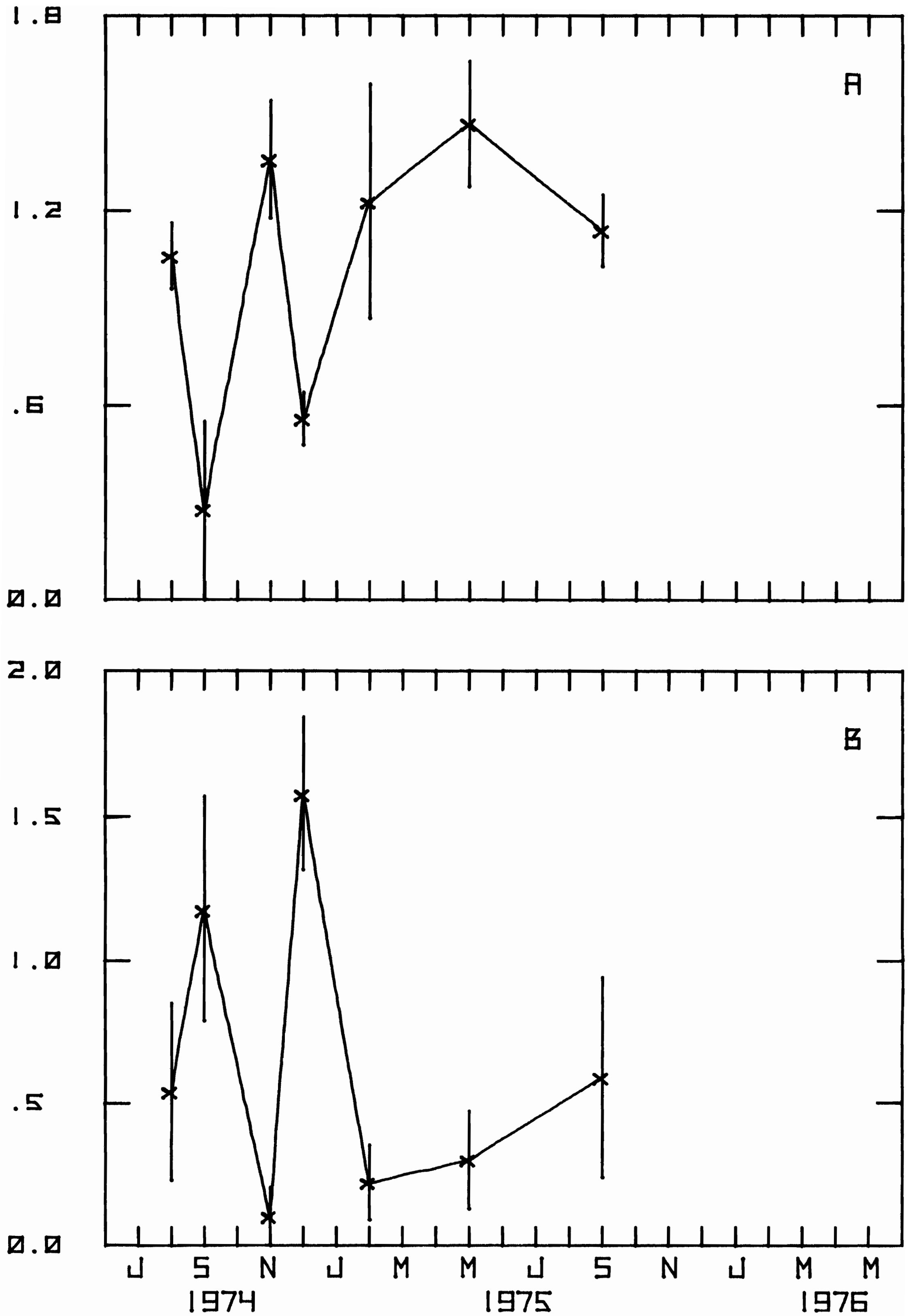

FIGURE 41. A. Mean mollusc diversity, H', per core, H-3. B. Mean crustacean diversity, H', per core, H-3. Vertical lines represent standard error.

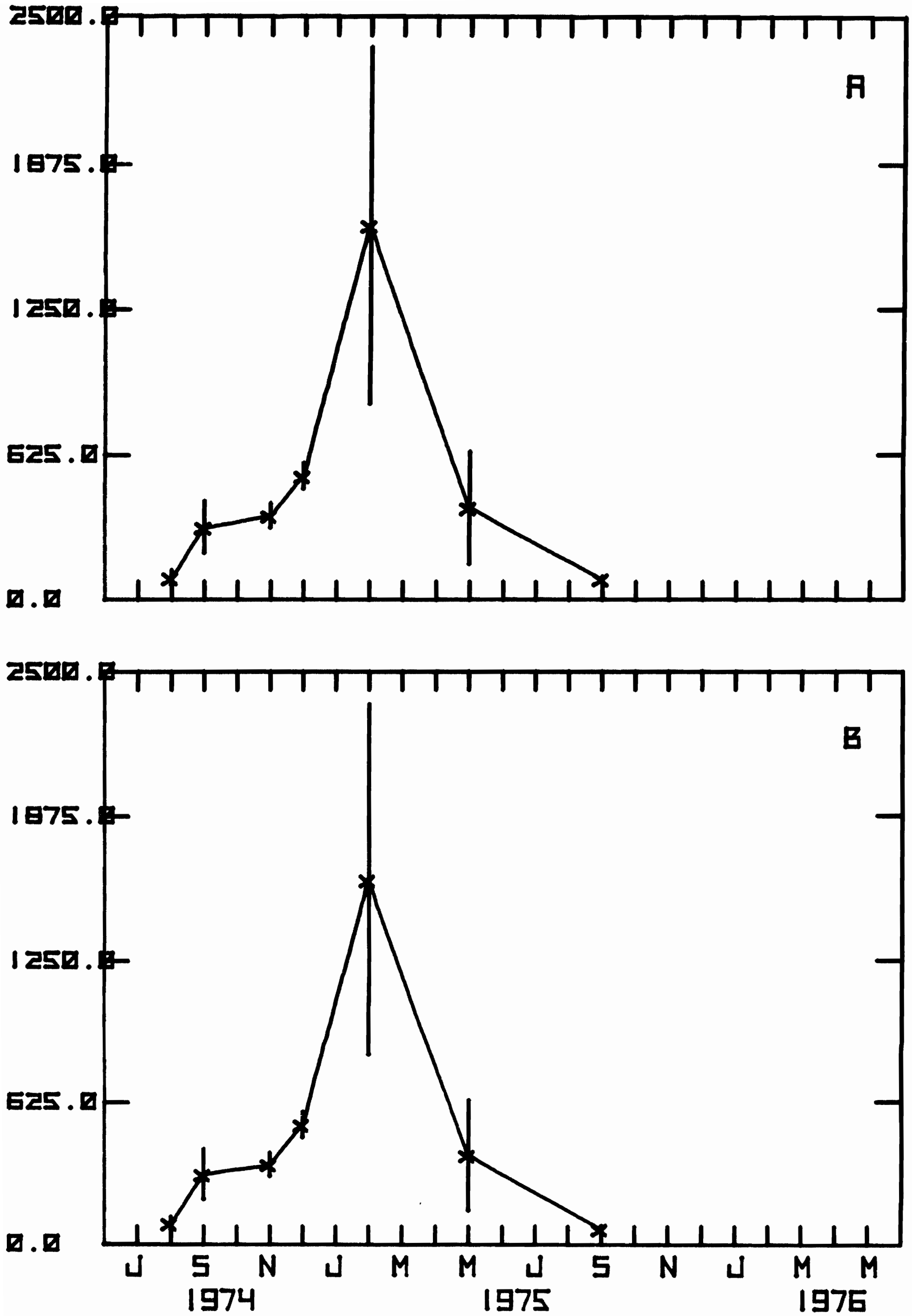

FIGURE 42. A. Mean number of individuals per core, all groups, H-2.
B. Mean number of polychaete individuals per core, H-2.
Vertical lines represent standard error.

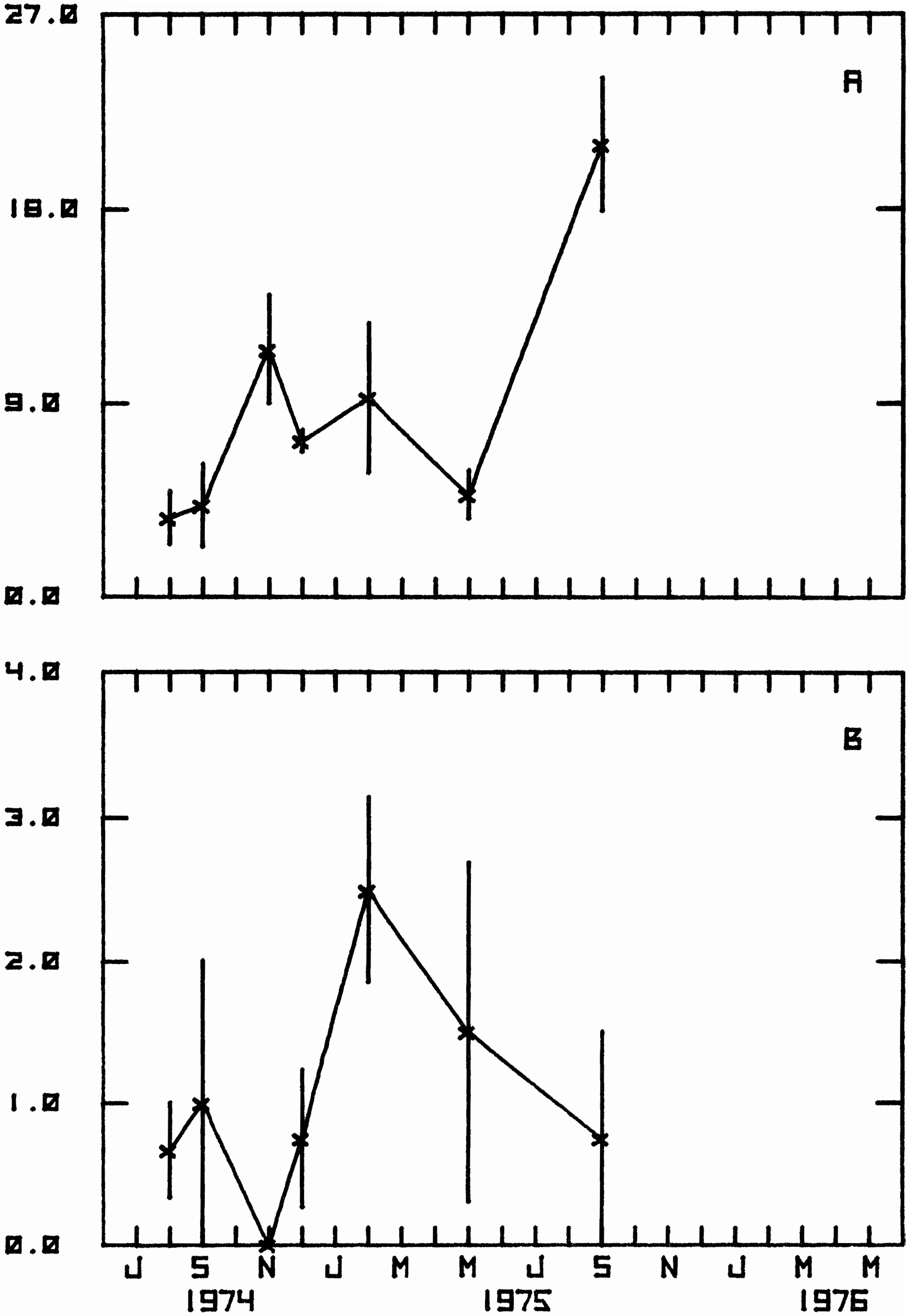

FIGURE 43. A. Mean number of mollusc individuals per core, H-2.
B. Mean number of crustacean individuals per core, H-2.
Vertical lines represent standard error.

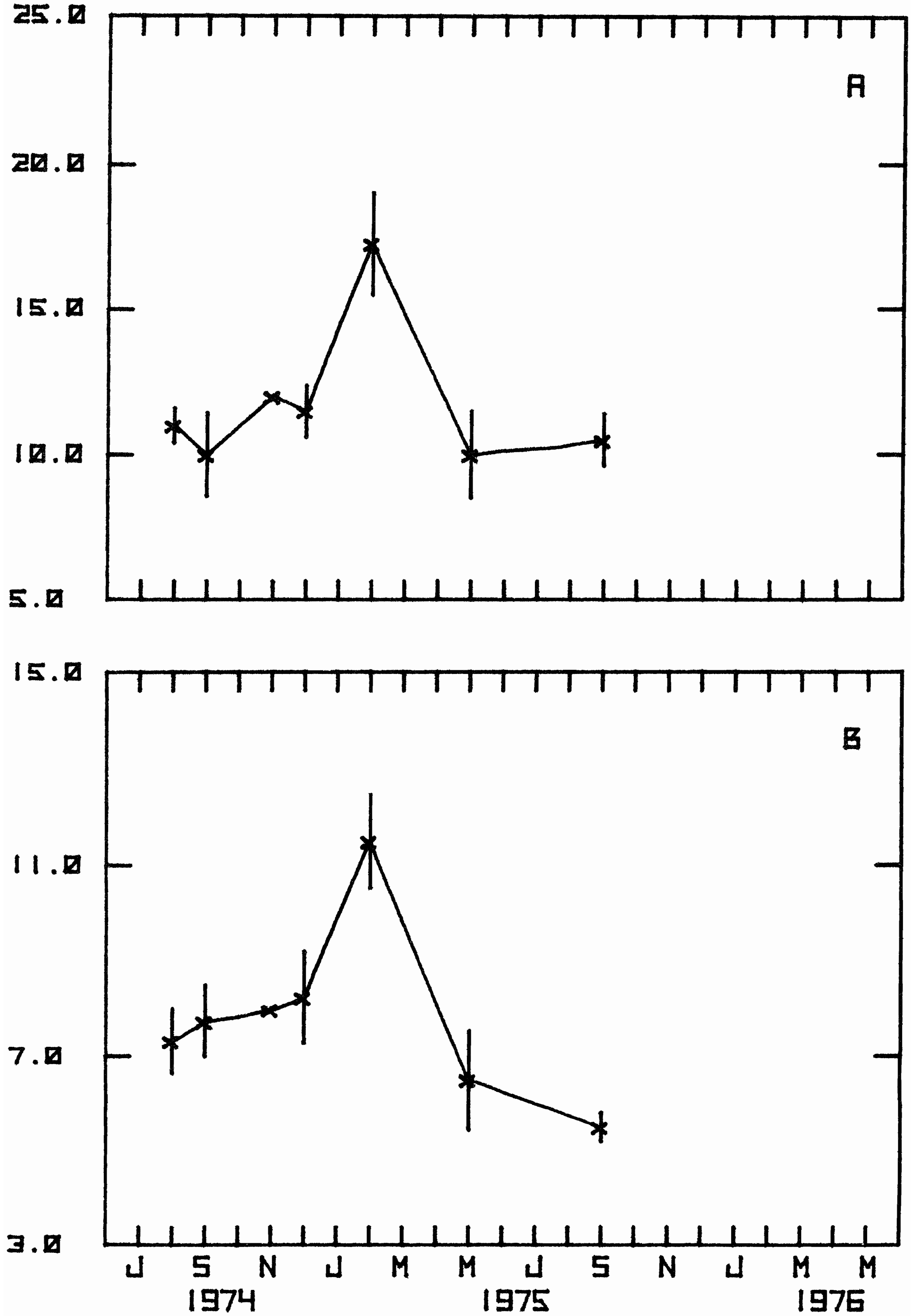

FIGURE 44. A. Mean number of species per core, all groups, H-2. B. Mean number of polychaete species per core, H-2. Vertical lines represent standard error.

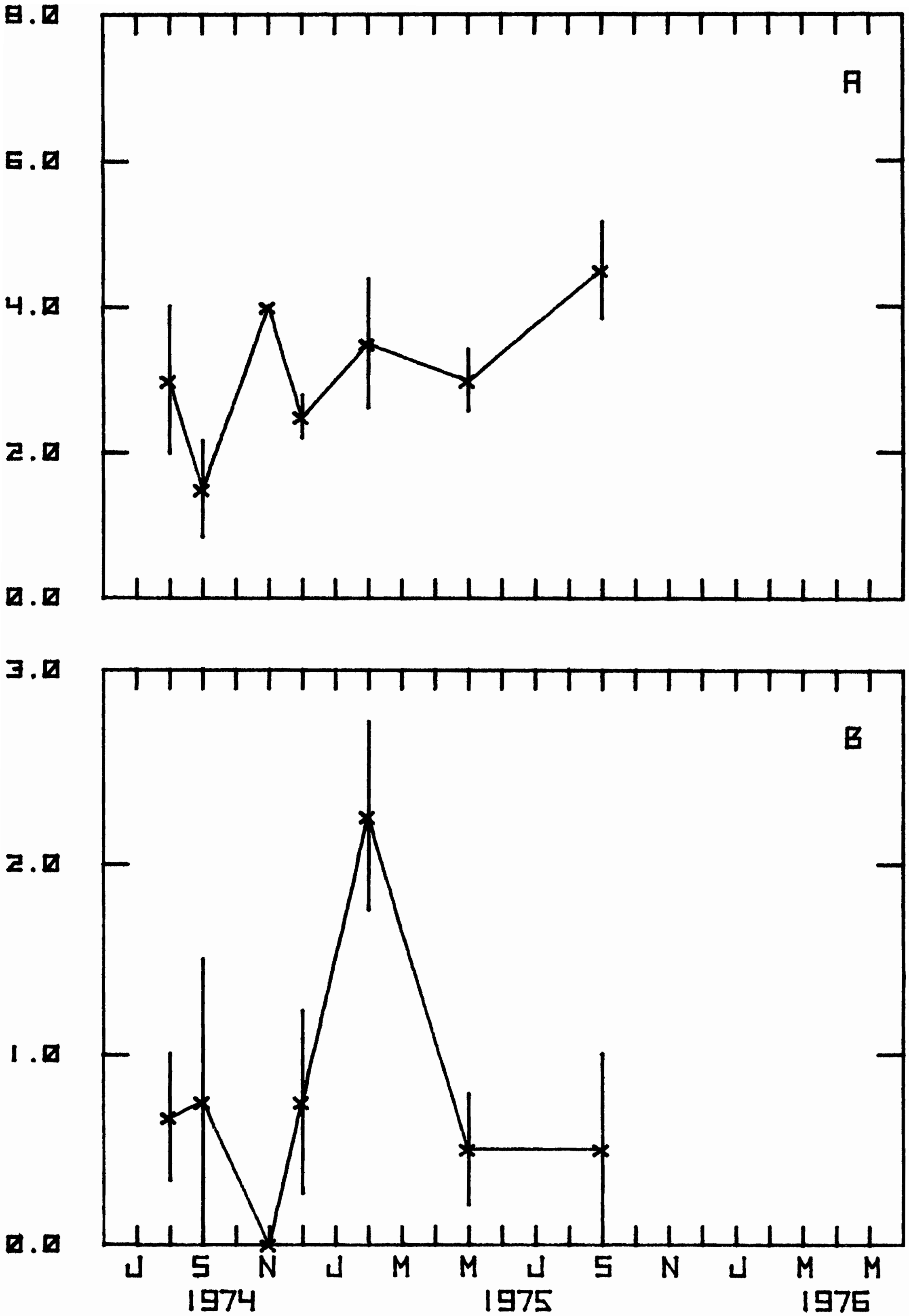

FIGURE 45. A. Mean number of mollusc species per core, H-2. B. Mean number of crustacean species per core, H-2. Vertical lines represent standard error.

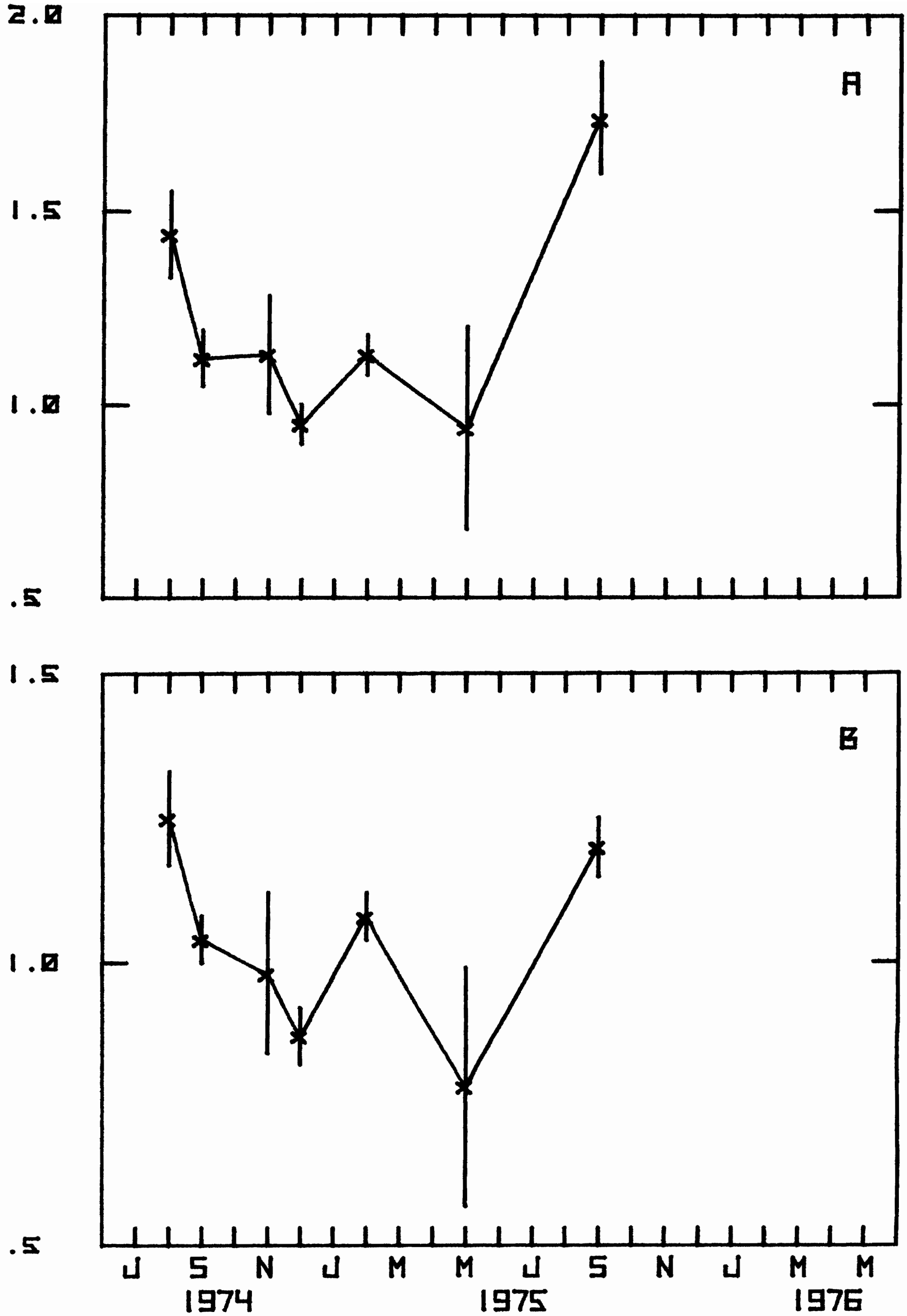

FIGURE 46. A. Mean total diversity, H', per core, all groups, H-2.
B. Mean polychaete diversity, H', per core, H-2.
Vertical lines represent standard error.

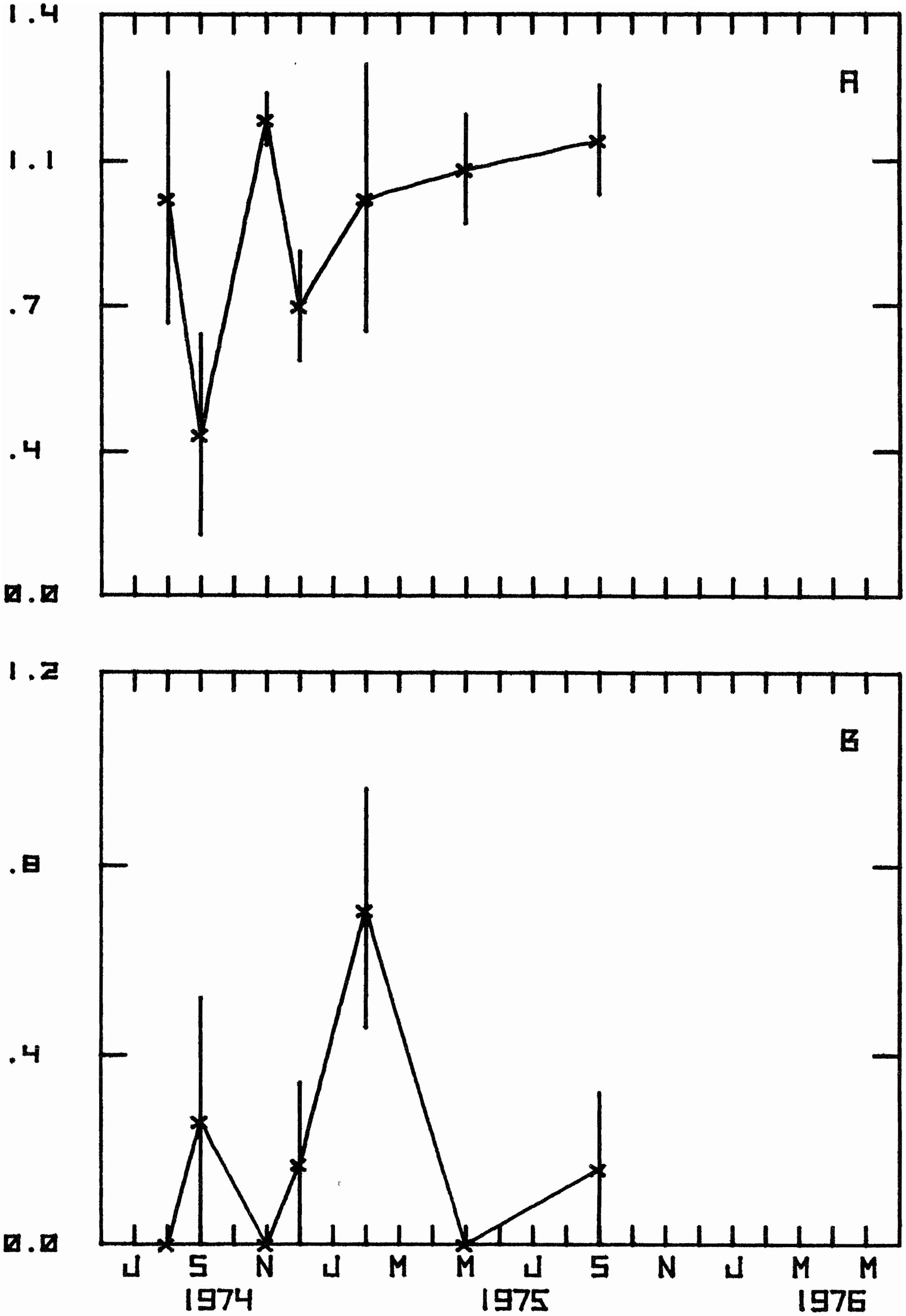

FIGURE 47. A. Mean mollusc diversity, H', per core, H-2. B. Mean crustacean diversity, H', per core, H-2. Vertical lines represent standard error.

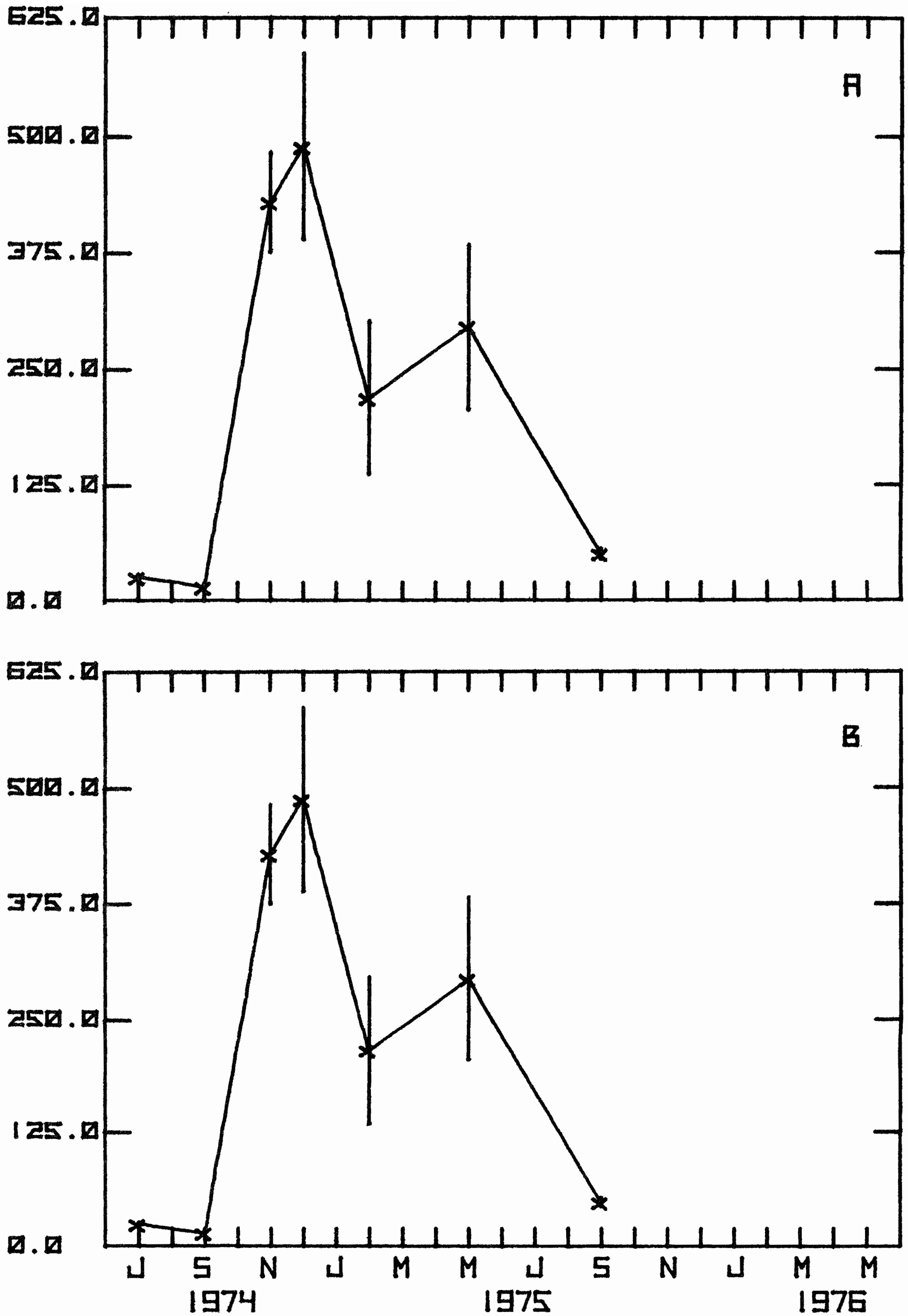

FIGURE 48. A. Mean number of individuals per core, all groups, H-1.
B. Mean number of polychaete individuals per core, H-1.
Vertical lines represent standard error.

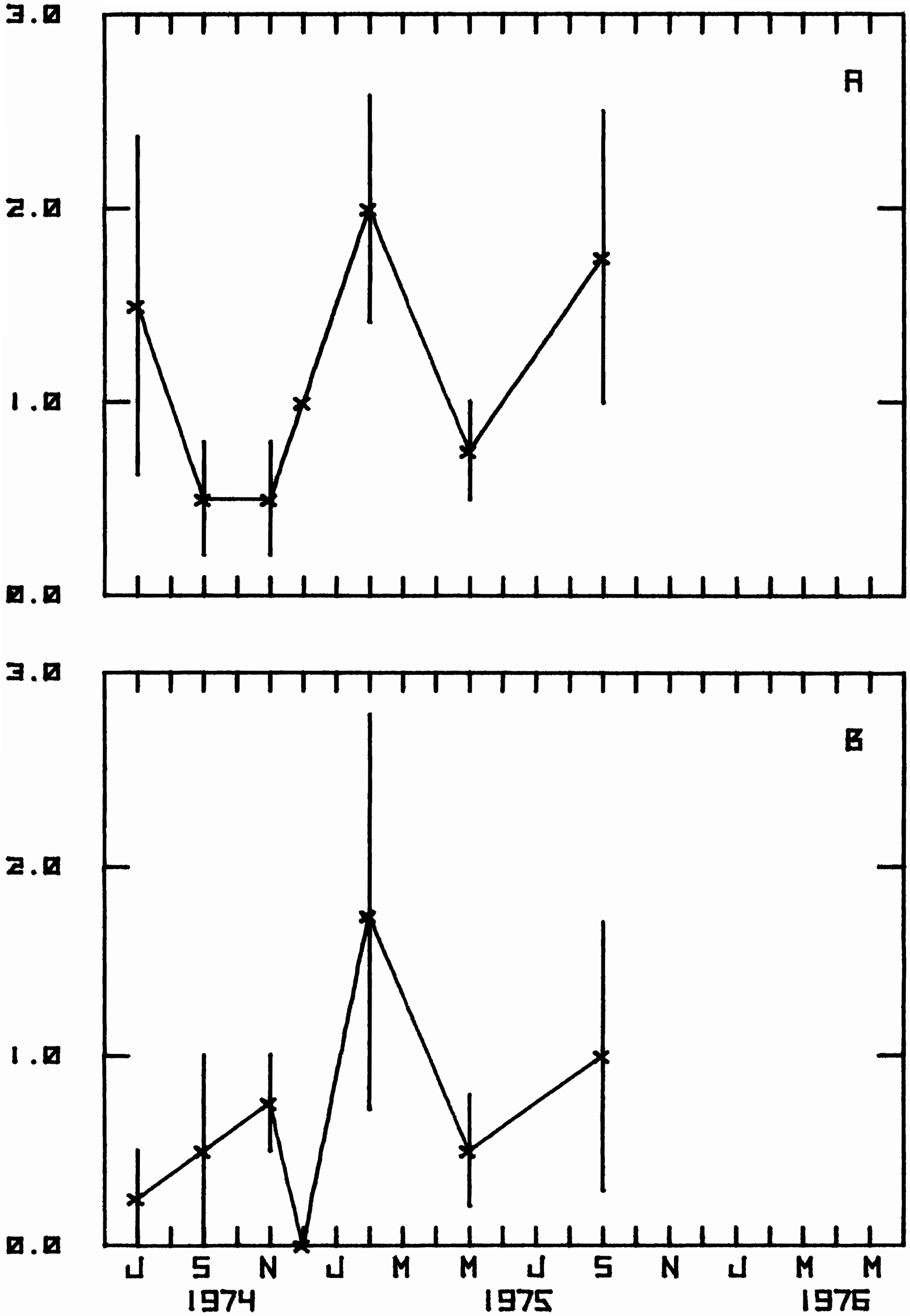

FIGURE 49. A. Mean number of mollusc individuals per core, H-I.
B. Mean number of crustacean individuals per core, H-I.
Vertical lines represent standard error.

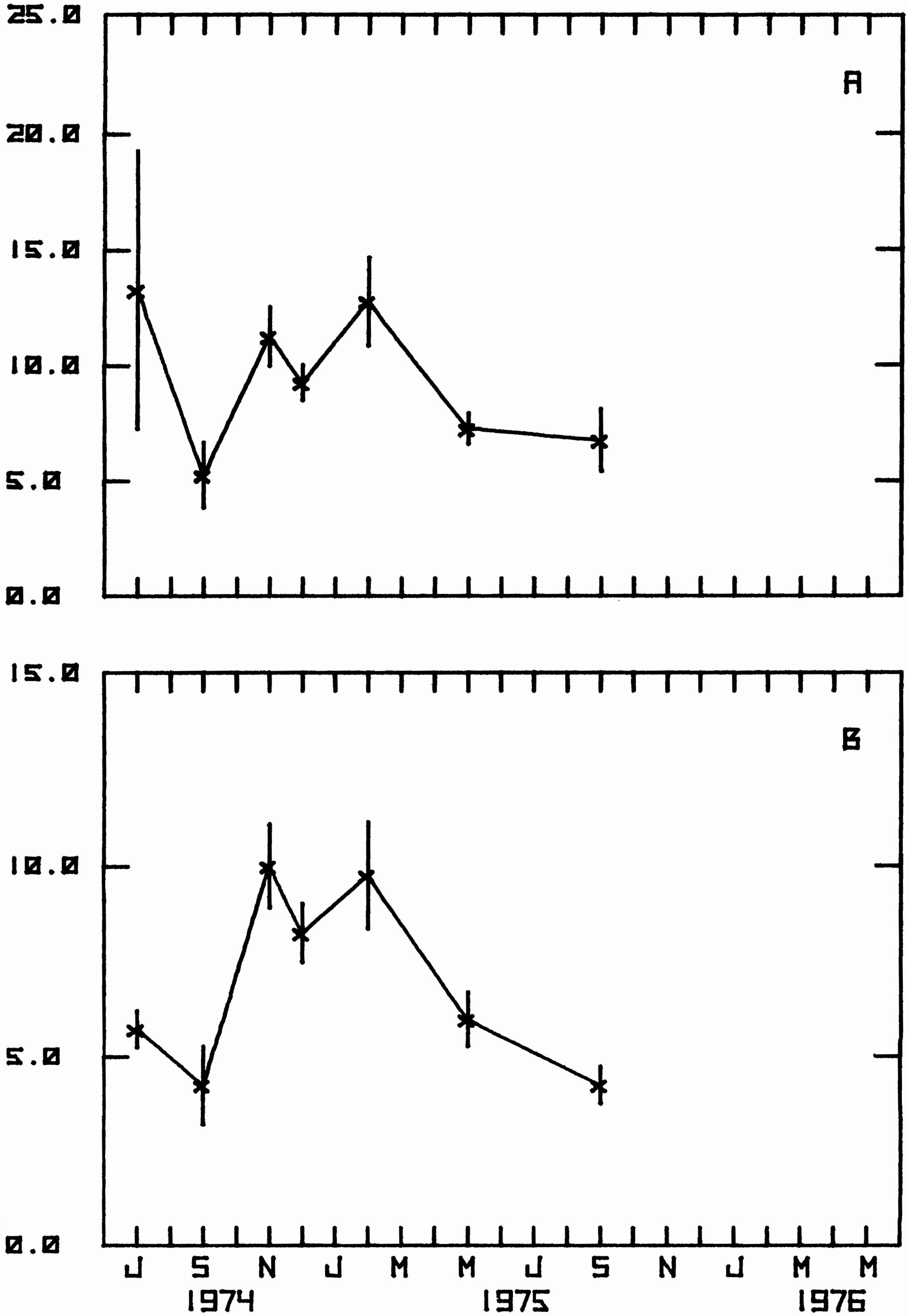

FIGURE 50. A. Mean number of species per core, all groups, H-I.
B. Mean number of polychaete species per core, H-I.
Vertical lines represent standard error.

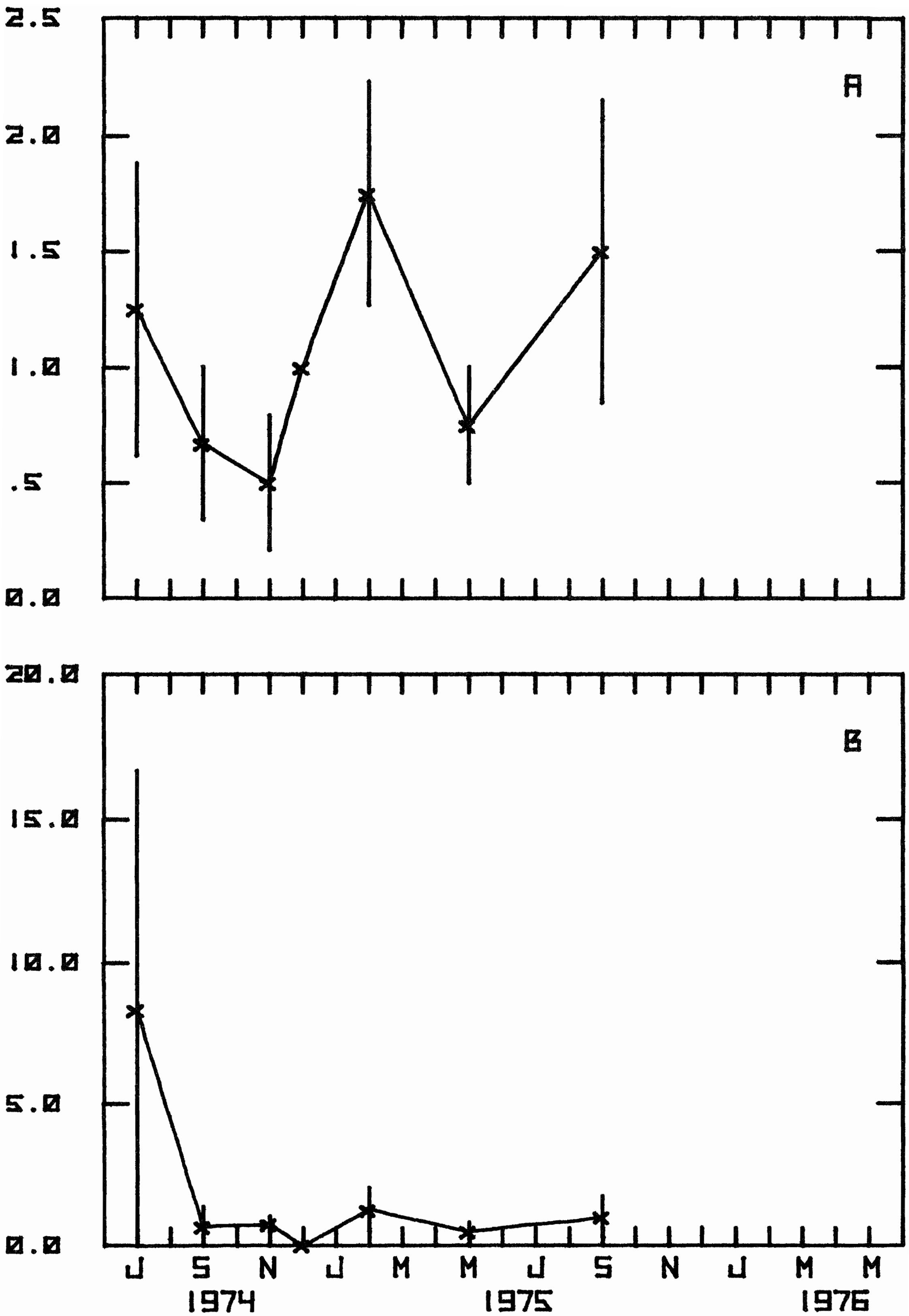

FIGURE 51. A. Mean number of mollusc species per core, H-1.
B. Mean number of crustacean species per core, H-1.
Vertical lines represent standard error.

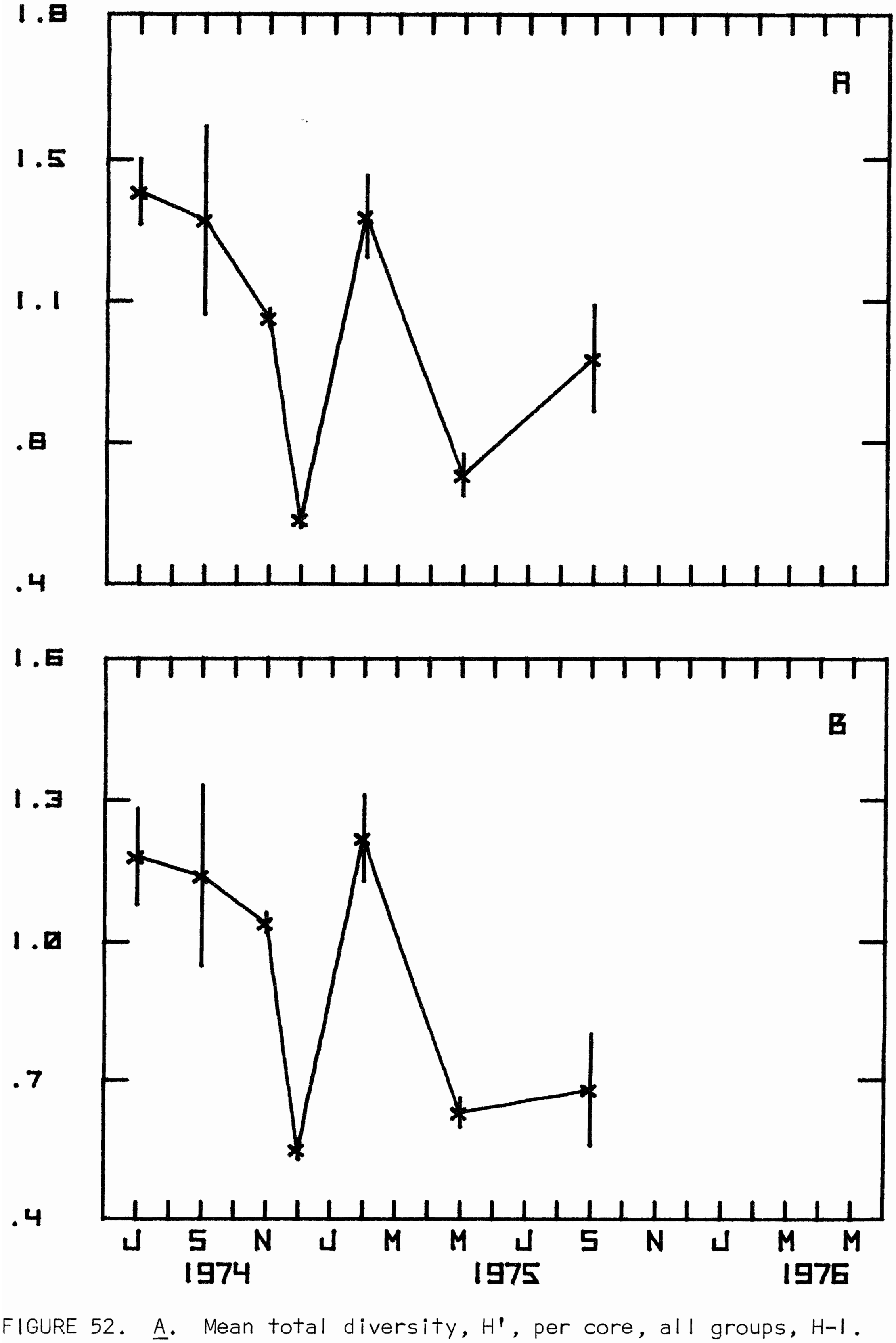

FIGURE 52. A. Mean total diversity, H', per core, all groups, H-I.
B. Mean polychaete diversity, H', per core, H-I. Vertical lines represent standard error.

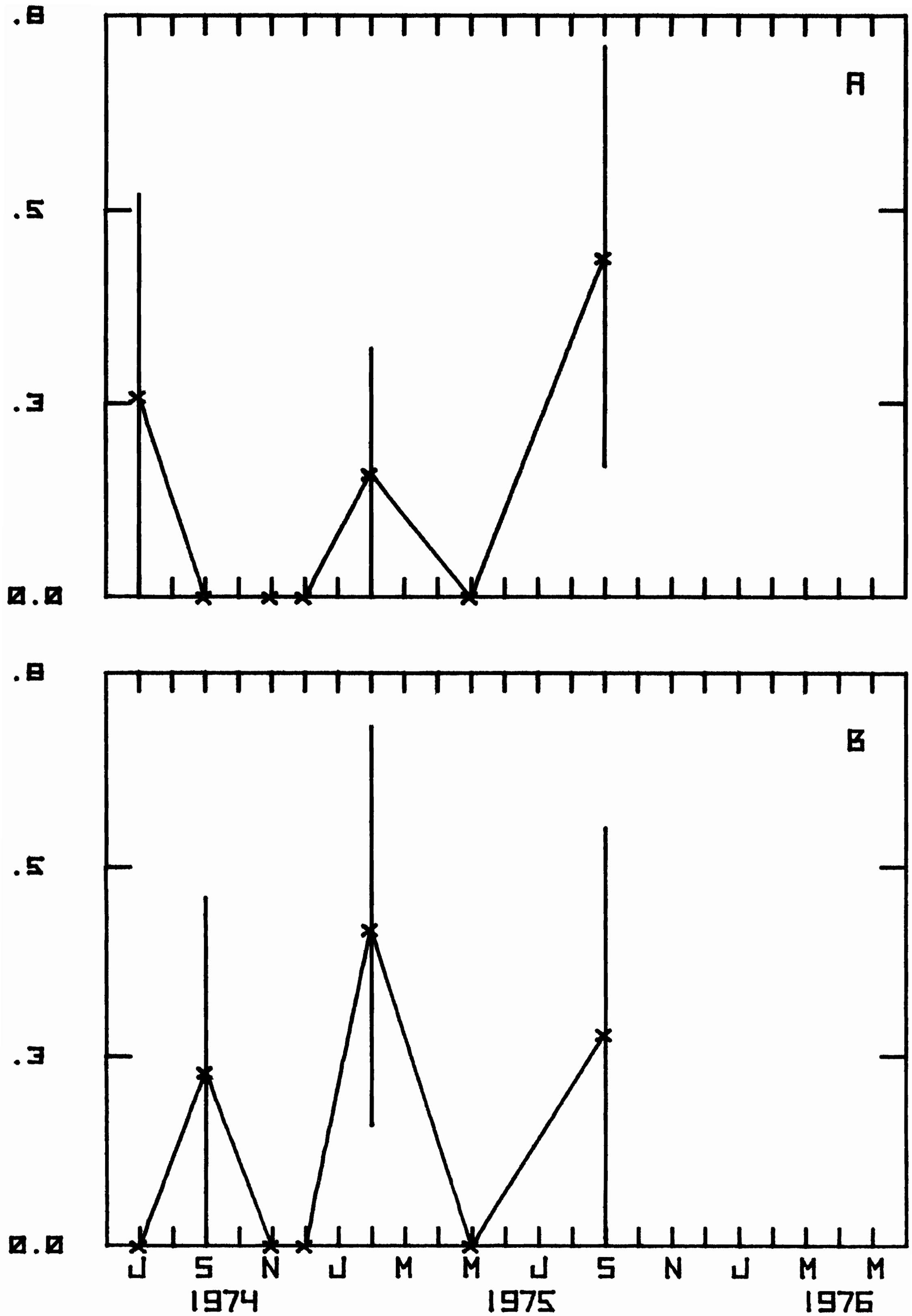

FIGURE 53. A. Mean mollusc diversity, H', per core, H-I. B. Mean crustacean diversity, H', per core, H-I. Vertical lines represent standard error.

most of the phoronid larvae originate. On the other hand, H-4 is located in the entrance channel which is simply a continuation of Elkhorn Slough (Figure 1).

In summary, the successional patterns after both the 1971 and 1974 disturbances involved many of the same species, but were grossly dissimilar because of the recruitment and survival of a dense population of *Phoronopsis viridis*. Early polychaete colonists responded to the break-up of the phoronid patch as if it were a disturbance. The rate of recovery of the pre-disturbance infauna was much longer in the presence of *P. viridis* (H-4 three years, H-3 probably two years).

The interpretation of the successional patterns after the 1974 dredging was complicated by differential disturbance. The outer harbor (H-3) and back harbor (H-1) stations were dredged relatively clean, but not so well as H-4, while H-2 was dredged unevenly and there was probably a significant amount of slumping into excavations. (More large animals were present after the dredging.) The two inner harbor stations recovered at the same rate; however, H-2 was less disturbed than H-1. If the disturbance at H-2 had been more complete, we believe that H-2 would have taken longer to recover. While the inner harbor areas recovered within a year, the pre-disturbance fauna at H-3 was not re-established by the end of the first year. By comparing H-4 and H-3, we estimate that recovery at H-3 will be complete within two years.

C. Subtidal Offshore Stations.

Three stations were established offshore in the area of the tanker anchorage. These stations were designated N-2, N-3 and N-4 and were set up

Table 13. STATION N-2

Principal species and their statistical parameters by sampling date.

	29 August 1974 (4 replicates)				23 & 27 September 1974 (2 replicates)				14, 18 & 20 November 1974 (5 replicates)				11 January 1975 (3 replicates)			
	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$
Number polychaete individuals	59	14.75	10.92	1.65	51	25.50	0.50	0.50	131	26.20	108.70	4.66	47	15.67	20.33	2.60
Chaetozone setosa									10	2.00	1.00	0.44	7	2.33	4.33	1.20
Dispio uncinata	9	2.25	0.92	0.48					13	2.60	3.80	0.87	7	2.33	2.33	0.88
Haploscoloplos pugettensis																
Heteromastus filiformis					4	2.00	0.00	0.00								
Magelona sacculata					7	3.50	4.50	1.50	10	2.00	2.50	0.71				
Nephtys caecoides	10	2.50	1.67	0.64												
Nephtys caecoides/parva																
Paraonides platybranchia									36	7.20	41.20	2.87	12	4.00	1.00	0.58
Prionospio cirrifera																
Prionospio pygmaea					13	6.50	0.50	0.50								
Scoloplos armiger	9	2.25	1.58	0.63	9	4.50	0.50	0.50	17	3.40	2.30	0.68				
Thalanessa spinosa					4	2.00	2.00	1.00								
Number crustacean individuals	321	80.25	1714.25	20.70	148	74.00	800.00	20.00	349	69.80	208.70	6.46	50	16.67	2.33	0.88
Diastylopsis tenuis	27	6.75	12.25	1.75												
Eohaustorius estuarius	31	7.75	30.92	2.78	8	4.00	2.00	1.00	71	14.20	16.70	1.83	15	5.00	4.00	1.16
Eohaustorius sawyeri	154	38.50	1547.67	19.67	75	37.50	420.50	14.50	132	26.40	49.30	3.14	13	4.33	0.33	0.33
Eohaustorius sencillus	29	7.25	30.25	2.75	6	3.00	2.00	1.00	49	9.80	17.20	1.86				
Euphilomedes carcharodonta					4	2.00	2.00	1.00	11	2.20	2.20	0.66				
Euphilomedes longiseta	9	2.25	10.25	1.60					34	6.80	13.70	1.66				
Megaluropus longimeris					6	3.00	0.00	0.00								
Mesolamprops sp.	10	2.50	1.67	0.64	4	2.00	2.00	1.00								
Monoculodes spinipes	14	3.50	1.67	0.64	4	2.00	8.00	2.00								
Paraphoxus daboius									16	3.20	5.70	1.07				
Paraphoxus lucubrans																
Paraphoxus obtusidens	79	19.75	847.58	14.56	7	3.50	24.50	3.50								
Pinnixa franciscana	15	3.75	26.92	2.59	13	6.50	84.50	6.50	11	2.20	2.20	0.66	7	2.33	16.33	2.33
Synchelidium spp.					6	3.00	2.00	1.00								
Number mollusc individuals	13	3.25	0.92	0.48	16	8.00	18.00	3.00	37	7.40	38.80	2.79	28	9.33	14.33	2.19
Mysella aleutica					4	2.00	2.00	1.00	14	2.80	3.70	0.86				
Olivella pycna					6	3.00	0.00	0.00					20	6.67	10.33	1.86
Olivella pycna juv.																
Siliqua sp.	6	1.50	0.33	0.29												
Tresus-like									10	2.00	20.00	2.00				
Total number PCM individuals	393	98.25	1700.92	20.62	215	107.50	544.50	16.50	517	103.40	609.30	11.04	125	41.67	14.33	2.19
Number polychaete species		8.25	1.58	0.63		11.00	0.00	0.00		10.80	7.70	1.24		7.67	6.33	1.45
Number crustacean species		11.50	1.67	0.65		13.50	0.50	0.50		9.80	2.70	0.74		6.00	1.00	0.58
Number mollusc species		2.50	0.33	0.29		4.00	2.00	1.00		2.60	0.30	0.24		3.33	0.33	0.33
Total number PCM species		22.25	0.92	0.48		28.50	4.50	1.50		23.20	10.70	1.46		17.00	1.00	0.58
Diversity (H')		0.75	0.02	0.07		2.66	0.16	0.29		2.56	0.00	0.07		2.55	0.01	0.06
Evenness (J')		2.36	0.19	0.22		0.79	0.01	0.07		0.82	0.00	0.01		0.90	0.00	0.01

Table 13. STATION N-2 continued

	2 April 1975 (3 replicates) N	X̄/CORE	S^2	$S_{\bar{X}}$	17 June 1975 (3 replicates) N	X̄/CORE	S^2	$S_{\bar{X}}$	16 September 1975 (3 replicates) N	X̄/CORE	S^2	$S_{\bar{X}}$
Number polychaete individuals	19	6.33	4.33	1.20	48	16.00	9.00	1.73	123	41.00	49.00	4.04
Chaetozone setosa					6	3.00	2.00	1.00				
Dispio uncinata												
Haploscoloplos pugettensis									6	2.00	1.00	0.58
Heteromastus filiformis												
Magelona sacculata					7	2.33	2.33	0.88	16	5.33	6.33	1.45
Nephtys caecoides												
Nephtys caecoides/parva									7	2.33	2.33	0.88
Paraonides platybranchia												
Prionospio cirrifera					17	5.67	16.33	2.33				
Prionospio pygmaea									10	3.33	2.33	0.88
Scoloplos armiger	6	2.00	4.00	1.16								
Thalanessa spinosa									48	16.00	27.00	3.00
Number crustacean individuals	32	10.67	6.33	1.45	296	88.67	30.33	3.18	303	101.00	1009.00	18.34
Diastylopsis tenuis												
Eohaustorius estuarius	8	2.67	4.33	1.20	27	9.00	52.00	4.16				
Eohaustorius sawyeri					166	55.33	82.33	5.24	159	53.00	252.00	9.16
Eohaustorius sencillus					15	5.00	3.00	1.00	15	5.00	13.00	2.08
Euphilomedes carcharodonta												
Euphilomedes longiseta					27	9.00	52.00	4.16	81	27.00	111.00	6.08
Megaluropus longimeris												
Mesolamprops sp.												
Monoculodes spinipes					13	4.33	0.33	0.33	11	3.67	0.33	0.33
Paraphoxus daboius												
Paraphoxus lucubrans					6	2.00	3.00	1.00	13	4.33	20.33	2.60
Paraphoxus obtusidens												
Pinnixa franciscana					25	8.33	72.33	4.91				
Synchelidium spp.												
Number mollusc individuals	5	1.67	0.33	0.33	8	2.67	5.33	1.33	50	16.67	25.33	2.91
Mysella aleutica												
Olivella pycna												
Olivella pycna juv.									37	12.33	10.33	1.86
Siliqua sp.												
Tresus-like												
Total number PCM individuals	56	18.67	24.33	2.85	352	117.33	162.33	7.36	476	158.67	1125.33	19.37
Number polychaete species		4.67	1.33	0.67		8.00	1.00	0.58		12.00	1.00	0.58
Number crustacean species		3.00	1.00	0.58		5.67	1.33	0.67		10.00	4.00	1.15
Number mollusc species		1.67	0.33	0.33		2.00	3.00	1.00		4.33	1.33	0.67
Total number PCM species		9.00	7.00	1.53		15.33	5.33	1.33		26.33	2.33	0.88
Diversity (H')		1.94	0.04	0.11		1.37	0.01	0.07		2.34	5.34	2.44
Evenness (J')		0.90	0.00	0.02		0.50	0.00	0.02		0.70	0.52	0.75

Table 14. STATION N-3

Principal species and their statistical parameters by sampling date.

	30 August 1974 (4 replicates)				27 September 1974 (2 replicates)				3 November 1974 (5 replicates)				16 January 1975 (3 replicates)			
	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$	N	$\bar{X}$/CORE	s^2	$s_{\bar{X}}$
Number polychaete individuals	169	42.50	181.67	6.74	295	147.50	2112.50	32.50	178	35.60	102.30	4.52	146	48.67	134.33	6.69
Amaeana occidentalis	18	4.50	1.00	0.50	10	5.00	2.00	1.00	15	3.00	0.50	0.32	44	14.67	16.33	2.33
Armandia brevis					154	77.00	392.00	14.00								
Exogone lourei					14	7.00	32.00	4.00	23	4.60	6.80	1.17	7	2.33	0.33	0.33
Glycinde polygnatha																
Gyptis brevipalpa																
Harmothoe scriptoria																
Lumbrineris luti																
Magelona sacculata																
Mediomastus californiensis	82	20.50	129.67	5.69	40	20.00	288.00	12.00	93	18.60	123.80	4.98	47	15.67	92.33	5.55
Nephtys cornuta franciscana																
Nothria elegans	9	2.25	1.58	0.63												
Prionospio cirrifera	19	4.75	3.58	0.95	40	20.00	32.00	4.00								
Prionospio pygmaea					13	6.50	0.50	0.50					18	6.00	3.00	1.00
Thalanessa spinosa	9	2.25	4.25	1.03									8	2.67	4.33	1.20
Number crustacean individuals	903	225.75	1739.58	20.85	334	167.00	450.00	15.00	555	111.00	150.50	5.49	294	98.00	931.00	17.62
Eohaustorius sencillus	227	56.75	597.58	12.22	96	48.00	98.00	7.00	140	28.00	83.50	4.09	59	19.67	0.33	0.33
Euphilomedes carcharodonta	301	75.25	449.58	10.60	60	30.00	0.00	0.00	42	8.40	32.30	2.54				
Euphilomedes oblonga	48	12.00	18.67	2.16	23	11.50	12.50	2.50	45	9.00	7.00	1.18	34	11.33	22.33	2.73
Hemilamprops californica	15	3.75	2.92	0.85												
Listriella diffusa	32	8.00	22.00	2.34	21	10.50	0.50	0.50	28	5.60	1.30	0.51	21	7.00	4.00	1.16
Mesolamprops sp.																
Paraphoxus daboius	227	56.75	336.92	9.18	103	51.50	4.50	1.50	263	52.60	104.80	4.58	144	48.00	588.00	14.00
Paraphoxus epistomus	30	7.50	7.00	1.32	16	8.00	18.00	3.00	21	4.20	5.70	1.07	6	2.00	0.00	0.00
Paraphoxus lucubrans	8	2.00	4.67	1.08									6	2.00	0.00	0.00
Pinnixa franciscana					10	5.00	8.00	2.00	11	2.20	9.20	1.36	11	3.67	30.33	3.18
Number mollusc individuals	77	19.25	54.92	3.70	28	14.00	72.00	6.00	19	3.80	3.70	0.86	26	8.67	17.33	2.40
Macoma sp.																
Mysella aleutica					6	3.00	0.00	0.00					16	5.33	14.33	2.19
Olivella pycna																
Protothaca staminea					4	2.00	2.00	1.00								
Siliqua spp.																
Tellina modesta	40	10.00	34.67	2.94	16	8.00	50.00	5.00								
Total number PCM individuals	1150	287.50	3343.00	28.91	657	328.50	5724.50	53.50	752	150.40	170.80	5.84	466	155.33	537.33	13.38
Number polychaete species		11.75	0.25	0.25		16.50	0.50	0.50		9.80	0.70	0.37		11.33	10.33	1.86
Number crustacean species		10.25	0.92	0.48		9.00	2.00	1.00		7.20	0.70	0.37		9.33	2.33	0.88
Number mollusc species		6.75	4.92	1.11		4.00	0.00	0.02		2.60	1.30	0.51		3.33	0.33	0.33
Total number PCM species		28.75	4.92	1.11		29.50	0.50	0.50		19.60	2.80	0.75		24.00	21.00	2.65
Diversity (H')		2.27	0.00	0.01		2.48	0.00	0.05		2.11	0.02	0.07		2.36	0.06	0.14
Evenness (J')		0.68	0.00	0.01		0.73	0.00	0.01		0.71	0.00	0.02		0.75	0.00	0.02

Table 14. STATION N-3 continued

	5 April 1975 (3 replicates)				17 June 1975 (3 replicates)				16 September 1975 (3 replicates)				23 February 1976 (3 replicates)			
	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$
Number polychaete individuals	146	48.67	49.33	4.06	143	47.67	72.33	4.91	278	92.67	432.33	12.00	209	69.67	254.33	9.21
Amaeana occidentalis	32	10.67	22.33	2.73	24	8.00	28.00	3.06	`23	7.67	2.33	0.88	23	7.67	6.33	1.45
Armandia brevis																
Exogone lourei									19	6.33	9.33	1.76	17	5.67	12.33	2.03
Glycinde polygnatha									27	9.00	127.00	6.51				
Gyptis brevipalpa									6	2.00	3.00	1.00				
Harmothoe scriptoria					6	2.00	3.00	1.00								
Lumbrineris luti									8	2.67	4.33	1.20	13	4.33	6.33	1.45
Magelona sacculata	8	2.67	6.33	1.45	61	20.33	5.33	1.33	15	5.00	7.00	1.53				
Mediomastus californiensis	72	24.00	127.00	6.51	11	3.67	9.33	1.76	107	35.67	162.33	7.36	123	41.00	57.00	4.36
Nephtys cornuta franciscana									6	2.00	1.00	0.58				
Nothria elegans																
Prionospio cirrifera									14	4.67	20.33	2.60				
Prionospio pygmaea					17	5.67	0.33	0.33								
Thalanessa spinosa	6	2.00	3.00	1.00					38	12.67	4.33	1.20	13	4.33	1.33	0.67
Number crustacean individuals	233	77.67	308.33	10.14	117	39.00	624.00	14.42	450	150.00	1159.00	19.66	321	107.00	427.00	11.93
Eohaustorius sencillus	95	31.67	120.33	6.33	20	6.67	66.33	4.70	105	35.00	169.00	7.51	83	27.67	4.33	1.20
Euphilomedes carcharodonta					31	10.33	30.33	3.18	94	31.33	142.33	6.89				
Euphilomedes oblonga	20	6.67	22.33	2.73					30	10.00	9.00	1.73	32	10.67	5.33	1.33
Hemilamprops californica																
Listriella diffusa					6	2.00	1.00	0.58					19	6.33	2.33	0.88
Mesolamprops sp.					20	6.67	16.33	2.33								
Paraphoxus daboius	72	24.00	76.00	5.03					164	54.67	342.33	10.68	144	48.00	129.00	6.56
Paraphoxus epistomus	18	6.00	4.00	1.16	22	7.33	10.33	1.86	13	4.33	1.33	0.67	23	7.67	4.33	1.20
Paraphoxus lucubrans																
Pinnixa franciscana	14	4.67	20.33	2.60									11	3.67	8.33	1.67
Number mollusc individuals	16	5.33	5.33	1.33	32	10.67	2.33	0.88	63	21.00	16.00	2.31	75	25.00	169.00	7.51
Macoma sp.													9	3.00	4.00	1.16
Mysella aleutica													45	15.00	57.00	44.36
Olivella pycna					6	2.00	3.00	1.00								
Protothaca staminea																
Siliqua spp.					14	4.67	0.33	0.33								
Tellina modesta													12	4.00	7.00	1.53
Total number PCM individuals	395	131.67	486.33	12.73	291	97.00	307.00	10.12	791	263.67	3045.33	31.86	605	201.67	900.33	17.32
Number polychaete species		9.67	8.33	1.67		10.67	4.33	1.20		16.67	0.33	0.33		7.33	10.33	1.86
Number crustacean species		8.00	1.00	0.58		9.33	2.33	0.88		8.33	1.33	0.67		5.33	2.33	0.88
Number mollusc species		3.67	1.33	0.67		4.00	1.00	0.58		6.33	4.33	1.20		1.67	2.33	0.88
Total number PCM species		21.33	10.33	1.86		24.00	4.00	1.16		31.33	9.33	1.76		14.33	25.33	2.91
Diversity (H')		2.30	0.02	0.09		1.78	0.01	0.05		2.68	0.03	0.10		2.40	0.01	0.04
Evenness (J')		0.75	0.00	0.01		0.76	0.00	0.03		0.78	0.00	0.02		0.76	0.00	0.01

Table 15. STATION N-4

Principal species and their statistical parameters by sampling date.

	29 August 1974 (4 replicates)				27 September 1974 (2 replicates)				5 November 1974 (5 replicates)				4 January 1975 (3 replicates)			
	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$	N	$\overline{X}$/CORE	S^2	$S_{\overline{X}}$
Number polychaete individuals	102	35.50	32.33	2.84	137	69.00	2592.00	36.00	227	45.40	223.30	6.68	168	56.00	21.00	2.65
Amaeana occidentalis									17	3.40	1.30	0.51	42	14.00	1.00	0.58
Armandia brevis	16	4.00	30.00	2.74	39	19.50	144.50	8.50								
Axiothella rubrocincta																
Eumida tubiformis																
Exogone lourei									11	2.20	0.70	0.37	9	3.00	3.00	1.00
Glycinde sp.					4	2.00	2.00	1.00								
Gyptis brevipalpa																
Heteromastus filiformis																
Lumbrineris luti													6	2.00	1.00	0.58
Magelona pitelkai																
Magelona sacculata																
Mediomastus californiensis	35	8.75	8.25	1.44	46	23.00	882.00	21.00	78	15.60	81.80	4.04	54	18.00	112.00	6.11
Nephtys cornuta franciscana																
Nothria elegans	9	2.25	0.92	0.48	5	2.50	12.50	2.50	11	2.20	2.70	0.74	8	2.67	6.33	1.45
Prionospio cirrifera					4	2.00	2.00	1.00								
Prionospio pygmaea					8	4.00	2.00	1.00								
Thalanessa spinosa	12	3.00	3.33	0.91	8	4.00	8.00	2.00	17	3.40	3.30	0.81				
Number crustacean individuals	830	207.50	6056.33	38.91	291	145.50	2812.50	37.50	435	87.00	396.50	8.90	145	48.33	202.33	8.21
Aoroides columbiae					5	2.50	12.50	2.50								
Eohaustorius sencillus	213	53.25	3124.92	27.95	86	43.00	98.00	7.00	85	17.00	100.50	4.48	26	8.67	46.33	3.93
Euphilomedes carcharodonta	241	60.25	460.92	10.73	42	21.00	128.00	8.00	26	5.20	9.70	1.39				
Euphilomedes oblonga	105	26.25	309.58	8.80	58	29.00	0.00	0.00	107	21.40	47.30	3.08	35	11.67	10.33	1.86
Hemilamprops californica	17	4.25	14.25	1.89												
Listriella diffusa	36	9.00	51.33	3.58	13	6.50	84.50	6.50	26	5.20	6.20	1.11	9	3.00	1.00	0.58
Mesolamprops sp.																
Paraphoxus cf. cognatus	11	2.75	4.25	1.03												
Paraphoxus cognatus																
Paraphoxus daboius	172	43.00	797.33	14.12	67	33.50	1104.50	23.50	162	32.40	70.30	3.75	65	21.67	34.33	3.38
Paraphoxus epistomus	8	2.00	4.67	1.08	6	3.00	2.00	1.00	20	4.00	6.00	1.10				
Paraphoxus lucubrans	9	2.25	10.25	1.60												
Paraphoxus spinosus					7	3.50	24.50	3.50								
Synchelidium spp.	8	2.00	2.00	0.71												
Number mollusc individuals	81	20.25	53.58	3.66	11	5.50	4.50	1.50	56	11.20	9.70	1.39	9	3.00	3.00	1.00
Cooperella subdiaphana									15	3.00	4.50	0.95				
Macoma sp.																
Mysella aleutica									27	5.40	23.30	2.16				
Siliqua spp.																
Tellinidae																
Tellina modesta	50	12.50	48.33	3.48	8	4.00	8.00	2.00								
Total number PCM individuals	1053	263.25	5968.25	38.63	440	220.00	10368.00	72.00	724	144.80	651.70	11.42	322	107.33	376.33	11.20
Number polychaete species		15.00	0.00	0.00		14.50	12.50	2.50		17.00	3.50	0.84		16.33	9.33	1.76
Number crustacean species		11.25	6.25	1.25		8.50	4.50	1.50		7.00	1.00	0.45		6.00	4.00	1.16
Number mollusc species		6.50	0.33	0.29		2.00	0.00	0.02		3.80	0.20	0.20		2.33	2.33	0.88
Total number PCM species		32.75	8.92	1.49		25.00	32.00	4.00		27.80	7.70	1.24		24.67	8.33	1.67
Diversity (H')		2.29	0.05	0.12		2.40	0.04	0.14		2.60	0.02	0.07		2.54	0.00	0.04
Evenness (J')		0.65	0.01	0.04		0.75	0.00	0.01		0.78	0.00	0.01		0.79	0.00	0.02

Table 15. STATION N-4 continued

	2 April 1975 (3 replicates)				19 June 1975 (3 replicates)				16 September 1975 (3 replicates)				23 February 1976 (3 replicates)			
	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$	N	$\overline{X}$/CORE	s^2	$s_{\overline{X}}$
Number polychaete individuals	103	34.33	132.33	6.64	348	86.00	18.33	10.58	189	63.00	211.00	8.39	276	92.00	228.00	8.72
Amaeana occidentalis	19	6.33	17.33	2.40	25	8.33	2.33	0.88					17	5.67	2.33	0.88
Armandia brevis																
Axiothella rubrocincta									6	2.00	3.00	1.00				
Eumida tubiformis					7	2.33	2.33	0.88	13	4.33	34.33	3.38				
Exogone lourei													14	4.67	2.33	0.88
Glycinde sp.																
Gyptis brevipalpa													8	2.67	2.33	0.88
Heteromastus filiformis	12	4.00	3.00	1.00												
Lumbrineris luti					13	4.33	0.33	0.33					14	4.67	4.33	1.20
Magelona pitelkai									7	2.33	4.33	1.20	6	2.00	3.00	1.00
Magelona sacculata	12	4.00	3.00	1.00	33	11.00	4.00	1.16	57	19.00	21.00	2.65				
Mediomastus californiensis	16	5.33	5.33	1.33	106	35.33	132.33	6.64	14	4.67	14.33	2.19	173	57.67	110.33	6.06
Nephtys cornuta franciscana									14	4.67	4.33	1.20				
Nothria elegans					12	4.00	4.00	1 16								
Prionospio cirrifera					6	2.00	0.00	0.00	6	2.00	1.00	0.58				
Prionospio pygmaea													7	2.33	4.33	1.20
Thalanessa spinosa									11	3.67	2.33	0.88				
Number crustacean individuals	78	26.00	193.00	8.02	300	100.00	381.00	11.27	141	47.00	39.00	3.61	249	83.00	1057.00	18.77
Aoroides columbiae																
Eohaustorius sencillus					31	10.33	20.33	2.60					10	3.33	9.33	1.76
Euphilomedes carcharodonta					75	25.00	196.00	8.08	64	21.33	50.33	4.10	7	2.33	0.33	0.33
Euphilomedes oblonga	19	6.33	46.33	3.93	40	13.33	56.33	4.33	19	6.33	4.33	1.20	77	25.67	226.33	8.69
Hemilamprops californica	8	2.67	2.33	0.88	14	4.67	2.33	0.88								
Listriella diffusa					9	3.00	0.00	0.00					23	7.67	1.33	0.67
Mesolamprops sp.					10	3.33	4.33	1.20								
Paraphoxus cf. cognatus																
Paraphoxus cognatus					17	5.67	17.33	2.40					18	6.00	49.00	4.04
Paraphoxus daboius	18	6.00	12.00	2.00	87	29.00	43.00	3.79	24	8.00	13.00	2.08	92	30.67	182.33	7.80
Paraphoxus epistomus									16	5.33	9.33	1.76	6	2.00	1.00	0.58
Paraphoxus lucubrans																
Paraphoxus spinosus																
Synchelidium spp.					6	2.00	0.00	0.00								
Number mollusc individuals	5	1.67	2.33	0.88	10	3.33	10.33	1.86	84	28.00	39.00	3.61	122	40.67	16.33	2.33
Cooperella subdiaphana																
Macoma sp.													20	6.67	17.33	2.40
Mysella aleutica													31	10.33	17.33	2.40
Siliqua spp.													9	3.00	1.00	0.58
Tellinidae									10	3.33	17.33	2.40				
Tellina modesta									44	14.67	40.33	3.67	56	18.67	4.33	1.20
Total number PCM individuals	186	62.00	63.00	4.58	658	189.00	28.00	16.17	414	138.00	652.00	14.74	646	215.67	27.23	15.72
Number polychaete species		13.67	2.33	0.88		19.00	7.00	1.53		22.33	24.33	2.85		16.33	2.33	0.88
Number crustacean species		8.67	4.33	1.20		11.67	0.33	0.33		8.00	4.33	1.15		10.00	13.00	2.08
Number mollusc species		1.33	1.33	0.67		2.00	3.00	1.00		7.67	0.33	0.33		5.67	1.33	0.67
Total number PCM species		23.67	2.33	0.88		32.33	12.33	2.03		38.00	7.00	4.04		32.00	25.00	2.89
Diversity (H')		2.85	0.00	0.02		2.76	0.01	0.05		3.06	0.06	0.14		2.59	0.00	0.03
Evenness (J')		0.90	0.00	0.01		0.79	0.00	0.01		0.85	0.00	0.02		0.75	0.00	0.01

in nine, eighteen and twenty-four meters of water, respectively. The locations of the stations are indicated in Figure 1.

These stations were sampled in the same manner as the harbor subtidal station. The methods are outlined in the Methods section of this report.

It should be noted that the taking and complete processing of samples from these stations was done by personnel presently working on another grant. The resources of the present funding from PG&E would not have allowed us to process these samples in the time available.

Sampling was begun at these stations in mid-August and continued to February 1976. (N-2 was sampled only from August 1974 to September 1975.) Initially, sampling was monthly (August and September), then bimonthly (November and January) and finally quarterly.

We have finished processing all the samples taken.

Considering first station N-2, the shallowest of the three (nine meters), we found that it was dominated by crustacea at the first sampling in August 1974 (Table 13-A, Figure 55-B), with a mean number per core of 80.2 ±20.7. The dominant species by number at that time were the amphipods Eohaustorius sawyeri and Paraphoxus obtusidens. Very few polychaetes or molluscs were found (Table 13-A). Crustacean numbers (and total numbers of individuals) remained high until January 1975, when the mean number of individuals per core dropped to 16.6 ±0.9 (Table 13-D, Figure 55-B). The number of individuals of polychaetes and molluscs did not show a similar drop and, in fact, remained rather constant (Figures 54-B, 55-A). This decline in number of crustacean individuals was statistically significant ($P < .05$, t-test) and probably reflected the effect of the onset of winter storms on these surface or shallow-burrowing amphipods.

The decline in numbers of individuals reached a low point in April 1975 for all groups. At that time, only two species, Scoloplos armiger, a polychaete, and Eohaustorius estuarius, an amphipod crustacean, were present in any numbers. The number of crustacean individuals per core dropped to 10.7 ±1.5 in April 1975.

An equally dramatic increase in numbers of individuals per core followed this low (Figure 54-A). This increase in both numbers of individuals and species was most marked in the dominant crustacea, but the mollusca and polychaeta also showed significant increases in abundance (Figures 54-B and 55-A).

In June 1975, the station was again dominated numerically by Eohaustorius sawyeri with E. estuarius and E. longiseta second in abundance. The number of crustacean individuals per core rose to 88.7 ±3.2, a significant increase ($P < .05$, t-test) over the April figure.

At the final sampling in September 1975, the total number of individuals had again increased, this time to the highest levels recorded (Figure 54-A). The dominance in numbers remained with the crustacea and E. sawyeri was the numerically dominant species.

The above changes in numbers of individuals are mirrored also in the graphs which show changes in the mean numbers of species per core (Figures 56-A to 57-B).

The changes in diversity (H') on the other hand, do not show such dramatic changes and, whereas diversity also showed a drop, it began in April, not January, and reached a low point in September rather than June (Figures 58-A to 59-B). Diversity increased again in September at the last sampling.

We feel the changes observed at this station are the result of changes in environment induced or aggravated by winter storms and are not the result of breeding cycles (Oliver, et al, 1976). The dramatic decrease in numbers of species and individuals during the winter storm season is possibly due to migrations seaward by the dominant amphipods, as Oliver et al (1976) have suggested. This gives a basic pattern to the shallow water station, which tends to mask any other variation due to breeding cycles (Oliver, et al, 1976). Because of the short sampling time, we cannot say anything about long-term variations in the community.

Station N-3 is deeper than N-2 (eighteen meters vs. nine meters), but still falls within the shallow water crustacean zone of Oliver, et al (1976) and was dominated in August 1974 primarily by small pericaridean amphipods. The dominant species in August were the ostracod Euphilomedes carcharodonta and the amphipods Euhaustorius sencillus and Paraphoxus daboius (Table 14-A). The polychaete Mediomastus californiensis was also quite abundant. In September 1974, numbers of individuals per core were even higher, due primarily to the large numbers of the opportunistic polychaete Armandia brevis.

The numbers of individuals of all species at N-3 declined significantly from a high in September 1974 of 328.5 ±53.5 individuals per core to 150.4 ±5.8 individuals per core in November ($P < .05$, t-test). Much of this decline was a result of the great decrease in the numbers of E. carcharodonta and *Armandia brevis*.

The numbers of individuals per core of all species remained at the above low levels throughout the winter and early spring (January and April 1975) and reached the lowest point in the two years in June 1975, when the mean number of individuals per core was 97.0 ±10.1, a significant decrease from January ($P < .05$, t-test).

As at N-2, the September 1975 sampling produced a significant increase in the mean number of individuals per core ($P < .05$, t-test; Figure 60-A). This increase fell off significantly by the last sampling in February 1976, but was not nearly as dramatic as the decline recorded over the winter in 1974 - 1975 (Figure 60-A).

As at N-2, the fluctuations in total numbers of individuals per core were primarily a function of changes in the crustacea (Figure 60-B). The only exception was the big bloom of the polychaete *Armandia brevis* in September 1974, followed by its equally dramatic decline (Table 14).

Fluctuations in the numbers of species per core at N-3 were not as dramatic as the fluctuations in individuals (Figures 62-A to 63-B). Whereas the changes in total numbers of individuals per core were due primarily to crustacea, the changes in species per core were due primarily to polychaetes (Figure 62-B). Crustacean species numbers stayed relatively stable throughout the study period (Figure 63-B). Polychaete species numbers, on the other hand, showed peaks in September of both years, probably representing larval settlement of several species (Oliver, *et al*, 1976).

Total diversity (H') at station N-3 showed fluctuations, but these could not be associated with any short- or long-term seasonal trend (Figure 65-A). The large changes in species numbers and numbers of individuals were primarily responsible for the observed changes in diversity and masked any potential seasonal changes.

The faunal composition at station N-4, the deepest station, at twenty-four meters, had more polychaetes and somewhat fewer crustacean species than the shallower stations (Figures 68-A and 69-B). The reduced wave action and more stable substrate at this depth were accompanied by a reduction in the numbers of motile crustacea which were characteristic of the shallower areas. Molluscs, again, were relatively unimportant (Figures 67-A and 69-A).

Despite the increase in number of polychaete species at this station, the numerically dominant species at the first sampling in August 1974 were crustaceans (Figure 67-B). The most abundant species were the astracods Euphilomedes carcharodonta and E. oblonga and the amphipods Euhaustorius sencillus and Paraphoxus daboius (Table 15-A).

As in the other stations, the total numbers of individuals per core declined, in this case steeply, through the winter of 1974-75 (Figure 66-A). This decline was statistically significant between September 1974 and April 1975 ($P < .05$, t-test). The decline in numbers of individuals was primarily due to the decline in numbers of the dominant species of crustacea mentioned above. (Compare Figures 66-A, 66-B, 67-A and 67-B.)

After reaching a low in April 1975, the numbers of individuals per core rose significantly in June 1975 ($P < .05$, t-test), due to increased numbers of both crustacea and polychaetes (Figures 66-B and 67-B). Another significant decline occurred in September 1975, but rather than decline further as happened over the winter of 1974-75, numbers of individuals rose significantly in the winter of 1975-76, as evidenced by the February 1976 samples. Much of this increase in numbers of individuals was due to increased numbers of Mediomastus californiensis, P. daboius and E. oblonga.

The number of species per core evidenced less dramatic changes over the two years than did the number of individuals (Figures 68-A to 69-B). As with the numbers of individuals, the numbers of species per core dropped significantly from August 1974 to September 1974 ($P < .05$, t-test). This drop was due primarily to changes in the number of species of molluscs (Figure 69-A). Polychaete species did not change significantly (Figure 68-B). From September 1974 through April, there was further significant decline in the mean number of species per core ($P < .05$, t-test), the lowest number of species coming in April 1975 (Figure 66-A). This decline was due primarily to a decrease in crustacean species, as the polychaete numbers actually rose slightly in this interval (Figures 68-B and 69-B).

From April through September 1975, the number of species increased significantly ($P < .05$, t-test). This was due to a rise in the numbers of polychaete species (Figure 68-B) and mollusc species (Figure 69-A).

Another decline occurred between September 1975 and February 1976, but it was not significant ($P > .05$, t-test; Figure 68-A).

Thus, at this deepest station, the numbers of individuals and number of species per core both dropped significantly over the winter-spring of 1974-75, but failed to do so again the following winter. This is consistent with what has occurred at the other stations and may reflect the fact that the 1975-76 winter season was extraordinary in that there were no real storms.

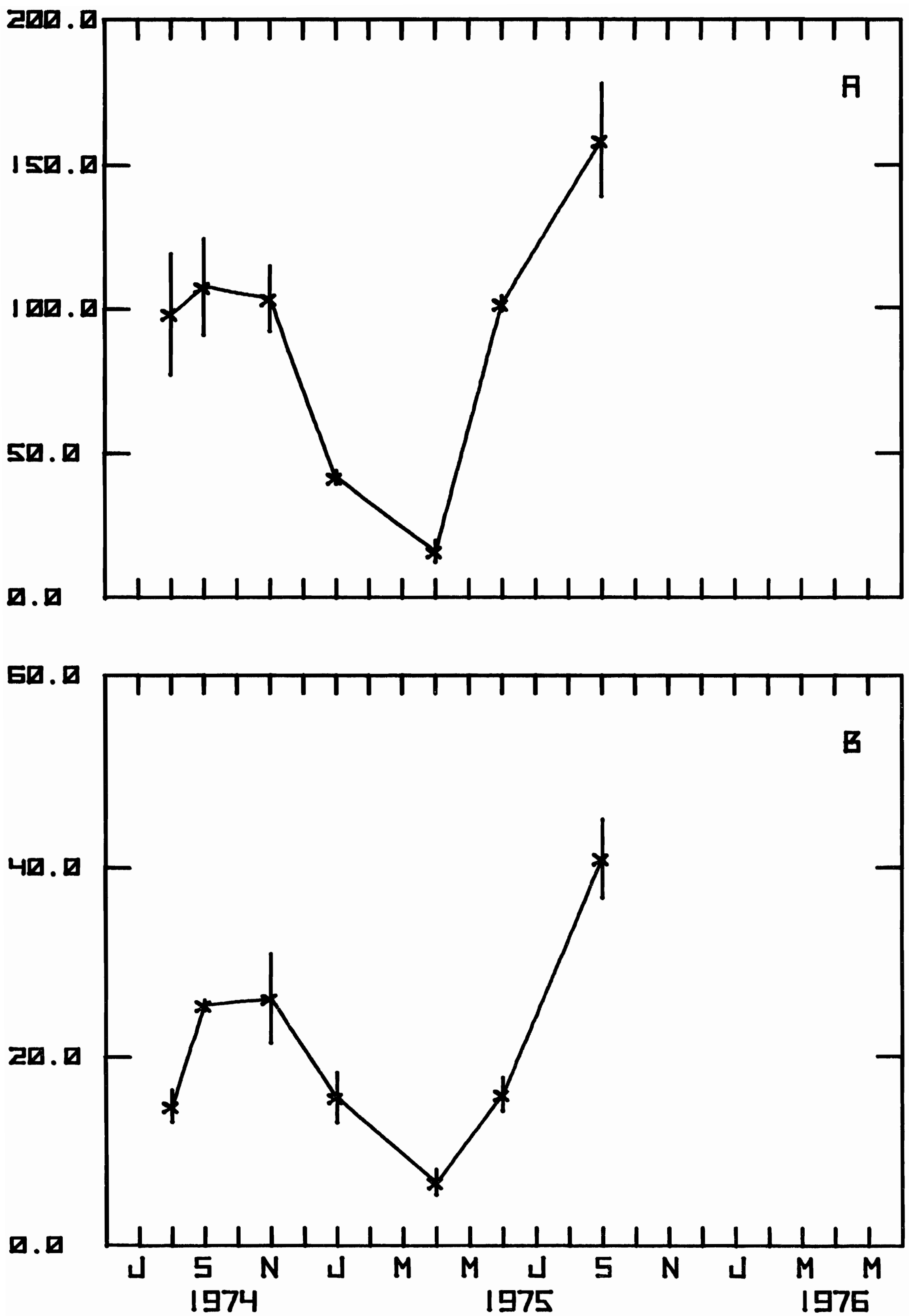

FIGURE 54. A. Mean number of individuals of all groups per core, N-2.
B. Mean number of polychaete individuals per core, N-2.
Vertical lines represent standard error.

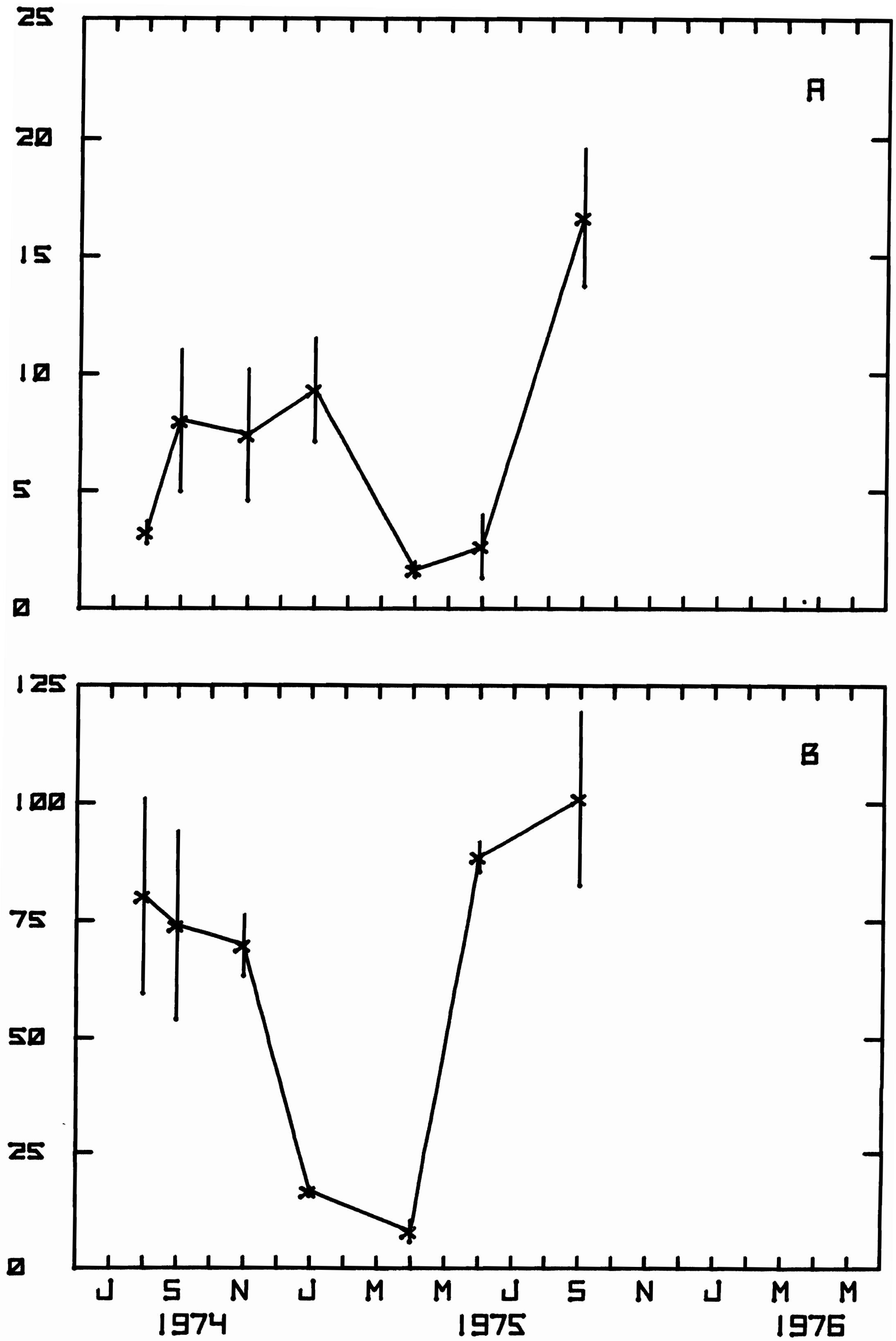

FIGURE 55. A. Mean number of mollusc individuals per core, N-2.
B. Mean number of crustacean individuals per core, N-2.
Vertical lines represent standard error.

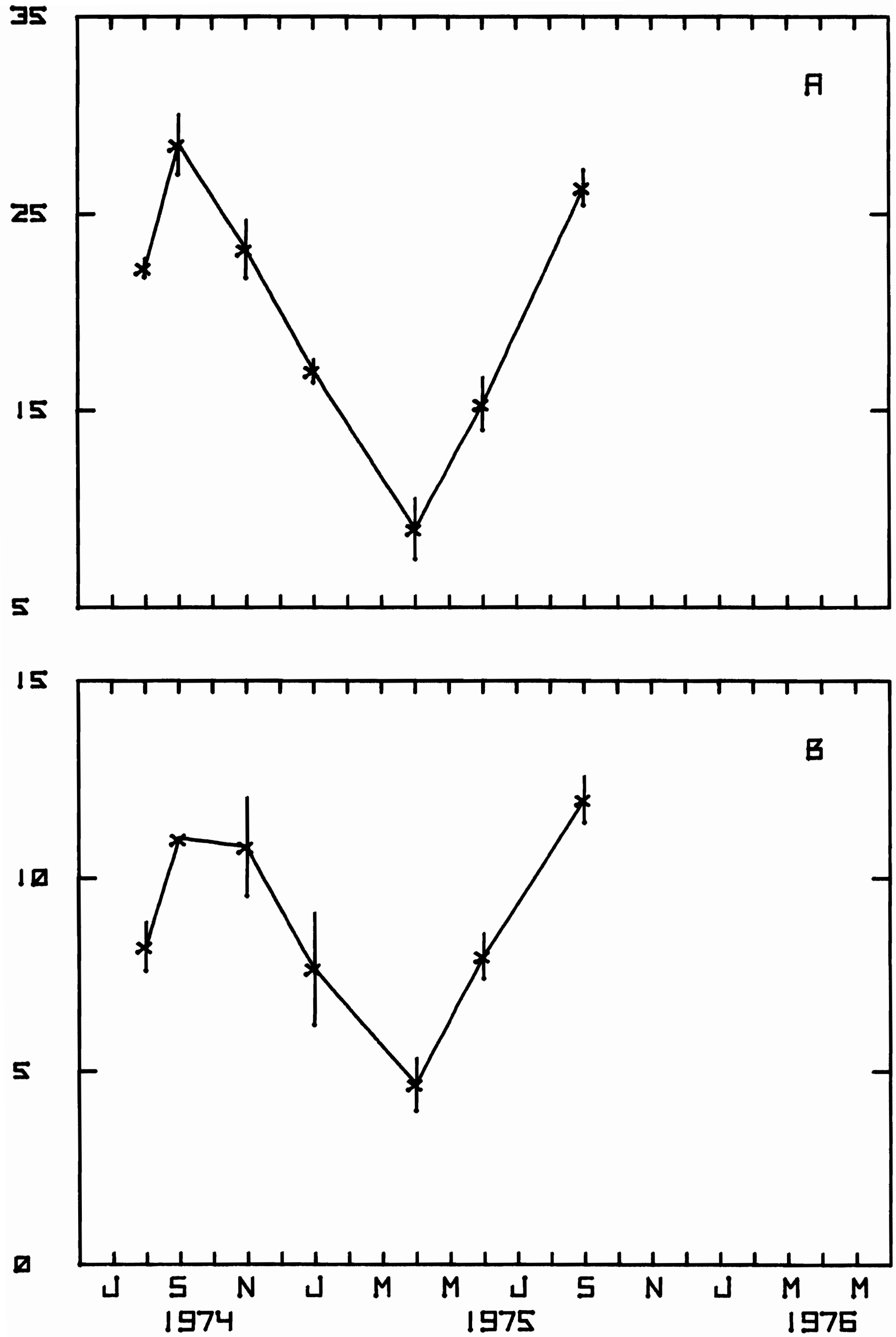

FIGURE 56. A. Mean number of species per core, all groups, N-2.
B. Mean number of polychaete species per core, N-2.
Vertical lines represent standard error.

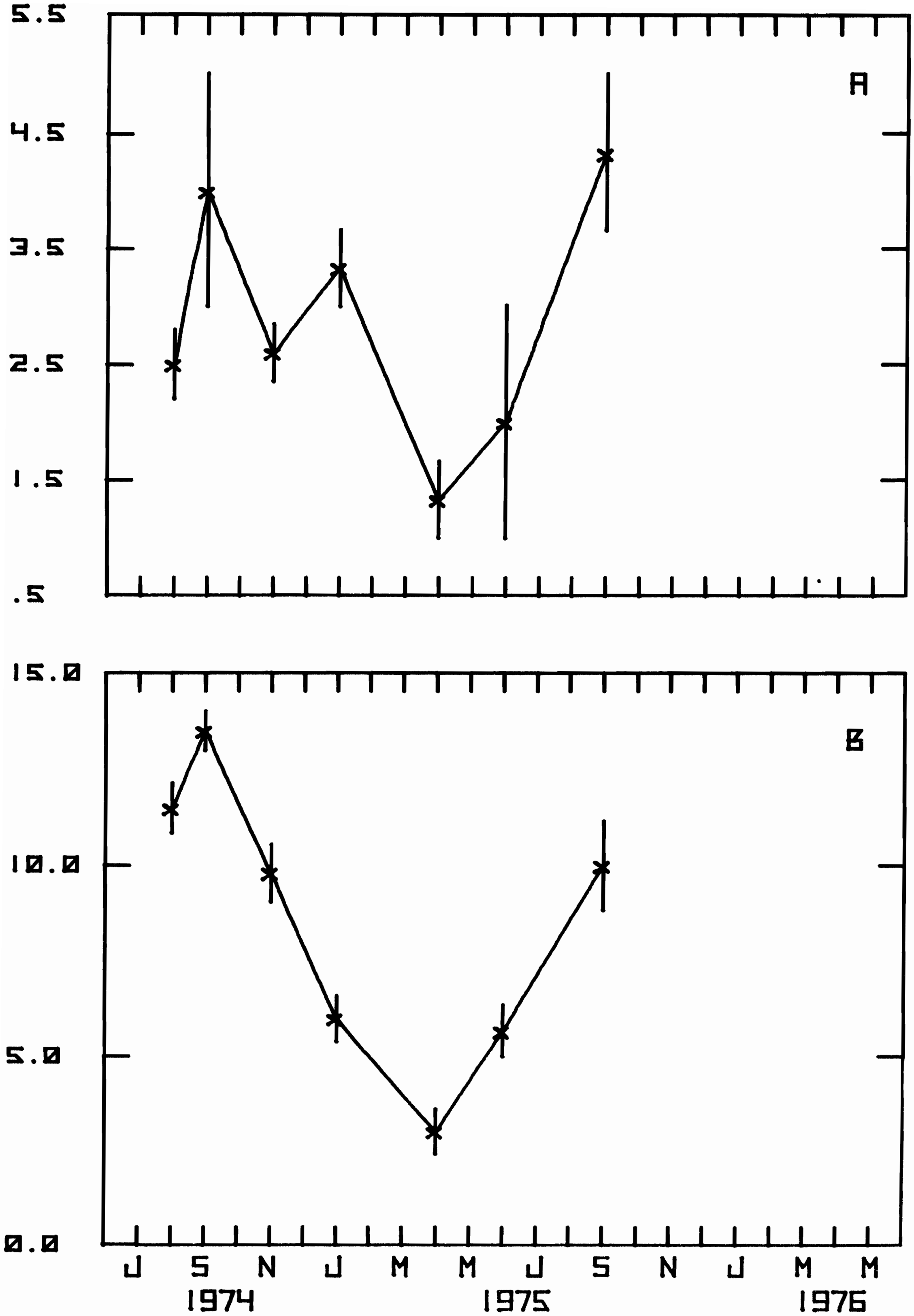

FIGURE 57. A. Mean number of mollusc species per core, N-2. B. Mean number of crustacean species per core, N-2. Vertical lines represent standard error.

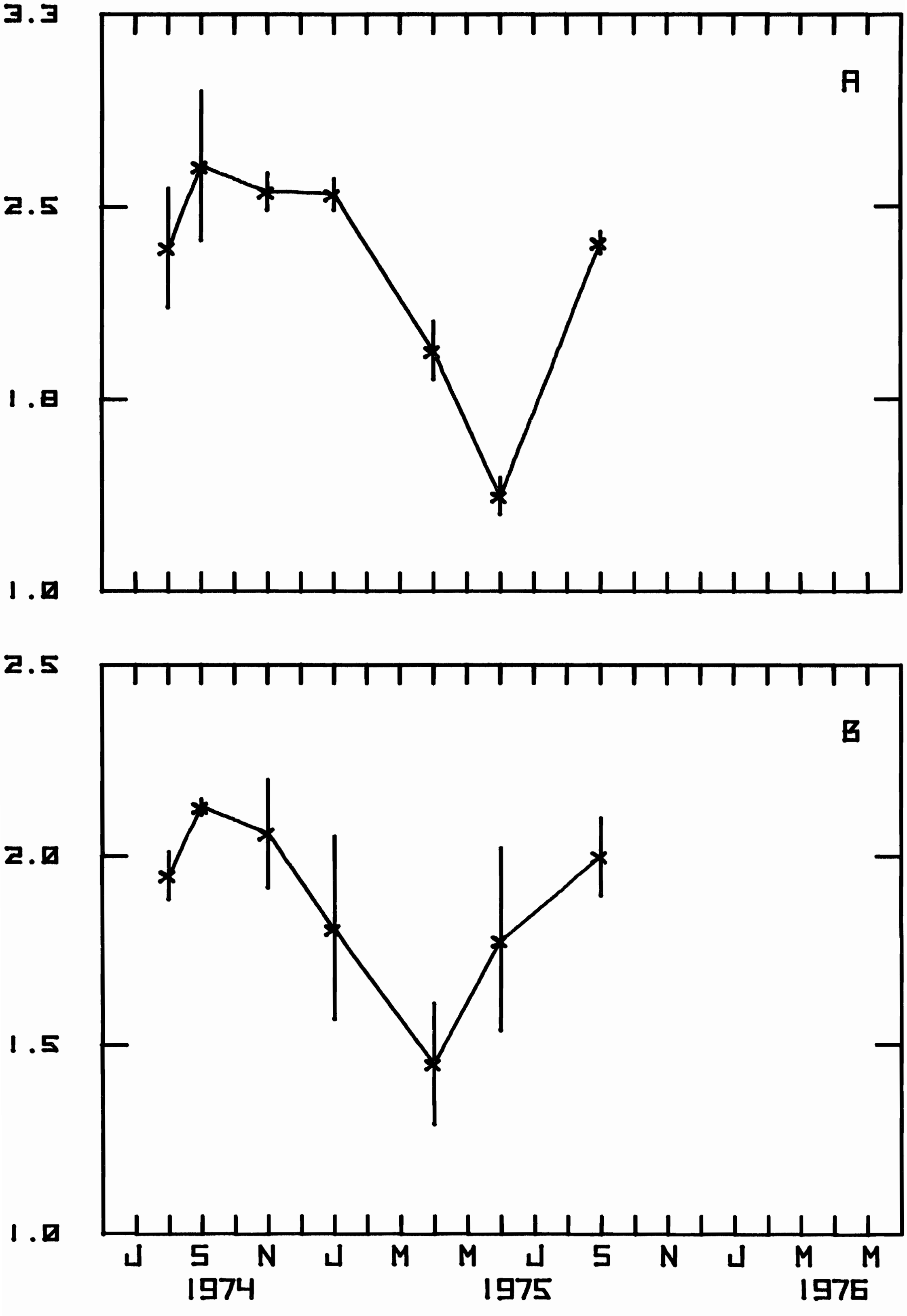

FIGURE 58. A. Mean total diversity, H', per core, N-2. B. Mean polychaete diversity, H', per core, N-2. Vertical lines represent standard error.

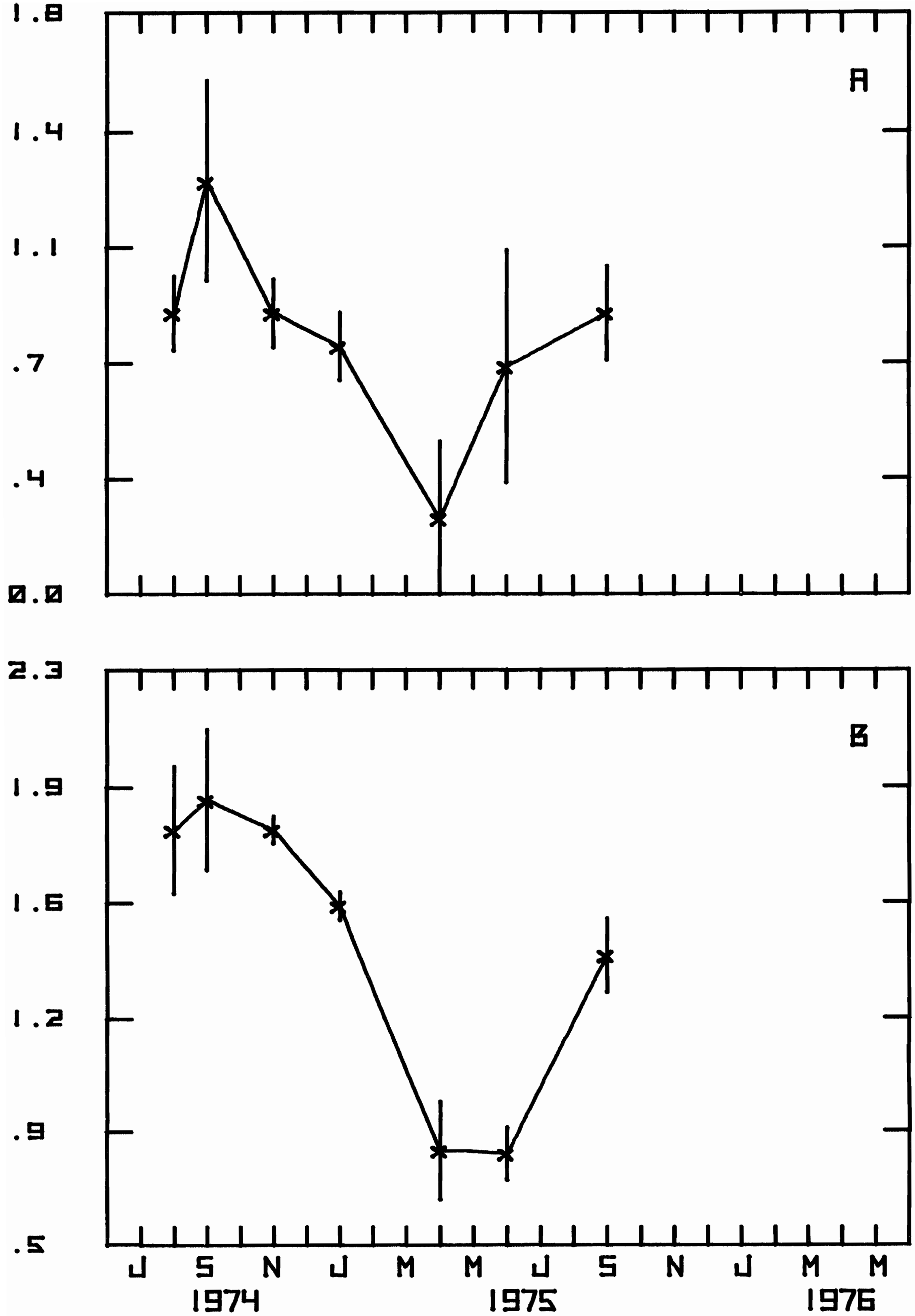

FIGURE 59. A. Mean mollusc diversity per core, N-2. B. Mean crustacean diversity per core, N-2. Vertical lines represent standard error.

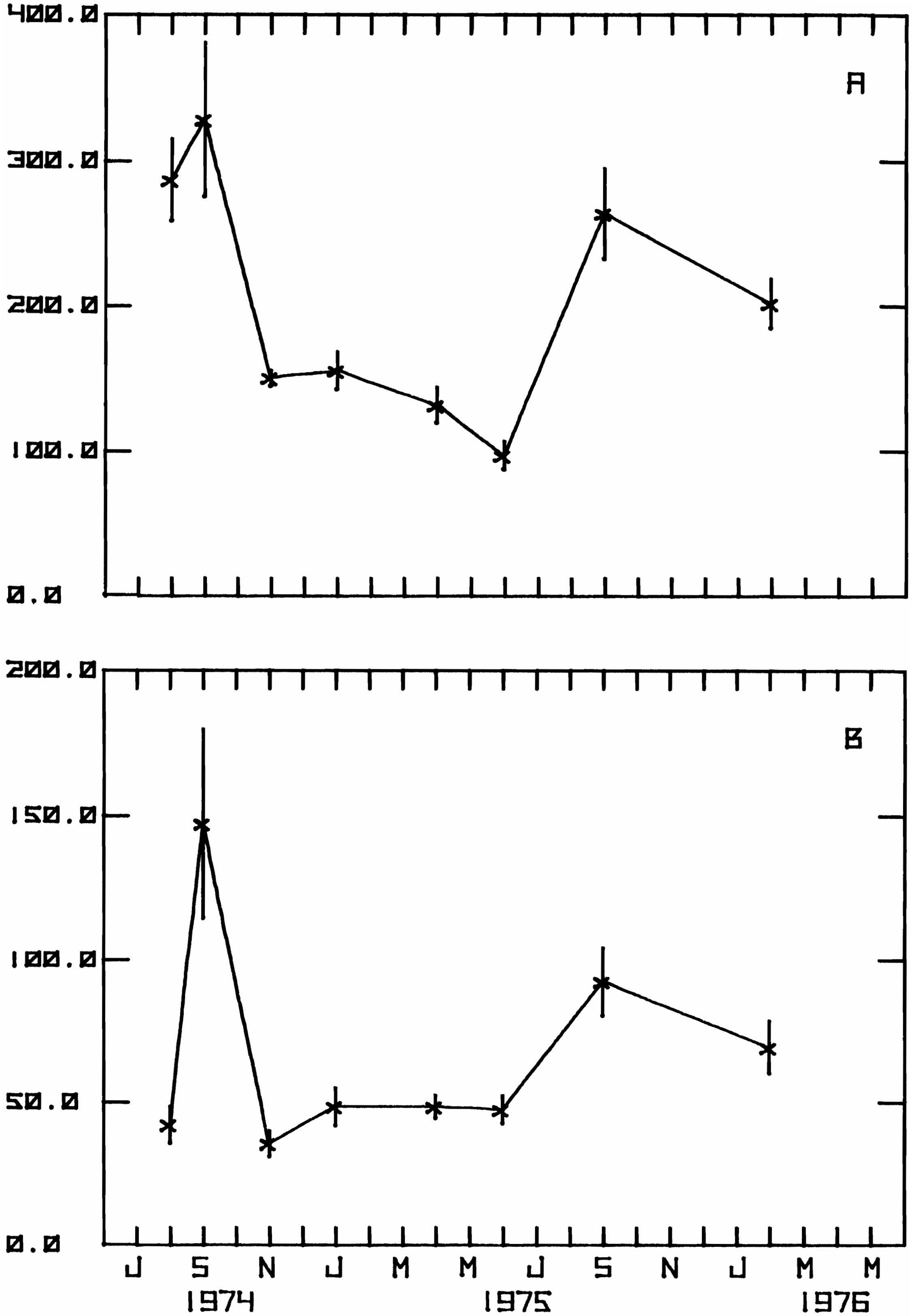

FIGURE 60. A. Mean number of individuals per core, all groups, N-3.
B. Mean number of polychaete individuals per core, N-3.
Vertical lines represent standard error.

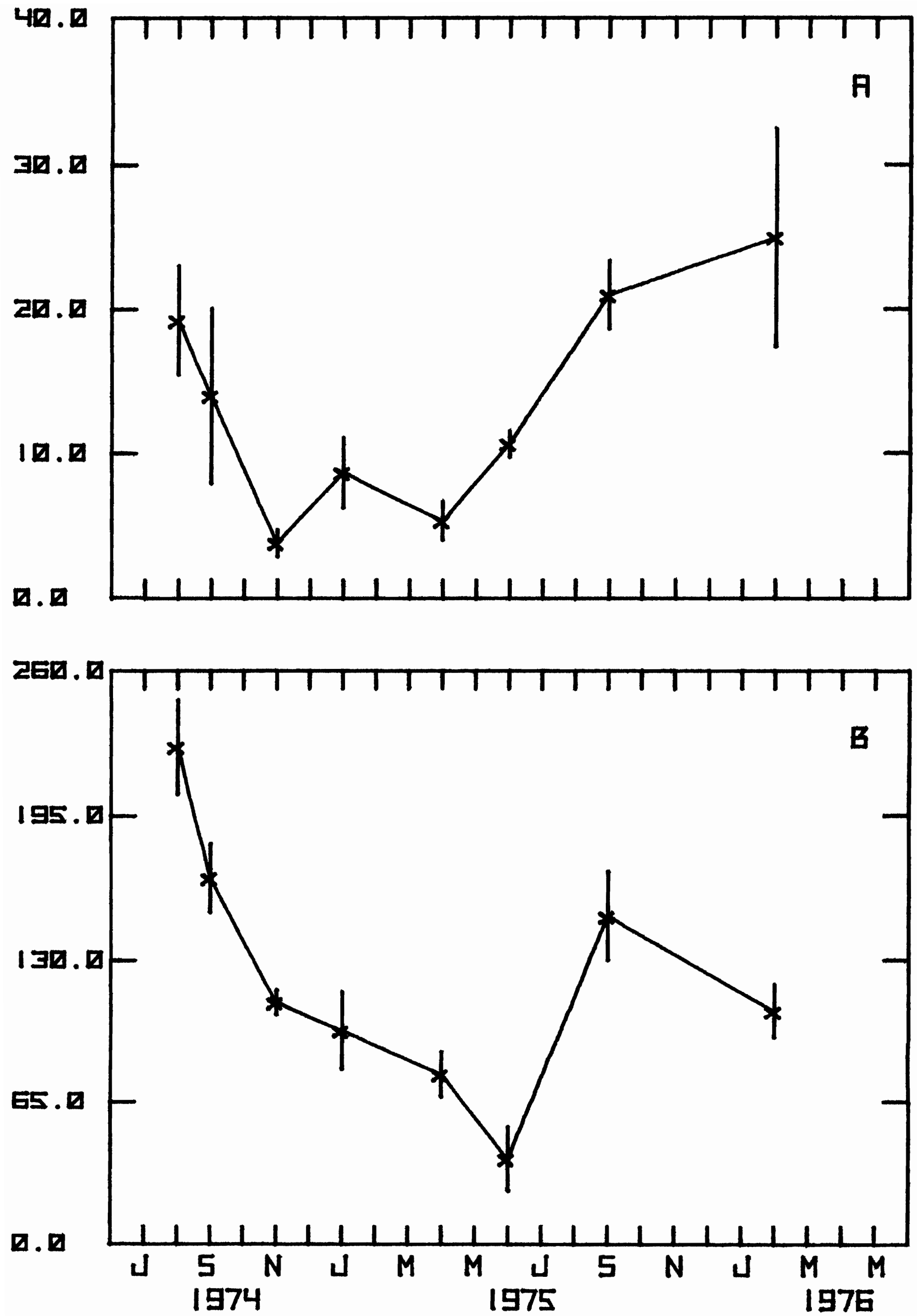

FIGURE 61. A. Mean number of mollusc individuals per core, N-3.
B. Mean number of crustacean individuals per core, N-3.
Vertical lines represent standard error.

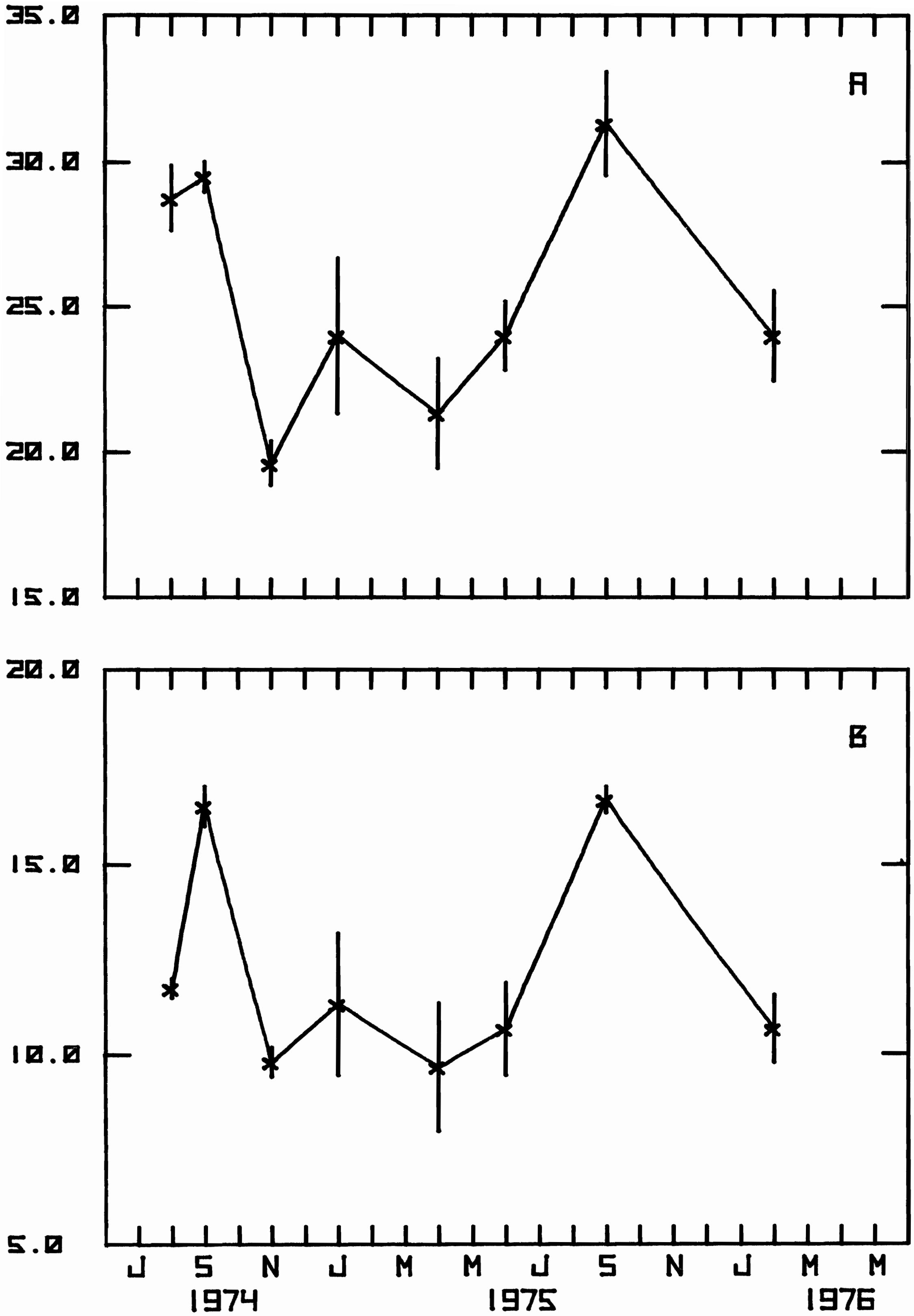

FIGURE 62. A. Mean number of species per core, all groups, N-3.
B. Mean number of polychaete species per core, N-3.
Vertical lines represent standard error.

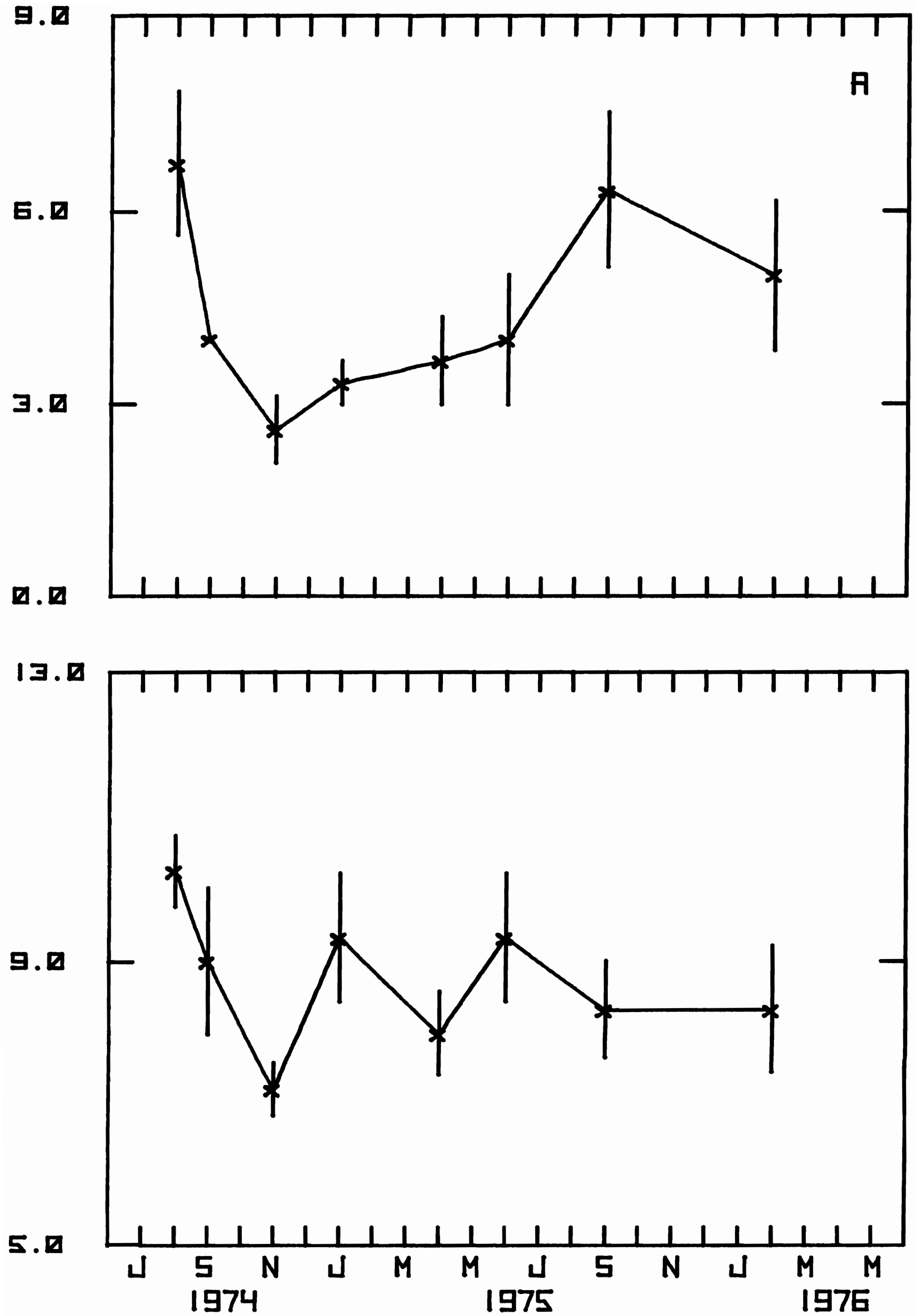

FIGURE 63. A. Mean number of mollusc species per core, N-3. B. Mean number of crustacean species per core, N-3. Vertical lines represent standard error.

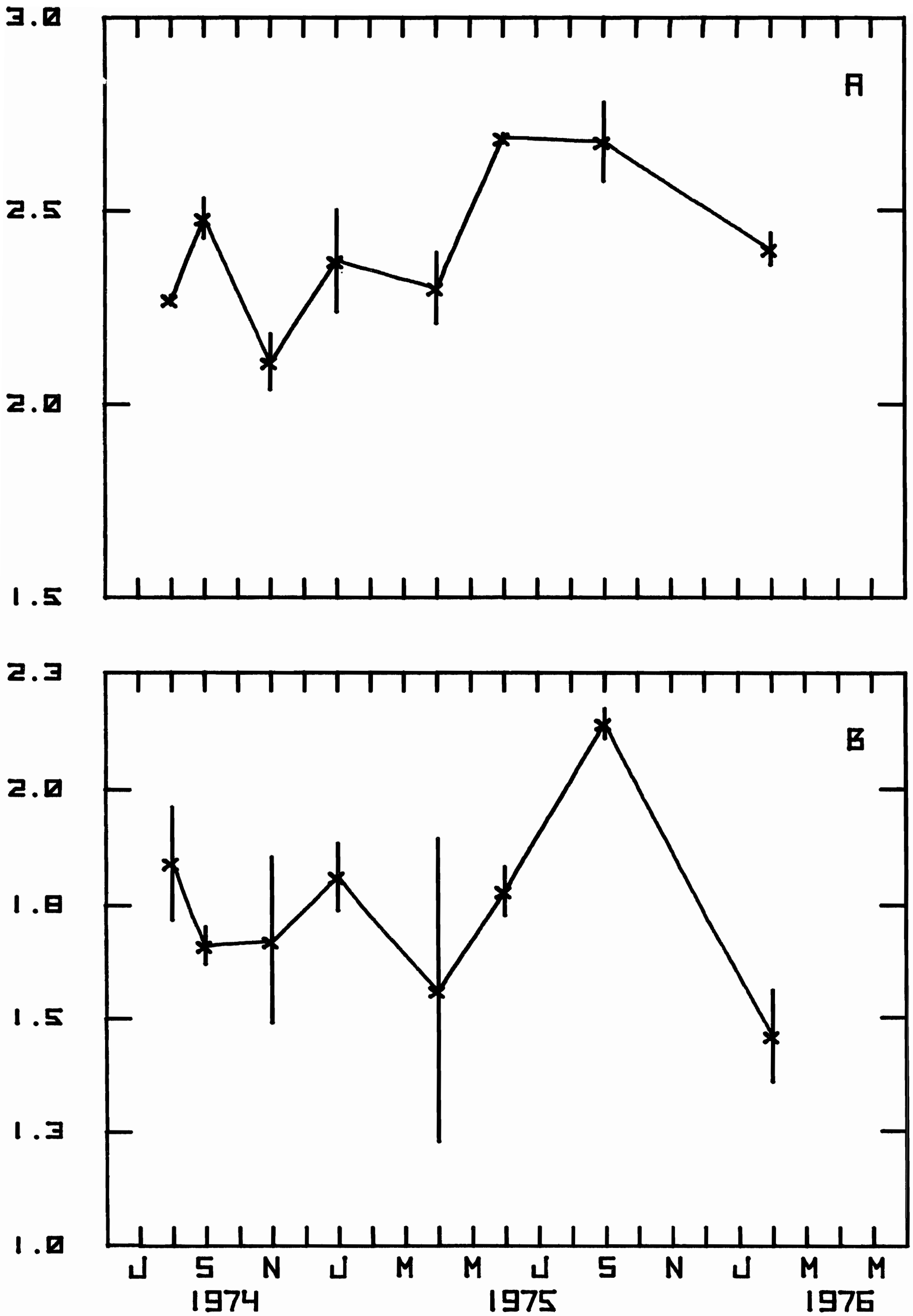

FIGURE 64. A. Mean total diversity, H', per core, all groups, N-3. B. Mean polychaete diversity, H', per core, N-3. Vertical lines represent standard error.

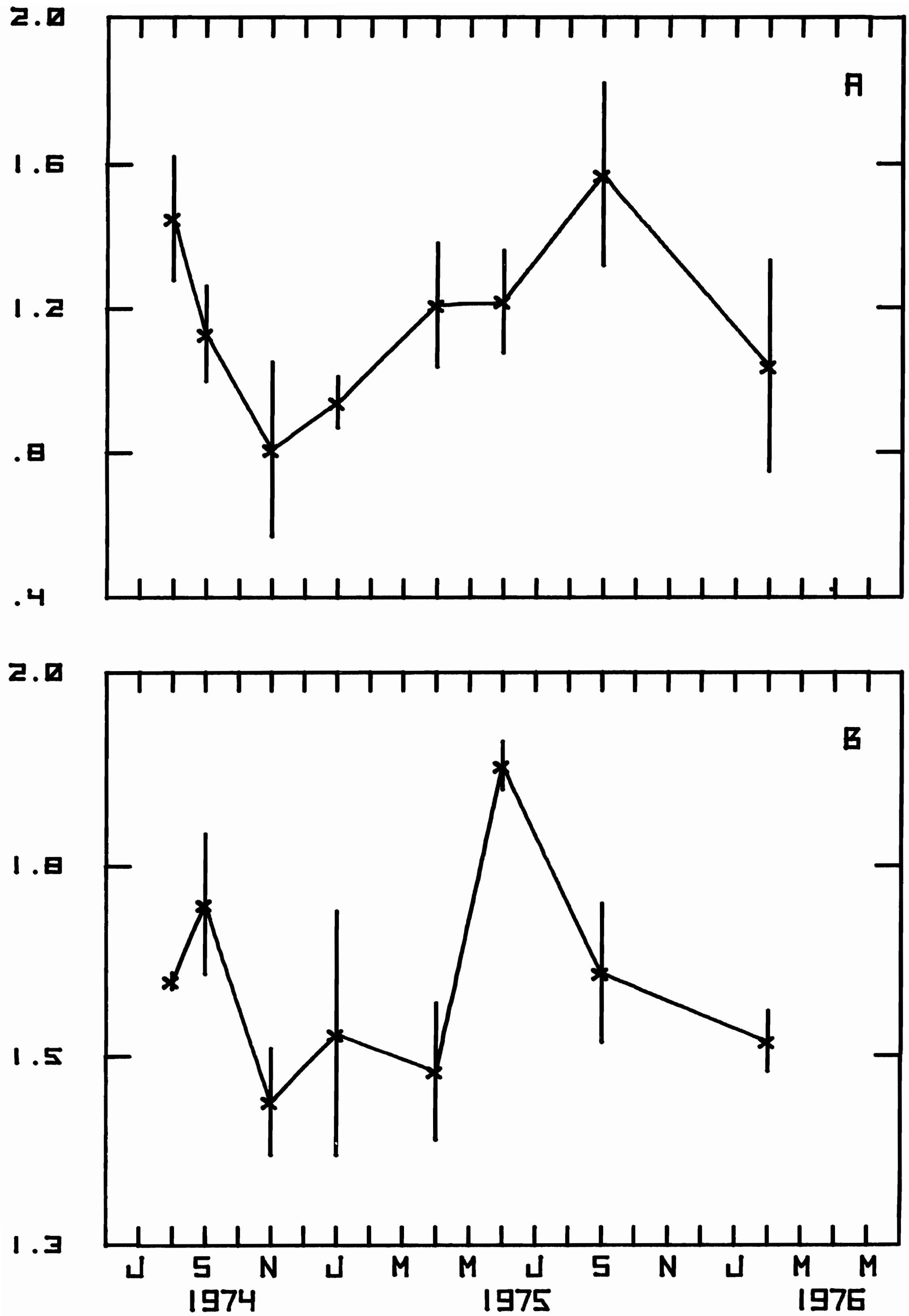

FIGURE 65. A. Mean mollusc diversity per core, N-3. B. Mean crustacean diversity per core, N-3. Vertical lines represent standard error.

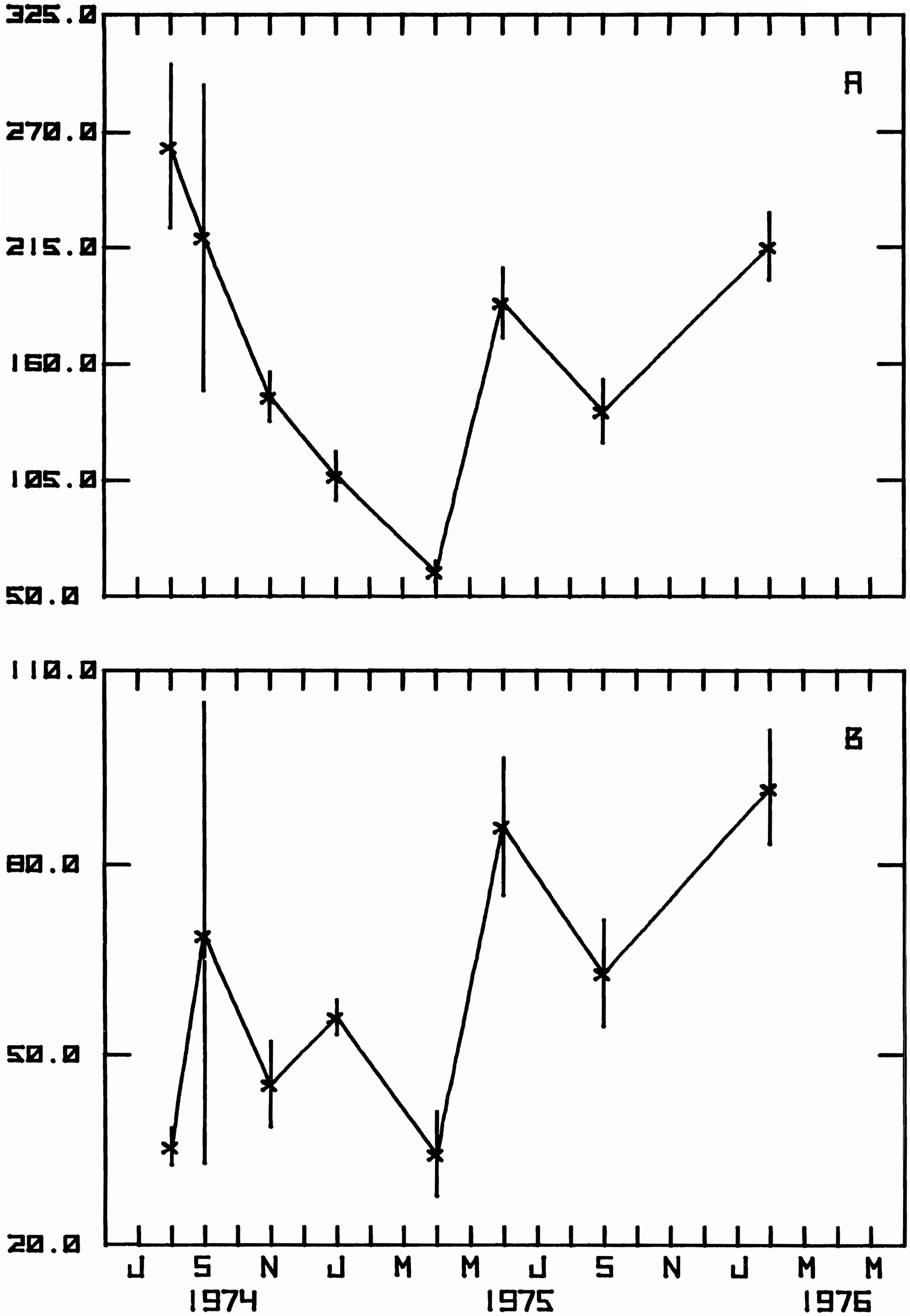

FIGURE 66. A. Mean number of individuals per core, all groups, N-4.
B. Mean number of polychaete individuals per core, N-4.
Vertical lines represent standard error.

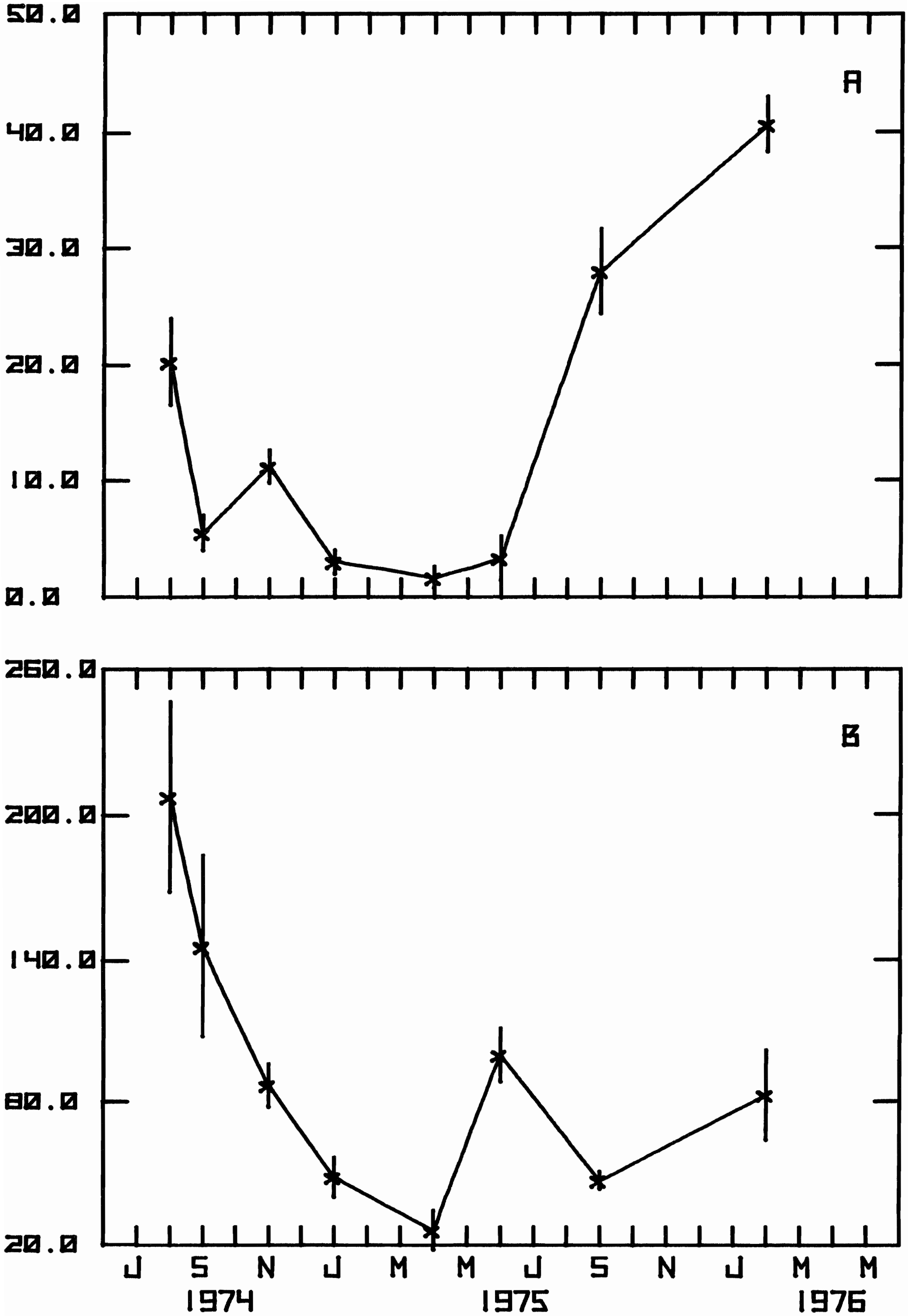

FIGURE 67. A. Mean number of mollusc individuals per core, N-4.
B. Mean number of crustacean individuals per core, N-4.
Vertical lines are standard error.

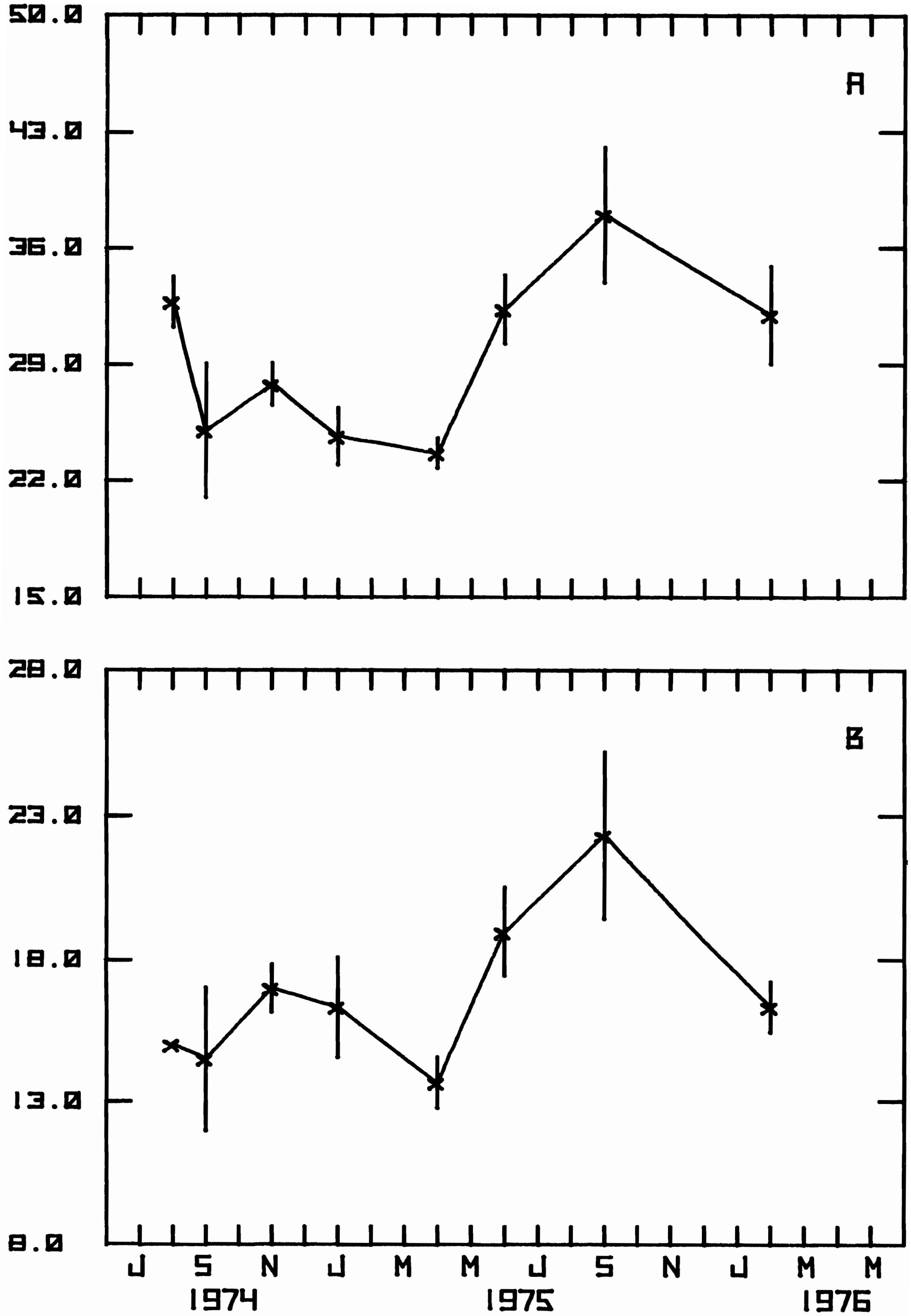

FIGURE 68. A. Mean number of species per core, all groups, N-4.
B. Mean number of polychaete species per core, N-4.
Vertical lines are standard error.

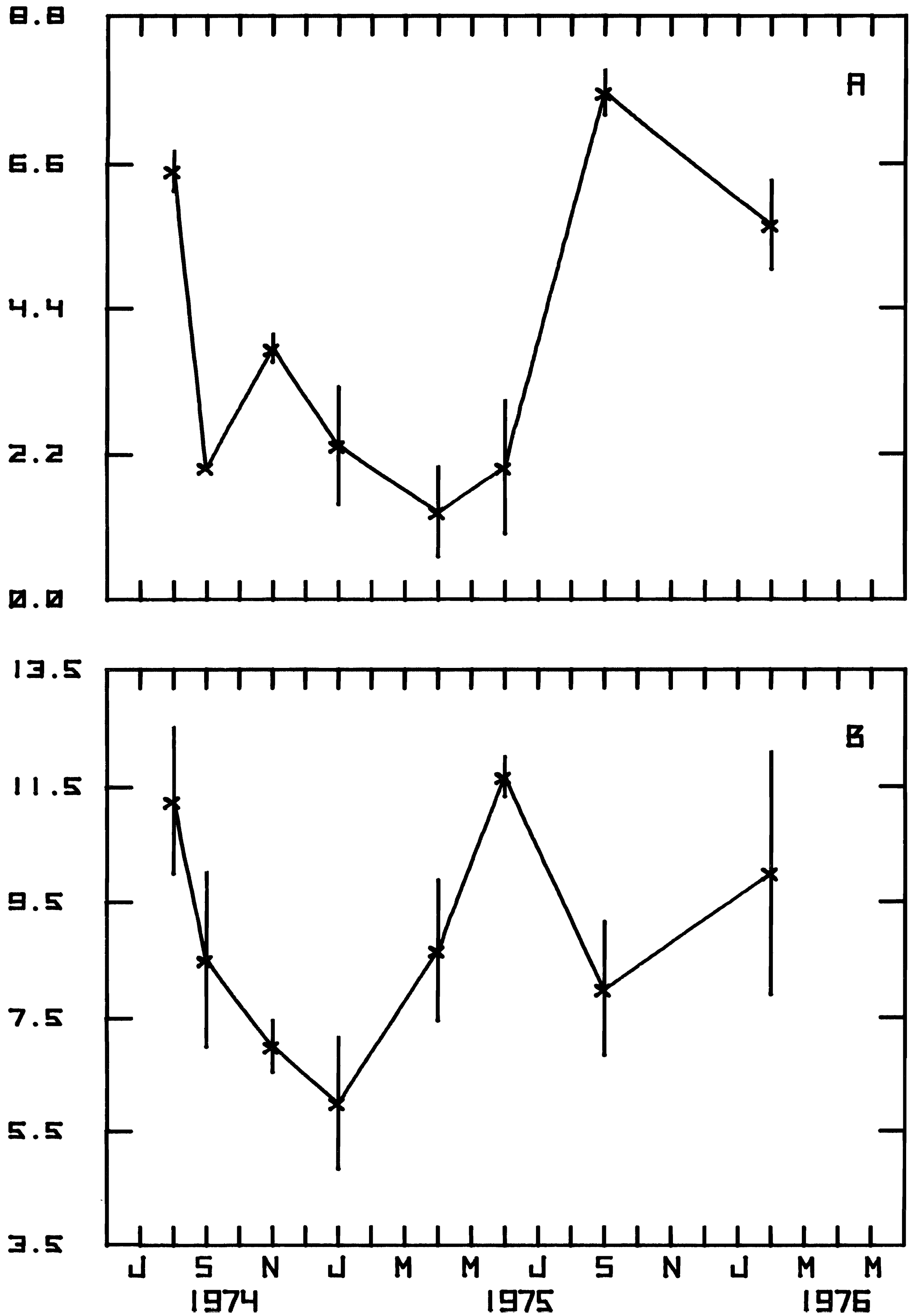

FIGURE 69. A. Mean number of mollusc species per core, N-4. B. Mean number of crustacean species per core, N-4. Vertical lines are standard error.

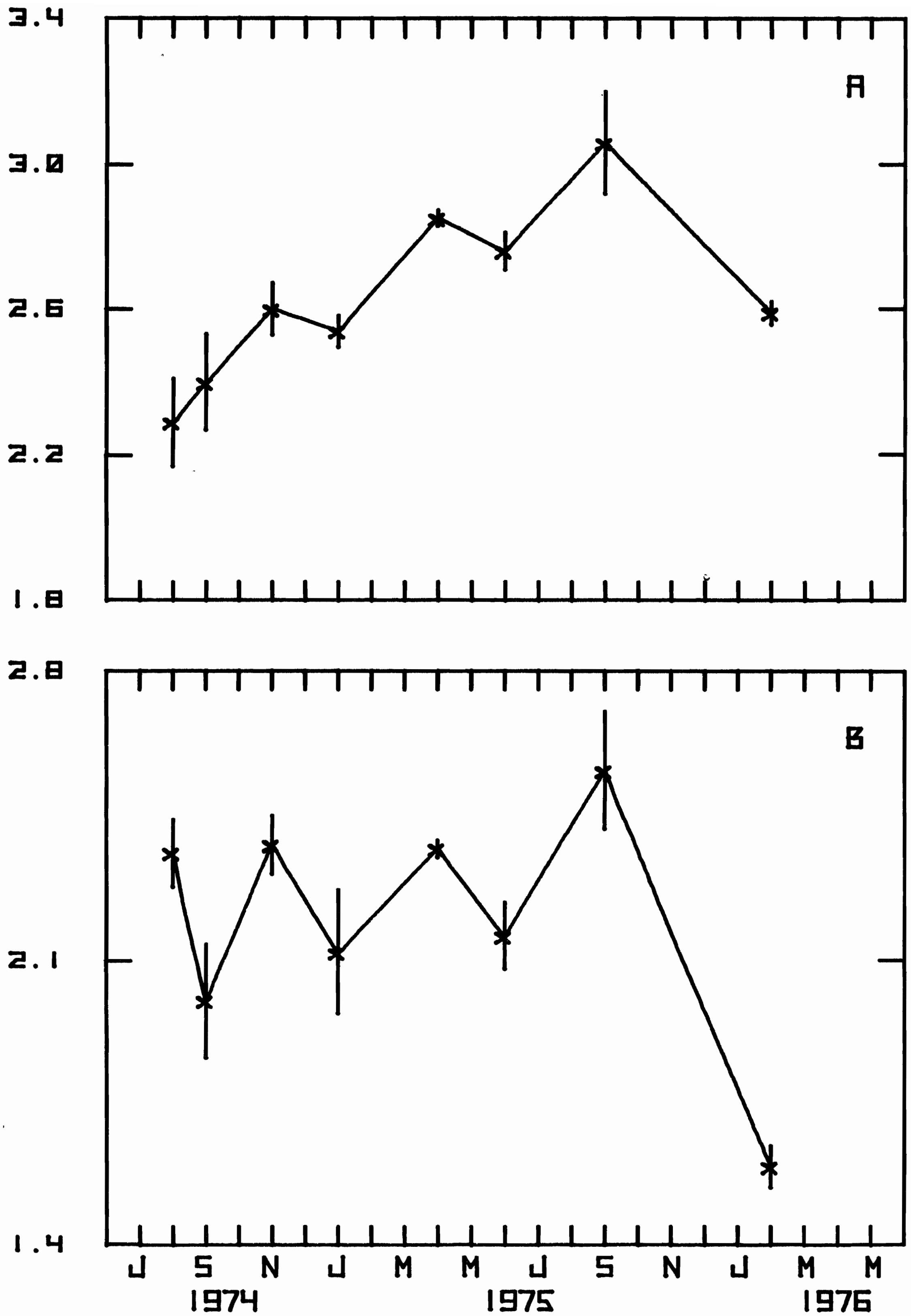

FIGURE 70. A. Mean total diversity, H', per core, all groups, N-4. B. Mean polychaete diversity, H', per core, N-4. Vertical lines are standard error.

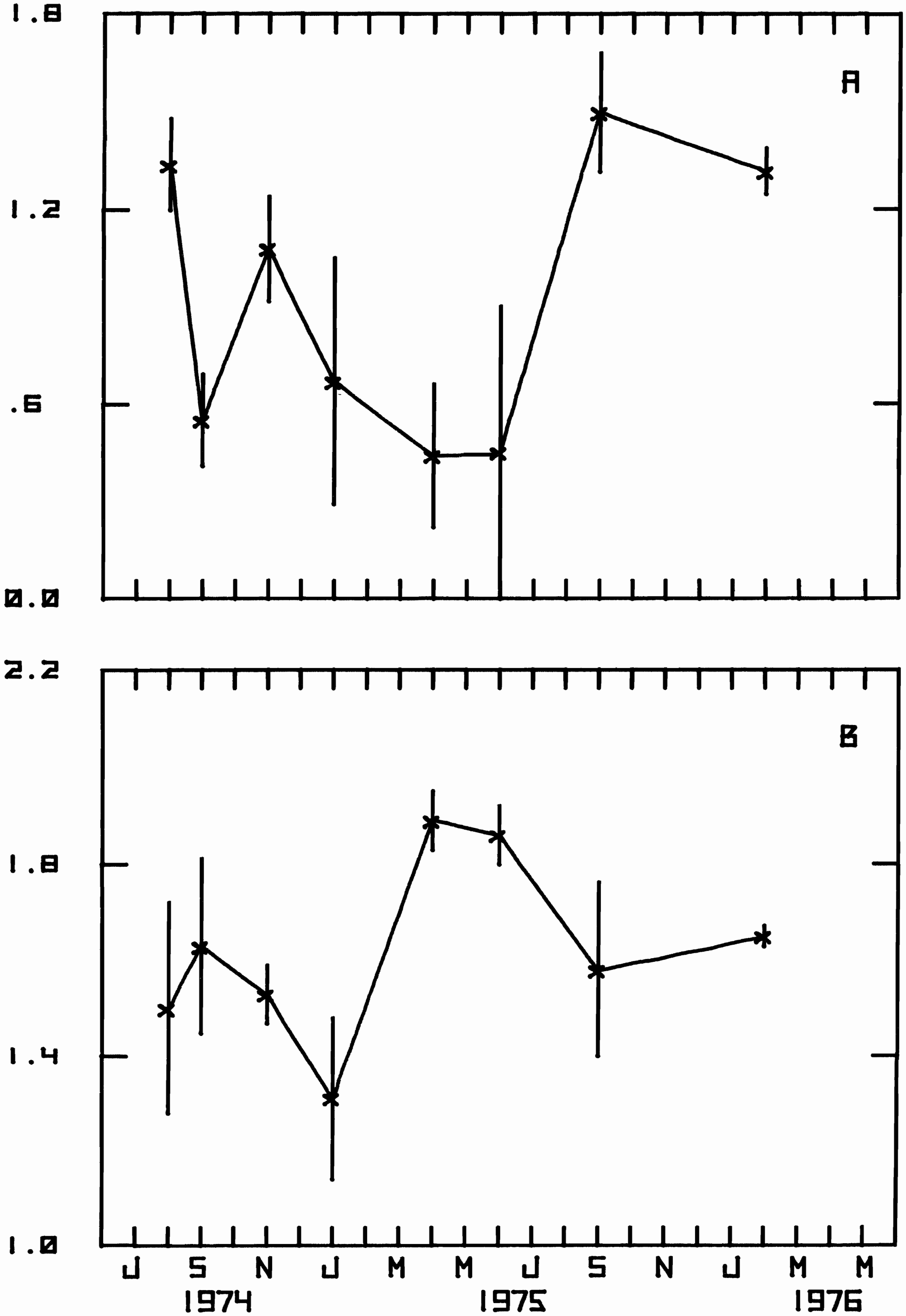

FIGURE 71. A. Mean mollusc diversity, H', per core, N-4. B. Mean crustacean diversity, H', per core, N-4. Vertical lines are standard error.

Diversity (H') at N-4 showed a consistent upward trend from August 1974 through September 1975, falling off only in the February 1976 sample (Figure 70-A). This trend was not reflected in the crustacean, polychaete or mollusc diversities, which varied irregularly over this same period (Figures 69-B, 70-A and 70-B).

In summary, we can say that these offshore stations are primarily dominated by motile crustacean species and, in general, changes in numbers of individuals per core over the season are due to changes in this fraction. This dominance weakens as depth increases, but even at N-4 (twenty-four meters), where polychaete species outnumber the crustacea species, the changes in the total numbers of individuals are due mainly to crustacea. Both average numbers of individuals and species per core dropped during the winter of 1974-75, but did not during the second winter (1975-76). We feel that this may be the result of an anomalous winter in 1975-76 in which no storms occurred. However, at present, we do not have the necessary further evidence to test this hypothesis. Diversity (H') in general evidenced less change over the sampling period and at N-3 and N-4 even showed a consistent upward trend. Again, we do not know why this was the case.

D. Qualitative Surveys of the Subtidal Benthic Fauna in Elkhorn Slough.

A series of SCUBA dives in Elkhorn Slough was conducted between 15 May and 10 June 1975. The purpose of these dives was to make qualitative observations and collections in areas not accessible at low tides and unsampled by our subtidal quantitative stations in the harbor. Nine dives were made at the five stations shown in Figure 2. This discussion will describe each of these stations. All dives were made at moderately high tides (+3.5 to +5.0 feet). Divers were Mark Silberstein, Terry Eckhardt and Doug Vaughn.

1. Station 1 - Highway One Bridge. ("Bridge" label of Figure 2)

The bridge pilings here were covered from higwater line to bottom with Metridium senile, especially on the east side. Anthopleura and Mytilus were also present. The bottom (five meters) was composed of muddy sand, shells, rocks and old bridge pilings. Hundreds of small orange anemones (Metridium) were attached to shells. Very large Tresus nuttalli siphons were fairly abundant, as were burrows of Urechis caupo with fecal pellets at the entrances. Several Cancer antennarius were seen, and schools of perch swam along the pilings. The anemones and siphons seen here were generally larger than their counterparts at the other stations.

2. Station 2 - PG&E Outfall. (Near benthic station 2, Figure 2)

A total of four dives were made at this station in an attempt to assess the effects of the outfall on the area. The first dive was in mid-channel just beyond the outfall. The sandy mud bottom was densely populated with large clam siphons. The siphons of Zirfaea pilsbryi were most numerous, with large Tresus siphons also present. Urechis burrows were present, and sabellid and terebellid polychaetes were observed but not collected. A few Polinices and one Aglaja inermis (= Navanax inermis) were seen. Four cores identical to the ones used in the intertidal mud flat sampling were taken at this station and yielded infauna similar to the intertidal stations, but a few new species of polychaetes were also taken. (See species list.) The mid-channel on the bridge side of the outfall was very similar to this area. These might be considered a baseline for comparisons to the immediate outfall area.

A dive was made from the bank directly opposite the outfall to as near to the outfall as was possible. The bottom at the beginning of the dive was very similar to the Zirfaea beds described above. The depth was about two meters. Near mid-channel, a sparse algal covering of Ulva and Gracilaria was present. At mid-channel, this gave way to Zostera beds, which seemed rather extensive and contained Aplysia californica and egg masses in abundance. Aside from the perch, these were the most obvious large organisms associated with the beds. Nearer to the outfall, algae again became dominant on the bottom, with plants appearing much larger and more abundant than the algal bed opposite the outfall. Some Tresus nuttalii siphons were found here and fairly large Anthopleura xanthogrammica attached to the larger shells on the bottom. From here to the mouth of the outfall, the current from the outfall caused progressively increasing scouring, so that the depth increased and sediment gave way to only shells. On some of these, a small, bright anemone was the only sign of life. In conclusion, the outfall seemed to increase diversity and abundance except where the strength of the current scoured the sediment away. The overall areal extent of the outfall's influence appeared limited to about 150 meters square.

3. Station 3 - Zirfaea Beds (Near Dairy Station 3, Figure 2)

The bottom here was softer than the other stations and was composed of silty clay mixed with small shells and fragments. The bivalve Zirfaea pilsbryi was very abundant here. Other siphons and burrows were not very evident. The fleshy, white Zirfaea siphons extended well above the sediment and did not retract rapidly upon touching. They seemed to have great potential as a food source for the bottom-feeding fish. The tube-dwelling anemone *Pachycerianthus fimbriatus* was also here, as were species of both terebellid and sabellid polychaetes. Large *Polinices* leaving wide mucous trails were encountered. Silberstein collected *Doriopsilla albopunctata* and *Acanthodoris lutea* and several *Aglaja inermis* were seen. A small cancer crab was found under a shell, and a chiton of the genus *Mopalia* was seen.

4. Station 4 - Oyster Beds (No. 5, Figure 73)

The channel was not as well defined at this station, with a gradual taper to a maximum depth of about three meters. The bottom was littered with a mixture of shells of *Mytilus* and oysters. Conspicuously present were the large empty shells of the Japanese oyster *Crassostrea gigas*. A rich epifauna was associated with these shell beds, including encrusting bryozoans, anemone and colonial tunicates. A bright pink sponge was also growing on the shells. The nudibranch *Aeolidia papillosa* was present in abundance, and *Anisodoris nobilis* and *Dailula sandiegensis* in lesser numbers. These beds seemed rather extensive in area.

5. Station 5 - Near Kirby Park (No. 4, Figure 2)

Here was a soft mud bottom with some harder debris such as cement blocks and rocks scattered about. About ten feet in depth, this station had a few large clams and was characterized by sponges, burrowing anemones and nudibranchs. Visibility limited observations here, but it seemed similar to station 4, except no oysters or mussls were seen in the immediate area.

E. Acknowledgements

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IV. FORAMINIFERA OF ELKHORN SLOUGH

by

Evelyn Shumaker and James Nybakken

A. Introduction

There have been no published reports on the Foraminifera of Elkhorn Slough. The monumental study by MacGinitie (1935) discusses the protozoa briefly, but of the protozoan species mentioned, none are Foraminifera. This is perhaps due to the specialized techniques necessary to separate Foraminifera from the sediments. The only available information on the foraminiferan fauna of Elkhorn Slough is contained in three unpublished student reports at the Moss Landing Marine Laboratories. One by Short (1968) lists fourteen genera from a selected area of Bennett's Slough. Another by Hanson (1968) lists fifteen genera, while Briggs (1968) lists nine genera.

The present study was undertaken to establish the species of Foraminafera found in Elkhorn Slough at the present time and to obtain some estimate of their relative abundance and distribution. We do not consider it definitive and would hope that it will serve as a basis upon which further study will be done.

B. Methods and Materials

Samples were collected from eleven stations in Elkhorn Slough on July 14, 1975. These stations were drawn from a wide variety of locations in the slough (see Figure 72). Samples were collected using a Phleger corer of 3.7 cm internal diameter. A single core was taken at each station. Cores

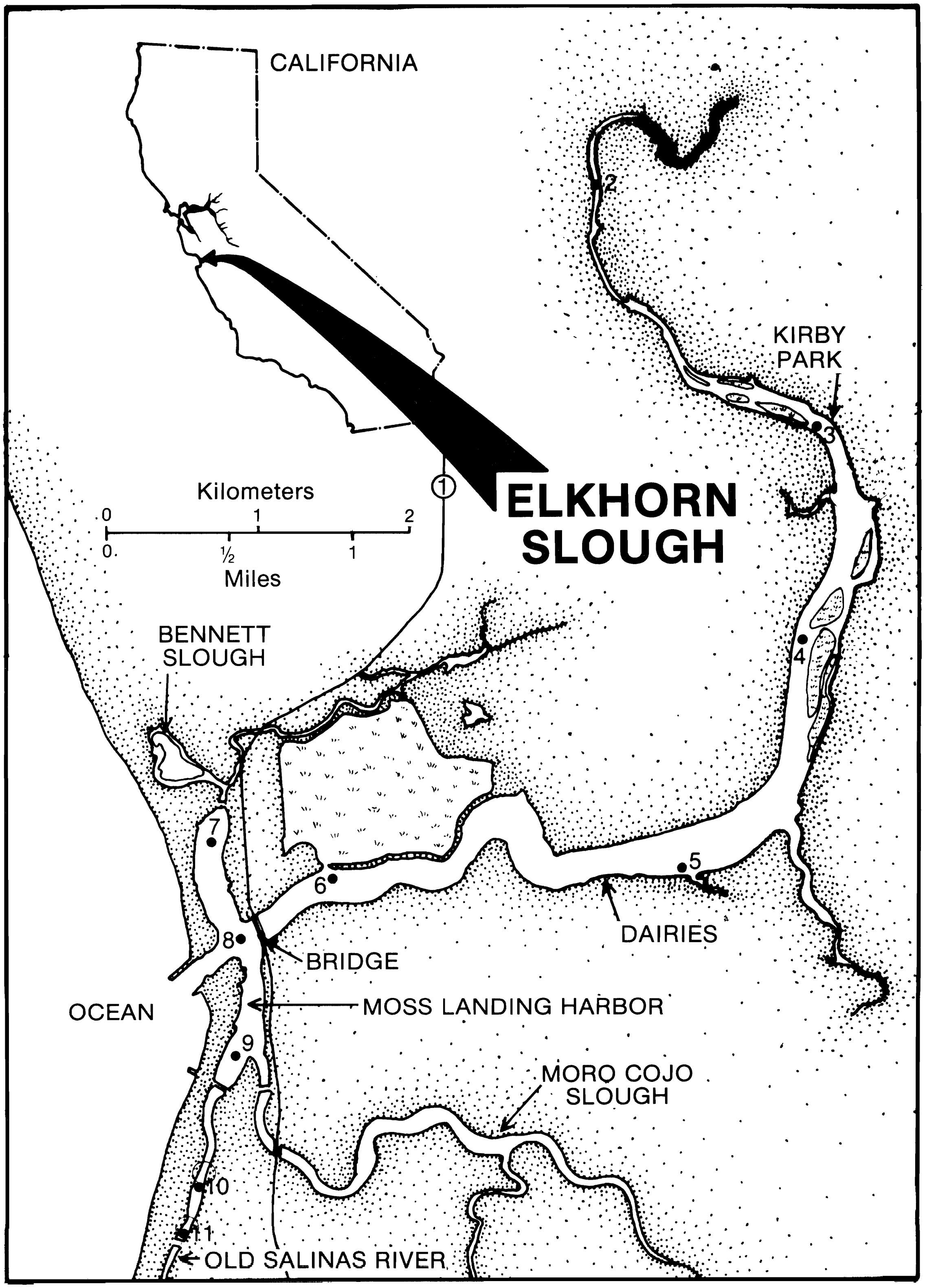

FIGURE 72. Map of the Moss Landing-Elkhorn Slough area with numbers representing sampling sites for Foraminifera

were retrieved from all stations except station 8, where currents prevented obtaining the sample.

From each core, the top 2 cm were removed for analysis for Foraminifera. At stations 1 - 6, the 2-cm sections were split longitudinally before further treatment because of excessive organic debris in the core. The core from station 2 had to be omitted because the amount of debris prevented analysis. Samples from stations 7 - 11 had much less debris and were not split before analysis.

The 2-cm sections from each core were placed in 50 ml beakers containing 10% buffered formalin and allowed to sit for 30 minutes. Sections were then washed through a 62-mu screen and decanted back into the 50 ml beaker. The samples were then stained in Sudan black B following the method of Walker, et al (1974) and rinsed in methanol. Each sample was then dried and floated in a bromoform/methanol mixture to remove the Foraminifera.

All the living Foraminifera in each sample were then identified and counted using a Nikon dissecting microscope. Reference specimens of each species and/or genus were mounted on a type slide and stored in the Moss Landing Museum collections.

From these data, similarity indices were constructed following the method outlined in Southwood (1968) to compare stations. A further analysis was made of the Foraminifera at each station to divide them into the percent of Rotaliina, Textulariina and Miliolina. Since each of these three suborders is characteristic of a given habitat type (Rotaliina = cosmopolitan; Textulariina = marsh; Miliolina = typically marine), it was possible to further characterize the stations. Diversity calculations were made using the Brillouin and

Shannon measures (Pielou, 1966).

C. Results

The species of Foraminifera and their relative abundance in the core at each station are given in Table 16. Diversity tabulations are given in Table 17. Positioning of the stations with respect to the percent of composition of the three suborders of Foraminifera is given in Figure 73 and Table 18. Similarity indices among the stations are given in the form of a trellis diagram in Figure 74. A list of species of Foraminifera identified from Elkhorn Slough in this study is given in Table 19.

D. Discussion

The total number of species recovered and identified in the samples was twenty-seven and probably represents a fairly good first approximation of the foraminiferan fauna of the slough. It is of interest to note that species diversity is low at most stations, reflecting the concentration of abundance into one or two species. The slough is, in other words, characterized by high dominance at most stations. The least dominance and highest diversity is found, surprisingly, at the mid-slough stations (3, 4 and 5) and at station 11, furthest up the Old Salinas River Channel. We have no explanation for that pattern at present.

Another interesting and unexpected result was the complete absence of Foraminifera at station 7 by the Moss Landing Yacht Harbor. This absence was reconfirmed by Dr. Roberta Smith-Evernden of the University of California at Santa Cruz, who independently took samples at this station and also found no Foraminifera. This is a very unusual situation and one for which we have

TABLE 16: Elkhorn Slough

Sample Size, Species Composition
and Abundance of Foraminifera
at the sampling sites

Station 1: train crossing (10.75 cc sample)

Species	Abundance	Percent
Ammonia beccarii	557	91.0
Elphidiella hannai	1	0.2
Elphidium excavatum forma clavata	13	2.0
Elphidium ex. forma selseyensis	10	1.6
Elphidium frigidum	8	1.3
Globigerina sp.	1	0.2
Haplophragmoides subinvolutum	1	0.2
Orbulina universa	1	0.2
Trochammina inflata	19	3.1
unidentified arenaceous fragments	1	0.2
total	612	

Station 2: omitted due to abundance of organic debris

Station 3: Kirby Park (10.75 cc sample)

Species	Abundance	Percent
Ammonia beccarii	10	30.0
Elphidium ex. forma selseyensis	3	9.0
Elphidium sp.	1	3.0
Jadammina macrescens	5	15.0
Osangularia sp.	3	9.0
Reophax nanus	1	3.0
Trochammina inflata	10	30.0
total	33	

Station 4: (10.75 cc sample)

Species	Abundance	Percent
Ammonia beccarii	33	52.0
Cassidulina limbata	1	2.0
Elphidium ex. forma clavata	3	5.0
Elphidium ex. forma selseyensis	7	11.0
Jadammina macrescens	2	3.0
Quinqueloculina compta	2	3.0
Trochammina inflata	8	13.0
unidentified arenaceous fragments	8	13.0
total	64	

Station 5: (10.75 cc sample)

Ammonia beccarii	18	24.0
Elphidium ex. forma clavata	5	7.0
Elphidium ex. forma selseyensis	47	63.0
Jadammina macrescens	3	4.0
Trochammina inflata	2	3.0
total	75	

Station 6: PG & E Outfall (10.75 cc sample)

Ammonia beccarii	152	36.0
Buccella frigida	3	1.0
Bulimina marginata	1	0.2
Cassidulina limbata	1	0.2
Cibicides fletcheri	4	1.0
Elphidiella hannai	7	2.0
Elphidium ex. forma clavata	14	3.0
Elphidium ex. forma selseyensis	222	53.0
Elphidium frigidum	1	0.2
Florilus basispinatus	1	0.2
Jadammina macrescens	1	0.2
Osangularia spp.	1	0.2

Species	Abundance	Percent
Quinqueloculina compta	1	0.2
Rosalina columbiensis	1	0.2
Rosalina sp.	1	0.2
Sagrina sp.	1	0.2
Trochammina inflata	7	2.0
Trochammina sp.2	1	0.2
Trochammina sp.3	1	0.2
Trochammina sp.4	1	0.2
total	422	

Station 7: NO FORAMS yacht harbor

Station 8: NO SAMPLE Hwy 1 bridge
current too swift to sample

Station 9: Moss Landing Harbor (21.5 cc sample)

Ammonia beccarii	15	43.0
Elphidiella hannai	1	3.0
Elphidium ex. forma clavata	1	3.0
Elphidium ex. forma selseyensis	17	49.0
Quinqueloculina compta	1	3.0
total	35	

Station 10: tower (21.5 cc sample)

Ammonia beccarii	587	70.0
Cyclogyra involvens	1	0.1
Elphidium ex. forma clavata	13	1.6
Elphidium ex. forma selseyensis	163	20.0
Elphidium sp.	1	0.1
Haplophragmoides subinvolutum	11	1.3
Jadammina macrescens	9	1.1
Miliommina fusca	23	2.8

Species	Abundance	Percent
Quinqueloculina compta	4	0.5
Trochammina inflata	21	2.5
Trochammina sp.1	1	0.1
unidentified arenaceous fragments	1	0.1
total	835	

Station 11: tide gates (21.5 cc sample)

Species	Abundance	Percent
Elphidium ex. forma selseyensis	1	0.9
Haplophragmoides subinvolutum	30	26.0
Jadammina macrescens	6	5.3
Miliommina fusca	18	15.8
Reophax nanus	1	0.9
Trochammina inflata	52	45.6
unidentified arenaceous fragments	6	5.3
total	114	

TABLE 17: Elkhorn Slough
Diversity and Evenness Values
for Eight Stations

station number	Shannon H'	Shannon J'	Brillouin H	Brillouin J
1	0.45	0.20	0.43	0.19
3	1.66	0.85	1.41	0.85
4	1.53	0.74	1.36	0.72
5	1.04	0.65	0.95	0.64
6	1.22	0.41	1.16	0.40
9	1.02	0.63	0.88	0.62
10	0.99	0.40	0.96	0.39
11	1.39	0.72	1.31	0.71

TABLE 18: Elkhorn Slough

Percent Distribution of Foraminifera
Among Three Suborders

	percent of Rotaliina	percent of Textulariina	percent of Miliolina
station 1:	96.4	3.27	0.33
station 3:	51.5	48.5	0.0
station 4:	68.74	28.13	3.13
station 5:	93.34	6.67	0.0
station 6:	97.2	2.61	0.24
station 9:	97.14	0.0	2.86
station 10:	91.5	7.9	0.6
station 11:	0.88	99.12	0.0

Miliolina = typically marine

Rotaliina = cosmopolitan

Textulariina = many species typical marsh

TABLE 19: Elkhorn Slough

Species List: O. Foraminifera

Ammonia beccarii (Linne)

Buccella frigida (Cushman)

Bulimina marginata d'Orbigny

Cassidulina limbata Cushman and Hughes

Cyclogyra involvens (Reuss)

Elphidiella hannai (Cushman and Grant)

Elphidium excavatum (Terquem) forma selseyensis (Heron-Allen and Earland)

Elphidium excavatum (Terquem) forma clavata Cushman

Elphidium frigidum Cushman

Elphidium de Montfort sp.

Florilus basispinatus (Cushman and Moyer)

Globigerina d'Orbigny sp.

Haplophragmoides subinvolutum Cushman and McCulloch

Jadammina macrescens (Brady)

Miliommina fusca (Brady)

Orbulina universa d;Orbigny

Osangularia Brotzen (lens)

Quinqueloculina compta Cushman

Reophax nanus Rhumbler

Rosalina columbiensis (Cushman)

Rosalina d'Orbigny sp.

Sagrina d'Orbigny sp.

Trochammina inflata (Montagu)

Trochammina Parker and Jones spp. 1, 2, 3, 4

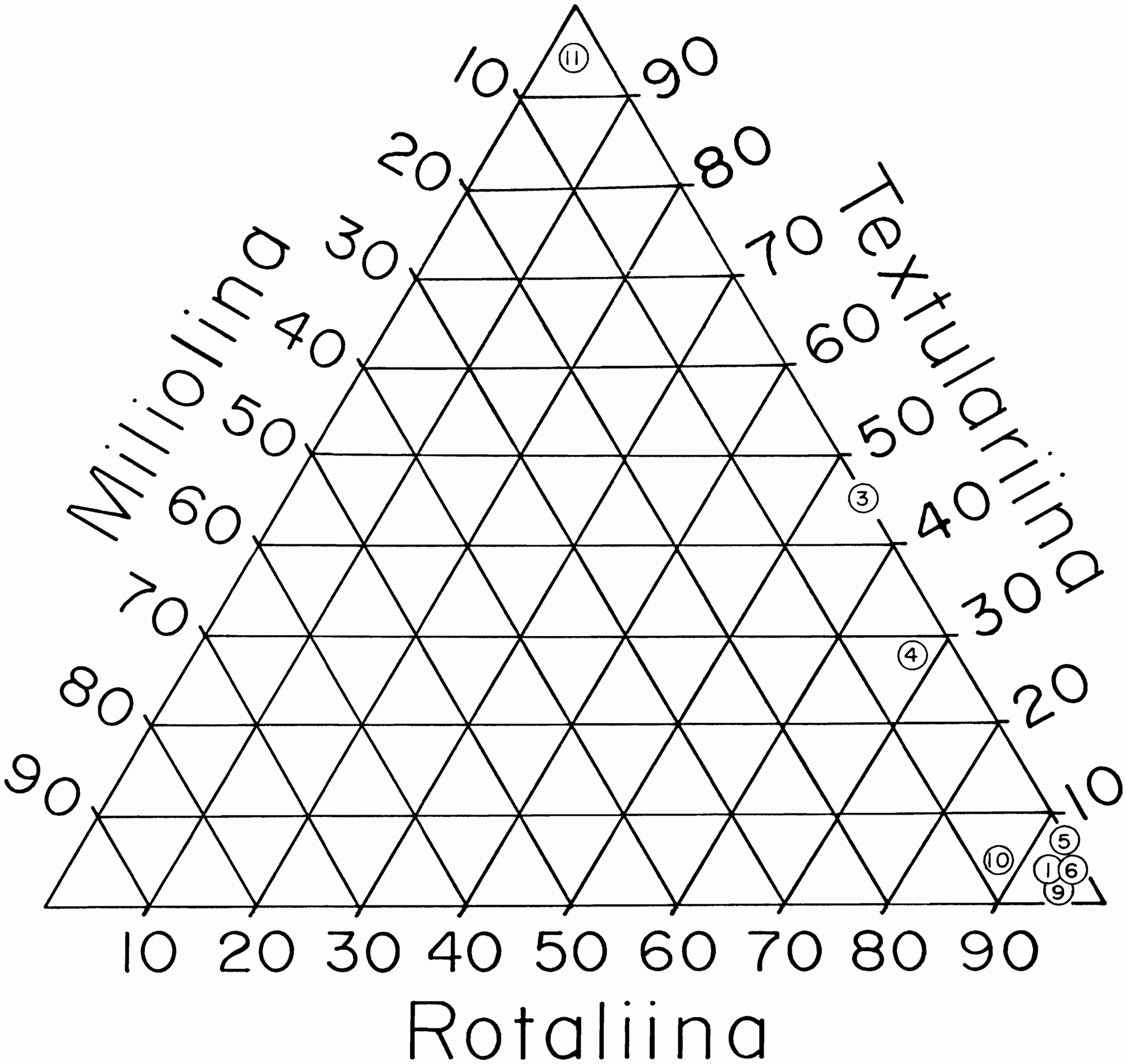

FIGURE 73. Positioning of Foraminifera sampling sites with respect to percent composition relative to three suborders

station	1	3	4	5	6	9	10	11
1								
3	35.0							
4	65.7	57.3						
5	30.3	39.7	48.0					
6	39.9	39.4	52.1	81.8				
9	46.8	39.4	61.1	78.1	89.4			
10	4.3	12.7	16.1	23.1	19.5	64.5		
11	4.2	37.7	18.1	7.5	0.9	0.9	8.6	

FIGURE 74: Elkhorn Slough

Matrix of Similarity Values for Eight Stations no adequate explanation at this time.

Partitioning of the composition of the fauna at each station into the percent which were Rotaliina, Textulariina and Miliolina and, hence, representing groups distributed typically cosmopolitan, marsh and marine, respectively, served to aid in classifying habitats. As can be seen from Figure 73, all stations analyzed gave compositions which were either cosmopolitan or marsh in distribution. No station had a fauna which could be considered marine, even those such as 6 and 9, which were closest to the harbor entrance.

The above analysis, coupled with the similarity analysis, permitted grouping of stations representing perhaps differing communities. On the basis of these analyses, it is possible to divide the Foraminifera into at least three different assemblages. One represents the uppermost area of the slough (Station 1) strongly dominated by Ammonia beccarii; a second area comprising, at least for now, the majority of the remainder of the slough and Moss Landing Harbor (stations 4, 5, 6 and 9), which has less dominance (= higher diversity), with Ammonia beccarii sharing dominance with Elphidium excavatum; and a final area, represented by station 11, dominated by the Textulariinids Haplophragmoides subinvolutum and Trochammina inflata.

Whereas at least three distinct assemblages of Foraminifera were found in Elkhorn Slough in this study, Briggs reported only two, a marine facies dominated by Nonionella and Globigerina, and an estuarine one composed primarily of Trochammina, Textularia and Quinqueloculina. Briggs also reported that the genera Ammonia and Elphidium were of general distribution with one or the other dominant at all stations. Unfortunately, Briggs reported both living and dead Foraminifera and the raw data upon which he based his graphs are not now available, so it is difficult to make close comparisons with the present study, even though his transects are close to certain of our stations. Thus, Briggs took his samples from three transects, one near the bridge (our closest stations are 6 and 8), one near The Dairies (same as our station 5) and a third at Kirby Park (our station 3). Each transect had three sample sites. Our results concur with Briggs in that Ammonia and Elphidium are the dominant genera throughout the slough. However, we did not find Nonionella (= Florilus) at all common at any station, indicating, as previously stated, that typically marine foraminiferan facies were not present. However, the Briggs study was done at a different time of the year than ours and, since neither study ranged over seasons, it may be that the associations change. At any rate, there are no data available to assess this contention.

Our results agree with Briggs (1968) with respect to an estuarine facies dominated by Trochammina, Textularia and Quinqueloculina, except that our samples had no Textularia and Trochammina was more common than Quinqueloculina.

The study by Short (1968) was done only in the restricted area of Elkhorn Slough where the present yacht harbor is located. The area was the same as that encompassed by our station 7. In this area, Short had twelve stations. She found fourteen genera in this area, of which a species of Ammonia was by far the most abundant. The other abundant genera were Trochammina, Elphidium and Quinqueloculina. Hence, the dominant genera were the same as we have found in most stations in the slough. What is of significance here, however, is that at our station 7, as noted previously, we found no Foraminifera during our sampling! We do not now know what this means, but at least it suggests a drastic change in the environment between 1968 and 1975.

The last study with which comparisons may be made is that of Hanson (1968). Unfortunately, this paper is not in our files of student papers in the Moss Landing Marine Laboratories library, so a detailed comparison is precluded. We do know Hanson found fifteen genera and defined three assemblages: a true marine group characterized by the genera Nonionella (= Florilus), Eponides and Cassidulina; a true estuarine fauna dominated by arenaceous genera, especially Trochammina and Textularia; and an upper slough assemblage, less well defined, dominated by the genus Miliammina. Our results suggest a similarity to the Hanson study in that we also found three assemblages, but lacking a copy of the Hanson paper, we cannot assess if the areas coincided. Certainly we found no true marine facies.

Although the present study has validated some of the earlier student work and has established the first species list for the slough, the differences between it and earlier work, particularly the problem of the absence Foraminifera at station 7 now as compared to earlier and the difference in genera and species,suggest that considerably more work is needed to understand even the beginnings of the ecology of Foraminifera in Elkhorn Slough.

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V. THE INVERTEBRATES OF ELKHORN SLOUGH

(Exclusive of Insects, Archnids, Certain Minor Phyla and Lower Chordates)

A. Introduction

It has now been forty years since MacGinitie (1935) published his now classic paper on the invertebrates of Elkhorn Slough. Since that time, the slough has undergone a considerable number of changes, primarily man-made or man-induced. These changes are documented in Gordon (1974). As a result of these alterations, it is reasonable to suspect that there have been corresponding changes in the invertebrate species inhabiting the slough. Unfortunately, the original paper by MacGinitie was not quantitative. It is, therefore, not possible to analyze the changes in relative abundances of various invertebrate species over this time period. We are thus left with only the option of considering qualitative changes in the species and simple comparisons of presence or absence.

Despite the classic study of MacGinitie which conferred upon Elkhorn Slough the unique status of having its fauna well studied before the advent of man-induced changes, there have been no published follow-up accounts of the whole invertebrate fauna. As a result of this, a truly unique opportunity to obtain some assessment of long-term changes in faunal composition has not been realized. It is with the thought of filling this gap that we have here put together a species list of the invertebrates of Elkhorn Slough. This species list is based on species reported as present in various literature references, which are noted on the list; on voucher specimens present in the museum of the Moss Landing Marine Laboratories; on the collections made during the past two years with support from PG&E; and on collections made by various individuals in the scientific community over the years but for which specimens may not always be available. Reference to "Light's" in the list means the new third edition of Light's Manual of the Intertidal Invertebrates of the Central California Coast, edited by Smith and Carlton.

The list specifically excludes insects and other terrestrial arthropods. It is by no means considered by us to be complete. We have constructed it at this time with the hope that by doing so, we may obtain feedback which will enable us in the future to publish a more complete list from which we can begin to analyze changes which have taken place since MacGinitie's work.

The present list incorporates a considerable number of changes to the one presented in our annual report of last year. We are particularly indebted to Mr. James Carlton for his careful work on the original list and the additions and corrections which he furnished us. We also thank Evelyn Shumaker for providing the first species list of Foraminifera from Elkhorn Slough and Gary McDonald for the extensive list of opisthobranch mollusks.

It is well to remember that MacGinitie did not cover some invertebrate groups as well as others (Foraminifera, Platyhelminthes, Bryozoa) and that still others were not covered at all (Nematoda, Rotifera, Gastrotricha, Kinorhyncha). The same is true for the present list. We do not have good collections and/or identifications on Bryozoa, Platyhelminthes and Porifera. We have, further, made no attempt to collect and identify parasitic species, Copepoda, Nematoda, Rotifera, Gastrotricha, Kinorhyncha and Protozoa (exclusive of Foraminifera). Hence, this list can be considered primarily a list of free-living macro-invertebrate species.

Finally, one should note that MacGinitie's work covered only the lower reaches of Elkhorn Slough, whereas this present work extends as far up the slough as the present boat landing at Kirby Park.

B. Comparisons with MacGinitie (1935)

It is not our intention at this time to give a rigorous comparison between the invertebrate fauna which we now find in Elkhorn Slough and that found by MacGinitie. This is due to the fact that the present species list is still incomplete and must await further revision before this comparison can be made. Rather, what we discuss here are some of the obvious differences between the two lists and suggest some possible reasons for these discrepancies.

Perhaps the most striking difference between our present species list and MacGinitie's (1935) is the complete absence of the polychaete family Spionidae from MacGinitie's list. Our present study lists twenty species from the slough; furthermore, some of these species are among the most common organisms in our quantitative cores. We have no explanation for this difference at this time. It does not seem likely that at least a few species of this common family were not present in Elkhorn Slough, even when MacGinitie did his work. It also does not seem likely that he could have missed these animals because of size, since he did record organisms as small as protozoans as well as other polychaetes in the same size class.

Although the absence of spionids is the most striking difference between our present survey and MacGinitie with respect to polychaetes, there are other, probably less significant, differences. For example, MacGinitie reports no phyllodocids, but we have four species; nor orbiniids, but we have found three species; no hesionids, but our samples yield three species; no dorvilleids and we find two species; and no magelonids, ctenodrillids and goniadids, whereas we have one species in each of the above groups. On the other hand, we have few specimens of terebellid polychaetes from the slough (but divers have observed them; see Section V). He also reports two species of sabellids, but we presently have found only one.

In the crustacea, MacGinitie has a much longer list of decapod species than we have documented. Part of this is due to the fact that we do not obtain these larger animals in our samples nor have we made a concerted effort to obtain qualitative samples of these animals. Of particular interest here is the presence of eight species of pea crabs (Pinnotheridae) in MacGinitie's list. The present state of taxonomy in this group is confused (see Light's manual, page 407) such that it may well be impossible to make valid comparisons with MacGinitie with respect to this group. We have also not recorded any hermit crabs from the slough, although they are undoubtedly present.

MacGinitie reports no pycnogonids from the slough, but we record three species. Perhaps this is directly due to the activities of man, as all these species are recorded from the breakwater protecting the harbor entrance.

In the phylum Mollusca, several interesting comparisons can be made. In the first place, MacGinitie records five species of bivalve molluscs which bore into shale or other rock, as well as two additional species of bivalves which nestle in the holes bored by the other five. We have not found any of these species as yet, but that is probably because we have not searched the rocks by the Highway I bridge where MacGinitie reported them.

A more interesting comparison with MacGinitie involves the opisthobranch gastropod molluscs. Because of our strong interest in opisthobranchs here, we have collected Elkhorn Slough rather thoroughly for this group. The list of opisthobranchs which we record reflects this. As a result, we feel that our knowledge of what species are present is better at present for this group than perhaps for any other. We list now thirty-three species from the slough, whereas MacGinitie listed only five. It is difficult, however, to make really valid comparisons, since MacGinitie turned over all his opisthobranch specimens to MacFarland and many were probably never reported in the literature. Analysis of MacFarland's (1966) posthumous memoir reveals six species of opisthobranchs recorded from Elkhorn Slough and most were noted as collected by MacGinitie. The species listed were *Aglaja diomedea* (= *A. ocelligera*), *Chelidonura inermis*, *Aplysia californica*, *Phyllobranchopsis enteromorphae* (= *Aplysiopsis smithi*), *Elysia bedeckta* (= *E. hegpethi*) and *Diaulula sandiegensis*. It should be noted that many of the opisthobranch species reported here have been found on floating docks and the presence of these in the slough since MacGinitie did his work has undoubtedly increased the number of species found.

Although close examination of the species list will reveal many more differences between our work and that of MacGinitie, we are not in a position at present to consider whether these differences are real or represent a lack of effort on our part with respect to that group. For example, we list no chitons for the slough, whereas MacGinitie lists several. This is undoubtedly due to the fact that we have not made the effort as yet to collect this group in the slough. Hence, comparisons must await further work.

C. Literature Cited

Gordon, B.L., 1974. Monterey Bay Area: Natural history and cultural imprints. Pacific Grove: Boxwood Press, 202 pp.

MacFarland, F.M., 1966. Studies of Opisthobranchiata Mollusks of the Pacific Coast of North America. Mem. Cal. Acad. Sci. 6: 543 pp.

MacGinitie, G.E., 1935. Ecological aspects of a California marine estuary. Amer. Midl. Nat. 16(5): 629-765.

Higher Taxon	Species	Synonyms	References	Comments
Protozoa				
	Noctiluca sp.		1	
	Vorticella sp.		1	
	Amphisia sp.		1	
	Condylostoma sp.		1	
	Cypridium sp.		1	
	Onychaspis sp.		1	
	Tracheolocerca sp.		1	
	Loxophyllum sp.		1	
	Frontonia sp.		1	
	Uronychia sp.		1	
	Hypotrichia sp.		1	
	Stylotrichia sp.		1	
	Dinophrys sp.		1	
	Loxodes sp.		1	
	Pleuronema sp.		1	
	Strombidium sp.		1	
	Cyclidium sp.		1	
	Euplotes sp.		1	
	Zoothamnion sp.		4	common on settling plates
	Folliculina sp.		4	uncommon on settling plates
	Acineta sp.		4	common on hydroid stalks
	Ammonia beccarii (Linne)		2	
	Buccella frigida (Cushman)		2	
	Bulimina marginata d'Orbigny		2	
	Cassidulina limbata Cushman and Hughes		2	
	Cyclogyra involvens (Reuss)		2	
	Elphidiella hannai (Cushman and Grant)		2	
	Elphidium excavatum (Terquem) forma selseyensis (Heron-Allen and Earland)		2	
	Elphidium excavatum (Terquem) forma clavata Cushman		2	
	Elphidium frigidum Cushman		2	
	Elphidium de Montfort sp.		2	
	Florilus basispinatus (Cushman and Moyer)		2	
	Globigerina d'Orbigny sp.		2	
	Haplophragmoides subinvolutum Cushman and McCulloch		2	

Higher Taxon	Species	Synonyms	References	Comments
Protozoa (cont.)				
	Jadammina macrescens (Brady)		2	
	Miliommina fusca (Brady)		2	
	Orbulina universa d'Orbigny		2	
	Osangularia Brotzen (lens)		2	
	Quinqueloculina compta Cushman		2	
	Reophax nanus Rhumbler		2	
	Rosalina columbiensis (Cushman)		2	
	Rosalina d'Orbigny sp.		2	
	Sagrina d'Orbigny sp.		2	
	Trochammina inflata (Montagu)		2	
	Trochammina Parker and Jones spp. 1, 2, 3, 4		2	
Porifera				
	Halisarca sacra de Laubenfels, 1930		1	one identified in Light's, questionable by Carlton
	Cliona celata Grant, 1826		1,3	
	Mycale macginitiei de Laubenfels, 1930		1	
	Haliclona cinera de Laubenfels, 1932		1	two species in Light's, A & B!
	Haliclona permollis (Bowerbank, 1866)		3	on jetty = sp. A in Light's
Cnidaria				
	Obelia longissima (Pallas, 1766)		1,4,5	
	Opercularella lacerata (Johnston, 1847)		1	
	Campanularia sp.		1	
	Abietinaria filicula (Ellis and Solander, 1786)		1	
	Aglaophenia struthionides (Murray, 1860)		1	
	Syncoryne mirabilis (Agassiz, 1862)		1	
	Bougainvillia mertensi Agassiz, 1862		1	
	Tubularia crocea (Agassiz, 1862)		1	
	Polyorchis penicillatus (Eshscholtz, 1829)		3	near Skipper's
	Zaolutus actius Hand, 1935		1	
	Anthopleura xanthogrammica (Brandt, 1835)		1,3	
	Anthopleura elegantissima (Brandt, 1835)		1,3	
	Metridium senile (Linne, 1767)		1,3	common on pilings
	Aurelia aurita (Linne, 1758)		1	only Scyphistomas found
	Pelagia colorata, Russell, 1964		4	commonly washed in
	Pachycerianthus fimbriatus (McMurrich, 1910)		2	unconfirmed, based on photos of divers

Higher Taxon	Species	Synonyms	Reference	Comments
Bracniopoda				
	Glottidia albida (Hinds, 1844)		2, 4	in mud at Skipper's
Polychaeta				
	Halosydna brevisetosa Kinberg, 1855	Halosydna insignis Baird, 1863	1	not in Light's; could be H. brevisetosa Kinberg, 1855
	Harmothoe lunulata (delle Chiaje, 1841)		2	subtidal cores from WES study
	Harmothoe priops Hartman, 1961		2	subtidal cores from WES study
	Hesperonoe adventor (Skogsberg, 1928)		1	commensal
	Hesperonoe complanata (Johnson, 1901)		1	commensal
	Pholoe glabra Hartman, 1961		2	subtidal cores from WES study
	Sthenelais fusca Johnson, 1897		1	
	Sthenelais verruculosa Johnson, 1897		2	subtidal cores from WES study
	Paleanotus bellis (Johnson, 1897)		2	
	Pareurythoe californica (Johnson, 1897)		1, 2	
	Neanthes virens (Sars, 1835)		1, 4	uncommon
	Nereis grubei (Kinberg, 1866)		2	Skipper's dock
	Nereis procera Ehlers, 1868		1, 2	
	Nereis vexillosa Grube, 1851		1	
	Nereis dumerilii (Audouin & Milne-Edwards)		1	not in Light's; probably Platynereis bicanaliculata
	Platynereis bicanaliculata (Baird, 1863)		2	
	Perinereis monterea (Chamberlain, 1918)		1	
	Nephtys assimilis Oersted, 1843		1	not in Light's; perhaps N. caecoides Hartman, 1938
	Nephtys caeca (Fabricius, 1780)		1	
	Nephtys caecoides Hartman, 1938		2	
	Nephtys cornuta franciscana Clark & Jones, 1955		2	
	Glycera robusta Ehlers, 1868		1, 2	
	Glycera rugosa Johnson, 1901	Glycera americana Leidy, 1855	1	not in Light's; perhaps <u>Hemipodus</u>
	Glycera convoluta Keferstein, 1862		2	
	Hemipodus borealis Johnson, 1901		2	
	Diopatra ornata Moore, 1911		2	subtidal cores from WES study
	Diopatra splendidissima Kinberg, 1865		2	subtidal cores from WES study
	Nothria elegans (Johnson, 1901)		1, 2	
	Onuphis eremita Audouin & Milne-Edwards, 1832-1834		1, 2	not in Light's
	Leodice longicirrata Webster, 1884	Eunice longicirrata Webster, 1884	1	not in Light's; not in Hartman's catalog
	Lumbrineris tetraura (Schumarda, 1861)	L. impatiens Claparede, 1868	1, 2	in channel cores
	Lumbrineris luti Berkeley & Berkeley, 1945		2	subtidal cores from WES study
	Lumbrineris cruzensis Hartman, 1944		2	not in Light's

Higher Taxon	Species	Synonyms	Reference	Comments
Polychaeta (cont.)	Lumbrineris limicola Hartman, 1944		2	in channel cores
	Lumbrineris zonata (Johnson, 1901)		2	
	Audouinia tentaculata (Montagu, 1808)	Cirriformia tentaculata (Montagu, 1808)	1	not in Light's; probably C. spirabranchia
	Telepsavus costarum Claparede, 1870		2	subtidal cores from WES study
	Chaetozone setosa Malmgren, 1867		2	subtidal cores from WES study
	Cirriformia siprabrancha (Moore, 1904)		4	from Jim Rote
	Cirratulus cirratus (Muller, 1776)		2	in fish stomach, also bottom samples
	Tharyx monilaris Hartman, 1960		2	subtidal cores from WES study
	Tharyx parvus Berkeley, 1929		2	
	Stylarioides plumosa Muller, 1788		1	not in Light's; not in Hartman's catalog
	Armandia brevis (Moore, 1906)	Armandia bioculata Hartman, 1938	1, 2	common
	Capitella capitata (Fabricius, 1780)		1, 2	
	Notomastus giganteus (Moore, 1909)		1	not in Light's; Hartman lists it from 200 fm in Alaska
	Notomastus magnus Hartman, 1947		3	
	Notomastus tenuis Moore, 1909		1, 2	common
	Mediomastus californiensis Hartman, 1944		2	
	Heteromastus filobranchus Berkeley & Berkeley, 1932		2	in channel cores
	Pectinaria auricoma (Muller, 1788)		1	not in Light's; Hartman lists as European species
	Pectinaria californiensis Hartman, 1941		2	probably same as P. auricoma of MacGinitie
	Ampharete labrops Hartman, 1961		2	
	Ctenodrilus serratus (Schmidt, 1857)		2	
	Dorvillea articulata Hartman, 1938		2	subtidal cores from WES study
	Protodorvillea gracilis (Hartman, 1938)		2	
	Schistomeringos rudolphi (delle Chiaje, 1828)	Dorvillea rudolphi	2	Light's uses D. rudolphi
	Glycinde sp.		2	
	Gyptis brevipalpa (Hartmann-Schroder, 1959)		2	
	Microphthalmus sp.		2	possibly a new species
	Trochochaeta multisetosum	Disoma franciscanum (Hartman, 1947)	2	in channel core
	Magelona sacculata Hartman, 1961		2	
	Haploscoloplos pugettensis (Pettibone, 1957)		2	H. elongatus in L.M.
	Naineris dendritica (Kinberg, 1867)		2	
	Scoloplos sp.		2	this may be S. armiger
	Scoloplos armiger (Muller, 1776)		2	subtidal cores from WES study
	Owenia sp.		2	this may be O. collaris
	Owenia collaris Hartman, 1955		2	subtidal cores from WES study
	Pilargis maculata Hartman, 1947		2	

Higher Taxon	Species	Synomyms	Reference	Comments
Polychaeta (cont.)	Pilargis berkeleyi Monro, 1933		1	
	Sigambra tentaculata (Treadwell, 1941)		2	subtidal cores from WES study
	Anaitides c.f. muscosa (Oersted, 1843)		2	
	Anaitides williamsi Hartman, 1936		2	
	Eteone dilatae Hartman, 1936		2	
	Eteone longa californica Hartman, 1936		2	as E. californica in Light's
	Eulalia quadrioculata Moore, 1906		2	
	Eumida bifoliata (Moore, 1909)		2	
	Hesionura sp.		2	
	Exogone lourei Berkeley & Berkeley 1938		2	
	Syllides sp.		2	
	Typosyllis armillaris (Muller, 1771)		2	subtidal cores from WES study
	Amaena occidentalis (Hartman, 1944)		2	subtidal cores from WES study
	Pista elongata Moore, 1909		1	Light's records it from rocks
	Polycirrus sp.		2	
	Neoamphitrite robusta (Johnson, 1901)	Terebella robusta (Johnson, 1901)	1	N. robusta in Light's
	Loimia medusa (Savigny, 1818)	Loimia montagui (Grube)	1	as L. medusa in Light's
	Eudistylia polymorpha (Johnson, 1901)		1	
	Chone gracilis Moore, 1906		2	subtidal cores from WES study
	Chone infundibuliformis Kroyer, 1856		1	not in Light's; Hartman reports as European species
	Boccardia columbiana (Berkeley, 1927)		2	
	Boccardia proboscidea Hartman, 1940		2	
	Boccardia hamata (Webster, 1879)	Boccardia uncata Berkeley, 1927	2	not in Light's
	Dispio uncinata Hartman, 1951		2	not in Light's; Hartman reports from Gulf of Mexico
	Malacoceros glutaeus (Ehlers, 1897)	Rhynchospio arenicola Hartman, 1936	2	
	Nerinides acuta (Treadwell, 1914)		2	subtidal cores from WES study
	Polydora brachycephala Hartman, 1936		2	
	Polydora citrona Hartman, 1941		2	not in Light's
	Polydora ligni Webster, 1879		2	
	Polydora socialis (Schmarda, 1861)		2	
	Prionospio cirrifera Wiren, 1883		2	
	Prionospio pinnata Ehlers, 1901		2	in channel core
	Prionospio pygmaea Hartman, 1961		2	
	Pseudopolydora paucibranchiata (Okuda, 1937)		2	
	Pygospio elegans Claparede, 1863		2	
	Scololepis (Nerinides) tridentata (Southern, 1914)		2	
	Streblospio benedicti Webster, 1879		2	

Higher Taxon	Species	Synonyms	Reference	Comments
Polychaeta (cont.)	Spiophanes bombyx (Claparede, 1870)		2	
	Spiophanes missionensis Hartman, 1941		2	subtidal cores from WES study
	Spiophanes berkeleyorum Pettibone, 1962	Spiophanes sp. A. of Hodgson	2	
Hirudinea				
	Branchellion sp.		1	as a new species, this group not covered in current study
Echinodermata				
	Strongylocentrotus purpuratus (Stimpson, 1857)		2	on oyster docks
	Pisaster ochraceus (Brandt, 1835)		1,3	
	Amphiodia occidentalis (Lyman, 1860)		1	
	Ophiothrix spiculata LeConte, 1851		1	
	Dendraster excentricus (Eschscholtz, 1831)		1,2	common offshore on sand
	Caudina chilensis (J. Muller, 1850)		1	
	Leptosynapta albicans (Selenka, 1867)		1	
Crustacea				
(Cirripedia)	Lepas hilli Darwin, 1854		1	Not in Light's, but all Lepas are washed in
	Balnaus tintinnabulum californicus Pilsbry, 1916		1	not covered in present study
	Balanus nubilis Darwin, 1854	B. nubilus	1	
	Sacculina sp. (on Pugettia producta)		1	not in Light's, probably Heterosaccus californicus Boschma, 1933
(Branchiuva)				
	Argulus melanostrictus Wilson, 1935		1	not in Light's
(Copepoda)	Hemicyclops thysanotus Wilson, 1935		1	whole group not keyed in Light's nor have we covered it
	Hemicyclops callianassae Wilson, 1935		1	
	Modiolicola gracilis Wilson, 1935		1	
	Trebius caudatus Kroyer, 1837		1	
(Isopoda)	Lironeca vulgaris Stimpson, 1857		1	parasitic on fish
	Limnoria sp.		1,7	one species, probably L. quadripunctuta or L. tripunctata, common on pilings
	Portunion conformis Muscatine, 1956		7	in body cavity of Hemigrapsus
	Pentidotea resecata (Stimpson, 1857)		1	
	Idotea wosnosenskii (Brandt, 1851)		3	at end of jetty
	Phyllodurus abdominalis Stimpson, 1857		1	parasitic on Upogebia
	Ianiropsis montereyensis Menzies, 1952		2	
	Exosphaeroma media (George & Stromberg)		2	
	Munna ubiquita Menzies, 1952		2	subtidal cores from WES study
(Tanaidacea)	Tanais c.f. carolinii Milne-Edwards		3	Light's manual reports only T. vanis
	Anatanais hormani (Richardson, 1905)		2	
	Leptochelia dubia Kroyer, 1842		2	

Higher Taxon	Species	Synonyms	Reference	Comments
Crustacea	Cyclaspis sp.		2	this may be Cyclaspis nubila
(cont.)	Cyclaspis nubila Zimmer, 1936		2	subtidal cores from WES study
(Cumacea)	Hemilamprops californica Zimmer, 1936		2	subtidal cores from WES study
	Lamprops sp.		2	Skipper's
(Amphipoda)	Argissa hamatipes (Norman, 1869)		2	subtidal cores from WES study
	Allorchestes angusta Dana, 1854		2	
	Amphithoe lacertosa Bate, 1958		1	
	Anisogammarus confervicolus (Stimpson, 1857)	Gammarus confervicolus	1, 2	as Gammarus conferivicolus in MacGinitie
	Aoroides columbiae Walker, 1898		1, 2	
	Atylus tridens (Alderman, 1936)		2	subtidal cores from WES study
	Corophium acherusicum Costa, 1857		2, 3	
	Corophium insidiosum Crawford, 1937		2	
	Corophium spinicorne Stimpson, 1857		1, 3	
	Corophium uenoi Stephensen, 1932		2	possibly introduced
	Dulichia sp.		2	subtidal cores from WES study
	Eohaustorius sencillus Barnard, 1962		2	subtidal cores from WES study
	Jassa sp.		2	
	Ischyrocerus pelagops Barnard, 1962		2	
	Listriella diffusa Barnard, 1959		2	subtidal cores from WES study
	Maera sp.		2	
	Melita sp.		2	
	Metopa sp.		2	
	Monoculodes spinipes Mills, 1962		3	not in Light's; in harbor entrance
	Orchestia traskiana Stimpson, 1857		2	
	Paraphoxus daboius Barnard, 1960		2	subtidal cores from WES study
	Paraphoxus variatus Barnard, 1960		2	subtidal cores from WES study
	Photis sp.		2	subtidal cores from WES study
	Podocerus sp.		2	subtidal cores from WES study
	Protomedeia articulata Barnard, 1962		2	
	Synchelidium shoemakeri Mills, 1962		2	
	Tiron biocellata Barnard, 1962		2	subtidal cores from WES study
	Caprella californica Stimpson, 1857		2	subtidal cores from WES study
	Caprella equilibra Say, 1817		1	as C. equilibria Say, 1818 in Light's
	Caprella verrucosa Boecht, 1871		1	not in Light's
	Caprella ferrea Mayer, 1903		3	from end of jetty
	Caprella gracilior Mayer, 1903		3	from Elkhorn Yacht Club
	Caprella brevirostris Mayer, 1903		3	from Elkhorn Yacht Club
	Caprella mendax Mayer, 1903		2	

Higher Taxon	Species	Synonyms	Reference	Comments
Crustacea (cont.)				
(Amphipoda	Caprella natalensis Mayer, 1903		2	
cont.)	Caprella c.f. penantis Leach, 1814		2	
	Tritella laevis		3	from end of jetty
(Mysidacea)	Acanthomysis sp.		2	
(Leptostraca)	Nebalia pugettensis Clark, 1932		2	
(Decapoda)	Hippolyte californiensis Holmes, 1895		1	
	Heptacarpus paludicola Holmes, 1900	Spirontocaris paludicola (Holmes, 1900)	1,2	as H. paludicola in Light's
	Heptacarpus pictus (Stimpson, 1871)	Spriontocaris picta (Stimpson, 1871)	1	as H. pictus in Light's
	Crago nigricauda (Stimpson, 1856)	Crangon nigricauda Stimpson, 1856	1,3	as Crangon in Light's
	Synalpheus lockingtoni (Coutiere, 1909)		7	in L.M.
	Betaeus longidactylus Lockington, 1877		1	
	Upogebia pugettensis (Dana, 1852)		1,3	rare in slough today
	Callianassa californiensis Dana, 1854		1,3	common in slough
	Callianassa gigas Dana, 1852		1	rare according to Light's
	Isocheles pilosus (Holmes, 1900)		2	
	Pagurus hirsutiusculus (Dana, 1851)		1	
	Pagurus samuelis (Stimpson, 1857)		1	
	Pachycheles rudis Stimpson, 1859		1	
	Petrolisthes cinctipes (Randall, 1839)		1	
	Cancer productus Randall, 1839		1,2	
	Cancer antennarius Stimpson, 1856		1,2,3	
	Cancer anthonyi Rathbun, 1897		1,3	
	Cancer gracilis Dana, 1852		1,2	
	Cancer gibbosulus (DeHaan, 1835)		1	
	Cancer jordani Rathbun, 1900		1,2	
	Pinnixa faba (Dana, 1851)		1	
	Pinnixa franciscana Rathbun, 1918		1,2	difficult group with taxonomy, not well worked out, all commensal (Pinnixa faba through Pinnixa tubicola)
	Pinnixa longipes (Lockington, 1877)		1	
	Pinnixa schmitti Rathbun, 1904		1	
	Pinnixa tomentosa Lockington, 1876		1	not in Light's
	Pinnixa tubicola Holmes, 1895		1,2	
	Scleroplax granulata Rathbun, 1893		1,2	
	Opisthopus transversus Rathbun, 1893		1	
	Hemigrapsus oregonensis (Dana, 1851)		1,2,3	commonest large crab in slough
	Hemigrapsus nudus (Dana, 1851)		1	
	Pachygrapsus crassipes Randall, 1839		3	

Higher Taxon	Species	Synonyms	Reference	Comments
Crustacea (cont.)				
(Decopoda cont.)	Randallia ornata (Randall, 1839)		3	rare
	Loxorhynchus grandis Stimpson, 1857		3	not in Light's
	Pugettia producta (Randall, 1839)		2	
	Euphausia pacifica Hansen, 1911		4	washed in, found at low tide
Ostracoda				
	Podocopid ostracod		2	
	Euphilomedes carcharodonta Smith, 1951		2	subtidal cores from WES study
	Euphilomedes longiseta (Juday, 1907)		2	
	Euphilomedes oblonga Juday, 1907		2	subtidal cores from WES study
Pycnogonida				
	Pycnogonum stearnsi Ives, 1892		3	end of breakwater
	Lecythorhynchus hilgendorfi (Bohm, 1879)	Lecythorhynchus marginatus Cole, 1904	3	end of breakwater
	Phoxichilidium femoratum (Rathke, 1799)		3	end of breakwater
Mollusca				
(Bivalvia)	Ostrea lurida Carpenter, 1864		1,3	questionably present on floats at Yacht Club
	Crassostrea virginica (Gmelin, 1791)	Ostrea elongata Solander, 1786	1	introduced
	Mytilus edulis Linnaeus, 1758		1,2,4,	common on Sandholt Bridge pilings
	Modiolus rectus (Conrad, 1837)		1,3	near Yacht Club
	Modiolus capax (Conrad, 1837)		1	Light's lists as rock dweller & So. Calif.
	Musculus sp.		2	
	Adula diegensis (Dall, 1911)	Botula diegensis (Dall, 1911)	1	bores in shale
	Lithophaga plumula Hanley, 1844	L. p. kelseyi Hertlein & Strong, 1946	1	bores in shale
	Pseudochama exogyra (Conrad, 1837)		1	
	Kellia laperousii (Deshayes, 1839)		1,3	in floats at Yacht Club
	Mysella sp.		2	this may be M. aleutica
	Mysella aleutica (Dall, 1899)		2	subtidal cores from WES study
	Orobitella rugifera (Carpenter, 1864)	Pseudopythina rugifera (Carpenter, 1864)	1	
	Pseudopythina compressa Dall, 1899		1	not in Light's
	Tivela stultorum (Mawe, 1823)		1	common on open sand beaches, not in slough
	Transennella tantilla Gould, 1852		2	subtidal cores from WES study
	Saxidomus nuttalli Conrad, 1837		1,2,3	fairly common in places
	Protothaca tenerrima (Carpenter, 1856)	Paphia tenerrima (Carpenter, 1856)	1,3	rare
	Protothaca staminea (Conrad, 1837)		1,2,3	common in lower slough
	Gemma gemma (Totten, 1834)		2	common, introduced
	Petricola carditoides (Conrad, 1837)		1	found in pholad holes

Higher Taxon	Species	Synonyms	Reference	Comments
Mollusca				
(Bivalvia	Mactra sp.		2	perhaps small M. dolabriformis?
cont.)	Tresus nuttalli (Conrad, 1837)		1,2,3	commonest large clam in slough
	Tagelus californianus (Conrad, 1837)		1	dead shells common, no live ones seen
	Nuttallia nuttallii (Conrad, 1837)	Sanguinolaria nuttallii (Conrad, 1837)	1	
	Tellina modesta (Carpenter, 1864)	Tellina buttoni Dall, 1900	1,2	
	Tellina bodegensis Hinds, 1845		1	
	Tellina meropsis Dall, 1900		2	subtidal cores from WES study
	Tellina nuculoides (Reeve, 1854)		2	subtidal cores from WES study
	Macoma inquinata (Deshayes, 1855)		1,2	
	Macoma nasuta (Conrad, 1837)		1,2,3	commonest clam in the slough
	Macoma secta (Conrad, 1837)		1,2,3	common deeper than M. nasuta
	Macoma acolasta Dall, 1921		2	
	Macoma balthica (Linnaeus, 1758)	Macoma inconspicua (Broderip & Sowerby, 1829)	2,3	
	Solen sicarius Gould, 1850		1,2	
	Siliqua lucida (Conrad, 1837)		1,2	
	Cooperella subdiaphana (Carpenter, 1864)		2	subtidal cores from WES study
	Mya arenaria Linnaeus, 1758		1,2	introduced
	Cryptomya californica (Conrad, 1837)		1,2,3	commensal in burrows
	Platyodon cancellatus (Conrad, 1837)		1	bores in shale
	Panopea generosa (Gould, 1850)		1,3	very rare in slough
	Hiatella arctica (Linnaeus, 1767)	Saxicava arctica Linnaeus, 1767	1,3	on Yacht Harbor floats
	Zirfaea pilsbryi Lowe, 1931	Zirfaea gabbi Tryon, 1862 in MacGinitie	1,2,3	common in clay
	Chaceia ovoidea (Gould, 1851)	Pholadidea ovoidea (Gould, 1851)	1	bores in rock
	Penitella penita (Conrad, 1837)	Pholadidea penita (Conrad, 1837)	1	bores in rock
	Bankia setacea (Tyron, 1863)		1,3	in Kaiser intake pipes
	Lyrodus pedicellatus (Quatrefages, 1849)	Teredo diegensis Bartsch, 1916	1	introduced
	Lysonia californica Conrad, 1837		2	subtidal cores from WES study
	Hinnites giganteus Gray, 1825		1	
	Pododesmus cepio (Gray, 1850)	Pododesmus macroschisma (Deshayes, 1839)	1	
	Clinocardium nuttallii (Conrad, 1837)	Cardium corbis (Martyn, 1784)	1,3	not uncommon at lower end of slough
	Trachycardium quadragenarium (Conrad, 1837)		2	not in Light's
(Gastropoda)	Diodora aspersa (Rathke, 1833)		1	as D. a. (Eschscholtz) in MacGinitie
	Collisella limatula (Carpenter, 1864)	Acmaea limatula (Carpenter, 1864)	1	
	Collisella scabra (Gould, 1846)	Acmaea scabra Gould, 1846	1,4	common on jetty
	Notoacmea persona (Rathke, 1833)	Acmaea persona Eschscholtz	1	

Higher Taxon	Species	Synonyms	Reference	Comments
Mollusca				
(Gastropoda	Tegula funebralis (Adams, 1855)	T. funebrale (Adams, 1854)	1,4	common on jetty
cont.)	Lacuna porrecta Carpenter, 1863		1	unidentified species in PG&E
	Lacuna unifasciata Carpenter, 1863		1	unidentified species in PG&E
	Littorina scutulata Gould, 1849		1	common on rocks by Highway 1 bridge
	Alvinia acutelirata Carpenter 1864	A. compacta Carpenter, 1864	2	
	Assiminea californica (Tryon, 1865)		2	
	Batillaria attramentaria (Sowerby, 1855)	erroneously called B. zonalis (Brug, 1792)	3	introduced, very common in Salicornia
	Crepidula nummaria (Gould, 1846)	C. nivea Adams, 1852	1	
	Epitonium bellastriatum (Carpenter, 1864)		2	subtidal cores from WES study
	Polinices draconis (Dall, 1903)		1	not in Light's, probably P. lewisi
	Polinices lewisi (Gould, 1847)		4	uncommon at lower end
	Acanthina spirata (Blainville, 1832)		1,3	common on rocks by Highway 1 bridge
	Nucella emarginata (Deshayes, 1839)		3	on jetties
	Vitrinella sp.		2	
	Nassarius fossatus (Gould, 1850)	Nassa fossata (Gould, 1849) of MacGinitie	1	
	Nassarius mendicus (Gould, 1849)		2	subtidal cores from WES study
	Nassarius rhinetes Berry, 1935		2	subtidal cores from WES study
	Nassarius perpinguis (Hinds, 1844)		2	subtidal cores from WES study
	Olivella biplicata (Sowerby, 1825)		1,2,3	
	Olivella pycna Berry, 1935		2	
	Kurtziella plumbea Hinds, 1843	Mangelia barbarensis	2	subtidal cores from WES study
	Mitrella gouldii (Carpenter, 1857)		2	
	Mitrella carinata (Hinds, 1844)		2	
	Carinaria sp.		3	washed in
	Onchidella borealis Dall, 1871		2	
	Ovatella myosotis (Draparnaud, 1801)	Phytia setifer (Cooper, 1872)	7	
	Chelidonura inermis (Cooper, 1862)	Aglaja inermis & Navanax inermis	1,3	uncommon
	Aglaja diomedea (Bergh, 1894)		5	
	Haminoea vesicula (Gould, 1855)		1,3	uncommon, but rarely locally abundant
	Cylichna attonsa (Carpenter, 1865)		2	subtidal cores from WES study
	Bulla gouldiana Pilsbry, 1843		5	
	Aplysia californica Cooper, 1863	Tethys californicus (Cooper, 1863)	1,4	uncommon but may be more uncommon in channel
	Phyllaplysia taylori Dall, 1900		1,4	on Zostera
	Aplysiopsis smithi Marcus, 1961	Hermaeina smithi in MacFarland, 1966	3,5	
	Elysia hedgpethi Marcus, 1961		5	
	Coryphella trilineata O'Donoghue, 1921	C. fisheri MacFarland, 1966	3,5	common on Skipper's docks
	Coryphella cooperi Cockerell, 1901		5	rare

Higher Taxon	Species	Synonyms	Reference	Comments
Mollusca				
(Gastropoda cont.)	Coryphella sp.		5	probably undescribed
	Alderia modesta (Loven, 1844)		2	in Vaucheria mats
	Stiliger fuscovittata Lance, 1962		5	
	Hermissenda crassicornis (Eschscholtz, 1831)		1,3,5	common at times
	Cumanotus beaumonti (Eliot, 1906)		3,5	always on Tubularia
	Eubranchus rustyus (Marcus, 1961)		5	probably the new species of Galvina in MacGinitie
	Emarcusia morroensis Roller, 1972		5	rare, Skipper's docks
	Aeolidia papillosa (Linnaeus, 1761)		1,5	on or near anemones
	Catriona alpha (Baba & Hamatani, 1961)		5	Skipper's docks
	Trinchesia albocrusta (MacFarland, 1966)		5	Skipper's docks
	Doto amyra Marcus, 1961	Doto varians MacFarland, 1966	5	Probably the new species reported by MacGinitie
	Melibe leonina (Gould, 1852)		4	washed in
	Dendronotus frondosus (Ascanius, 1774)	D. venustus MacFarland, 1966	5	probably the new species reported by MacGinitie
	Dendronotus iris Cooper, 1863		2,4	subtidal on Pachycerianthus
	Polycera atra MacFarland, 1905		3,5	
	Polycera hedgpethi Marcus, 1964		5	
	Archidoris montereyensis (Cooper, 1862)		3,5	fairly common on mud
	Onchidoris hystricina (Bergh, 1878)		5	
	Onchidoris bilamellata (Linnaeus, 1767)		5	on barnacles
	Acanthodoris rhodoceras Cockerell & Elliot, 1905		5	
	Acanthodoris cf pilosa (Abildgaard, 1789)		5	
	Acanthodoris lutea MacFarland, 1925		2	confirmed?
	Diaulula sandiegensis (Cooper, 1862)		5	
	Ancula lentiginosa Farmer, 1964		5	rare
	Ancula pacifica MacFarland, 1905		5	
	Okenia angelensis Lance, 1966		5	
Polyplacophora				
	Ishnochiton cooperi Pilsbry	Lepidozona cooperi Pilsbry, 1892	1	
	Lepidochitona raymondi (Pilsbry, 1894)		1	not in Light's
	Mopalia ciliata (Sowerby, 1840)		1	
	Mopalia muscosa (Gould, 1846)		1	have not recorded this group for the slough yet
	Mopalia muscosa hindsii (Reeve, 1847)	M. hindsii (Reeve, 1847)	1	
Cephalopoda				
	Paroctopus apollyon (Berry, 1912)	Octopus dolfeini martini Pickford, 1964	1	one unknown octopus in MLML collection
Chordata				
	Branchiostoma californiense Andrews, 1893		2	

Reference Code

1 = MacGinitie, 1935

2 = PG&E study of Elkhorn Slough 1974-1976

3 = MLML Museum Specimen

4 = J. Nybakken collection or observation

5 = G. McDonald collection or observation

6 = Listed in Light's Manual as from Elkhorn Slough

7 = James Carlton

8 = Pam Roe

VI. PRELIMINARY BASELINE STUDIES OF THE INTERTIDAL SANDY BEACH AT MOSS LANDING

by

James Oakden and James Nybakken

A. Introduction

The sand beach is the most extensive intertidal habitat of Monterey Bay. It is biologically a very harsh environment, encompassing most of the rigors of the rocky intertidal (high wave action, wide temperature range, periodic tidal exposure) with the addition of high abrasion levels and lack of firm substrate for attachment. Despite its rigorous environment and barren appearance, the sand beach harbors a numerous fauna.

The fauna of the beach exhibits the characteristics of communities in harsh environments, namely, low species diversity, but large numbers of individuals of each species.

Although the beach may appear to be a uniform environment, it actually consists of a number of different habitats. The amount of time that a given area is exposed varies with vertical distance relative to tidal datum. The size of the sand grains at a given area also varies to a certain extent vertically and horizontally. These factors, combined with other environmental parameters, lead to zoned habitats (Dahl, 1952).

Beach zonation, while not nearly as well studied as rocky-intertidal zonation, has long been recognized. Dahl (1952), after research on a number of sand beaches in Europe and South America, suggested that sand beach macrofauna could be subdivided into three belts: (1) the subterrestrial fringe (Talitrid-Ocypodid belt); (2) the midlittoral zone (Cirolana belt); and (3) the sublittoral fringe (rich and varied fauna). His theories, which are based in part upon the efforts of earlier workers, have been supported by recent findings.

In the United States, a large body of recent work exists for the Atlantic coast sandy beaches, but very little ecological work has been published for the Pacific. One of the first to study Pacific coast sand beaches was Weiser (1959), who worked with small invertebrates of beaches in Puget Sound. In Southern California, Klapow (1970, 1972) studied Excirolana. Enright (1961) worked with Synchelidium; Cox and Dudley (1968), Efford (1965, 1966, 1969, 1970) and several others worked with Emerita. In Monterey Bay, however, only three published studies are available: Nybakken and Stephenson (1975) on Pismo clams; Efford (1965), who sampled beaches in Monterey Bay for Emerita; and Clark and Haderlie (1962), who determined the distribution of Nephtys sp.

The purpose of this study was to define zonation on the Moss Landing Beach and to attempt to take quantitative samples which might be used to establish relative abundances of species and their changes with time. The study area was located on the beach in front of Moss Landing Marine Laboratories about one hundred yards south of Sandholt Pier (Figure 1). The beach is a typical high-energy beach composed of quartz sand, the majority of which enters the bay from the Pajaro and Salinas Rivers (Arnal, et al, 1973). Longshore current varies with the season and direction of incoming swells, but is generally from north to south. The Moss Landing beach is unusual in that it is a short distance from the head of the Monterey Submarine Canyon. The canyon appears to have little effect on the transport of sand via the longshore current (Dittmer, 1972), but diffracting incoming waves may make the Moss

Landing beach different from surrounding beaches.

B. Methods and Materials

A baseline was first laid out parallel to the surf zone. The end of the baseline (station 3-1) was found by triangulation, using as reference points areas on Sandholt Pier and the shore beyond, a point on the fence surrounding the Moss Landing Marine Laboratories and a fan on the roof of the Laboratories. This method was accurate to within about 1 meter. From this base point, the rest of the stations were located measuring with a 30-meter tape. The stations were placed at 5-meter intervals vertically down the beach and at 10-meter intervals horizontally along the beach, and labeled accordingly. The first number in the station label refers to the vertical distance from the base point, which was station 3-1; the second refers to the horizontal distance from the base point. For example, station 4-2 would be 5m seaward and 10m south of base station 3-1. Station 17-1, the lowest vertical station sampled, was 70m seaward from the baseline. At each station, duplicate samples were taken, replicate 'A' centered 1 meter north of the station and replicate 'B' located 1 meter south.

Due to lack of personnel, beach profiles were not taken; therefore, in order to relate the stations to absolute tide levels, the tide level (from a tide table) of the lowest station exposed on a given day was found. Over several days and different low tides, a profile could be developed. At each sampling site, a square wooden frame (area .25 m^2) was pressed into the sand, leaving an impression. The sand within this impression was then scooped out with a shovel to a depth of 5cm. In order to test the consistency of this sampling method, a series of ten samples were dug and placed into buckets.

The buckets were then weighed using a hand-held fish scale. The weights were found to be within five percent, demonstrating that the method had good reproducibility.

After the sand was dug, it was put into a sieve with Nytex 1mm mesh screen and sieved in the surf, after which the residue was rinsed into labeled glass jars. In some cases, when the percentage of coarse sand (> 1mm) appeared too great for the sample to be easily sieved, the sample was "swirled" on the beach. The swirling technique consisted of placing a small amount (about ½ pint) of the sample into a bucket, adding some seawater and swirling the water vigorously around inside the bucket. The water, a small amount of the sediment and the animals were then decanted into the sieve. Each sub-sample was swirled a minimum of five times and the process was repeated for the whole sample.

After each pair of samples was removed, a sediment core was taken halfway between the impressions. To do this, a plastic tube with a diameter of 4cm was pressed into the sand. By placing a hand over the top of the tube, vacuum was created and the core withdrawn. A 15cm section was then extruded into a whirl-pac and transported to the lab for later analysis.

In the laboratory, the samples were fixed in buffered formalin and stained with rose bengal. Later, the samples were sorted under a dissecting microscope, the individuals identified to the lowest taxon feasible and then preserved in 70% ethanol. When large quantities of sand were present in the sample, a different method was used to separate the animals from the sand in order to avoid impossible sorting times. One technique tried was flotation in a dense liquid (Dexter, 1974; Sameoto, 1969). We experimented with this method and tried several other dense liquids as well, including chilled hypersaline solutions, carbon tetrachloride, glycerine, sodium silicate and Karo syrup. Each of these methods involved some difficulties, so a better method was sought. The aforementioned swirl method was the ultimate choice and has been used in other studies (Oliver and Slattery, 1973; Weiser, 1959) with good results. The residue from a number of samples that had been swirled was carefully sorted, but no animals were ever found, demonstrating the reliability of the method.

The sediment cores were analyzed in the lab using the settling tube method of Emery (1938). The cores were found to have distinct layers of different sizes of sand, so each of the layers was measured and separated. A size analysis was then run on each layer. For each layer, the median, mode, skewness and sorting coefficients were found using the equations of Folk and Ward (1957) (Appendix I).

C. Discussion of Methods

Any given sampling technique is simply the best compromise between what would be ideal and what can practically be done. This is especially true of this study. There are such a wide variety of organisms on the beach that no single technique can adequately cover them all, nor was there time to use a multiplicity of techniques. For example, in order to retain the most animals, a .5 mm mesh would have been ideal. With such a small-mesh screen, so much sand would have been retained that not enough samples could have been taken and processed to get a representative section of the fauna. Using a 1 mm screen, the oligochaetes, small polychaetes, nematodes, nemertines and juvenile amphipods were not completely retained, but more samples could be taken and processed. When the sand was fine-grained, few sampling difficulties were involved, but when coarse (> 1 mm) layers were encountered, as was often the case, the taking and processing of the samples became an arduous and time-consuming process. It was not unusual to have five pints of sand retained on the screen after sieving. In order to avoid the difficulties involved in large quantities of coarse sand, a 2 mm mesh screen would have been ideal. Very little sand would have remained on such a screen, but only the largest animals; i.e., *Blepharipoda occidentalis*, *Tivela stultorum*, adult *Paraphoxus* spp. and *Archaeomysis* sp., *Emerita analoga* and large *Nepyths californiensis* would be retained. Hence, this size was not used.

The 5 cm sampling depth of this study was the result of another compromise. Five cm was chosen as the minimum depth at which a representative sample of the major organisms would be acquired. *Archaeomysis* sp. (Ricketts, *et al*, 1968) and *Excirolana* sp. (Klapow, 1972) are found in the top 1 cm of sand. Little is known of the distribution of *Saccocirrus* sp. *Emerita analoga* is generally found in the top 5 cm, but large individuals burrow to 15 cm and deeper (Efford, 1965). Adult *Orchestoidea* spp. have permanent burrows to 60 cm deep and so were not sampled at all, but young individuals burrow to about 5 cm (Craig, 1973). Lab experiments with *Paraphoxus* nov. sp. showed an average burrowing depth of 2 - 3 cm, with excursions to 10 cm. *Tivela stultorum* burrows to a depth equal to its shell length, so only small individuals would be recovered, although there are few large clams in the area (Nybakken and Stephenson, 1975).

Beach sediment is continually being deposited or eroded by wave action and being moved parallel to the beach by longshore transport. Erosion may be gradual, over a long period or sudden during storms. Dittmer (1972), working at Moss Landing Beach, observed changes of 80 cm over a month's time. Jones (1970) reported that 40 cm of erosion in rough weather in a single tide was not uncommon, and Bascom (1964) reported an overnight drop of five feet on an Oregon beach.

These sediment changes affect the width of the beach, causing the surf zone to migrate on or offshore. Maintaining permanent station markers in this shifting environment was not feasible, due to destruction by the surf (and weekend beach-goers), nor would they mark the same habitat, as sediment size, exposure time and wave action changed with time at any given place.

Several approaches have been used in attempts to sample the same beach community over time. One method (Croker, Hager and Scott, 1975) has been to take samples at a given distance from the high tide mark. This is a good solution, but could result in sampling two widely different ecological locations on successive days. Another method is to sample at given tidal heights (Dexter, 1969). As the beach level changes, the height above MLLW of a given spot would change; therefore, a constant re-evaluation of station locations would be required.

The method most often used, and the one used in the present study, is to determine stations from fixed reference points. By monitoring the same geographical location, a progression of different faunal assemblages will be sampled at different times of the year, because of the changes in sediment size and relative tidal height. However, the shifts in location of the zones are interesting in themselves. If the data are interpreted with the changes in mind, valid conclusions can probably be drawn.

Another of the headaches of sampling on the beach was the patchiness of many of the organisms. The patchiness of Orchestoidea spp., which are found in conjunction with beach-cast algae, will be discussed later. Emerita analoga is another animal that exhibits pronounced patchy distribution. Efford (1965) followed individual aggregations of Emerita on the LaJolla Beach over a three-year period. Aggregations persisted even when artificially moved to new locations, indicating that they were probably biological in origin rather than a function of sorting of the physical environment. Reasons for the aggregations are poorly understood, but their purpose may be to increase the effectiveness of filter feeding (Wynne-Edwards, 1962), to reduce predation (Efford, 1965) or they may be related to the positions of wave convergence zones (Cubit, 1969).

In an attempt to check patchiness along the beach at the same tide level, two series of samples were taken in lines parallel to the surf zone (Table 22). It can be seen that, while the same types of organisms were found along the beach at the same level, the numbers of individuals in each sample varied widely, even between replicates at the same station, thus documenting the patchiness. Other of the beach organisms undoubtedly exhibited either large- or small-scale patchiness, but such distribution could only be detected by a detailed study with a sampling method designed for the individual species.

Hence, whereas this study has delimited a few of the macrofaunal organisms present on the sandy beach and established some one-time estimates of relative abundance and zonation, it remains impossible to offer any established quantitative base from which to make predictions or assess damage.

D. Results

A total of 29 genera, representing 5 phyla, were found in the course of the study (see Table 20). The data for each sampling date are listed in Table 21.

Some groups could not be identified to species. Saccocirrus in our samples consisted of at least two undescribed species. The Nassarius sp., Tellina sp. and Corophium sp. were too young to be identified, except to genus. The Orchestoidea consisted of at least two species, O. corniculata and O. californiana, but for the purposes of discussion, were all considered together.

For various reasons, including those outlined previously, the majority of species cannot be realistically analyzed as to zonation, abundance and distribution. The nemertines, nematodes, oligochaetes and archiannelids were small enough to pass through the 1 mm mesh, so the numbers obtained for them are, to a great extent, a function of how thoroughly the samples were sieved. The same is true of the interstitial polychaetes such as the genera Eteone, Pisione and Hesioneura. A number of other intertidal animals, including Crangon, Mandibulaphoxus and most of the polychaetes, were so rare and appeared in so few samples that any statements concerning their distribution would be pure conjecture. Several other taxa, including Paraphoxus obtusidens, Nassarius sp., Tellina sp., Synchelidium shoemakeri and Monoculodes spinipes are basically subtidal (Oliver, et al, 1976), with only occasional individuals entering the extreme lower intertidal. The genus Corophium is basically a mudflat dweller (Meadows, 1964), so the individuals that were found (all of which were juveniles) were probably washed out of Elkhorn Slough. Eliminating the above then means the majority of this discussion will be limited to the few large, more common animals.

Analyzing the data for these few species, the first thing that becomes apparent is the clumping of individual species into contiguous stations. This clumping becomes more obvious when the numbers of individuals of a given species at each station are graphed over time (Figures 75-77). By totaling the number of individuals of each species for each station, the zonation can be demonstrated (Figure 79). This last method may not be entirely valid due to the aforementioned changing of the level of the beach, which shifts the tidal zones to different stations. This changing of centers of distribution was apparent in Excirolana linguifrons and Orchestoida spp., the two genera found highest on the beach (Figure 75). In October and early November, Excirolana linguifrons was found primarily at the 5 and 7 stations, but in later November shifted down to the 3 and 5 stations. Orchestoidea spp. exhibited this same trend, shifting from the 3, 5, 7 stations higher up the beach, beyond the sampling area (during qualitative samples in December, they were observed to be present in the high intertidal).

The laminations that were found in the sediment cores made interpretation of the sediment data and the traditional correlations between fauna and sediment size most difficult. When the surface sediment size was plotted for an individual station over time, an inconclusive graph resulted (Figure 78).

Table 20

Species list of macro-invertebrates obtained in samples taken between October 1975 and June 1976. This list omits major taxa for which no specific or generic identifications were made.

Polychaeta

- Anaitides groenlandica
- Eteone dilatae
- Glycera sp.
- Hemipodus borealis
- Hesionura sp.
- Heteromastus filiformis
- Nephtys californiensis
- Pisione remota
- Pygospio californica
- Saccocirrus spp.
- Spio sp.

Crustacea

- Archaeomysis grebnitzkii
- Blepharipoda occidentalis
- Corophium spp.
- Crangon nigromaculata
- Cumella vulgaris
- Emerita analoga
- Eohaustorius washingtonianus
- Excirolana linguifrons
- Mandibulophoxus gilesi
- Monoculodes spinipes
- Orchestoidea spp.
- Paraphoxus nov. sp.
- Paraphoxus obtusidens
- Synchelidium shoemakeri

Mollusca

- Nassarius sp.
- Siliqua lucida
- Tellina sp.
- Tivela stultorum

Table 21

Numbers of individuals of each species per station for each sampling date. The lowest tide level on the sampling date is also given for reference.

7 October 1975 tide, -.8
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B	9-1A	9-1B	11-1A
Polychaeta									
Eteone dilatae									1
Nephtys californiensis									1
Spionidae									1
Crustacea									
Archaeomysis grebnitzkii							2	2	5
Emerita analoga			5	9	1	1			1
Excirolana linguifrons			18	13	2	1			
Orchestoidea spp.	31	25			8				
Paraphoxus nov. sp.						6	3		1

1 November 1975 tide, -.4
sampling stations

Taxon	6-1A	6-1B	6-2A	6-2B	7-1A	7-1B	7-2A	7-2B	8-1A	8-1B	9-1A	9-1B
Polychaeta												
Capitellidae									1			
Eteone dilatae		1										
Glycera sp.	6	1	2			1						
Hesionura sp.									2			
Pisione remota	2	1	1						2			
Saccocirrus spp.		1	6			1			2			
Crustacea												
Archaeomysis grebnitzkii	1		2		1	1	12	5	3	3	6	1
Emerita analoga		33	4	4	2			2	2	4	2	1
Excirolana linguifrons		2	2	4		1	2	3			1	
Orchestoidea spp.		2										
Paraphoxus nov. sp.		1		1	1	2	1	5				
Paraphoxus obtusidens												1
Nematoda	4	6	31	8		5			5	1		
Nemertinea	2	3	7	4		2		2	8	2	1	
Oligochaeta	9	3	2	1						1		

Table 21 continued

29 December 1975 tide, -1.0
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B	9-1A	9-1B	11-1
Polychaeta									
Saccocirrus spp.			1						
Crustacea									
Archaeomysis grebnitzkii	1	2	1		27	67	1	6	106
Emerita analoga	6	4	1	2		1			1
Excirolana linguifrons	12	11	3	3	1				
Mandibulophoxus gilesi					1				
Paraphoxus nov. sp.			4	5	2	2	1		2
Mollusca									
Tivela stultorum									1
Nemertinea			2	1		1	2	10	1

15 January 1976 tide, -.9
sampling stations

Taxon	5-1A	5-1B	7-1A	7-1B	9-1A	9-1B	11-1A	11-1B	13-1A	13-1B
Polychaeta										
Saccocirrus spp.		1		8	1					
Crustacea										
Archaeomysis grebnitzkii					1					1
Corophium spp.	3	1	2	3	1	1				1
Emerita analoga	6	6			2					
Excirolana linguifrons	5	4		1						
Mandibulophoxus gilesi								1	1	1
Paraphoxus nov. sp.						2	1	1	2	
Mollusca										
Tivela stultorum										1
Nemertinea	8	17	7	6		2				

Table 21 continued

26 January 1976 tide, -.4
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B	9-1A	9-1B	11-1A	11-1B
Polychaeta										
?Phyllodocidae					1					
Saccocirrus spp.					9	6				
Crustacea										
Archaeomysis grebnitzkii					2	8	5	10	2	2
Corophium spp.					1					
Cumella vulgaris					1		1			
Excirolana linguifrons	30	28								
Paraphoxus nov. sp.					2	1			3	
Mollusca										
Tivela stultorum								1		
Nemertinea					16	10			1	

26 February 1976 tide, -.3
sampling stations

Taxon	7-1A	7-1B	9-1A	9-1B	11-1A	11-1B	13-1A	13-1B
Polychaeta								
Nephtys californiensis							1	
Crustacea								
Archaeomysis grebnitzkii	3	2	2		4	3		3
Emerita analoga					1	3	1	1
Mandibulophoxus gilesi					1		7	14
Paraphoxus nov. sp.	2	3	4	2	2	3	4	4
Nemertinea			6					

Table 21 continued

19 April 1976 tide, -.6
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B
Polychaeta						
Hemipodus borealis	1		1	2		
Nephtys californiensis			1		1	
Pisione remota					1	
Pygospio californica				2		
Saccocirrus spp.			1			1
Crustacea						
Emerita analoga			3	2	1	2
Excirolana linguifrons	94	108	13	2		
Orchestoidea spp.	3	3				
Nemertinea						

17 May 1976 tide, -1.1
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B
Polychaeta						
Hemipodus borealis			1		1	
Pisione remota			2			
Saccocirrus spp.			2		10	3
Crustacea						
Emerita analoga			7	5	2	1
Excirolana linguifrons	59	87	3	3		
Orchestoidea spp.		2				
Nemertinea						

Table 21 continued

15 June 1976 tide, -.4
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B	9-1A	9-1B	11-1A	11-1B
Polychaeta										
Heteromastus filiformis										1
Nephtys californiensis						1	1	1	1	1
Saccocirrus spp.		1		1						
Spio sp.										1
Crustacea										
Emerita analoga			11	6	3	2	5	6	2	3
Eohaustorius washingtonianus									1	2
Excirolana linguifrons	103	71	17	3			1			
Mandibulophoxus gilesi					3	9				
Orchestoidea spp.	14	16								
Paraphoxus nov. sp.								1		5
Mollusca										
Nassarius sp.									1	
Tellina sp.							1			
Tivela stultorum								1		
Oligochaeta	4			2						

Table 21 continued

18 November 1975 tide, -.5
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B
Polychaeta						
Pisione remota					7	3
Saccocirrus spp.	1	2		1	35	20
Crustacea						
Archaeomysis grebnitzkii				1	2	1
Emerita analoga			13	15		
Excirolana linguifrons	6	8	3	1		
Orchestoidea spp.	1					
Nematoda	48	39	3	2		4
Nemertinea	10	17			12	7
Oligochaeta	14	15				

1 December 1975 tide, -1.4
sampling stations

Taxon	3-1A	3-1B	5-1A	5-1B	7-1A	7-1B	11-4A	11-4B	13-4A	13-4B	15-4A	15-4B	17-4A	17-4B
Polychaeta														
Nephtys californiensis													2	
Pisione remota					1	1								
Saccocirrus spp.			1		241	50								
Crustacea														
Archaeomysis grebnitzkii								1	1	1		1		
Corophium spp.			2			1								
Crangon nigromaculata										1				
Emerita analoga		1	23	25										
Eohaustorius washingtonianus							1		2	2		2		
Excirolana linguifrons	14	18	2	3										
Mandibulophoxus gilesi							20	2	5	5	2	4		
Monoculodes spinipes											1			1
Paraphoxus nov. sp.							8	1	5	2		4		1
Synchelidium shoemakeri													1	
Mollusca														
Siliqua lucida											1			
Nemertinea	1		18	2	105	20								
Oligochaeta			5		11									

Table 22

Numbers of individuals of each species per station for two sampling dates. All samples at each station are from the same tide level. The lowest tide level is given for reference.

	10 October 1975 tide, + 3 sampling stations							
Taxon	3-1A	3-1B	3-4A	3-4B	3-5A	3-5B	3-6A	3-6B
Crustacea								
Archaeomysis grebnitzkii	1	1	2					
Excirolana linguifrons		1	25	28	11	19	34	37
Orchestoidea spp.	8	15	1	2	19	6	3	3
Insecta		2						2

	17 October 1975 tide, +.9 sampling stations							
Taxon	7-1A	7-1B	7-2A	7-2B	7-3A	7-3B	7-4A	7-4B
Polychaeta								
Anaitides groenlandica							1	
Hesioneura sp.							1	
Nephtys californiensis	1							
Pisione remota							2	
Saccocirrus spp.		11	1				203	
Spionidae					1			
Crustacea								
Archaeomysis grebnitzkii	4	3	8	6	5	7	3	9
Emerita analoga						1		1
Excirolana linguifrons		2						
Orchestoidea spp.								
Paraphoxus nov. sp.	3							
Nematoda		4					4	
Nemertinea		6	4	6	2		12	4

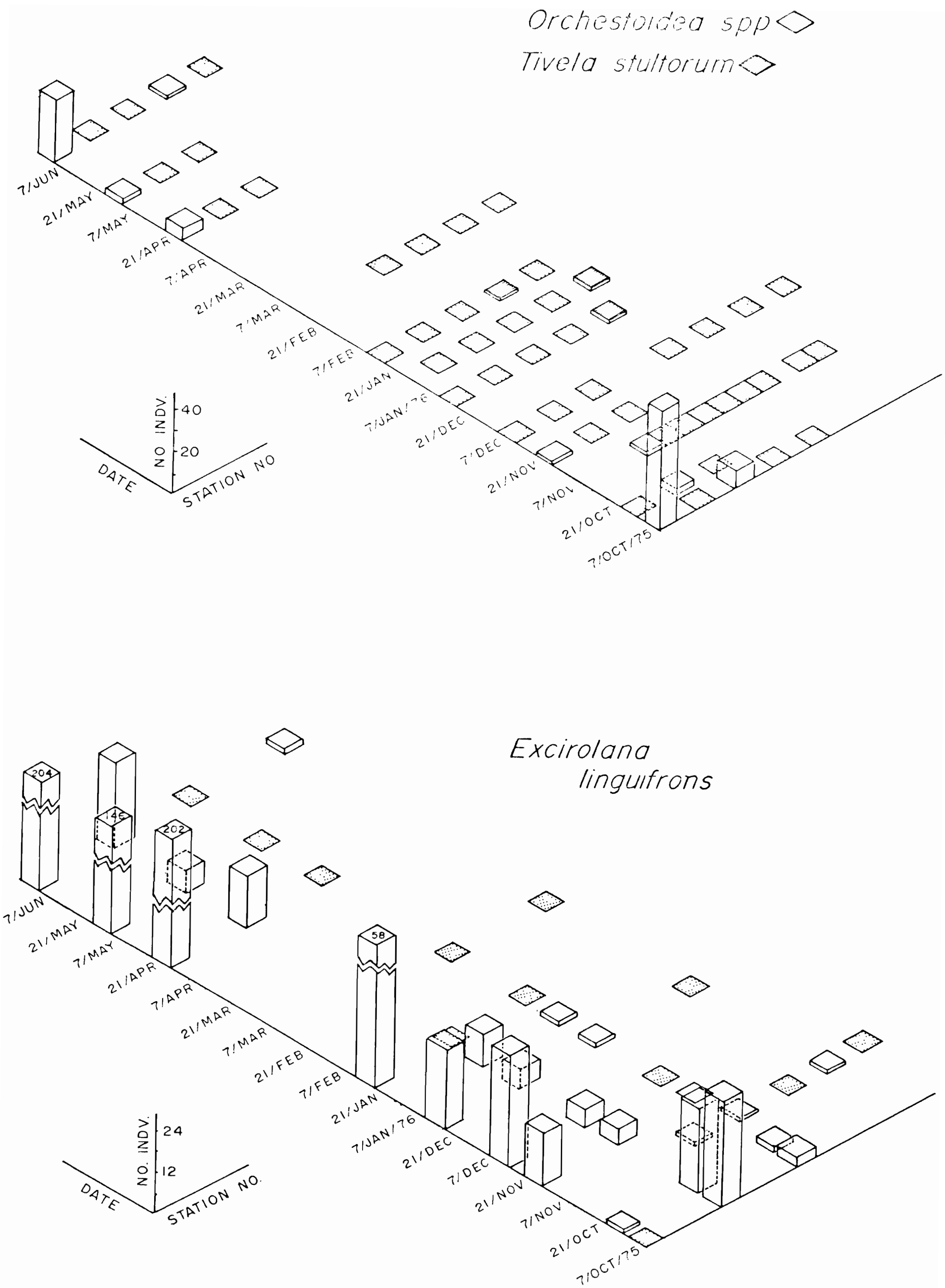


FIGURE 75. Abundance of Orchestoidea spp., Tivela stultorum and Excirolana linguifrons on Moss Landing Beach by tide level and sampling date

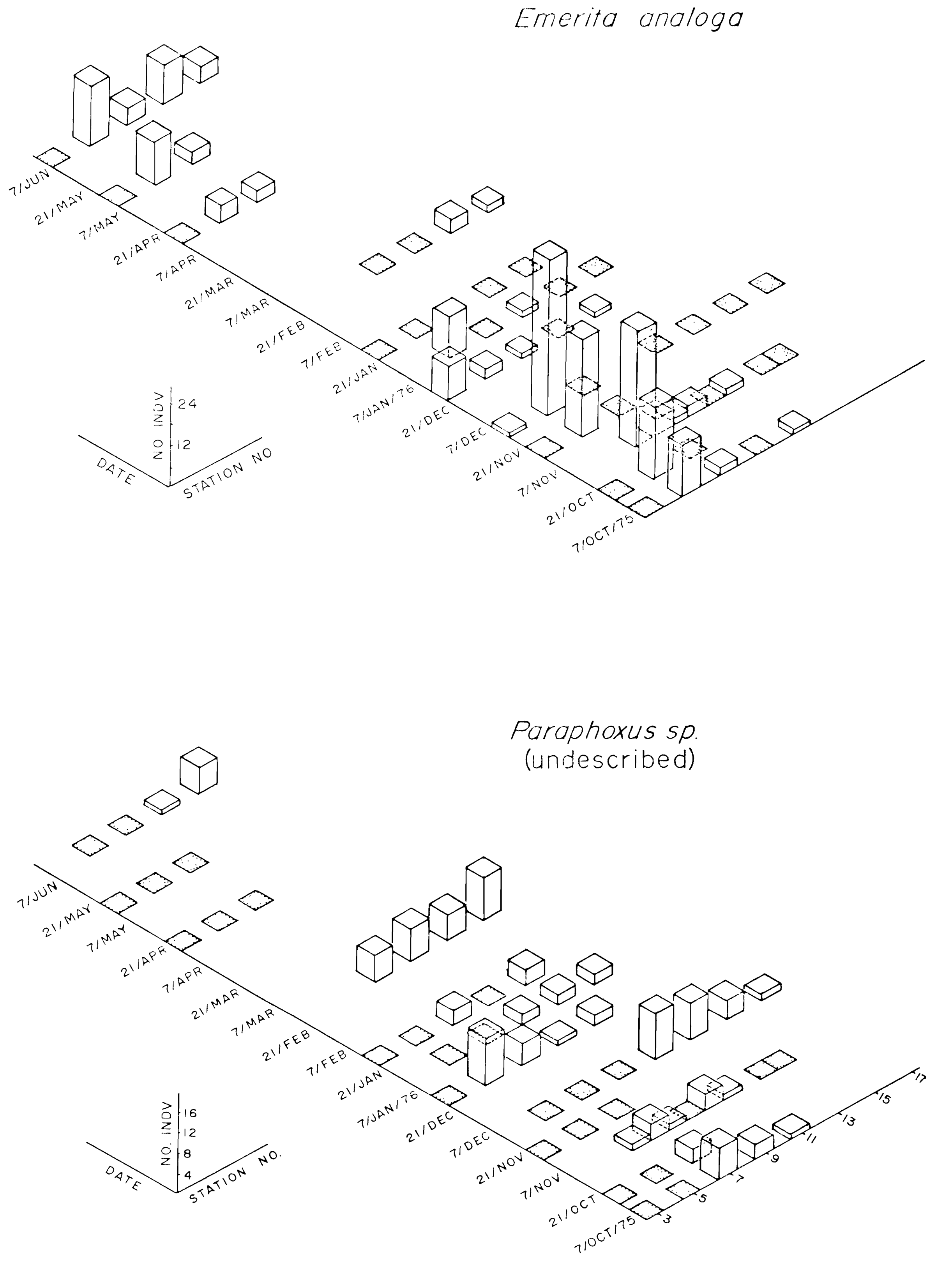
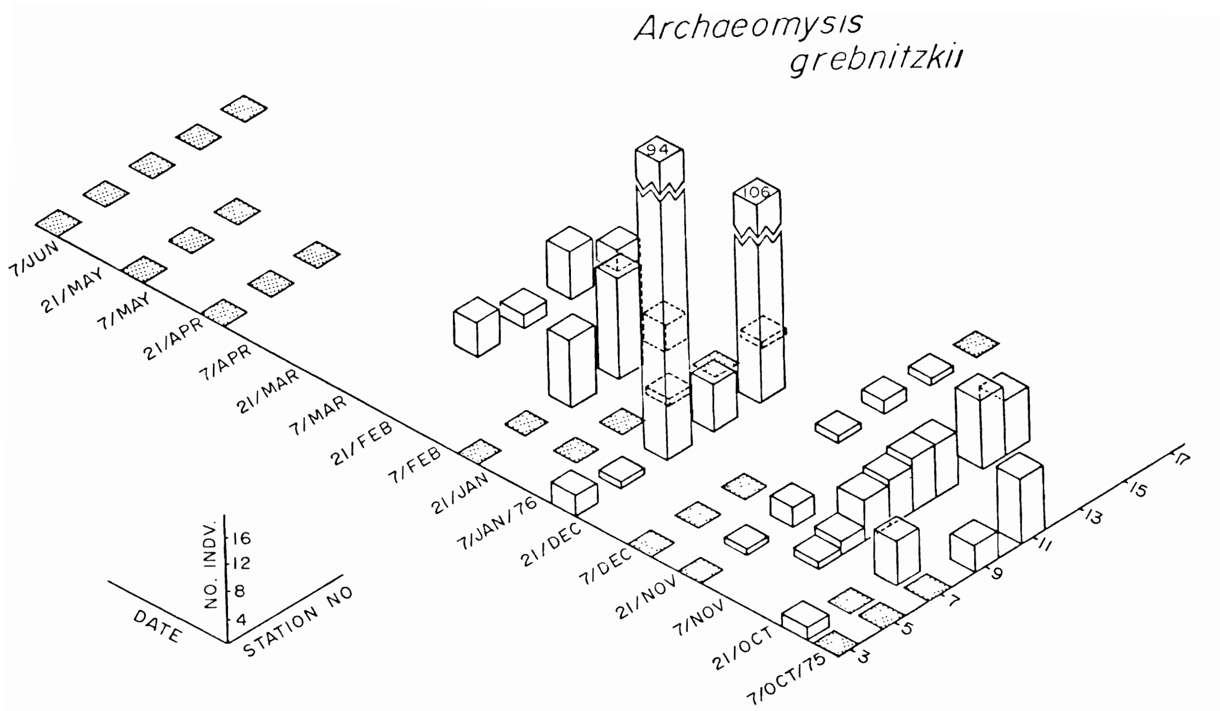


FIGURE 76. Abundance of Emerita analoga and Paraphoxus sp. on Moss Landing Beach by tide level and sampling date



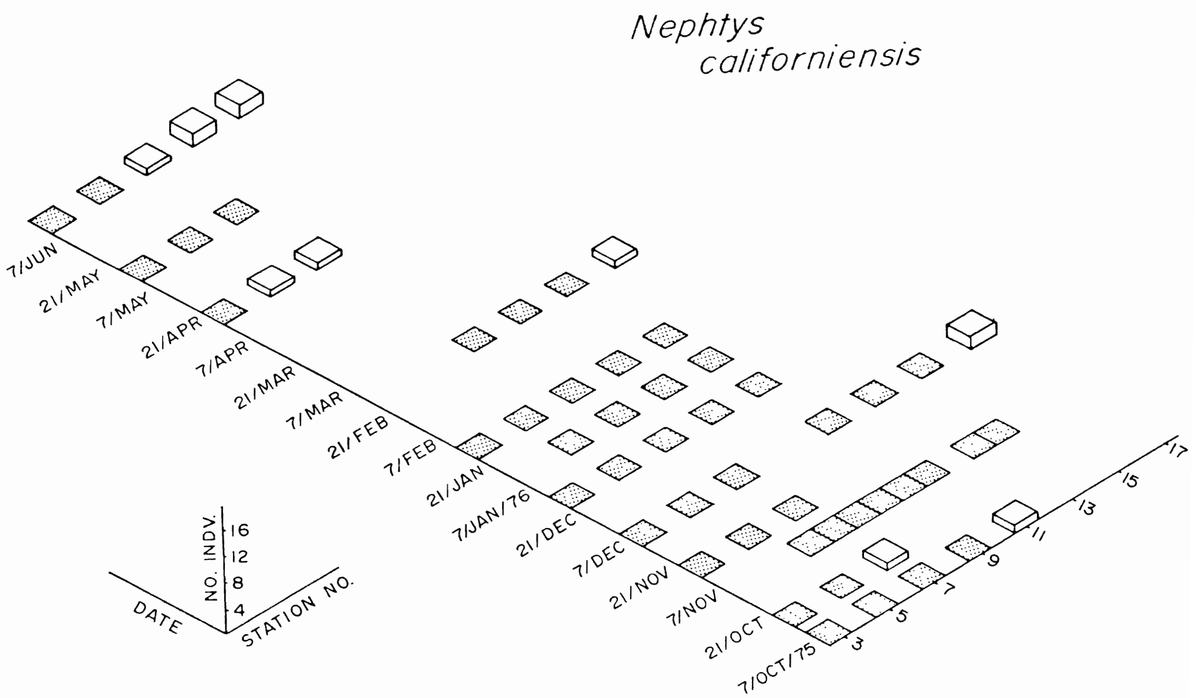


FIGURE 77. Abundance of Archaeomysis grebnitzkii and Nephtys californiensis on Moss Landing Beach by tide level and sampling date

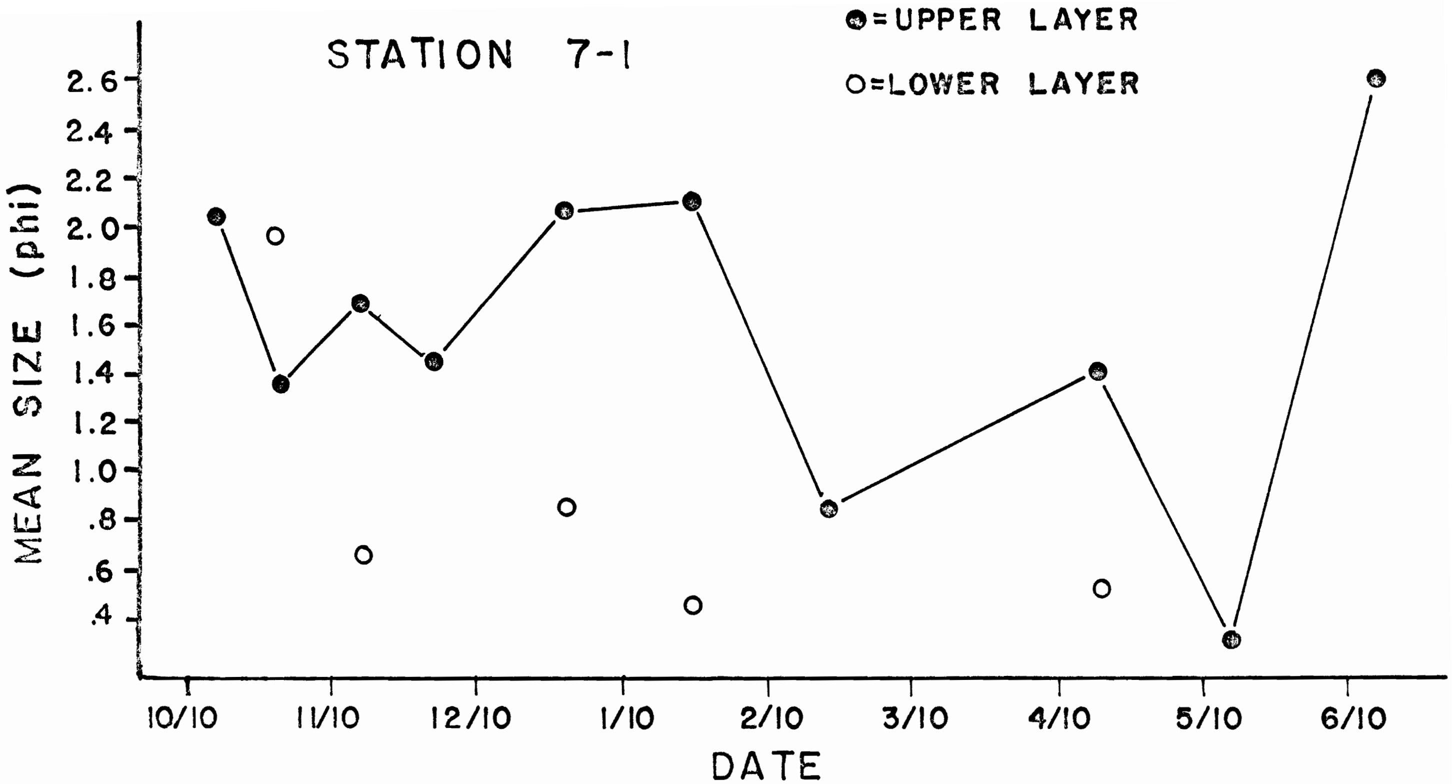


FIGURE 78. Change in surface sediment size with time at station 7-1

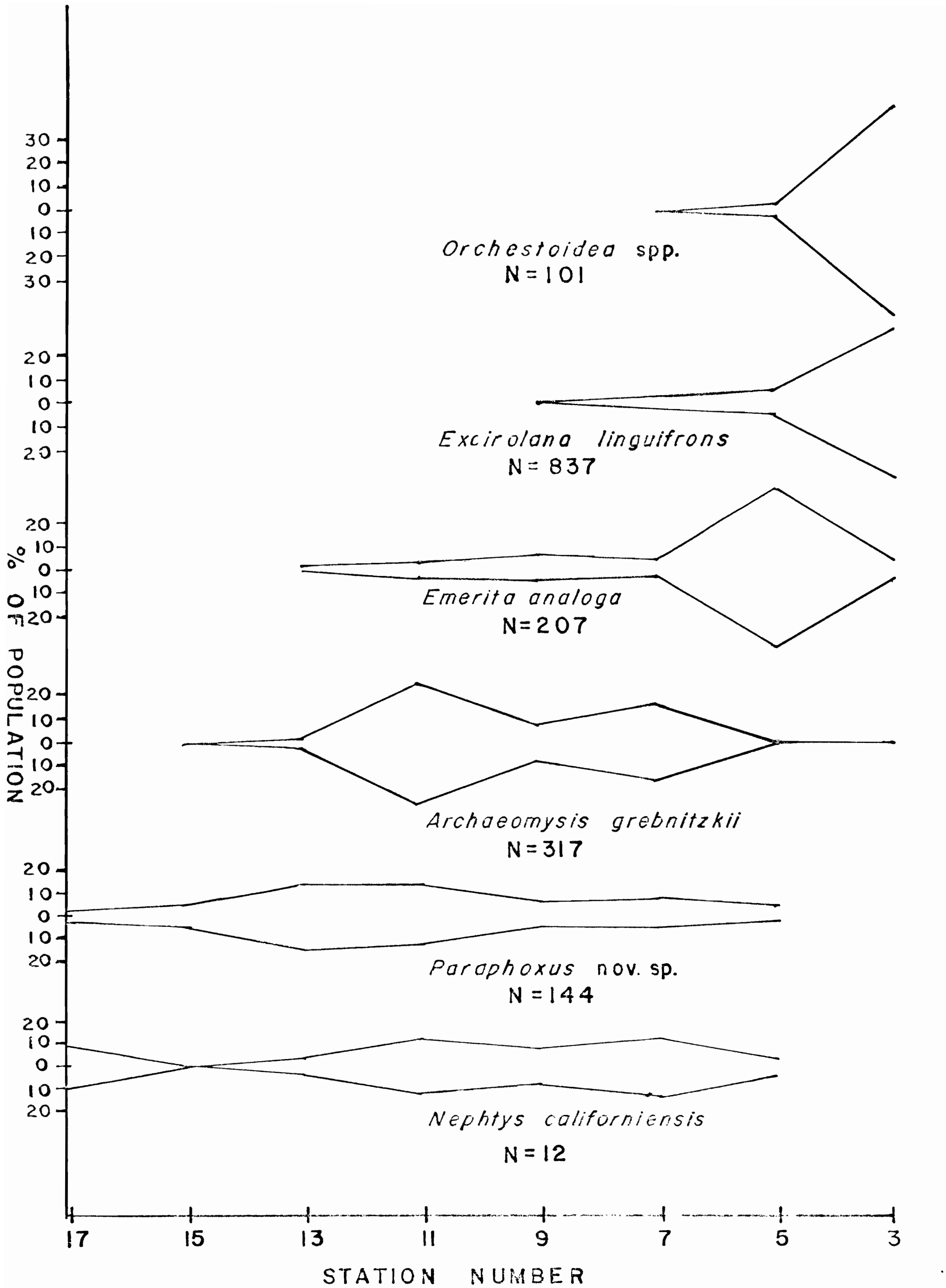


FIGURE 79. Abundance of dominant invertebrate species on Moss Landing Beach with respect to tide level and station number

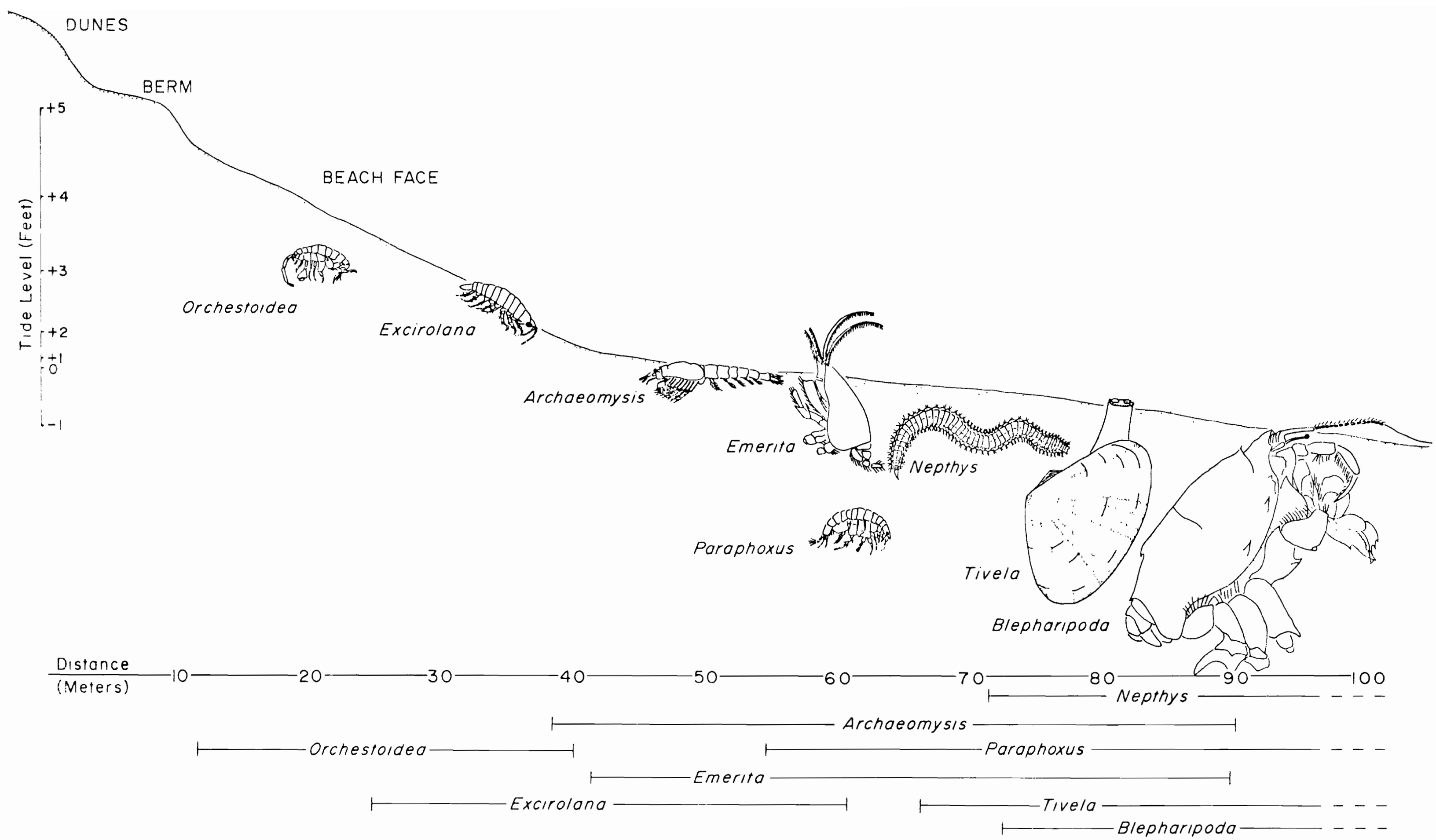


FIGURE 80. Diagrammatic representation of zonation of numerically-dominant invertebrate species on Moss Landing Beach

A regression of mean particle size against sorting coefficient yielded a correlation coefficient 'r' of .84, indicating that generally, the finer-sized sand was better sorted than the coarser sizes. This is what would be expected in the light of earlier studies by Handin (1951) and Trask and Johnson (1955) and appeared to result because the mechanics of motion of flow required to move the larger particles caused large variations in turbulence, which, in turn, presumably was a factor in causing a spread in grain size in the deposits (Inman, 1949).

E. Discussion

The gross zonation found on the Moss Landing Beach corresponds to the zonation advanced by Dahl (1952) to categorize European and South American beaches. In the highest zone (Dahl's "Talitrid-Ocypodid belt") is found the Talitrid amphipod genus _Orchestoidea_ (Figures 79 and 80). The relative numbers of individuals shown are probably not accurate, due to the great burrowing depth and the active escape from the sampling jars by individuals, but the zonation is probably correct. The next lower zone (Dahl's "Cirolana zone") centered on station 3 is dominated by the Cirolanid isopod _Excirolana linguifrons_ (Figures 79 and 80). _Excirolana linguifrons_ generally showed the highest density of the larger beach organisms, with densities approaching $800/m^2$ in the spring. Dahl (1952) lumped the rest of the beach animals together into a "sub-littoral fringe", but the Moss Landing Beach might be considered to have an '_Emerita_ zone' centered around the level of station 6. _Emerita analoga_ (Figure 79) was the only organism with a center of distribution in this area and it was consistently found there. The aggregations that usually characterize Emerita (Efford, 1965) were not apparent from our data, since it was necessary to sample horizontally along the beach to define the aggregations.

Paraphoxus nov. sp. and Archaeomysis grebnitzkii had distributions very similar to each other centered around the level of station 8 (Figures 79 and 80). The numbers of individuals varied greatly over time (Figures 76 and 77). Much of the variation may be due to reproductive cycles. Since both Paraphoxus and A. grebnitzkii brood their young in a marsupium, the release of young should have an immediate effect on population numbers. The peaks of Archaeomysis grebnitzkii on 12/28/75 and of the Paraphoxus nov. sp. and A. grebnitzkii on 2/26/76 were due to newly-released juveniles.

The published studies on burrowing depth have generally been done on beaches with much finer sediment sizes than occur on the Moss Landing Beach. Whether the coarse sediment sizes that occur at Moss Landing have an effect on the vertical distribution of animals within the sand is a matter for conjecture. Jones (1970), working with the cirolanid isopod genus Eurydice, found that they burrowed deepest in coarse grades of sand. Since it is well established that coarser sediments are disturbed to a greater depth by wave action than finer sand (King, 1959), it may be necessary for an organism to burrow deeper in coarse sand to avoid being washed away. Wave action also effects burrowing depth. Emerita analoga was found to move deeper into the sand during storms (Cubit, 1969). In the field, we have on several occasions observed E. analoga and Paraphoxus nov. sp. that had stopped burrowing at the interface between coarse and fine sand layers, supporting the supposition that burrowing depth may be effected by sediment size.

One major organism, Blepharipoda occidentalis, was not found at all in the top 5 cm, so would have been completely overlooked. Qualitative sampling that was being conducted concurrent to this study using a 2 mm mesh screen and a sampling depth of about 20 cm, gave a good idea of the zonation of Blepharipoda and hence, its inclusion on the zonation diagram (Figure 80).

Sediment size also effects vertical distribution on the beach. Sameoto (1969) working with haustoriid amphipods, Weiser (1956, 1959) with cumaceans and small macrofauna, Jones (1970) with isopods and Nybakken and Stephenson (1975) with Tivela stultorum, have all shown correlation between infaunal distribution and sediment size. It is also often observed that, since beach grain size is a function of wave action, the distribution attributed to sediment size may, in some cases, be just a reflection of an organisms's tolerance to wave action.

As was noted earlier, the laminations found in the sediment cores make correlation of sediment size with distribution difficult. Since two or three layers were often found in the top 5 cm of core, it cannot be stated in which layer(s) the animals were when captured. It appears that beach laminations can form in at least two different ways: (1) from changes in wave characteristics with subsequent changes in the depositional and erosional capabilities of the waves (Clifton, 1969) or (2) under constant wave conditions, changes in the water table increase or decrease the amount of water that percolates through the sand instead of returning in the backwash, thus changing the size of the particles that are deposited (Duncan, 1964). Laminations are well understood from a geological viewpoint in both intertidal and subtidal areas (Clifton, Hunter and Phillips, 1971), but there is apparently no biological work on the effects of laminations on the infauna.

Archaeomysis grebnitzkii and Excirolana linguifrons, since they were only found in the top 1 cm of sediment, can validly be compared to sediment size. The results are inconclusive. Archaeomysis grebnitzkii was found in sand from .9 to 2.3 phi and E. liquifrons in sand from .43 to 2.14 phi. The distributions of Nephtys californiensis and N. cirrosa have been found to be determined completely by sediment size (Clark and Haderlie, 1962). In our study, Nephtys californiensis was found to occur in well-sorted, fine-grained sand. However, not enough individuals were found and no other geographical areas were sampled, so it cannot be determined if this was only incidental to their occurrence in the low intertidal zone or whether distribution was actually determined by sediment size. Nephtys californiensis is known to move farther offshore in periods of rough weather (Oliver, et al, 1976), indicating wave action probably has an effect on their distribution.

If sediment size alone cannot be used to explain the distribution of animals on the beach, other factors must be considered. Food is a factor that could possibly limit distribution. While food is generally not a limiting factor on the beach (Dahl, 1952), the organisms might be clumped around their food source. A good example are the Orchestoidea spp., which are very active scavengers that eat beach-cast algae (Bowers, 1964). The Orchestoidea are found along the high-tide line where their food supply has accumulated. Emerita analoga, by contrast, feeds by using its antennae to filter plankton and ditritus out of the backwash of the waves. Since the filtering process is most efficient when large quantities of water are utilized, E. analoga is found in the swash zone, the area of greatest water movement (Ricketts, et al, 1968). Blepharipods occidentalis and Excirolana linguifrons are both scavengers that leave the sand to feed when immersed (Dahl, 1952). Their upper limits of distribution may be partially controlled by the amount of immersion time that they need to procure their food.

The predators, such as Nephtys californiensis (Clark, 1962) and Paraproxus nov. sp. (pers. data), would probably be found with their prey species, but without knowing the distribution of the prey, it was impossible to assess what effect prey distribution had on the predator. The whole subject of biological, as opposed to environmental, factors as regulators of distribution on the beach is poorly known. Work in the rocky intertidal has shown that the upper and lower limits of distribution of various animals are determined by biological factors such as competition, predation or symbiotic relationships (Connell, 1975). It is difficult to do ecological studies on sand beaches, due to the instability of the substrate and the mobility of the organisms. Future laboratory studies may shed some light on this area, but for now, inter- and intra-specific interactions remain nebulous and poorly known.

In summary, the fauna of the high-energy Moss Landing sand beach can be divided into four vertical zones, characterized by the dominant species. They are, from highest to lowest: (1) Orchestoidea zone; (2) Excirolana zone; (3) Emerita zone; and (4) sub-littoral fringe, containing a diverse fauna. Little can be said concerning the changes in relative abundance over time, due to sampling difficulties endemic to sand beaches, but changes in abundance did not appear to affect zonation.

F. Acknowledgements

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H. Appendix. Folk and Ward sediment size parameters for the sand beach.

Date Mo/day/year	Station	Mean	Median	Sorting	Skewness	Kurtosis
10/17/75	7-1	2.13	2.21	0.48	-0.25	1.04
	5-1	2.01	2.08	0.43	-0.20	1.05
10/31/75	3-1	1.61	1.62	0.66	-0.09	1.18
	3-1	-0.01	0.00	1.04	-0.01	0.99
	4-1	1.61	1.83	0.84	-0.34	0.81
	4-1	0.12	0.12	1.07	0.00	0.98
	5-1	1.95	2.03	0.49	-0.21	1.01
	5-1	0.95	1.00	1.02	-0.12	0.82
	6-1	1.26	1.52	1.04	-0.41	0.99
	7-1	1.31	1.47	0.83	-0.25	0.65
	7-1	2.03	2.12	0.48	-0.30	1.12
	7-1	0.62	0.28	1.12	0.31	0.65
11/01/75	8-1	2.29	2.29	0.34	-0.01	1.08
	8-1	0.62	0.58	1.27	-0.02	0.69
	8-1	1.89	2.07	0.76	-0.47	1.50
	9-1	1.30	1.90	1.20	-0.62	0.78
11/18/75	3-1	1.54	1.58	0.63	-0.07	1.01
	3-1	0.90	1.15	1.24	-0.25	0.85
	5-1	0.65	0.58	0.99	0.00	0.86
	5-1	1.71	1.78	0.46	-0.24	0.92
	7-1	1.71	1.72	0.44	-0.01	0.85
	7-1	1.28	1.57	0.96	-0.44	0.81
	7-1	0.65	0.60	1.25	0.00	0.64
12/01/75	3-1	1.41	1.55	0.70	-0.28	29.91
	5-1	1.78	1.82	0.42	-0.16	0.89
	7-1	1.37	1.60	0.83	-0.41	1.04
	13-4	2.33	2.38	0.39	-0.18	0.98

Folk and Ward sediment size parameters for the sand beach.

Date Mo/day/year	Station	Mean	Median	Sorting	Skewness	Kurtosis
12/28/75	3-1	1.88	1.97	0.44	-0.27	0.95
	5-1	2.08	2.12	0.38	-0.14	1.10
	5-1	0.90	0.84	0.97	0.06	0.88
	7-1	2.14	2.17	0.42	-0.11	1.39
	7-1	0.97	0.90	0.82	0.11	0.78
	9-1	1.08	1.05	0.81	0.02	0.75
	11-1	1.34	1.62	1.03	-0.43	0.93
01/26/76	3-1	1.90	1.98	0.46	-0.23	1.01
	7-1	2.16	2.28	0.66	-0.26	0.99
	7-1	0.48	0.45	0.97	0.04	0.98
02/26/76	7-1	0.91	0.92	0.98	-0.05	0.91
	7-1	2.20	2.20	0.43	0.02	0.97
	13-1	2.47	2.48	0.42	-0.01	1.02
04/19/76	3-1	1.40	1.48	0.62	-0.21	1.08
	7-1	0.55	0.50	0.99	0.03	0.96
05/17/76	7-1	0.35	0.40	1.27	-0.10	0.92
	5-1	0.43	0.43	0.66	0.01	1.00
	3-1	1.23	1.28	0.64	-0.13	1.08
06/15/76	3-1	1.35	1.47	0.73	-0.25	0.97
	7-1	2.64	2.66	0.33	-0.10	1.09

SPECIES COMPOSITION, ABUNDANCE AND ECOLOGICAL STUDIES OF FISHES, LARVAL FISHES, AND ZOOPLANKTON IN ELKHORN SLOUGH

Prepared by

Gregor M. Cailliet, Principal Investigator

Brooke Antrim, Graduate Assistant, Fish Investigations
David Ambrose, Graduate Assistant, Fish Investigations
Stephen Pace, Graduate Assistant, Zooplankton Investigations
Marty Stevenson, Graduate Assistant, Larval Fish Investigations

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SPECIES COMPOSITION, ABUNDANCE AND ECOLOGICAL STUDIES OF FISHES, LARVAL FISHES, AND ZOOPLANKTON IN ELKHORN SLOUGH

A. STATEMENT OF ORGANIZATION

For purposes of organization, this portion of the report will be divided into three sections, the first dealing with the fish and macroinvertebrate sampling program, the second with the sports-fishery studies, and the third with the larval fishes and zooplankton sampling program. Each of these sections will have its own introduction, materials and methods, and results and discussion sections, but the figures, tables and literature cited sections will be all combined at the end.

During this study, the aid of many people enabled us to complete tasks that would have otherwise been impossible. We would like to thank all the students at MLML who helped in our field investigations, especially M. E. Anderson, J. Appiah, J. Barry, J. Dykzeul, D. Grabost, R. Helm, M. Gordon, A. A. Ruagh, D. Streig, J. Trainer, and W. Wright. Also, C. Jong, P. Slattery, and S. J. Tanner helped immensely with prey item identification. Personnel at Tetra Tech, Inc. were very helpful in providing computer assistance in organizing and analyzing the large data base from this study and we appreciate their efforts very much.

B. FISH AND MACROINVERTEBRATE INVESTIGATIONS

1. Introduction

For the 23 months since August, 1974, we have been regularly sampling the fish fauna of Elkhorn Slough, a coastal tidally influenced embayment located in the center of Monterey Bay (Figure 1). The original objectives of this study were: (1) to provide information on the fish populations of Elkhorn Slough, (2) to determine seasonal changes in these populations, (3) to study the feeding habits and reproductive cycles of fish species utilizing the slough, (4) to relate feeding habits to food available, and (5) to collect comparable data from the shallow shelf near the opening of the slough in order to determine the interactions of fish populations between this area and the slough as well as the amount of "slough-dependence" exhibited by these fishes. In addition, information was gathered on the invertebrates captured during the fish sampling program.

This report will include a brief description of fish and macroinvertebrate sampling methods and a relatively detailed analysis of catch statistics from otter trawl and various other collections. Information on the tag and recapture studies, the feeding habit studies of the dominant slough fishes, and a discussion of reproductive activities of fishes in Elkhorn Slough will also be presented.

II. Methods

Collections were made frequently at four locations in Elkhorn Slough (Kirby Park, the dairies, the bridge, and Bennett Slough) and at two locations in the ocean, north and south of the harbor mouth (Figure 1, Table 1). A small otter trawl (16 foot headrope and 19 foot footrope, with $1\frac{1}{2}$" (#9) stretch mesh in the body and $1\frac{1}{4}$" (#15) stretch mesh with a $\frac{1}{2}$" stretch mesh liner in the codend) was towed behind a 16 foot Boston Whaler with a 40 H.P. Johnson outboard motor for 5 to 10 minutes, into the tidal flow (if any) at flood tide. Average speed of these tows was estimated to be between 3 and 4 knots and the distance towed was between 0.3 and 0.5 miles. All catch data were standardized to catch per ten minute tow.

The otter trawl was only useful in the main channel of the slough, where the water is deep and the channel sufficiently long. Since the trawl appeared to miss some species that were visually present, other sampling techniques were used on a more sporadic schedule. One of these, a small beach seine (approximately 30 m long with $\frac{1}{2}$" and $\frac{1}{4}$" stretch mesh) was used primarily in Bennett Slough (Figure 1, Table 1), which is a small, shallow embayment north of the harbor area. Another larger beach seine (approximately 80 m long with 1" stretch mesh in the body and $\frac{1}{2}$" stretch mesh in the purse) was used only six times (Table 1) and these data will not be reported here. A small monofilament gill net (30 m long, 2 m high, with two 5 m panels of 2", 1", and ½" stretch mesh each) was set between two anchors for 4 hours at the three Elkhorn Slough stations (Table 1). The gill net was used primarily to catch the smaller schooling fishes not adequately sampled by the otter trawl, such as silversides and herrings. These data will also not be presented here due to small sample size. Rather, a detailed analysis of the otter trawl and small beach seine samples will be presented.

Once a collection was made, all species of fishes and macroinvertebrates were identified and counted. A subsample of approximately 20 of each species of fish was preserved, when available, for stomach content analysis and reproductive studies. In addition, fish that appeared healthy were measured, tagged, and released. The remainder of the catch was counted and measured for size frequency analysis.

All catch statistics were standardized to 10 minute tows, so that they could be compared on a seasonal and locational basis. Catch statistics were calculated to express abundance both as mean numbers (Figures 3, 9, 15, and 21) and as mean weight (in grams) of fishes per 10 minute tow. For this latter calculation, since not all fish were weighed but all were measured, a length weight regression was calculated for each species and a weight could be estimated using the length data. These individual species weights were then combined for each tow, by season, and by location (Figures 4, 10, 16, and 22) to show trends in biomass. All fish species collected were tabulated at each station and their numerical abundances, expressed as mean number per 10 minute tow (with standard deviation), are presented in tabular form (Tables 3 - 7). Also given are the overall mean abundances and ranks of these species, along with monthly information on fishing effort and total number of species and individuals caught. To understand the minimum number of tows necessary to adequately represent the species composition, a cumulative species curve was plotted against the number of tows (Figure 2). The dairies station was chosen to best represent the slough environment and the months (May - October, 1975 and 1976) were used because they had the highest number of species and this would give the most conservative estimate of sufficient sample number. The macroinvertebrate catch data are presented as total number of individuals caught at each station over the entire sampling period (Table 8).

Several indices of diversity were calculated for fishes from the different stations over the year. Diversity was estimated by calculating the mean number of species per tow (Figures 5, 11, 17, and 23), and by calculating the information function:

$$H' = -\Sigma P_i \ln P_i$$

where $P_i = n_i/N$ (Shannon and Weaver, 1963) (Figures 6, 12, 18, and 24). An estimate of evenness was obtained using:

$$J' = \frac{H'}{H'_{max}}$$

after Pielou (1969) (Figures 7, 13, 19, and 25). An estimate of the extent that one (or a few) species dominated the collections was calculated as:

$$D = \Sigma P_i^2$$

after Odum (1971) (Figures 8, 14, 20, and 26).

Means of these values, with their standard errors, were plotted on a monthly basis to see if seasonal trends could be detected (Figures 3 - 26).

To assess migration patterns, slough dependences, and possibly population densities of common fishes in Elkhorn Slough, fishes that were healthy were tagged with serially numbered internal anchor tags (Floy Tag and Mfg. Co.), having the address of MLML on them and released (Table 9). At the time of release, their condition was subjectively evaluated as good (swam strongly), fair (swam away after a short period), and poor (struggled considerably). All fishes recaptured either by our trawling activities or by fishermen who happened to catch them were recorded and measured. To encourage fishermen to return tagged fish, posters were distributed all over the Moss Landing and Castroville area.

Fishes removed for feeding habit analysis were returned to the laboratory and fixed in 10% formalin, and then stored in specimen jars until time was available to enumerate the contents in the stomach. Stomachs were removed, and with contents intact the fullness of the gut was subjectively scored as 0 = empty; 1 = 25%; 2 = 50%; 3 = 75%; and 4 = 100% full. State of digestion was scored as 1 = very finely digested, nothing recognizable; 2 = medium digestion, some recognizable parts; 3 = some digestion, some undigested material; and 4 = undigested, whole animals. The contents were then removed, identified to the lowest possible taxa (we depended strongly upon the benthic invertebrate group for this), measured with an ocular micrometer, and counted. The percent volume contribution of each prey group was subjectively estimated. Any intestinal parasites were identified, counted and measured. The Index of Relative Importance of each prey item was estimated for food-containing fish as a linear combination of its numerical and volumetric importance and frequency of occurrence (Pinkas, et al., 1971). The numerical importance of a particular item was the percentage ratio of its abundance to the total abundance of all items in the contents. Its volumetric importance was its average percent volume. Its percent frequency of occurrence was the percentage of fish containing at least on individual. The combination equaled, in percents, (number + volume) x (frequency). The IRI ranks the relative importance of dietary items.

Prey composition was analyzed only for those species of fish that were numerically abundant. Therefore, feeding habits will be presented for *Leptocottus armatus* and for fishes of the families Atherinidae, Embiotocidae, Bothidae, and Pleuronectidae (Tables 10 - 23). Elasmobranchs were not studied since they were inadequately sampled by our gear and were the subject of prior research (MacGinitie, 1935; Russo, 1975; Talent, 1973 a, b).

Gonads of some of the preserved fish were removed, measured and histologically analyzed for sex and gonad maturation stage. In addition, qualitative observations were used to assess which species of fish undergo part or all of their reproductive activities in Elkhorn Slough.

III. Results and Discussion

a. Fish and Macroinvertebrate Samples

During the two year study period, a total of 322 samples were taken at five stations in and around Elkhorn Slough (Table 1). Of these, 229 were with the small otter trawl, 14 were with a small gill net, and 79 were either with the small or large beach seine. All collections in Bennett Slough were taken with the small beach seine, while most of those in Elkhorn Slough proper were with the otter trawl. These otter trawl collections most comprehensively represent the period sampled during this survey.

A total of 81 species of fishes were captured in these collections and by shore fishermen (Table 2). Not included in this number are the categories of fish eggs or young rockfishes, which may or may not change the total number of species captured. This is a larger number of species than the 64 reported by Kukowski (1972) or the 75 species listed by Browning (1972). However, it must be noted that some of the increase is due to the extent of our sampling program and the pier and jetty environment at the head of the slough, which attracts fishes that can be more easily caught by our nets and by shorefishermen.

In all, 19,518 fish were caught at the five regularly sampled stations using otter trawls and the small beach seine (Tables 3 - 7), indicating that Elkhorn Slough has a very abundant fish fauna. In general, the bridge station had the highest abundance of fishes, with a mean density of 209.3 fish per ten minute tow (standard error = 82.4), while the ocean station consistently had the lowest densities (12.5 fish per tow, S.E. = 1.6). The other two stations were intermediate in fish abundance, with the dairies having an overall mean of 66.2 (S.E. = 2.0) and Kirby Park yielding 77.7 (S.E. = 15.3).

Likewise, the bridge station had the highest overall mean number of species per tow (9.0, S.E. = 1.0), when compared to the dairies (5.4, S.E. 0.5), Kirby Park (4.5, S.E. = 0.6), and the ocean station (2.2, S.E. = 0.3). It appears that the bridge station benefited from the attraction that rocks and pier pilings have for shore fishes, thus accounting for the occurrence of "non-slough" fishes that would not otherwise be there, thus increasing the number and types of fish available in that area (see Table 5).

The cumulative species curve for the dairies begins to level off at around six tows, suggesting that this number adequately assesses at least the dominant or important species of fishes (Figure 2) for the slough environment. Since many more tows than this were taken at each station and usually during each season, a comparison of the overall fish species composition can be made to detect differences in the various stations over time.

Fewer individuals (949) were taken by otter trawls at the ocean station than at any other station even though many more tows (76) were taken. The number of species (35), however, was comparable to all but the Kirby Park station. In most months, the number of species captured was under 10, with the exception of the summer months (Table 3). One of the dominant species at the ocean station, Psettichthys melanostictus, was never caught in the four slough stations. The other dominants were Citharichthys stigmaeus, Hyperprosopon argenteum, Pleuronichthys decurrens, Platichthys stellatus, Phanerodon furcatus, and Amphistichus argenteus. Catch rates over the year were so low that the towing was increased from 5 to 10 minutes to raise the probability of a larger catch. In March, we used a larger otter trawl (26 foot headrope) and caught more individuals and slightly more species. Since this larger trawl did not increase our catch significantly, and since we had been using the small trawl consistently for over a year, we continued to use the smaller trawl and attempted to increase our sample size each month.

The catch data for Bennett Slough (using the small seine) showed a relatively low number of species (20) from 74 seines, but a high number of individuals (949, Table 4). Since the seine was used it is not valid to compare the catch rates for Bennett Slough with other slough stations, however, it is likely that the seines captured most species occupying Bennett Slough and gave at least an idea of the relative abundance of the fish fauna inhabiting that location. It is notable that several of the species caught in Bennett Slough, Acanthogobius flavimanus, Clevelandia ios, and Gasterosteus aculeatus, were not caught at any other station in the slough. In addition Syngnathus leptorhynchus-griseolineatus was much more abundant in Bennett Slough (Table 4) than at any of the other stations (Tables 3, 5, 6, 7). It is possible that some of these are excluded from the main slough otter trawl catches due to mesh size. The dominant fishes caught in Bennett Slough were Clevelandia ios, Leptocottus armatus, Platichthys stellatus, Atherinops affinis, and Embiotoca jacksoni. Porichthys notatus is a seasonal visitor as a spawning adult or newly recruited juvenile. The majority of these fishes are also quite common in the rest of Elkhorn Slough, and it appears from the catch rates of the individual dominant species that most of them are present abundantly all year.

In the 35 tows taken at the bridge station, 7, 326 individuals comprised of 38 species were captured (Table 5). The November 1974 catch was from only one very productive night haul taken during an intense and prolonged red tide. This one tow captured 1,414 individuals of 17 species, most of which (1,208) were *Cymatogaster aggregata*. If this haul is not included, the mean number of fishes per five minute tow reduces to only 66.9 ($\pm$ 148.0). Nevertheless, the bridge station consistently produced the highest abundance and usually the most species. One of the possible reasons for this, already considered, is the availability of diverse substrate such as the bridge pilings and other rocky debris. Species that would be more typically found in rocky areas are *Artedius harringtoni*, *Coryphopterus nicholsii*, *Hexagrammos decagrammus*, *Hypsurus caryi*, *Neoclinus uninotatus*, *Ophiodon elongatus*, *Scorpaenichthys marmoratus*, and juvenile *Sebaste*s, especially *S. auriculatus*, *S. mystinus*, *S. paucispinis* and *S. rastrelliger*. It is also possible that there was some effect of the Pacific Gas and Electric Company's outfall, which discharges heated water into slough waters near there, but this cannot be adequately evaluated. The regular dominant species of slough fishes still headed the list when ranked in order of mean abundance per ten minute tow. These were *Cymatogaster aggregata*, *Phanerodon furcatus*, *Embiotoca jacksoni*, *Citharichthys stigmaeus*, *Parophrys vetulus*, *Platichthys stellatus*, *Scorpaenichthys marmoratus*, and *Leptocottus armatus*. Of these, the presence of *S. marmoratus* is probably related to the available rocky substrate. *Citharichthys stigmaeus* is probably there (and at the dairies, Figure 6) since the station is closer to the shallow ocean coastline where they are abundant and the sediment is probably more similar to their ocean habitat. It should be noted that sanddabs were not collected in large abundance at Kirby Park (Table 7).

The 38 species caught in 49 tows at the dairies were represented by 3,245 individuals (Table 6). This station, along with the bridge, had the most species collected. Commonly abundant species were Cymatogaster aggregata, Phanerodon furcatus, Embiotoca jacksoni, Citharichthys stigmaeus, Parophrys vetulus, and Platichthys stellatus. The top six species were present all year around, but the other fishes in the top ranks were more irregularly abundant. The seventh ranked fish, Clupea harengus pallasii, was only captured in two months, but in such large numbers that it ranked highly overall. Parophrys vetulus were mostly juveniles captured during the spring and Porichthys notatus were mostly juveniles that probably recently hatched from egg masses. Sebastes auriculatus, which ranked eighth, were juveniles that were caught in abundance only once. The mean number of fish per ten minute tow did not vary much over the year, and the fishes ranking highly appear to be representative of the fish fauna of the slough environment. The six top ranking species at this station are the same as for the bridge (see Table 5).

There were 3,803 specimens of 26 species of fishes caught during the 23 month period in 49 otter trawl tows at the Kirby Park station (Table 7). The consistently present species were Cymatogaster aggregata, Leptocottus armatus, Platichthys stellatus, Embiotoca jacksoni, Phanerodon furcatus, and young Myliobatis californica. There was a noticeable drop in the abundance of these species during the winter months. Species that had high ranks but that were distinctly seasonal in their abundance were Parophrys vetulus, Engraulis mordax, and Clupea harengus pallasii. The high abundances of Parophrys vetulus were due to large numbers of juveniles during the spring months and those of Clupea harengus pallasii occurred a bit earlier and appeared to correlate with their known time of spawning on eelgrass in shore waters (Miller and Schmidtke, 1956).

Incidental catches of invertebrates yielded 55 species, several of which had not been sampled in the benthic cores (Table 8). The tows at the ocean station yielded the highest number of invertebrate species (31) with the dairies and bridge the next two highest. Two crustacean shrimp Crangon nigricauda and C. nigromaculata and one decapod crab Hemigrapsus oregonensis, were the predominant species of invertebrates captured in otter trawl tows.

Species composition, especially of the dominants, was most similar between the dairies and the bridge and least similar between any of the slough stations (dairies, bridge or Kirby Park) and the ocean station (see Tables 3 - 7). Kirby Park had few species not found elsewhere, and therefore it is apparently dependent on other and adjacent areas for its species. Another interpretation would be that few species can be successful at the inland end of the slough. Additionally, few of the species from Kirby Park also occurred at the ocean station. The bridge and the dairies were the most similar, and the ocean station was very dissimilar when compared to any of the slough stations.

Seasonal variation in fish abundance was high, but at most stations a noticeable depression in mean number of fish per tow during the winter months occurred (Figures 3, 9, 15, 21), with the exception of the bridge station which appeared to have similar abundances all year (Figure 9). The exceptionally high peak during November at the bridge station was from one tow at night during an intensive red tide, and was almost entirely composed of the shiner perch, *Cymatogaster aggregata*. Night collections such as these should probably be evaluated separately. Also, the lack of standard errors around most of the means reflects the small sample number during each month, a result of the consistently high catches there (see Table 5). Again, it is obvious that the ocean catches were always low (the abundance coordinate is 1/10 that of the other stations and the highest catch per tow was near the lowest for the other stations).

A similar trend was evident when the mean weight of fishes per ten minute tow was plotted against season, except that there was considerably more variability in the curves (Figures 4, 10, 16, 22). Thus it appears, despite the fact that the decline in abundance of fish during winter months does not take into account the average size of the fishes considered, that this seasonal change is real in terms of biomass as well. It is also interesting to note that these winter declines in fish abundance occurred during a year with relatively normal rainfall (1974 - 1975) and one in which virtually no rainfall occurred at all (1975 - 1976). There are a couple of unusual declines in the seasonal biomass curves, at the ocean station (Figure 4) and at the bridge (Figure 5), during the months following the steep increase after the winter decline in both years. It is difficult to imagine a reason for this, even when one looks at the species composition data (Tables 3 and 5).

In the seasonal plots of mean number of species per tow (Figures 5, 11, 17, 23) and diversity index (Figures 6, 12, 18, 24) there was, again, a strong decline during the winter months indicating that the trends for abundances of fish are paralleled by a lack of species during the winter. This was primarily due to species richness, since these two indices behave similarily and the evenness index (J') did not show any trends (Figures 7, 13, 19, 25). Much of the increase in diversity at Kirby Park during the spring and summer was due to additional species that entered the slough as juveniles, such as juvenile rockfishes and young English sole (*Parophrys vetulus*). The winter decline in diversity was altered at the bridge station during November 1974 and it appears that this was due to the extensive red tide during that time and that it was all based on one night tow. The dominant species was the shiner perch *Cymatogaster aggregata*, but 17 species total were taken in that tow (Table 5), thus increasing the diversity indices considerably. Otherwise, it appears that the fish fauna at the bridge also declined in diversity during the winter months (Figure 11). The ocean station, even though it has fewer species to begin with, also showed this winter decline in diversity (Figure 5). The increase in diversity during March 1975 might be attributed to the use of the larger trawl rather than a real increase in diversity. However, since all the subsequent samples were taken with the normal, smaller trawl, and the diversity still holds up, it appears that this spring increase in diversity is a real occurrence, at the ocean station and at stations within the slough.

Mean dominance indices, which measure the amount that one species numerically dominates an assemblage and therefore is similar to but the reverse of the evenness index, behaved so that no seasonal trends could be delineated, despite the fact that they appeared to be highly variable among seasons for all stations (Figures 8, 14, 20, and 26). This, again, is an indication that the seasonal trends obvious in the species richness indices are due to the addition of more species before and after the winter season rather than to a shift in proportion of individuals among species.

b. Fish Tagging Studies

In all, 2,285 fish from 24 species have been tagged in Elkhorn Slough and the ocean (Table 9). To date, 135 have been recovered, all close to where they were originally captured, tagged and released. Nine of the 419 tagged Embiotoca jacksoni have been returned and 76 of the 1051 tagged Platichthys stellatus have been returned, about half from fishermen and most of the other half from our seining activities in Bennett Slough. Only one of the 165 tagged Leptocottus armatus, while 2 of the tagged Scorpaenichthys marmoratus have been returned, both from fishermen. We have experienced difficulty in tagging the extremely small fishes, and apparently there is a high mortality associated with catching, measuring, handling, and tagging these fishes. Our best luck has been with the heartier fishes such as Platichthys stellatus, Embiotoca jacksoni, Phanerodon furcatus, and Leptocottus armatus. Unfortunately, one of the most abundant fish, Cymatogaster aggregata, is not a good tagging candidate, due to its small size and the low probablility of its recapture by fishermen (see Table 24), except at Skipper's. Some preliminary results on laboratory maintenance of tagged fish indicate that the tagging procedure itself does not kill many specimens. However, it may reduce the ability of a tagged fish to survive in the water.

The majority of the tag returns were from the Bennett Slough location (Table 9), and this is probably due to the large sport fishing effort at that location, the fact that it is a small, enclosed embayment, and the intense sampling with beach seines we have done. The next highest return area was the bridge station, a passage for any fish entering or leaving the slough and also a site of intense fishing (Skipper's, see Table 24). Also, more fish have been tagged at both of these stations than elsewhere. Due to the scarcity of fishes at the ocean station, only 41 fish were tagged from there, thus making estimates of slough-dependence very difficult.

In general, the proportion of returned tags to tags at large is very small, indicating either loss of tagged fish or an extremely abundant fish fauna. It is interesting to note that, despite the intense fishing at the two recent shark derbies, not one tagged fish or elasmobranch was captured. It appears that the number of fishes in Elkhorn Slough is sufficiently large to prevent a large proportion of our tagged fish to be recaptured. It also appears that little migration has occurred out of Elkhorn Slough since only 2 tagged individuals have been recaptured elsewhere in the bay.

c. Fish Reproductive Habits

At present, we have information that indicates several species depend upon the slough for a nursery ground. Large numbers of juvenile English sole, *Parophrys vetulus*, have been found at all stations during the spring months and it appears that the young of this species find conducive conditions in Elkhorn Slough (Smith and Nitsos, 1969; Ambrose, 1976). Also, spawning adult *Porichthys notatus* were found during the spring months at Kirby Park and in Bennett Slough, and their young have been found in large numbers, especially in the relatively protected areas like

Bennett Slough (Tables 4 - 7). At least seven species of embiotocids bear live young in the slough, and these are among the dominant species occurring all year such as *Cymatogaster aggregata* (Bane and Robinson, 1970), *Phanerodon furcatus* (Banerjee, 1971), and *Embiotoca jacksoni* (Isaacson and Isaacson, 1966). Several species of elasmobranchs also bear live young in Elkhorn Slough (Talent, 1973a), and these are known to be regular occupants of these waters (Talent, 1973b). Young of *Citharichthys stigmaeus* are often common in catches, especially near the mouth of the slough. Juvenile rockfishes often occur in very large numbers in Elkhorn Slough waters, especially at the bridge and dairies (Tables 5, 6). We have collected egg masses of the herring (*Clupea harengus pallasii*) and the two silversides, *Atherinops affinis* and *Atherinopsis californiensis* (Ruagh, 1976), but their abundances are nowhere near those found for herring in Tomales Bay (Hardwick, 1973).

d. Fish Feeding Habit Analysis

Out of over 19,000 fishes caught using otter trawls, beach seines and gill nets over the two year study period, 1,913 individuals from five families have been dissected for stomach contents and analyzed. These five families were chosen because they comprise the majority of the teleostean fish fauna in the slough system. The results of these feeding habit studies will be presented by family.

1. Atherinidae

Although members of this family were poorly represented in our otter trawl collections, they are important members of the Elkhorn Slough fish fauna, as indicated by their abundance in gill net collections (Ruagh, 1976). From this family, 605 individuals of two species were analyzed.

Atherinopsis californiensis (the jacksmelt) from Skipper's had euphausiids as the most abundant food item (Table 10). The diatoms *Gyrosigma* spp., the algae *Enteromorpha* spp., Naviculoideae, and *Melosira moniliformis* played a minor role in the diet. A larger variety of food items were eaten by *Atherinops affinis* (the topsmelt) at Skipper's. The most abundant food items were cyclopoid copepods, euphausiids, calanoid copepods, and *Melosira moniliformis*. Other food items, such as *Pleurosigma* spp., ostracods, Naviculoideae, *Gyrosigma* spp., *Ectocarpales* spp., and cypris larvae were moderately important.

The most abundant jacksmelt food items at the bridge station were *Ulva lactuca*, jacksmelt eggs, *Enteromorpha* spp., *Schizonema* spp., and *Melosira moniliformis* (Table 11). Less important food items at this station were Naviculoideae and zoea larvae. The topsmelt here ate mostly ostracods, Naviculoideae, Foraminifera, *Navicula distans* and *Schizonema* spp., and calanoid and harpacticoid copepods. The less important food items in the topsmelt diet at this station were nematodes, *Melosira moniliformis*, *Pleurosigma* spp., *Enteromorpha* spp., and the amphipods, *Anisogrammarus confervicolus*.

The most abundant food items in the jacksmelt diet at the dairies were Melosira moniliformis and Enteromorpha spp. (Table 12). Calanoid copepods and jacksmelt eggs were only minor items. In the topsmelt diet, the most abundant food items were Gyrosigma spp., harpacticoid copepods, Melosira moniliformis, and Naviculoideae. A less important food item was Enteromorpha.

The most abundant jacksmelt food items at Kirby Park were Melosira moniliformis and Enteromorpha spp. (Table 13). Jacksmelt eggs were of moderate importance. For topsmelt, Enteromorpha intestinalis, nematoda, and Melosira moniliformis formed the dominant food, while other prey items were less important.

2. Embiotocidae

Stomach contents of eight species of Embiotocids were examined from the Elkhorn Slough study area. They were Cymatogaster aggregata, Phanerodon furcatus, Embiotoca jacksoni, Damalichthys vacca, Hyperprosopon argenteum, H. anale, Micrometrus minimus, and Amphistichus argenteus.

At the ocean station, a shallow sandy surf area, three species occurred often enough to warrant stomach content analysis (Table 15). Hyperprosopon anale (N=16) proved to be predominantly a pelagic crustacean feeder. Although digested material ranked first in the I.R.I.'s, crab megalops comprised 18% of the diet followed by unidentified mysids, crab zoea, Calanus pacificus, and small fish fragments. An examination of the stomachs (N=10) of Amphistichus argenteus indicates a benthic life style. Digested material was accorded the highest I.R.I. ranking. The relatively high contribution to the diet of two amphipods, Atylus tridens and Monoculodes spinipes which ranked second and fourth respectively, is notable since other authors have not reported amphipods to be an important part of the diet (Carlisle et al., 1960; DeMartini, 1969; Stephens et al., 1957). This, however, could be an artifact of the small sample size. Dendraster excentricus fragments were also found and ranked third among the prey items. Another unusual feature was the relatively low ranking of Emerita analoga, the anomuran sand crab, which the previous authors all listed as the primary dietary constituent. An extremely small sample of Phanerodon furcatus (N=2), indicated that they fed on bivalves.

At the bridge station, the stomach contents of six species were studied (Tables 16 and 17). Phanerodon furcatus (N=51) had a rather diverse diet. Digested material ranked first due to its high percent by volume and common occurrence. Caprella spp. (a combination of three species: C. californica, C. mendax, and C. equilibra) was second in I.R.I. rankings followed by unidentifiable bivalve fragments, unidentifiable polychaete fragments, the gammarid amphipod Corophium spp., and other unidentifiable amphipod fragments. Cymatogaster aggregata (N=35), which was the dominant fish caught at all three slough stations (the bridge, dairies, and Kirby Park), clearly demonstrated its tendency to eat epifaunal organisms similar to observations by Bane and Robinson (1970) in upper Newport Bay and Odenweller (1975) for Seal Beach. The polychaete Armandia brevis and unidentified harpacticoid copepods were the two highly dominant prey items, aside from digested material. The diet of Embiotoca jacksoni (N=31) at the bridge was also dominated by digested material. Unidentifiable polychaete fragments ranked second, followed by Caprella spp., unidentifiable amphipod fragments, Aoroides columbiae, and Corophium spp. (Table 16). Hyperprosopon argenteum (N=16) at the bridge fed primarily upon gastropods, bivalves, and Protothaca spp. (Table 17). Amphipods and polychaetes were of minor significance. Two other species were studied, but very few individuals were dissected. Micrometrus minimus (N=4) ate mostly amphipods, while Damalichthys vacca (N=4) ate mostly molluscs and some amphipods.

At the dairies, four species of surfperches were studied (Table 18). In Phanerodon furcatus (N=23) digested material ranked first in I.R.I. standings, followed by 6 unidentifiable polychaete fragments, Corophium spp., unidentifiable amphipod fragments, and Atherinopsis californiensis eggs. Cymatogaster aggregata (N=16) stomachs also had much digested material. However, harpacticoid copepods comprised a major part of the diet, while polychaetes were of minor significance. Damalichthys vacca (N=8) consumed primarily decapod crabs, fish eggs, and bivalve molluscs, while Embiotoca jacksoni (N=7) ate a wide variety of items, including decapods, bivalve molluscs, and polychaete worms.

At Kirby Park the diets of three species were studied (Table 19). C. aggregata (N=108) fed predominantly on a very abundant gammarid amphipod *Corophium* spp., which comprised 53% by number of the total diet and was found in 84% of the stomachs examined. This was supplemented by a spionid polychaete *Streblospio benedicti*, unidentifiable harpacticoids, and by a cumacean, *Cyclaspis* sp. *Embiotoca jacksoni* (N=18) at Kirby Park heavily utilized *Corophium* as a primary food source, although it should be noted that the number of stomachs examined was small. *Hemigrapsus oregonensis* also contributed a relatively significant portion of the diet being found in 28% of the stomachs examined. *Phanerodon furcatus* (N=9), a relatively rare fish at Kirby Park, fed on an altogether different aggregation of prey items than the other species at that station. Unidentifiable decapods (probably *H. oregonensis*) ranked second behind digested material, followed by bivalve shell fragments, *Atherinopsis californiensis* eggs, the pelecypod *Gemma gemma*, and two amphipods, *Corophium* spp., and *Aoroides columbiae*.

3. *Leptocottus armatus*

Individuals of *Leptocottus armatus* (N=44) lumped together from all stations fed primarily on *Hemigrapsus oregonensis* and *Anisogrammarus confervicolus*, indicating that it tended to be a top predator (Jones, 1962), despite its small size (Table 14). The remainder of its diet included digested material, unidentified fish, *Corophium*, *Enteromorpha*, and clam siphons.

4. Pleuronectiformes

Stomach contents of the four most common species of Pleuronectiform fishes were examined from the Elkhorn Slough study, including Citharichthys stigmaeus (Bothidae) and Parophrys vetulus, Platichthys stellatus, and Psettichthys melanostictus (Pleuronectidae).

At the ocean station, all four species occurred in sufficient number to warrant stomach content analysis (Table 20). Platichthys stellatus (N=28) ate primarily Pinnixia franciscana, Siliqua sp., Nothria elegans, Cancer magister, and Dendraster excentricus. The English sole, Parophrys vetulus (N=43) consumed Prionospio pygmaeus, Armandia brevis, Euphilomedes carcharodonta, Synchelidium spp., Capitella capitata, and Monoculoides spp., indicating primarily an amphipod and polychaete diet. Citharichthys stigmaeus (N=97) a crustacean feeder, ate primarily Acanthomysis davisii, Atylus tridens, and Scleroplax granulata. The fourth species, Psettichthys melanostictus (N=55), fed mostly on mysids when young and on fish when adult.

The bridge station had three species of flatfish occur abundantly enough for feeding habit analysis (Table 21). The smaller starry flounders (Platichthys stellatus) (N=17) ate primarily small bivalve siphons, while the larger individuals (N=53) ate Urechis caupo, whole bivalves and large bivalve siphons such as Tresus nuttallii, and the mudcrab Hemigrapsus oregonensis indicating a change in feeding habits with size (Orcutt, 1950; Ambrose, 1976). Parophrys vetulus (N=112) fed mostly on small bivalve siphons, small polychaetes such as Armandia brevis and Capitella capitata, Notomastus tenuis and Streblospio benedicti, and the amphipod Aoroides columbiae. Citharichthys stigmaeus (N=177) fed mainly on the polychaete Armandia brevis and the gammarid amphipod Aoroides columbiae and the caprellid amphipod Caprella californica.

At the dairies, the same three species of flatfish occurred (Table 22), and were studied for prey composition. Small individual starry flounders (N=32) ate small bivalves, the polychaetes Armandia brevis, Streblospio benedicti and the amphipod Aoroides columbiae, and small bivalve siphons, mostly from Macoma spp. Large individuals (N=27) consumed Saxidomus nuttalli siphons, whole Macoma spp., Hemigrapsus oregonensis, and some Urechis caupo. Parophrys vetulus (N=52) fed on similar bivalve siphons, polychaetes, and amphipods as at the bridge station. Citharichthys stigmaeus (N=65) had a diet dominated by the amphipod Aoroides columbiae and bivalve siphons, while Streblospio benedicti and Armandia brevis were also consumed.

Only two species of flatfishes were common at the Kirby Park station (Table 23). The starry flounders (N=83) here were smaller than at the other stations, and ate primarily Streblospio benedicti, bivalve siphons, Corophium spp., and Ammonia beccarii; whereas the larger starry flounders (N=83) once again consumed prey items such as larger bivalve siphons, Gemma gemma, the amphipod Corophium spp., the polychaete Streblospio benedicti and Capitella capitata. The only other species of flatfish, Parophrys vetulus (N=50), fed on Streblospio benedicti, bivalve siphons, Corophium spp. and Cyclaspis sp.

C. SPORTSFISHERY STUDIES IN ELKHORN SLOUGH

I. Introduction

In order to fully understand the processes regulating the abundance and distribution of fishes in the slough environment, it is desirable to have an estimate of the mortality caused by fishing upon the various species of fishes subject to sportfishermen. Since these data are relatively easy to come by, and also provide a separate assessment of fish species composition from the kinds of gear we employed in the first part of our study, we have been performing creel censuses at several sites on the slough to determine which species of fishes are caught by fishermen, and when and where the fish are more susceptible to this fishing pressure.

II. Methods

From July 1974 through June 1976, regular visits were made to five separate fishing locations on or near Elkhorn Slough (Figure 27). These sites, the north and south jetties, Skipper's dock, Bennett Slough, and Kirby Park, were chosen because they appeared to be the most often used areas for shore-fishing. It was beyond the scope of this study to assess the fishing intensity of skiff fishermen, however casual observations indicate that skiff fishery activity was very low, when compared to shore fishing. One possible exception to this statement would be the fishing activity associated with the shark derbies held every summer, an event that has been well documented in the literature (Herald et al., 1969).

Creel censuses were used to estimate angler effort and efficiency at these five slough locations at approximately weekly intervals. During a census, all fishermen at the particular location were asked the number of hours he or she had been fishing and what kind of bait used. The fish that had been captured were then sorted, identified, and measured. These data were later used to calculate the number of angler hours per census visit (an estimate of fishing intensity), and the mean number of fish caught per angler hour (an estimate of catch per unit effort), for each location over the entire two year period. In addition, species composition of the angler catch by location and season were tabulated, resulting in a list of species ranked by their relative abundance in the catch (see Table 24). To detect possible seasonal changes in the dominant fish appearing in the angler catch, the percent frequency by number of the dominant sportfish was plotted on a quarterly basis (Figures 39 and 40).

In order to assess the relevance of our subsamples, that is a creel census taken during the morning hours in winter versus one taken during the afternoon in the summer, we decided to intensively sample entire daylight periods at four locations (Bennett Slough, the north and south jetties, and Skipper's dock) for fishing activity. Instead of using the number of angler hours, which could overlap if the same fisherman was reinterviewed several times, we used the actual number of lines in the water at hourly intervals over several days at each location to obtain an estimate of fishing effort during a daily period (see Figures 28 and 29).

III. Results and Discussion

In all, 3,175 anglers were interviewed during 429 visits at these five locations (Table 24). These fishermen had fished for 7,109.7 hours and had caught 5,869 fish, for an overall mean catch rate of 0.83 fish per angler hour.

In both years of the study, three of these five locations were found to be relatively productive in terms of fishing success, while the other two (Kirby Park and Bennett Slough) were less so (Table 24). The overall catch rates indicated that the two jetties and Skipper's had very similar and relatively high catch rates, ranging from 0.80 fish per angler hour at Skipper's to 0.88 fish per angler hour at the southern jetty, while that at Kirby Park (0.64) and Bennett Slough (0.56) were less.

The mean number of angler hours per visit was also greater at the north jetty (23.1), south jetty (15.0) and Skipper's (30.9) than at either Bennett Slough (3.0) or Kirby Park (1.6) (Table 24). Bennett Slough did, however, have one very high value during the first year, primarily due to one very successful fisherman, as indicated by the extremely high standard deviation.

Daily variation in angler effort appeared to be similar among stations and time of year (Figures 28 and 29), with a small peak in the number of lines fishing generally occurring near noontime, and often again in the late afternoon.

Throughout the study, the number of species caught at the three more successful stations was consistently high, ranging between 23 and 27, while that of Bennett Slough and Kirby Park was very low, ranging between 5 and 6 (Table 24). It is interesting to note that this agrees fairly closely with the information presented earlier regarding the otter trawl and beach seine sampling program (see Tables 3 - 7).

In general, the same species dominated at each station, as indicated by the similarities of ranks for the dominant species caught (Table 24). Of the total 47 species captured by fishermen, approximately 8 were dominant: Leptocottus armatus, Platichthys stellatus, Phanerodon furcatus, Embiotoca jacksoni, Cymatogaster aggregata, Hyperprosopon argenteum, Psettichthys melanostictus, and Atherinopsis californiensis (Table 24, Figures 39 and 40). L. armatus ranked first or second at the north and south jetties and Bennett Slough, while Platichthys stellatus, Phanerodon furcatus, Embiotoca jacksoni, Cymatogaster aggregata, and Hyperprosopon argenteum dominated the more inland fishing spots. At the north and south jetties Psettichthys melanostictus, Hyperprosopon argenteum and the sciaenid, Genyonemus lineatus were important. It is apparent that these species live near the mouth of the slough, in and around the jetties, but from our other catch information, are not generally abundant in the slough proper. As expected, then, typical slough species rank high at all stations.

Other species were caught in large numbers, but without the consistency exhibited by the more dominant ones. Many of the juvenile rockfishes, for example Sebastes paucispinis or S. mystinus, *Genyonemus lineatus*, or such fishes as *Hyperprosopon ellipticum*, which are relatively rare, schooling fishes, periodically dominated the catch for a short time, but were not regular members.

The dominant fish in the angler catch varied considerably over the two year study period at both the north and south jetties (Figure 39) and at Skipper's (Figure 40). *Leptocottus armatus* comprised the greatest amount of the catch at the jetties during the summer months, when it is at its peak in abundance (Figure 39). Other species periodically contributed to the catch in large numbers, such as *Atherinopsis californiensis*, which is found in schools in the slough and may be caught in large numbers sometimes and not at all at other times, or *Sebastes paucispinis* (Figure 40), which definitely become seasonally available as they enter the slough as juveniles. The dominant species, however, which are typical members of the slough fish fauna, generally ranked high in abundance in the angler catch.

Seasonal variability in angling success in Elkhorn Slough can be attributed to two major sources. First, angler effort is generally lower during winter months, probably due to harsher weather conditions and this is particularly evident at the north jetty and Skipper's (Figures 30 and 32), where a winter low of around four angler hours per visit compared with a summer high of over 60 angler hours per visit. The south jetty tended to show less seasonal variation in angler effort (Figure 31), perhaps since it is a bit more sheltered from the blustery northwest winds that occur in Monterey Bay much of the winter months. Secondly, the abundance of fishes may be much lower in winter months, as evidenced by the decrease in catch per unit effort (Figures 33 - 35) at that time. Again, the north jetty location shows this variability particularly well during 1974 - 1975, ranging from around 2.2 in September of 1974 to only about 0.2 in December of the same year (Figure 33), while in the year 1975 - 1976, the variation is less pronounced, perhaps due to anomalous water temperatures at that time, or some other as yet undefined parameter. Skipper's dock showed some seasonality in this respect, but not at the same magnitude (Figure 35) as the north jetty. The south jetty catch per unit effort did not show any discernible pattern of variability, but did peak strongly during December 1975, perhaps due to high catches of _Atherinopsis californiensis_ (see Figure 39).

The number of species caught each month varied at the three stations (Figures 36 - 38) and this may reflect fish availability as well as fishing effort in that the number of species in the catch should drop as the two other values drop. For the north jetty and Skipper's, it appears that the trends are similar to that seen with fishing effort (see Figures 30 and 32), but the south jetty pattern does not resemble that for effort at all (Figure 31) and this difference may reflect fish availability. Lower winter fishing intensity may have been due to some factor other than poor weather conditions. Perhaps fishermen have another indicator of poor fishing success such as poor visibility, turbulence, or some other factor, that causes them to decide not to fish.

From our censuses, we can estimate crudely the number of fishermen that use Elkhorn Slough every year, much in the way Browning (1972) derived his value of 20,000. Using our estimates of total numbers of anglers and the number of visits it took to census those anglers (429), we can come up with a total of approximately 22,000 fishermen per year, a value extremely close to Browning's (1972) figure. Further, we can estimate the total number of fish taken from Elkhorn Slough per year by multiplying the estimated number of anglers (22,000) by the mean number of fish taken per angler (1.85). This indicates that roughly 41,000 fish are taken by anglers per year in Elkhorn Slough.

D. PLANKTON STUDIES: FISH LARVAE AND ZOOPLANKTON

I. Introduction

The basic objective of this study was "to determine the abundance and composition of fish larvae and dominant zooplankton in Elkhorn Slough". The ultimate goal was to gain an integrated idea of the major faunal components of the slough, as Haertel and Osterberg (1967) did in their survey of fishes, benthos, and zooplankton in the Columbia River estuary. Another major goal was to evaluate the use of Elkhorn Slough waters as a nursery ground for marine fishes by surveying the larval fishes, much in the way Pearcy and Myers (1974) evaluated Yaquina Bay in Oregon.

The first year of this study was spent designing and evaluating the sampling methods for both zooplankton and larval fishes, and in enumerating the major groups of zooplankton and typical larval fishes contained in the samples taken regularly during the year in Elkhorn Slough. Before systematic sampling could begin, the net dimensions and means by which to move the nets through the water was determined. Then stations were set up to sufficiently survey the slough's waters, and a towing regime was scheduled, taking into consideration the length and speed of tow, depth of tow, time of day, and tidal factors. Once these considerations were made, we then began our comprehensive sampling programs.

II. Methods

Collections were made monthly at five locations in Elkhorn Slough (Figure 41). Since there is no single instrument capable of sampling the full range of planktonic organisms, we have attempted to design a practical sampling system for particular animals in the Elkhorn Slough waters. We designed a system that would sample both zooplankton and larval fishes and would: (1) remain above the 85% filtering efficiency value (Tranter and Smith, 1968), (2) be operated efficiently by two operators in a small shallow-draft boat, (3) have no preceding structures to increase the possibility of avoidance by plankton, and (4) have fewer sources of disturbing vibrations.

There are two types of nets in the system, designed according to clogging, mesh size, open area ratios, and drag characteristics (Gehringer, 1968). The first, referred to as "the zooplankton net", is 2.69 m long, 1 m of which is a cylinder 0.5 m in diameter and has 153 μ mesh, with the remainder conically shaped down to the cod-end, and made of the same mesh netting (Figure 42). The "larval fish net" is 2.2 m long, the first section of which is a reducing cone constructed of canvas with a 42.5 cm diameter opening, an angle of expansion of 5° and a length of 0.51 m (Figure 42). The reduced area increases the open area ratio and decreases the filtration pressure on the mesh, thus permitting an increase in velocity with the accompanying acceleration of water at the mouth of the net (Tranter and Smith, 1968). The filtering section of net is a half-meter cone constructed of 405 μ mesh 1.7 m long. In three separate tows, the "zooplankton net" was found to have a mean filtering efficiency of 99.2%, while in four tows that of the "larval fish net" was 89.1%, both of which satisfied the stated needs.

Since it was believed that towing such nets in shallow waters behind an outboard motor would increase the probability of avoidance and escape, a "push-net system" similar to one described by Miller (1973) was designed to allow the nets to sample the water in front of the moving boat. The sampler in this system is a portable frame constructed of ½" diameter galvanized pipe (Figure 43). The paired nets are shackled within the 1.9 by 0.6 m rectangular frame at the front of the sampler, and, when in operation, the frame is suspended over the bow of the 16' Boston Whaler by means of a gin pole (Figure 44). The vertical extent of the sampling can vary from surface to depths of one m and can be adjusted with the block and tackle to ride above the water surface when in transit between stations.

While sampling, the boat operator guides the boat in mid-channel, maintains a constant speed between station marks (137 - 297 m apart), and records the time sampled. The net operator raises and lowers the sampler, cleans the nets and changes cod-ends after sampling. The cod-ends are 32 oz. tall glass jars, clamped onto the end of the net. Samples were preserved in 10% formalin and stored until they could be sorted.

Sampling and subsampling procedures were evaluated by collecting a series of 10 tows and enumerating 10 aliquots by calculating the means and 95% confidence intervals of Acartia californiensis trinast for all aliquots of each of the paired tows. *Acartia californiensis* was chosen since it is numerous and best represents the euryhaline zooplankton fauna year round (Pace, unpublished data). Aliquots were 5 - 20 ml subsamples of the total collection, and the amount of each aliquot was determined by the density of *Acartia* in the sample. It was intended that at least 30 individuals of all copepods be present in order for the aliquot size to be a fair sample. The mean values of the aliquots were then proportionally increased according to the percent of the sample the aliquot measured.

After evaluating the sampling procedure, two samples were taken each month at each of the five stations in Elkhorn Slough (Figure 41) for the first year with each pair of nets. The number of samples was increased to four per month in June, 1975, to better estimate densities, since the cumulative number of species of larval fishes, when plotted against the randomly pooled number of tows, levels off at four (Figure 45) and that for zooplankton at three tows (Figure 56). Samples were taken at high slack tide in order to minimize the effect of tidal surge in the amount of water filtered. All samples were preserved in 10% formalin and stored on shore for later analysis.

All larval fish from the "larval fish net" samples have been sorted out of these collections and have been identified to the lowest taxa, usually to species, or at worse, to family. These counts have been standardized to numbers per 100 cubic m of water filtered. All of the collections made with the "zooplankton net" have been sorted, identified, and enumerated (see Tables 30 - 34), but all collections of zooplankton taken with the "larval fish net" have only been sorted into broad taxonomic categories for the first year (see Nybakken et al., 1975). Counts of zooplankton from the "zooplankton net" have been standardized to numbers per cubic meter of water filtered. In addition, a rough estimate of diversity for both zooplankton and larval fish was made by calculating mean number of species (= lowest taxon) per tow.

III. Results and Discussion: Larval Fishes

A total of 260 samples containing 2,341 larvae were taken at the five stations from the harbor entrance to Kirby Park (Tables 25 - 29). Twenty-four distinct species from 16 families were captured during the study period. The taxon osmeridae does not represent a distinct species since the only identifiable fish belonging to this family were late postflexion larvae and juvenile *Hypomesus pretiosus*. The larvae placed in this category most likely are the younger larvae of *H. pretiosus* but the present state of larval taxonomy for this family prohibits accurate identification. The taxon atherinidae here represents only a single species, however, young larvae of the two species known to inhabit the slough (*Atherinops affinis* and *Atherinopsis californiensis*) are presently indistinguishable. Since gravid females of both species were captured during their known spawning season and since atherinid larvae were also captured then (Clark, 1929; Hart, 1973; Ruagh, 1976), it is most probable that this taxon includes larvae of both species. The taxonomic category Sebastes sp. also was counted as a single species, and since only three individuals were caught during the entire study on two different occasions, it is highly likely that this group consists of one species or at the most two. It appears, from plotting the cumulative number of species of fish larvae against the pooled number of tows, that 4 samples are sufficient to assess the species composition of larvae in Elkhorn Slough (Figure 45).

Combining all five stations, Engraulis mordax was the most abundant larva in Elkhorn Slough with a total of 763 taken in 22 months. Gillichthys mirabilis was second with 516 larvae, while another goby, Clevelandia ios, was next with 216 individuals. A cottid, Leptocottus armatus, ranked fourth, followed by Clupea harengus pallasii, the family osmeridae, and sciaenid I. Together, these taxa accounted for 89% of all the fish larvae collected in the 260 samples.

A substantial variation in species composition and abundance was observed among the various stations (Tables 25 - 29). The most speciose station in the slough system was the harbor entrance, where 444 larvae of 18 distinct species were caught in 29 larval fish samples. The total number of species captured for any one sampling period ranged from two to eight and abundances averaged 474 larvae per 1000 m^3.

High densities of larval fish generally were correlated with peaks in numbers of species per tow (Figures 46 and 47). Larvae peaked during the autumn and winter months of both years, with a smaller, but significant peak in March of 1976 (Figure 46). These peaks were dominated by high abundances of single larval taxa with sciaenid I and osmeridae contributing most to the first peak and *Engraulis mordax* to the second (Figure 46, Table 25). The larvae caught in January 1975 were 91% osmeridae and the larvae caught in June 1975 were 91% *E. mordax*. It is notable that the deep water of the Monterey Submarine Canyon had a definite influence on larvae. Twice *Stenobrachius leucopsarus* larvae were caught at the harbor entrance station and once at the bridge station (Tables 25 and 26). On another occasion, a *Bathylagus ochotensis* larva was taken at the harbor entrance. These occurrences were not entirely unexpected since Eldridge and Bryan (1972) had earlier reported taking myctophid and gonostomatid larvae at the mouth to Humboldt Bay.

Peaks in the mean number of species per tow (Figure 47) were apparent in the late winter months of both 1975 and 1976 and the fall of 1975, with the highest number of species per tow occurring on March 15, 1975. Dominant taxa were *E. mordax*, osmeridae, sciaenid I, *L. armatus*, and *C. ios*. These taxa comprised 90% of the total number of larvae caught at the harbor entrance. The second and third ranked taxa decreased in relative importance at the more shoreward stations. The third and fourth ranked larvae, however, generally increased in relative importance away from the ocean.

The overall abundance of larval fishes at the bridge station was lower, with an average of only 92.9 per 1000 m^3 (Table 26). The 16 species caught in 57 tows at this station were represented by only 162 individuals and the number of species for any one sampling period ranged from 0 to 8. *Engraulis mordax*, *L. armatus*, *C. ios*, osmeridae, *Gillichthys mirabilis*, sciaenid I and *Ammodytes hexapterus* comprised 87% of the total catch. Larval abundances varied considerably among seasons, with different species being responsible for apparent peaks (Figure 48). Species diversity was consistently low (Figure 49), with one exception, during the months of January through April, 1976, when, in addition to the normally occurring species, larvae of *Ammodytes hexapterus*, *Lyopsetta exilis*, goby I, and *Sebastes* sp. occurred (Table 26).

In the 58 tows taken at the dairy station, 188 individuals comprised of 15 species were captured (Table 27), and the number of species caught in any one sampling date varied from one to seven with a slight tendency for increasing during late 1975 and early 1976, primarily due to large numbers of *E. mordax*, sciaenid I, atherinidae and *L. armatus* (Figure 50, Table 27). The mean number of species per tow (Figure 51) was also very sporadic and followed a similar trend. *Engraulis mordax*, *L. armatus*, *C. ios*, sciaenid I, *G. mirabilis*, *Neoclinus uninotatus*, and atherinidae comprised 82% of the total number caught.

Fifty-eight tows were taken at the red house station, capturing 436 larvae belonging to 12 different taxa (Table 28). The number of species captured on any single date ranged from one to six. Abundance of larvae was highly variable (Figure 52). In September and October of 1974, G. mirabilis and E. mordax produced a peak, followed by an abrupt absence of most larvae. In the winter of 1975, L. armatus and C. harengus were responsible for the increased densities, but there was not a similar increase in larval fish abundance observed in the winter of 1976. Densities remained relatively low until June 1976, when G. mirabilis and C. ios became numerous. No clear pattern of diversities was clearly discernible (Figure 53). The mean number of species per tow was low, typically around two. Contrary to data from previous stations, the dominant species of larvae was G. mirabilis. This together with L. armatus, C. ios, E. mordax, and C. harengus pallasii comprised 85% of all the larvae.

Kirby Park with 570 larvae per 1000 m^3 had the highest overall density of larval fish found in the slough (Table 29). In 58 tows, 1,111 individuals of 13 taxa were taken. The number of species caught at any one time usually ranged from one to six but on one occasion (January, 1976) eight were taken (Table 29).

Larval fish densities at Kirby Park were almost invariably high (Figure 54), rarely dropping below 400 larvae per 1000 m^3. On four different occasions, densities reached very high levels. In March of 1975, C. harengus, E. mordax, and G. mirabilis larvae were abundant and accounted for this peak (Figure 54, Table 29). No further major peaks of abundance occurred until October of 1975, when E. mordax larvae were again found in extremely high densities. The next peak occurred again in the month of March, during 1976, when E. mordax larvae were very dense. Another large peak occurred in June of 1976 and was due entirely to G. mirabilis larvae. The four top ranked species (E. mordax, G. mirabilis, C. harengus pallasii, and C. ios) contributed 89% of the total number of individuals (Table 29). Although Kirby Park had fewer species overall than most of the other stations, the mean number of species per tow was relatively high and relatively consistent (Figure 55). On at least half the sampling days, three or more species per tow were taken.

At both the red house and Kirby Park larvae of the family Gobiidae become increasingly important (Tables 28 and 29). Gillichthys mirabilis larvae reached densities of 469 and 1,213 larvae per 1000 m^3 respectively. Clevelandia ios reached peaks of 150 and 253 larvae per 1000 m^3 respectively. No other station in the slough reached densities this high for either species during the study period.

A comparison of all slough stations reveals some trends in larval fish abundance and species composition. Kirby Park had the highest mean densities, with the harbor entrance close behind. The other three stations, all within the slough system, had fewer larvae. A different trend occurred with respect to total number of larval fish species, where more species were caught near the ocean and fewer in the slough system proper. *Engraulis mordax* larvae were abundant throughout the slough but preflexion larvae were more numerous at the oceanward stations, while postflexion larvae dominated the Kirby Park collections (M. Stevenson, unpublished data). The two gobies, *C. ios* and *G. mirabilis* were most abundant in the shoreward locations. Osmerid larvae were more abundant at stations near the ocean, while those of *L. armatus* had the highest densities at the central stations.

Two distinct seasonal groups of larvae were apparent (Tables 25 - 29). *Engraulis mordax* and the gobies *G. mirabilis* and *C. ios*, and sciaenid I formed a late summer and fall group while *L. armatus*, *C. harengus pallasii*, the family osmeridae, and *A. hexapterus* formed a winter - early spring group. Although anchovy were abundant in the winter also they were not included in the winter group since they were mainly postflexion larvae and early juveniles that were overwintering at Kirby Park.

In the few comparable studies that have been done on the Pacific coast, similarities in species composition and temporal and spatial abundance have been found. Eldridge and Bryan (1972) in doing a survey of the larval fish of Humboldt Bay found that *Lepidogobius lepidus* and *Clupea harengus pallasii* larvae both dominated his samples. Together, these species accounted for 82% of the fish captured. Three other species of fish also contributed significantly to the total catch: *Leptocottus armatus*, *Spirinchus* thaleichthys, and Clevelandia ios comprised 13% of the catch. In Elkhorn Slough a goby and clupeoid fish were also the most dominant larvae. However, L. lepidus was replaced by G. mirabilis and C. harengus pallasii was replaced by Engraulis mordax. No larvae of L. lepidus were captured. Although C. harengus pallasii was captured within the slough, it was not nearly as abundant in Elkhorn Slough as in Humboldt Bay. This is most likely due to the lack of any sizable Zostera beds in the Slough for use as a spawning substrate. L. armatus, an osmerid, and C. ios were also important in the Elkhorn Slough system.

Temporal patterns of larval fish abundance in Humboldt Bay and Elkhorn Slough are also very similar. Eldridge and Bryan (1972) observed peaks in seasonal abundance both in January - February and in April - May produced by the species that formed the winter - early spring group in Elkhorn Slough. Since Humboldt Bay did not have large larval populations of E. mordax or G. mirabilis, it also did not undergo observed abundance peaks found in the late summer and fall. Eldridge and Bryan (1972) did notice an increase in numbers of C. ios larvae in October.

The observed spatial distribution in Eldridge and Bryan's (1972) study is also similar to that found in our Elkhorn Slough study. He found that the number of larvae increased with increasing distance from the mouth of the Bay and that the lowest number of species captured was at a station which experienced the widest range of salinities and temperatures. With the exception of our harbor entrance location, which is essentially ocean water, there was a similar trend in larval abundance occurrences. Also, fewer species were captured at the red house and Kirby Park stations where salinities and temperatures are subject to larger fluctuations (Broenkow, 1977).

Pearcy and Myers (1974) conducted an investigation of the larval fish of Yaquina Bay in Oregon. Their investigation consisted of three sets of data. The first set was an eleven year series (393 tows) at a single station in the Bay. The second and third sets of data dealt with horizontal variation within the Bay (223 tows) and up to 10 miles offshore from the Bay (113 tows) over a period of 1 year from June 1969 - June 1970. The species composition of Yaquina Bay fish larvae was almost identical to that found by Eldridge and Bryan (1972) in Humboldt Bay. *C. harengus pallasii* and *L. lepidus* both accounted for 90% of all the larvae captured in this eleven year study. *Engraulis mordax* was never found in great abundance in Yaquina Bay, but during the one year study designed to show horizontal variation, these larvae were captured throughout the bay and up to 3 miles offshore (Pearcy and Myers, 1974). This distribution and the fact that large numbers of anchovy eggs were found within the bay is in disagreement with Richardson's (1973) findings that anchovy larvae were abundant well offshore, usually in Columbia River plume waters, but not near the coast. The extremely high densities of anchovy eggs caught at the harbor entrance and bridge stations (M. Stevenson, unpublished data) and large numbers of larvae caught both at the stations near the mouth of the slough as well as at the Kirby Park station indicate that *Engraulis mordax* is not only important as a near shore spawner but also may utilize the upper reaches of the slough for early development.

Larvae of the pleuronectiform fishes were essentially absent from Humboldt Bay (Eldridge and Bryan, 1972), Yaquina Bay (Pearcy and Myers, 1974), and Elkhorn Slough (see Tables 25 - 29). However, juveniles of *Parophrys vetulus*, *Citharichthys stigmaeus*, and *Platichthys stellatus* are known to be abundant in all three embayments (Horn and Allen, 1976). Misitano (1976) showed that *P. vetulus* larvae do not enter Humboldt Bay until they are about 10 mm and ready to metamorphose into a juvenile. It is likely that *C. stigmaeus* and *P. stellatus* enter the slough in a similar manner and are spawned nearby in the ocean. Pearcy and Myers (1974) suggested that the sediments in protected waters provide an ideal feeding habitat for the young as opposed to coarse sand sediments at similar depths along the open coast. They also suggest that the larvae enter Yaquina Bay by descending into deeper water where the net transport exists up the estuary resulting in movement into and retention within the estuary. Our available data from Elkhorn Slough suggest that this is not the case. Elkhorn Slough, not having a consistent freshwater input, does not develop the two-layered transport system observed in Yaquina Bay and characteristic of most true estuaries. The mechanism of entry and the actual spawning areas of these fish therefore remain unknown.

As Pearcy and Myers (1974) concluded, planktonic surveys of fish larvae are not adequate to assess completely the slough as a nursery ground for fishes. Plankton nets are selective toward newly hatched and only weakly swimming larvae, which may be extremely patchy. Larvae of atherinids, for example, are large and active swimmers when they hatch and are apparently able to avoid the nets.

Therefore, any conclusions about the role Elkhorn Slough plays in the development of nearshore fish eggs and larvae, is limited to those species that have larvae that are susceptible to capture by our zooplankton gear. It is apparent from our data, that some species (such as *Engraulis mordax*) utilize the waters of the slough in great numbers, while others (osmeridae, sciaenid I) utilize Elkhorn Slough in less numbers.

IV. Results and Discussion: Zooplankton

A total of 24 taxa were taken in 264 samples at five stations in Elkhorn Slough over the twenty-three month period from August 1974 to June 1976 (Tables 30 - 34). From these samples all copepods were sorted to the lowest possible taxa. The *Acartia* spp. designation indicates all individuals in that genus from the copepodite I stage to the adult copepodite VI stage, and this taxon is comprised of *A. clausi*, *A. tonsa* and *A. californiensis* (Thomas E. Bowman, U.S.N.M., personal communication). The *Eurytemora* sp. designation is the species *Eurytemora hirundoides* Nordquist. Copepodites A, B, and C were not identified to species due to the absence of intact adults in the samples. All other major groups, including the remaining crustacea, were sorted and identified to the lowest possible taxa and representatives of each have been preserved as voucher specimens in the museum of Moss Landing Marine Laboratories. It appears from plotting the cumulative number of taxa of zooplankton against the pooled number of tows that 3 samples are sufficient to assess the species composition of zooplankton in Elkhorn Slough (Figure 56).

Nineteen taxa were collected in 36 tows and averaged 5,065 individuals per cubic meter of seawater filtered at the harbor entrance station, and the number of species caught ranged from five in April 1976 to twelve in March 1975 (Table 30). During this study, there were two periods of high zooplankton standing stock. The period from February to October 1975 was represented by high density values (Figure 57) and a relatively large number of species (Figure 58). During this productive period abundance values of Acartia spp. contributed to less than half of the total zooplankton abundances (38%). Other abundant species at this time included Calanus pacificus (3%), Oithona spinifera (6%), Evadne nordmanni (15%) and barnacle nauplii (14%) (Table 30). Contrary to the conditions of the first peak abundance period, the second period in June 1976 had higher density values but with fewer species (31,000/liter filtered and five to seven species). In this period Acartia spp. accounted for 79% of the total zooplankton standing stock (Table 30), a significant difference from the 38% dominance of

Acartia spp. from the first period. The other abundant forms were *Oithona spinifera*, *Microcalanus* sp., barnacle nauplii, and polychaete larvae. More intermittent taxa were *Podon leuckarti*, *Evadne nordmanni*, and lamellibranch larvae.

At the bridge station twenty-one taxa were caught in 56 tows and averaged 5,338 zooplankton per cubic meter of water filtered, with the number of taxa ranging from four in February to fourteen in April 1975, and the greater number of species occurring in the fall of 1974 and 1975 and in the spring of 1975 (Table 31 and Figure 60). These two periods of high standing stock values were similar to those at the harbor entrance, but total abundances were not as high and had more species during June 1976. During this June 1976 peak, *Acartia* spp. were not as dominant (57%) as at the harbor entrance station (Tables 30, 31), and were less abundant, indicating perhaps that *Acartia* spp. were more productive at stations nearer the ocean than in lower Elkhorn Slough. Other observations, however, may modify such a conclusion, since lower standing crop values were observed at the harbor entrance station than at the bridge station in June 1975 (Figures 57, 59). This discrepancy indicates the presence of either extremely patchy populations (high standard error) or a sudden "bloom" of *Acartia* spp. at the lower slough area not recorded in the harbor entrance because of sampling biases. High standing stocks in the first period of June to October were comprised of an initially high density of *Acartia* spp. (80%) in June and a somewhat lower density of this taxon in August to October (24% - 50%) (Table 31). In the months of June to October 1975 the intermediately abundant forms were Podon leuckarti, Evadne nordmanni, and Pachygrapsus crassipes. Overall, the commonly abundant taxa were Acartia spp., Oithona spinifera, Microcalanus sp., barnacle nauplii, and polychaete larvae.

In the 54 samples taken at the dairies station the overall average of 5,335 zooplankton per cubic meter of water filtered was comprised of twenty-two taxa, with the lowest number of taxa (4) occurring in August 1975 and highest (13) in December 1975. The two periods of high zooplankton standing stock were not as well defined here as at the two previous stations (Figure 61). The first period of September to December 1975 was characterized by high dominance values of Acartia spp. (39% - 51%) but relatively low abundances, with a sudden drop in total zooplankton abundance values occurring in October. Species such as Oithona spinifera, Microcalanus sp., Evadne nordmanni, Podon leuckarti, and barnacle nauplii were of greater numerical importance during this decline. The second period of high density values was similar to that of the first period, also indicating that Acartia spp. densities, as well as total densities, were less by a factor of two than at the bridge or dairies station (Tables 31, 32). Overall, the abundant members of the zooplankton at this station were Calanus pacificus, Oithona spinifera, Microcalanus sp., Eucalanus bungi, Tortanus discaudatus, Podon leuckarti, Evadne nordmanni, copepodite A, and the ostracods. Other taxa present were *Pachygrapsus crassipes*, barnacle nauplii, and polychaete larvae.

The twenty taxa caught in 56 tows at the red house station averaged 3,685 individuals per cubic meter of water filtered, and the number of taxa ranged from six in the months of March, June, and September in 1975 and January and June in 1976 to fourteen in the month of October 1975 (Table 33). Unlike the three previous stations, red house showed only one productive period in 1975 over the entire twenty-three month sampling period, beginning in March 1975, when the number of taxa dropped to six and dominance of *Acartia* spp. increased to 91%. At the end of this period in September, where a second peak occurred, *Acartia* spp. was no longer as dominant (40%), and the density of a greater number of species increased (Figure 63, 64). The second period of zooplankton productivity observed at the other stations in June 1976 did not appear in samples taken at red house indicating that the blooms in *Acartia* spp. typical of Monterey Bay waters did not occur in the relatively isolated slough waters. This is further supported by hydrographic data (Smith, 1973) which suggested that the upper extent of the tidal prism in Elkhorn Slough is near the area between the red house and Kirby Park stations. Consistently abundant taxa at the red house station were *Acartia* spp., barnacle nauplii, *Oithona spinifera*, and *Microcalanus* sp. Strong seasonally dominant taxa were *Evadne nordmanni*, *Podon leuckarti*, and *Pachygrapsus crassipes*. Members of the zooplankton community that contributed to the major differences in abundances between the total zooplankton and *Acartia* spp. in the period of May and September 1975 were *Microcalanus* sp., *Oithona spinifera*, *Evadne nordmanni*, and *Podon leuckarti*.

At the Kirby Park station there was an average of 6,944 individuals captured per cubic meter of seawater filtered represented by 21 taxa from a total of 54 samples with the number of observed taxa per sampling period ranging from one to thirteen in June 1976 and November 1974, respectively (Table 34). The trends in abundance of zooplankton and of *Acartia* spp. were inversely related to trends in numbers of taxa present (Figures 65, 66). Two periods of high *Acartia* spp. standing stock were noted in 1975 and 1976 as at previous stations. However, the higher *Acartia* spp. abundances at Kirby Park, when compared to those at red house may indicate two separate populations, one of ocean origin and another more isolated one at Kirby Park. Other zooplankton included lamellibranch larvae which ranked high, but were distinctly seasonal in their abundance and other meroplankton, such as barnacle nauplii and polychaete larvae, which were abundant year long, but which were in greatest numbers during the spring months (Table 34). But the major differences in abundances between total zooplankton and *Acartia* spp. in the summer and fall months of June to November were due to such members of the pelagic community as *Calanus pacificus*, *Eurytemora hirundoides*, *Oithona spinifera*, copepodite A, *Microcalanus* sp., *Evadne nordmanni*, and *Podon leuckarti*. Overall, the commonly abundant taxa were *Acartia* spp., barnacle nauplii, *Oithona spinifera*, polychaete larvae, lamellibranch larvae, and *Microcalanus* sp.

In summary, Kirby Park yielded the greatest zooplankton densities while red house station produced the least (Tables 30 - 34). Densities of total zooplankton and *Acartia* spp. were inversely related over time to the number of species present. *Acartia* spp. numerically dominated the catch at all stations, especially those more inshore, such as the red house (30%) and Kirby Park (62%). The peak total densities at the mid-slough station near the dairies were not dominated as much by *Acartia* spp. (26%), while in the stations nearer the mouth of the slough (harbor entrance, 29%; bridge, 37%) abundances were distributed seasonally among several other species of zooplankton.

Species composition was similar among all stations sampled, especially those near each other. The red house and dairies had the highest proportion of species jointly occurring, while the Kirby Park and red house stations had the lowest. Kirby Park had similar dominant species as the other stations, but seasonal densities of some species were greater than at the other stations.

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Table 1. Elkhorn slough fish catch locations, methods, and times

(August 1974 - June 1976)

		Kirby Park			Dairies		Bridge			Ocean		Bennett Slough
	Month	O.T.	G.N.	B.S.	O.T.	G.N.	O.T.	G.N.	B.S.	O.T.	B.S.	B.S.
1974	August	1			2		1					2
	September	2			1		1					1
	October	2			1		1			4		2
	November	1		1	3		1			4		2
	December	6			5		2			3		1
1975	January	6			4		3			4	2	3
	February	2	1		2	1	3	1		4		
	March	1			2		2	2	2	4		4
	April	2	1		4		4	1		2		3
	May	1	1		2		1	3		3		
	June	2	1		3	1	2			4		
	July	3			3		1			3		
	August	2			2		1			4		
	September	3			2		1			4		2
	October	2			2		1			4		9
	November	1			2		1			3		5
	December	2			2		1			4		4
1976	January	2			2		2			3		2
	February	2			2		4	1	1	3		6
	March	2			2		1			4		8
	April	2			2		4			4		11
	May	2			1		2			4		2
	June	1			1		1			3		8
		52	4	1	55	2	43	8	3	79	2	75

Totals: O.T. = 229 G.N. = 14 B.S. = 79

Table 2. List of fishes collected in the Elkhorn Slough area by otter trawl, beach seine, gill net, and shore fishermen (August 1974 - June 1976)

Acanthogobius flavimanus	Mustelus henlei
Ammodytes hexapterus	Myliobatis californica
Amphistichus argenteus	Neoclinus uninotatus
Amphistichus koelzi	Oncorhynchus tsawytscha
Amphistichus rhodoterus	Ophiodon elongatus
Artedius harringtoni	Oxyjulis californica
Atherinops affinis	Oxylebius pictus
Atherinopsis californiensis	Paralichthys californicus
Cebidichthys violaceus	Parophrys vetulus
Chitonotus pugetensis	Peprilus simillimus
Chilara taylori	Phanerodon furcatus
Citharichthys sordidus	Platichthys stellatus
Citharichthys stigmaeus	Pleuronichthys decurrens
Clevelandia ios	Porichthys notatus
Clupea harengus pallasii	Raja binoculata
Coryphopterus nicholsii	Rhacochilus toxotes
Cottus asper	Roccus saxatilis
Cymatogaster aggregata	Scorpaenichthys marmoratus
Damalichthys vacca	Sebastes atrovirens
Dorosoma petenense	Sebastes auriculatus
Embiotoca jacksoni	Sebastes carnatus
Embiotoca lateralis	Sebastes caurinus
Engraulis mordax	Sebastes chrysomelas
Eucyclogobius newberryi	Sebastes dallii
Gasterosteus aculeatus	Sebastes flavidus
Genyonemus lineatus	Sebastes goodei
Gibbonsia metzi	Sebastes melanops
Gillichthys mirabilis	Sebastes mystinus
Hexagrammos decagrammus	Sebastes paucispinis
Hyperprosopon anale	Sebastes rastrelliger
Hyperprosopon argenteum	Seriphus politus
Hyperprosopon ellipticum	Spirinchus starksi
Hypomesus pretiosus	Squalus acanthias
Hypsopsetta guttulata	Stellerina xyosterna
Hypsurus caryi	Symphurus atricauda
Lepidogobius lepidus	Syngnathus leptorhynchus-griseolineatus
Lepidopsetta bilineata	Trachurus symmetricus
Leptocottus armatus	Triakis semifasciata
Lyopsetta exilis	Urolophus halleri
Microgadus proximus	Zalembius rosaceus
Micrometrus minimus	

Table 3.

Fish Sample Monthly Summary

OCEAN STATION

Number of Fish/10 Minute Tow (Mean ± Standard Deviation)

FISH SPECIES	1974 Oct*	Nov*	Dec*	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean ± SD	Overall Rank
Ammodytes hexapterus	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-		-	-	-	-	-	-	0.3 (0.5)	-	0.03 (0.15)	24
Amphistichus argenteus	5.0 (7.6)	3.5 (5.7)	C.3 (C.6)	-	-	-	-	-	1.3 (1.0)	-	0.3 (0.5)	-	-	0.3 (0.5)	-	-	-	-	-	0.8 (1.0)	-	0.57 (2.33)	7
Citharichthys sordidus	-	-	1.3 (2.3)	-	-	0.5 (0.6)	-	-	-	1.3 (2.3)	0.3 (0.5)	-	-	-	-	-	-	-	-	-	-	0.14 (0.67)	12
Citharichthys stigmaeus	-	4.0 (4.9)	1.3 (2.3)	0.5 (0.6)	0.3 (0.5)	12. (11.7)	3.5 (2.1)	2.3 (2.5)	0.8 (1.0)	1.3 (2.3)	1.3 (1.0)	2.8 (2.1)	8.8 (5.7)	0.8 (1.0)	1.3 (2.5)	8.3 (6.8)	4.0 (6.1)	0.5 (0.6)	0.5 (0.6)	0.8 (0.5)	3.3 (4.9)	2.74 (4.78)	1
Cymatogaster aggregata	-	-	-	-	-	0.5 (1.0)	-	-	7.3 (11.2)	0.3 (0.6)	0.8 (1.0)	-	-	-	-	-	-	-	-	-	-	0.46 (2.79)	9
Damalichthys vacca	-	-	-	-	-	1.3 (1.9)	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	-	-	0.08 (0.48)	15
Embiotoca jacksoni	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	0.01 (0.11)	30
Genyonemus lineatus	-	-	-	-	-	-	1.0 (1.4)	-	-	0.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	0.04 (0.26)	22
Hyperprosopon anale	3.5 (4.1)	1.5 (1.9)	-	-	-	3.0 (6.0)	0.5 (0.7)	3.3 (5.8)	2.0 (2.0)	1.7 (2.1)	0.3 (0.5)	5.5 (5.1)	0.3 (0.5)	-	-	-	0.3 (0.6)	-	-	13.3 (16.3)	-	1.76 (4.99)	3
Hyperprosopon argenteum	-	-	-	-	-	-	-	0.3 (0.6)	1.0 (1.2)	-	-	-	-	-	-	-	-	-	-	-		0.07 (0.34)	19
Hypsopsetta guttulata	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	-	0.3 (0.5)	0.3 (0.6)	-	-	-	-	-	0.04 (0.20)	21
Hypsurus caryi	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	-	-	-	-	-	-	-	0.3 (0.5)	-	0.03 (0. 6)	25
Leptocottus armatus	-	-	-	-	-	-	-	-	-	-	-	0.5 (1.0)	-	-	-	-	-	-	-	-	-	0.03 (0.23)	23
Micrometrus minimus	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	0.01 (0.11)	26
Myliobatis californica	-	-	-	-	-	-	-	0.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01 (0.11)	27
Ophiodon elongatus	-	-	-	-	-	-	-	1.0 (1.7)	2.3 (2.9)	1.0 (1.7)	-	0.3 (0.5)	-	-	-	-	-	-	-	0.3 (0.5)	-	0.22 (0.90)	11
Paralichthys californicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	-	-	0.01 (0.11)	32
Parophrys vetulus	-	-	-	-	-	0.5 (1.0)	2.5 (3.5)	-	0.5 (0.6)	-	4.0 (1.6)	2.5 (1.0)	0.3 (0.5)	-	-	-	0.7 (1.2)	-	-	0.5 (0.6)	-	0.53 (1.25)	8
Phanerodon furcatus	0.5 (1.0)	-	0.7 (1.2)	-	-	-	0.5 (0.7)	3.3 (5.8)	0.8 (1.0)	0.7 (1.2)	3.5 (2.9)	2.5 (3.8)	-	-	-	-	-	-	-	-	-	0.58 (1.77)	6
Platichthys stellatus	0.5 (1.0)	0.5 (1.0)	0.7 (1.2)	-	-	4.0 (0.8)	0.5 (0.7)	0.3 (0.6)	0.8 (1.0)	1.0 (1.0)	1.0 (0.8)	1.0 (1.4)	0.5 (1.0)	0.3 (0.5)	-	0.3 (0.6)	-	-	0.3 (0.5)	1.3 (1.0)	0.3 (0.6)	0.64 (1.10)	5
Pleuronichthys decurrens	-	-	-	-	-	1.8 (2.4)	-	-	-	17.0 (29.4)	1.8 (1.0)	3.3 (4.3)	-	-	-	0.3 (0.6)	-	-	0.3 (0.5)	-	0.7 (0.6)	1.08 (5.95)	4
Psettichthys melanostictus	-	0.5 (1.0)	-	0.3 (0.5)	0.3 (0.5)	3.0 (1.8)	0.5 (0.7)	-	1.3 (1.9)	1.8 (2.9	0.8 (1.0)	3.5 (2.4)	13.3 (16.5)	4.5 (4.5)	4.0 (3.4)	5.7 (2.3)	0.7 (1.2)	0.5 (0.5)	2.5 (1.3)	2.5 (1.7)	2.7 3.1)	2.37 (4.79)	2
Raja binoculata	0.5 (1.0)	-	-	-	-	-	-	-	-	-	-	-	0.5 (1.0)	-	-	-	-	-	-	0.3 (0.5)	-	0.07 (0.34)	18
Rhacochilus toxotes	-	-	-	-	-	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	-	-	-	0.01 (0.11)	28
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	0.8 (1.0)	-	-	0.3 (0.5)	-	0.3 (0.5)	-	-	-	-	-	-	-	0.07 (0.30)	16
Sebastes caurinus	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	0.01 (0.11)	29
Sebastes goodei	-	-	-	-	-	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	-	-	-	0.01 (0.11)	34
Sebastes mystinus	-	-	-	-	-	-	-	-	1.0 (1.2)	0.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	0.07 (0.34)	17
Sebastes paucispinis	-	-	-	-	-	-	-	-	1.3 (1.9)	0.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	0.08 (0.48)	14
Spirinchus starksi	-	-	-	-	-	-	0.5 (0.7)	9.7 (16.7)	0.8 (1.5)	-	0.3 (0.5)	-	-	-	-	-	-	-	-	-	-	0.45 (3.34)	10
Squalus acanthias	-		-	-	-	-	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	-	-	0.01 (0.11)	35
Stellerina xyosterna	-	-	-	-	-	-	-	-	0.3 (0.5)		-	-	-	-	-	-	-	-	-	-	-	0.01 (0.11)	30
Syngnathus leptorhynchus-griseolineatus	-	-	-	0.3 (0.5)	-	-	-	-	0.3 (0.5)	-	-	-	0.5 (1.0)	0.3 (0.5)	-	-	-	-	0.5 (0.6)	-	-	0.09 (0.33)	13
Young Sebastes spp.	-	-	-	-	-	-	-	0.3 (0.6)	0.5 (1.0)	-	-	-	-	-	-	-	-	-	-	0.3 (0.5)	-	0.05 (0.28)	20
Zalembius rosaceus	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	C.01 (C.11)	33
Number of Species Caught	5	6	5	3	2	10	9	9	17	15	13	12	7	4	4	5	5	2	5	12	4		
Total Number of Fish Caught	40	40	13	7	2	110	20	64	90	84	58	90	96	27	22	45	18	4	16	82	21		
Mean Number of Fish per 10 Min Tow	10.0 (11.7)	10.0 (8.8)	4.3 (3.8)	1.8 (2.9)	0.5 (1.0)	27.5 (14.5)	10.0 (4.2)	21.3 (15.8)	22.5 (3.0)	28.0 (40.7)	14.5 (7.1)	22.5 (16.5)	24.0 (20.5)	6.8 (4.4)	5.5 (5.3)	15.0 (7.9)	6.0 (6.9)	1.0 (0.8)	4.0 (1.2)	20.5 (18.6)	7.0 (7.8)		
Number of Tows	4	4	3	4	4	4	2	3	4	3	4	4	4	4	4	3	3	4	4	4	3		

* These were 5 minute tows that were doubled to correspond to 10 minute tow values.

Table 4.

Fish Sample Monthly Summary

BENNETT SLOUGH
(All are common sense seines - numbers are expressed as number per seine tow)

Species of Fishes	1974 Aug	Sep	Oct	Nov	Dec	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	$\bar{N}$/Seine	Rank
Acanthogobius flavimanus	0	1.0	0	-	0	0	-	0	0	-	-	-	-	9.0	0	0.2	0	0	0	0	0	0	0	0.71	13
Atherinops affinis	11.5	0	7.0	-	2.0	8.7	-	6.0	1:7	-	-	-	-	0	1.4	0	0	0	0	0	0	0	2.8	2.42	4
Atherinopsis californiensis	0	0	0	-	0	0	-	0	0	-	-	-	-	23.5	0	0.4	0	0	0	0	0	0	0.6	1.44	10
Clevelandia ios	82.0	94.0	13.5	-	28.0	0.3	-	5.7	3.0	-	-	-	-	15.0	8.7	0	0	0	0	0	2.1	6.5	83.1	20.11	1
Clupea harengus pallasii	9.0	1.0	0	-	0	0.7	-	0.3	0.3	-	-	-	-	0	0	0	0	0	0	0	0.6	0	1.9	0.81	12
Cottus asper	0	0	0	-	0	0	-	0	0	-	-	-	-	0	0	0	0	0	0.2	0	0	0	0	0.01	20
Cymatogaster aggregata	6.0	0	0.5	-	0	0	-	0.3	0	-	-	-	-	14.0	2.6	1.4	0	0.5	0	0	0	0	0.3	1.51	9
Embiotoca jacksoni	17.5	0	1.5	-	0	0.3	-	0.3	0	-	-	-	-	0	3.2	6.6	0	1.5	0.2	0	0	1.5	1.8	2.02	5
Engraulis mordax	0.5	0	0	-	0	0	-	0	0	-	-	-	-	0	0	0	4.5	0	0	0	0	0	0	0.29	15
Eucyclogobius newberryi	0	0	0	-	0	0	-	0	0	-	-	-	-	0	0	0	0	0	0	0	0	0	0.6	0.04	17
Gasterosteus aculeatus	15.5	5.0	0	-	0	0.3	-	0.7	1.0	-	-	-	-	0	0.1	0	0	0	0	0	0.6	6.0	3.1	1.90	6
Hyperprosopon argenteum	0	0	0	-	0	0	-	0	0	-	-	-	-	0	0	0	0	0.5	0	0	0	0	0	0.03	18
Hypomesus pretiosus	0	0	0	-	0	0	-	0	0	-	-	-	-	0	0	0	0	0	0	0	8.8	4.0	1.4	0.84	11
Leptocottus armatus	82.0	14.0	9.5	-	0.3	0.3	-	0	9.3	-	-	-	-	4.0	5.1	5.2	1.4	2.0	1.8	1.5	22.0	30.5	58.9	14.58	2
Lepidogobius lepidus	0	0	0	-	0	0	-	0	0	-	-	-	-	0	0	0	0	0	0	0	0.6	0	9.3	0.58	14
Phanerodon furcatus	0	0	0	-	0	0	-	0	0	-	-	-	-	1.5	0.2	0.6	0	0	0	0	0	0	0	0.14	16
Platichthys stellatus	10.5	0	0.5	-	19.0	9.7	-	5.7	7.0	-	-	-	-	13.5	25.6	20.8	37.5	30.5	23.8	8.1	6.1	1.0	4.6	13.17	3
Porichthys notatus	22.0	3.0	0.5	-	0	0.3	-	0	0.3	-	-	-	-	1.5	2.8	0	0	0	0.2	0	0.4	0	0.4	1.85	7
Syngnathus leptorhynchus-griseolineatus	5.0	7.0	0.5	-	3.3	0	-	0.7	1.3	-	-	-	-	4.5	2.2	0.8	0	0	0.2	0	0.5	0	1.6	1.62	8
Urolophus halleri	0	0	0	-	0	0	-	0	0	-	-	-	-	0	0.1	0.2	0	0	0	0	0	0	0	0.02	19
Number of Species Caught	11	7	8	-	5	8	-	8	8	-	-	-	-	9	11	9	3	5	6	2	9	6	14		
Total Number of Fish Caught	503	125	67	-	158	78	-	20	24	-	-	-	-	173	468	181	174	70	158	77	458	99	1362		
Mean Number of Fish per Seine Tow	251.5	125.0	33.5	-	52.7	26.0	-	6.7	8.0	-	-	-	-	86.5	52.0	36.2	43.5	35.0	26.3	9.6	41.6	49.5	170.3		
Number of Tows	2	1	2	0	3	3	0	3	3	0	0	0	0	2	9	5	4	2	6	8	11	2	8		

Table 5.

Fish Sample Monthly Summary

BRIDGE STATION

Number of Fish/10 Minute Tow (Mean ± Standard Deviation)

FISH SPECIES	1974 Aug*	Sep*	Oct*	Nov*	Dec*	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean ± SD	Overall Rank
Artedius harringtoni	-	2.0 (θ)	-	2.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0 (θ)	-	-	-	0.14 (0.49)	27
Atherinops affinis	-	-	-	40.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.14 (6.76)	13
Atherinopsis californiensis	-	-	-	-	-	-	-	-	-	1.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.17)	36
Chilara taylori	-	-	-	2.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06 (0.34)	32
Citharichthys stigmaeus	144.0 (θ)	106.0 (θ)	6.0 (θ)	156.0 (θ)	10.5 (9.2)	1.3 (1.5)	0.5 (0.7)	-	-	-	21.5 (5.0)	1.0 (θ)	14.0 (θ)	29.0 (θ)	40.0 (θ)	83.0 (θ)	30.0 (θ)	4.5 (5.0)	1.3 (3.5)	13.0 (θ)	13.0 (θ)	7.0 (7.1)	20.0 (θ)	21.54 (39.40)	4
Clevelandia ios	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.17)	37
Coryphopterus nicholsii	-	-	-	2.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06 (0.34)	30
Cymatogaster aggregata	174.0 (θ)	30.0 (θ)	22.0 (θ)	2416.0 (θ)	0.5 (0.7)	-	1.0 (1.4)	0.5 (0.7)	-	13.0 (θ)	13.0 (1.4)	9.0 (θ)	9.1 (θ)	45.0 (θ)	40.0 (θ)	39.0 (θ)	-	1.0 (1.4)	-	1.0 (θ)	12.0 (θ)	16.0 (71.4)	214.0 (θ)	90.94 (408.80)	1
Damalichthys vacca	10.0 (θ)	-	-	-	-	0.3 (0.6)	-	3.0 (2.8)	1.5 (0.7)	-	8.0 (2.8)	-	-	2.0 (θ)	12.0 (θ)	-	-	-	0.5 (0.1)	6.0 (θ)	1.0 (θ)	1.5 (2.1)	-	1.77 (3.24)	9
Embiotoca jacksoni	88.0 (θ)	122.0 (θ)	20.0 (θ)	2.0 (θ)	18.0 (22.6)	4.0 (6.9)	3.0 (1.4)	85.0 (1.4)	-	7.0 (θ)	36.0 (46.7)	10.0 (θ)	10.0 (θ)	34.0 (θ)	158.0 (θ)	87.0 (θ)	3.0 (θ)	-	6.3 (11.2)	6.0 (θ)	85.0 (θ)	34.5 (38.9)	45.0 (θ)	30.49 (41.55)	3
Engraulis mordax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.0 (θ)	0.66 (3.89)	15
Hexagrammos decagrammus	-	-	-	-	-	-	-	-	-	-	1.0 (1.4)	-	-	-	-	-	-	-	-	-	-	-	-	0.06 (0.34)	29
Hyperprosopon argenteum	22.0 (θ)	16.0 (θ)	-	4.0 (θ)	-	-	0.5 (0.7)	1.5 (2.1)	-	2.0 (θ)	0.5 (0.7)	-	-	2.0 (θ)	1.0 (θ)	-	-	-	-	-	-	-	5.0 (θ)	1.63 (4.56)	10
Hypsurus caryi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0 (θ)	-	-	0.06 (0.34)	33
Lepidogobius lepidus	4.0 (θ)	-	-	-	-	-	-	-	-	-	0.5 (0.7)	-	1.0 (θ)	-	-	-	-	-	-	-	-	-	-	0.17 (0.71)	23
Leptocottus armatus	20.0 (θ)	12.0 (θ)	-	26.0 (θ)	-	-	0.5 (0.7)	-	-	-	1.0 (1.4)	2.0 (θ)	1.0 (θ)	1.0 (θ)	1.0 (θ)	-	-	-	0.3 (0.5)	1.0 (θ)	-	0.5 (0.7)	3.0 (θ)	2.06 (5.68)	8
Micrometrus minimus	6.0 (θ)	8.0 (θ)	4.0 (θ)	-	-	-	-	-	-	-	1.0 (1.4)	-	3.0 (θ)	3.0 (θ)	3.0 (θ)	-	-	-	-	3.0 (θ)	-	-	9.0 (θ)	1.17 (2.36)	12
Myliobatis californica	-	-	-	-	-	0.3 (0.6)	0.5 (0.7)	0.5 (0.7)	-	-	-	-	1.0 (θ)	-	-	-	-	-	-	-	1.0 (θ)	-	-	0.14 (0.36)	26
Neoclinus uninotatus	-	10.0 (θ)	-	2.0 (θ)	-	-	-	-	-	-	-	-	1.0 (θ)	-	-	-	-	-	-	-	-	-	1.0 (θ)	0.40 (1.72)	17
Ophiodon elongatus	2.0 (θ)	-	-	2.0 (θ)	-	-	-	-	1.0 (1.4)	4.0 (θ)	0.5 (0.7)	-	-	-	1.0 (θ)	-	-	-	-	-	-	-	-	0.34 (0.87)	18
Paralichthys californicus	-	-	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.17)	34
Parophrys vetulus	70.0 (θ)	12.0 (θ)	-	-	-	-	-	-	-	8.0 (θ)	11.0 (8.5)	4.0 (θ)	49.0 (θ)	36.0 (θ)	17.0 (θ)	-	-	-	-	6.0 (θ)	2.0 (θ)	2.0 (1.4)	20.0 (θ)	7.14 (15.42)	5
Phanerodon furcatus	220.0 (θ)	94.0 (θ)	16.0 (θ)	148.0 (θ)	45.5 (55.9)	18.3 (31.8)	15.5 (14.9)	70.0 (14.1)	0.5 (0.7)	67.0 (θ)	11.0 (7.1)	48.0 (θ)	49.0 (θ)	46.0 (θ)	47.0 (θ)	2.0 (θ)	-	-	1.8 (2.9)	-	17.0 (θ)	19.5 (23.3)	78.0 (θ)	34.80 (48.36)	2
Platichthys stellatus	10.0 (θ)	14.0 (θ)	8.0 (θ)	4.0 (θ)	6.5 (2.1)	2.0 (2.0)	4.0 (0.0)	8.0 (2.8)	32.0 (33.9)	14.0 (θ)	2.0 (1.4)	4.0 (θ)	4.0 (θ)	3.0 (θ)	3.0 (θ)	12.0 (θ)	2.0 (θ)	5.5 (3.5)	1.0 (0.8)	6.0 (θ)	4.0 (θ)	4.5 (0.7)	3.0 (θ)	9.36 (6.46)	6
Pleuronichthys decurrens	-	-	-	4.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	1.0 (θ)	1.0 (θ)	0.5 (0.7)	-	-	-	0.5 (0.7)	-	0.23 (0.73)	21
Porichthys notatus	-	-	-	8.0 (θ)	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	-	0.29 (1.36)	20
Rhacochilus toxotes	12.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0 (θ)	-	-	-	-	2.0 (θ)	1.0 (θ)	-	1.0 (θ)	0.80 (2.83)	14
Scorpaenichthys marmoratus	8.0 (θ)	50.0 (θ)	2.0 (θ)	-	0.5 (0.7)	-	0.5 (0.7)	-	-	-	2.0 (1.4)	.0 (θ)	-	5.0 (θ)	16.0 (θ)	7.0 (θ)	2.0 (θ)	1.0 (1.4)	1.0 (1.4)	10.0 (θ)	1.0 (θ)	4.0 (5.7)	8.0 (θ)	3.71 (8.87)	7
Sebastes auriculatus	8.0 (θ)	18.0 (θ)	-	8.0 (θ)	-	-	0.5 (0.7)	-	-	3.0 (θ)	1.0 (0.0)	2.0 (θ)	-	1.0 (θ)	-	1.0 (θ)	-	-	-	-	-	-	-	1.26 (3.49)	11
Sebastes caurinus	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.17)	38
Sebastes mystinus	2.0 (0)	10.0 (θ)	4.0 (θ)	4.0 θ	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	0.60 (1.19)	16
Sebastes paucispinis	6.0 (θ)	-	-	-	-	-	-	-	-	-	-	1.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	0.20 (1.02)	22
Sebastes rastrelliger	-	-	-	-	-	-	-	-	-	-	1.0 (1.4)	-	-	-	-	-	-	-	-	2.0 (θ)	-	-	2.0 (θ)	0.17 (0.57)	24
Spirinchus starksi	-	-	-	-	-	-	-	-	-	-	-	1.0 (θ)	-	-	-	-	-	-	-	-	-	-	-	0.03 (0.17)	35
Symphurus atricauda	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	-	2.0 (θ)	-	-	-	-	-	-	-	-	-	-	0.09 (0.37)	28
Syngnathus leptorhynchus-griseolineatus	-	-	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	1.0 (θ)	-	0.5 (0.7)	-	3.0 (θ)	-	-	-	0.17 (0.57)	25
Triakis semifasciata	-	-	-	-	-	1.0 (1.4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06 (0.34)	31
Young Sebastes spp.	-	-	-	-	-	-	-	-	-	-	1.0 (1.4)	1.0 (θ)	-	-	-	-	-	-	-	-	-	0.5 (0.7)	8.0 (θ)	0.34 (1.39)	19
Number of Species Caught	17	14	8	17	8	6	11	7	6	9	21	12	12	12	13	9	5	6	7	13	11	12	15		
Total Number of Fish Caught	806	504	82	2830	165	79	55	337	72	119	228	84	144	207	351	233	38	26	50	60	139	269	440		
Mean Number of Fish per 10 Min Tow	806.0 (θ)	504.0 (θ)	82.0 (θ)	2830.0 (θ)	82.5 (88.4)	26.3 (41.4)	27.5 (14.9)	168.5 (14.9)	36.0 (35.4)	119.0 (θ)	114.0 (59.4)	84.0 (θ)	144.0 (θ)	207.0 (θ)	351.0 (θ)	233.0 (θ)	38.0 (θ)	13.0 (12.7)	12.5 (14.4)	60.0 (θ)	139.0 (θ)	134.5 (150.6)	440.0 (θ)		
Number of Tows	1	1	1	1	2	3	2	2	2	1	2	1	1	1	1	1	1	2	4	1	1	2	1		

* These were 5 minute tows that were doubled to correspond to 10 minute tow values.
θ - standard deviation undefined

Table 6.

Fish Sample Monthly Summary

DAIRY STATION

Number of Fish/10 Minute Tow (Mean ± Standard Deviation)

FISH SPECIES	1974 Aug*	Sep*	Oct*	Nov	Dec	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct+	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean ± SD	Overall Rank
Artedius harringtoni	-	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0 (0)	-	-	-	0.06 (0.32)	29
Atherinops affinis	-	-	-	-	0.2 (0.5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02 (0.14)	37
Atherinopsis californiensis	-	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06 (0.32)	26
Citharichthys stigmaeus	1.0 (1.4)	-	12.0 (0)	4.0 (5.3)	0.2 (0.5)	0.5 (0.6)	0.5 (0.7)	-	1.0 (1.2)	-	2.0 (1.7)	1.5 (0.7)	0.5 (0.7)	20.0 (18.4)	20.5 (9.2)	-	1.0 (0)	1.5 (0.7)	0.5 (0.7)	-	1.7 (1.2)	5.0 (0)	3.0 (0)	2.92 (6.43)	4
Clupea harengus pallasii	-	-	-	-	-	-	-	-	-	39.5 (55.9)	-	-	-	-	-	3.0 (0)	-	-	-	-	-	-	-	1.67 (11.28)	7
Coryphopterus nicholsii	-	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	-	0.02 (0.14)	36
Cymatogaster aggregata	12.0 (17.0)	42.0 (0)	10.0 (0)	26.7 (21.6)	18.0 (39.1)	1.8 (2.6)	2.5 (2.1)	-	9.3 (17.8)	4.5 (0.7)	5.3 (6.7)	51.0 (52.3)	29.5 (23.3)	67.5 (36.1)	73.0 (75.0)	-	-	5.0 (7.1)	-	5.0 (0)	7.3 (8.7)	3.0 (0)	132.0 (0)	19.06 (32.85)	1
Damalichthys vacca	-	-	-	-	1.0 (2.2)	0.3 (0.5)	1.5 (2.1)	-	1.0 (2.0)	1.5 (2.1)	3.0 (1.7)	5.5 (7.8)	0.5 (0.7)	-	4.0 (5.7)	2.0 (0)	-	-	-	2.0 (0)	0.7 (0.6)	3.0 (0)	8.0 (0)	1.27 (2.43)	10
Embiotoca jacksoni	5.0 (1.4)	40.0 (0)	30.0 (0)	6.7 (7.0)	4.4 (5.6)	2.5 (5.0)	2.5 (2.1)	1.5 (2.1)	3.3 (2.5)	-	14.0 (22.5)	13.5 (16.3)	2.5 (2.1)	15.5 (16.3)	13.0 (8.5)	3.0 (0)	1.0 (0)	-	-	1.0 (0)	8.7 (15.0)	1.0 (0)	119.0 (0)	8.88 (19.14)	3
Engraulis mordax	-	2.0 (0)	-	-	-	-	-	-	-	1.5 (2.1)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10 (0.51)	24
Gasterosteus aculeatus	1.0 (1.4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04 (0.29)	32
Hyperprosopon argenteum	4.0 (5.7)	-	-	-	0.6 (0.9)	-	0.5 (0.7)	0.5 (0.7)	-	0.5 (0.7)	0.7 (0.6)	9.5 (3.5)	-	1.0 (1.4)	-	2.0 (0)	-	-	-	-	0.3 (0.6)	-	1.0 (0)	0.86 (2.25)	11
Hypsopsetta guttulata	-	-	-	0.7 (1.2)	-	-	-	-	0.3 (0.5)	-	-	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	0.08 (0.34)	25
Lepidogobius lepidus	1.0 (1.4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	0.06 (0.32)	28
Lepidopsetta bilineata	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02 (0.14)	38
Leptocottus armatus	1.0 (1.4)	2.0 (0)	2.0 (0)	3.3 (3.1)	-	0.3 (0.5)	-	-	-	-	1.0 (1.7)	1.0 (0.0)	1.0 (0.0)	8.5 (10.6)	12.0 (5.7)	-	-	-	-	-	1.0 (1.0)	6.0 (0)	3.0 (0)	1.57 (3.49)	9
Micrometrus minimus	-	-	-	-	-	-	-	-	-	-	0.3 (0.6)	1.0 (1.4)	0.5 (0.7)	-	-	-	-	-	-	-	-	-	14.0 (0)	0.37 (2.02)	16
Myliobatis californica	-	-	-	-	-	-	-	-	0.3 (0.5)	-	0.3 (0.6)	0.5 (0.7)	-	0.5 (0.7)	-	-	-	-	-	-	1.0 (0.0)	-	-	0.14 (0.35)	22
Ophiodon elongatus	-	-	-	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02 (0.14)	35
Parophrys vetulus	-	-	-	-	-	-	-	-	2.0 (2.2)	1.0 (1.4)	5.3 (4.2)	17.5 (24.8)	-	7.5 (1.7)	5.5 (7.8)	-	-	-	-	6.0 (0)	8.7 (6.8)	10.0 (0)	-	2.63 (6.19)	5
Phanerodon furcatus	1.0 (1.4)	32.0 (0)	30.0 (0)	7.3 (11.0)	17.0 (15.0)	20.8 (26.8)	12.0 (2.8)	6.5 (7.8)	4.5 (5.3)	2.5 (2.1)	10.3 (11.9)	41.0 (28.3)	37.5 (6.4)	29.0 (25.5)	17.0 (7.1)	8.0 (0)	24.0 (0)	13.5 19.1)	-	13.0 (0)	7.0 (1.0)	20.0 (0)	214.0 (0)	18.78 (32.39)	2
Platichthys stellatus	-	2.0 (0)	-	1.3 (2.3)	2.0 (2.6)	2.5 (2.4)	1.5 (0.7)	2.0 (1.4)	4.8 (4.6)	5.0 (5.7)	1.0 (1.7)	3.5 (2.1)	0.5 (0.7)	4.0 (4.2)	1.5 (2.1)	1.0 (0)	6.0 (0)	4.0 (0.0)	3.5 (3.5)	5.0 (0)	3.7 (5.5)	5.0 (0)	-	2.59 (2.84)	6
Pleuronichthys decurrens	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	1.0 (0.0)	-	-	-	-	-	-	-	-	0.06 (0.24)	27
Porichthys notatus	-	-	-	8.0 (6.9)	-	-	-	-	-	-	-	-	0.5 (0.7)	2.0 (2.8)	0.5 (0.7)	-	-	-	-	-	-	-	-	0.61 (2.45)	12
Rhacochilus toxotes	-	-	-	-	0.2 (0.5)	-	-	-	-	-	-	0.5 (0.7)	-	-	0.5 (0.7)	-	-	-	-	-	-	1.0 (0)	1.0 (0)	0.10 (0.31)	23
Scorpaenichthys marmoratus	-	-	-	4.0 (4.0)	-	-	-	-	-	-	1.0 (1.0)	1.0 (1.4)	-	1.0 (0.0)	2.0 (1.4)	-	-	1.0 (1.4)	0.5 (0.7)	-	0.3 (0.6)	-	-	0.55 (1.39)	13
Sebastes atrovirens	-	-	-	0.7 (1.2)	-	-	-	-	-	-	-	-	-	-	3.5 (5.0)	1.0 (0)	-	-	-	-	-	-	-	0.20 (1.04)	17
Sebastes auriculatus	-	-	-	8.0 (7.2)	-	-	-	0.5 (0.7)	-	-	1.3 (1.5)	1.0 (1.4)	0.5 (0.7)	15.0 (19.8)	9.5 (12.0)	-	-	0.5 (0.7)	-	-	-	-	-	1.67 (5.29)	8
Sebastes caurinus	-	-	-	0.7 (1.2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04 (0.29)	33
Sebastes dalli	1.0 (1.4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04 (0.29)	34
Sebastes melanops	-	-	-	2.7 (4.6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.16 (1.14)	21
Sebastes mystinus	-	-	2.0 (0)	3.0 (4.2)	-	-	-	-	-	-	1.0 (1.7)	-	1.0 (1.4)	-	3.0 (4.2)	-	-	1.0 (1.4)	0.5 (0.7)	-	-	-	-	0.53 (1.53)	14
Sebastes paucispinis	-	-	-	-	-	-	-	-	-	-	-	9.5 (5.0)	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	0.41 (2.03)	15
Sebastes rastrelliger	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0 (1.4)	-	-	-	-	-	-	-	-	0.04 (0.29)	31
Syngnathus leptorhynchus-griseolineatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	1.0 (0)	0.04 (0.20)	30
Triakis semifasciata	-	-	-	0.7 (1.2)	-	-	-	-	-	-	-	-	-	0.5 (0.7)	2.5 (3.5)	-	-	-	-	-	-	-	-	0.16 (0.77)	19
Urolophus halleri	-	-	-	-	-	0.3 (0.5)	1.0 (1.4)	-	-	-	-	-	-	-	0.5 (0.7)	1.0 (0)	3.0 (0)	-	-	-	-	-	-	0.16 (0.55)	20
Young Sebastes spp.	-	-	-	-	-	-	-	-	-	-	-	1.0 (0.0)	3.5 (5.0)	-	-	-	-	-	-	-	-	-	1.0 (0)	0.20 (1.02)	18
Number of Species Caught	9	6	6	16	9	9	9	6	9	9	15	16	13	14	18	8	5	8	4	8	14	9	11		
Total Number of Fish Caught	54	120	86	234	218	116	45	23	105	113	141	317	157	345	341	21	35	54	10	36	124	54	497		
Mean Number of Fish per 10 Min Tow	27.0 (29.7)	120.0 (0)	86.0 (0)	78.0 (59.2)	43.6 (41.3)	29.0 (32.6)	22.5 (0.7)	11.5 (9.2)	26.3 (32.1)	56.5 (67.2)	47.0 (32.5)	158.5 (70.0)	78.5 (36.1)	172.5 (9.2)	170.5 (94.1)	21.0 (0)	35.0 (0)	27.0 (9.9)	5.0 (2.8)	36.0 (0)	41.3 (4.9)	54.0 (0)	497.0 (0)		
Number of Tows	2	1	1	3	5	4	2	2	4	2	3	2	2	2	2	1	1	2	2	1	3	1	1		

* These were 5 minute tows that were doubled to correspond to 10 minute tow values.
0 - Standard deviation undefined

Table 7.

Fish Sample Monthly Summary

KIRBY PARK

Number of Fish/10 Minute Tow (Mean ± Standard Deviation)

FISH SPECIES	1974 Sep*	Oct*	Nov*	Dec*	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean ± SD	Overall Rank
Atherinops affinis	-	-	-	1.0 (2.5)	-	-	-	-	-	-	-	-	0.7 (1.2)	-	2.0 (θ)	-	-	-	-	-	-	-	0.20 (0.93)	17
Atherinopsis californiensis	-	-	-	-	0.5 (1.2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5 (2.1)	1.0 (1.4)	-	0.16 (0.66)	18
Citharichthys stigmaeus	-	-	-	-	-	-	1.0 (θ)	-	-	-	-	-	0.3 (0.6)	-	-	0.5 (0.7)	-	-	-	-	-	-	0.04 (0.24)	23
Clupea harengus pallasii	-	-	-	-	1.7 (2.9)	0.5 (0.7)	13.0 (θ)	-	-	-	-	0.5 (0.7)	-	-	1.0 (θ)	-	-	-	1.5 (0.7)	-	5.0 (4.2)	-	0.80 (2.38)	9
Cymatogaster aggregata	118.0 (73.4)	52.0 (39.6)	54.0 (θ)	2.0 (4.9)	0.3 (0.5)	1.0 (1.4)	62.0 (θ)	28.0 (22.6)	53.0 (θ)	63.5 (79.9)	1.0 (8.5)	107.0 (131.5)	31.3 (25.4)	20.5 (12.0)	12.0 (θ)	0.5 (0.7)	-	-	0.5 (0.7)	27.0 (7.1)	204.5 (19.1)	190.0 (θ)	41.71 (62.61)	1
Damalichthys vacca	-	-	-	-	0.3 (0.5)	-	-	-	3.0 (θ)	1.0 (1.4)	1.0 (0.0)	-	0.7 (0.6)	-	-	-	-	-	-	2.0 (1.4)	-	-	0.31 (0.71)	13
Dorosoma petenense	-	-	-	4.7 (11.4)	-	-	-	-	-	-	-	-	-	-	1.0 (θ)	-	-	-	-	-	-	-	0.59 (4.00)	11
Embiotoca jacksoni	27.3 (11.1)	1.0 (1.4)	-	0.3 (0.8)	0.3 (0.5)	-	-	-	1.0 (θ)	-	-	0.5 (0.7)	2.0 (1.0)	0.5 (0.7)	2.0 (θ)	-	-	-	-	0.5 (0.7)	1.5 (2.1)	3.0 (θ)	2.16 (6.93)	6
Engraulis mordax	34.0 (46.8)	-	50.0 (θ)	-	1.7 (0.4)	-	-	-	-	0.5 (0.7)	7.5 (10.6)	1.5 (2.1)	0.7 (1.2)	0.5 (0.7)	2.0 (θ)	-	-	-	-	-	-	-	3.61 (14.40)	5
Hyperprosopon argenteum	-	-	-	-	-	-	1.0 (θ)	0.5 (0.7)	2.0 (θ)	4.5 (3.5)	-	-	-	-	-	-	-	-	-	-	-	-	0.27 (1.08)	14
Hypsopsetta guttulata	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	1.0 (θ)	-	-	-	-	0.5 (0.7)	-	-	0.06 (0.24)	21
Lepidogobius lepidus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5 (2.1)	1.0 (1.4)	18.0 (θ)	0.47 (2.61)	12
Leptocottus armatus	10.7 (5.0)	4.0 (5.7)	-	0.2 (0.4)	-	0.5 (0.7)	2.0 (θ)	0.5 (0.7)	1.0 (θ)	2.0 (2.8)	13.5 (12.1)	6.0 (5.7)	24.3 (37.0)	12.0 (11.3)	-	2.0 (2.8)	0.5 (0.7)	1.0 (0.0)	7.0 (7.0)	4.5 (4.9)	10.5 (7.8)	263.0 (θ)	10.20 (38.35)	2
Mustelus californicus	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	0.02 (0.14)	26
Myliobatis californica	-	6.0 (2.8)	-	-	0.3 (0.5)	0.5 (0.7)	-	0.5 (0.7)	4.0 (θ)	4.0 (0.0)	0.5 (0.7)	0.5 (0.7)	0.3 (0.6)	-	-	-	-	-	-	-	-	6.0 (θ)	0.76 (1.73)	10
Paralichthys californicus	-	-	-	-	-	-	-	-	-	-	-	-	0.3 (0.6)	-	-	-	-	-	-	-	-	-	0.02 (0.14)	25
Parophrys vetulus	-	-	-	-	-	-	2.0 (θ)	5.0 (0.0)	42.0 (θ)	125.0 (144.3)	-	-	-	-	-	-	-	-	-	16.0 (18.4)	30.0 (35.4)	12.0 (θ)	8.33 (33.70)	3
Phanerodon furcatus	1.3 (2.3)	2.0 (2.8)	2.0 (θ)	1.0 (2.5)	1.0 (1.7)	2.0 (2.8)	-	4.5 (3.5)	10.0 (θ)	5.5 (3.5)	1.5 (2.7)	0.5 (0.7)	2.7 (2.5)	1.0 (0.0)	1.0 (θ)	0.5 (0.7)	2.0 (2.8)	-	0.5 (0.7)	3.0 (1.4)	0.5 (0.7)	1.0 (θ)	1.73 (2.39)	7
Platichthys stellatus	7.3 (6.1)	2.0 (0.0)	34.0 (θ)	0.5 (0.8)	1.2 (1.0)	3.5 (3.5)	2.0 (θ)	4.0 (2.8)	6.0 (θ)	1.0 (1.4)	9.5 (13.4)	2.0 (2.8)	4.7 (6.4)	13.5 (7.8)	2.0 (θ)	3.0 (2.8)	-	8.0 (2.83)	3.0 (1.4)	4.0 (0.0)	0.5 (0.7)	18.0 (θ)	4.57 (6.62)	4
Porichthys notatus	2.0 (2.0)	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	12.0 (20.8)	-	-	-	-	-	-	-	-	-	0.88 (5.16)	8
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	1.0 (θ)	1.0 (1.4)	-	0.5 (0.7)	-	-	-	-	0.10 (0.37)	20
Sebastes auriculatus	-	-	-	-	-	-	-	-	-	-	-	-	-	1.0 (1.4)	-	-	-	-	-	-	-	-	0.04 (0.29)	23
Sebastes rastrelliger	-	-	-	-	-	-	-	0.5 (0.7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02 (0.14)	24
Seriphus politus	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0 (0.0)	6.0 (θ)	-	-	-	-	-	-	-	0.20 (0.93)	16
Triakis semifasciata	1.3 (2.3)	1.0 (1.4)	-	-	-	-	-	-	1.0 (θ)	-	1.0 (1.4)	1.0 (1.4)	-	0.5 (0.7)	-	-	-	-	-	0.5 (0.7)	-	-	0.27 (0.76)	15
Urolophus halleri	-	-	-	-	-	-	-	-	-	-	-	0.5 (0.7)	0.3 (0.6)	-	-	2.0 (2.8)	-	0.5 (0.7)	-	-	-	-	0.14 (0.61)	19
Number of Species Caught	8	7	4	7	9	6	6	9	11	9	9	10	13	11	11	8	2	4	5	11	9	8		
Total Number of Fish Caught	606	136	140	58	35	16	82	88	124	414	272	240	241	105	39	20	5	20	25	122	509	511		
Mean Number of Fish per 10 Min Tow	202.0 (34.9)	68.0 (45.3)	140.0 (θ)	5.0 (11.3)	5.8 (3.5)	8.0 (0.0)	82.0 (θ)	44.0 (31.1)	124.0 (θ)	207.0 (227.7)	136.0 (22.6)	120.0 (134.4)	80.3 (41.8)	52.5 (31.8)	39.0 (θ)	10.0 (1.4)	2.5 (3.5)	10.0 (4.2)	12.5 (7.8)	61.0 (79.7)	254.5 (67.2)	511.0 (θ)		
Number of Tows	3	2	1	6	6	2	1	2	1	2	2	2	3	2	1	2	2	2	2	2	2	1		

* These were 5 minute tows that were doubled to correspond to 10 minute tow values.
θ - Standard deviation undefined

Table 8.

Totals of Invertebrates Caught by Otter Trawl in Elkhorn Slough

Invertebrates	Kirby Park	Dairies	Bridge	Ocean
Aeolidia papillosa	7	6	1	1
Anthopleura sp.			3	
Aplysia californica		1	3	
Archidoris montereyensis	7	22		
Argulus pugettensis	x		5	18
Blepharipoda occidentalis				10
Cancer antennarius	1	9	4	
Cancer anthonyi			1	
Cancer gracilis	1	11	11	5
Cancer magister				2
Cancer productus		2	1	
Cancer sp.		1	1	1
Coryphella trilineata				1
Crangon nigricauda	334	74	32	
Crangon nigromaculata				243
Dendraster excentricus	78			61
Diaulula sandiegensis	2	1	1	
Emerita analoga				1
Entodesma sp.				1
Hemigrapsus oregonensis	169	55	17	1
Hemigrapsus nudus		x		
Heptacarpus sp.		1		
Hermissenda crassicornis	2	5	1	2
Isopoda (unident.)				5
Lecythorhynchus sp.				2
Lironeca spp.	106	40	23	77
Loligo opalescens	x			
Loxorhynchus grandis		1	3	
Macoma nasuta	7			
Mytilus californiensis				20
Mytilus edulus	2	x		
Nassarius fostus				1
Navanax (Aglaja) inermis	6	3		1
Nudibranch (unident.)		2		
Octopus sp.				1
Olivella pycna				1
Pectinidae		1		
Pelagia noctiluca		1	2	7
Penitella sp.		1		
Phyllaplysia taylori			1	
Pisaster brevispinus				2
Pisaster giganteus				2
Pleurobrachia bachei		x		x
Polinices lewisii			3	
Polycera atra			4	
Polyclinum planum				1
Porifera	x			
Protothaca staminea	3			
Pugettia productus		3	24	6
Scale worms (unident.)				2
Scrippsia pacifica				1
Shrimp (unident.)			1	1
Siliqua sp.				2
Spirontocaris sp.	1			
Velella velella		x		

Table 9

Tagging Activity Summary

(July 1974 - October 1976)

	Kirby Park	Dairies	Bridge	Ocean	Bennett	Total
Acanthogobius flavimanus	0	0	0	0	1	1
Atherinopsis californiensis	5	0	0	0	2	7
Cymatogaster aggregata	54	21	3	0	23	101
Citharichthys stigmaeus	0	0	1	1	0	2
Damalichthys vacca	0	1	15	0	0	16
Embiotoca jacksoni	0	35	319(4)*	0	65(5)	419(9)
Hyperprosopon argenteum	0	0	0	0	1	1
Hypsopsetta guttulata	1	1	0	1	0	3
Leptocottus armatus	0	8	7(1)	0	150(2)	165(3)
Mustelus henlei	0	0	5	0	0	5
Myliobatis californicus	18	8	2	1	0	29
Parophrys vetulus	80	16	0	2	0	98
Phanerodon furcatus	1	139	154	0	8	302
Platichthys stellatus	35(1)	39(1)	61(3)	9	907(113)	1051(121)
Pleuronichthys decurrens	0	1	2	3	0	6
Pleuronichthys verticalis	0	0	4	0	0	4
Porichthys notatus	0	0	0	0	2	2
Psettichthys melanostictus	0	0	0	24	0	24
Rhacochilus toxotes	0	0	1	0	0	1
Scorpaenichthys marmoratus	0	5	6(2)	0	0	11(2)
Sebastes auriculatus	0	1	0	0	0	1
Triakis semifasciata	2	3	18	0	0	23
Urolophus halleri	4	5	0	0	0	9
Syngnathus leptorhynchus-griseolineatus	0	0	0	0	4	4
						2285(135)

* Numbers in parentheses indicate the number of tagged fish recovered.

Table 10. Atherinid feeding habit summary at Skipper's docks. %N = percent numerical composition of prey in diet. %V = percent volumetric composition of prey in diet. %F.O. = percent frequency of occurrence. IRI = index of relative importance.

SKIPPERS

Prey Categories	*Atherinopsis californiensis* %N	%V	%F.O.	I.R.I.	Ranks	*Atherinops affinis* %N	%V	%F.O.	I.R.I.	Ranks
Plants										
Chlorophyta										
Enteromorpha spp.	---	5.73	12.50	71.62	3	---	2.84	10.08	28.62	16
Rhodophyta										
Tanais spp.						1.29	0.69	5.04	9.98	20
Phaeophyta										
Bangiales spp.						---	2.22	3.36	7.46	21
Ectocarpales spp.						---	8.55	13.44	114.91	10
Chrysophyta (Diatoms)										
Gyrosigma spp.	---	8.29	18.75	155.43	2	---	7.41	15.96	118.26	9
Licmorpha spp.						---	4.66	15.12	70.46	12
Melosina moniliformis	---	2.62	18.75	49.12	5	---	7.06	28.57	201.70	4
Naviculoideae (unident.)	---	5.48	12.50	68.50	4	---	5.42	23.52	127.48	8
Pleurosigma spp.	---	2.30	12.50	28.75	6	---	7.73	18.48	142.85	6
Schizonema spp.						---	2.97	6.72	19.95	18
Nematoda						0.28	0.13	12.60	5.16	22
Arthropoda										
Crustacea										
Ostracoda										
Ostracods						14.90	1.98	8.40	141.79	7
Copepoda										
Calanoid copepods						22.03	5.58	12.60	347.88	3
Cyclopoid copepods						22.14	7.65	15.96	475.49	1
Harpacticoid copepods						7.31	1.96	5.88	54.50	14
Amphipoda										
Anisogammarus confervicolus						0.58	7.07	8.40	64.26	13
Anisogammarus spp.						1.29	3.36	5.88	27.34	17
Corophium insidiosum						0.08	0.67	0.84	0.63	24
Corophium spp.						0.45	2.94	5.88	19.93	19
Brachiopoda										
Zoea larvae						4.43	1.08	5.88	32.40	15
Euphausiacea	100.00*	74.77	75.00	13107.75	1	16.22	7.55	18.48	439.27	2
Cladocera						0.53	0.74	1.68	2.13	23
Cirripedia										
Cypris larvae						8.41	2.80	9.24	103.58	11
Miscellaneous										
detritus	---	0.80	12.50	10.00	7	---	6.59	23.52	154.99	5
Total Number of Prey Categories				7				24		
Number of Fish Examined (with contents)				25				140		

*This value is unrealistically high since only one prey item could be given a numerical importance value.

Table 11. Atherinid feeding habit summary at the bridge station. (for details of symbols, see Table 10).

BRIDGE

Prey Categories	*Atherinopsis californiensis* %N	%V	%F.O.	I.R.I.	Ranks	*Atherinops affinis* %N	%V	%F.O.	I.R.I.	Ranks
Plants										
Chlorophyta										
Enteromorpha spp.	---	16.58	28.57	473.69	4	---	1.62	4.16	6.74	13
Ulva lactuca	---	25.36	30.35	769.67	1					
Rhodophyta										
Gelidium sinicola	---	2.96	7.14	21.13	11					
Chrysophyta (Diatoms)										
Biddulphia spp.	---	2.82	5.35	15.08	12					
Licmorpha spp.	---	1.61	14.28	22.99	10					
Melosira moniliformis	---	7.39	35.71	263.89	6	---	5.35	14.58	78.00	11
Navicula distans						---	9.77	29.16	284.89	5
Naviculoideae (unident.)	---	2.70	19.64	53.02	8	---	16.85	45.83	772.23	3
Pleurosigma spp.						---	2.16	29.16	62.98	12
Schizonema spp.	---	12.95	25.00	323.75	5	---	13.85	18.75	259.68	6
Protozoa										
Foraminifera						28.80	2.95	12.50	396.87	4
Nematoda	0.28	0.05	3.57	1.17	14	1.98	2.97	16.66	82.46	10
Arthropoda										
Crustacea										
Ostracoda										
Ostracods						42.75	3.90	33.33	1554.84	1
Copepoda										
Calanoid copepods	22.87	0.46	5.35	124.81	7	13.83	4.52	10.41	191.02	7
Harpacticoid copepods						12.38	2.05	12.50	180.37	8
Amphipoda										
Anisogammarus confervicolus						0.24	2.08	2.08	4.82	14
Gammarid spp.	0.39	0.03	3.57	1.50	13					
Brachiopoda										
Zoea larvae	9.12	2.16	3.57	40.26	9					
Vertebrata										
eggs of *A. californiensis*	67.31	2.16	8.92	619.67	2					
Miscellaneous										
detritus						---	23.85	45.83	1093.04	2
digested material	---	22.73	26.78	608.70	3	---	8.02	20.83	167.05	9
Total Number of Prey Categories				14					14	
Number of Fish Examined (with contents)				57					48	

Table 12. Atherinid feeding habit summary at the dairies station. (for details of symbols, see Table 10).

DAIRIES

Prey Categories	*Atherinopsis californiensis* %N	%V	%F.O.	I.R.I.	Ranks	*Atherinops affinis* %N	%V	%F.O.	I.R.I.	Ranks
Plants										
Chlorophyta										
Enteromorpha intestinalis						---	7.26	17.07	123.92	6
Enteromorpha spp.	---	27.19	44.68	1214.85	2	---	4.19	12.19	51.07	7
Chrysophyta (Diatoms)										
Biddulphia spp.						---	1.75	19.51	34.14	8
Gyrosigma spp.	---	1.91	8.51	16.25	9	---	36.19	53.65	1941.59	1
Licmorpha spp.						---	0.21	4.87	1.02	12
Melosira moniliformis	---	37.36	40.42	1510.09	1	---	10.65	41.46	441.55	4
Navicula distans						---	0.97	12.19	11.82	11
Naviculoideae(unident.)	---	2.45	10.64	26.07	8	---	9.75	39.02	380.44	5
Pleurosigma spp.	---	0.64	4.25	2.72	11	---	1.26	12.19	15.36	9
Nematoda	1.16	0.12	6.38	8.16	10	1.72	0.14	7.31	13.60	10
Arthropoda										
Crustacea										
Copepoda										
Calanoid copepods	78.64	5.00	6.38	533.62	4					
Harpacticoid copepods						98.27	3.17	12.19	1236.55	3
Amphipoda										
Anisogammarus confervicolus	0.02	0.41	2.12	0.91	12					
Corophium spp.	3.23	1.38	6.38	29.41	6					
Vertebrata										
eggs of A. californiensis	16.55	0.21	2.12	35.53	5					
Miscellaneous										
detritus	---	19.34	57.44	1110.89	3	---	24.39	73.17	1784.61	2
digested material	---	4.36	6.38	27.81	7					
Total Number of Prey Categories				12					12	
Number of Fish Examined (with contents)				48					52	

Table 13. Atherinid feeding habit summary at the Kirby Park station. (for details of symbols, see Table 10).

KIRBY PARK

Prey Categories	*Atherinopsis californiensis* %N	%V	%F.O.	I.R.I.	Ranks	*Atherinops affinis* %N	%V	%F.O.	I.R.I.	Ranks
Plants										
Chlorophyta										
Enteromorpha intestinalis						---	39.83	49.02	1952.47	1
Enteromorpha spp.	---	25.95	54.19	1406.23	2	---	13.46	19.60	263.81	4
Rhodophyta										
Achrochetium porphyrae	---	1.06	2.29	2.42	10					
Gelidium sinicola	---	0.22	0.76	0.16	12					
Polysiphonia spp.						---	1.92	1.96	3.76	10
Chrysophyta (Diatoms)										
Gyrosigma spp.	---	0.34	6.10	2.07	11	---	6.48	9.80	63.50	5
Melosira moniliformis	---	37.86	62.60	2370.03	1	---	23.31	68.62	1599.53	3
Navicula distans						---	0.97	11.76	11.40	9
Naviculoideae(unident.)						---	2.73	17.64	48.15	7
Annelida										
Polychaeta										
Tubularians	1.52	0.80	4.58	10.62	7					
Nematoda	0.007	0.16	0.76	0.12	13	100.00*	0.13	17.64	1766.29	2
Arthropoda										
Crustacea										
Ostracoda										
Ostracods	3.23	0.02	0.76	2.47	9					
Copepoda										
Calanoid copepods	25.22	0.53	1.52	39.14	6					
Cyclopoid copepods	5.82	0.03	0.76	4.44	8					
Vertebrata										
eggs of A. californiensis	64.03	2.50	5.34	355.27	4					
Miscellaneous										
detritus	---	8.64	13.74	118.71	5	---	4.28	9.80	41.94	8
digested material	---	21.98	25.19	553.67	3	---	6.87	7.84	53.86	6
Total Number of Prey Categories	13					10				
Number of Fish Examined (with contents)	145					90				

*This value is unrealistically high since only one prey item could be given a numerical importance value.

Table 14. Leptocottus feeding habit summary at all stations. (for details of symbols, see Table 10).

Leptocottus armatus

ALL STATIONS

Prey Categories	%N	%V	%F.O.	I.R.I.	Rank
Algae					
Enteromorpha	0.00	8.72	34.09	297.52	6
Algal debris	0.00	1.36	2.27	3.09	19
Nemertea (unident.)	2.27	0.02	2.27	5.21	18
Annelida					
Polychaeta					
Polychaeta (unident.)	0.25	0.22	2.27	1.09	20
Eteone sp.	1.19	1.25	6.81	16.68	11
Arthropoda					
Crustacea					
Copepoda (unident.)	2.27	0.90	2.27	7.23	16
Amphipoda					
Amphipoda (unident.)	0.00	3.70	4.54	16.83	10
Caprella sp.	2.04	0.04	6.81	14.21	12
Anisogammarus confervicolus	20.25	12.00	27.27	879.59	2
Corophium sp.	10.67	3.06	22.72	312.40	5
Isopoda (unident.)	0.34	0.02	2.27	0.82	21
Decapoda					
Decapoda (unident.)	2.90	3.72	9.09	60.33	9
Hemigrapsus oregonensis	22.48	18.56	29.54	1213.07	1
Upogebia pugettensis	2.27	2.04	2.27	9.81	13.5
Insecta					
Terrestrial insects (unident.)	0.56	0.56	6.81	7.74	15
Mollusca					
Bivalvia					
Bivalvia (unident.)	0.56	2.02	2.27	5.88	17
Tresus nuttallii	2.27	2.04	2.27	9.81	13.5
Clam siphons	9.00	4.86	13.63	189.08	7
Vertebrata					
Osteichthys					
Fish (unident.)	9.24	10.56	18.18	360.26	4
Miscellaneous					
Detritus	0.00	6.45	13.63	88.01	8
Digested material	0.00	15.77	29.54	466.01	3

Total Number of Individual Prey Items	382
Total Number of Prey Species	21
Number of Fish Examined (with contents)	44

Table 15. Embiotocid feeding habit summary at the ocean station. (for details of symbols, see Table 10).

OCEAN

Prey Categories	Hyperprosopon anale %N	%V	%F.O.	I.R.I.	Rank	Amphisticus argenteus %N	%V	%F.O.	I.R.I.	Rank	Phanerodon furcatus %N	%V	%F.O.	I.R.I.	Rank
Arthropoda															
Crustacea															
Copepoda															
Calanoida (unident.)	2.08	0.12	6.25	13.80	10										
Calanus pacificus	11.93	5.50	43.75	762.84	5										
Malacostraca															
Amphipoda (unident.)	9.44	0.50	18.75	186.53	9										
Allorchesles angusta	0.69	0.12	6.25	5.12	13	0.52	0.10	10.00	6.26	15.5					
Atylus tridens	6.02	1.37	31.25	231.11	8	15.99	6.10	40.00	883.95	2					
Corophium sp.	0.88	0.12	12.50	12.61	11										
Monoculoides spinipes						16.66	0.90	30.00	526.99	4					
Oedicerotidae (unident.)						0.52	0.10	10.00	6.26	15.5					
Cumacea															
Cumacea (unident.)						3.33	0.20	10.00	35.33	10					
Diastylopsis tenuis						1.66	0.40	10.00	20.66	12					
Mysidacea (unident.)	16.26	3.06	68.75	1328.61	3	3.68	2.00	10.00	56.84	9					
Acanthomysis sculpta						9.44	4.20	20.00	272.88	5					
Metamysidopsis elongata						8.33	0.60	20.00	178.66	6					
Decapoda															
Decapoda (unident.)	4.89	2.68	31.25	237.02	7	0.09	1.00	10.00	10.90	13.5					
Crab zoea (unident.)	15.32	6.62	50.00	1097.39	4										
Crab megalops (unident.)	18.61	12.12	50.00	1537.20	2										
Emerita analoga	0.05	0.25	6.25	1.91	14	10.00	7.00	10.00	170.00	7					
Mollusca															
Bivalvia															
Bivalvia (unident.)						0.00	3.40	10.00	34.00	11	50.00	40.00	50.00	4500.00	2
Echinodermata															
Echinoidea															
Dendraster excentricus	0.69	0.62	6.25	8.24	12	10.00	6.50	40.00	660.00	3					
Vertebrata															
Osteichthys															
Fish eggs (Atherinidae)						9.63	5.50	10.00	151.39	8					
Fish parts (unident.)	6.82	4.87	31.25	365.77	6										
Miscellaneous															
Algal debris						0.09	1.00	10.00	10.90	13.5					
Digested material	0.00	62.00	100.00	6200.00	1	0.00	60.50	100.00	6050.00	1	0.00	60.00	100.00	6000.00	1
Sand particles						0.00	0.50	10.00	5.00	17					
Total Number of Individual Prey Items				413					170					5	
Total Number of Prey Categories				14					17					2	
Number of Fish Examined (with contents)				16					10					2	

Table 16. Embiotocid feeding habit summary at the bridge station. (for details of symbols, see Table 10).

BRIDGE

Prey Categories	Phanerodon furcatus %N	%V	%F.O.	I.R.I.	Rank	Cymatogaster aggregata %N	%V	%F.O.	I.R.I.	Rank	Embiotoca jacksoni %N	%V	%F.O.	I.R.I.	Rank
Protozoa															
Foraminifera															
Ammonia beccarii											2.94	0.35	6.45	21.32	11
Platyhelminthes															
Turbellaria (unident.)						0.28	0.02	2.85	0.89	25					
Nematoda (unident.)						0.43	0.17	17.14	10.34	15					
Annelida (unident.)						3.00	1.31	5.71	24.70	11					
Hirudinea (unident.)						0.00	0.02	2.85	0.10	32.5					
Oligochaeta (unident.)						0.71	2.28	8.57	25.71	10					
Polychaeta															
Polychaeta (unident.)	12.12	3.86	27.45	438.94	4	8.04	6.91	34.28	512.83	4	1.11	24.96	70.96	1851.20	2
Polychaeta fecal pellets	0.00	0.15	1.96	0.30	31										
Capitellidae (unident.)	7.04	1.98	13.72	123.89	7	4.71	1.57	11.42	71.79	7					
Capitella capitata	5.63	2.52	13.72	112.11	8	4.07	3.17	11.42	82.83	6	0.14	0.03	3.22	0.57	27
Lumbrineridae (unident.)						0.04	0.02	2.85	0.20	31.5					
Lumbrineris sp.	0.28	0.11	1.96	0.77	26						0.05	0.16	3.22	0.69	25
Nephthyidae (unident.)	1.71	1.27	1.96	5.86	16										
Nereidae (unident.)	0.49	0.35	1.96	1.65	23	0.08	0.05	2.85	0.41	28					
Nereis sp.											0.96	1.12	9.67	20.28	12
Platynereis bicaniculata	2.80	1.31	13.72	56.50	9	0.42	0.28	5.71	4.04	18	1.08	0.83	9.67	18.61	13
Onuphidae (unident.)	0.15	0.09	1.96	0.48	28										
Armandia brevis	1.66	0.76	3.92	9.52	14	36.99	14.14	51.42	2630.03	2	2.81	1.77	12.90	59.16	7
Phyllodocidae (unident.)	0.08	0.11	1.96	0.39	30						0.02	0.16	3.22	0.60	26
Polynoidae (unident.)	0.11	0.29	1.96	0.80	25										
Streblospio benedicti						0.86	0.51	2.85	3.94	20					
Syllidae (unident.)						0.95	0.28	2.85	3.53	21					
Arthropoda															
Crustacea															
Copepoda															
Calanoida (unident.)						0.64	0.05	5.71	4.03	19					
Harpacticoida (unident.)	0.25	0.05	5.88	1.85	22	24.98	3.57	74.28	2121.27	3	0.58	0.09	9.67	6.56	18
Ostracoda (unident.)	0.03	0.03	3.92	0.27	32	0.71	0.20	20.00	18.38	12	0.49	0.16	16.12	10.57	16
Cirripedia															
Cypris larvae	0.03	0.01	1.96	0.10	33	0.02	0.05	5.71	0.47	27					
Malacostraca															
Amphipoda															
Amphipoda (unident.)	6.37	0.92	17.64	128.81	6	1.00	0.05	5.71	6.06	17	29.03	0.77	32.25	961.49	4
Allorchestes angusta											0.01	0.06	3.22	0.26	29
Anisogammarus confervicolus	2.02	0.25	11.76	26.83	12						2.15	0.06	3.22	7.14	17
Aoroides columbiae	1.24	0.31	9.80	15.26	13	3.44	0.57	34.28	137.79	5	15.01	4.61	41.93	822.93	5
Atylus tridens											0.11	0.45	6.45	3.63	21
Caprella sp.	23.30	10.64	45.09	1531.33	2	2.15	0.60	22.85	63.01	8	18.86	9.48	48.38	1371.61	3
Corophium sp.	5.95	1.03	27.45	191.86	5	2.21	0.34	22.85	58.35	9	5.47	3.03	35.48	301.94	6
Euphilomedes carcharodonta						0.00	0.02	2.85	0.10	32.5					
Ischyroceridae (unident.)	0.18	0.03	1.96	0.43	29										
Ischyrocerus sp.	0.48	0.35	9.80	8.19	15	0.07	0.02	2.85	0.28	30	1.44	1.00	6.45	15.76	15
Cumacea															
Cumacea (unident.)						0.08	0.02	2.85	0.33	29					
Cyclaspis sp.	0.70	0.09	3.92	3.15	19	0.52	0.20	11.47	8.25	16	0.13	0.06	6.45	1.30	24
Isopoda															
Munna sp.						0.50	0.25	17.14	13.14	14	1.50	0.70	19.35	42.95	9
Tanaidacea															
Lepidochelia dubia	0.31	0.19	3.92	1.98	20	0.17	0.08	2.85	0.75	26					
Decapoda															
Decapoda (unident.)											0.21	0.41	9.67	6.12	19
Hemigrapsus oregonensis	3.72	2.19	7.84	46.44	10										
Insecta															
Terrestrial insects (unident.)	0.28	0.01	1.96	0.58	21										
Mollusca															
Gastropoda (unident.)						0.04	0.02	2.85	0.20	31.5					
Neogastropoda															
Nassarius sp.											0.02	0.03	3.22	0.17	30
Bivalvia															
Bivalvia (unident.)	5.28	5.21	45.09	473.73	3	0.24	1.40	8.57	14.09	13	1.65	0.16	9.67	17.57	14
Mytilidae (unident.)											0.41	0.19	6.45	3.93	20
Modiolus sp.											1.64	1.16	9.67	27.14	10
Mytilus sp.											0.36	0.16	6.45	3.40	22
Protothaca sp.	1.96	0.29	1.96	4.42	17										
Vertebrata															
Osteichthys															
Atherinopsis californiensis eggs	3.12	0.43	7.84	27.88	11										
Adhesive filaments	0.17	0.07	3.92	0.97	24										
Fish eggs (unident.)						0.71	0.02	2.85	2.12	23					
Fish otoliths (unident.)											0.05	0.03	3.22	0.28	28
Miscellaneous															
Algal debris	0.02	0.50	7.84	4.20	18	0.00	0.28	5.71	1.63	24	0.00	0.32	9.67	3.12	23
Digested material	0.00	62.56	98.03	6134.17	1	0.00	60.22	100.00	6022.85	1	0.00	45.19	96.77	4373.56	1
Sediment debris						0.00	0.85	2.85	2.44	22	0.00	2.58	19.35	49.94	8
Terrestrial seeds (unident.)	0.98	0.01	1.96	1.96	27										
Total Number of Individual Prey Items				1134					1910					2031	
Total Number of Prey Categories				33					34					30	
Number of Fish Examined (with contents)				51					35					31	

Table 17. Embiotocid feeding habit summary at the bridge station.

(for details of symbols, see Table 10).

BRIDGE

Prey Categories	Hyperprosopon argenteum					Micrometrus minimus					Damalichthys vacca				
	%N	%V	%F.O.	I.R.I.	Rank	%N	%V	%F.O.	I.R.I.	Rank	%N	%V	%F.O.	I.R.I.	Rank
Protozoa															
Sarcodina															
Foraminifera (unident.)	3.12	0.06	6.25	19.92	10.5										
Acanthocephala						2.17	0.75	25.00	73.09	8					
Annelida															
Polychaeta															
Polychaeta (unident.)	6.25	0.93	6.25	44.92	6										
Polychaeta fecal pellets	0.00	4.62	6.25	28.90	8										
Platynereis bicaniculata	2.08	0.93	6.25	18.88	12										
Arthropoda															
Crustacea															
Ostracoda (unident.)	6.25	0.06	6.25	39.45	7										
Cirripedia (unident.)	1.04	0.31	6.25	8.46	13	4.34	0.75	25.00	127.44	7					
Malacostraca															
Amphipoda															
Amphipoda (unident.)	12.50	0.12	12.50	157.81	5										
Anisogammarus confervicolus						16.08	1.75	50.00	891.84	3	7.29	5.00	25.00	307.29	4
Aoroides columbiae	3.12	0.06	6.25	19.92	10.5										
Caprella sp.						57.63	28.75	75.00	6479.23	1					
Corophium sp.	3.12	0.31	6.25	21.48	9	9.75	2.75	50.00	625.07	4	8.33	1.25	25.00	239.58	5
Insecta															
Terrestrial insects (unident.)						10.00	5.00	25.00	375.00	5					
Mollusca															
Gastropoda (unident.)	21.71	12.62	37.50	1287.89	2						16.66	13.75	25.00	760.41	3
Bivalvia															
Bivalvia (unident.)	14.25	13.80	25.00	701.25	3						67.70	41.25	100.00	10895.83	1
Protothaca sp.	14.02	9.37	25.00	585.06	4										
Vertebrata															
Osteichthys															
Fish eggs (unident.)	0.00	0.06	6.25	0.39	15										
Miscellaneous															
Algal debris						0.00	6.25	50.00	312.50	6					
Digested material	0.00	56.18	100.00	5618.75	1	0.00	54.00	100.00	5400.00	2	0.00	38.75	100.00	3875.00	2
Sediment debris	0.00	0.18	6.25	1.17	14										
Total Number of Individual Prey Items				983					70					39	
Total Number of Prey Categories				15					8					5	
Number of Fish Examined (with contents)				16					4					4	

Table 18. Embiotocid feeding habit summary at the dairies station. (for details of symbols, see Table 10).

DAIRIES

Prey Categories	*Phanerodon furcatus* %N	%V	%F.O.	I.R.I.	Rank	*Cymatogaster aggregata* %N	%V	%F.O.	I.R.I.	Rank	*Damalichthys vacca* %N	%V	%F.O.	I.R.I.	Rank	*Embiotoca jacksoni* %N	%V	%F.O.	I.R.I.	Rank
Nemertea (unident.)	2.17	0.21	4.34	10.39	15											1.09	0.71	14.28	25.90	8
Nematoda (unident.)						0.53	0.12	12.50	8.25	12						1.58	0.14	14.28	24.71	9
Acanthocephala (unident.)											0.96	0.12	12.50	13.58	6	9.89	1.42	14.28	161.69	6
Annelida (unident.)	2.89	0.86	4.34	16.38	12															
Oligochaeta (unident.)						1.95	1.56	18.75	65.90	7										
Polychaeta																				
Polychaeta (unident.)	25.51	7.91	47.82	1598.53	2	1.04	5.31	18.75	119.14	4						10.71	2.85	28.57	387.75	4
Polychaeta fecal pellets						0.00	8.37	12.50	104.68	5						0.00	0.42	28.57	12.24	12
Capitellidae (unident.)	0.28	0.43	4.34	3.10	17	0.16	0.25	6.25	2.61	15										
Capitella capitata						1.75	3.68	12.50	67.98	6										
Armandia brevis	2.78	0.43	4.34	13.98	13															
Serpulidae (unident.)	4.34	0.43	4.34	20.79	11															
Streblospio benedicti						2.08	0.62	6.25	16.92	11										
Sipunculoidea (unident.)																11.11	0.71	14.28	168.93	5
Arthropoda																				
Crustacea																				
Copepoda																				
Calanoida (unident.)						3.33	0.43	12.50	47.19	8										
Calanus pacificus						1.50	1.56	6.25	19.14	10										
Harpacticoida (unident.)						15.16	3.93	31.25	596.88	2										
Cirripedia																				
Cypris larvae (unident.)						0.50	0.50	6.25	6.31	13										
Malacostraca																				
Amphipoda																				
Amphipoda (unident.)	11.10	0.91	26.08	313.39	4											4.76	0.28	14.28	72.10	7
Anisogammarus confervicolus	0.94	0.60	8.69	13.48	14															
Aoroides columbiae	0.24	0.08	8.69	2.89	19											1.09	0.28	14.28	19.78	10.5
Caprella sp.	5.08	3.78	13.04	115.67	6															
Corophium sp.	9.46	2.60	26.08	315.06	3															
Cumacea																				
Cyclaspis sp.						0.08	0.18	12.50	3.34	14										
Isopoda																				
Ianiropsis analoga	8.12	4.13	8.69	106.61	7	6.06	5.25	12.50	141.38	3										
Munna sp.	0.21	0.13	8.69	2.98	18	0.18	0.12	6.25	1.96	16										
Decapoda																				
Decapoda (unident.)	1.81	2.60	8.69	38.43	10											44.44	7.14	85.71	4421.76	2
Hemigrapsus oregonensis	4.36	1.86	13.04	81.36	8						55.74	88.62	100.00	14437.40	1					
Mollusca																				
Amphineura																				
Polyplacophora (unident.)																1.09	0.28	14.28	19.78	10.5
Gastropoda (unident.)											0.13	0.12	12.50	3.19	7					
Bivalvia																				
Bivalvia (unident.)	2.69	3.17	8.69	51.03	9						6.14	1.87	25.00	200.49	5	14.19	12.57	42.85	1147.09	3
Bivalve siphons						3.12	0.31	6.25	21.48	9										
Protothaca sp.											8.23	2.37	37.50	397.84	3					
Vertebrata																				
Osteichthys																				
Atherinopsis californiensis eggs	8.68	8.04	8.69	145.46	5															
Fish eggs (unident.)	0.56	0.08	8.69	5.65	16						28.78	2.50	37.50	1173.00	2					
Miscellaneous																				
Digested material	0.00	61.52	100.00	6152.17	1	0.00	67.75	100.00	6775.00	1	0.00	4.37	62.50	273.43	4	0.00	73.14	100.00	7314.28	1
Zostera fragments	0.00	0.13	4.34	0.56	20															
Total Number of Individual Prey Items				1114					861					248					48	
Total Number of Prey Categories				20					16					7					12	
Number of Fish Examined (with contents)				23					16					8					7	

Table 19. Embiotocid feeding habit summary at the Kirby Park station. (for details of symbols, see Table 10).

KIRBY PARK

Prey Categories	Cymatogaster aggregata %N	%V	%F.O.	I.R.I.	Rank	Embiotoca jacksoni %N	%V	%F.O.	I.R.I.	Rank	Phanerodon furcatus %N	%V	%F.O.	I.R.I.	Rank
Protozoa															
Sarcodina															
Foraminifera															
Foraminifera (unident.)						0.83	0.11	11.11	10.49	9					
Ammonia beccarii	1.47	0.21	16.66	28.05	11	0.16	0.22	22.22	8.55	10	2.13	0.11	11.11	24.97	11
Elphidium gunteri	0.00	0.00	0.92	0.00	43.5										
Platyhelminthes															
Turbellaria (unident.)	0.06	0.02	2.77	0.24	25.5										
Nemertea (unident.)	0.50	0.07	3.70	2.12	18										
Nematoda (unident.)	0.34	0.15	9.25	4.66	14										
Annelida															
Hirudinea (unident.)	0.04	0.02	1.85	0.13	28.5										
Oligochaeta (unident.)	1.76	1.17	12.96	38.11	9										
Polychaeta															
Polychaeta (unident.)	1.54	3.79	15.74	84.15	7	2.08	0.22	5.55	12.80	8	0.00	2.88	11.11	32.09	9
Capitellidae (unident.)	1.05	0.60	2.77	4.58	15										
Capitella capitata	0.54	0.28	3.70	3.07	17										
Nereis sp.															
Platynereis bicaniculata											2.13	4.44	11.11	73.12	8
Phyllodocidae (unident.)	0.00	0.04	0.92	0.04	35										
Spionidae (unident.)	2.79	3.14	24.07	143.13	5										
Streblospio benedicti	15.58	8.69	37.96	921.56	3										
Polydora socialis	0.08	0.21	1.85	0.54	21										
Pseudopolydora paucibranchiata	0.06	0.07	1.85	0.26	23.5										
Exogone lourei	0.03	0.13	0.92	0.15	27										
Arthropoda															
Crustacea															
Copepoda															
Calanoida (unident.)	0.09	0.03	1.85	0.24	25.5										
Harpacticoida (unident.)	5.48	1.13	25.92	171.63	4										
Ostracoda															
Podocopid ostracod (unident.)	1.28	0.31	16.66	26.58	12	0.05	0.11	11.11	1.81	13	0.42	0.11	11.11	5.98	14
Cirripedia															
Cypris larvae (unident.)	0.00	0.00	0.92	0.01	40										
Malacostraca															
Amphipoda															
Amphipoda (unident.)	2.86	0.76	8.33	30.28	10										
Allorchestes angusta	0.33	0.31	5.55	3.61	16						1.28	0.55	11.11	20.41	12
Anisogammarus confervicolus						0.04	0.16	16.66	3.54	12					
Aoroides columbiae	0.48	0.02	2.77	1.42	19						3.94	0.66	22.22	102.45	7
Caprella sp.	0.01	0.04	0.92	0.05	32										
Corophium sp.	53.63	21.33	84.25	6316.51	1	88.84	34.66	94.44	11664.60	1	10.81	2.77	11.11	151.07	6
Melita sp.	0.02	0.03	1.85	0.10	30										
Parathemisto pacifica															
Cumacea															
Cyclapsis sp.	3.53	1.53	25.92	131.47	6										
Isopoda															
Isopoda (unident.)	0.01	0.01	0.92	0.02	37										
Ianiropsis analoga	0.02	0.02	0.92	0.04	35										
Aegathos sp.	0.00	0.00	0.92	0.01	40										
Mysidacea (unident.)															
Decapoda															
Decapoda (unident.)	0.02	0.12	1.85	0.26	23.5	1.25	1.11	22.22	52.61	5	22.41	14.44	33.33	1228.71	2
Crab megalops	0.00	0.04	0.92	0.04	35										
Hemigrapsus oregonensis						5.65	7.05	27.77	353.03	4	0.03	2.22	11.11	25.10	10
Insecta															
Terrestrial insects (unident.)	0.01	0.09	2.77	0.31	22										
Mollusca															
Gastropoda (unident.)	0.13	0.00	0.92	0.13	28.5										
Bivalvia															
Bivalvia (unident.)	0.12	0.09	4.62	0.99	20	0.76	0.50	22.22	28.12	7	0.85	21.22	55.55	1226.49	3
Bivalve siphons	0.01	0.01	1.85	0.05	32										
Gemma gemma	1.47	0.01	0.01	0.01	40	0.07	0.05	5.55	0.74	14	22.64	2.88	33.33	851.28	5
Psephidia sp.						0.20	0.16	16.66	6.22	11					
Vertebrata															
Osteichthys															
Atherinopsis californiensis eggs	1.30	1.09	9.25	22.22	13						22.18	18.33	22.22	900.41	4
Adhesive filaments	0.00	0.00	0.92	0.00	43.5										
Fish eggs (unident.)															
Fish otoliths (unident.)	0.03	0.01	0.92	0.05	32										
Miscellaneous															
Algal debris	0.00	1.69	23.14	39.22	8	0.00	2.88	16.66	48.14	6	0.00	0.55	11.11	6.17	13
Digested material	0.00	51.67	100.00	5167.59	2	0.00	38.77	72.22	2804.62	2	0.00	28.77	88.88	2558.02	1
Sediment debris	0.00	0.00	0.92	0.01	40	0.00	14.00	33.33	466.66	3					
Terrestrial seeds	0.00	0.00	0.92	0.01	40	0.01	0.05	5.55	0.41	15					
Total Number of Individual Prey Items				11821					4290					784	
Total Number of Prey Categories				44					15					14	
Number of Fish Examined (with contents)				108					18					9	

Table 20. Pleuronectiform feeding habit summary at the ocean station. (for details of symbols, see Table 10).

Prey Categories	*Platichthys stellatus* %N	%V	%F.O.	I.R.I.	Ranks	*Parophrys vetulus* %N	%V	%F.O.	I.R.I.	Ranks	*Citharichthys stigmaeus* %N	%V	%F.O.	I.R.I.	Ranks	*Psettichthys melanostictus* ≤150mm %N	%V	%F.O.	I.R.I.	Ranks	*Psettichthys melanostictus* >150mm %N	%V	%F.O.	I.R.I.	Ranks
Protozoa																									
Foraminifera (unident.)						0.24	0.26	2.32	1.16	68.8															
Elphidiella spp.						0.50	0.26	2.32	1.76	63.3															
Cnidaria																									
Obelia sp.											0.91	0.36	1.03	1.30	58										
Nemertea																									
Nemertea (unident.)	1.01	0.62	3.57	5.81	33																				
Brachiopoda																									
Brachiopoda (unident.)																0.32	0.25	2.56	1.47	15					
Annelida																									
Polychaeta																									
Polychaeta (unident.)	0.75	0.75	7.14	10.71	21	0.66	1.07	13.95	24.13	26						1.28	2.05	2.56	8.57	12					
Sigalionidae (unident.)						0.28	0.97	4.65	5.81	48															
Phyllodocidae (unident.)											0.54	0.85	2.06	2.86	41										
Anaitides sp.						0.82	1.45	6.97	15.82	32															
Eteone sp.						0.80	1.80	30.23	78.59	8	0.40	0.76	2.06	2.38	47										
Eteone longa californica											0.18	0.51	1.03	0.71	64										
Eumida bifoliata						0.14	0.80	2.32	2.18	58.5	0.44	0.77	1.03	1.24	59.5										
Hesperone complanata											0.51	1.11	3.09	5.00	34										
Glycera sp.						1.28	1.61	2.32	6.70	44															
Goniadidae (unident.)											0.44	1.03	1.03	1.51	55										
Nepthys sp.	0.50	1.87	3.57	8.46	25.5	0.35	1.78	4.65	9.90	38															
Onuphidae (unident.)	0.50	12.52	7.14	92.96	8						1.83	2.74	3.09	14.12	18										
Nothria sp.	1.51	2.50	3.57	14.31	19	1.71	2.42	2.32	9.58	39	0.59	1.48	1.03	2.13	52										
Nothria elegans	3.66	5.63	25.00	232.25	3						1.47	2.04	4.12	14.46	16										
Onuphis eremita	1.51	4.13	3.57	20.13	16																				
Scoloplos sp.						0.78	0.56	4.65	6.23	45.5															
Spionidae (unident.)											0.11	0.10	1.03	0.21	74.5										
Polydora sp.						7.38	5.37	4.65	59.28	13															
Prionospio pygmaeus						4.21	3.38	32.55	247.05	2	1.51	1.03	1.03	2.61	45										
Streblospio benedicti						2.67	1.44	4.65	19.11	29	2.14	1.62	4.12	15.49	15										
Opheliidae (unident.)											0.17	0.21	1.03	0.39	71.5										
Armandia brevis						10.36	5.39	13.95	219.71	3	0.11	0.26	2.06	0.76	63										
Magelona sacculata						6.28	4.85	2.32	25.82	25															
Capitellidae (unident.)						0.14	0.32	4.65	2.13	60	0.70	1.20	2.06	3.91	36										
Capitella capitata	23.25	5.00	3.57	100.85	7	1.32	2.80	20.93	86.23	6	0.10	0.27	1.03	0.38	73										
Mediomastus californiensis						0.24	0.26	2.32	1.16	68.8	0.17	0.21	1.03	0.39	71.5										
Notomastus tenuis						0.14	2.42	2.32	5.93	47															
Terebellidae (unident.)						2.43	0.92	9.30	31.15	20	0.66	0.96	2.06	3.33	38										
Amaena occidentalis						1.71	0.32	2.32	4.70	51	0.86	1.53	3.09	7.38	29										
Echinodermata																									
Dendraster excentricus	0.82	4.44	28.57	150.27	6	0.31	0.45	34.88	26.50	24	1.89	0.51	3.09	7.41	28										
Ophiuroidea																									
Ophiuroidea (unident.)						0.24	0.52	2.32	1.76	63.3											3.12	0.62	6.25	23.43	12
Arthropoda																									
Crustacea																									
Ostracoda																									
Ostracoda (unident.)						1.14	0.78	4.65	8.92	41															
Podocopid ostracod (unident.)						0.14	0.32	2.32	1.06	80.5															
Euphilomedes spp.						0.24	0.26	2.32	1.16	68.8	5.07	0.27	1.03	5.50	32										
Euphilomedes carcharodonta						2.28	1.18	44.18	152.86	4	1.21	1.12	6.18	14.39	17										
Euphilomedes longiseta						0.37	0.78	4.65	5.34	49															
Euphilomedes oblonga						3.20	0.88	6.97	28.43	22															
Cirripedia																									
Cirripedia (unident.)	1.01	0.25	3.57	4.49	34.5	0.24	0.26	2.32	1.16	68.8															
Copepoda																									
Calanoida (unident.)						0.19	0.21	4.65	1.86	62	0.85	0.36	3.09	3.73	37										
Harpacticoida (unident.)						2.36	0.52	25.58	73.67	10	5.95	1.82	4.12	32.01	7										
Isopoda																									
Bathecopea daltonae	1.01	0.25	3.57	4.49	34.5	0.14	0.17	9.30	2.88	57	0.44	0.15	1.03	0.60	67										
Cumacea																									
Cumacea (unident.)						0.24	0.26	2.32	1.16	68.8	0.33	0.44	2.06	1.58	54										
Anchuolurus occidentalis						0.14	0.16	2.32	0.69	82	0.50	0.14	1.03	0.65	65										
Cyclaspis sp.						2.03	1.30	2.32	7.72	43															
Diastylopsis tenuis						0.86	0.63	25.58	33.88	18	0.52	0.37	3.09	2.75	42										
Hemilamprops californica						1.08	1.00	20.93	43.53	17	0.26	0.38	2.06	1.31	57										
Lamprops sp.						1.82	1.56	23.25	78.58	9	1.06	1.21	3.09	7.01	30										
Mesolamprops sp.						0.14	0.32	2.32	1.06	80.5	0.50	0.59	1.03	1.12	61										
Amphipoda																									
Gammaridea (unident.)	0.67	0.20	10.71	9.31	23	2.38	0.71	20.93	64.67	11	1.67	0.82	4.12	10.25	23.5										
Allorchestes angusta											1.31	0.97	4.12	9.39	26	0.89	1.02	5.12	9.82	10					
Ampelisca cristata						0.24	0.26	2.32	1.16	68.8															
Aoroides columbiae						0.33	0.42	18.60	13.95	34	0.38	0.34	4.12	2.96	40										
Atylus tridens											2.82	2.28	20.61	105.61	3	1.28	1.53	5.12	14.46	7					
Bathymedon sp.	1.01	0.62	7.14	11.63	20	0.24	0.26	2.32	1.16	68.8											3.12	0.31	6.25	21.48	13
Corophium spp.						0.32	0.29	16.27	9.92	37	1.33	0.56	10.30	19.46	10										
Eohaustorius sp.	0.50	0.50	3.57	3.57	37	0.24	0.26	2.32	1.16	68.8	0.44	0.10	1.03	0.55	69										
Jassa sp.											0.22	0.36	1.03	0.59	68										
Lysianassidae (unident.)						0.24	0.52	2.32	1.76	63.3															
Megaluropus longimerus											0.22	0.22	1.03	0.45	70										
Metopa sp.						0.24	0.76	2.32	1.16	68.8															
Metopacistella sp.											1.82	0.36	1.03	2.24	49										
Monoculoides sp.	0.50	0.25	3.57	2.67	39.3	1.69	0.95	30.23	79.80	7	1.43	0.86	8.24	18.86	11										
Monoculoides spinipes						0.99	1.29	2.32	5.28	50	5.02	3.26	4.12	34.11	6	0.51	0.51	5.12	4.26	14					
Paraphoxus epistomius											1.50	1.11	1.03	2.68	43										
Paraphoxus lucubrans	1.01	0.75	3.57	6.28	30.5	0.63	0.64	16.27	20.66	28	1.00	0.36	1.03	1.40	56										
Paraphoxus obtusidense	1.85	1.46	10.71	35.45	13	0.99	0.37	6.97	9.47	40	0.67	0.68	4.12	5.56	31										
Protomediarticulata sp.						0.24	0.26	2.32	1.16	68.8															
Synchelidium sp.						0.98	0.98	44.18	86.59	5	1.04	1.08	6.18	13.10	20	0.47	0.64	7.69	8.56	13					
Synchelidium shoemakeri						0.30	0.28	6.97	4.04	54	3.79	5.02	2.06	18.14	13	0.09	0.12	2.56	0.57	16					
Tiron biocellata											4.46	3.67	2.06	16.74	14										
Caprella spp.						0.24	0.26	2.32	1.16	68.8	1.47	1.44	3.09	8.99	27										
Mysidacea																									
Mysidacea (unident.)											0.55	0.51	2.06	2.18	51										
Acanthomysis spp.						0.42	0.16	2.32	1.34	67	0.82	1.16	10.30	20.39	9	5.12	2.56	5.12	39.44	6	6.25	6.25	6.25	78.12	7
Acanthomysis davisi						0.14	0.80	2.32	2.18	58.5	11.64	10.85	48.45	1089.64	1	61.58	55.64	84.61	9919.47	1					
Acanthomysis nephropthalma											1.59	1.73	3.09	10.25	23.5										
Acanthomysis sculpta																0.94	0.76	5.12	8.76	11					
Metamysidopsis elongata											0.36	0.25	1.03	0.62	66	9.66	7.58	28.20	486.75	2					
Neomysis kadiakensis											1.14	1.03	1.03	2.23	50	9.08	8.66	17.94	318.57	3					
Decapoda																									
Crangon spp.											1.64	2.47	3.09	12.69	21	3.67	4.82	7.69	65.35	5	12.50	12.50	12.50	312.50	5
Crangon nigromaculata																					5.20	5.62	12.50	135.41	6
Crangon stylirostris											1.66	2.86	3.09	13.96	19										
Spirontocaris sp.											1.35	1.03	1.03	2.45	46	0.12	0.07	2.56	0.52	17					
Callianassa californica	0.50	1.87	3.57	8.46	25.5																				
Brachyura (unident.)	1.13	1.50	14.28	37.55	12						0.72	0.91	11.34	18.48	12										
Cancer sp.	0.50	1.25	3.57	6.24	32						0.97	0.78	3.09	5.40	35	2.56	2.56	2.56	13.14	8					
Cancer jordani											0.14	0.36	2.06	1.03	62										
Cancer magister	20.47	6.95	7.14	195.77	5																				
Pinnixa sp.											3.08	2.69	2.06	11.88	22										
Pinnixa franciscana	5.84	3.61	32.14	303.72	1	4.71	4.85	2.32	22.17	27	2.49	1.94	9.27	41.06	5										
Scleroplax granulata	1.17	0.66	10.71	19.59	17	3.99	1.61	2.32	12.99	35	1.88	2.06	23.71	93.41	4										
Blepharopoda occidentalis	0.50	6.26	3.57	24.13	15																2.08	2.50	6.25	28.64	11
Emerita analoga	7.07	12.52	3.57	69.93	10																				
Brachyuran eggs																					5.68	2.18	6.25	49.18	10
Mollusca																									
Bivalvia																									
Bivalvia (unident.)	0.50	0.33	10.71	8.88	24	1.37	1.14	20.93	52.53	14	0.89	0.59	2.06	3.04	39										
Bivalve siphons	0.50	0.81	7.41	9.35	22	2.17	2.16	13.95	60.40	12	0.78	0.46	3.24	10.21	25										
Saxidomus nuttallii siphons						5.34	2.62	2.32	18.46	30															
Tresus nuttallii						4.42	3.07	6.97	52.20	15															
Tresus nuttallii siphons	1.51	0.62	3.57	7.60	29																				
Macoma spp	1.01	1.25	3.57	8.06	27.5	1.05	3.16	6.97	29.34	21	0.11	0.10	1.03	0.21	74.5										
Macoma nasuta						0.32	0.35	9.30	6.23	45.5															
Tellina sp.						0.19	0.66	4.65	3.95	55	0.89	1.03	1.03	1.97	53										
Tellina bodegensis	1.01	1.25	3.57	8.06	27.5	0.14	0.16	2.32	4.18	53															
Tellina modesta	1.01	1.25	7.14	16.06	18	0.44	0.48	13.95	12.83	36															
Tellina nuculoides						1.01	0.78	4.65	8.32	42															
Siliqua spp	3.16	5.33	28.57	243.13	2	0.44	0.50	18.60	17.48	31	0.44	0.77	1.03	1.24	59.5										
Solen sicarius	1.51	0.25	3.57	6.28	30.5	0.38	2.78	4.65	14.69	33	2.04	2.60	1.03	4.77	35										
Mysella sp.						0.57	0.16	2.32	1.69	66															
Cryptomya californica	7.32	3.00	7.14	73.68	9																				
Mya arenaria	1.01	1.25	14.28	32.27	14																				
Bornia sp.	0.50	0.25	3.57	2.67	39.3																				
Clinocardium nuttallii	1.51	2.19	14.28	52.83	11	0.61	1.07	30.23	50.78	16						2.56	1.53	2.56	10.51	9					
Gastropoda																									
Polinices sp.						0.57	0.32	2.32	2.06	61															
Neogastropoda (unident.)						0.24	0.26	2.32	1.16	68.8															
Nassarius sp	0.50	0.37	3.57	3.10	38																				
Olivella pycna	0.50	0.25	3.57	2.67	39.3	1.64	2.26	9.30	36.27	19															
Vertebrata																									
Fish eggs (unident.)						0.53	0.78	2.32	3.03	56															
Fish (unident.)											0.73	1.48	1.03	2.27	46						19.12	13.12	31.25	1007.93	1
Engraulis mordax																					18.75	18.75	18.75	703.12	2
Spirinchus starksi																					3.12	5.00	6.25	50.78	9
Citharichthys stigmaeus																					0.18	0.93	6.25	7.04	14
Parophys vetulus																					6.25	5.62	6.25	74.21	8
Psettichthys melanostictus																					14.58	14.37	18.75	542.96	3
Miscellaneous																									
Terrestrial seeds						0.19	0.28	9.30	4.37	52															
Algae	0.00	1.25	3.57	4.46	36	0.00	2.37	11.62	27.53	23	0.00	2.60	1.03	2.67	44										
Digested material	0.00	3.83	53.57	205.17	4	0.00	3.95	95.34	376.59	1	0.00	8.37	72.16	603.97	2	0.00	8.71	33.33	290.59	4	0.00	12.18	43.75	533.20	4
Total Number of Individual Prey Items			434					3863					1188					502					70		
Total Number of Prey Categories			41					82					75					7					14		
Number of Fish Examined (with contents)			28					43					97					39					16		

Table 21. Pleuronectiform feeding habit summary at the bridge station. (for details of symbols, see Table 10).

Prey Categories	*Platichthys stellatus* (100-199mm)					*Platichthys stellatus* (200-299mm)					*Parophrys vetulus*					*Citharichthys stigmaeus*				
	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks
Protozoa																				
Foraminifera (unident.)																1.13	0.63	2.82	4.96	30
Echiuroidea																				
Urechis caupo						14.37	16.69	56.60	1757.99	1	0.17	0.27	0.89	0.39	66	0.46	0.22	0.56	0.38	56.3
Phoronidea																				
Phoronopsis virdis											2.20	0.86	0.89	2.72	40	0.25	0.10	1.12	0.39	55
Annelida																				
Polychaeta																				
Polychaeta (unident.)	9.85	7.77	30.76	541.99	4	3.36	1.63	13.20	65.86	8	2.29	1.60	17.85	69.43	10	2.91	2.09	18.64	93.20	8
Polynoidae (unident.)											0.29	0.56	0.89	0.75	60	4.06	3.2	1.69	12.28	16
Phyllodocidae (unident.)											0.34	0.27	0.89	0.54	62	0.69	1.76	0.56	1.37	43
Anaitides sp.																1.04	0.78	1.12	2.03	36
Eteone sp.						2.01	0.84	1.88	5.35	2'	0.39	0.55	7.14	6.71	30	0.73	0.81	2.25	3.46	31
Eteone longa californica											0.50	0.67	0.89	1.04	55					
Eumida sp.																0.13	0.05	0.56	0.10	61
Eumida bifoliata											0.29	0.65	2.67	2.50	43	0.35	1.40	3.38	5.91	28
Exogone lourei											0.31	0.57	5.35	4.70	35	0.69	0.60	2.25	2.90	33
Platynereis bicanaliculata											2.04	3.20	8.03	42.07	13	2.32	1.42	2.25	8.41	23
Glycera sp.	0.05	0.43	7.69	3.69	18	5.66	6.34	1.88	22.56	13										
Glycera robusta	8.91	7.77	7.69	128.26	6															
Nepthys cornuta franciscana											0.74	0.76	2.67	4.00	36					
Onuphidae (unident.)																2.61	3.15	0.56	3.22	32
Nothria sp.						0.50	0.63	1.88	2.12	27										
Nothria elegans																1.49	0.39	1.12	2.10	35
Dorvilleidae (unident.)											0.52	0.98	1.78	2.67	41					
Lumbrineris sp.						1.25	0.90	1.38	4.04	25	0.39	0.93	3.57	4.71	34	0.35	4.67	1.12	5.52	29
Haploscoloplos pugettensis											0.11	0.13	0.89	0.21	69					
Spionidae (unident.)						0.30	0.36	1.88	1.24	30	1.18	0.64	3.57	6.49	31	2.54	3.21	19.20	110.40	6
Boccardia probascidae											0.33	0.67	0.89	0.89	56.3					
Polydora sp.											0.33	0.67	0.89	0.89	56.3					
Prionospio pygmaeus											0.33	0.67	0.89	0.89	56.3					
Rhynchospio sp.											1.10	0.28	0.89	1.22	53					
Streblospio benedicti											1.71	1.11	18.75	52.87	12	0.76	0.88	4.51	7.39	25
Cirratulus cirratus											0.53	1.20	4.46	7.71	29					
Armandia brevis	33.29	18.59	53.84	2793.21	2	14.63	8.14	3.77	85.84	6	12.55	7.34	74.10	1473.84	2	10.96	8.04	87.00	1653.00	2
Capitellidae (unident.)						1.50	1.17	1.88	5.01	22.5	0.99	1.17	9.82	21.21	18	3.49	2.58	1.69	10.25	21
Capitella capitata	5.04	2.91	23.07	183.40	5	2.24	2.13	3.77	16.47	15	3.31	2.72	20.53	123.79	6	0.82	0.87	6.77	11.44	18
Mediomastus california											2.03	2.11	3.57	14.77	21					
Notomastus tenuis						3.60	2.95	5.66	37.07	11	2.22	5.82	22.32	179.45	5	0.46	1.65	1.12	2.36	34
Terebellidae (unident.)											1.80	2.00	17.85	67.83	11					
Echinodermata																				
Ophiuroidea											0.54	1.26	2.67	4.80	33					
Arthropoda																				
Crustacea																				
Ostracoda																				
Podocopid ostracod (unident.)											0.29	0.19	3.57	1.71	50	0.18	0.09	1.69	0.45	54
Copepoda																				
Calanoida (unident.)											0.29	0.28	0.89	0.50	63.5	1.01	0.35	7.90	10.74	20
Harpacticoida (unident.)											3.60	0.93	16.07	72.79	9	1.70	0.34	18.64	38.02	11
Cirripedia																				
Cirripedia larvae											0.22	0.36	3.57	2.07	47	3.85	0.94	6.21	29.74	13
Cirripedia tentacles											3.56	1.42	2.67	13.29	22	2.67	2.74	6.21	33.59	12
Isopoda																				
Isopoda (unident.)											0.43	0.47	2.67	2.40	45					
Ianeropsis montereyensis																0.17	0.17	1.69	0.57	52
Tanaidacea																				
Leptochelia dubia	0.04	0.21	15.38	3.84	17						0.80	0.50	14.28	18.56	19.5	0.49	0.34	2.25	1.86	38
Cumacea																				
Cyclaspis sp.											1.34	1.03	5.35	12.67	24	0.88	0.22	7.34	8.07	24
Hemilamprops californica											0.50	0.67	5.35	6.25	32					
Amphipoda																				
Gammaridea (unident.)											3.11	0.44	2.67	9.47	28	0.40	0.17	2.82	1.60	42
Anisogammarus confervicolus						0.01	0.08	1.88	0.16	33	0.88	0.84	1.78	3.06	38					
Aoroides columbiae	1.82	2.78	23.07	106.12	7	0.24	0.45	1.88	1.29	31	3.66	2.29	45.55	271.02	4	4.10	2.37	46.32	299.69	4
Atylus tridens	0.20	0.09	7.69	2.23	19											0.46	0.22	0.56	0.38	56.3
Corophium spp.	0.22	0.15	15.38	5.69	15	0.03	0.17	1.88	0.37	32	1.51	0.86	10.71	25.38	14	0.43	0.34	9.03	6.95	26
Synchelidium shoemakeri																0.76	0.36	1.69	1.89	37
Tyron biocellata																0.46	0.44	1.12	1.00	47.5
Caprella spp.											0.49	0.75	8.03	9.95	27	2.20	1.30	27.11	94.88	7
Caprella californica											1.49	1.75	3.57	11.56	25	5.67	4.80	22.03	230.65	5
Mysidacea																				
Mysidacea (unident.)																1.61	0.44	0.56	1.14	46
Acanthomysis sp.											0.33	0.44	0.89	0.68	61	0.80	0.83	3.95	6.43	27
Acanthomysis davisii											0.88	0.84	0.89	1.53	51					
Metamysidopsis californica																0.13	0.16	1.12	0.32	59
Decapoda																				
Crangon sp.						0.50	0.20	1.88	1.31	29						3.45	4.24	1.69	12.99	15
Brachyura (unident.)	8.91	1.94	7.69	83.43	10	2.46	2.00	9.43	42.05	10	0.19	0.28	2.67	1.25	52	1.66	1.18	7.34	20.84	14
Cancer sp.						0.44	0.36	1.88	1.50	28						0.23	0.46	0.56	0.38	56.3
Cancer gracilis						1.17	0.63	1.88	3.38	26										
Pinnixa sp.																0.26	0.78	0.56	0.58	51
Scleroplax granulata						3.19	1.87	11.32	57.27	9	0.33	0.89	0.89	1.08	54	0.23	1.10	0.56	0.74	50
Hemigrapsus oregonensis						2.49	3.11	15.09	84.50	7						0.54	0.63	1.12	1.31	44
Hemigrapsus nudus						2.07	0.36	1.88	4.56	24										
Insecta																				
Terrestrial insects																3.60	3.46	1.69	11.93	17
Mollusca																				
Bivalvia																				
Bivalvia (unident.)	1.89	1.88	23.07	86.97	9	6.50	2.71	26.41	243.23	4	1.28	1.08	10.71	25.27	15	0.84	0.49	8.47	11.26	19
Bivalve siphons	22.19	13.03	69.23	2438.28	3	4.98	2.39	24.52	180.71	5	18.92	13.60	78.57	2555.09	1	10.64	4.16	65.53	969.84	3
Mytilus sp.																2.08	1.10	0.56	1.78	39
Modiolus sp.											0.50	0.55	1.78	1.86	48					
Gema gema											0.69	0.68	1.78	2.43	44					
Protothaca staminea											0.29	0.28	0.89	0.50	63.5					
Saxidomus nuttalli											0.76	0.54	14.28	18.56	19.5	0.69	1.10	0.56	1.00	47.5
Saxidomus nuttallii siphons						6.61	7.92	1.88	27.31	12						0.46	0.22	1.12	0.76	49
Transennella tantilla											0.22	1.40	1.78	2.88	39					
Mactridae (unident.)						2.20	0.79	1.88	5.62	20	0.63	1.48	5.35	11.28	26					
Tresus nuttallii						1.88	0.79	1.88	5.01	22.5	0.26	0.27	0.89	0.47	65					
Tresus nuttallii siphons	0.99	1.51	15.38	38.45	12	8.55	6.74	18.86	288.36	3										
Tellinidae (unident.)											0.67	0.22	0.89	0.79	59					
Macoma spp.	0.20	0.43	7.69	5.22	16	2.49	1.35	5.66	21.73	14	1.43	1.46	34.82	100.62	7	0.38	0.46	10.16	8.53	22
Macoma nasuta	3.51	2.42	15.38	91.20	8	1.76	2.11	1.88	7.27	17.5	2.33	1.24	3.57	12.74	23	0.18	0.07	0.56	0.14	60
Siliqua sp.	2.22	0.97	7.69	24.33	13															
Cryptomya californica						1.76	2.11	1.88	7.27	17.5	0.13	0.13	0.89	0.23	68					
Mya arenaria	0.60	0.97	7.69	12.07	14	1.11	0.71	3.77	6.86	19	1.97	1.78	6.25	23.43	16					
Clinocardium nuttallii											0.53	0.92	16.07	23.30	17					
Gastropoda																				
Polinices sp.																0.08	0.07	0.56	0.08	62
Neogastropoda (unident.)																1.15	0.33	1.12	1.65	40
Lacuna sp.											0.16	0.22	0.89	0.33	67	0.52	0.31	0.56	0.46	53
Olivella pycna											0.59	0.42	1.78	1.79	49	0.69	0.44	1.12	1.26	45
Turbonilla sp.											0.67	0.67	1.78	2.38	46					
Egg mass (unident.)											3.90	0.22	0.89	3.66	37	4.37	0.65	9.03	45.33	10
Vertebrata																				
Clevelandia ios																1.44	1.38	0.56	1.63	41
Miscellaneous																				
Terrestrial seeds											0.29	0.42	3.57	2.53	42					
Algae	0.00	1.84	30.76	56.59	11	0.00	0.83	15.09	12.52	16	0.00	2.49	29.46	73.35	8	0.00	1.87	25.59	47.85	9
Digested material	0.00	34.15	92.30	3152.04	1	0.00	20.41	69.81	1424.82	2	0.00	14.65	99.10	1451.81	3	0.00	20.12	94.40	1899.32	1
Total Number of Individual Prey Items				228					2598					5455					4281	
Total Number of Prey Categories				19					33					69					62	
Number of Fish Examined (with contents)				17					53					112					177	

Table 22. Pleuronectiform feeding habit summary at the dairies station. (for details of symbols, see Table 10).

	Platichthys stellatus (100-199mm)					Platichthys stellatus (200-299mm)					Parophrys vetulus					Citharichthys stigmaeus				
Prey Categories	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks
Sipunculoidea																				
Sipunculoidea (unident.)											0.88	0.25	1.92	2 16	42					
Echiuroidea																				
Urechis caupo	0.76	0.74	3.12	4.68	22	4.40	5.52	7.40	73.40	7										
Phoronidea																				
Phoronopsis viridis											0.18	0.18	1.92	0.69	44.5					
Brachiopoda																				
Glottida albida						0.10	0.14	3.70	0.88	27	0.49	0.50	3.84	3.80	34					
Annelida																				
Oligochaeta											2.20	1.38	3.84	13.74	22	0.59	1.76	1.53	3.59	25
Polychaeta																				
Polychaeta (unident.)	8.54	2.14	21.87	233.57	6	3.70	0.81	11.11	50.10	12	3.26	2.43	19.23	10.94	25	1.67	1.96	24.61	89.33	5
Eteone sp.	0.13	0.20	6.25	2.06	27															
Eteone dilatae											0.40	1.00	1.92	2.68	38					
Eteone longa californica											2.20	1.25	1.92	6.62	29	1.35	0.88	1.53	3.41	26.5
Eumida bifoliata	0.03	0.14	3.12	0.53	30											0.69	1.24	3.07	5.92	22
Exogone lourei											1.80	1.75	3.84	13.63	23	1.04	0.34	1.53	2.11	32.3
Glycera sp.						0.20	0.97	3.70	4.32	21										
Glycera americana						0.47	0.36	3.70	3.07	23										
Hemipodus borealis											0.37	0.28	1.92	1.24	43					
Neanthes virens	3.44	5.24	3.12	27.08	12															
Nereis sp.	0.05	0.20	3.12	0.78	29															
Platynereis bicanaliculata	2.38	0.51	3.12	9.01	18															
Nepthys cornuta franciscana											0.55	1.41	1.92	3.76	35					
Lumbrineris sp.						0.33	1.13	11.11	16.22	16	0.59	1.14	3.84	6.64	28					
Spionidae (unident.)											3.22	1.85	15.38	77.97	8	1.25	2.29	1.53	5.41	23
Polydora sp.	0.59	0.25	3.12	2.62	26						0.40	3.77	1.92	8.00	26					
Prionospio pygmaeus											0.60	1.50	1.90	4.03	33					
Streblospio benedicti	12.67	13.27	12.50	324.25	5						6.28	2.43	30.76	267.90	4	5.35	4.00	13.84	129.40	4
Cirratulidae (unident.)											2.37	0.50	3.84	11.02	24	1.04	5.26	1.53	9.63	19
Cirratulus cirratus											1.35	2.36	3.84	14.24	21					
Tharyx sp.											0.40	0.75	1.92	2.20	40.5					
Armandia brevis	14.26	9.58	34.37	819.38	3	14.55	3.92	3.70	68.33	9	2.35	1.69	32.69	132.06	6	1.88	2.25	20.00	82.60	6
Capitellidae (unident.)											0.55	1.00	9.61	14.89	20	0.59	2.65	1.53	4.95	24
Capitella capitata	0.21	0.95	3.12	3.61	24						2.67	1.65	13.46	58.14	10	2.04	1.11	9.23	29.07	13
Mediomastus californiensis											0.40	1.25	1.92	3.16	36.5					
Notomastus tenuis	1.26	2.08	6.25	20.87	13	0.48	2.13	3.70	9.65	17	0.60	1.25	3.84	7.10	27					
Terebellidae (unident.)	0.48	0.77	3.12	3.90	23	0.24	0.73	3.70	3.38	22	1.00	0.82	13.46	24.49	14					
Arthropoda																				
Crustacea																				
Ostracoda																				
Podocopid ostracod (unident.)											1.17	0.40	13.46	21.13	6					
Copepoda																				
Calanoida (unident.)																1.04	0.34	1.53	2.11	32.3
Harpacticoida (unident.)											4.70	0.63	30.76	16.39	19	0.44	0.17	3.07	1.87	35
Isopoda																				
Isopoda (unident.)																1.04	0.17	1.53	1.85	36
Ianeropsis montereyensis																1.60	1.55	12.30	38.74	10
Taniadacea																				
Leptochelia dubia											0.92	0.45	19.23	26.34	13	1.50	0.73	9.23	20.58	15
Cumacea																				
Cyclaspis sp.											3.49	1.86	38.46	20.57	17	1.65	1.17	6.15	17.34	17
Hemilamprops californica											0.80	0.50	1.92	2.49	39					
Amphipoda																				
Gammaridea (unident.)	0.07	0.04	3.12	0.34	33															
Aoroides columbiae	8.63	6.06	31.25	459.06	4	6.72	3.13	7.40	72.89	8	7.30	3.65	46.15	505.34	3	28.22	17.61	64.61	2961.07	1
Corophium spp.	0.10	0.16	12.50	3.25	25						1.23	0.87	11.53	24.21	15	1.03	0.52	12.30	19.06	16
Synchelidium spp.																1.04	0.34	1.53	2.11	32.3
Caprella spp.											0.18	0.18	1.92	0.69	44.5	2.79	0.75	6.15	21.77	14
Caprella californica																0.14	0.22	1.53	0.55	39
Artemia salina																0.59	0.52	1.53	1.69	37
Mysidacea																				
Mysidacea (unident.)																9.44	1.51	4.61	50.47	7
Acanthomysis davisii																4.89	8.57	3.07	41.32	9
Decapoda																				
Crangon nigricauda																0.14	0.97	3.07	3.40	28
Callianassa californiensis						0.74	3.30	7.40	29.89	14										
Brachyura (unident.)	2.21	0.95	3.12	9.85	17						0.40	0.75	1.92	2.20	40.5	1.84	1.48	10.76	35.72	11
Cancer sp.						0.38	1.10	3.70	5.47	18										
Scleroplax granulata											1.20	1.25	1.92	4.70	32					
Hemigrapsus oregonensis	2.15	0.49	6.25	16.50	14	8.72	9.56	14.81	270.72	5						2.16	3.98	7.69	47.21	8
Mollusca																				
Bivalvia																				
Bivalvia (unident.)	1.89	2.65	28.12	127.66	8	4.72	4.12	11.11	98.21	6	1.83	1.11	11.53	33.89	11	0.65	0.34	1.53	1.51	38
Bivalve siphons	18.92	8.25	59.37	1613.08	2	13.53	6.51	48.14	964.72	2	28.57	12.19	76.92	3135.25	1	7.55	4.54	83.07	1004.31	3
Transennella tantilla											0.80	2.51	1.92	6.35	30					
Saxidomus nuttalli siphons	4.20	3.99	6.25	51.18	11	21.73	19.49	14.81	610.46	3	2.83	1.45	17.30	74.04	9	1.77	2.56	1.53	6.62	21
Protothaca staminea	0.29	0.22	3.12	1.59	28	0.31	0.97	3.70	4.73	20										
Gemma gemma																1.35	0.88	1.53	3.41	26.5
Mactridae (unident.)											0.89	0.75	3.84	6.29	31					
Tresus nuttallii siphons	6.00	3.02	12.50	112.75	9	5.77	2.57	7.40	61.71	[illegible]										
Macoma spp.	5.16	3.26	25.00	210.50	7	5.41	3.48	33.33	287.30	[illegible]	2.04	1.21	40.38	131.23	7	0.50	0.36	3.07	2.64	30
Macoma nasuta	1.20	0.74	3.12	6.05	21	3.73	3.67	7.40	54.76	[illegible]	4.51	2.63	3.84	27.41	12	0.26	1.13	1.53	2.12	31
Solen sicarius						1.87	3.67	7.40	40.99	13										
Cryptomya californica						0.10	0.36	3.70	1.70	24										
Entodesma saxicola											0.40	1.25	1.92	3.16	36.5					
Clinocardium nuttallii	2.21	1.92	3.12	12.88	16	1.64	4.41	3.70	22.38	15										
Gastropoda																				
Neogastropoda (unident.)	0.68	0.29	6.25	6.05	20	0.10	0.19	3.70	1.07	26										
Polinices sp.	0.06	0.07	3.12	0.40	31.5															
Vertebrata																				
Fish eggs	0.06	0.07	3.12	0.40	31.5											5.34	2.05	4.61	34.06	12
Fish (unident.)																0.29	8.84	1.53	13.96	18
Clevelandia ios	0.05	2.07	3.12	6.61	19															
Miscellaneous																				
Terrestrial seeds	1.14	0.55	9.37	15.83	15	0.24	0.07	3.70	1.14	25	1.44	0.40	9.61	17.68	18	4.95	0.34	1.53	8.09	20
Algae	0.00	2.45	25.00	61.25	10	0.00	0.73	7.40	5.40	19	0.00	3.66	63.46	232.26	5	0.00	1.06	3.07	3.25	29
Digested material	0.00	26.51	96.87	2568.02	1	0.00	16.82	81.48	1370.49	1	0.00	29.72	92.30	2743.15	2	0.00	13.34	96.92	1292.91	2
Total Number of Individual Prey Items			2933					396					1392					1931		
Total Number of Prey Categories			33					27					45					39		
Number of Fish Examined (with contents)			32					27					52					65		

Table 23. Pleuronectiform feeding habit summary at the Kirby Park station. (for details of symbols, see Table 10).

Prey Categories	*Platichthys stellatus* (≤ 99mm)					*Platichthys stellatus* (100-199mm)					*Parophrys vetulus*				
	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks	%N	%V	%F.O.	I.R.I.	Ranks
Protozoa															
Foraminifera (unident.)						1.22	0.98	6.02	13.24	15	1.83	0.48	4.00	9.24	20
Ammonia beccarii	8.00	0.33	13.33	111.11	6	0.56	0.08	6.02	3.85	21	3.98	0.69	14.00	6.53	26
Elphidium gunteri											1.37	0.32	2.00	3.38	29
Nemertea															
Nemertea (unident.)						0.29	0.04	1.20	0.39	32	0.80	0.39	8.00	9.52	18
Echiuroidea															
Urechis caupo						0.01	0.05	1.20	0.07	40					
Annelida															
Oligochaeta											2.28	1.63	2.00	7.82	22
Polychaeta															
Polychaeta (unident.)						1.94	2.59	16.86	76.37	10	2.56	2.51	14.00	70.98	11
Phyllodocidae (unident.)						0.01	0.13	1.20	0.16	38.5					
Eteone sp.						0.47	0.38	9.63	8.18	17	1.55	0.80	8.00	18.80	17
Eteone longa californica						0.09	0.13	1.20	0.26	35					
Eumida sp.											4.35	1.63	4.00	23.92	14
Eumida bifoliata											1.83	3.60	4.00	9.43	19
Exogone lourei	0.35	0.33	6.66	4.56	11	0.75	0.74	2.40	3.57	22	3.59	3.46	16.00	112.80	7
Spionidae (unident.)						'.01	0.62	1.20	1.95	24					
Polydora sp.						0.05	0.09	1.20	0.16	38.5					
Prionospio sp.						0.11	0.18	1.20	0.34	33					
Pseudopolydora paucibranchiata	0.60	0.33	6.66	6.26	10	0.18	0.07	2.40	0.60	31					
Streblospio benedicti	39.82	22.20	80.00	4962.00	2	9.48	5.60	28.91	435.96	4	12.79	8.23	62.00	1303.24	2
Nepthys cornuta franciscana											1.59	0.97	2.00	5.12	28
Cirratulidae (unident.)						2.32	2.30	2.40	11.08	16	2.12	2.17	26.00	111.54	8
Armandia brevis						0.19	0.14	2.40	0.79	29	3.99	5.04	12.00	108.36	9
Capitellidae (unident.)						0.17	0.37	1.20	0.64	30					
Capitella capitata	13.02	8.46	46.66	1003.66	4	9.22	5.01	22.89	325.72	5	3.21	1.80	18.00	90.18	10
Notomastus tenuis						0.02	0.22	1.20	0.28	34	1.14	3.27	2.00	8.82	21
Arthropoda															
Crustacea															
Ostracoda															
Podocopid ostracod (unident.)	0.49	0.20	20.00	13.96	8	.13	0.15	1.20	1.53	27	0.85	0.25	18.00	19.80	16
Copepoda															
Harpacticoida (unident.)											15.17	4.26	10.00	194.30	6
Isopoda															
Iareropsis montereyensis						0.01	0.02	1.20	0.02	41	1.37	0.48	4.00	7.40	23
Cumacea															
Cyclaspis sp.	1.87	0.26	20.00	42.79	7						5.32	1.38	34.00	227.80	5
Amphipoda															
Allorchestes argusta						'.00	0.74	3.61	6.28	20					
Aoroides columbiae						0.94	0.41	4.81	6.49	18	1.48	0.52	10.00	20.00	15
Corophium spp.	10.57	3.26	53.33	727.59	5	2'.49	10.96	50.60	1640.45	3	6.80	3.18	42.00	419.16	4
Decapoda															
Cancer sp.						0.45	0.26	2.40	1.70	25					
Hemigrapsus oregonensis						1.43	1.26	1.20	3.22	23					
Insecta															
Terrestrial insects (unident.)											1.14	0.32	2.00	2.92	30.5
Terrestrial insect larvae						0.04	0.13	1.20	0.20	37					
Mollusca															
Bivalvia															
Bivalve siphons	23.62	9.60	66.66	2214.90	3	17.88	10.06	61.44	1716.63	2	10.26	7.54	64.00	1139.20	3
Modiolus sp.											0.33	0.29	4.00	2.48	32
Gemma gemma						4.80	1.75	18.07	118.35	7	1.03	0.71	4.00	6.96	24
Mactridae (unident.)						6.95	7.14	6.02	84.82	8					
Tresus nuttallii						2.34	2.73	3.61	18.30	13					
Tresus nuttallii siphons						3.50	1.75	3.61	18.95	12					
Macoma spp.						2.16	1.55	4.81	17.84	14	1.14	0.48	4.00	6.48	27
Myidae (unident.)	1.66	0.06	6.66	11.55	9	3.00	3.91	7.22	49.89	11					
Clinocardium nuttallii						0.89	0.74	1.02	1.66	26					
Gastropoda															
Neogastropoda (unident.)						0.80	0.27	6.02	6.44	19	0.68	0.32	2.00	2.00	33
Cephalaspida (unident.)						0.13	0.05	1.20	0.21	36					
Vertebrata															
Fish eggs (unident.)											1.14	0.32	2.00	2.92	30.5
Miscellaneous															
Terrestrial seeds						0.18	0.09	3.61	0.97	28	2.97	0.32	2.00	6.58	25
Algae						0.00	5.77	49.39	284.98	6	0.00	16.08	4.00	64.32	12
Digested material	0.00	51.20	100.00	5120.00	1	0.00	29.11	90.36	2630.38	1	0.00	25.89	82.00	2122.98	1
Total Number of Individual Prey Items				355					3951					1058	
Total Number of Prey Categories				12					41					33	
Number of Fish Examined (with contents)				15					83					50	

Table 24.

Ranks of Fish Species from Creel Censuses

	North Jetty		South Jetty		Skippers		Bennett Slough		Kirby Park	
	July June 1974-1975	July June 1975-1976	July June 1974-1975	July June 1975-1976	July June 1974-1975	July June 1975-1976	July June 1974-1975	July June 1975-1976	July June 1974-1975	July June 1975-1976
Leptocottus armatus	1	1	1	2	7	13	1	2	2.5	-
Embiotoca jacksoni	10	4	20	7.5	1	4	-	-	2.5	-
Platichthys stellatus	2	3	3	5	8	18.5	2	1	5	-
Phanerodon furcatus	3	6	7	9	3	2	-	3	1	-
Genyonemus lineatus	11	13	2	7.5	-	18.5	-	-	-	-
Cymatogaster aggregata	8	10.5	13	16	2	1	-	-	-	1
Psettichthys melanostictus	5	5	4	6	-	-	-	-	-	-
Hyperprosopon argenteum	6	2	5.5	3	4	3	-	4.5	-	-
Atherinopsis californiensis	4	8	5.5	1	12.5	5	-	-	-	-
Damalichthys vacca	-	21	20	11.5	6	8	-	4.5	-	-
Sebastes paucispinis	9	15.5	-	-	5	6	-	-	-	-
Rhacochilus toxotes	15	10.5	11.5	10	9	7	-	-	-	2
Ophiodon elongatus	7	-	16.5	18	-	-	-	-	-	-
Scorpaenichthys marmoratus	18.5	10.5	8	23.5	11	9	-	-	6	-
Hexagrammos decagrammus	14	14	9	18	17	11	-	-	-	-
Citharichthys stigmaeus	12	15.5	16.5	23.5	22	25	-	-	-	-
Hyperprosopon ellipticum	-	25	-	4	-	16	-	-	-	-
Embiotoca lateralis	18.5	7	16.5	18	18	21	-	-	-	-
Sebastes mystinus	13	18.5	16.5	-	14	10	-	-	-	-
Roccus saxatilis	-	-	-	-	-	-	-	-	4	-
Amphistichus rhodoterus	16	-	10	-	10	18.5	-	-	-	-
Amphistichus argenteus	18.5	21	-	13	22	12	-	-	-	-
Sebastes chrysomelas	-	10.5	-	11.5	-	-	-	-	-	-
Sebastes auriculatus	-	18.5	-	14	-	14.5	-	-	-	-
Amphistichus koelzi	-	27	11.5	23.5	-	-	-	-	-	-
Squalus acanthias	-	17	-	15	-	-	-	-	-	-
Oxylebius pictus	-	21	-	20.5	22	25	-	-	-	-
Porichthys notatus	-	-	14	20.5	22	-	-	-	-	-
Atherinops affinis	18.5	-	-	-	22	-	-	-	-	-
Parophrys vetulus	21	-	-	-	-	-	-	-	-	-
Neoclinus uninotatus	-	-	-	-	16	14.5	-	-	-	-
Hypsurus caryi	-	-	-	-	15	18.5	-	-	-	-
Oncorhynchus tsawytscha	-	-	-	-	12.5	-	-	-	-	-
Hyperprosopon anale	-	-	20	-	-	-	-	-	-	-
Lyopsetta exilis	-	23	-	-	-	-	-	-	-	-
Ammodytes hexapterus	-	-	-	-	22	-	-	-	-	-
Trachurus symmetricus	-	-	-	23.5	22	-	-	-	-	-
Gibbonsia metzi	-	25	-	-	-	-	-	-	-	-
Cebidichthys violaceus	23.5	-	-	-	-	25	-	-	-	-
Engraulis mordax	22	-	-	-	26	-	-	-	-	-
Hypsopsetta guttulata	23.5	-	-	-	-	-	-	-	-	-
Oxyjulis californica	25.5	-	-	-	-	-	-	-	-	-
Microgadus proximus	-	-	22	-	-	-	-	-	-	-
Myliobatis californica	25.5	-	23	-	-	-	-	-	-	-
Sebastes flavidus	-	25	-	-	-	25	-	-	-	-
Sebastes carnatus	-	-	-	-	-	25	-	-	-	-
Peprilus simillimus	-	-	-	-	-	25	-	-	-	-
Number of Visits (Number of Months)	43 (12)	59 (12)	45 (12)	57 (12)	36 (12)	57 (12)	29 (12)	66 (12)	6 (4)	31 (12)
Total Angler Hours	1230.5	1129.4	816.0	713.4	975.0	1902.1	25.5	260.3	53.5	4.0
Mean Number of Angler Hours per Visit	26.0	19.1	17.5	12.5	27.0	33.4	0.8	3.9	10.2	0.1
Mean Number of Fish per Angler Hour (Standard Deviation)	0.76 (0.749)	0.56 (0.34)	0.76 (0.419)	0.84 (0.81)	0.79 (0.272)	0.81 (0.56)	1.44 (3.44)	0.38 (0.33)	0.36 (0.425)	0.75 (1.06)
Total Number Anglers	544	593	386	404	375	669	24	142	33	5
Number of Fish Caught	1335	683	701	646	888	1420	24	135	34	3
Number of Species	25	27	23	25	25	27	2	5	6	2

Table 25. Larval fish catch summary at the harbor station.

Number of Larval Fish/1000 m^3 Tow (Mean $\pm$ Standard Deviation)

HARBOR ENTRANCE

FISH SPECIES	1974 31 Oct	15 Nov	1975 27 Jan	15 Mar	28 Mar	23 Jun	19 Sep	1976 06 Jan	17 Feb	06 Mar	27 Apr	Overall Mean per 1000 m^3	Overall Rank
Ammodytes hexapterus	-	-	-	-	-	-	-	-	-	7.7 (15.5)	-	0.9 (5.9)	10
Atherinidae	-	-	-	31.0 (θ)	46.4 (21.9)	31.0 (43.7)	-	-	-	-	-	6.5 (17.3)	8
Bathylagus ochotensis	-	-	-	31.0 (θ)	-	-	-	-	-	-	-	0.9 (5.9)	10
Citharichthys sp.	-	-	-	-	-	-	-	-	-	7.7 (15.5)	-	0.9 (5.9)	10
Clevelandia ios	-	-	-	31.0 (θ)	15.5 (21.9)	-	23.2 (29.7)	-	20.7 (18.0)	23.2 (15.5)	31.0 (35.6)	18.2 (22.6)	5
Clinid I	-	-	-	-	-	-	-	15.5 (31.0)	-	61.9 (43.7)	-	10.5 (27.9)	6
Clupea harengus pallasii	-	-	15.5 (22.0)	-	-	-	-	-	-	-	-	0.9 (5.9)	10
Engraulis mordax	46.4 (65.6)	31.0 (θ)	15.5 (22.0)	31.0 (θ)	-	619.2 (131.3)	874.6 (325.1)	-	-	7.7 (15.5)	-	170.9 (344.6)	1
Gillichthys mirabilis	-	-	46.4 (22.0)	-	15.5 (21.9)	31.0 (43.7)	38.7 (39.0)	-	-	-	7.7 (15.5)	9.6 (22.0)	7
Leptocottus armatus	-	-	31.0 (43.7)	-	-	-	7.7 (15.5)	170.3 (39.9)	-	38.7 (39.0)	7.7 (15.5)	33.1 (61.3)	4
Neoclinus uninotatus	-	-	-	-		-	7.7 (15.5)	-	-	-	-	0.9 (5.9)	10
Osmeridae	-	-	1656.3 (284.5)	247.7 (θ)	15.5 (21.9)	-	-	-	10.2 (18.0)	7.7 (15.5)	-	126.0 (429.7)	2
Paralichthys californicus	-	-	-	-	-	-	7.7 (15.5)	-	-	-	-	0.9 (5.9)	10
Platichthys stellatus	-	-	-	-	-	-	-	-	-	-	7.7 (15.5)	0.9 (5.9)	10
Pleuronichthys verticalis	-	-	-	-	-	-	7.7 (15.5)	-	-	-	-	0.9 (5.9)	10
Sciaenid I	61.9 (0.0)	866.9 (θ)	31.0 (43.7)	61.9 (θ)	-	-	201.2 (78.0)	7.7 (15.5)	-	92.9 (66.9)	-	80.2 (170.0)	3
Sebastes sp.	-	-	-	-	-	-	-	-	10.2 (18.0)	-	-	0.9 (5.9)	10
Stenobrachius leucopsarus	-	-	15.5 (22.0)	-	-	-	-	-	10.2 (18.0)	-	-	2.2 (8.0)	9
Unidentified larval fish	-	-	-	-	-	-	7.7 (15.5)	7.7 (15.5)	-	31.0 (25.4)	-	7.4 (15.8)	
Number of Species Caught	2	2	7	6	4	5	8	3	4	8	4	18	
Total Number of Larval Fish Caught	7	29	118	14	6	44	152	26	5	36	7	444	
Mean Number of Larval Fish per 1000 m^3	108.4 (65.7)	897.8 (θ)	1826.6 (350.3)	433.4 (θ)	92.9 (43.8)	681.1 (131.4)	1168.7 (321.1)	201.2 (53.6)	51.6 (17.9)	278.6 (104.2)	54.2 (73.2)	474.0 (555.9)	
Number of Tows	2	1	2	1	2	2	4	4	3	4	4	29	

θ - Standard deviation undefined

Table 26. Larval fish catch summary at the bridge station.

Number of Larval Fish/1000 m^3 Tow (Mean ± Standard Deviation)

BRIDGE STATION

FISH SPECIES	1974 14 Sep	31 Oct	13 Nov	1975 27 Jan	16 Mar	02 Apr	01 May	16 Jun	24 Jun	30 Jul	12 Sep	09 Oct	31 Oct	09 Dec	1976 14 Jan	04 Feb	03 Mar	26 Apr	12 Jun	Overall mean per 1000 m^3	Overall Rank
Ammodytes hexapterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	81.7 (42.2)	-	-	-	5.9 (23.2)	6
Atherinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2 (16.3)	-	8.2 (16.3)	1.3 (6.2)	9
Clevelandia ios	16.3 (23.2)	16.3 (23.2)	-	-	-	16.3 (23.2)	-	-	-	49.0 (42.2)	-	8.2 (16.3)	-	8.2 (16.3)	-	24.5 (49.0)	16.3 (32.7)	16.3 (19.0)	49.0 (42.2)	13.7 (26.8)	3
Cebidichthys violaceus	-	-	-	-	-	-	-	16.3 (23.2)	-	-	-	-	-	-	-	-	-	-	-	0.7 (4.2)	11
Engraulis mordax	-	196.7 (138.6)	-	65.4 (92.5)	-	-	-	-	98.0 (92.4)	8.2 (16.3)	81.7 (56.5)	8.2 (16.3)	8.2 (16.3)	-	8.2 (16.3)	-	-	8.2 (16.3)	16.3 (32.7)	22.2 (53.3)	1
Gillichthys mirabilis	-	-	-	-	-	-	-	16.3 (23.2)	65.4 (46.2)	8.2 (16.3)	-	8.2 (16.3)	8.2 (16.3)	-	-	-	-	-	48.8 (61.8)	6.2 (22.5)	5
Goby I	-	-	-	-	32.7 (46.2)	-	-	-	-	-	-	-	-	-	-	8.2 (16.3)	-	-	-	2.9 (11.1)	8
Leptocottus armatus	-	-	-	16.3 (23.2)	-	-	-	16.3 (23.2)	-	-	-	16.3 (18.9)	49.0 (32.7)	24.5 (31.4)	81.7 (19.0)	8.2 (16.3)	40.8 (31.4)	-	-	16.6 (28.4)	2
Lyopsetta exilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2 (16.3)	-	-	-	0.7 (4.2)	11
Osmeridae	-	-	-	16.3 (23.2)	16.3 (23.2)	-	-	16.3 (23.2)	-	-	-	8.2 (16.3)	-	-	-	24.5 (31.3)	49.0 (19.0)	-	-	10.5 (24.2)	4
Oxyjulis californicus	-	-	-	-	-	-	-	-	-	8.2 (16.3)	-	-	-	-	-	-	-	-	-	0.7 (4.2)	11
Pleuronectidae	-	-	-	-	-	-	-	-	-	-	8.2 (16.3)	-	-	-	-	-	-	-	-	0.7 (4.2)	11
Sciaenid I	-	49.0 (23.2)	-	-	-	-	-	-	-	-	8.2 (16.3)	-	-	8.2 (16.3)	-	16.3 (19.0)	8.2 (16.3)	-	-	5.9 (14.1)	6
Sebastes sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.3 (19.0)	-	-	-	1.3 (6.2)	9
Stenobrachius leucopsarus	-	-	-	16.3 (23.2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7 (4.2)	11
Sygnathus sp.	-	-	-	-	-	-	-	-	-	-	-	-	8.2 (16.3)	-	-	-	-	-	-	0.7 (4.2)	11
Unidentified larval fish	-	-	-	-	16.3 (23.2)	-	-	-	-	8.2 (16.3)	-	24.5 (31.3)	-	-	-	-	-	-	-	3.4 (11.9)	
Number of Species Caught	1	3	0	4	2	1	0	4	2	4	3	4	4	3	1	8	5	2	4	16	
Total Number of Larval Fish Caught	1	16	0	7	4	1	0	4	10	10	12	9	9	5	19	23	15	3	14	162	
Mean Number of Larval Fish per 1000 m^3	16.3 (23.2)	261.4 (184.9)	0 (θ)	114.4 (161.8)	65.4 (92.4)	16.3 (23.2)	0 (0)	65.4 (0.0)	163.4 (46.2)	81.7 (32.7)	98.0 (70.6)	73.5 (72.5)	73.5 (41.1)	40.8 (41.1)	155.2 (77.2)	179.7 (137.4)	122.5 (72.5)	24.5 (31.3)	114.4 (126.6)	92.9 (90.5)	
Number of Tows	2	2	1	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	57	

θ - Standard deviation undefined

Table 27. Larval fish catch summary at the dairy station.

Number of Larval Fish/1000 m³ Tow (Mean ± Standard Deviation)

DAIRY STATION

FISH SPECIES	1974 14 Sep	31 Oct	13 Nov	1975 27 Jan	16 Mar	02 Apr	01 May	16 Jun	24 Jun	30 Jul	12 Sep	9 Oct	31 Oct	09 Dec	1976 14 Jan	04 Feb	03 Mar	26 Apr	12 Jun	Overall Mean per 1000 m³	Overall Rank
Ammodytes hexapterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70.6 (106.8)	-	-	-	5.1 (30.5)	8
Atherinidae	-	-	-	-	-	-	-	-	-	-	-	14.1 (28.2)	-	14.1 (28.2)	-	-	113.0 (103.4)	-	-	9.0 (37.9)	7
Clevelandia ios	-	-	-	56.5 (79.7)	-	-	84.7 (40.1)	-	113.0 (0.0)	14.1 (28.2)	28.2 (32.8)	-	-	14.1 (28.2)	-	14.1 (28.2)	28.2 (56.5)	-	14.1 (28.2)	16.4 (35.0)	3
Clupea harengus pallasii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56.5 (46.3)	-	-	4.0 (18.1)	10
Coryphopterus nicholsi	-	-	-	-	-	-	-	-	-	-	14.1 (28.2)	-	-	-	-	-	-	-	-	1.1 (7.3)	13
Engraulis mordax	28.2 (40.1)	339.0 (319.8)	28.2 (40.1)	28.2 (40.1)	28.2 (40.1)	28.2 (40.1)	-	-	169.5 (79.9)	-	98.9 (125.4)	-	155.4 (28.2)	127.1 (186.4)	28.2 (56.5)	-	14.1 (28.2)	-	-	51.4 (105.1)	1
Gillichthys mirabilis	56.5 (79.7)	-	-	-	-	-	-	-	56.5 (79.9)	14.1 (28.2)	-	-	-	-	-	14.1 (28.2)	14.1 (28.2)	-	42.4 (84.7)	9.6 (32.2)	5
Goby I	-	-	-	-	-	-	-	-	-	-	-	42.4 (28.2)	-	-	-	-	-	-	-	2.8 (12.4)	12
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.2 (32.8)	-	-	-	-	1.1 (7.3)	13
Leptocottus armatus	84.7 (40.1)	-	-	-	28.2 (40.1)	-	-	-	-	-	-	28.2 (56.5)	98.9 (28.2)	56.5 (79.7)	-	127.1 (71.2)	84.7 (56.5)	-	-	41.8 (65.5)	2
Neoclinus uninotatus	-	-	-	-	-	28.2 (40.1)	28.2 (40.1)	-	-	28.2 (56.5)	42.4 (54.2)	-	-	28.2 (32.8)	-	-	-	-	14.1 (28.2)	9.6 (26.0)	5
Osmeridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.1 (28.2)	14.1 (28.2)	-	4.0 (14.7)	10
Psettichthys melanostictus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.1 (28.2)	1.1 (7.3)	13
Sciaenid I	-	-	56.5 (79.7)	-	28.2 (40.1)	-	-	-	-	-	14.1 (28.2)	-	-	-	113.0 (92.1)	-	-	-	-	11.9 (39.0)	4
Sebastes sp.	-	-	-	-	-	-	-	-	-	-	7.3 (19.8)	-	14.1 (28.2)	28.2 (32.8)	-	-	-	-	-	5.1 (15.8)	8
Unidentified larval fish	-	-	-	84.7 (119.8)	-	56.5 (79.7)	-	56.5 (79.9)	-		-	-	-	-	14.1 (28.2)	14.1 (28.2)	14.1 (28.2)	-	-	9.7 (32.0)	
Number of Species Caught	3	1	2	2	3	2	2	1	3	3	6	3	3	6	4	4	7	1	4	15	
Total Number of Larval Fish Caught	6	12	3	6	3	4	4	2	12	4	16	6	19	19	24	17	24	1	6	188	
Mean Number of Larval Fish per 1000 m³	169.5 (79.9)	339.0 (314.8)	84.7 (119.8)	169.5 (0.0)	98.9 (58.0)	113.0 (159.8)	113.0 (0.0)	56.5 (79.9)	91.2 (102.1)	56.5 (79.9)	226.0 (265.0)	84.7 (56.5)	268.4 (54.1)	268.4 (245.7)	339.0 (46.1)	240.1 (168.7)	339.0 (211.4)	14.1 (28.2)	13.5 (84.7)	183.1 (168.1)	
Number of Tows	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	58	

Table 28. Larval fish catch summary at the red house station.

RED HOUSE

Number of Larval Fish/1000 m^3 Tow (Mean $\pm$ Standard Deviation)

FISH SPECIES	1974 14 Sep	31 Oct	13 Nov	1975 27 Jan	16 Mar	02 Apr	01 May	16 Jun	24 Jun	30 Jul	12 Sep	9 Oct	31 Oct	09 Dec	1976 14 Jan	04 Feb	03 Mar	26 Apr	12 Jun	Overall Mean per 1000 m^3	Overall Rank
Ammodytes hexapterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.5 (13.0)	-	-	-	1.3 (5.7)	9
Atherinidae	-	-	-	-	13.0 (18.5)	-	-	-	13.0 (18.5)	-	-	-	-	-	-	-	45.6 (57.8)	-	6.5 (13.0)	4.4 (18.2)	8
Clevelandia ios	52.1 (73.7)	13.0 (18.5)	-	26.0 (0.0)	13.0 (18.5)	-	-	13.0 (18.5)	13.0 (18.5)	45.6 (53.6)	13.0 (26.0)	19.5 (13.0)	26.0 (21.3)	-	6.5 (13.0)	6.5 (13.0)	6.5 (13.0)	52.1 (42.4)	149.7 (107.0)	27.9 (49.5)	3
Clinid I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5 (13.0)	-	-	-	-	0.5 (3.4)	11
Clupea harengus pallasii	-	-	-	-	195.3 (55.2)	39.1 (55.2)	-	-	-	-	-	-	-	-	-	13.0 (26.0)	-	104.2 (102.1)	-	16.1 (50.8)	5
Engraulis mordax	13.0 (18.5)	559.9 (534.1)	-	-	-	13.0 (18.5)	-	-	-	6.5 (13.0)	19.5 (25.0)	6.5 (13.0)	26.0 (0.0)	6.5 (13.0)	13.0 (15.1)	-	6.5 (13.0)	-	-	26.0 (124.5)	4
Gillichthys mirabilis	338.5 (291.9)	13.0 (18.5)	-	13.0 (18.5)	13.0 (18.5)	13.0 (18.5)	13.0 (18.5)	26.0 (36.8)	143.2 (18.4)	52.1 (18.4)	19.5 (25.0)	71.6 (32.8)	45.6 (44.5)	26.0 (29.9)	-	-	-	13.0 (15.1)	468.8 (278.1)	66.9 (149.7)	1
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5 (13.0)	19.5 (39.1)	26.0 (21.4)	52.1 (47.7)	-	13.0 (15.1)	8.1 (21.4)	6
Leptocottus armatus	-	-	-	455.7 (18.5)	-	-	-	-	-	-	-	45.6 (53.7)	32.6 (13.0)	65.1 (45.1)	19.5 (25.0)	26.0 (36.7)	13.0 (26.0)	-	-	29.7 (86.2)	2
Neoclinus uninotatus	-	-	-	-	-	13.0 (18.5)	-	26.0 (0.0)	13.0 (15.1)	71.6 (71.6)	6.5 (13.0)	6.5 (13.0)	-	6.5 (13.0)	-	-	-	-	-	7.6 (25.3)	7
Osmeridae	-	-	-	-	13.0 (18.5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5 (3.4)	11
Psettichthys melanostictus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5 (13.0)	0.5 (3.4)	11
Sciaenid I	-	-	13.0 (18.5)	-	-	-	-	-	-	-	-	-	-	-	6.5 (13.0)	-	-	-	-	0.8 (4.7)	10
Unidentified larval fish	-	-	-	13.0 (18.5)	52.1 (73.7)	-	-	13.0 (18.5)	-	-	-	6.5 (13.0)	-	6.5 (13.0)	13.0 (15.1)	-	13.0 (15.1)	-	-	5.5 (15.9)	
Number of Species Caught	3	3	1	3	5	4	1	3	4	4	4	5	4	5	6	5	5	3	5	12	
Total Number of Larval Fish Caught	31	45	1	39	23	6	1	6	13	27	9	24	20	18	13	14	21	26	99	436	
Mean Number of Larval Fish per 1000 m^3	403.7 (349.9)	585.9 (497.2)	13.0 (18.5)	507.8 (18.4)	299.5 (18.4)	78.1 (36.8)	13.0 (18.5)	78.1 (36.8)	169.3 (18.4)	175.8 (133.4)	58.6 (44.5)	156.3 (76.7)	130.2 (56.3)	117.2 (78.1)	84.6 (44.5)	91.1 (33.6)	136.7 (71.7)	169.3 (151.1)	644.5 (371.0)	196.2 (223.9)	
Number of Tows	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	58	

Table 29. Larval fish catch summary at the Kirby Park station.

KIRBY PARK — Number of Larval Fish/1000 m^3 Tow (Mean ± Standard Deviation)

FISH SPECIES	1974 14 Sep	31 Oct	13 Nov	1975 27 Jan	16 Mar	02 Apr	01 May	16 Jun	24 Jun	30 Jul	12 Sep	9 Oct	31 Oct	09 Dec	1976 14 Jan	04 Feb	03 Mar	26 Apr	12 Jun	Overall Mean per 1000 m^3	Overall Rank
Ammodytes hexapterus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4 (14.9)	-	-	-	0.6 (3.9)	9
Atherinidae	-	-	-	-	-	-	-	-	-	-	-	7.4 (14.9)	-	-	-	-	7.4 (14.9)	-	-	0.9 (5.4)	8
Clevelandia ios	14.9 (21.1)	74.4 (105.4)	-	14.9 (21.1)	14.9 (21.1)	29.8 (0.0)	-	253.0 (105.4)	29.8 (42.0)	208.3 (213.1)	29.8 (42.0)	81.9 (85.4)	74.4 (70.8)	14.9 (29.8)	7.4 (14.9)	-	59.5 (48.5)	7.4 (14.9)	14.9 (17.3)	49.4 (89.9)	4
Clinid I	-	-	-	-	-	-	-	-	-	22.3 (14.9)	52.1 (50.9)	-	-	7.4 (14.9)	-	-	-	-	-	0.6 (3.9)	9
Clupea harengus pallasii	-	-	-	-	580.4 (189.3)	163.7 (231.6)	44.6 (63.1)	-	-	-	-	-	-	-	81.9 (92.3)	14.9 (17.3)	81.9 (50.9)	193.5 (98.8)	-	52.9 (127.7)	3
Engraulis mordax	14.9 (21.1)	59.5 (189.3)	-	29.8 (0.0)	282.7 (189.3)	74.4 (105.4)	104.2 (63.1)	104.2 (63.1)	-	29.8 (24.4)	171.2 (129.5)	290.2 (284.8)	1443.5 (1303.6)	14.9 (29.8)	29.8 (59.5)	7.4 (14.9)	1086.3 (1713.1)	-	-	235.1 (659.8)	1
Gillichthys mirabilis	163.7 (189.3)	208.3 (294.6)	14.9 (21.1)	104.2 (63.1)	104.2 (21.1)	119.1 (84.2)	-	44.6 (21.1)	133.9 (189.3)	156.3 (122.3)	163.7 (29.8)	81.9 (81.9)	148.8 (94.1)	133.9 (110.1)	29.8 (34.2)	14.9 (17.3)	67.0 (56.3)	52.1 (44.6)	1212.8 (378.3)	172.9 (312.8)	2
Goby II	-	-	-	-	-	14.9 (21.1)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6 (3.9)	9
Hypomesus pretiosus	-	-	-	-	-	-	-	-	-	-	-	-	-	208.3 (204.8)	7.4 (14.9)	-	44.6 (89.3)	148.8 (80.7)	14.9 (29.8)	29.2 (83.0)	5
Leptocottus armatus	-	-	-	282.7 (273.5)	-	-	-	-	-	-	-	7.4 (14.9)	52.1 (28.6)	-	22.3 (28.6)	37.2 (44.6)	-	-	-	17.9 (65.8)	6
Neoclinus uninotatus	-	-	-	-	-	-	-	-	-	-	-	7.4 (14.9)	7.4 (14.9)	-	-	-	-	-	-	6.2 (19.0)	7
Sciaenid I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4 (14.9)	-	-	-	-	0.6 (3.9)	9
Sebastes paucispinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.4 (14.9)	-	-	-	-	0.6 (3.9)	9
Unidentified larval fish	-	-	-	-	-	29.8 (42.0)	14.9 (21.1)	-	-	-	-	-	7.4 (14.9)	7.4 (14.9)	-	7.4 (14.9)	-	-	-	2.9 (10.7)	
Number of Species Caught	3	3	1	4	4	5	2	3	2	4	4	6	5	5	8	5	6	4	3	13	
Total Number of Larval Fish Caught	13	23	1	29	66	29	11	27	11	56	56	64	233	52	26	12	181	54	167	1111	
Mean Number of Larval Fish per 1000 m^3	193.5 (147.3)	342.3 (357.8)	14.9 (21.0)	431.6 (357.8)	982.1 (336.7)	431.6 (189.4)	163.7 (105.2)	401.8 (147.3)	163.7 (147.3)	416.7 (353.0)	416.7 (128.6)	476.2 (314.0)	1733.6 (1182.1)	386.9 (273.9)	193.5 (172.7)	89.3 (42.1)	1346.7 (1737.3)	401.8 (51.6)	1242.6 (393.6)	570.1 (713.6)	
Number of Tows	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	4	4	4	4	58	

Zooplankton Sample Monthly Summary

HARBOR ENTRANCE

All are zooplankton push-samples.
Densities are expressed as number per cubic meter water filtered (Mean ± Standard Deviation)

Zooplankton taxa	1974 Aug	Sep	Oct	Nov	Dec	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean per meter^3	Overall Rank
Acartia spp.	-	102.8 (12.9)	-	423.3 (19.6)	-	693.9 (235.5)	-	765.0 (46.6)	-	-	4066.1 (490.7)	-	-	2831.0 (1016.5)	914.6 (8.9)	-	-	372.1 (27.4)	1240.3 (53.5)	1467.5 (92.2)	281.0 (83.0)	-	24452.2 (745.8)	2484.3 (5515.5)	1
Calanus pacificus	-	12.6 (0.6)	-	79.8 (24.5)	-	1096.3 (98.1)	-	-	-	-	138.8 (0.0)	-	-	652.2 (401.3)	-	-	-	2.2 (2.2)	19.9 (19.7)	-	-	-	-	148.7 (332.0)	6
Eucalanus bungi	-	0.9 (1.2)	-	-	-	55.5 (39.3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.1 (14.5)	16
Labidocera spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.8 (3.0)	-	-	-	-	-	0.5 (1.7)	18
Microcalanus spp.	-	-	-	333.1 (78.5)	-	388.6 (39.3)	-	207.3 (11.0)	-	-	194.3 (0.0)	-	-	929.8 (245.7)	463.6 (37.4)	-	-	336.5 (52.3)	198.4 (19.7)	107.5 (40.8)	78.1 (14.3)	-	277.5 (0.0)	312.1 (268.9)	5
Oithona spinifera	-	-	-	79.8 (44.2)	-	999.2 (78.5)	-	220.3 (9.8)	-	-	582.9 (157.0)	-	-	339.2 (946.8)	185.2 (15.2)	-	-	689.1 (15.3)	408.5 (14.0)	74.6 (36.9)	1358.3 (231.5)	-	111.0 (0.0)	750.2 (963.5)	2
Temora spp.	-	0.9 (1.2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1 (0.3)	19
Tortanus discaudatus	-	1.3 (0.6)	-	-	-	-	-	1.7 (0.0)	-	-	-	-	-	-	3.5 (1.4)	-	-	13.9 (7.9)	-	-	-	-	83.3 (117.7)	6.7 (27.8)	13
Evadne nordmanni	-	19.9 (11.0)	-	142.2 (54.0)	-	-	-	-	-	-	166.5 (39.3)	-	-	2803.3 (456.6)	315.6 (2.5)	-	-	-	-	33.8 (11.8)	81.5 (31.7)	-	5523.3 (745.8)	651.1 (1497.6)	3
Podon leuckarti	-	2.2 (0.6)	-	-	-	-	-	-	-	-	-	-	-	388.6 (119.9)	10.8 (5.9)	-	-	-	-	-	-	-	416.3 (39.3)	67.6 (154.1)	8
Pachygrapsus crassipes	-	6.1 (4.9)	-	17.3 (4.9)	-	-	-	12.1 (2.5)	-	-	-	-	-	-	11.7 (7.5)	-	-	14.3 (10.3)	13.0 (7.1)	6.9 (7.5)	-	-	-	7.1 (8.0)	12
Porcellanid	-	-	-	-	-	-	-	13.9 (2.5)	-	-	-	-	-	-	-	-	-	-	0.9 (1.7)	-	-	-	-	0.9 (3.3)	17
Pinnixa spp.	-	12.6 (4.3)	-	-	-	-	-	93.7 (29.4)	-	-	-	-	-	-	-	-	-	6.5 (3.9)	49.4 (3.3)	96.3 (142.0)	-	-	-	22.8 (55.5)	10
Ostracods	-	-	-	-	-	69.4 (19.6)	-	163.1 (22.1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.9 (40.6)	11
Barnacle nauplii	-	0.9 (0.0)	-	159.6 (78.5)	-	1290.6 (19.6)	-	2230.8 (142.3)	-	-	277.5 (39.3)	-	-	707.8 (343.3)	23.9 (9.0)	-	-	183.4 (35.1)	416.3 (54.4)	290.6 (27.7)	405.9 (56.8)	-	-	445.3 (550.0)	4
Polychaete larvae	-	-	-	405.9 (34.3)	-	208.2 (19.6)	-	7.8 (3.7)	-	-	97.1 (19.6)	-	-	-	35.6 (8.7)	-	-	-	26.9 (5.2)	254.7 (22.7)	-	-	194.3 (196.3)	97.1 (143.9)	7
Chaetognatha	-	-	-	-	-	-	-	12.1 (2.5)	-	-	-	-	-	-	16.9 (5.5)	-	-	-	19.9 (1.7)	-	-	-	-	4.8 (8.1)	15
Lamellibranch larvae	-	-	-	-	-	-	-	133.6 (19.6)	-	-	-	-	-	-	176.1 (41.1)	-	-	123.2 (10.8)	27.8 (10.2)	-	-	-	-	43.7 (67.7)	9
Hydromedusae	-	-	-	-	-	-	-	-	-	-	111.0 (78.5)	-	-	-	-	-	-	3.5 (3.2)	-	-	-	-	-	6.5 (29.0)	14
Number of species caught	-	10	-	8	-	8	-	12	-	-	8	-	-	7	11	-	-	11	11	8	5	-	7		
Total number of zooplankton caught	-	7,850	-	80,409	-	235,283	-	189,209	-	-	276,076	-	-	423,943	91,018	-	-	85,726	118,644	114,263	108,035	-	1521,837		
Total number of zooplankton per meter^3	-	161	-	1,641	-	4,802	-	3,801	-	-	5,634	-	-	11,352	1,857	-	-	1,749	2,416	2,432	2,205	-	31,058		
Number of push-samples	-	2	-	2	-	2	-	2	-	-	2	-	-	4	4	-	-	4	4	4	4	-	2		

Table 31.

Zooplankton Sample Monthly Summary

BRIDGE

All are zooplankton push-samples.
Densities are expressed as number per cubic meter water filtered (Mean ± Standard Deviation)

Zooplankton taxa	1974 Aug	Sep	Oct	Nov	Dec	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean per meter^3	Overall Rank
Acartia spp.	-	1085.8 (20.7)	-	223.5 (3.2)	-	1151.6 (170.6)	-	29.3 (10.3)	206.6 (12.9)	380.2 (20.7)	14049.7 (11803.0)	-	1279.6 (95.7)	3273.9 (356.0)	1515.4 (114.6)	1233.0 (409.6)	1953.2 (181.4)	1579.3 (338.3)	3549.9 (267.6)	3359.8 (67.2)	338.2 (46.0)	-	9728.4 (749.8)	3099.9 (4753.4)	1
Calanus pacificus	-	-	-	-	-	25.6 (25.9)	-	-	5.5 (2.6)	67.6 (7.8)	25.6 (30.1)	-	-	-	-	-	4.6 (1.8)	-	-	-	-	-	-	5.7 (16.5)	16
Eucalanus bungi	-	-	-	-		-	-	-	5.5 (2.6)	14.6 (5.2)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7 (3.0)	20
Eurytemora spp.	-	23.8 (7.8)	-	-	-	-	-	-	120.7 (20.7)	-	-	-	45.7 (17.3)	-	294.3 (83.0)	-	-	-	-	-	-	-	-	29.4 (80.7)	11
Microcalanus spp.	-	776.9 (28.4)	-	182.8 (6.5)	-	1122.4 (160.3)	-	153.5 (31.0)	330.9 (18.1)	71.3 (2.6)	427.7 (248.0)	-	404.0 (88.4)	-	515.5 (27.0)	-	-	244.9 (52.6)	-	184.6 (27.1)	54.8 (18.4)	-	226.7 (84.9)	241.2 (273.8)	6
Oithona spinifera	-	298.0 (18.1)	-	240.8 (20.0)	-	537.4 (67.2)	-	340.0 (25.9)	435.1 (72.4)	181.0 (2.6)	1678.1 (1554.9)	-	1221.1 (97.2)	586.8 (135.7)	544.7 (145.8)	398.5 (104.0)	394.8 (19.6)	1718.3 (80.5)	314.4 (88.1)	221.2 (40.1)	47.5 (18.4)	-	95.1 (94.4)	588.3 (649.2)	3
Tortanus discaudatus	-	5.5 (2.6)	-	2.7 (0.0)	-	-	-	-	16.5 (12.9)	-	-	-	-	-	-	-	20.1 (2.1)	-	-	-	-	-	73.1 (26.7)	7.5 (20.3)	15
Copepodite A	-	-	-	-	-	-	-	-	-	-	-	-	-	603.2 (123.6)	-	148.1 (172.2)	177.3 (34.6)	-	-	-	-	-	-	66.3 (168.5)	8
Copepodite B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.9 (40.8)	33.8 (12.1)	-	-	-	-	-	-	4.8 (15.4)	17
Copepodite C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	133.4 (155.5)	145.3 (46.4)	-	-	-	-	-	-	19.9 (62.2)	12
Evadne nordmanni	-	95.1 (10.3)	-	52.5 (1.9)	-	-	-	-	-	-	862.8 (996.6)	-	1853.5 (159.6)	1862.7 (69.7)	-	17.4 (7.5)	-	-	-	10.1 (1.8)	162.7 (27.6)	-	3411.0 (254.0)	589.6 (1053.7)	2
Podon leuckarti	-	-	-	21.5 (4.5)	-	-	-	-	-	-	-	-	-	363.8 (52.2)	-	47.5 (30.3)	-	-	-	-	-	-	3418.3 (172.8)	274.3 (885.9)	4
Pachygrapsus crassipes	-	639.8 (25.9)	-	13.3 (3.2)	-	-	-	149.9 (5.2)	42.0 (12.9)	27.4 (18.1)	-	-	-	-	-	-	7.3 (9.9)	-	179.1 (165.6)	9.1 (2.1)	29.3 (6.0)	-	73.1 (52.1)	52.4 (132.2)	9
Porcellanid	-	-	-	-	-	-	-	-	-	-	-	-	-	250.4 (97.4)	-	-	-	-	-	6.4 (3.5)	-	-	-	18.3 (68.9)	13
Pinnixa spp.	-	-	-	11.4 (1.9)	-	32.9 (25.9)	-	-	109.7 (15.5)	-	-	-	25.6 (18.4)	-	-	100.5 (39.0)	9.1 (6.3)	-	-	223.0 (18.2)	-	-	-	31.1 (63.6)	10
Ostracods	-	51.2 (15.5)	-	5.9 (0.7)	-	-	-	138.9 (72.4)	32.9 (5.2)	21.9 (20.7)	-	-	-	-	-	-	-	-	-	-	-	-	36.6 (48.5)	11.6 (32.4)	14
Barnacle nauplii	-	457.0 (25.9)	-	587.7 (72.4)	-	21.9 (0.8)	-	1392.9 (118.9)	54.8 (7.8)	151.7 (33.6)	457.0 (238.6)	-	155.4 (57.7)	162.7 (125.6)	268.7 (75.1)	137.1 (41.5)	16.5 (3.7)	-	14.6 (16.9)	1048.3 (36.9)	29.3 (15.8)	-	-	258.7 (366.1)	5
Polychaete larvae	-	352.8 (28.4)	-	44.3 (1.9)	-	259.6 (56.9)	-	32.9 (15.5)	82.3 (23.3)	-	11.0 (14.0)	-	263.2 (34.3)	21.9 (10.3)	-	63.1 (36.4)	19.2 (7.5)	-	-	203.8 (46.9)	51.2 (34.3)	-	-	72.8 (104.8)	7
Chaetognatha	-	20.1 (2.6)	-	5.9 (1.9)	-	-	-	-	11.0 (5.2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.3 (4.4)	19
Lamellibranch larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60.3 (78.3)	-	-	-	-	-	-	-	4.3 (24.1)	18
Hydromedusae	-	-	-	-	-	-	-	-	20.1 (2.6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7 (3.8)	20
Number of species caught	-	11	-	12	-	7	-	7	14	8	7	-	8	8	5	11	11	3	4	9	7	-	8		
Total number of zooplankton caught	-	176,979	-	64,742	-	146,540	-	104,039	68,522	42,580	814,303	-	244,037	331,331	145,945	110,289	129,326	164,726	188,697	244,883	30,609	-	793,397		
Total number of zooplankton per meter^3	-	3,806	-	1,392	-	3,151	-	2,237	1,473	916	17,512	-	5,248	7,124	3,139	2,372	2,781	3,543	4,058	5,266	713	-	17,062		
Number of push-samples	-	2	-	2	-	2	-	2	2	2	4	-	4	4	4	4	4	4	4	4	4	-	4		

Table 32.

Zooplankton Sample Monthly Summary

All are zooplankton push-samples.

DAKIE   Densities are expressed as number per cubic meter water filtered (Mean ± Standard Deviation)

Zooplankton Taxa	1974 Aug	Sep	Oct	Nov	Dec	1975 Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean per meter^3	Overall Rank
Acartia spp.	-	2559.5 (598.8)	-	399.7 (122.9)	-	2578.4 (983.1)	-	1011.1 (31.3)	255.9 (22.3)	1238.7 (366.4)	2559.5 (2237.5)	-	733.1 (302.1)	6180.7 (1429.0)	1622.6 (221.1)	4123.6 (261.1)	3251.5 (463.2)	880.0 (150.5)	3213.6 (803.0)	208.2 (15.7)	262.3 (22.3)	-	4540.7 (992.3)	2330.8 (1926.1)	1
Calanus pacificus	-	-	-	-	-	853.2 (151.9)	-	-	-	-	-	-	-	-	-	-	-	33.2 (20.9)	-	-	-	-	-	34.1 (163.8)	10
Eucalanus bungii	-	-	-	-	-	82.2 (62.6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.0 (17.9)	18
Eurytemora spp.	-	-	-	-	-	-	-	49.0 (6.7)	-	-	-	-	-	-	81.4 (15.1)	-	-	47.4 (10.9)	-	-	63.2 (44.7)	-	-	13.7 (27.9)	14
Microcalanus spp.	-	758.4 (71.5)	-	175.4 (29.1)	-	398.1 (62.6)	-	79.0 (17.9)	69.7 (2.2)	79.0 (49.1)	436.1 (78.9)	-	173.8 (57.8)	897.4 (75.8)	246.5 (32.8)	-	-	281.2 (44.5)	116.9 (33.2)	19.0 (4.7)	265.4 (26.8)	-	742.6 (322.1)	283.3 (297.6)	5
Oithona spinifera	-	290.7 (71.5)	-	371.3 (64.8)	-	1687.4 (134.1)	-	50.6 (4.5)	189.6 (8.9)	306.5 (67.0)	1245.0 (302.9)	-	2234.0 (268.4)	3286.3 (890.1)	249.6 (48.0)	1207.1 (103.5)	2338.3 (308.4)	1207.1 (121.7)	287.5 (65.6)	35.1 (15.3)	85.3 (22.3)	-	101.1 (53.6)	1013.5 (1043.9)	2
Tortanus discaudatus	-	-	-	-	-	56.9 (8.9)	-	-	-	-	-	-	-	-	-	44.2 (21.9)	-	-	-	-	-	-	56.9 (26.3)	9.6 (22.1)	15
Copepodite A	-	-	-	-	-	-	-		-	-	-	-	-	-	-	1279.7 (68.7)	483.5 (130.7)	-	-	-	-	-	-	130.6 (353.7)	7
Copepodite B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.4 (6.3)	-	-	-	-	-	-	-	2.1 (7.7)	19
Copepodite C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	262.3 (68.7)	-	-	-	-	-	-	19.4 (71.2)	13
Evadne nordmanni	-	-	-	75.8 (40.2)	-	139.0 (107.3)	-	-	-	-	-	-	-	2376.2 (483.2)	-	75.8 (27.3)	-	-	-	4.3 (3.5)	132.7 (26.8)	-	1943.3 (82.2)	338.8 (781.1)	4
Podon leuckarti	-	-	-	33.2 (2.2)	-	-	-	-	-	-	-	-	-	1832.7 (449.1)	-	91.6 (12.1)	-	-	-	-	-	-	1169.1 (183.0)	230.4 (562.7)	6
Emerita analoga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.2 (6.3)	-	-	-	-	-	-	-	0.2 (1.7)	22
Pachygrapsus crassipes	-	176.9 (89.4)	-	19.0 (13.4)	-	164.3 (71.5)	-	-	134.3 (33.5)	44.2 (17.9)	82.2 (95.4)	-	-	-	13.4 (11.4)	47.4 (12.1)	-	-	357.1 (247.8)	62.4 (12.9)	-	-	-	61.6 (118.3)	9
Pinnixa spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41.1 (6.3)	-	-	-	7.5 (0.8)	-	-	-	3.6 (11.0)	17
Porcellanid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	107.4 (39.3)	98.0 (12.1)	-	-	94.8 (6.2)	-	-	-	22.2 (43.2)	12
Ostracods	-	50.6 (17.9)	-	-	-	145.3 (8.9)	-	52.1 (38.0)	-	-	-	-	-	-	-	-	-	33.2 (9.5)	25.3 (10.3)	7.9 (6.2)	-	-	120.1 (48.9)	23.0 (43.2)	11
Barnacle nauplii	-	271.8 (98.3)	-	761.5 (250.2)	-	530.9 (107.3)	-	33.2 (20.1)	794.7 (91.6)	369.7 (120.7)	676.2 (490.7)	-	151.7 (70.7)	1162.8 (651.4)	748.1 (32.8)	2793.3 (375.4)	619.3 (110.7)	306.5 (87.9)	173.8 (65.6)	826.7 (82.4)	1087.0 (71.5)	-	353.9 (73.0)	721.2 (705.6)	3
Polychaete larvae	-	537.2 (8.9)	-	58.5 (6.7)	-	537.2 (223.4)	-	25.3 (8.9)	165.9 (2.2)	-	63.2 (102.7)	-	-	-	68.7 (25.2)	233.8 (112.3)	31.6 (24.2)	-	-	59.3 (4.9)	47.4 (4.5)	-	-	84.6 (152.4)	8
Chaetognatha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.8 (6.3)	-	72.7 (74.7)	-	-	-	-	6.6 (26.3)	16
Lamellibranch larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26.5 (16.6)	-	-	-	2.0 (8.0)	20
Hydromedusae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37.9 (4.5)	-	-	1.4 (7.2)	21
Number of species caught	-	7	-	8	-	11	-	7	6	5	6	-	4	6	7	13	8	7	7	11	8	-	8		
Total number of zooplankton caught	-	124,953	-	50,959	-	192,951	-	34,978	43,312	54,825	136,173	-	88,571	423,301	81,515	271,061	190,998	75,013	114,242	36,361	53,294	-	242,845		
Total number of zooplankton per meter^3	-	4,645	-	1,894	-	7,173	-	1,300	1,610	2,038	5,062	-	3,293	15,736	3,030	10,077	7,100	2,789	4,247	1,352	1,981	-	9,028		
Number of push-samples	-	2	-	2	-	2	-	2	2	2	4	-	4	4	4	4	4	4	4	4	2	-	4		

Table 33.

Zooplankton Sample Monthly Summary

All are zooplankton push-samples.

RED HOUSE

Densities are expressed as number per cubic meter water filtered (Mean ± Standard Deviation)

Zooplankton taxa	1974 Aug	Sep	Oct	Nov	Dec	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean per meter^3	Overall Rank
Acartia spp.	-	405.9 (22.8)	-	16.8 (10.4)	-	855.9 (182.4)	-	12550.7 (8.3)	1149.0 (82.9)	6495.2 (762.7)	2708.3 (1450.3)	-	483.6 (56.3)	6964.1 (665.7)	567.2 (34.5)	-	96.4 (6.8)	1302.8 (134.5)	3849.9 (82.1)	428.5 (43.3)	469.9 (32.4)	-	823.6 (82.1)	2071.3 (2921.0)	1
Calanus pacificus	-	-	-	-	-	372.2 (37.3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.3 (69.9)	12
Eurytemora spp.	-	-	-	-	-	-	-	187.6 (49.7)	-	-	93.8 (114.9)	-	-	-	29.7 (32.8)	-	-	-	-	-	11.0 (3.3)	-	26.4 (12.2)	20.3 (51.0)	10
Microcalanus spp.	-	309.2 (22.8)	-	3.3 (0.5)	-	322.4 (49.7)	-	-	167.1 (4.1)	152.4 (16.6)	52.8 (36.1)	-	269.7 (65.1)	562.8 (134.0)	107.0 (114.7)	-	-	203.7 (18.8)	117.2 (4.8)	14.1 (1.5)	44.5 (7.1)	-	19.1 (13.0)	141.1 (162.2)	6
Oithona spinifera	-	57.2 (6.2)	-	74.7 (3.1)	-	615.5 (58.0)	-	-	11.7 (8.3)	23.5 (33.2)	64.5 (27.5)	-	1162.2 (136.5)	2122.1 (62.0)	84.3 (24.5)	-	166.0 (3.3)	146.6 (23.9)	252.1 (31.4)	39.4 (4.3)	4.6 (1.5)	-	-	322.7 (587.4)	4
Tortanus discaudatus	-	-	-	-	-	20.5 (12.4)	-	-	-	-	-	-	-	-	1.4 (1.6)	-	3.9 (0.9)	16.1 (7.4)	13.2 (2.9)	-	-	-	-	3.3 (6.6)	16
Copepodite A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41.4 (44.7)	-	110.5 (6.5)	-	-	-	-	-	-	13.8 (34.6)	11
Copepodite B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.2 (2.6)	-	-	-	-	-	-	-	-	0.3 (1.2)	19
Copepodite C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.8 (0.9)	-	-	-	-	-	-	-	-	0.1 (0.4)	20
Evadne nordmanni	-	10.3 (2.1)	-	19.1 (1.0)	-	-	-	-	35.2 (8.3)	70.3 (33.2)	-	-	95.3 (28.5)	4507.9 (371.4)	2.6 (2.8)	-	-	-	19.1 (5.6)	1.1 (0.9)	2.0 (1.6)	-	203.7 (58.1)	350.1 (1168.3)	3
Podon leuckarti	-	-	-	-	-	-	-	-	-	-	-	-	-	2192.4 (80.1)	4.2 (4.5)	-	-	-	-	-	2.9 (1.6)	-	45.4 (12.1)	160.7 (569.0)	5
Pachygrapsus crassipes	-	95.3 (31.1)	-	-	-	-	-	-	93.8 (8.3)	-	-	-	126.0 (28.1)	-	8.4 (4.3)	-	4.2 (0.7)	159.7 (25.5)	10.3 (5.6)	75.5 (1.8)	5.3 (1.1)	-	-	35.2 (54.2)	8
Porcellanid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.1 (1.1)	-	33.7 (7.4)	2.6 (1.3)	-	-	-	2.8 (8.9)	17
Pinnixa spp.	-	-	-	-	-	5.9 (8.3)	-	181.7 (74.6)	87.9 (16.6)	187.6 (99.5)	-	-	-	-	5.5 (5.9)	-	13.0 (2.3)	-	133.4 (12.1)	2.0 (0.4)	-	-	-	27.9 (59.8)	9
Ostracods	-	-	-	1.5 (1.0)	-	55.7 (4.1)	-	52.8 (24.9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.9 (14.5)	15
Barnacle nauplii	-	123.1 (29.0)	-	52.8 (6.2)	-	-	-	439.7 (91.2)	1102.1 (8.3)	984.8 (218.5)	1327.8 (984.1)	-	360.5 (39.6)	703.5 (106.6)	84.3 (87.0)	-	-	107.0 (10.0)	320.9 (44.0)	457.8 (4.4)	838.5 (29.4)	-	939.4 (150.4)	469.7 (481.8)	2
Polychaete larvae	-	14.7 (4.1)	-	1.1 (0.5)	-	85.0 (4.1)	-	345.9 (74.6)	134.8 (24.9)	93.8 (66.3)	27.8 (38.7)	-	58.6 (31.4)	-	-	-	-	-	24.9 (5.6)	40.7 (1.4)	9.0 (5.7)	-	-	35.6 (71.5)	7
Botryllus spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.0 (4.1)	-	-	-	0.8 (3.0)	18
Chaetognatha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9 (1.0)	-	7.7 (2.3)	-	61.5 (15.5)	-	-	-	-	5.1 (16.3)	14
Lamellibranch larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	121.6 (41.5)	-	-	-	-	8.7 (33.1)	13
Number of species caught	-	7	-	7	-	8	-	6	8	7	6	-	7	6	14	-	8	6	12	10	9	-	6		
Total number of zooplankton caught	-	58,911	-	9,819	-	135,320	-	797,987	161,333	464,441	247,950	-	148,242	989,062	54,514	-	23,478	112,282	287,552	62,217	80,487	-	119,341		
Total number of zooplankton per meter^3	-	1,016	-	169	-	2,333	-	13,758	2,782	8,008	4,275	-	2,556	17,053	940	-	405	1,936	4,958	1,073	1,388	-	2,058		
Number of push-samples	-	2	-	2	-	2	-	2	2	2	4	-	4	4	8	-	4	4	4	4	4	-	4		

Table 34.

Zooplankton Sample Monthly Summary

KIRBY PARK

All are zooplankton push-samples.
Densities are expressed as number per cubic meter water filtered (Mean ± Standard Deviation)

Zooplankton taxa	1974 Aug	Sep	Oct	Nov	Dec	1975 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1976 Jan	Feb	Mar	Apr	May	Jun	Overall Mean per meter³	Overall Rank
Acartia spp.	-	-	-	158.8 (4.1)	-	100.4 (12.4)	-	1295.0 (68.4)	10418.3 (584.5)	8706.7 (18.9)	11106.7 (7676.8)	-	2320.0 (4470.7)	2490.0 (558.1)	4763.3 (329.4)	7853.3 (189.6)	640.0 (38.9)	496.7 (39.8)	1573.3 (69.7)	-	1435.0 (180.4)	-	10553.3 (916.3)	5407.7 (6167.2)	1
Calanus pacificus	-	-	-	-	-	68.3 (10.6)	-	-	-	-	-	-	-	-	63.3 (27.5)	-	-	2.5 (1.7)	-	-	4.6 (3.2)	-	-	8.1 (21.5)	13
Eucalanus bungi	-	-	-	-	-	2.9 (1.8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1 (0.5)	20
Eurytemora spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	126.7 (77.4)	-	-	-	-	-	-	-	-	9.4 (38.2)	12
Oithona spinifera	-	-	-	249.6 (2.9)	-	37.9 (4.1)	-	18.3 (2.4)	40.0 (18.9)	-	560.0 (206.6)	-	93.3 (51.1)	2060.0 (342.5)	140.0 (35.3)	125.0 (14.8)	219.6 (43.2)	841.7 (81.9)	-	-	4.4 (2.7)	-	-	312.7 (563.0)	3
Tortanus discaudatus	-	-	-	1.3 (0.6)	-	2.1 (0.6)	-	-	-	-	-	-	-	-	-	-	3.8 (1.6)	9.2 (8.3)	-	-	-	-	-	1.1 (3.2)	18
Copepodite A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	270.0 (29.6)	102.1 (28.4)	-	-	-	-	-	-	27.6 (74.9)	10
Copepodite C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47.5 (16.6)	-	-	-	-	-	-	3.5 (13.2)	15
Microcalanus spp.	-	-	-	112.1 (13.6)	-	-	-	108.3 (11.8)	466.7 (56.6)	-	40.0 (46.2)	-	253.3 (67.1)	476.7 (157.9)	720.0 (152.8)	-	-	312.5 (65.9)	-	-	17.5 (16.8)	-	-	161.6 (233.8)	6
Evadne nordmanni	-	-	-	18.8 (4.1)	-	1.7 (0.2)	-	-	-	-	-	-	-	376.7 (128.1)	-	11.7 (3.3)	-	-	-	-	-	-	-	29.5 (103.8)	9
Podon leuckarti	-	-	-	0.4 (0.6)	-	1.7 (2.4)	-	-	-	-	-	-	-	1623.3 (167.7)	-	33.3 (9.4)	-	-	-	-	-	-	-	122.8 (430.4)	7
Emerita spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.9 (2.1)	-	-	-	-	-	-	0.2 (0.9)	19
Pachygrapsus crassipes	-	-	-	3.8 (0.6)	-	0.8 (0.0)	-	151.7 (7.1)	93.3 (18.9)	-	-	-	213.3 (261.3)	-	-	98.3 (11.4)	22.5 (9.7)	25.8 (11.9)	133.3 (39.3)	-	14.2 (15.8)	-	-	47.9 (92.2)	8
Porcellanid	-	-	-	1.3 (0.6)	-	-	-	-	-	-	-	-	-	-	-	-	9.2 (8.4)	7.5 (1.7)	-	-	-	-	-	1.3 (3.6)	17
Pinnixa spp.	-	-	-	10.8 (3.5)	-	2.1 (0.6)	-	-	-	146.7 (56.6)	-	-	-	-	-	21.7 (6.4)	99.2 (34.4)	49.2 (16.2)	-	-	-	-	-	18.5 (39.7)	11
Ostracods	-	-	-	12.1 (2.9)	-	15.8 (3.5)	-	16.7 (14.7)	-	-	-	-	-	-	-	-	-	22.5 (11.0)	-	-	-	-	-	3.3 (7.8)	16
Barnacle nauplii	-	-	-	75.8 (9.4)	-	53.3 (5.9)	-	178.3 (16.5)	693.3 (452.6)	2160.0 (301.7)	866.7 (815.1)	-	266.7 (253.9)	1433.3 (268.9)	60.0 (40.0)	95.0 (29.0)	89.2 (10.8)	265.0 (84.6)	290.0 (101.2)	-	195.4 (65.5)	-	-	395.3 (570.3)	2
Polychaete larvae	-	-	-	35.4 (2.9)	-	15.0 (4.7)	-	666.7 (61.3)	666.7 (75.4)	200.0 (131.9)	293.3 (349.7)	-	200.0 (276.7)	-	110.0 (27.5)	351.7 (33.3)	68.8 (15.7)	15.9 (18.9)	-	-	451.7 (106.2)	-	-	202.6 (240.0)	4
Chaetognatha	-	-	-	3.8 (0.6)	-	-	-	-	-	-	-	-	-	-	-	40.0 (9.4)	21.7 (12.3)	-	-	-	-	-	-	4.7 (12.2)	14
Lamellibranch larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2518.3 (33.3)	-	-	-	-	-	-	-	186.5 (665.8)	5
Number of species caught	-	-	-	13	-	12	-	7	6	4	5	-	6	6	7	11	12	11	3	-	7	-	1		
Total number of zooplankton caught	-	-	-	26,785	-	15,402	-	124,185	631,293	571,883	656,202	-	170,677	431,460	305,148	582,333	67,652	104,474	101,827	-	108,263	-	538,218		
Total number of zooplankton per meter³	-	-	-	684	-	302	-	2,435	12,378	11,213	12,867	-	21,347	8,460	5,982	11,418	1,327	2,049	1,997	-	2,123	-	10,553		
Number of push-samples	-	-	-	2	-	2	-	2	2	2	4	-	4	4	4	4	4	4	8	-	4	-	4		

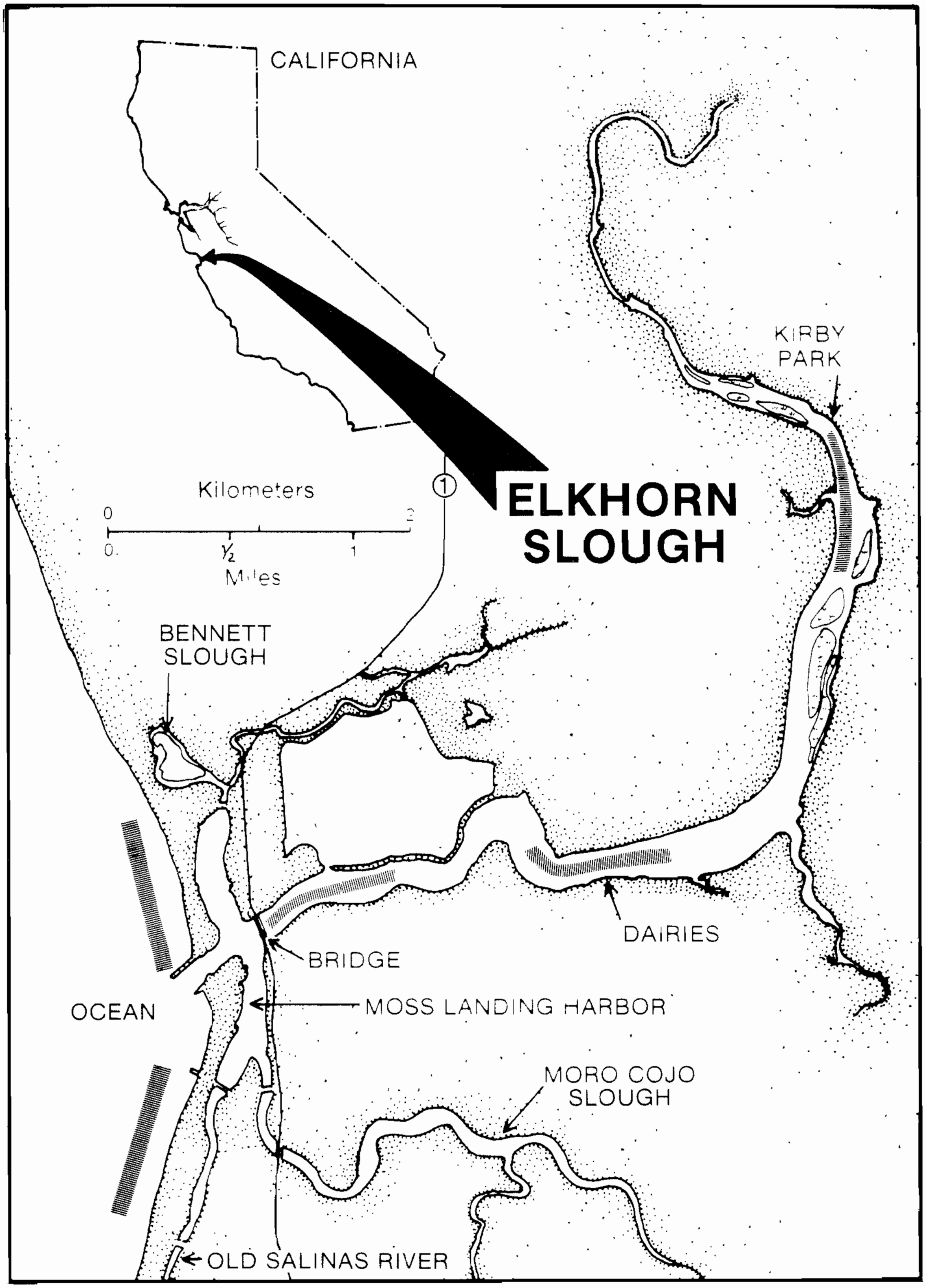

Figure 1. Map of Elkhorn Slough fish station. Regular trawl samples were taken in hatched areas.

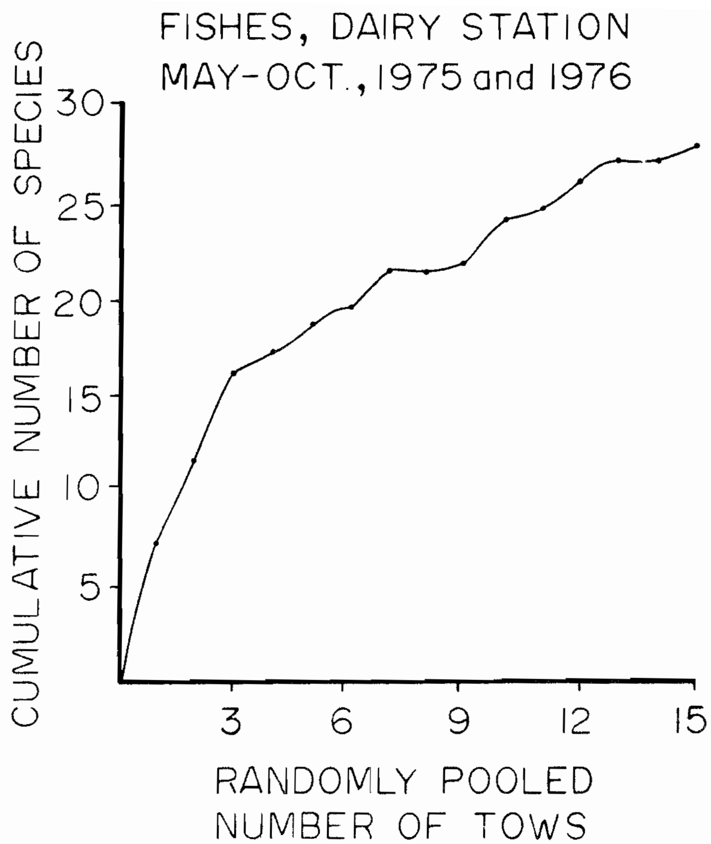

Figure 2. Cumulative number of fish species per 10 minute otter trawl tow.

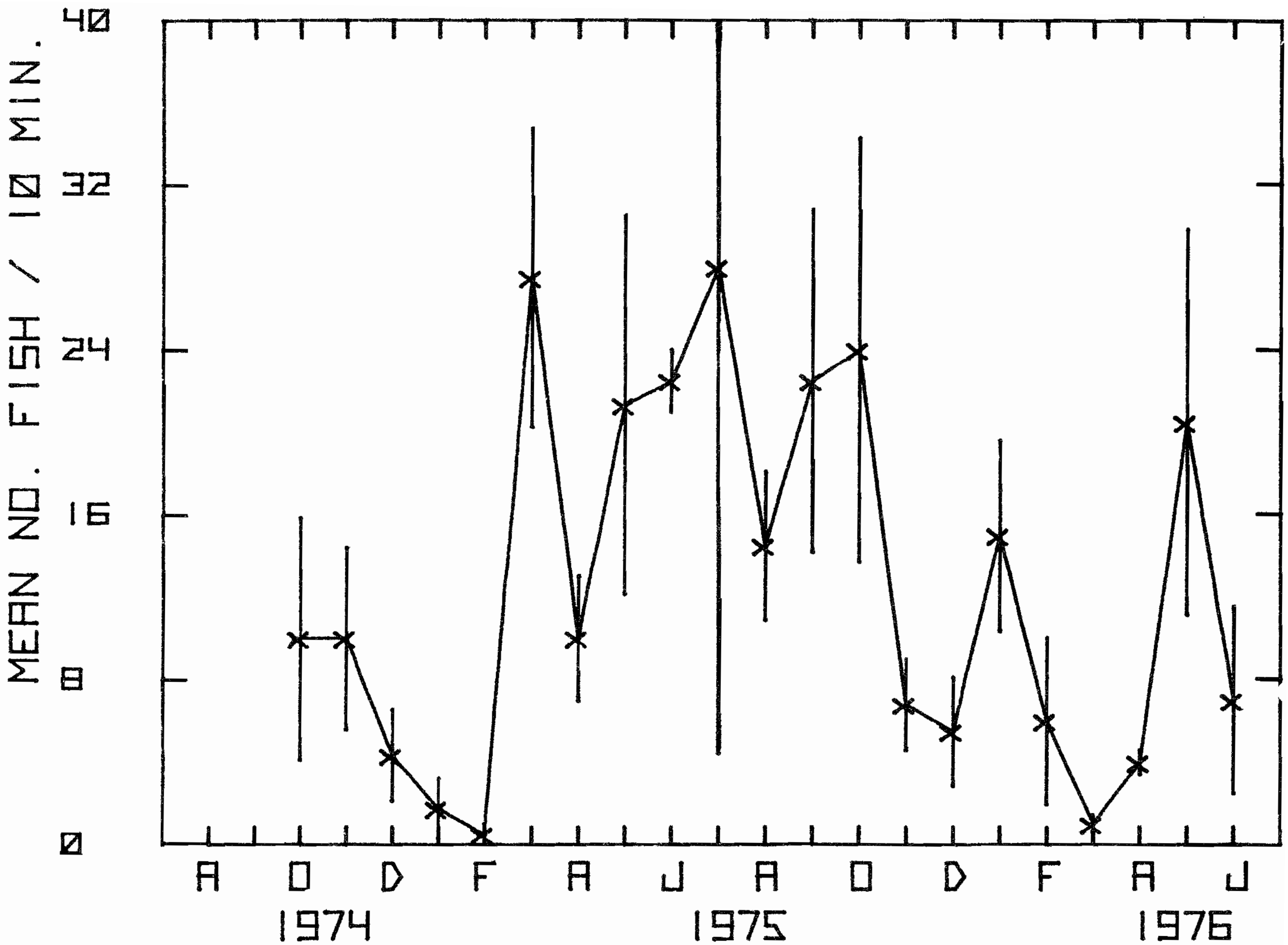

Figure 3. Ocean station monthly variation in mean number of fish per ten minute tow.

Vertical bars indicate standard error.

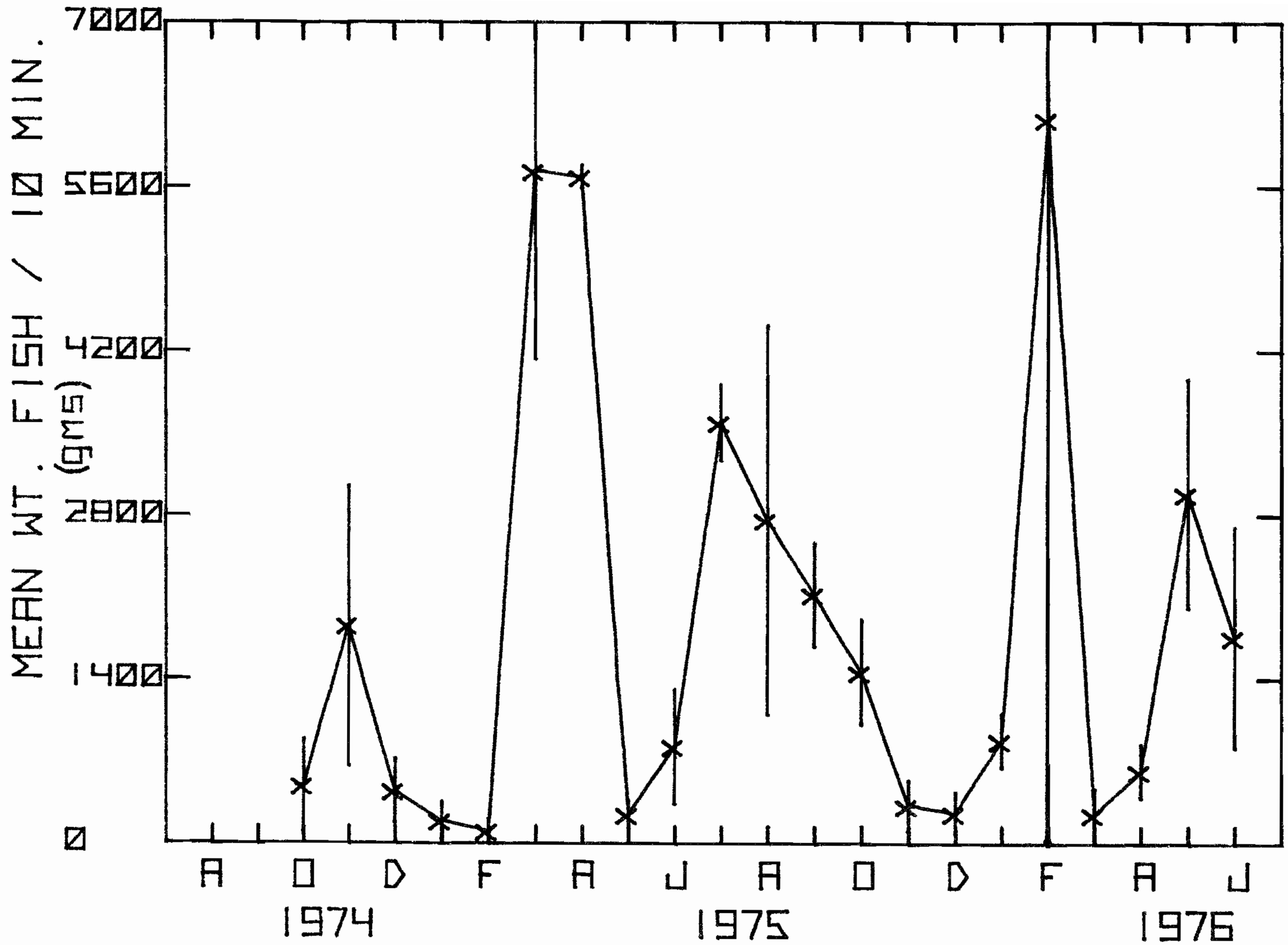

Figure 4. Ocean station monthly variation in mean biomass of fish per ten minute tow.

Vertical bars indicate standard error.

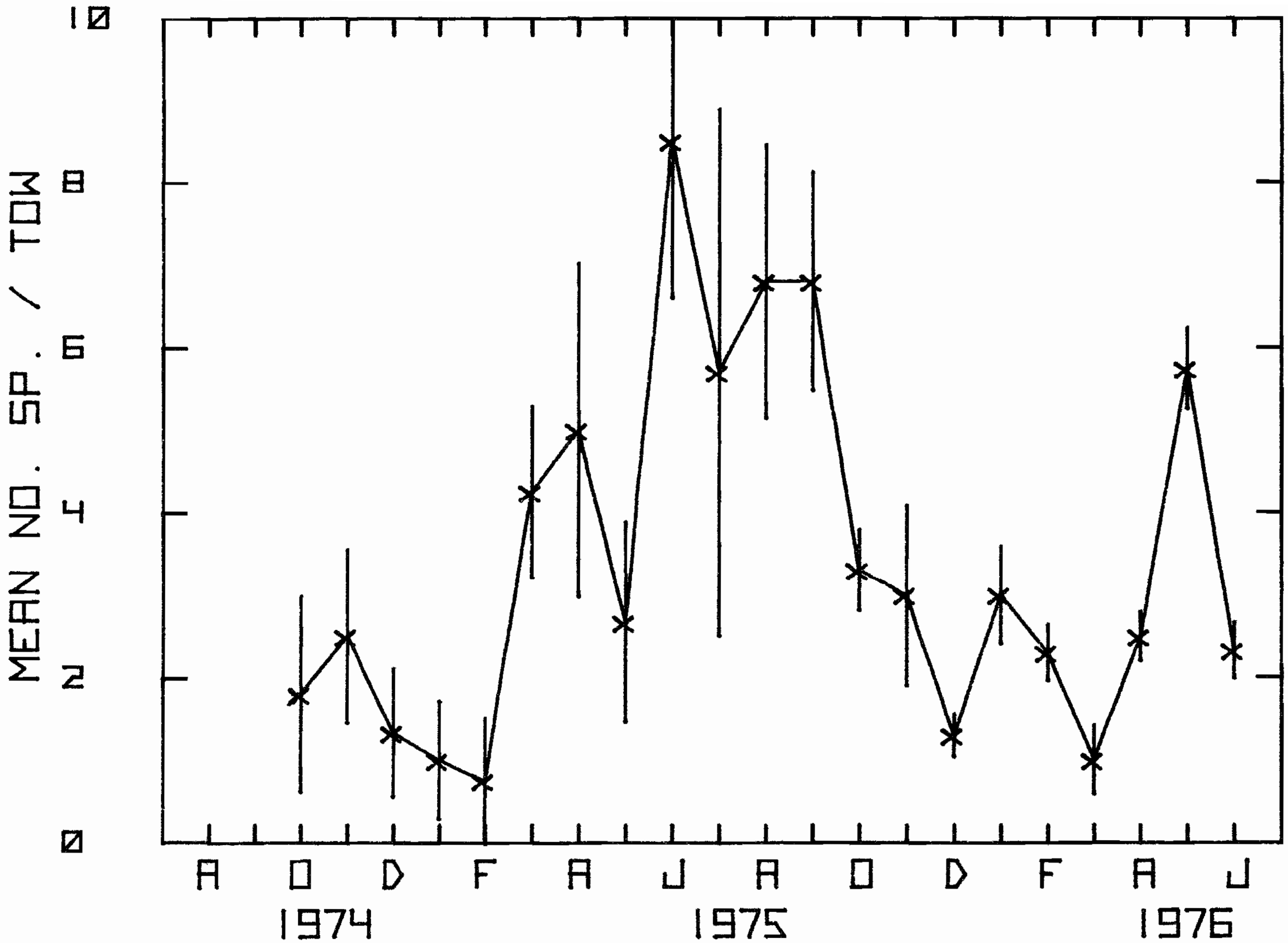

Figure 5. Ocean station monthly variation in mean number of fish species caught per ten minute tow. Vertical bars indicate standard error.

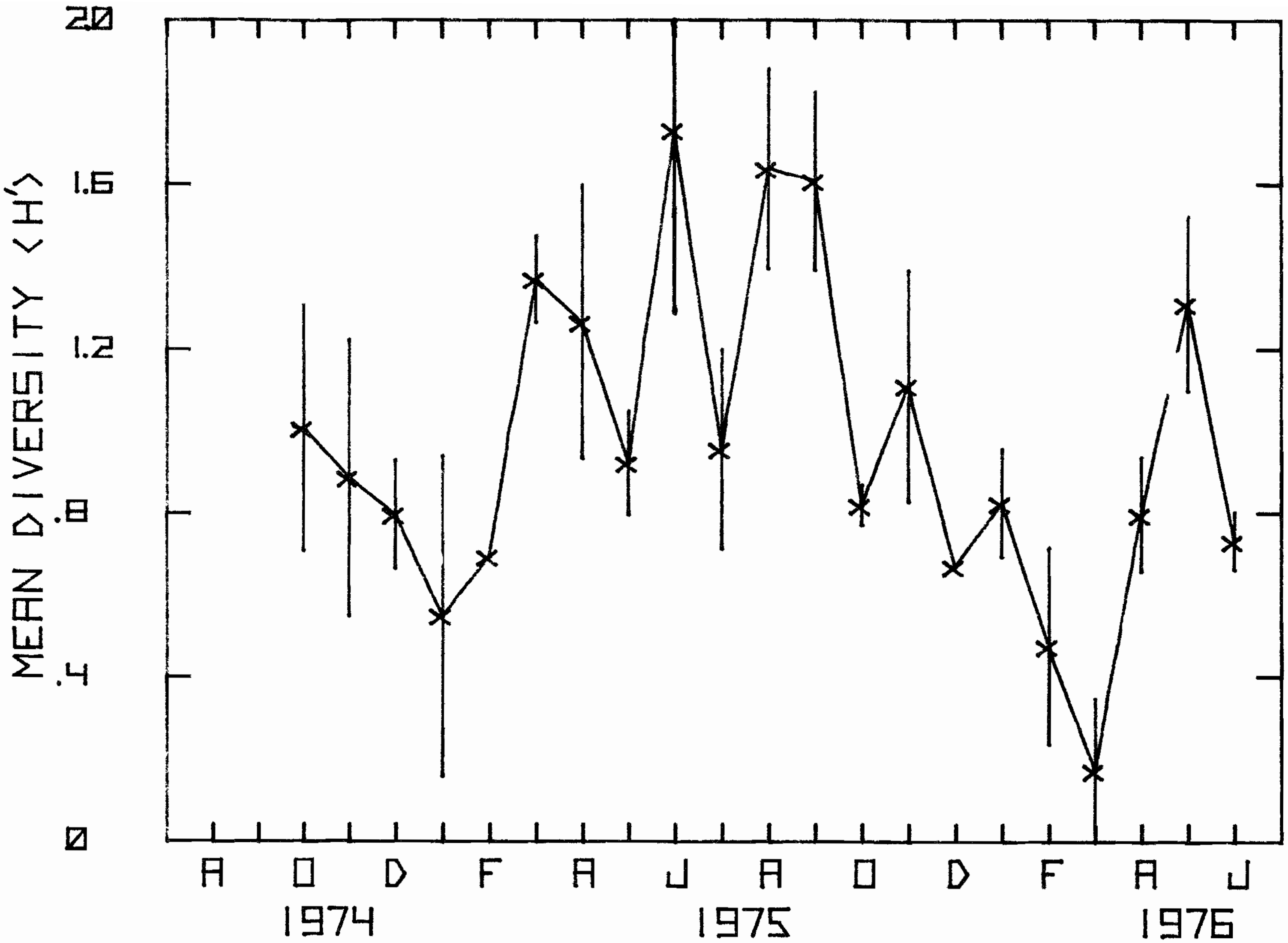

Figure 6. Ocean station monthly variation in mean diversity per ten minute tow.

Vertical bars indicate standard error.

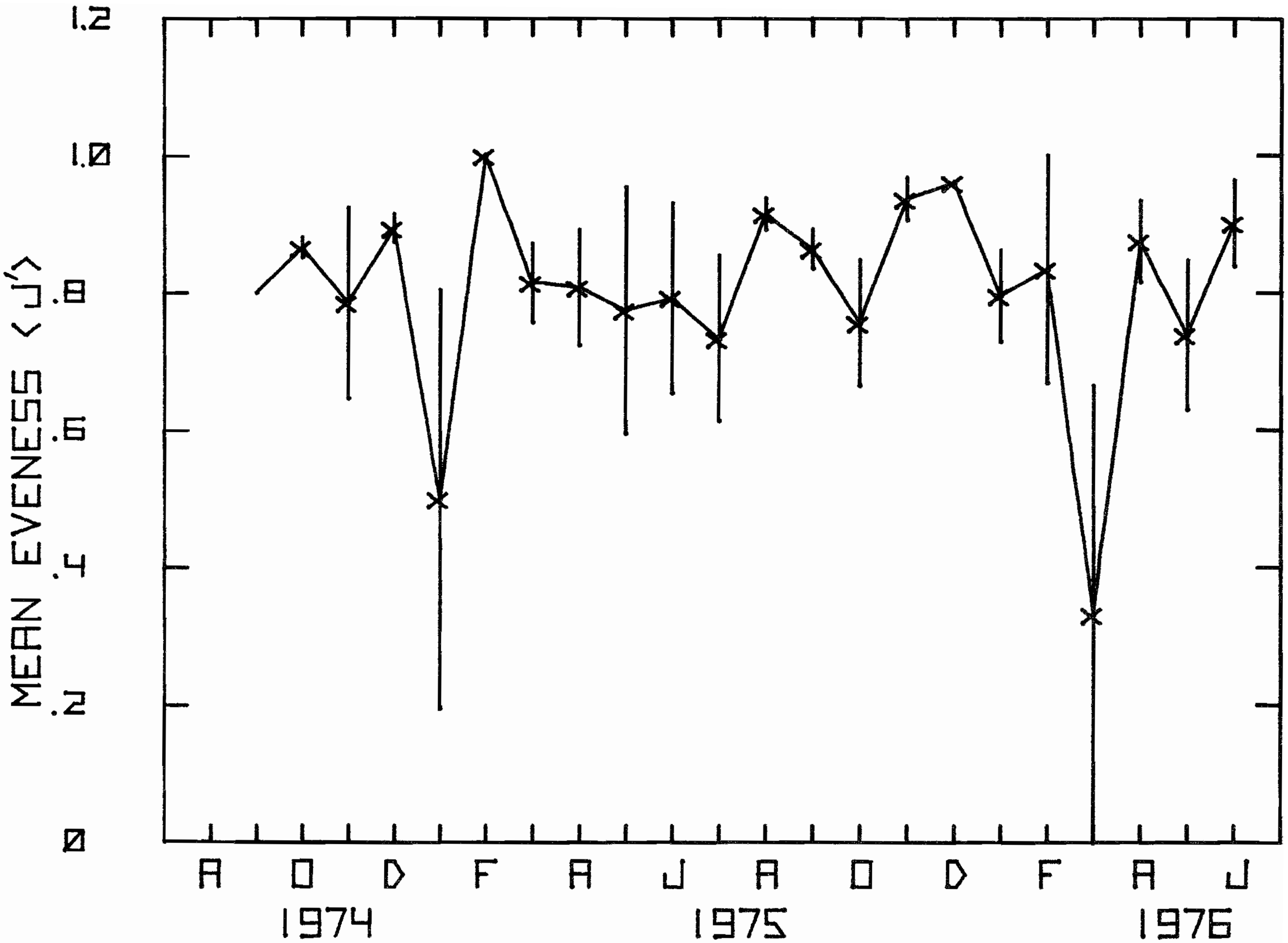

Figure 7. Ocean station monthly variation in mean evenness per ten minute tow. Vertical bars indicate standard error.

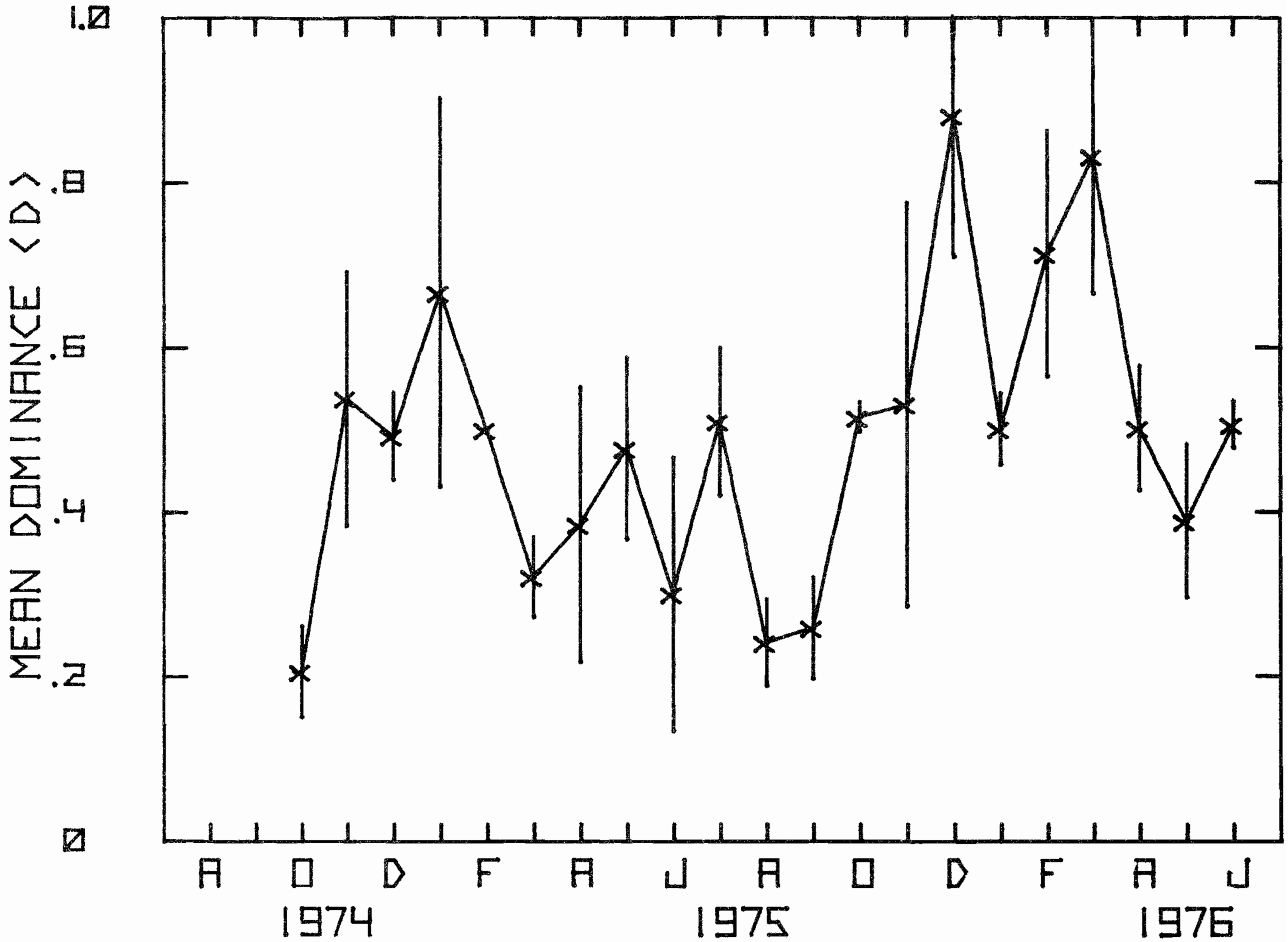

Figure 8. Ocean station monthly variation in mean dominance per ten minute tow.

Vertical bars indicate standard error.

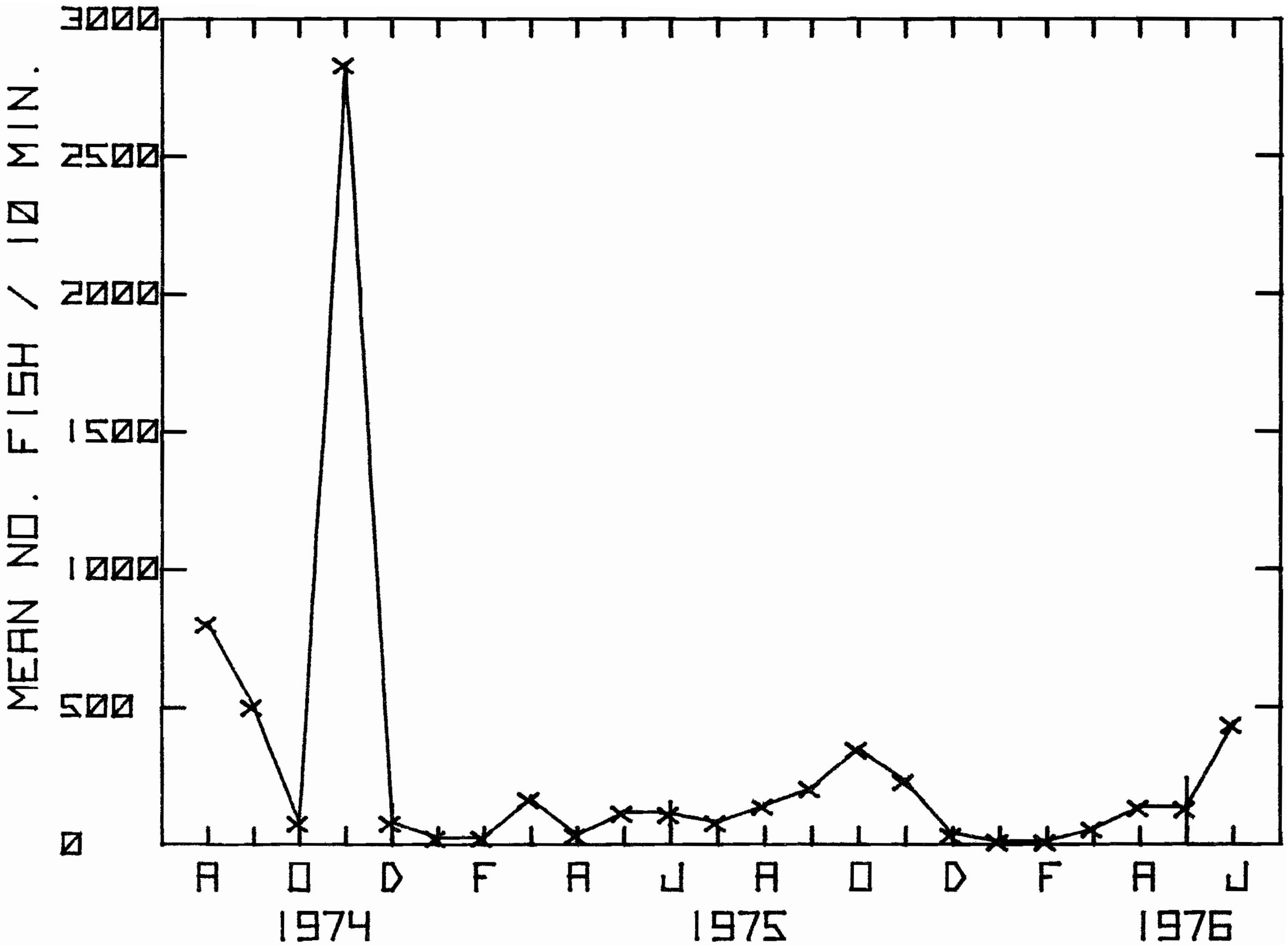

Figure 9. Bridge station monthly variation in mean number of fish per ten minute tow.

Vertical bars indicate standard error.

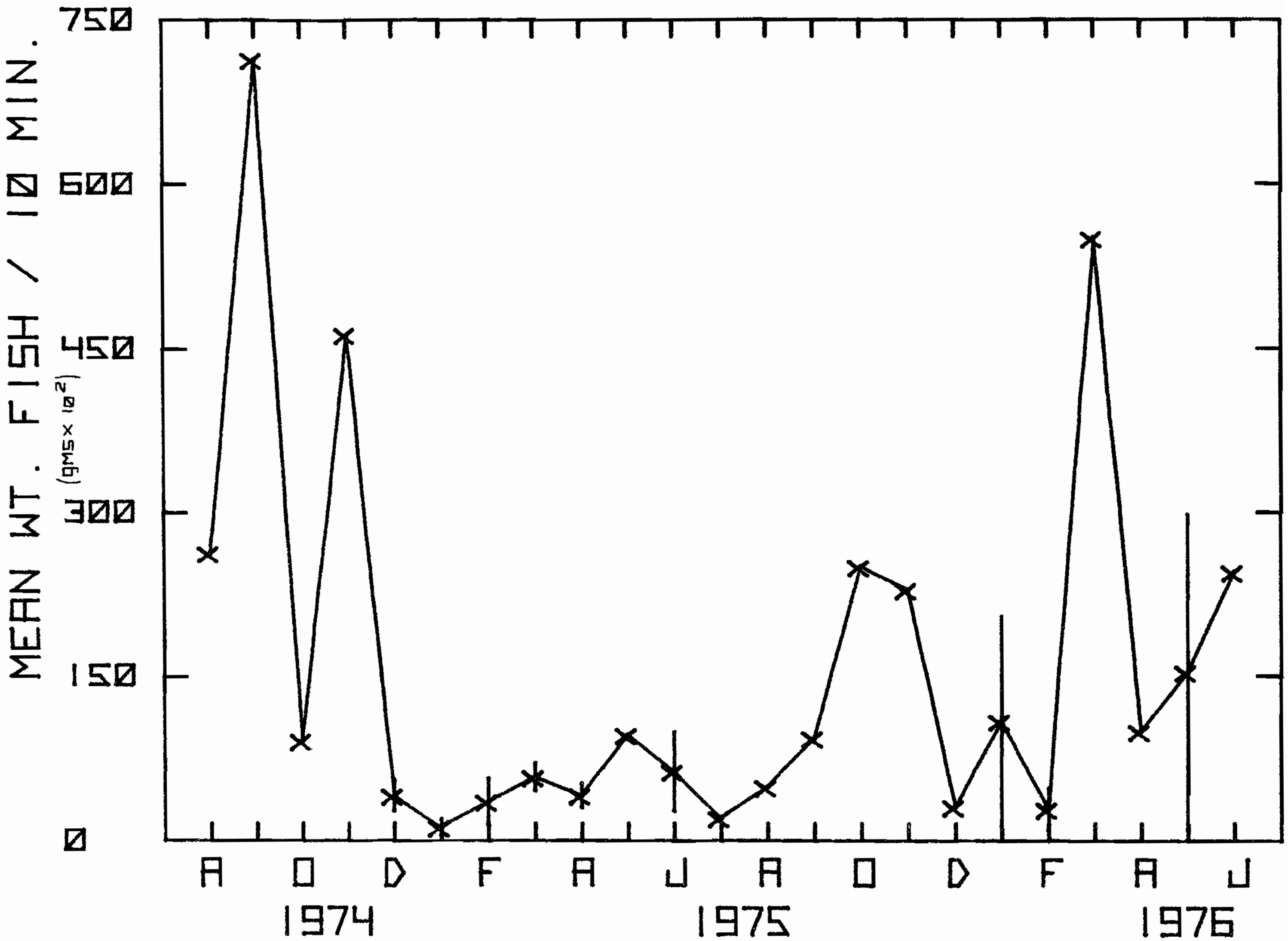

Figure 10. Bridge station monthly variation in mean biomass of fish per ten minute tow.

Vertical bars indicate standard error.

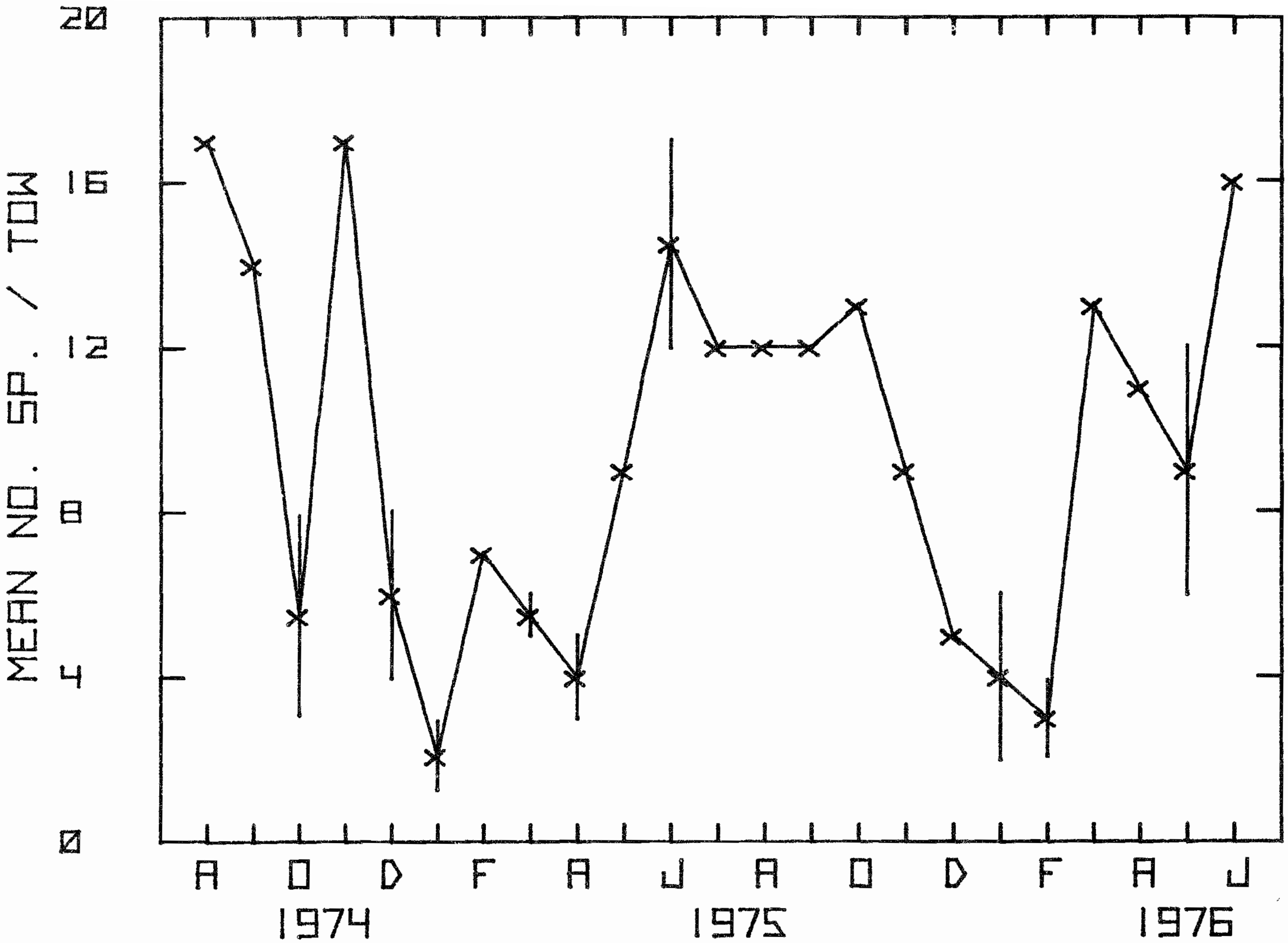

Figure 11. Bridge station monthly variation in mean number of fish species caught per ten minute tow. Vertical bars indicate standard error.

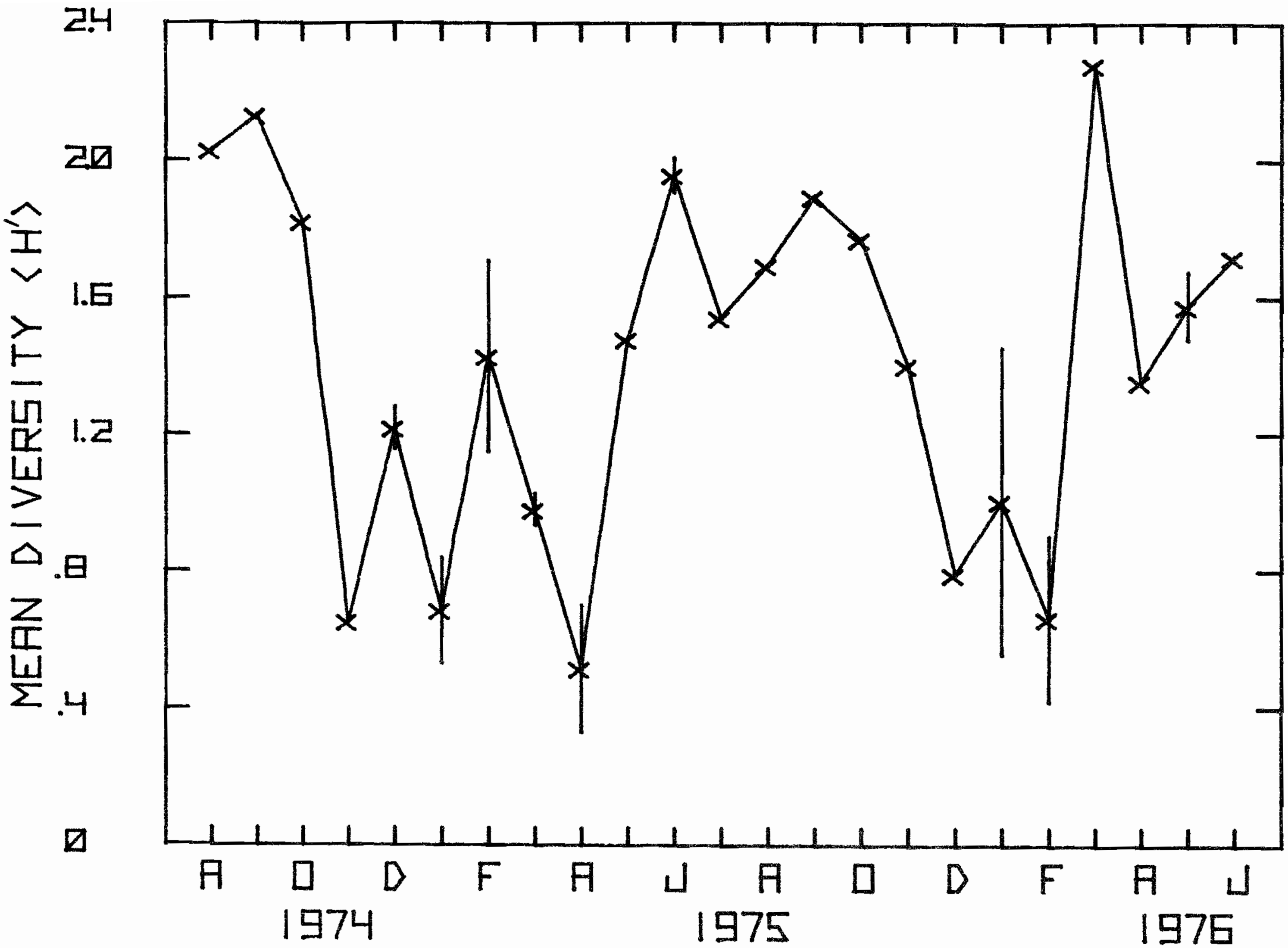

Figure 12. Bridge station monthly variation in mean diversity per ten minute tow.

Vertical bars indicate standard error.

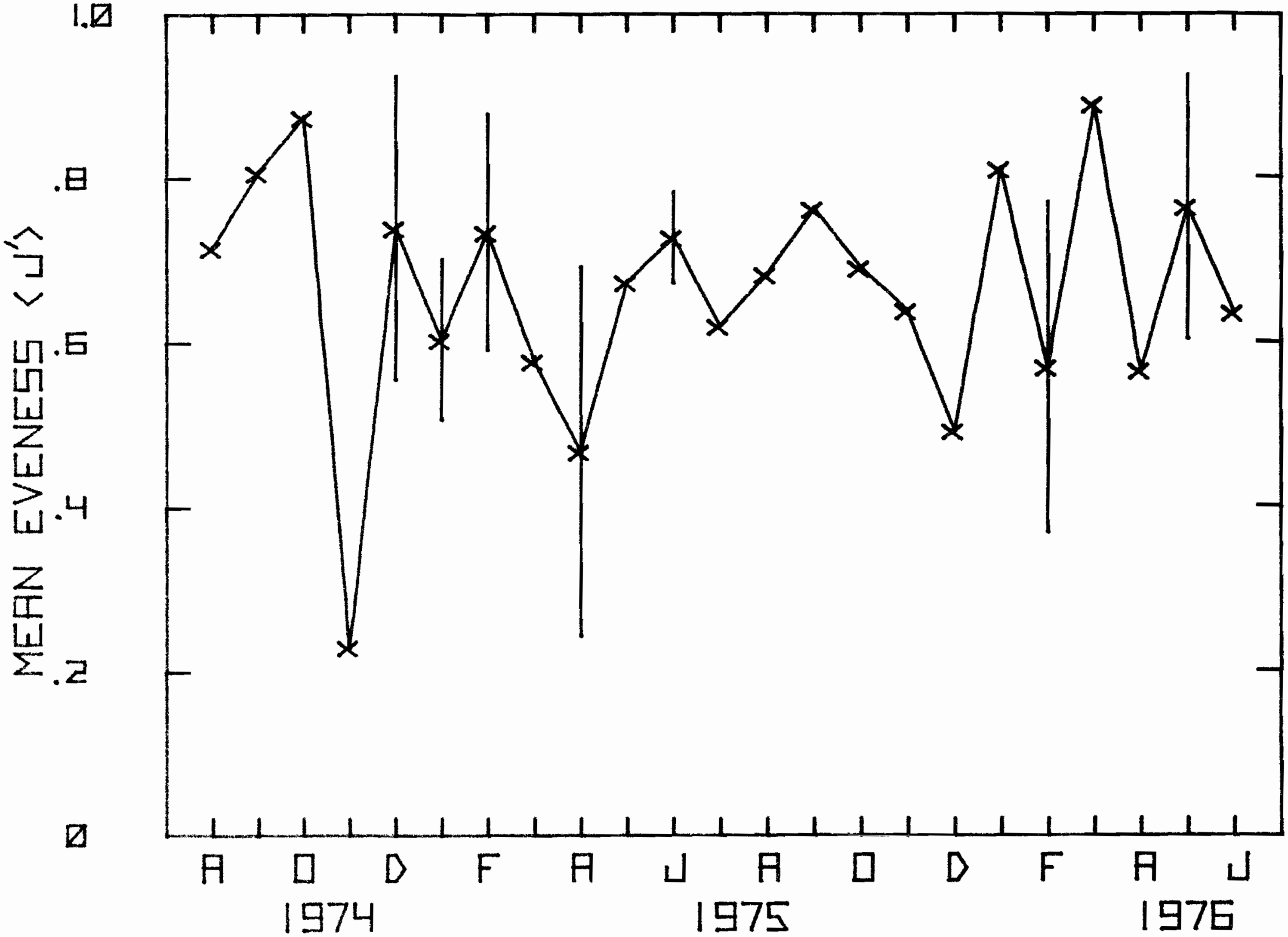

Figure 13. Bridge station monthly variation in mean evenness per ten minute tow.

Vertical bars indicate standard error.

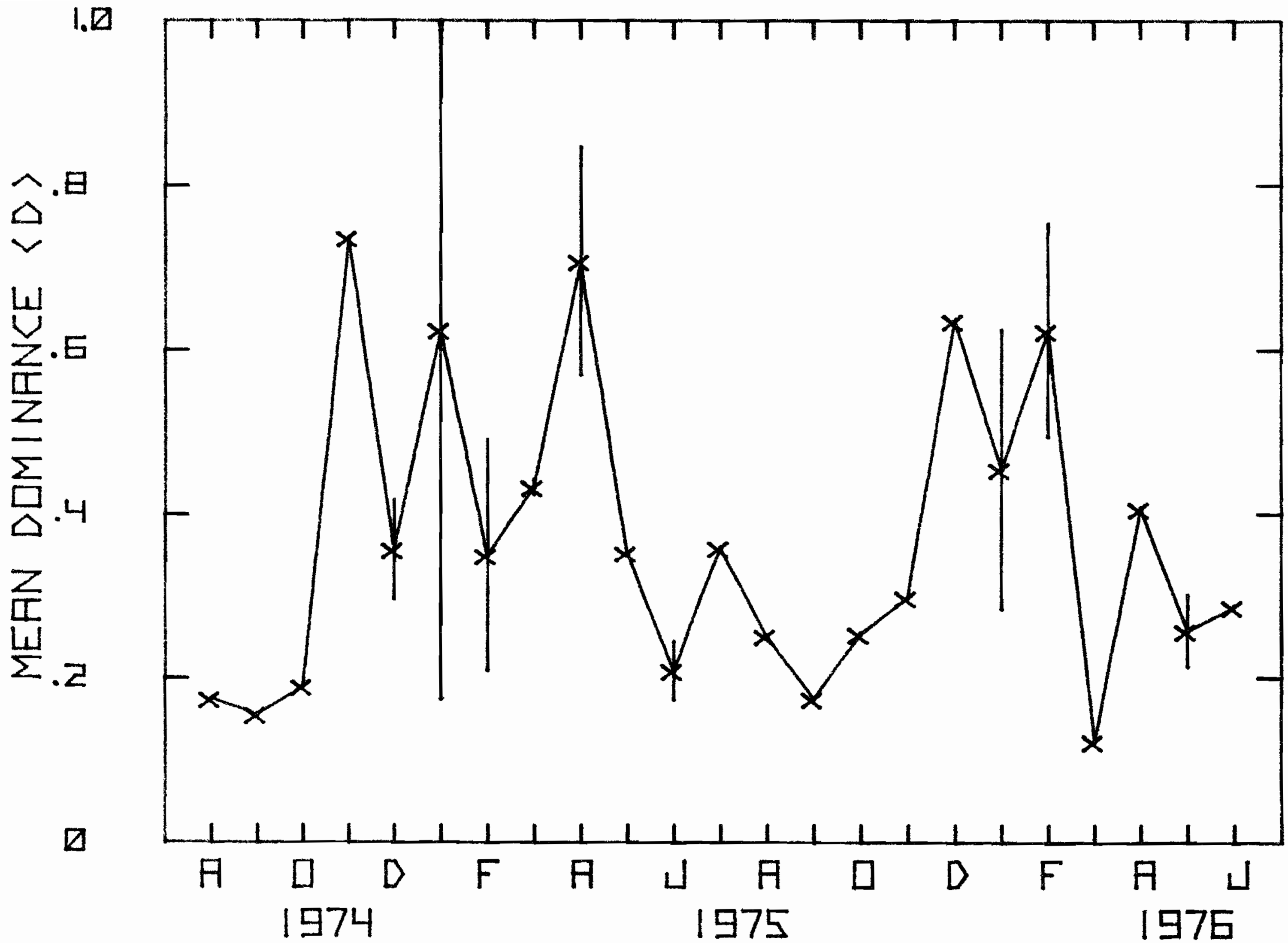

Figure 14. Bridge station monthly variation in mean dominance per ten minute tow. Vertical bars indicate standard error.

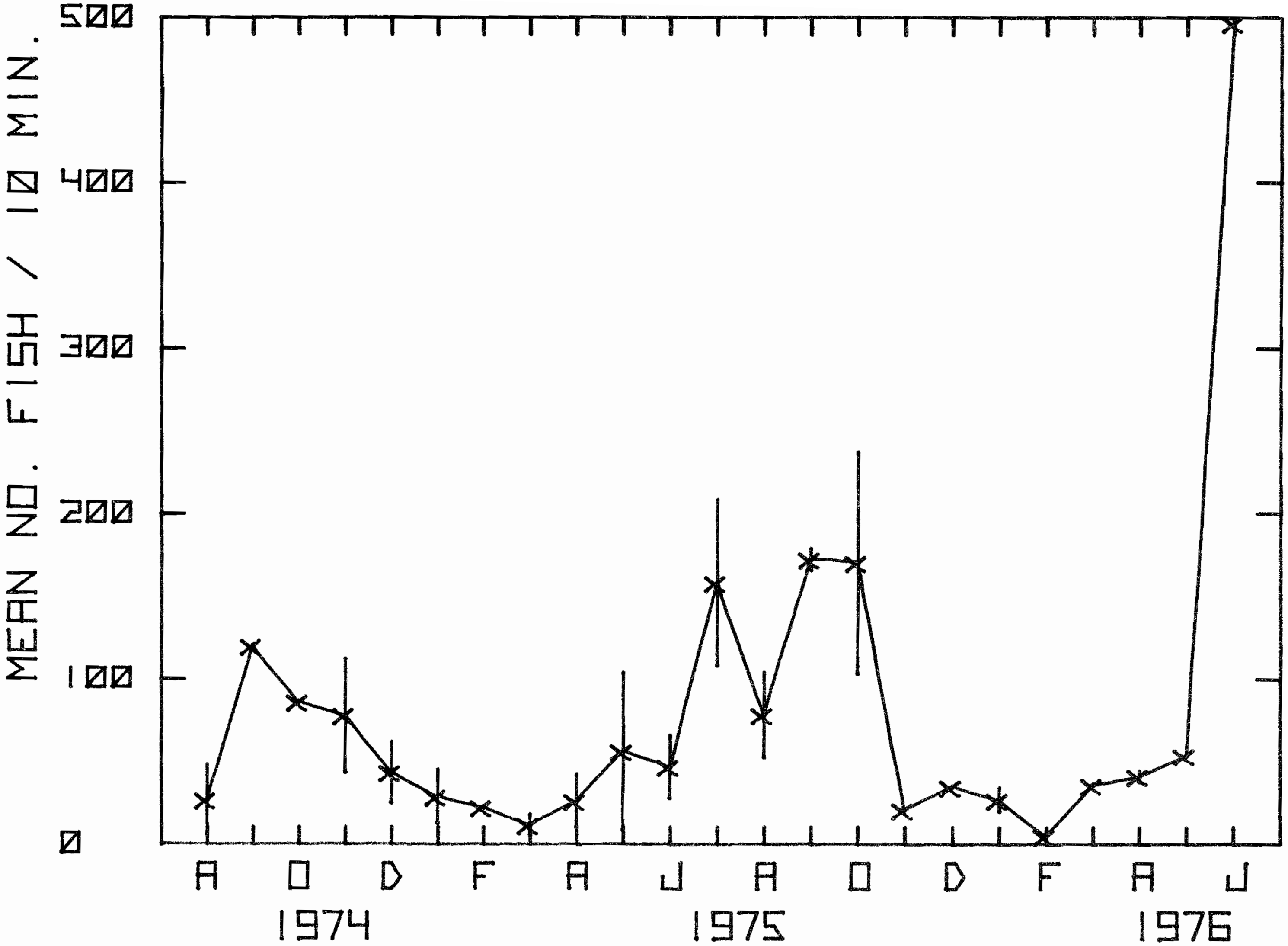

Figure 15. Dairies station monthly variation in mean number of fish per ten minute tow.

Vertical bars indicate standard error.

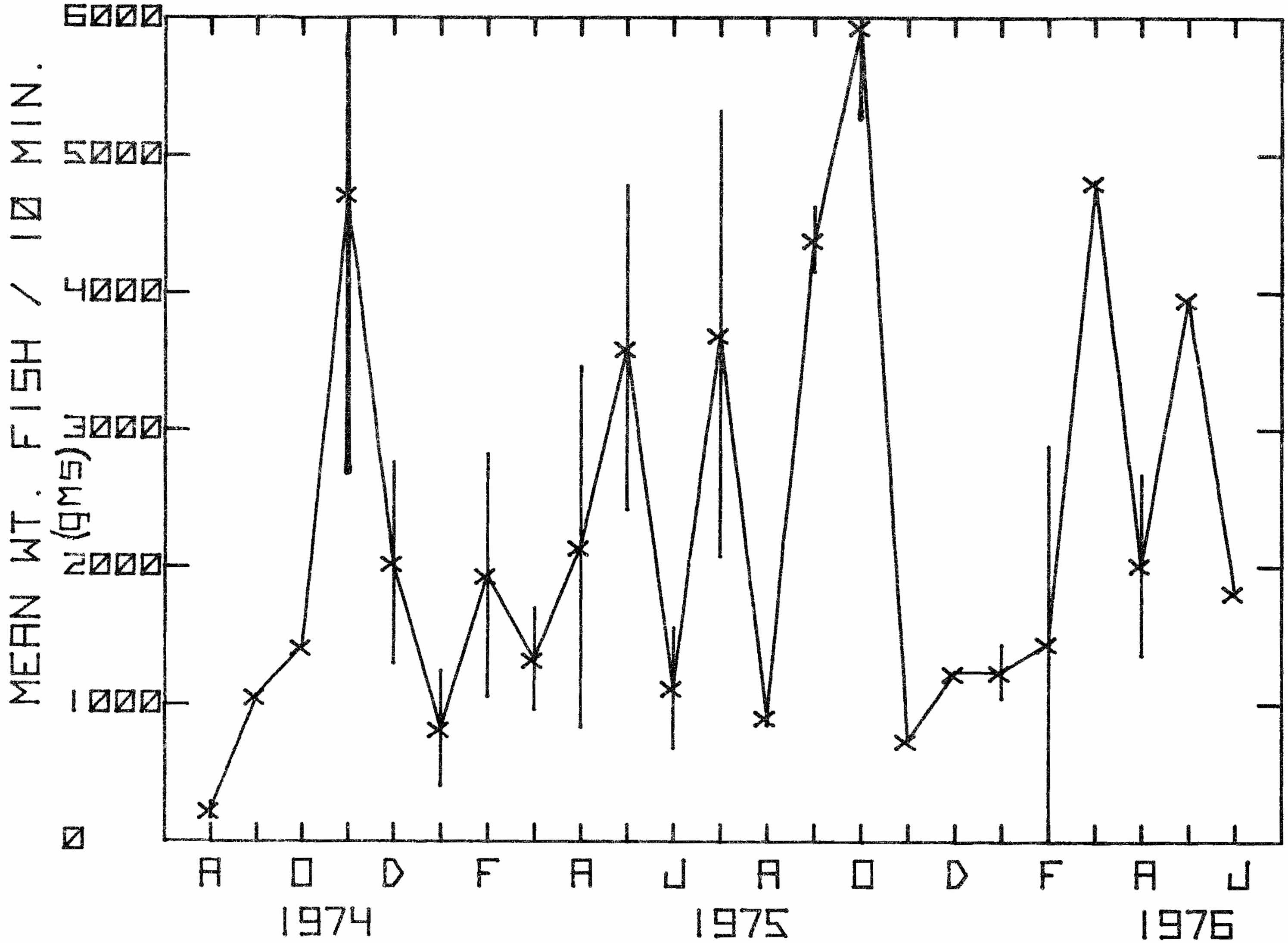

Figure 16. Dairies station monthly variation in mean biomass of fish per ten minute tow.

Vertical bars indicate standard error.

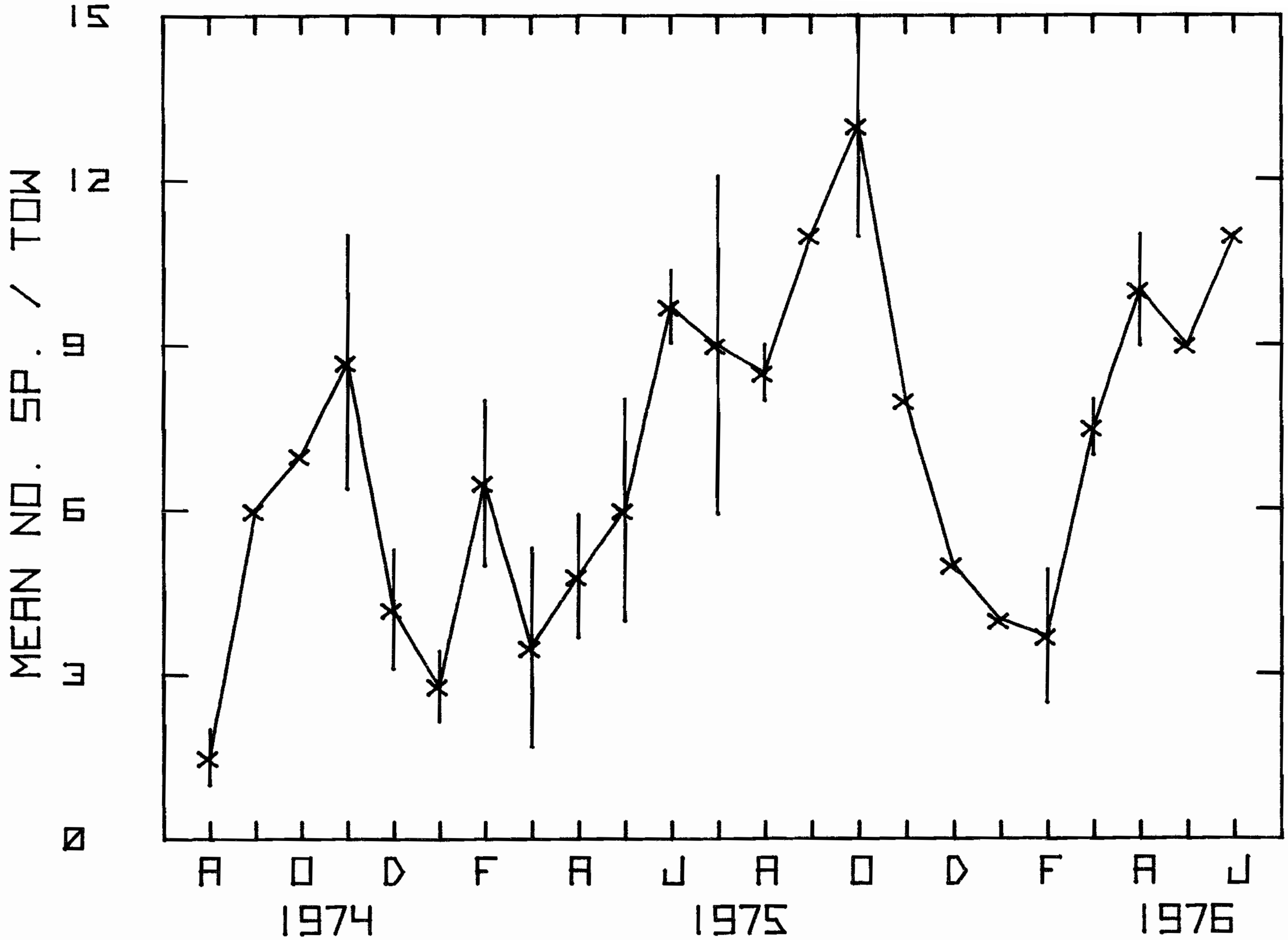

Figure 17. Dairies station monthly variation in mean number of fish species caught per ten minute tow. Vertical bars indicate standard error.

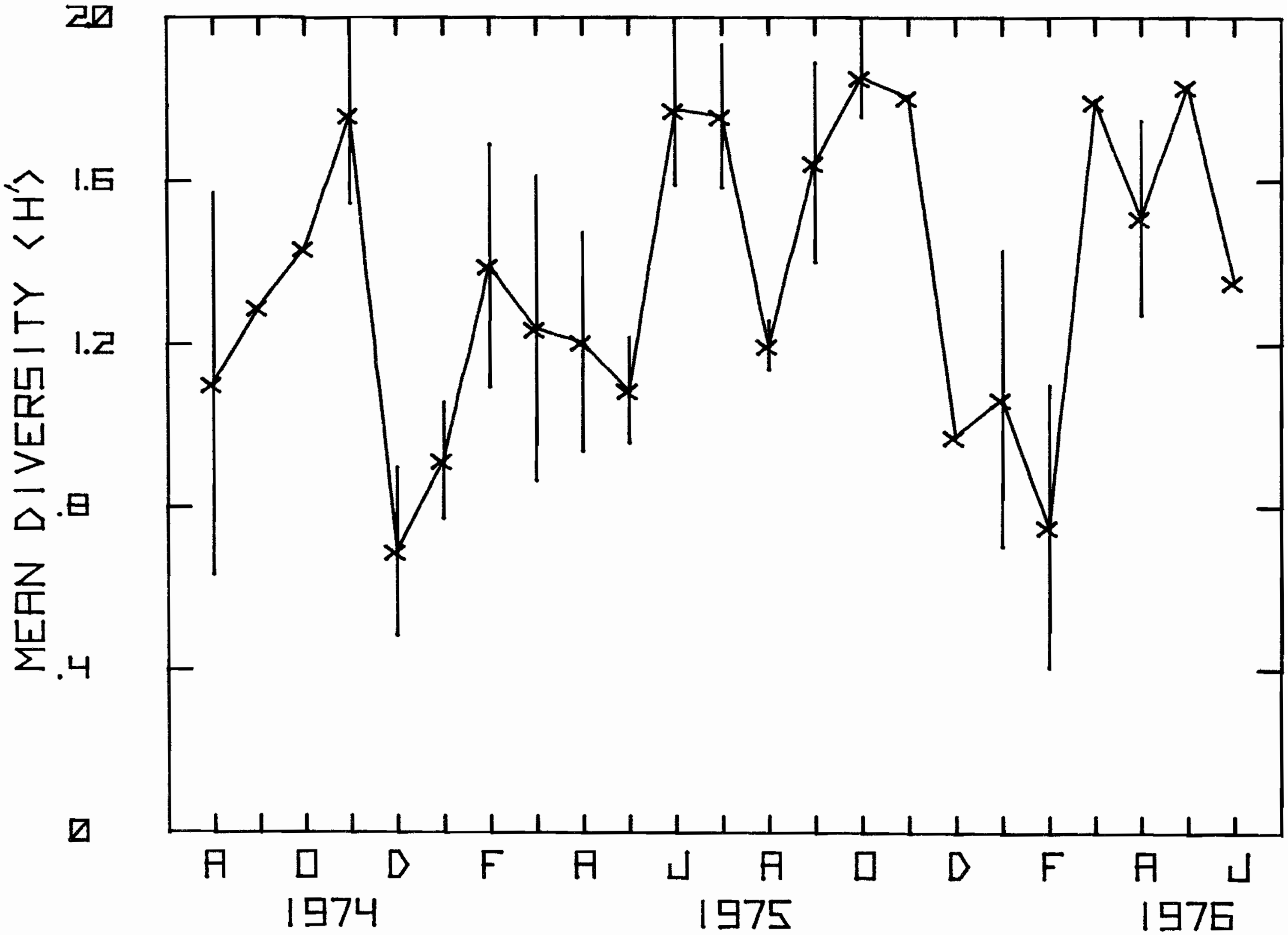

Figure 18. Dairies station monthly variation in mean diversity per ten minute tow.

Vertical bars indicate standard error.

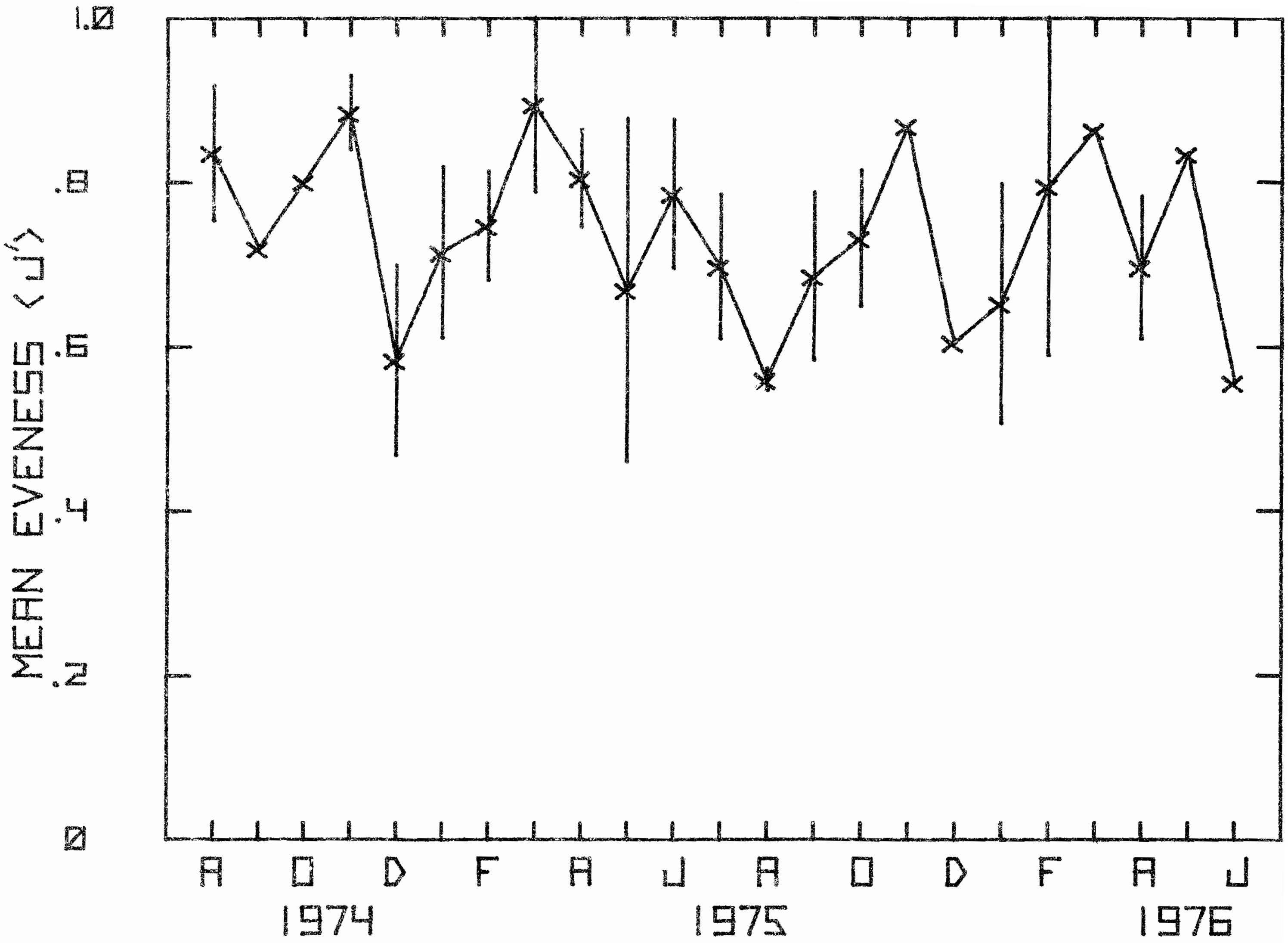

Figure 19. Dairies station monthly variation in mean evenness per ten minute tow.

Vertical bars indicate standard error.

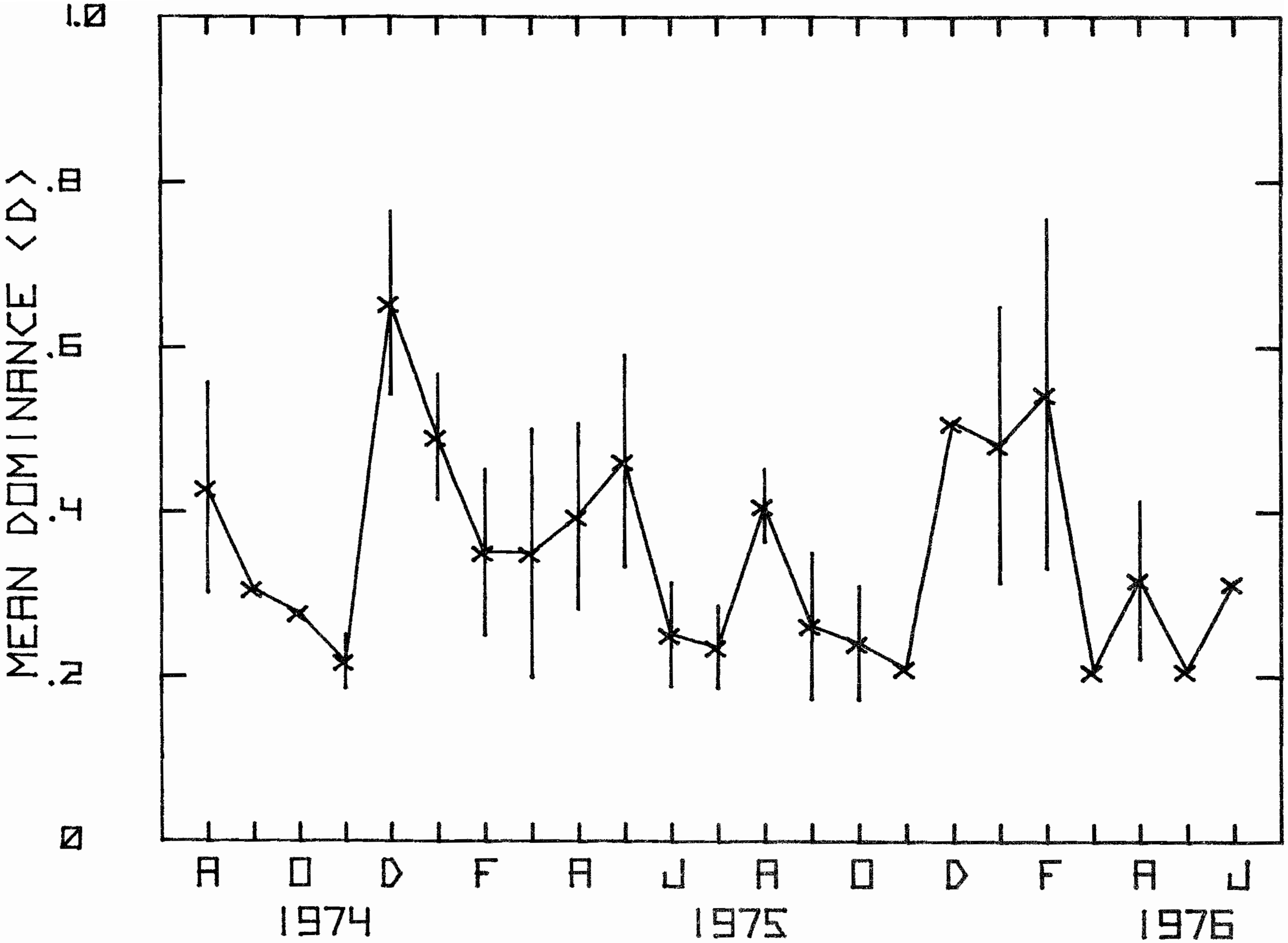

Figure 20. Dairies station monthly variation in mean dominance per ten minute tow.

Vertical bars indicate standard error.

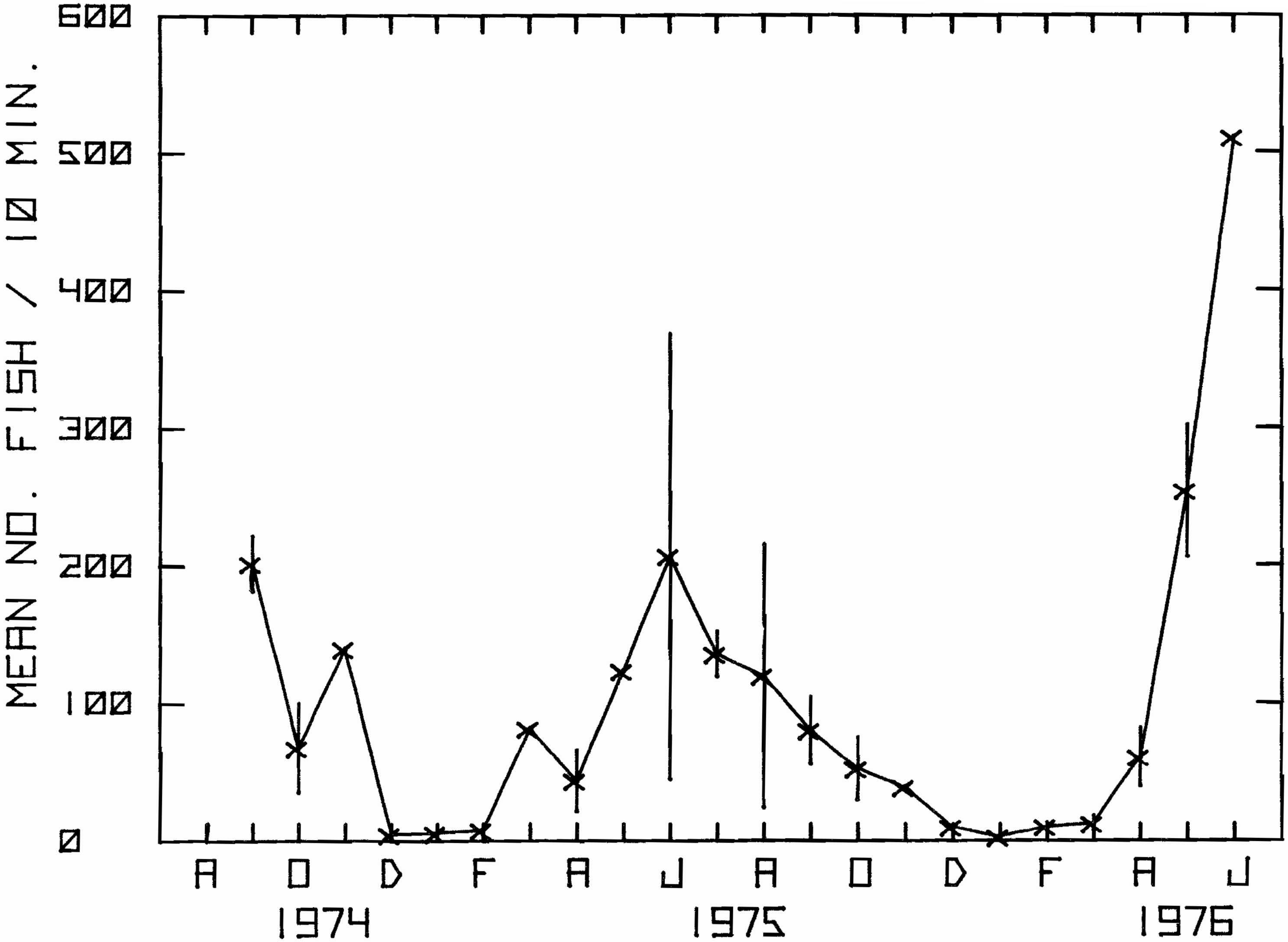

Figure 21. Kirby Park station monthly variation in mean number of fish per ten minute tow.

Vertical bars indicate standard error.

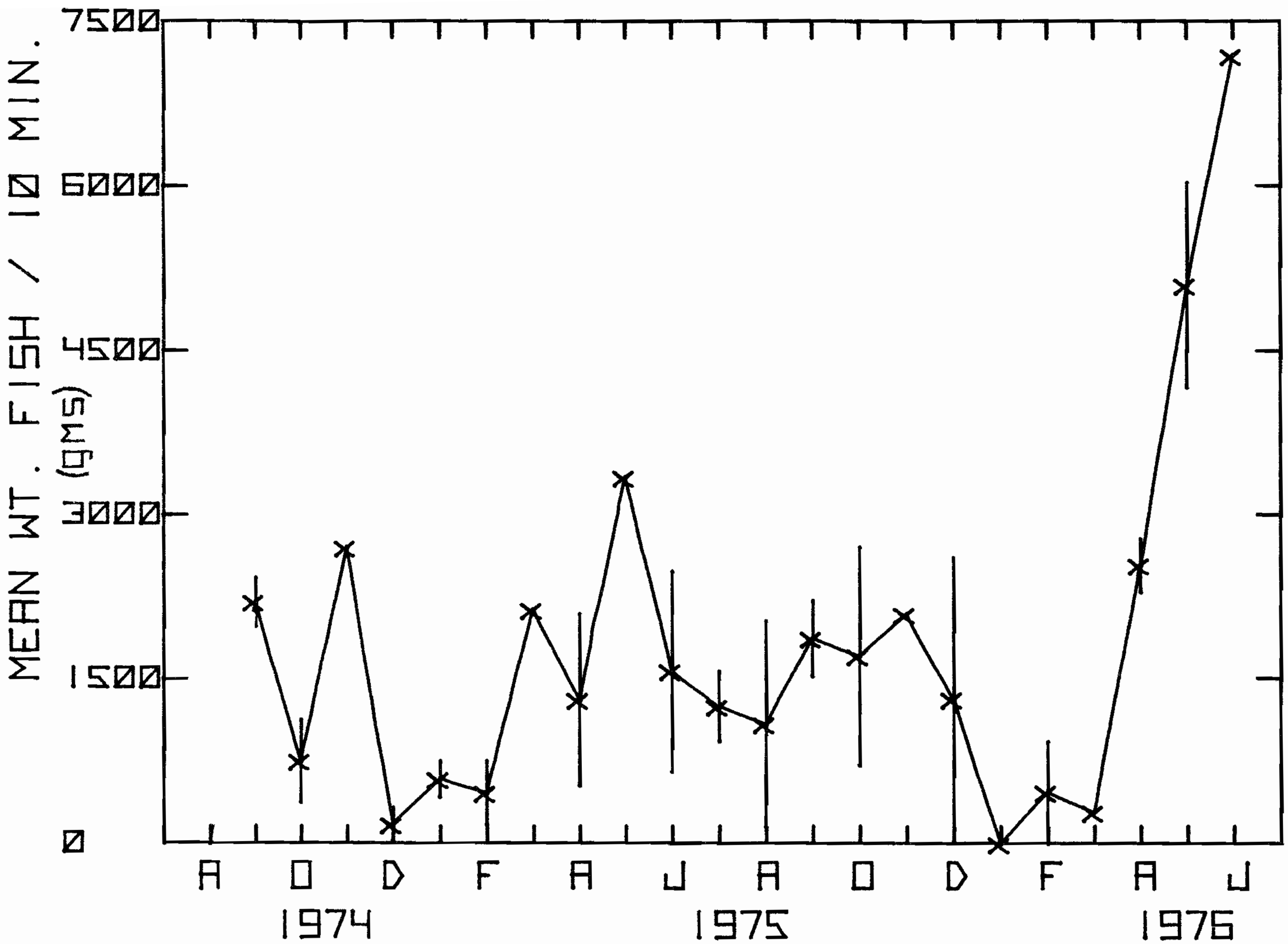

Figure 22. Kirby Park station monthly variation in mean biomass of fish per ten minute tow. Vertical bars indicate standard error.

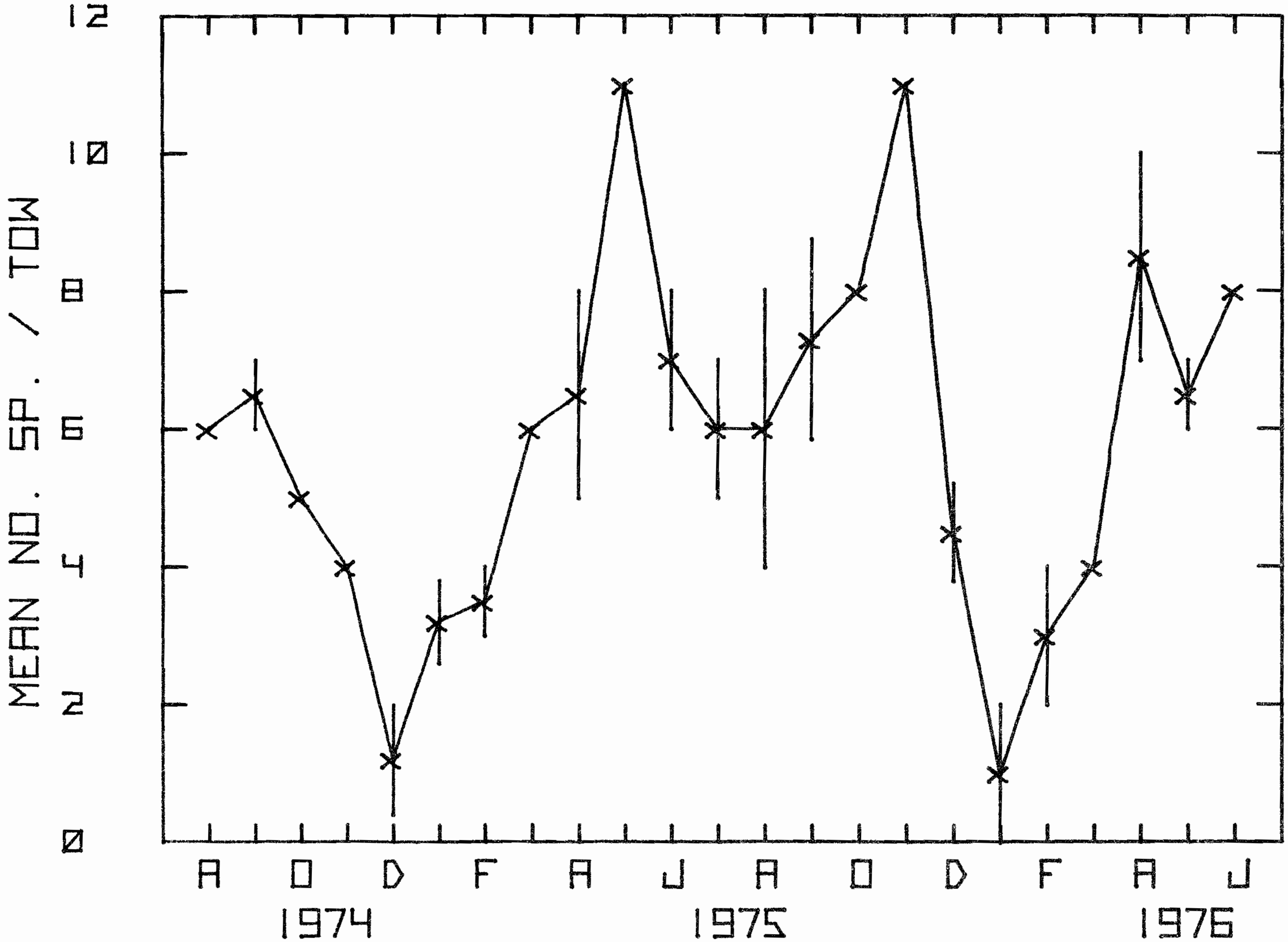

Figure 23. Kirby Park station monthly variation in mean number of fish species caught per ten minute tow. Vertical bars indicate standard error.

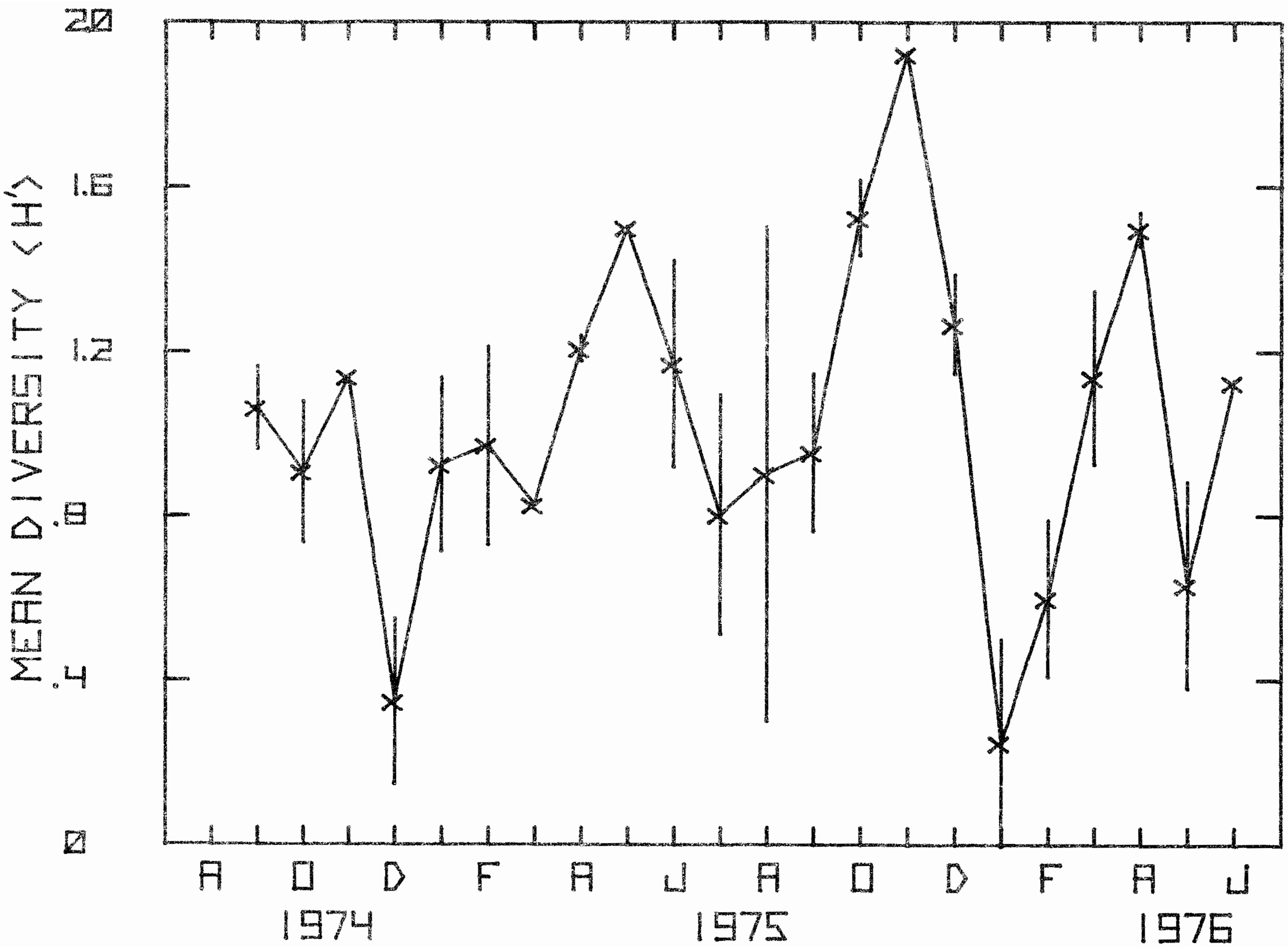

Figure 24. Kirby Park station monthly variation in mean diversity per ten minute tow. Vertical bars indicate standard error.

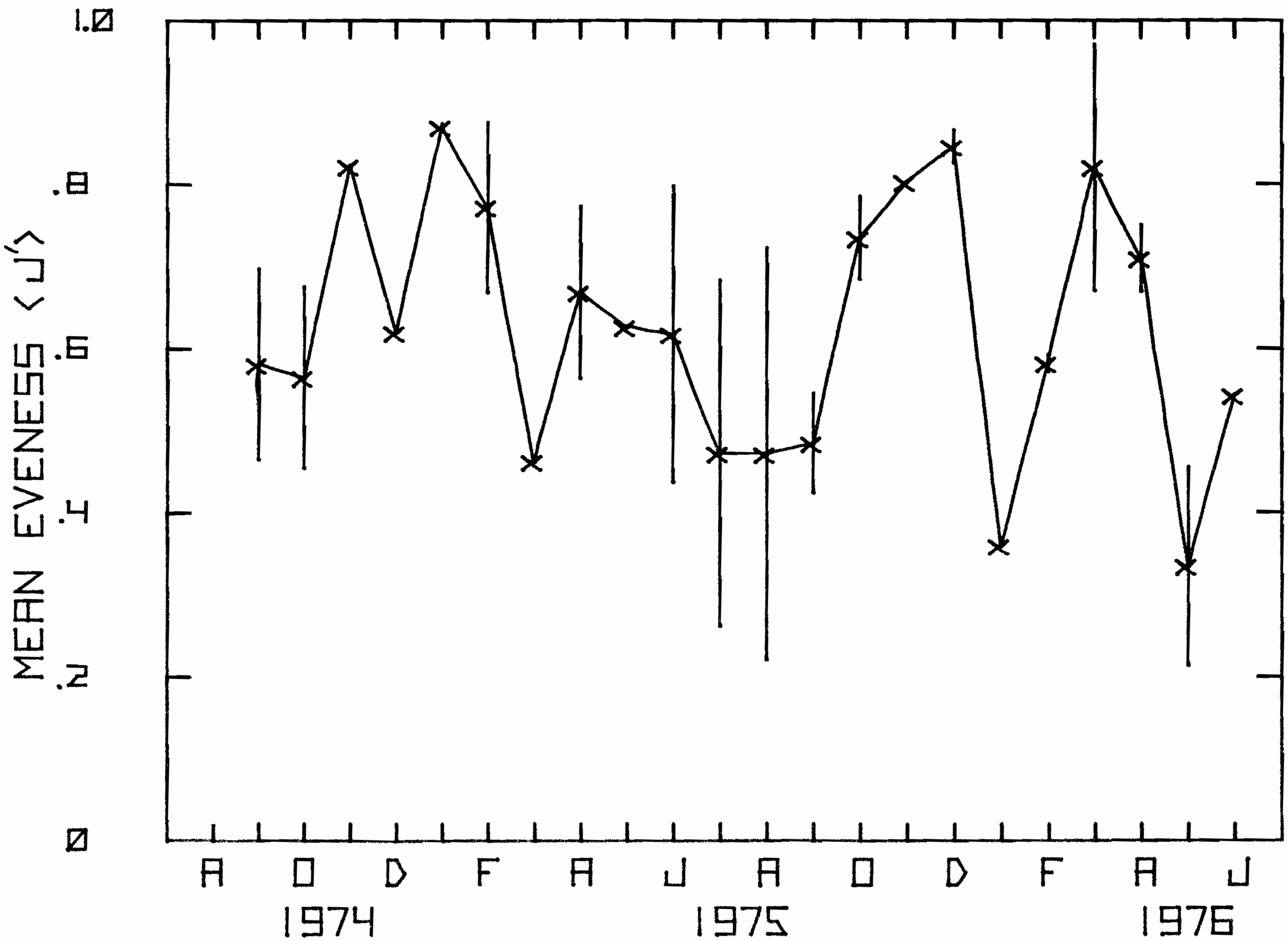

Figure 25. Kirby Park station monthly variation in mean evenness per ten minute tow. Vertical bars indicate standard error.

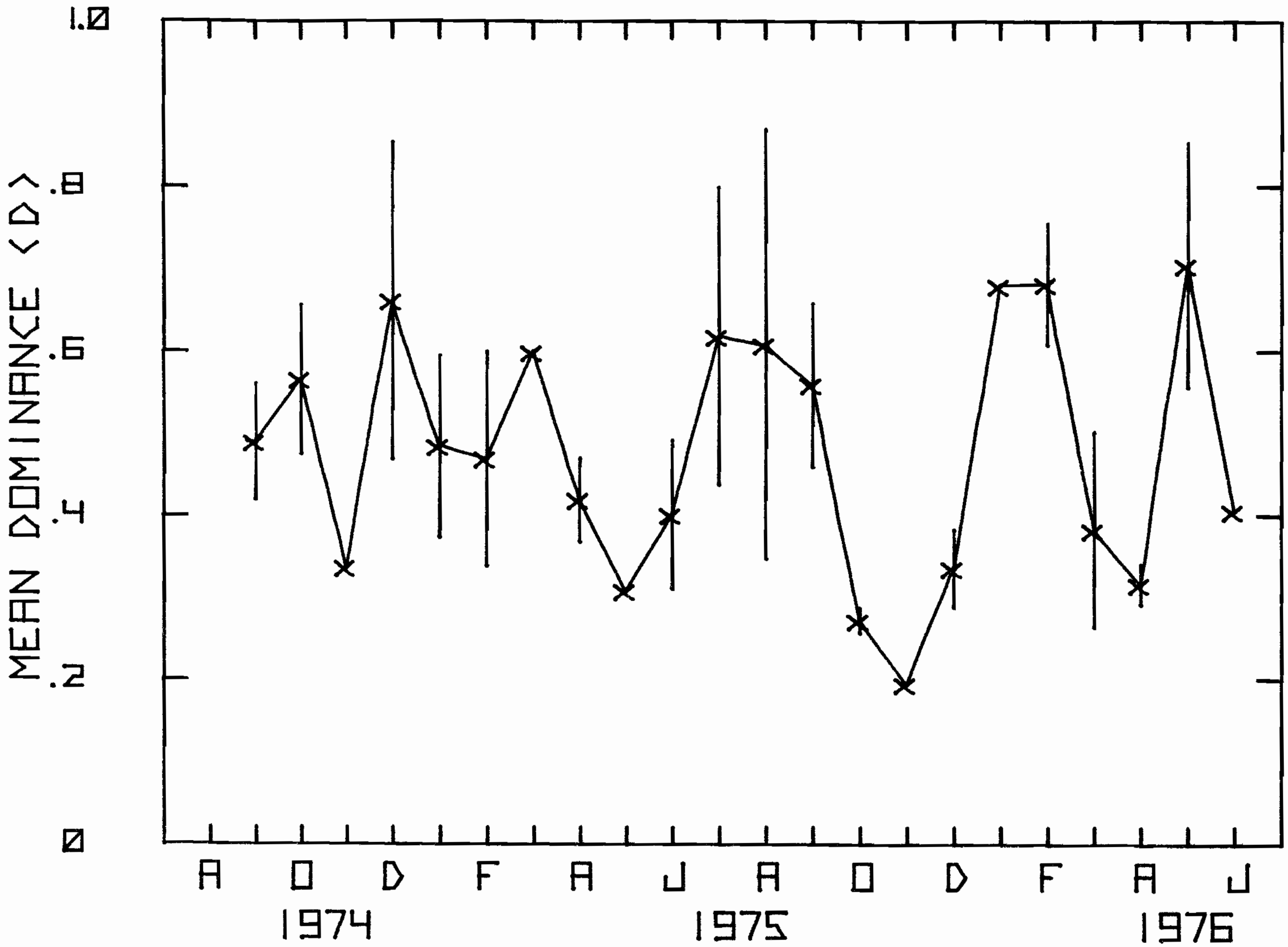

Figure 26. Kirby Park station monthly variation in mean dominance per ten minute tow.

Vertical bars indicate standard error.

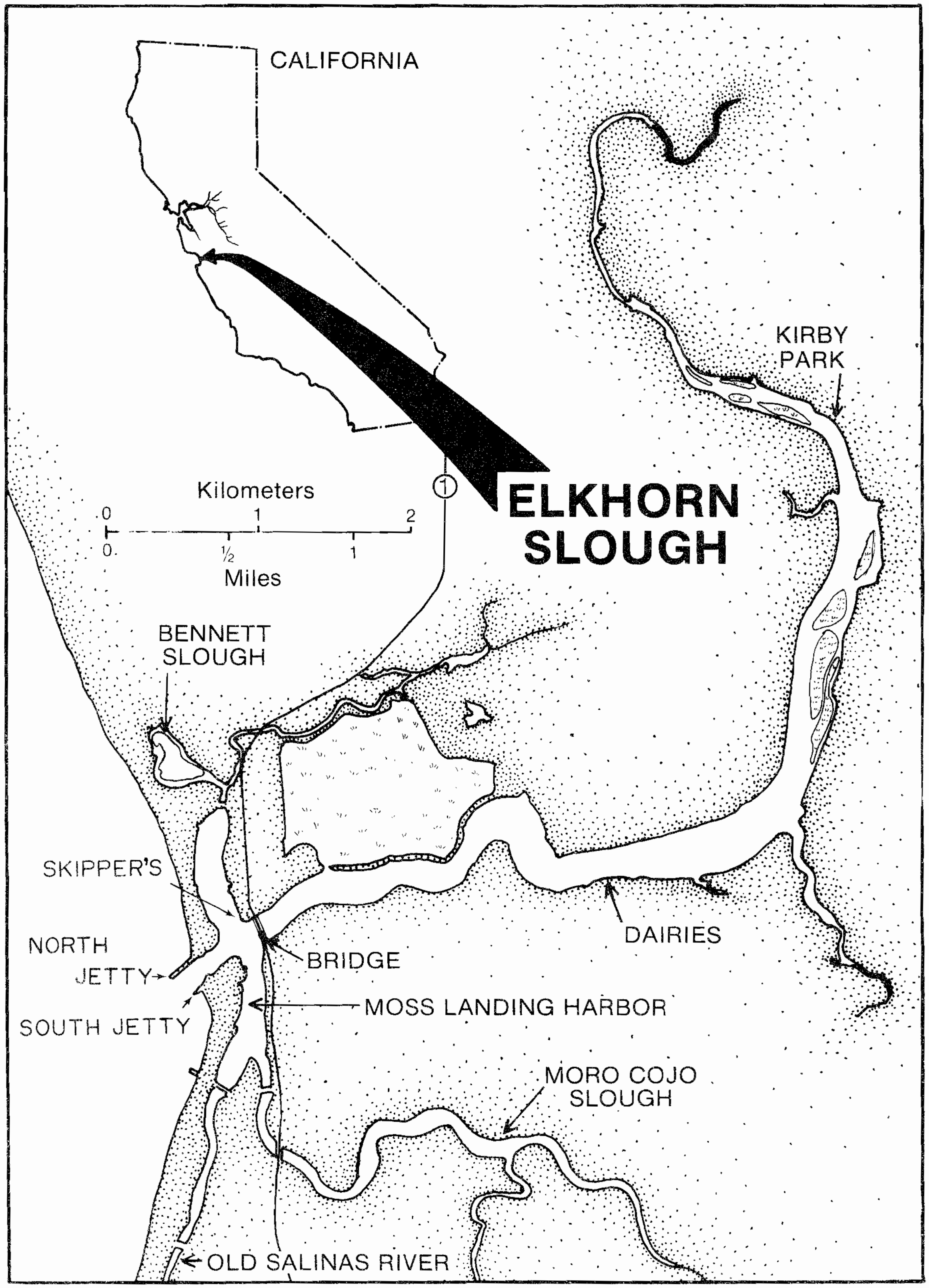

Figure 27. Map of creel census locations.

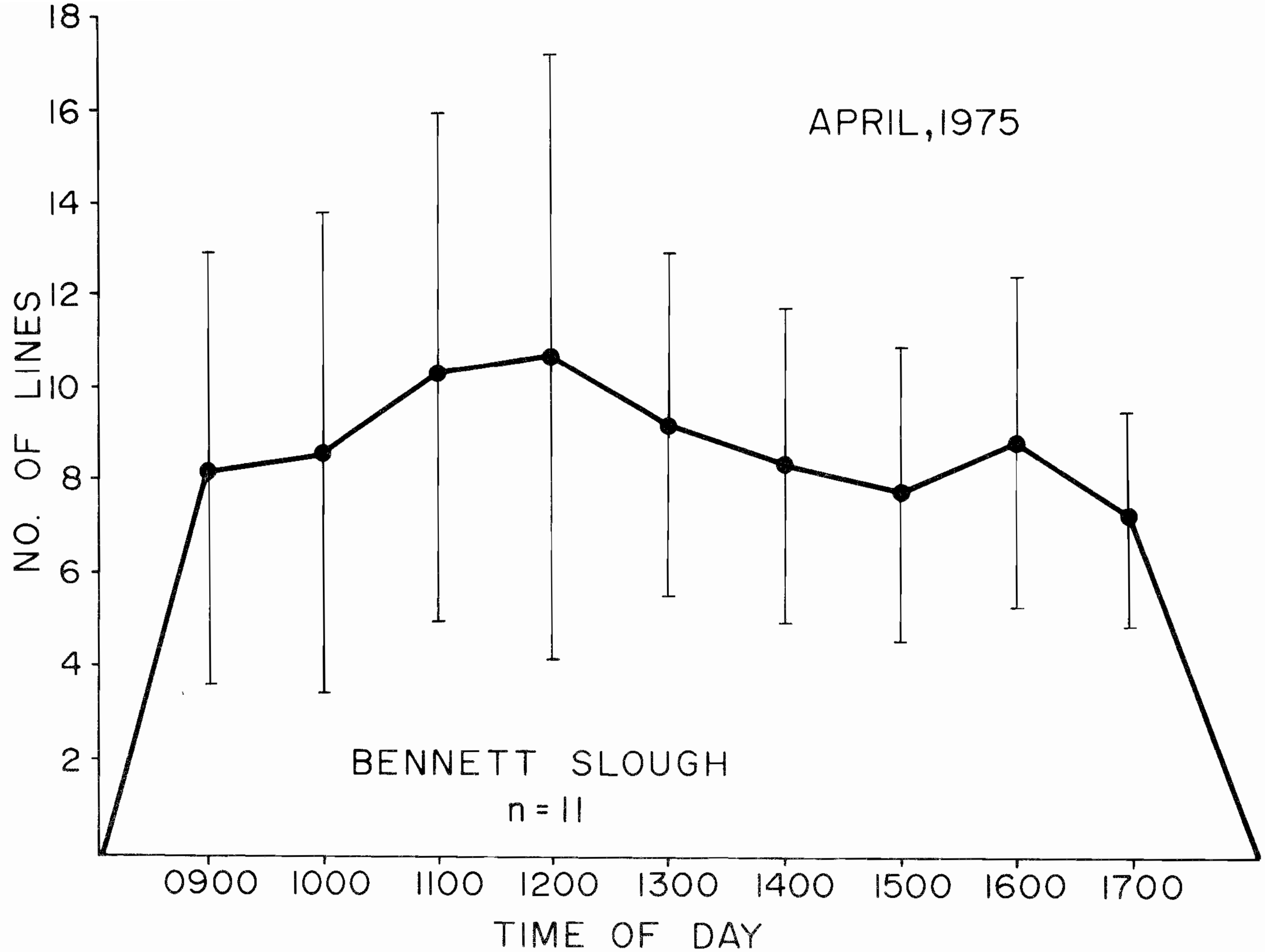

Figure 28. Fishing effort curve vs time at the Bennett Slough station. Vertical lines indicate 95% confidence intervals.

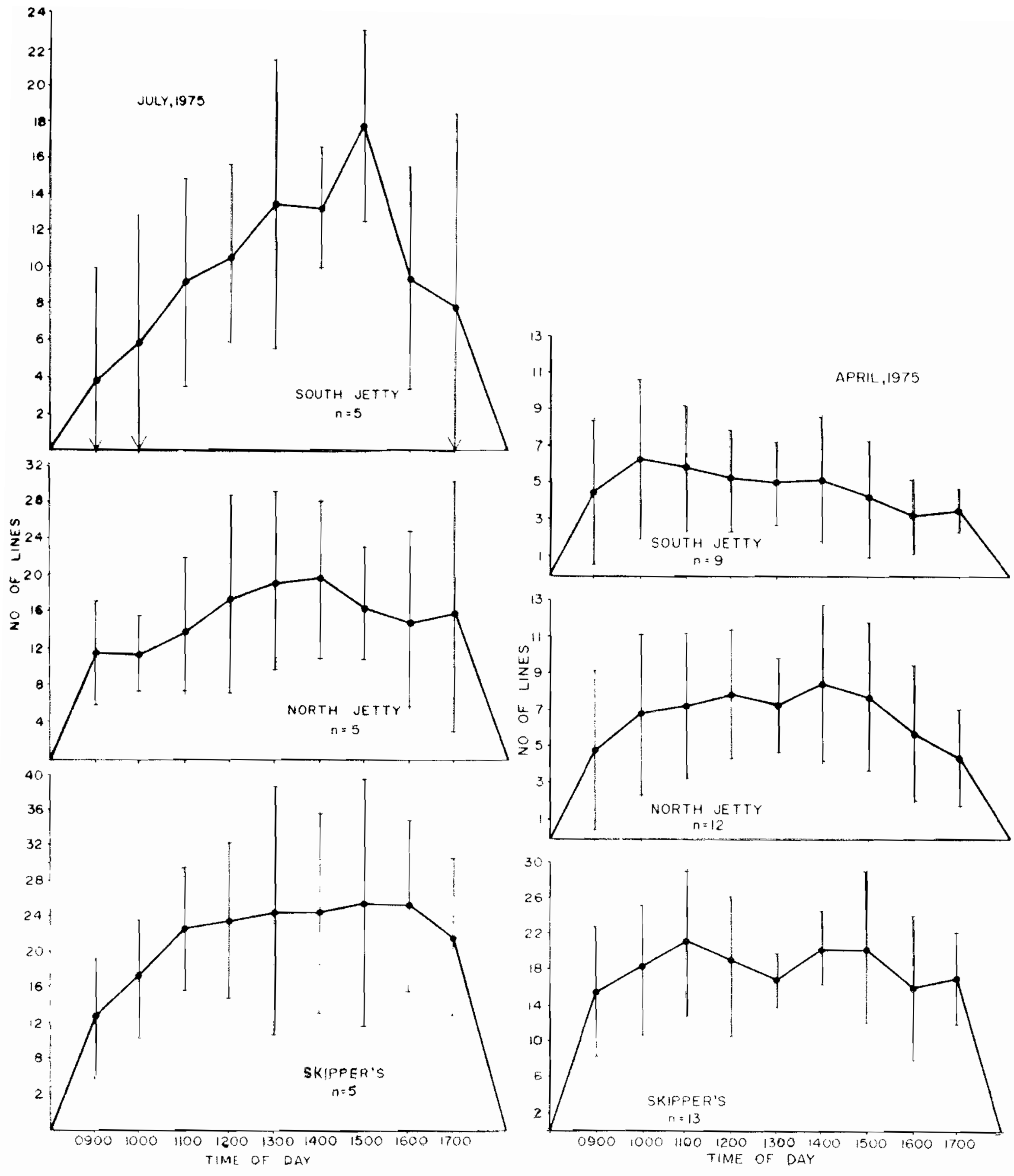

Figure 29. Fishing effort curve vs time at three locations for two different months. Vertical lines indicate 95% confidence intervals, and n is the number of days used for curves.

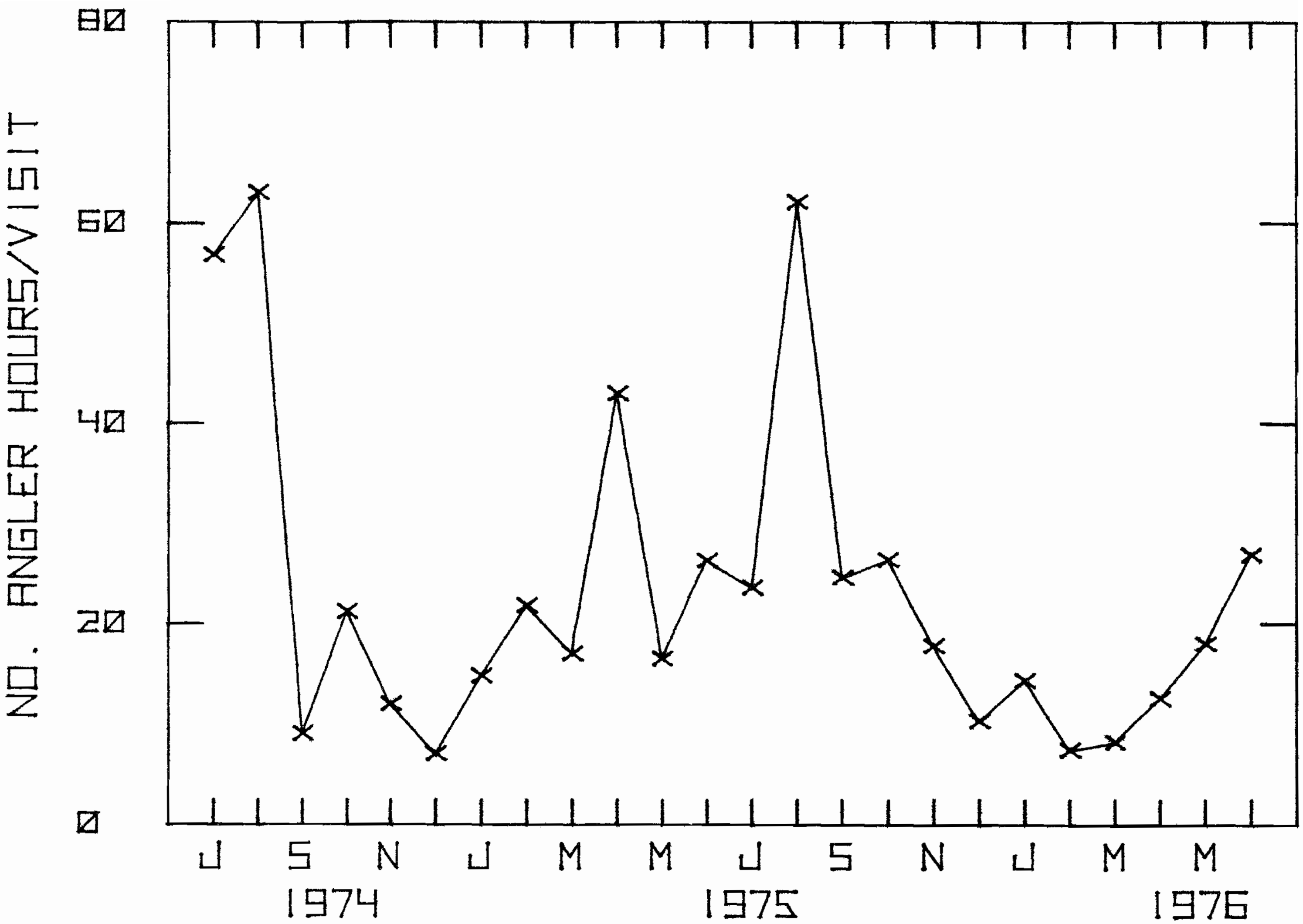

Figure 30. Monthly variation in the number of angler hours per visit at the North Jetty station.

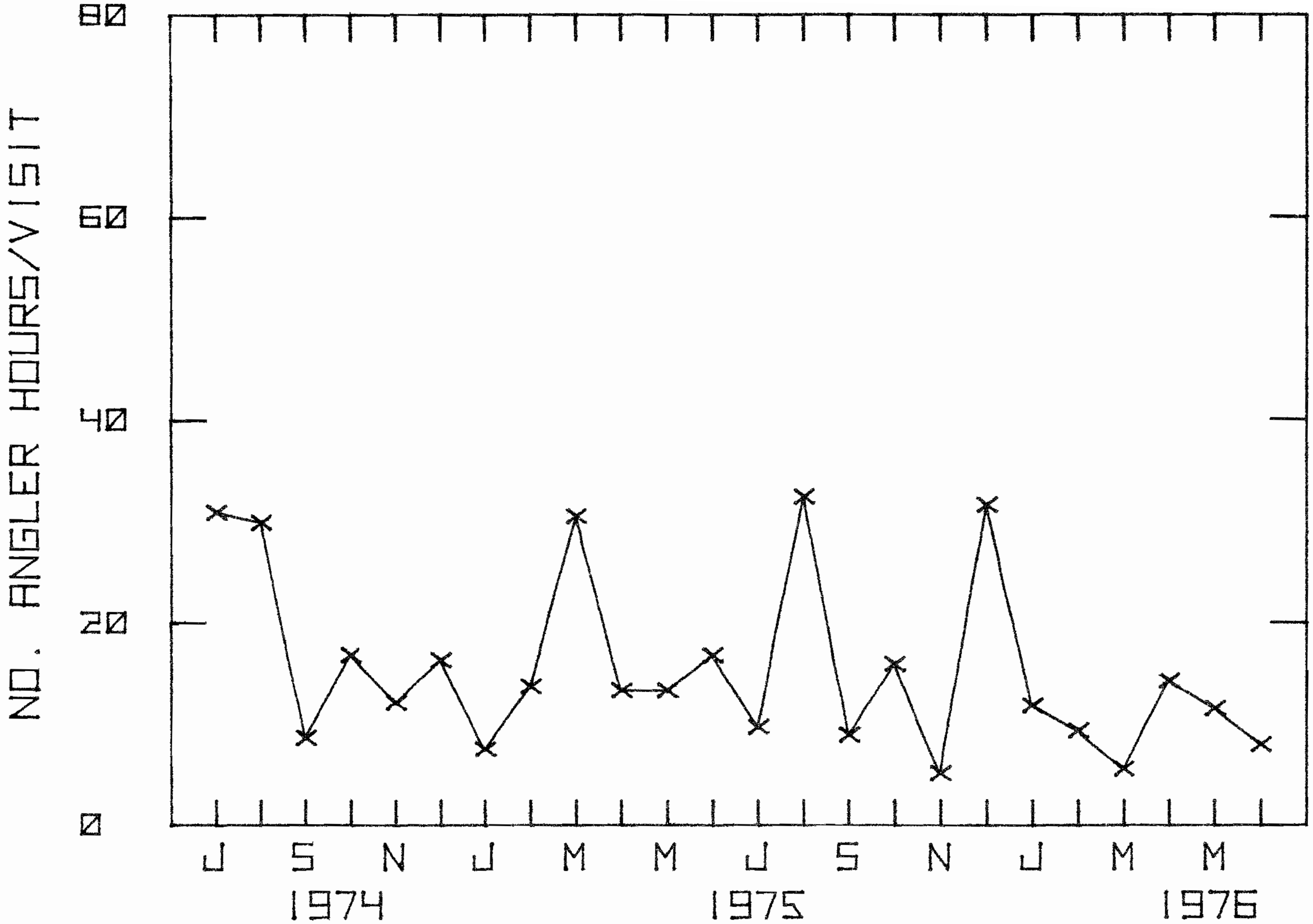

Figure 31. Monthly variation in the number of angler hours per visit at the South Jetty station.

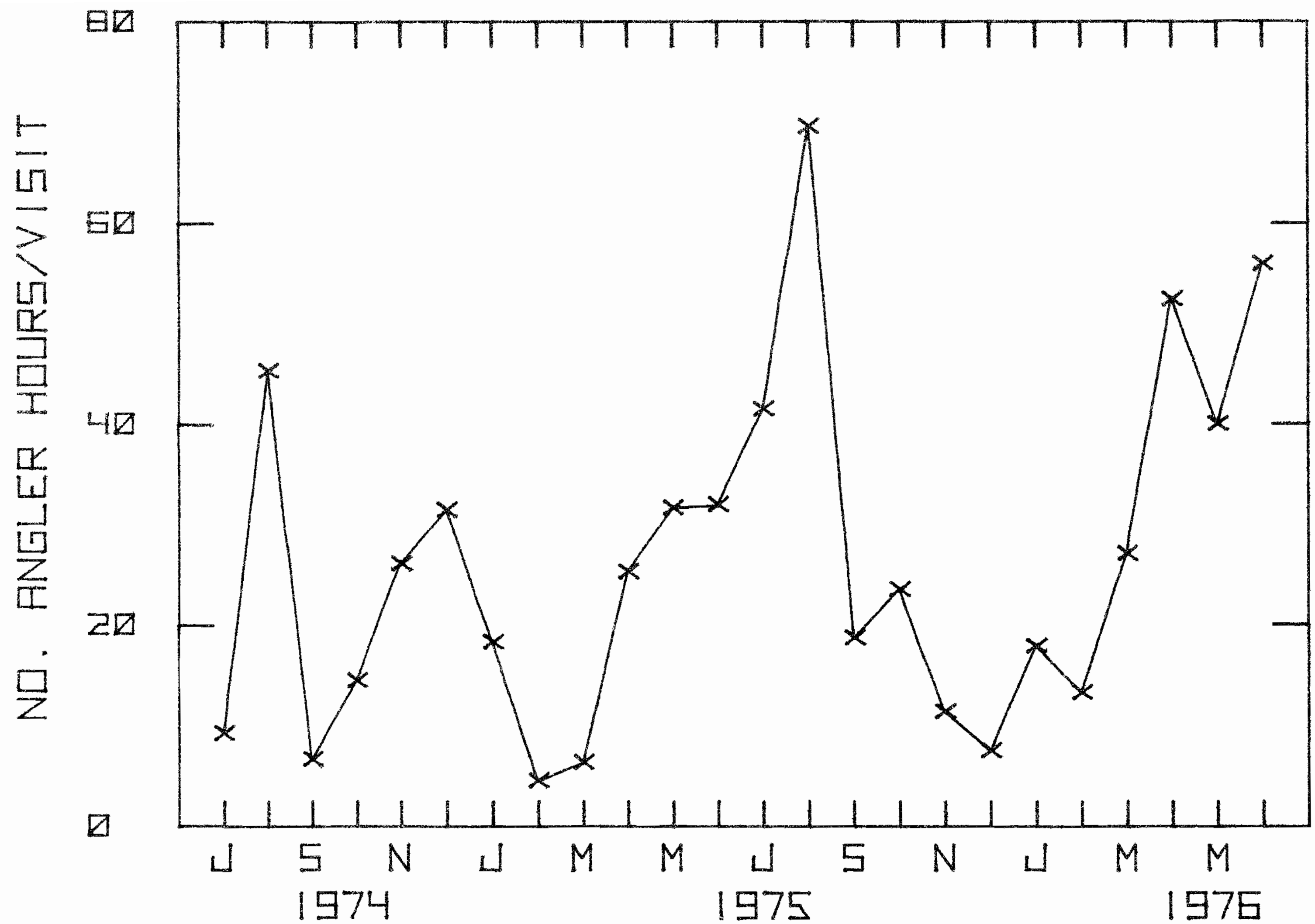

Figure 32. Monthly variation in the number of angler hours per visit at the Skipper's station.

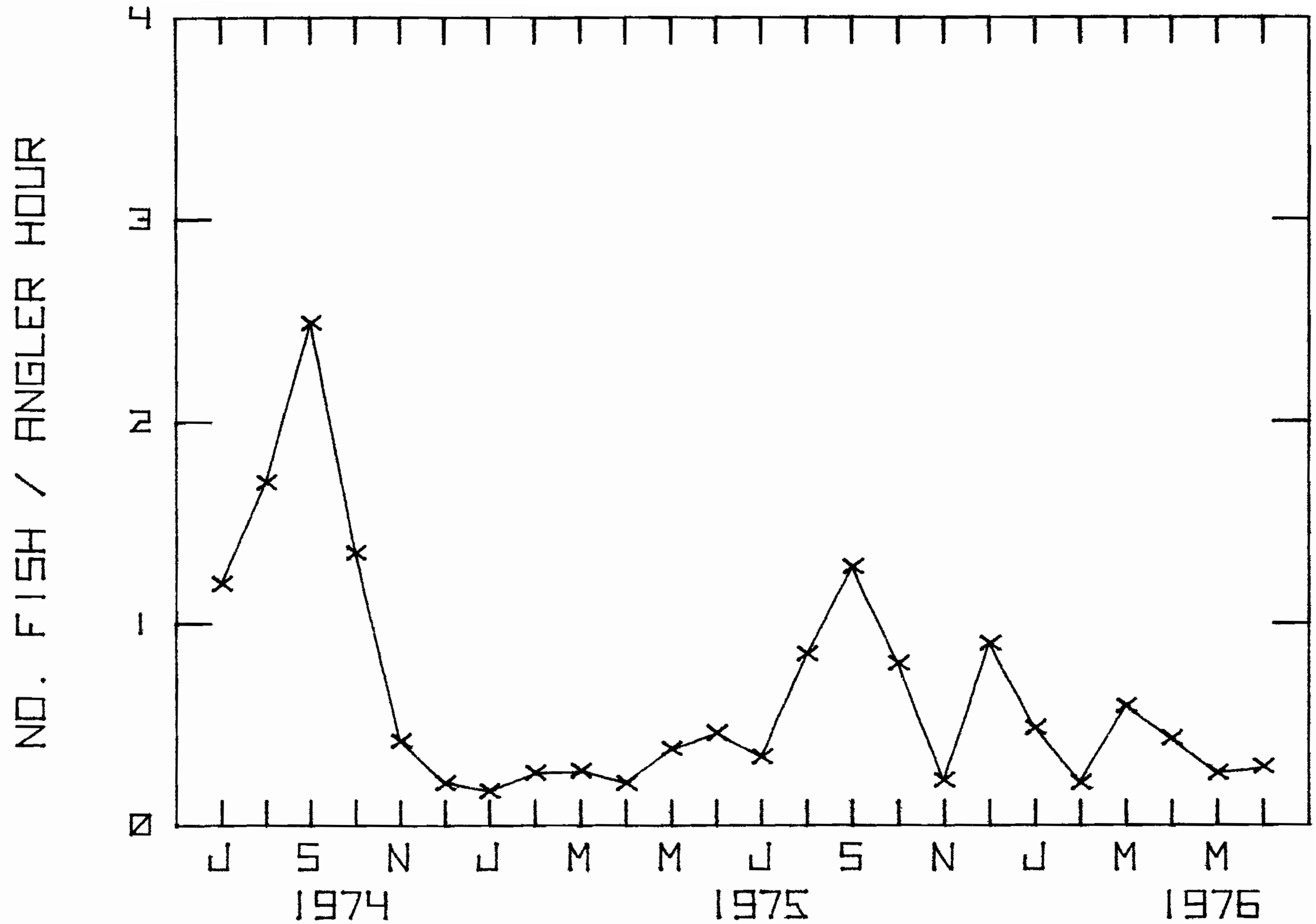

Figure 33. Monthly variation in the number of fish per angler hour at the North Jetty station.

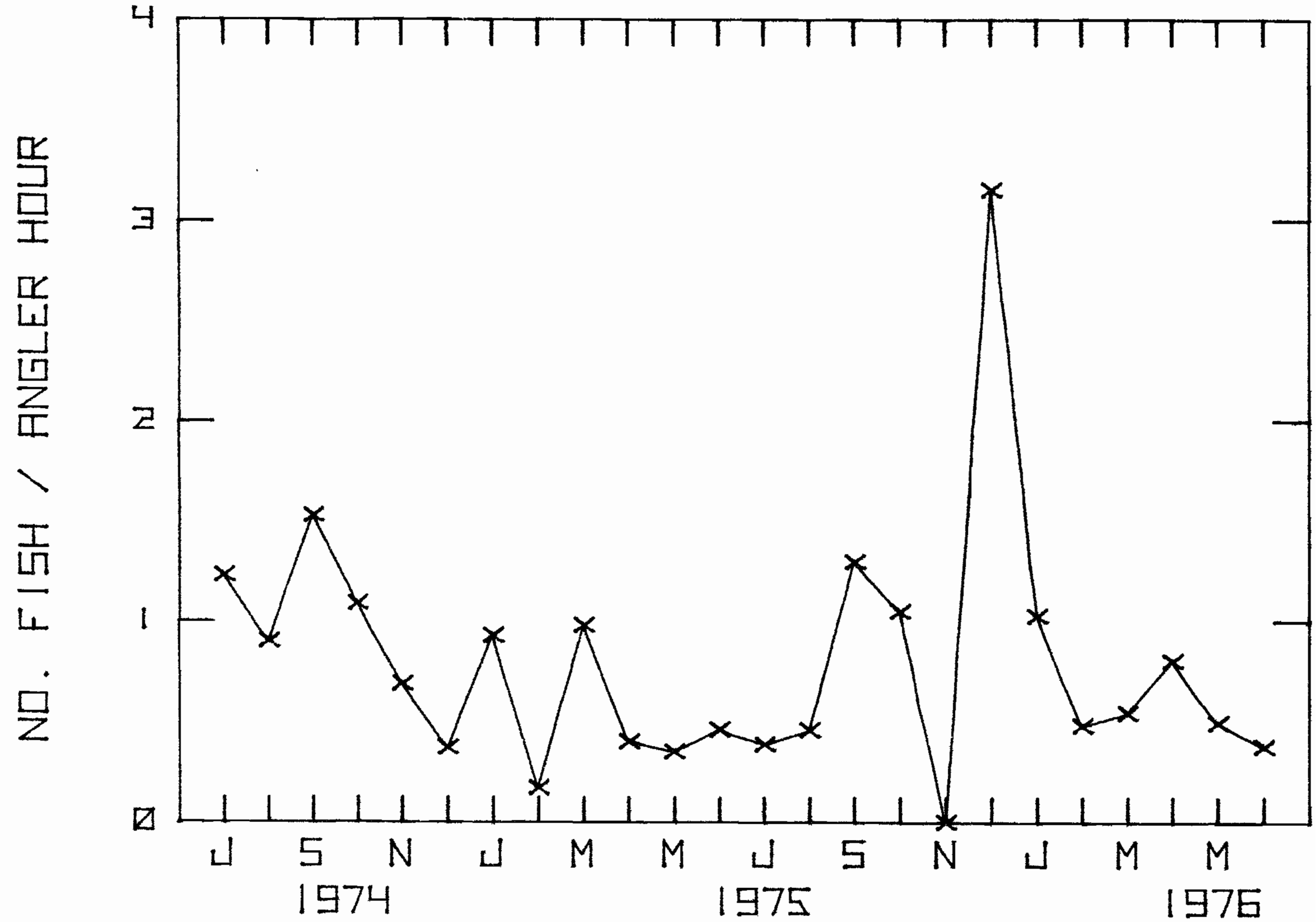

Figure 34. Monthly variation in the number of fish per angler hour at the South Jetty station.

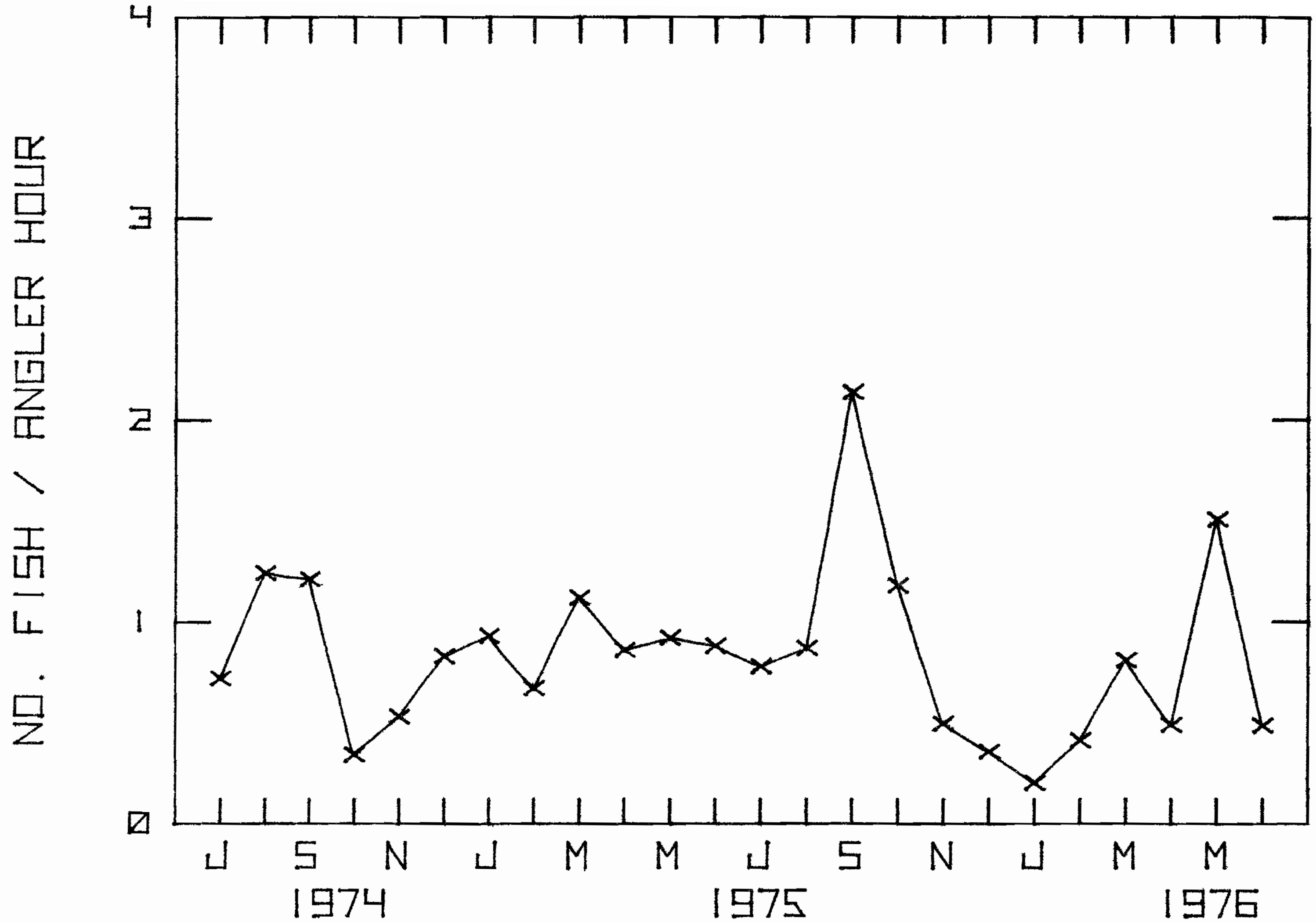

Figure 35. Monthly variation in the number of fish per angler hour at the Skipper's station.

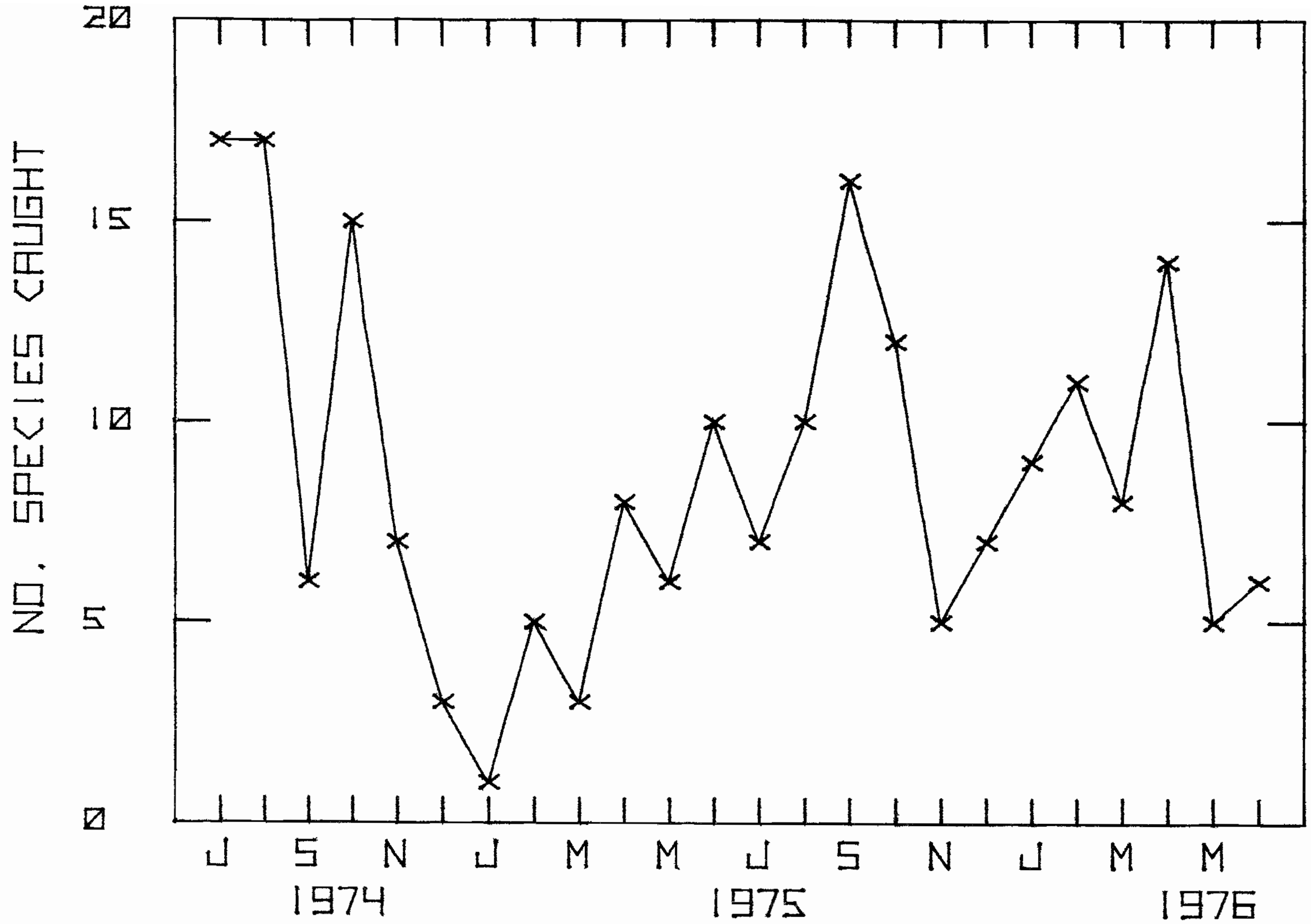

Figure 36. Monthly variation in the number of species caught at the North Jetty station.

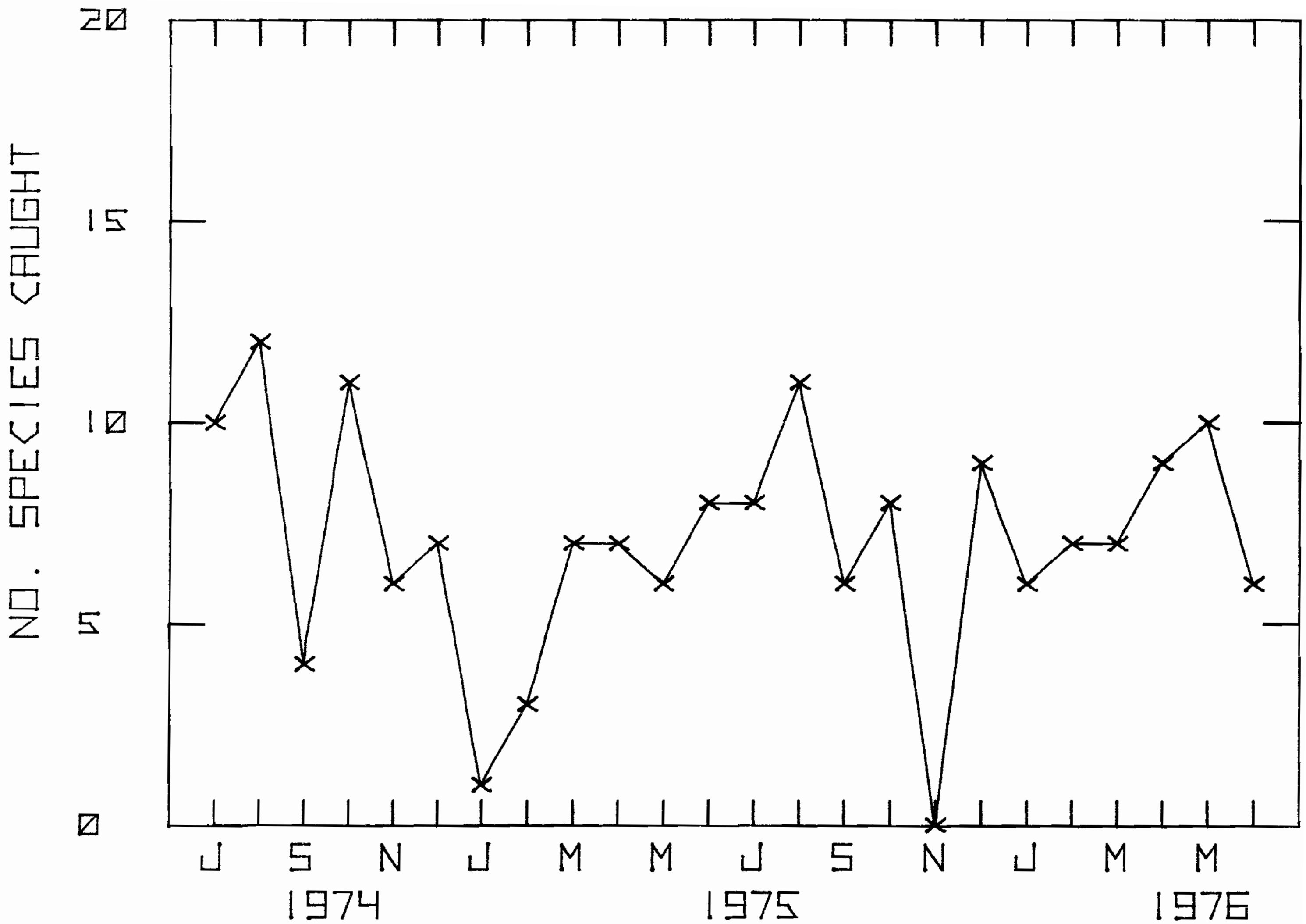

Figure 37. Monthly variation in the number of species caught at the South Jetty station.

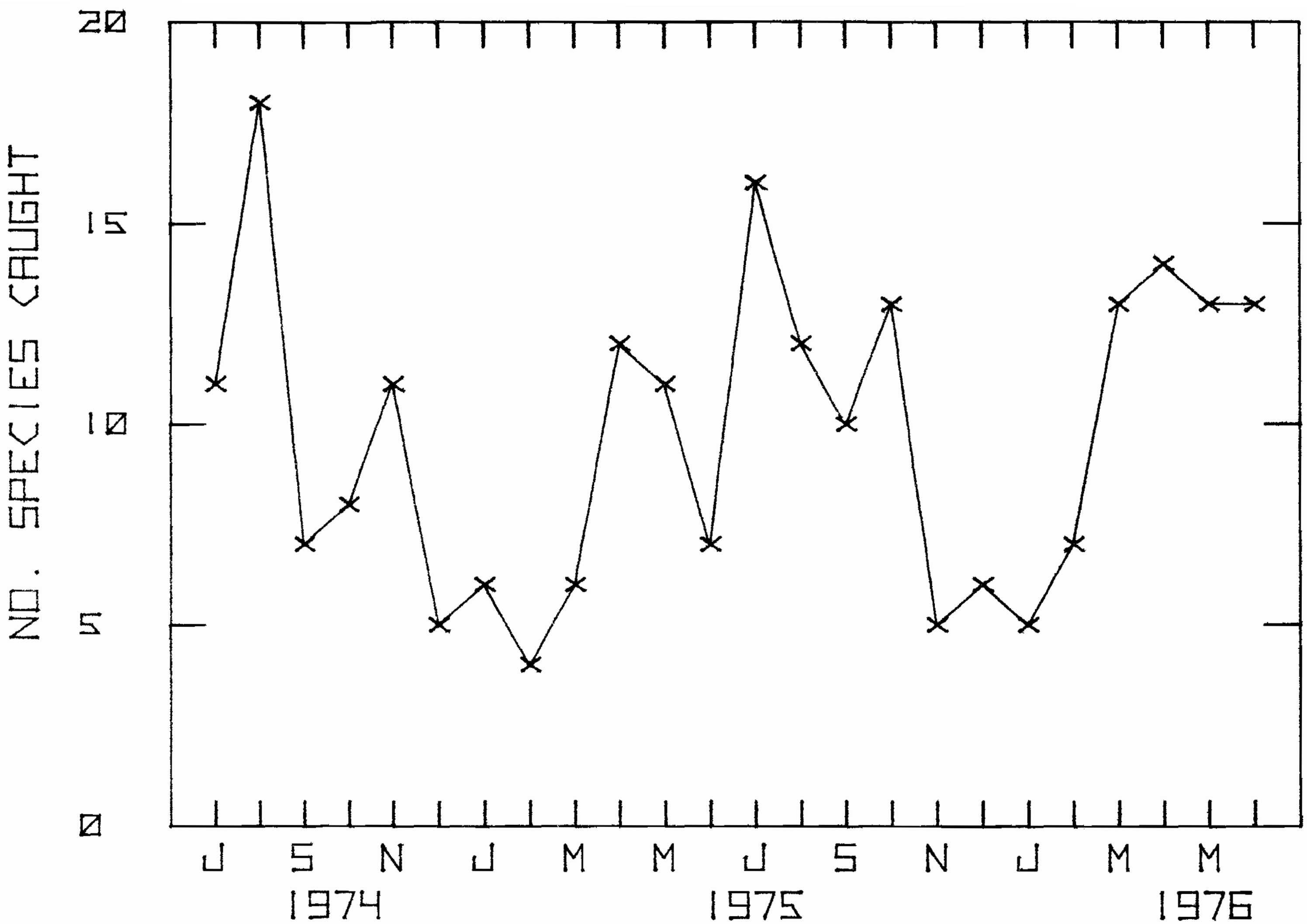

Figure 38. Monthly variation in the number of species caught at the Skipper's station.

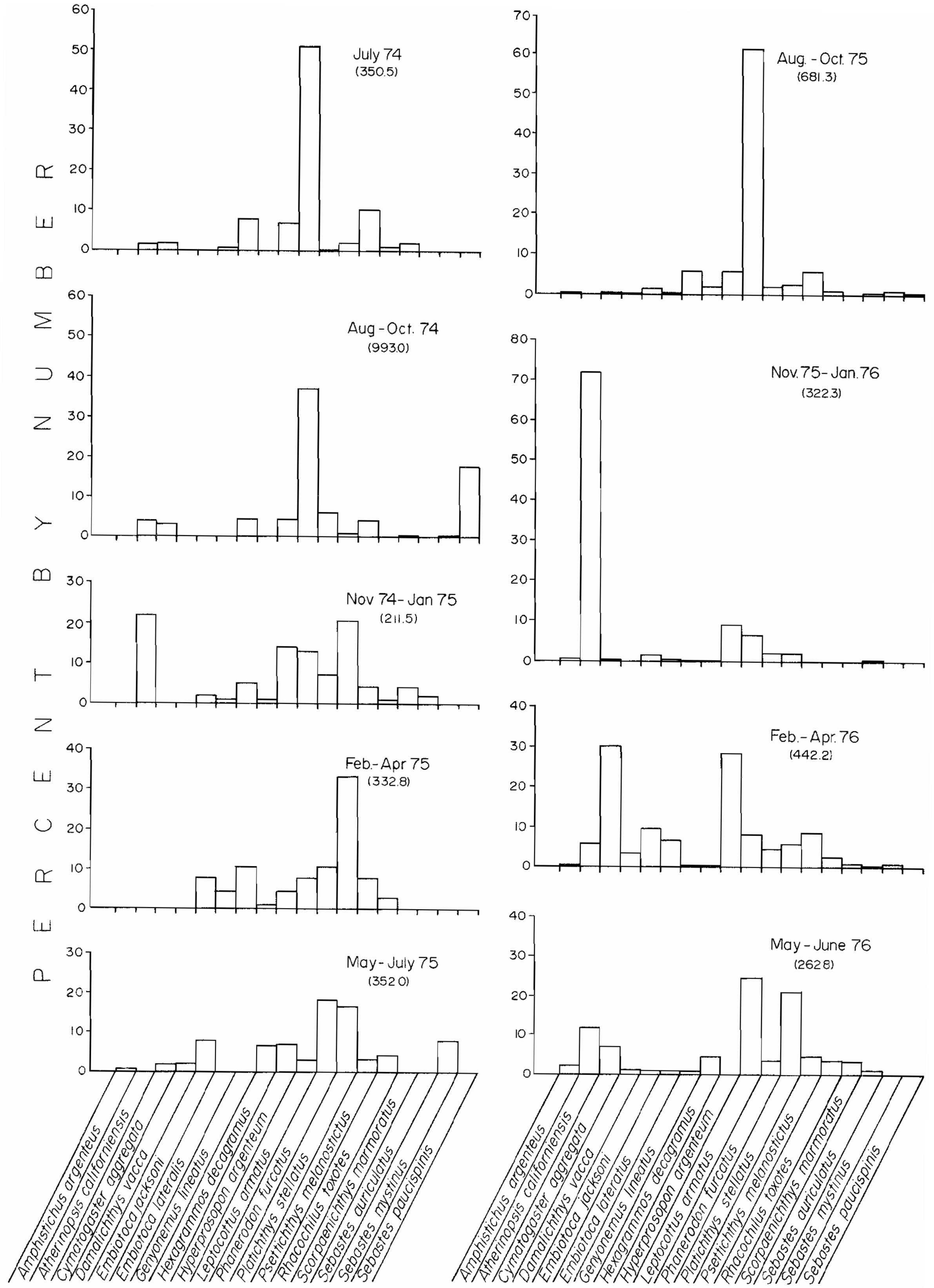

Figure 39. Percent numerical composition of the more dominant creel census fishes at the North and South jetty stations combined. Numbers in parentheses indicate the number of angler hours.

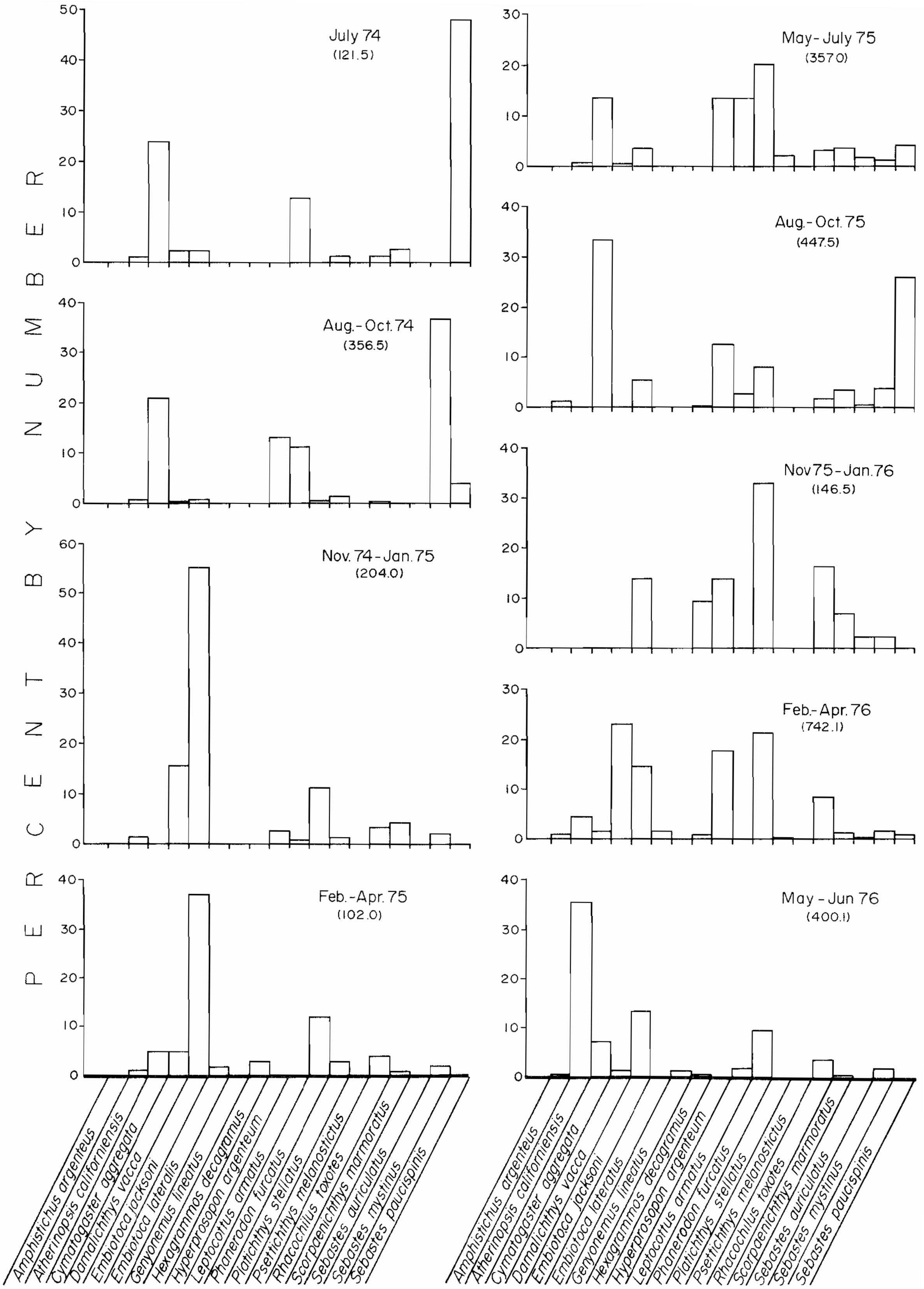

Figure 40. Percentage numerical composition of the more dominant creel census fishes at the Skipper's station. Numbers in parentheses indicate the number of angler hours.

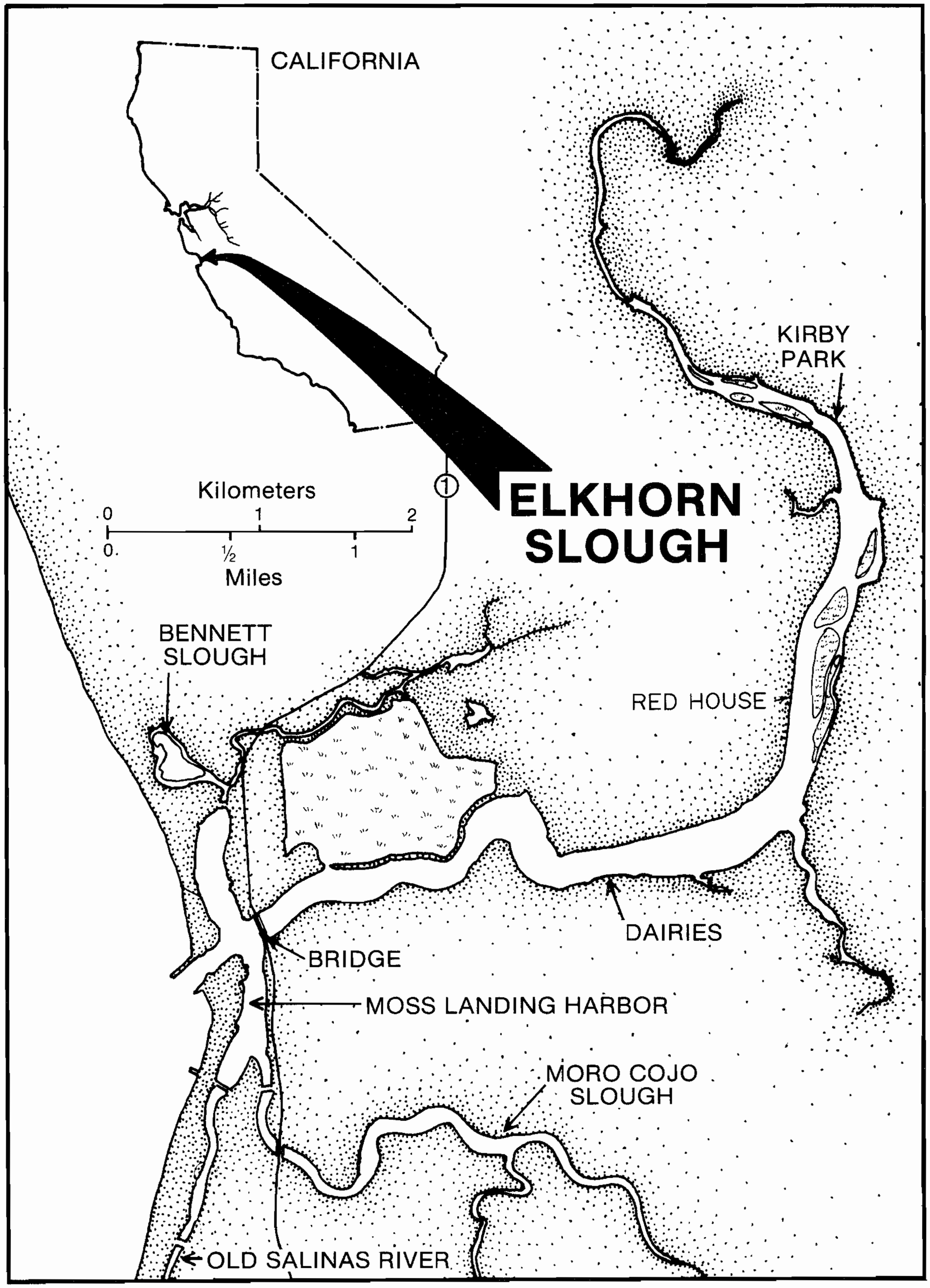

Figure 41. Map of zooplankton and larval fish push-net sample locations.

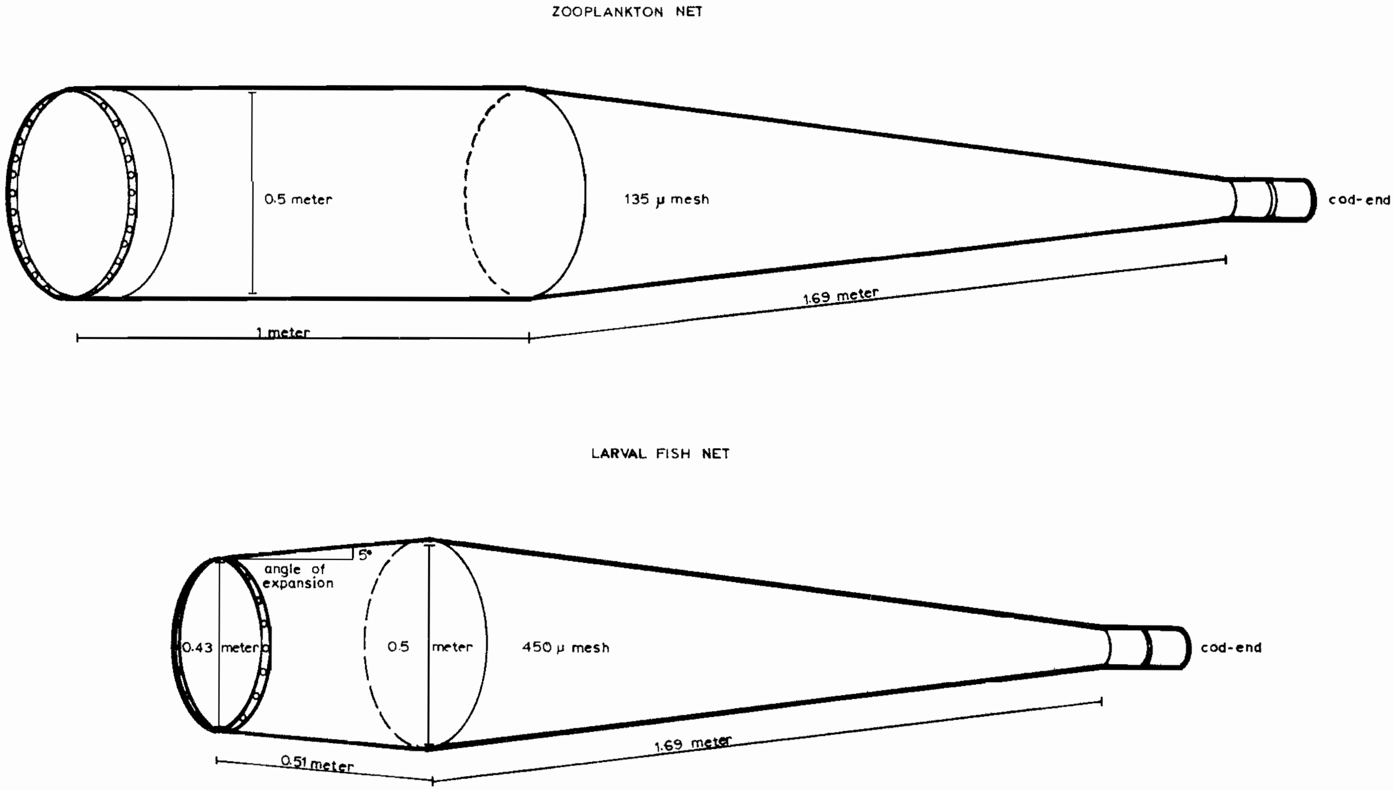

Figure 42. Diagram of the two types of zooplankton nets used to sample zooplankton and larval fishes in Elkhorn Slough.

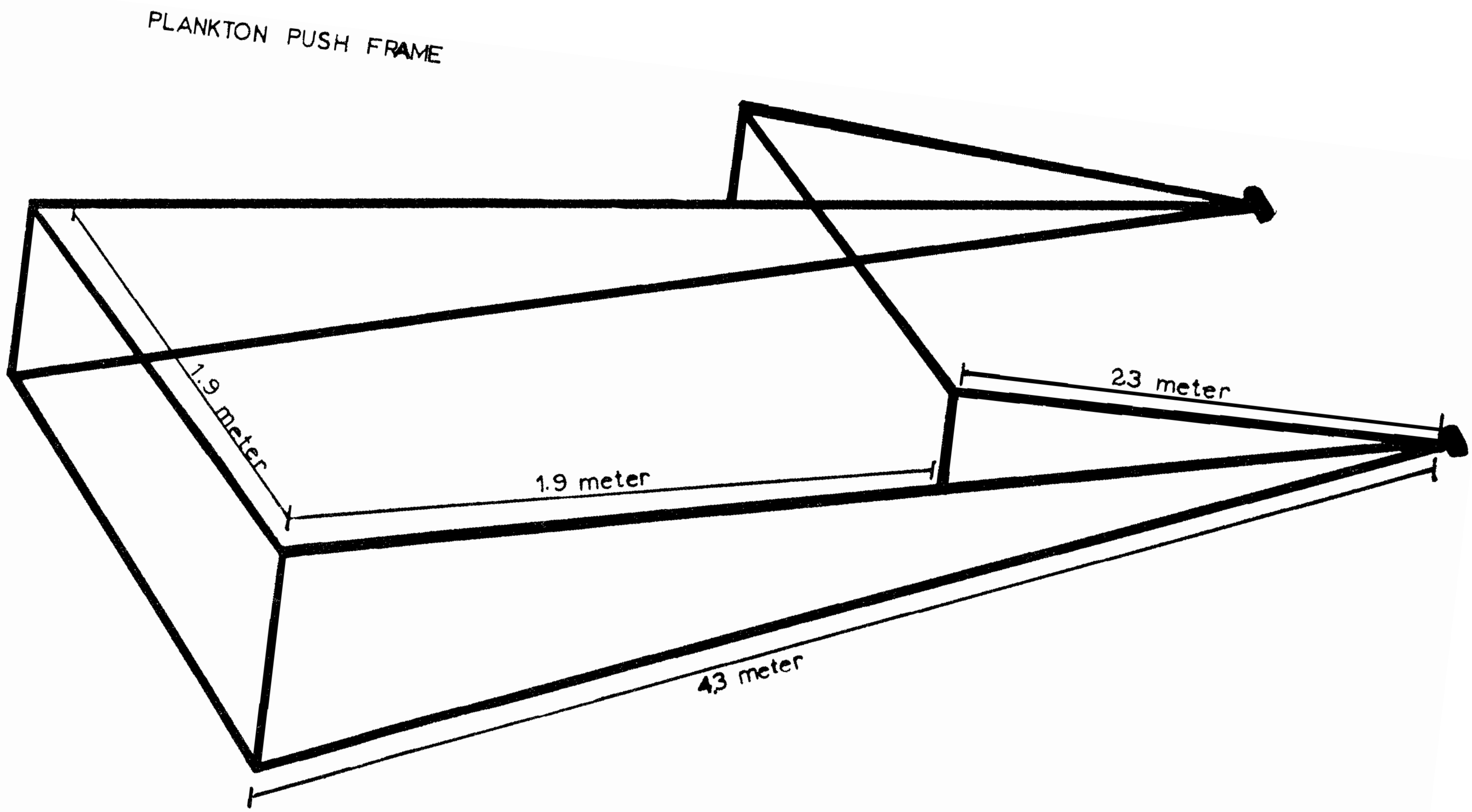

Figure 43. Diagram of frame used on the 16' Boston Whaler to push the zooplankton and larval fish nets.

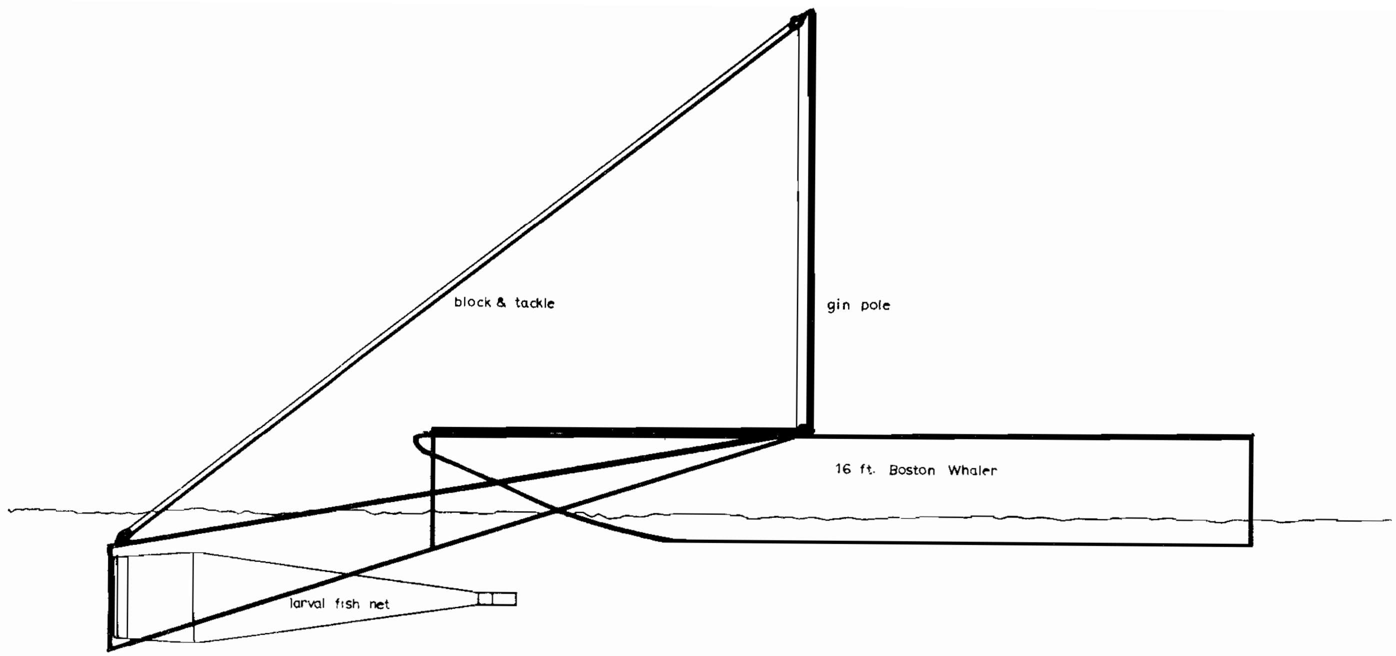

Figure 44. Diagram of zooplankton and larval fish push-net system in operation.

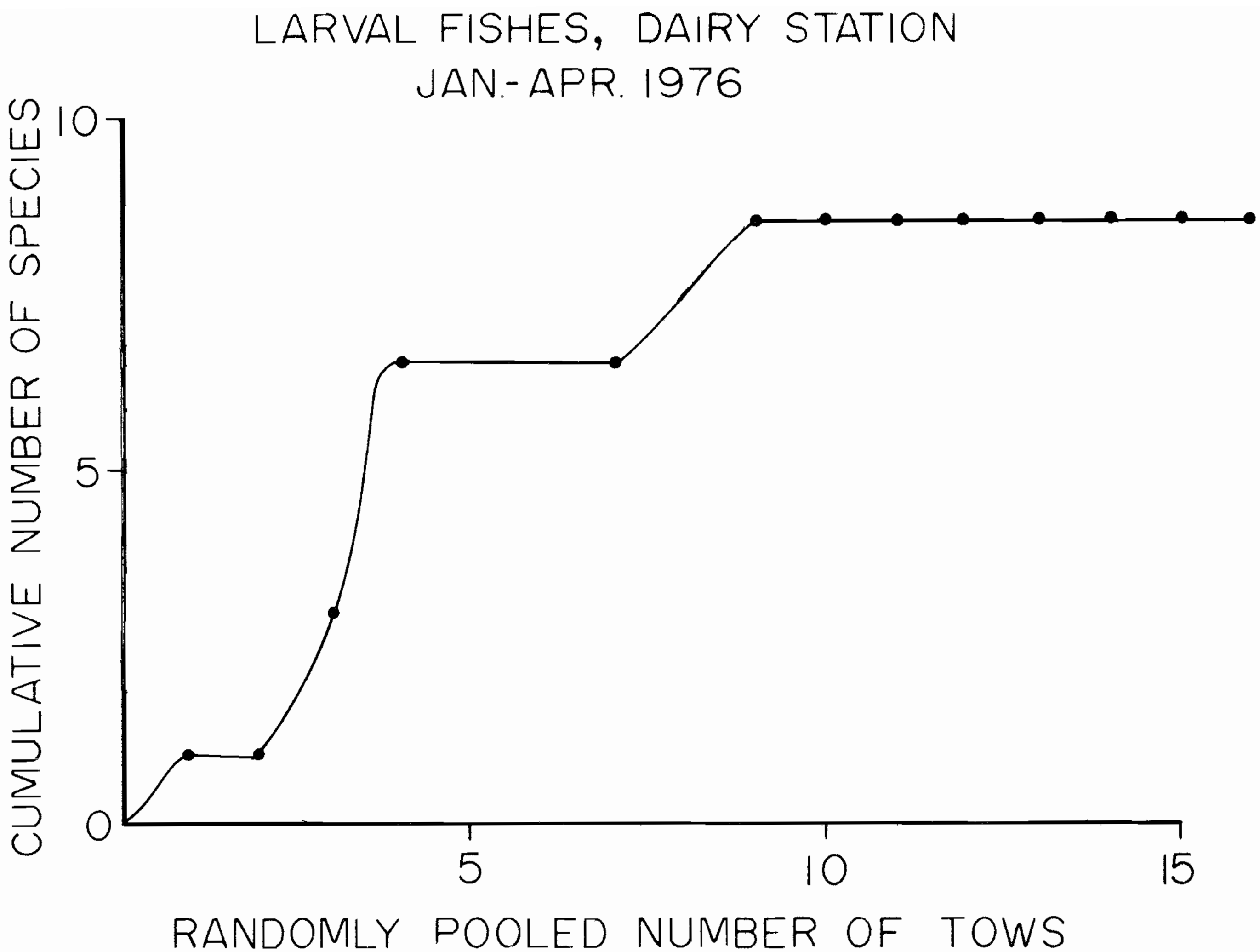

Figure 45. Cumulative number of larval fish species plotted against randomly pooled number of tows from the dairies station during January - April 1976.

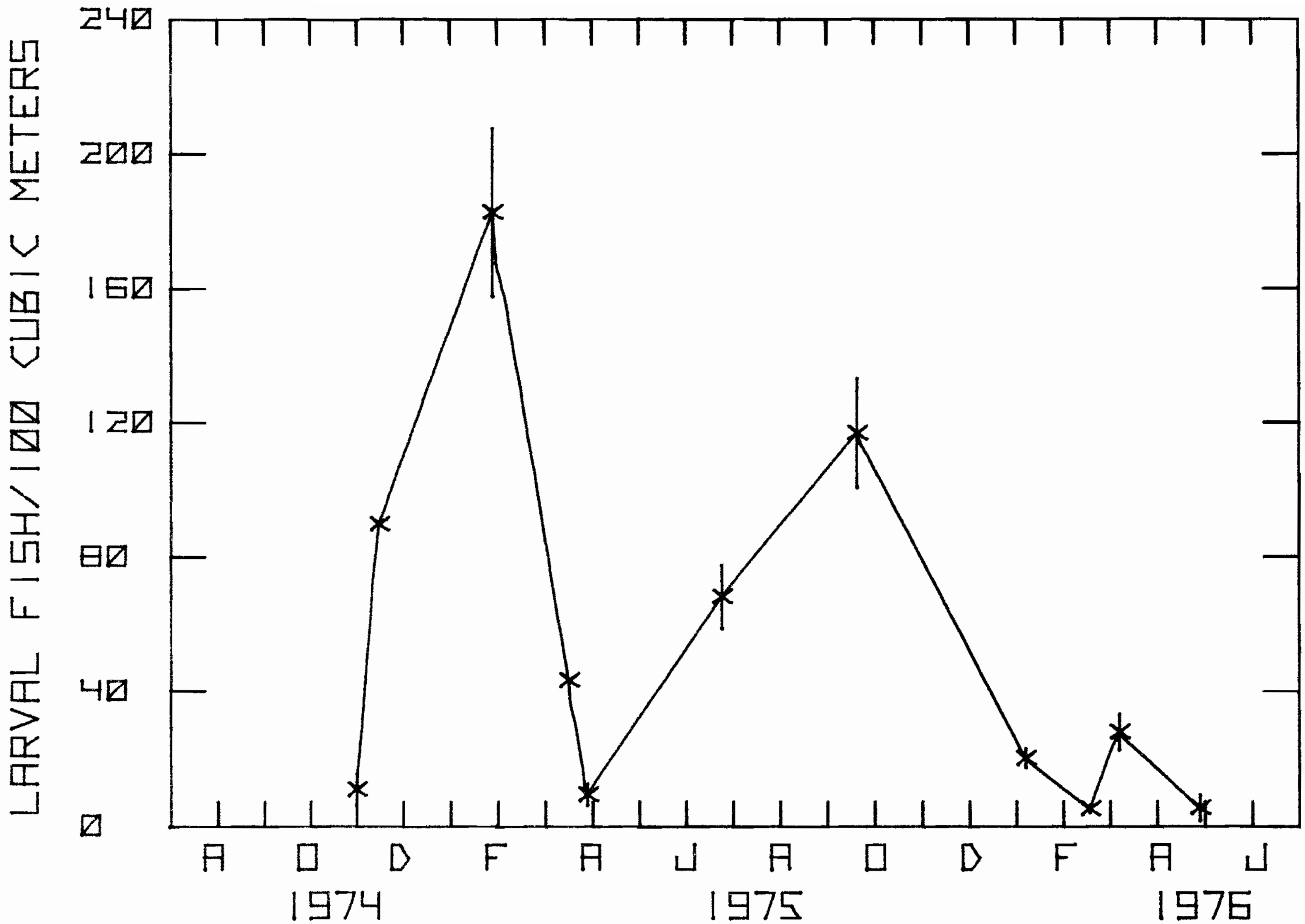

Figure 46. Seasonal variation in mean number of larval fish per 100 cubic meters at the harbor entrance station. Vertical lines represent one standard error. The mean values are positioned to reflect the time of the month these samples were taken. (See Tables 25-29 for sample size).

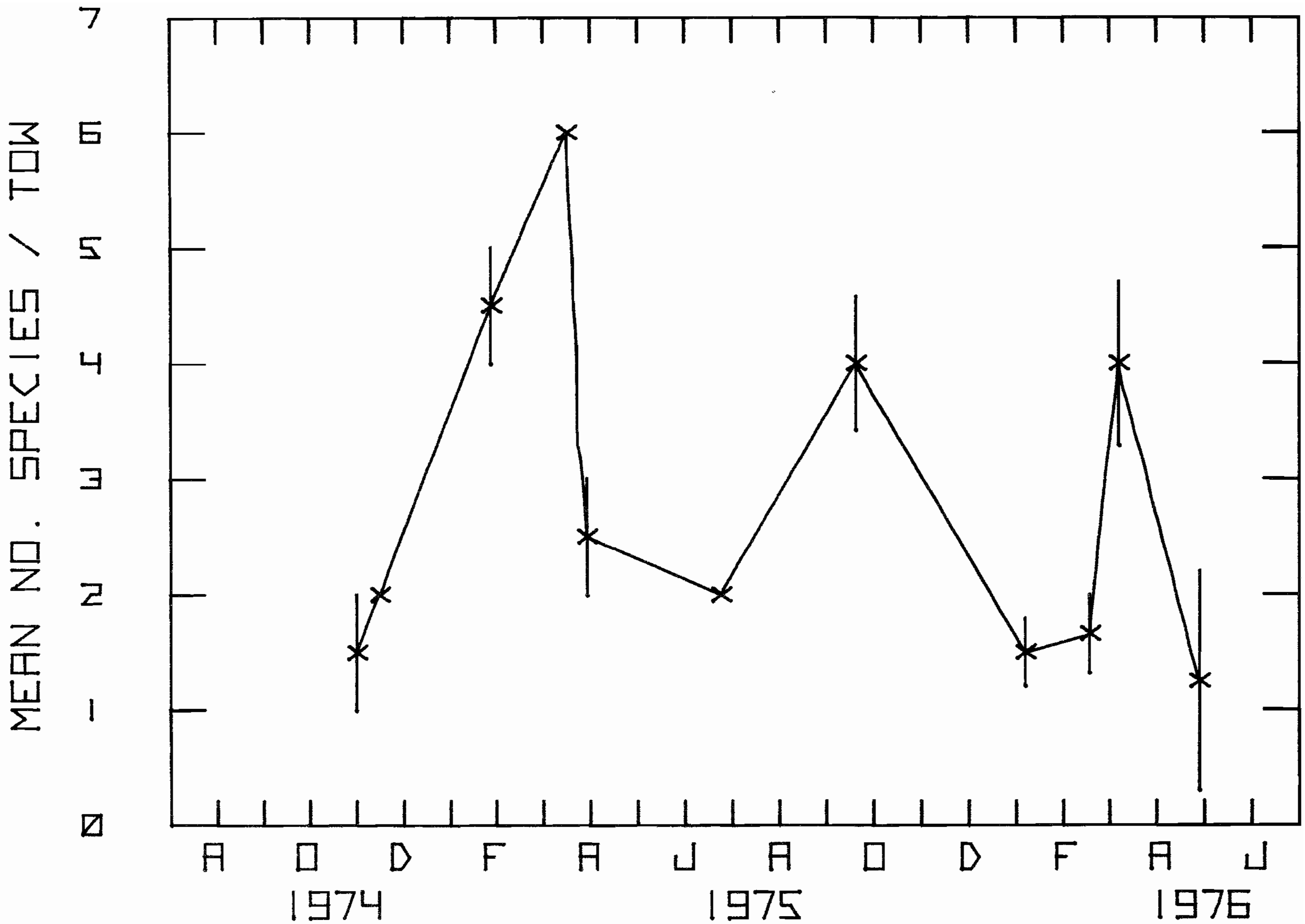

Figure 47. Seasonal variation in the mean number of larval fish species per tow at the harbor entrance station. For further explanation, see Figure 46.

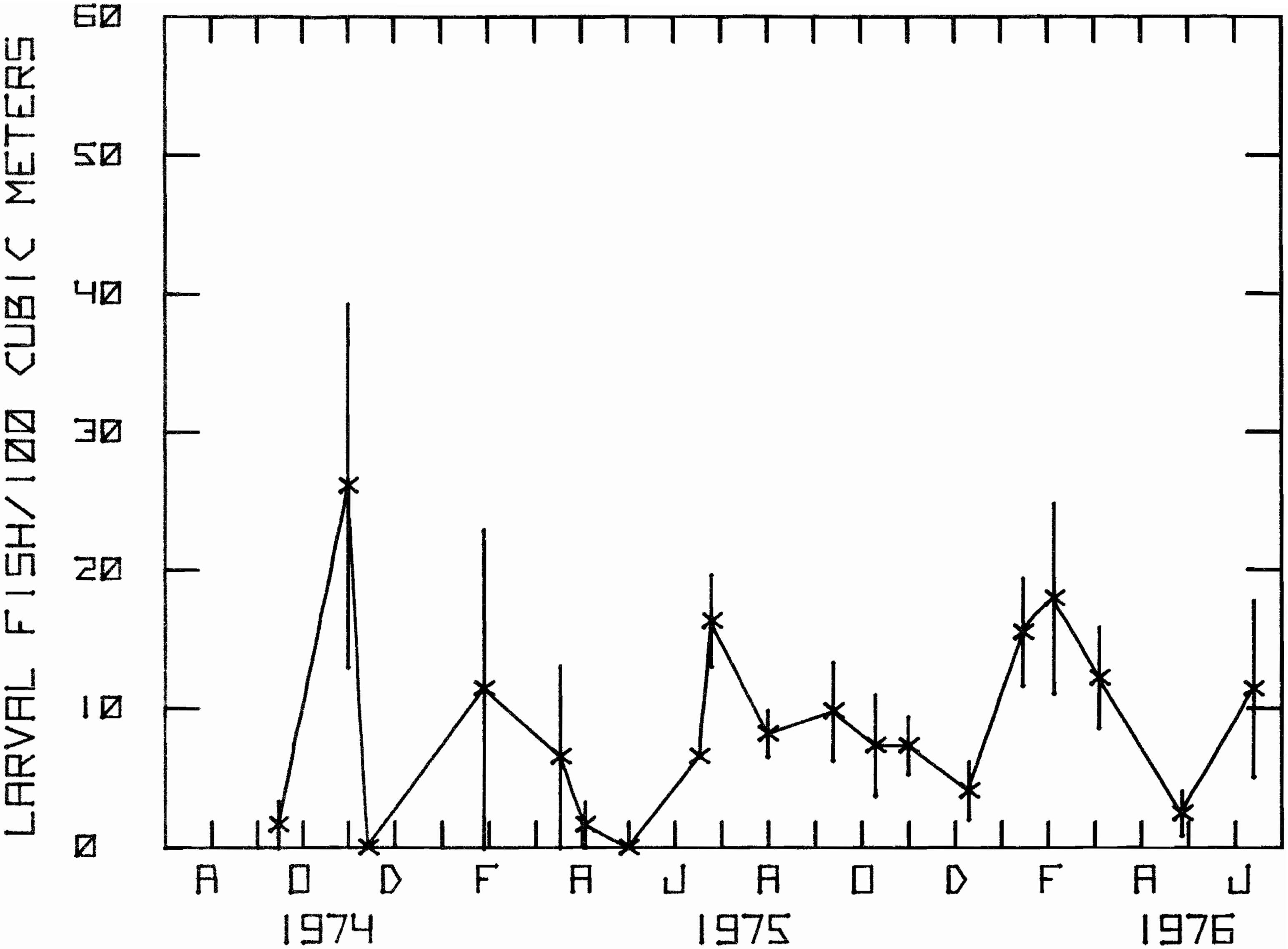

Figure 48. Seasonal variation in mean number of larval fish per 100 cubic meters at the bridge station. For further explanation, see Figure 46.

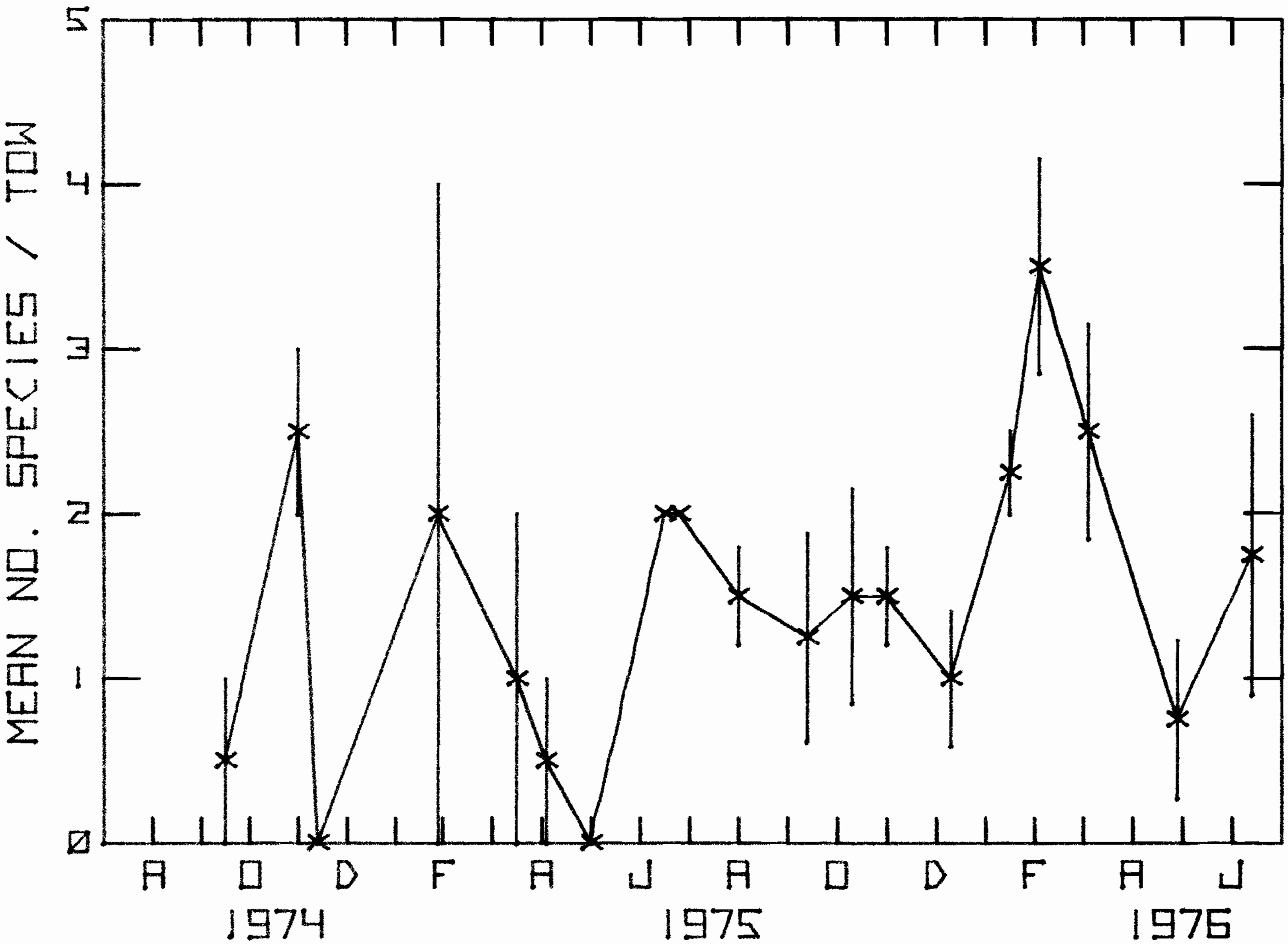

Figure 49. Seasonal variation in the mean number of larval fish species per tow at the bridge station. For further explanation, see Figure 46.

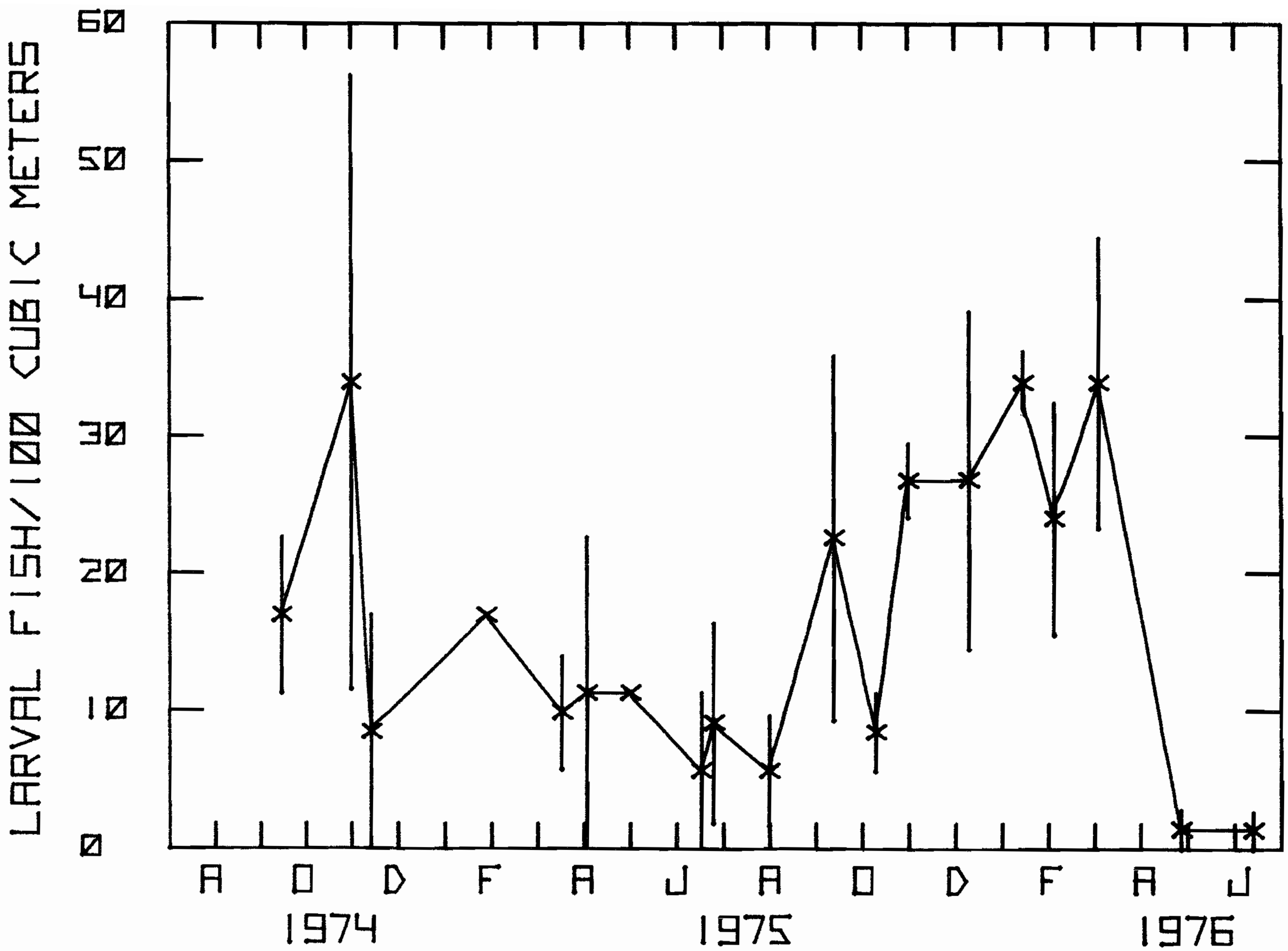

Figure 50. Seasonal variation in mean number of larval fish per 100 cubic meters at the dairies station. For further explanation, see Figure 46.

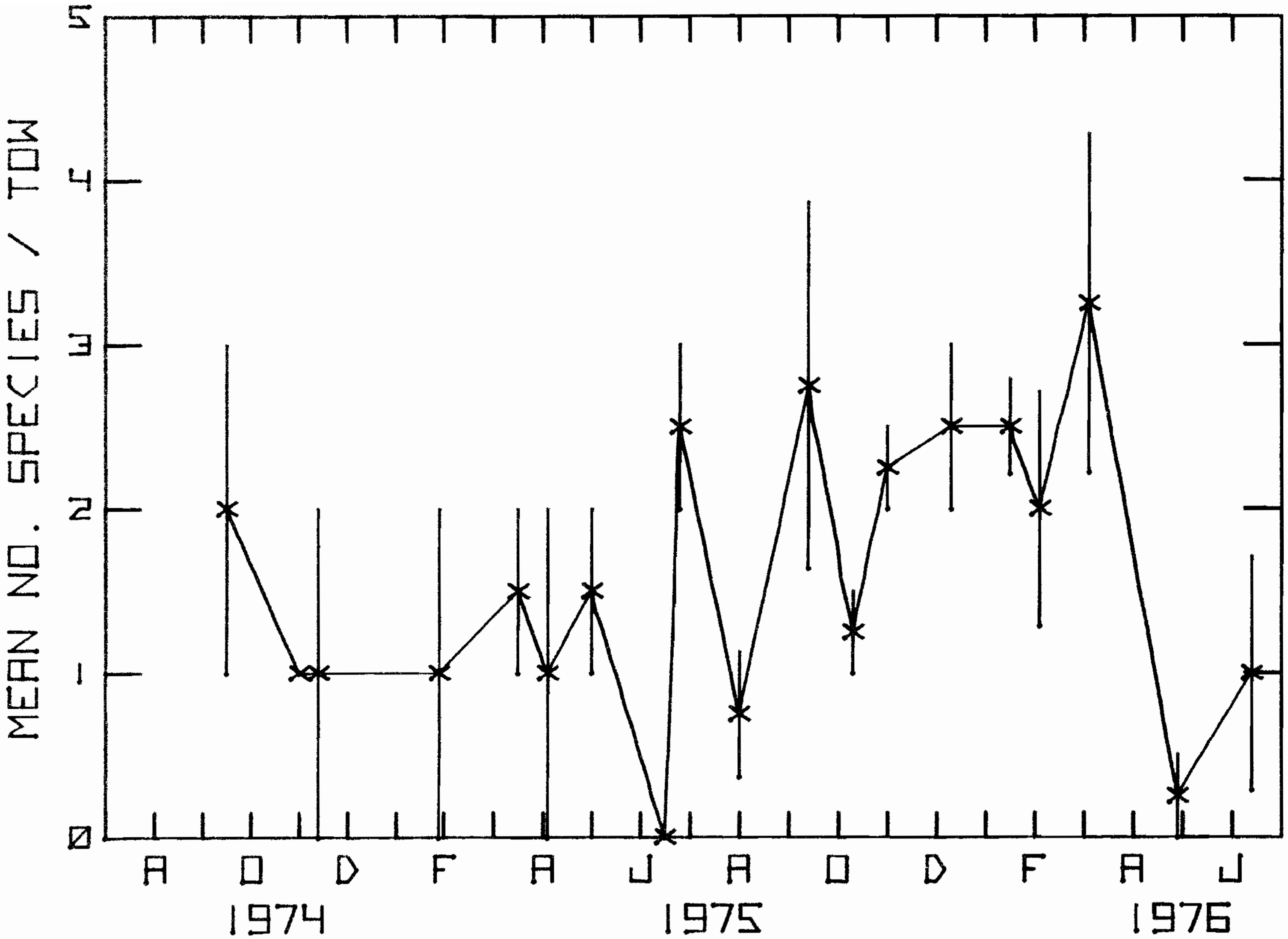

Figure 51. Seasonal variation in the mean number of larval fish species per tow at the dairies station. For further explanation, see Figure 46.

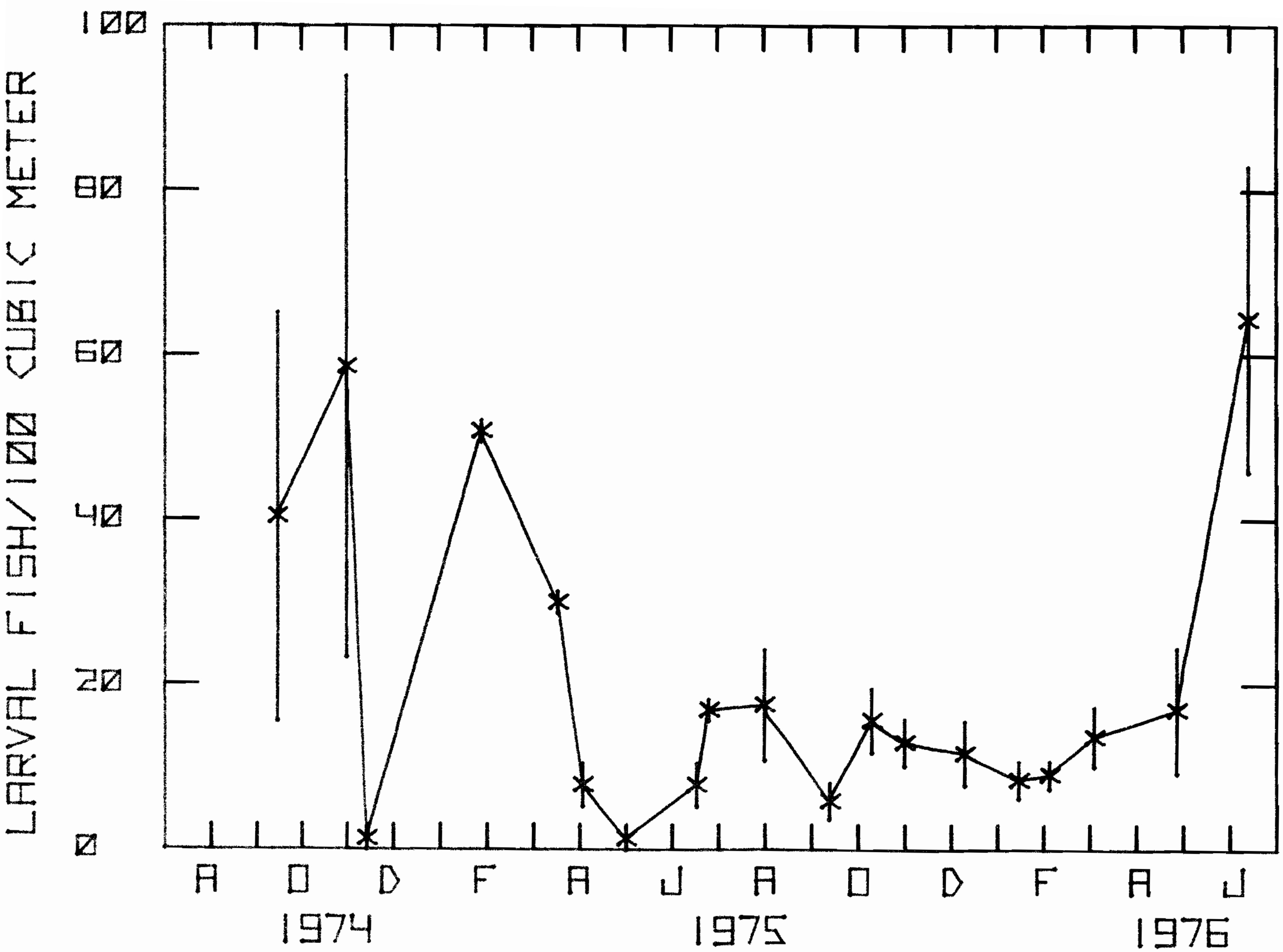

Figure 52. Seasonal variation in mean number of larval fish per 100 cubic meters at the red house station. For further explanation, see Figure 46.

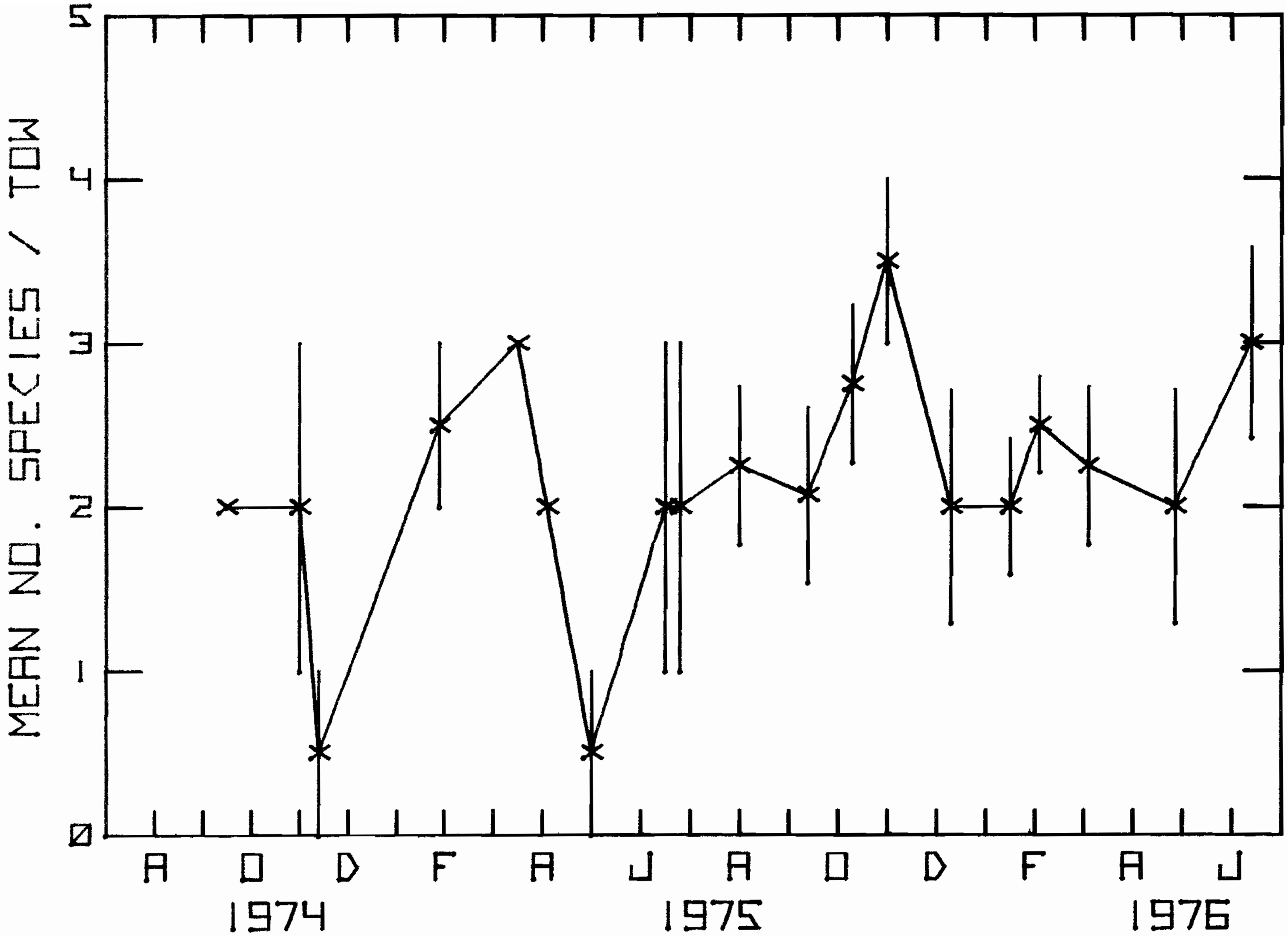

Figure 53. Seasonal variation in the mean number of larval fish species per tow at the red house station. For further explanation, see Figure 46.

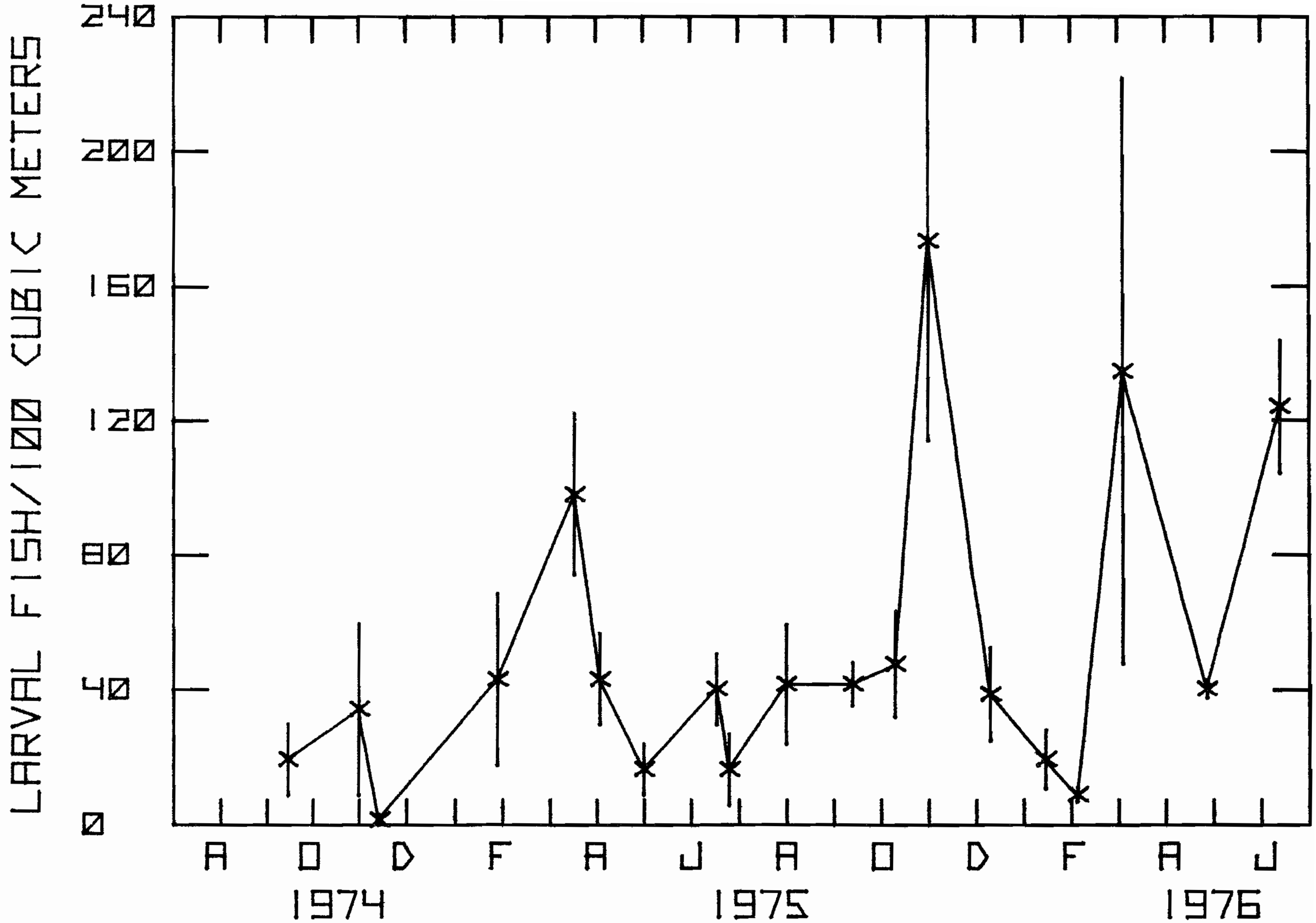

Figure 54. Seasonal variation in mean number of larval fish per 100 cubic meters at the Kirby Park station. For further explanation, see Figure 46.

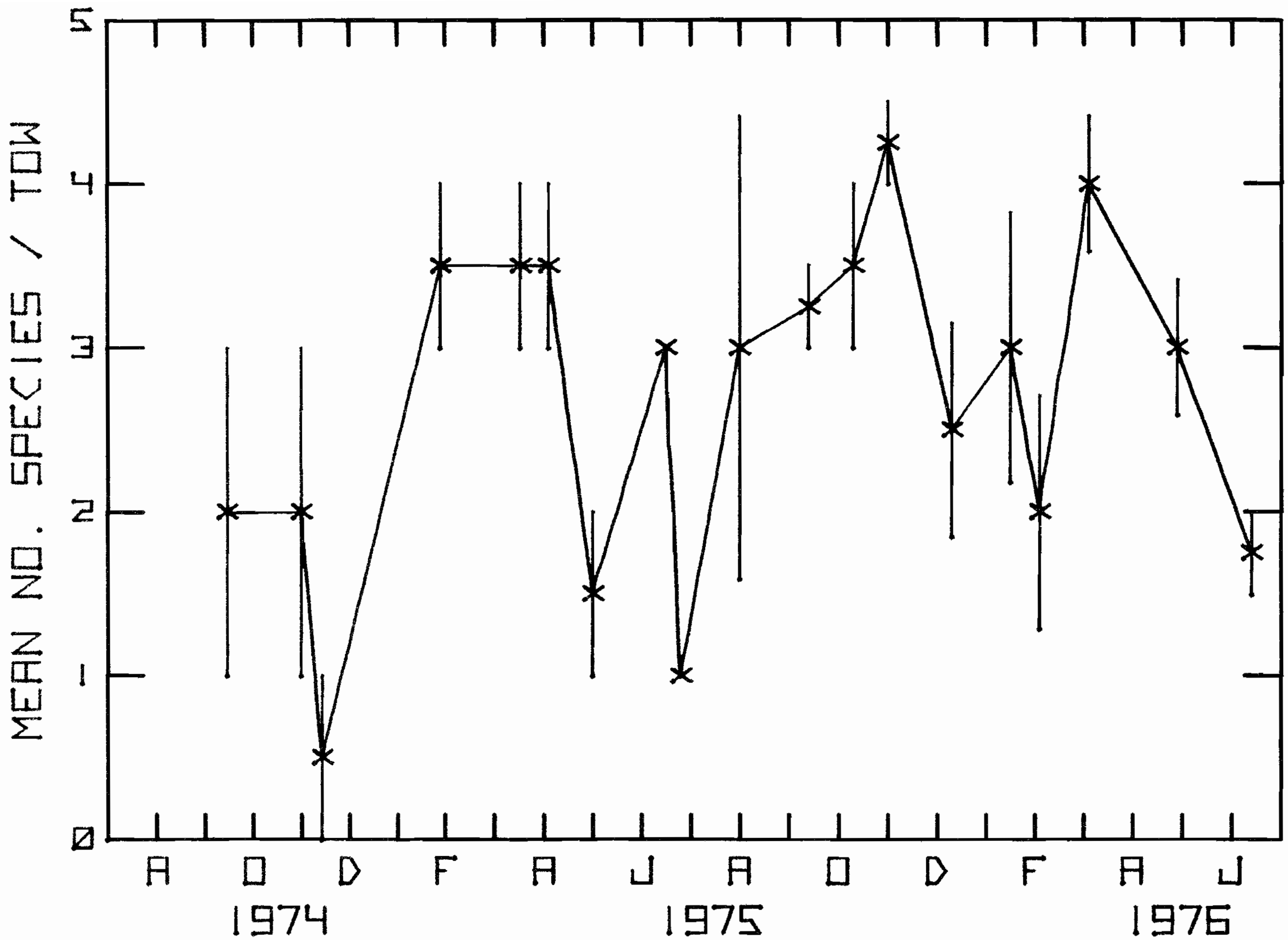

Figure 55. Seasonal variation in the mean number of larval fish species per tow at the Kirby Park station. For further explanation, see Figure 46.

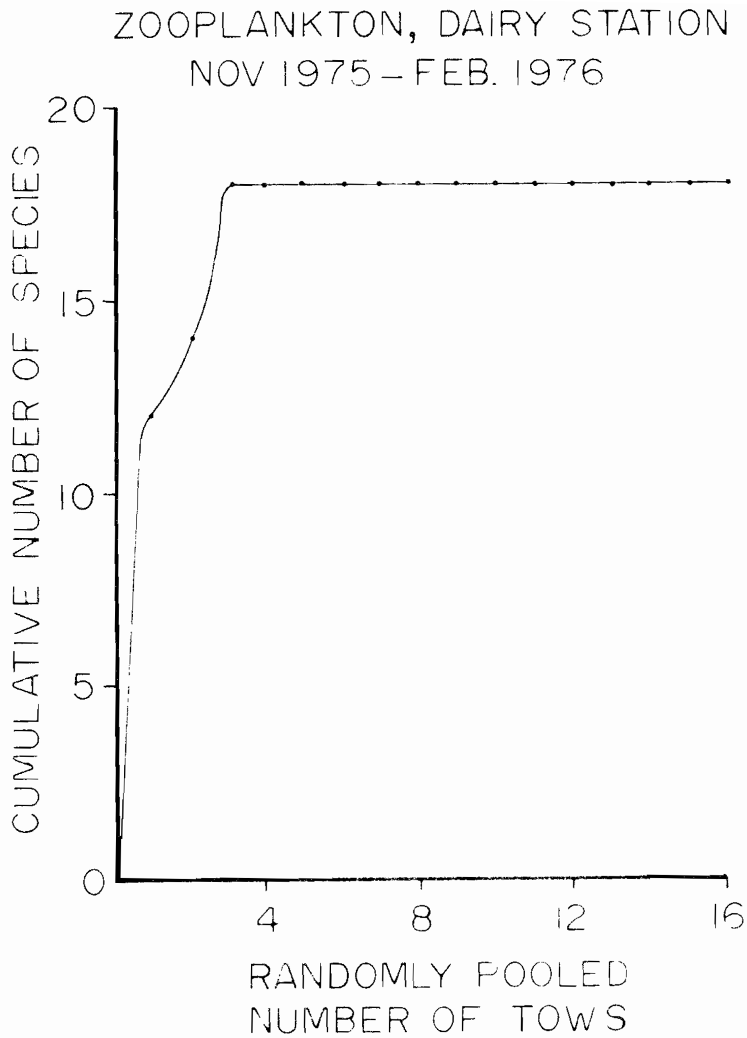

Figure 56. Cumulative number of zooplankton species plotted against a randomly pooled number of tows from the dairy station from November 1975 to February 1976.

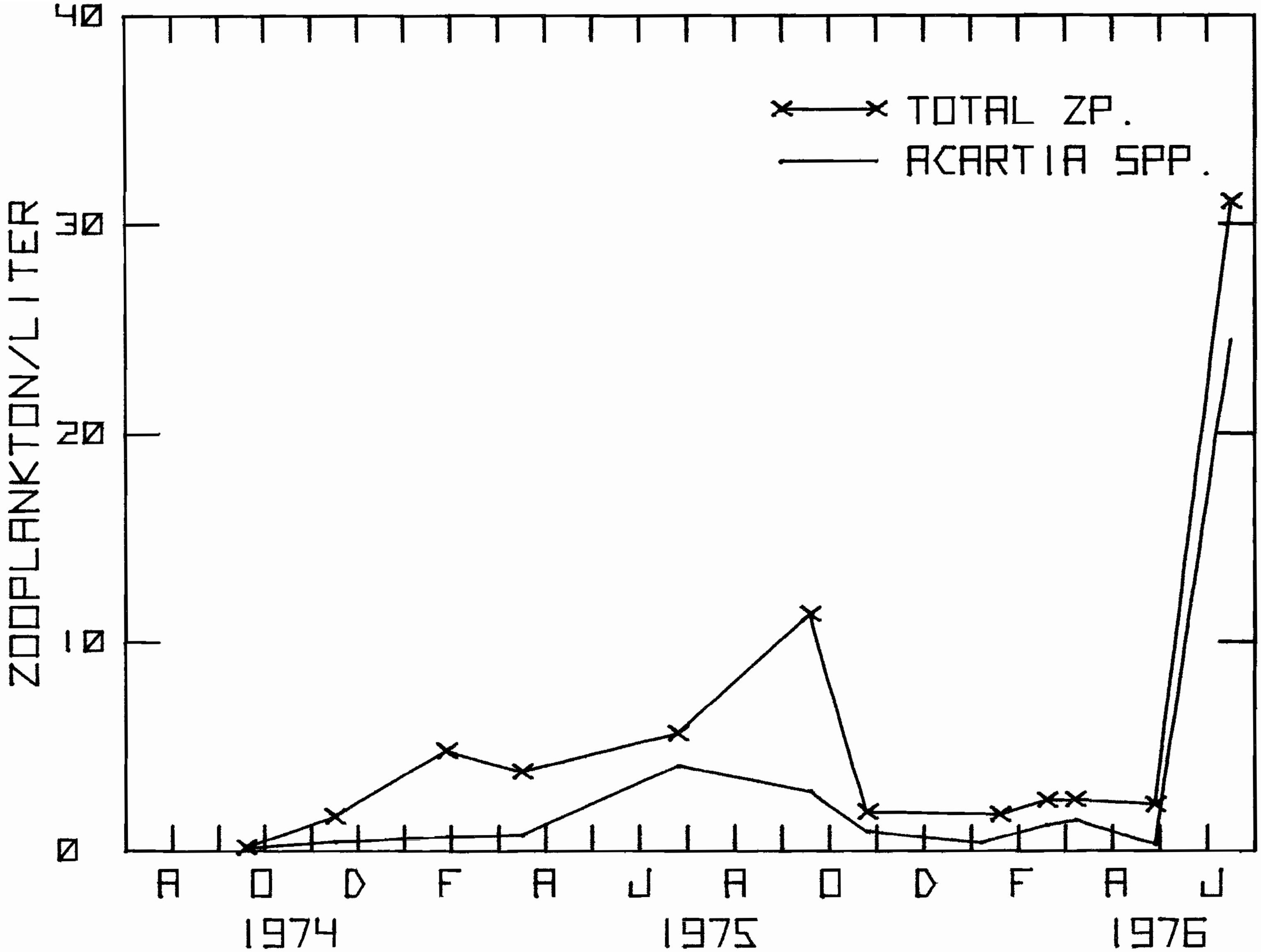

Figure 57. Total number of zooplankton and *Acartia* spp. collected per liter of water filtered by sampling date at the harbor entrance station. Number of samples are given in Tables 30 - 34.

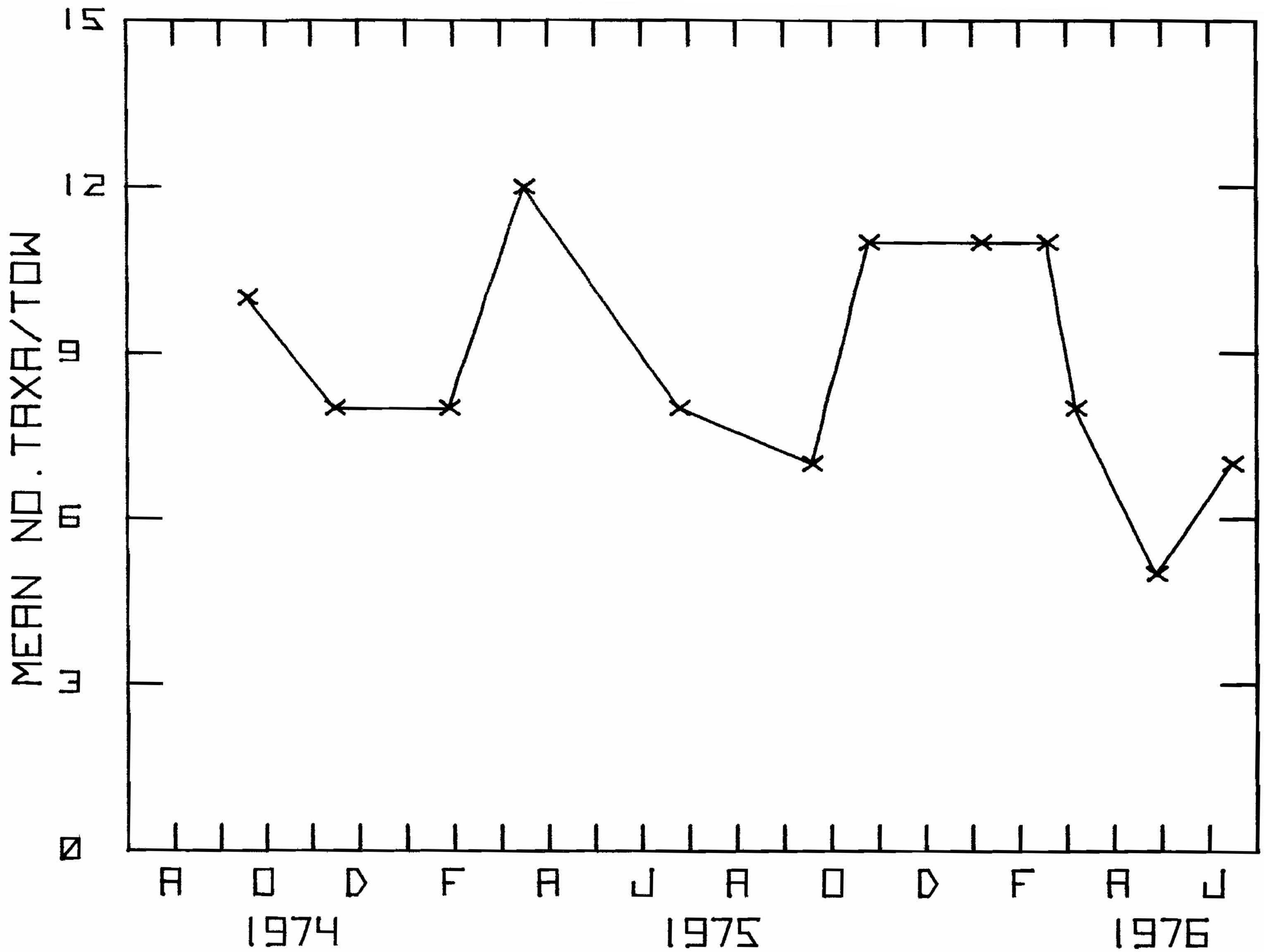

Figure 58. Mean number of taxa of zooplankton per tow at the harbor entrance station. For further details, see Figure 57.

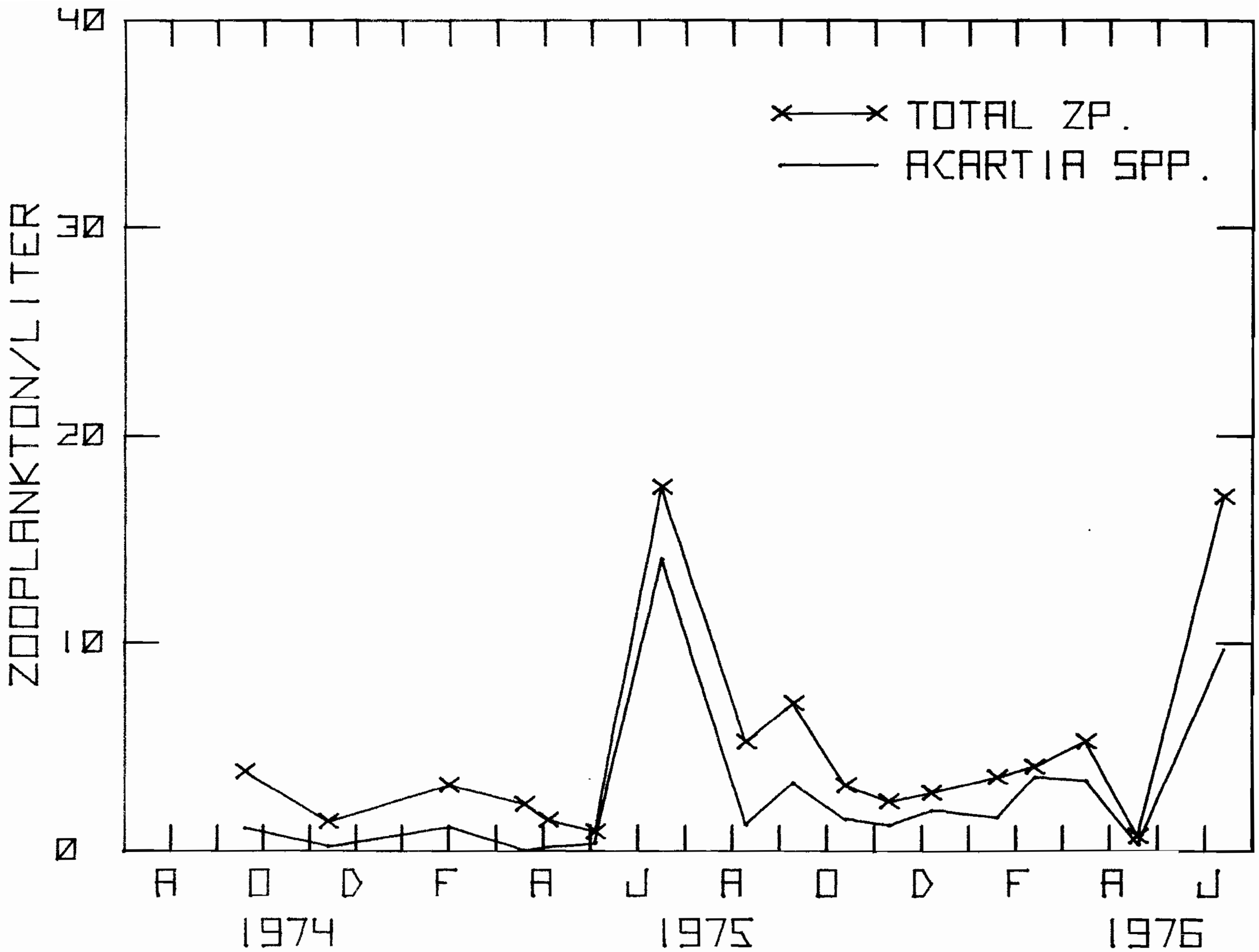

Figure 59. Total number of zooplankton and Acartia spp. collected per liter of water filtered by sampling date at the bridge station. Number of samples are given in Tables 30 - 34.

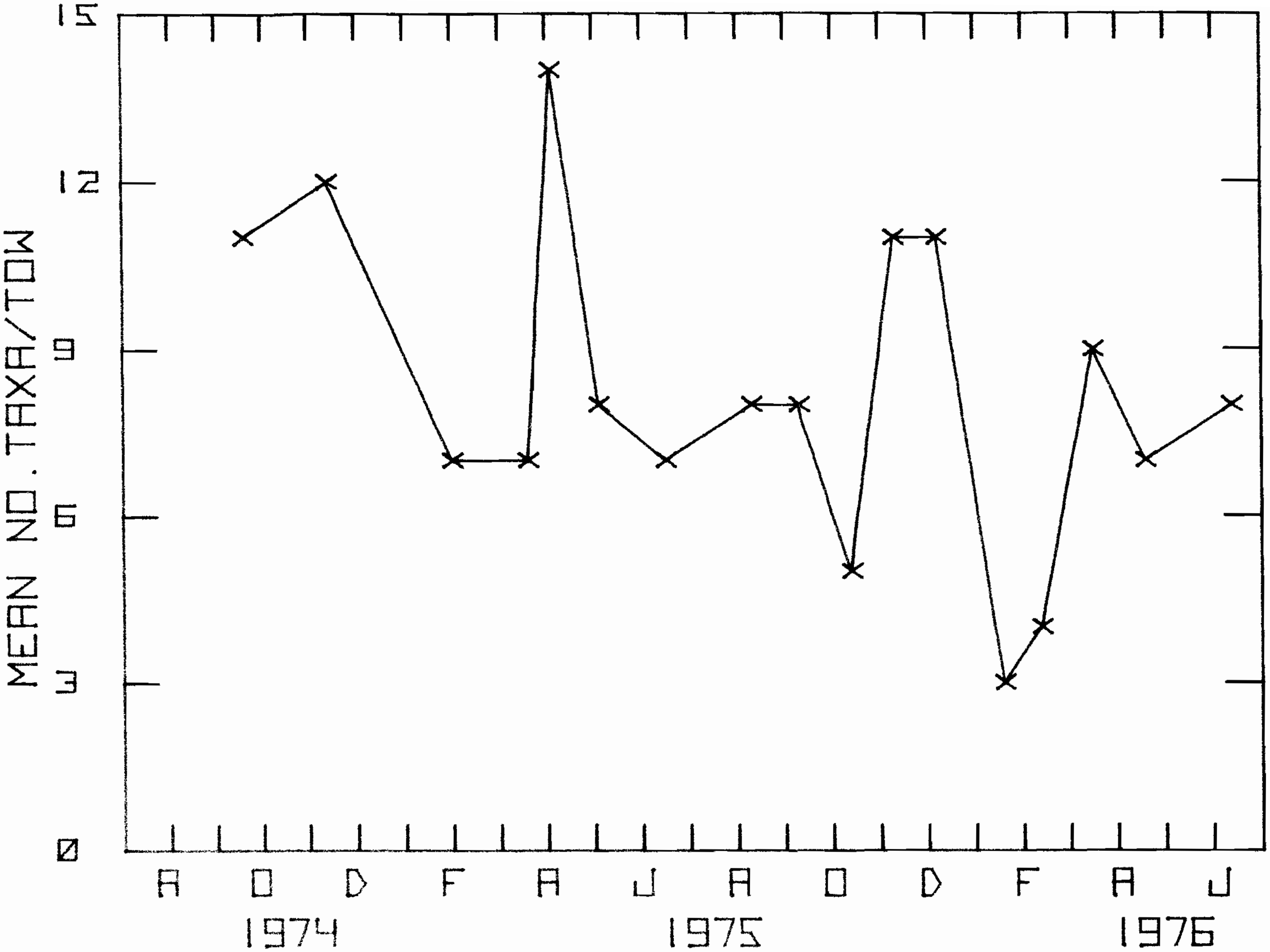

Figure 60. Mean number of taxa of zooplankton per tow at the bridge station. For further details, see Figure 57.

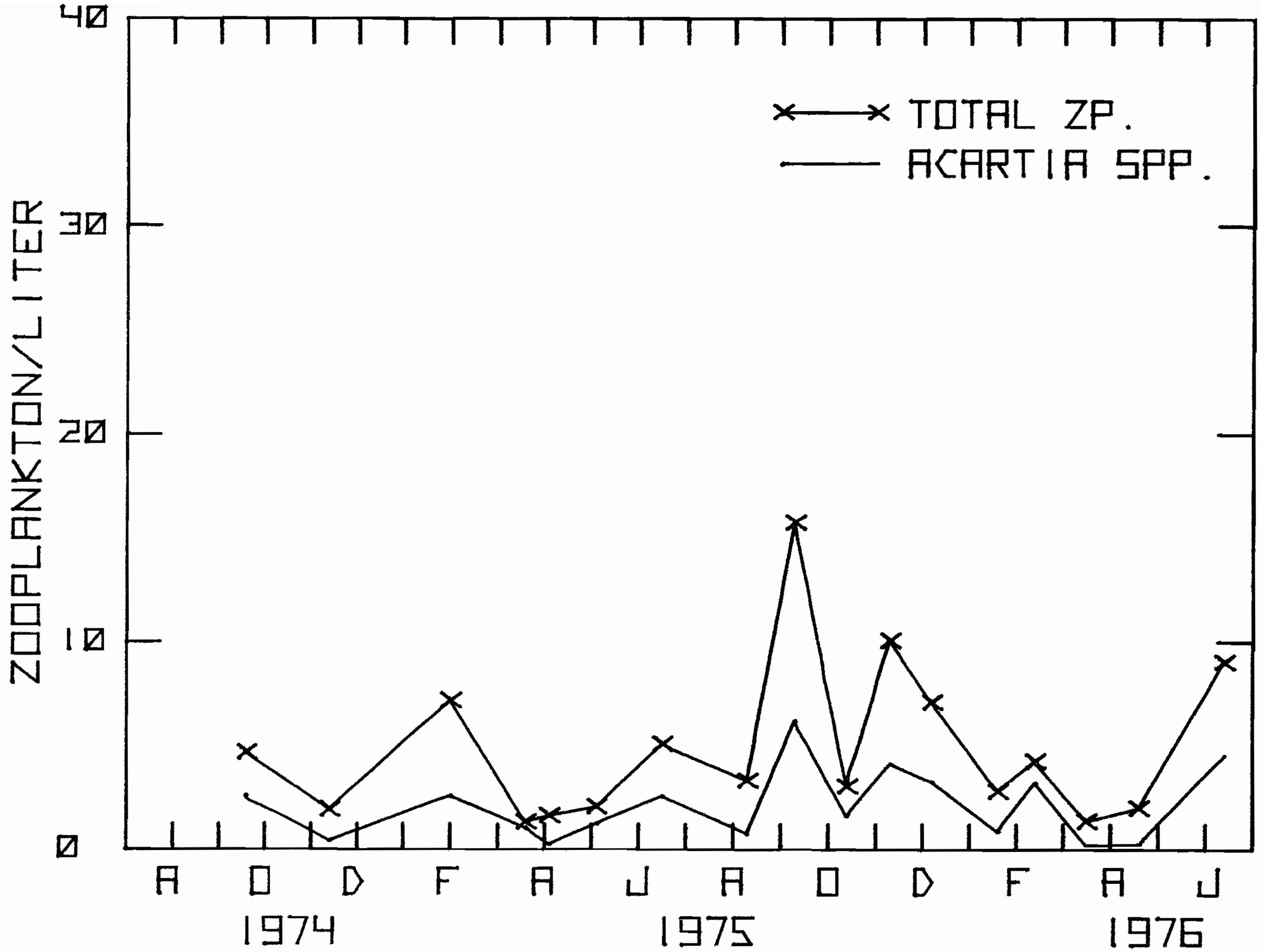

Figure 61. Total number of zooplankton and *Acartia* spp. collected per liter of water filtered by sampling date at the dairies station. Number of samples are given in Tables 30 - 34.

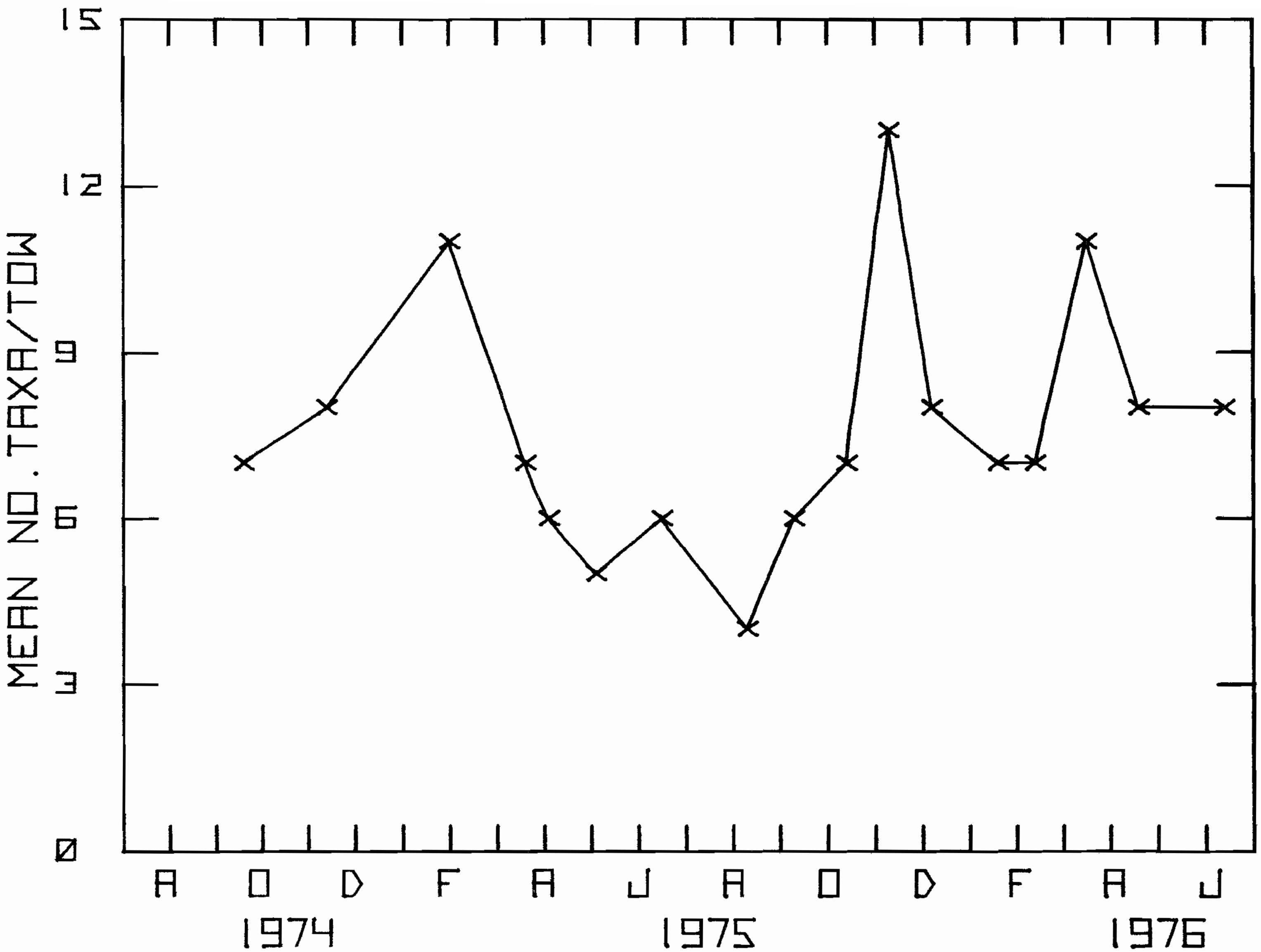

Figure 62. Mean number of taxa of zooplankton per tow at the dairies station. For further details, see Figure 57.

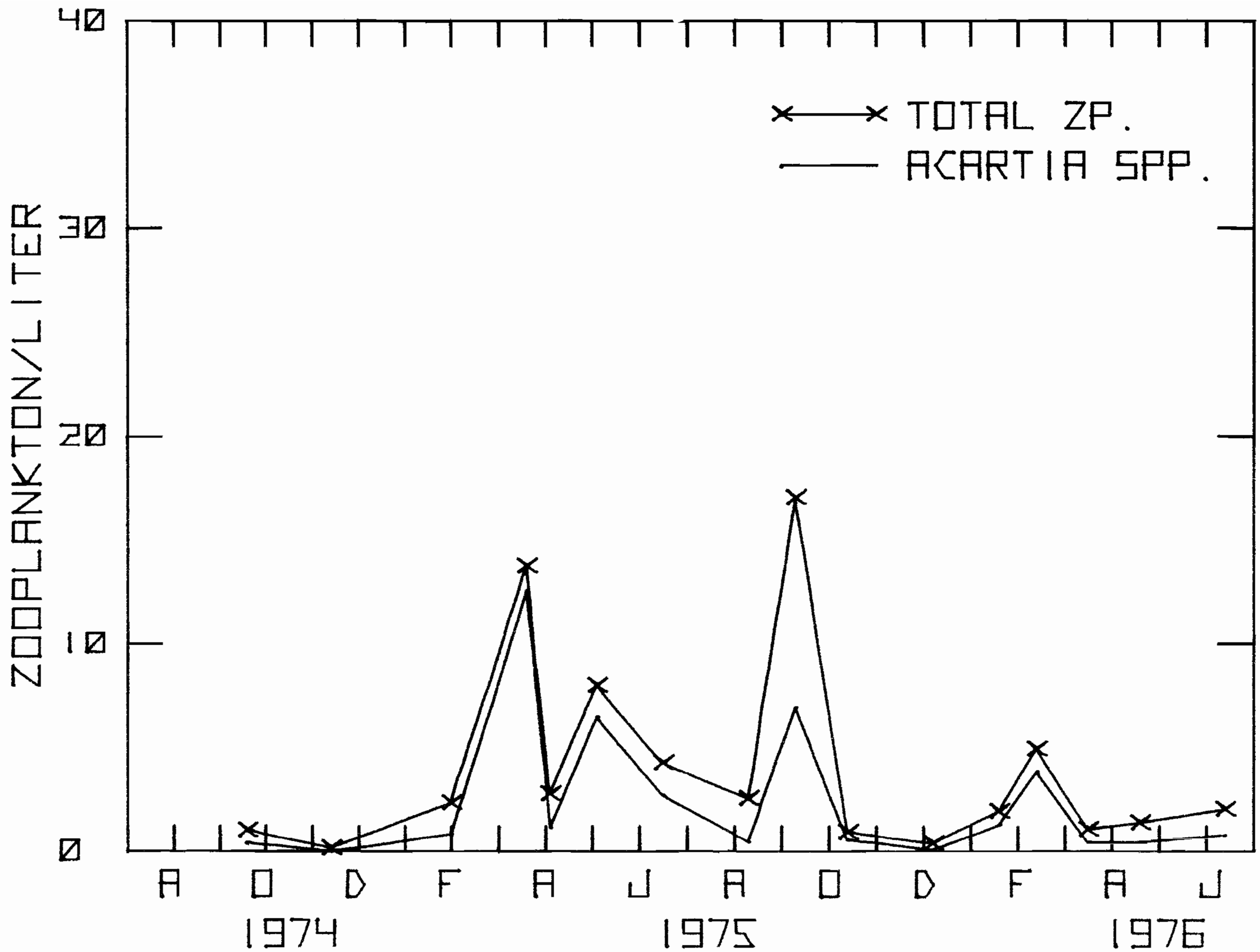

Figure 63. Total number of zooplankton and Acartia spp. collected per liter of water filtered by sampling date at the red house station. Number of samples are given in Tables 30 - 34.

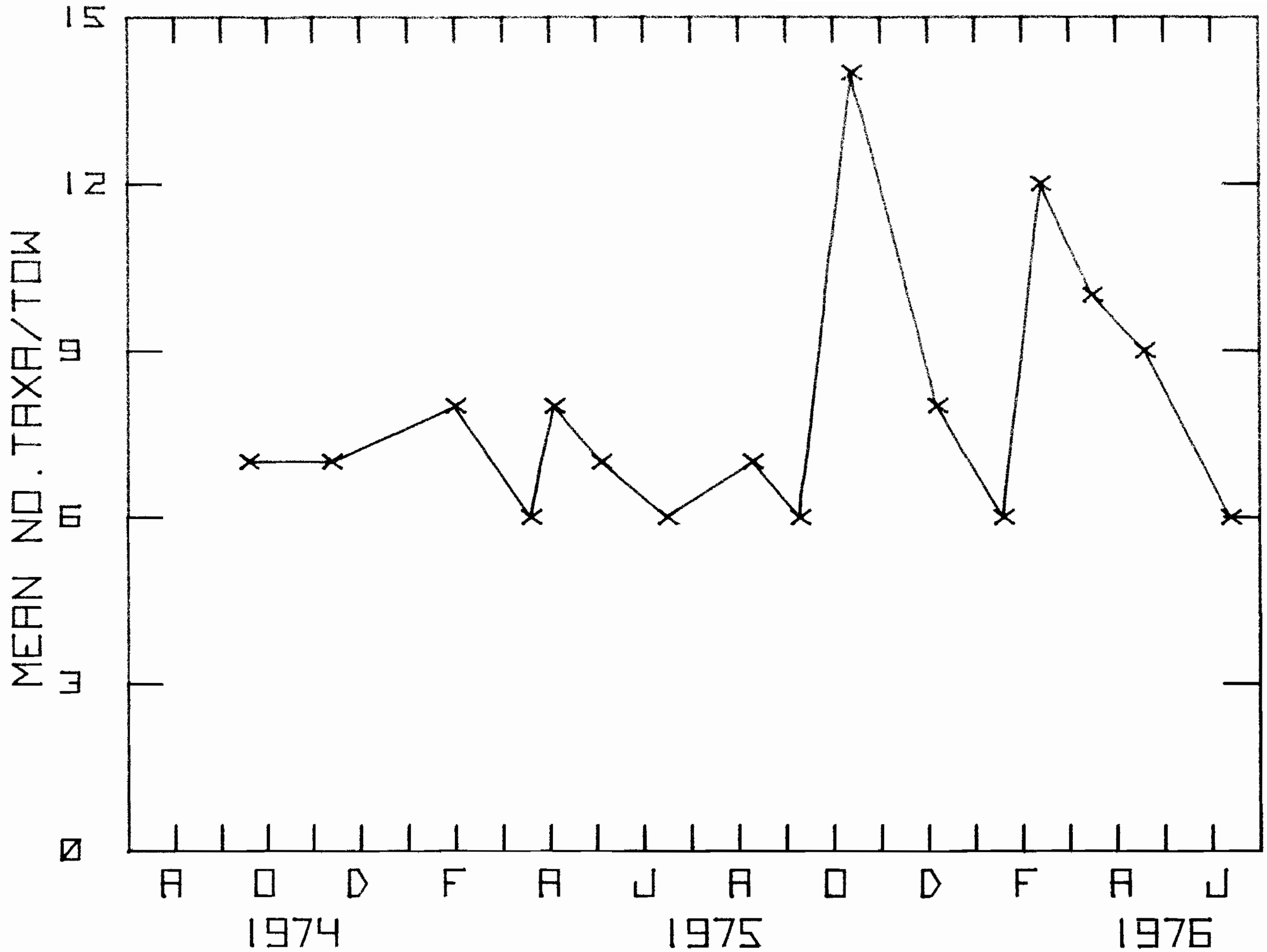

Figure 64. Mean number of taxa of zooplankton per tow at the red house station. For further details, see Figure 57.

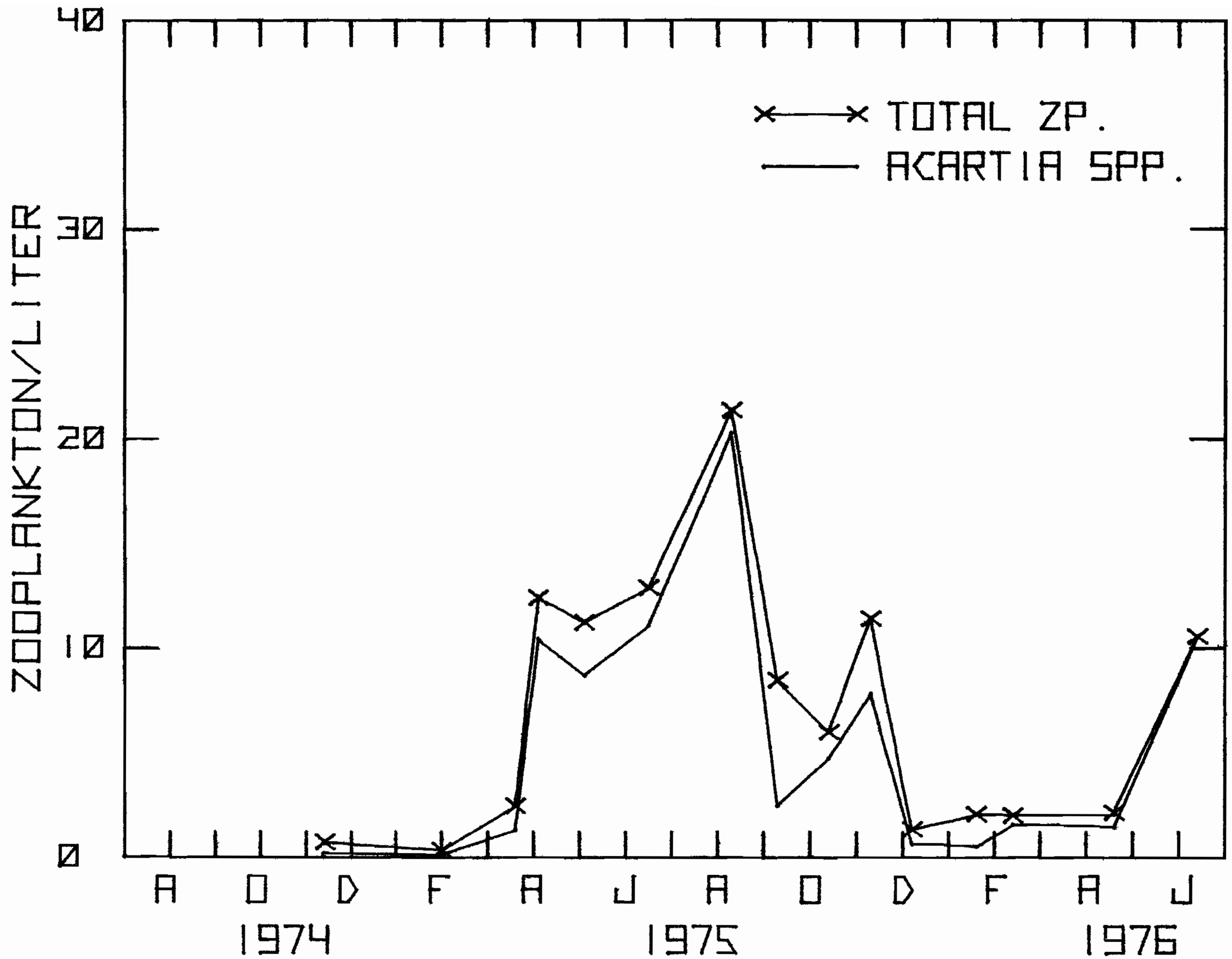

Figure 65. Total number of zooplankton and Acartia spp. collected per liter of water filtered by sampling date at the Kirby Park station. Number of samples are given in Tables 30 - 34.

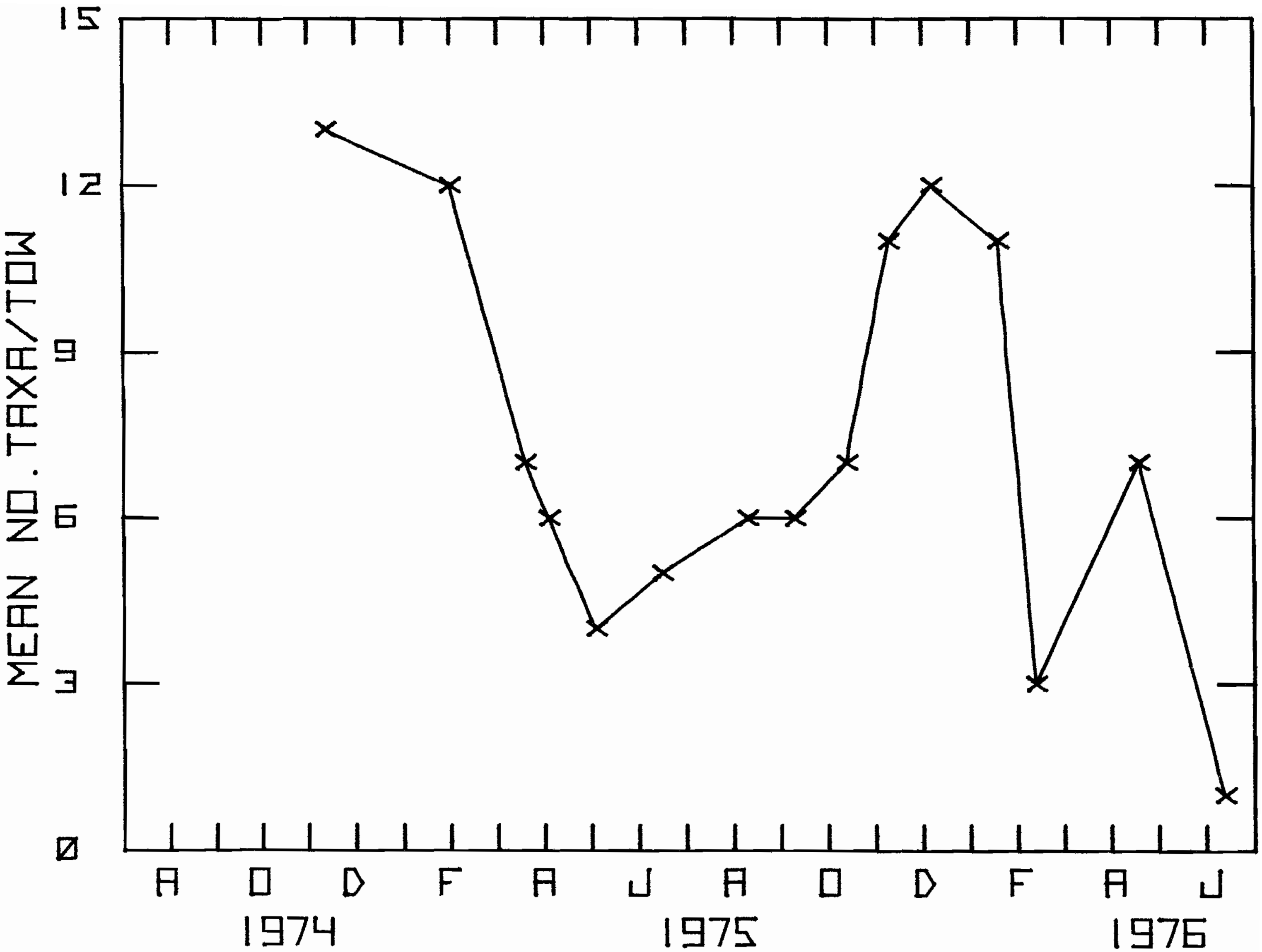

Figure 66. Mean number of taxa of zooplankton per tow at the Kirby Park station. For further details, see Figure 57.

WATER CHEMISTRY OF ELKHORN SLOUGH AND MOSS LANDING HARBOR

William Broenkow

Associate Professor

Moss Landing Marine Laboratories

Moss Landing, California 95039

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WATER CHEMISTRY OF ELKHORN SLOUGH AND MOSS LANDING HARBOR

I. Introduction

The chemical characterization of the waters of Elkhorn Slough and Moss Landing Harbor provides the framework for the interpretation of biological data, in particular the plankton and nekton. Thus the following studies were made in support of the biological studies and constitute a part of our total research effort. Additional hydrographic and chemical data in Monterey Bay have been obtained under separate research projects (California Cooperative Fisheries Investigations, Kaiser Refractories Receiving Water Monitoring; Broenkow et al, 1975, 1976; Broenkow 1975, 1976), so that seasonal changes in the offshore environment are also documented.

II. Methods

Station positions (Figure 1) were those used by Broenkow and Smith (1972) and two additional stations (1 and 10) have been used in this study to better define the hydrographic regime of the slough and harbor. Because of the shallowness of the slough, samples were taken at 1 m at each station. Smith (1973) showed that vertical stratification is present during rainy periods, but that a single sample is representative of water column-mean values. Samples were taken as close to high tide as practical to normalize strong tidal effects. Eleven stations were sampled monthly, and two stations (3 and 5) were studied for tidal effects by sampling hourly for 25 hour periods on 16-17 October 1974 near the end of the dry season and on 4-5 April 1975 during a rainy period.

Temperature. Water temperatures were determined using a bucket thermometer lowered to depth, allowed to soak for 5 minutes, then pulled to the surface rapidly and read. This procedure was repeated until a constant reading was obtained to $\pm$ 0.1°C.

Salinity. Salinity was determined using a Beckman RS-7B precision induction salinometer. Analyses were made in the laboratory and salinity was computed from conductivity ratio using the equations of Cox, et al. (1967). Substandard seawater was used to calibrate the salinometer before and after each set of 24 or fewer samples. Copenhagen water was used each month to standardize the substandard water.

Dissolved Oxygen. Water samples were treated in the field to fix the oxygen in the basic form. The samples were acidified and titrated in the laboratory within 8 hours of the sampling time using Carpenter's (1965) modification of the Winkler method. The total sample is titrated with approximately 0.02 N sodium thiosulfate to the starch endpoint. Precision of the analyses is about $\pm$ 0.06 ml/liter (2 SD).

Nutrient Ions. Five-hundred ml samples were collected and stored in ice chests at 5°C for up to 6 hours until they could be filtered in the laboratory (2 μm pore size) and frozen. Within 6 weeks of freezing the samples were quick thawed and analyzed for phosphate, nitrate, nitrite, ammonia and silica. Standards and reagent blanks were prepared fresh daily and were determined with each set of samples. Some of the samples had concentrations beyond the normal range of the methods listed below. The absorbance of these samples was determined with a 1 or 2 cm path and their concentrations calculated from extended range curves.

Dissolved reactive phosphate was determined by the method of Murphy and Riley (1962) described in Strickland and Parsons (1968) using ascorbic acid to reduce the phosphomolybdate complex. The sample absorbance was determined with a 10 cm path on a Brinkman PC 1000 Colorimeter at 880 nm. Precision of the analyses is about ± 0.03 μ moles/liter (2 SD) at the 2 μ mole/liter level and ± 0.6 μ mole/liter at the 10 μ mole/liter level.

Nitrate was determined by the cadmium-reduction method of Wood, et al. (1967) followed by the nitrite color development. The sample absorbance was determined with a 1 cm path using the PC 1000 Colorimeter at 545 nm. Precision of the analyses is about ± 0.5 μg-atoms/liter (2 SD) at the 20 μg-atoms/liter level.

Nitrite was determined by the method of Bendschneider and Robinson (1952) described by Strickland and Parsons (1967). The absorbance of the diazo color was determined on the PC 1000 using a 10 cm path at 545 nm. Precision of the method is about ± 0.03 μ mole/liter (2 SD) at the 1.5 μ mole/liter level and ± 0.1 μ mole/liter at the 10 μ mole/liter level.

Ammonia was determined by the indophenol method of Solorzano (1969) with the color absorbance determined with the PC 1000 at 650 nm using a 10 cm path. Precision of the method is about ± 0.1 μ mole/liter (2 SD) at the 3 μ mole/liter level and ± 0.4 μ mole/liter at the 20 μ mole/liter level.

Reactive silica was determined by the method of Mullin and Riley (1955) as modified by Strickland and Parsons (1968). The silicomolybdate complex was reduced by a metol-sulfite, oxalic acid solution, and the color absorbance was determined in a 1 cm path on a PC 1000 at 810 nm. Precision of the method is about ± 1 μ mole/liter (2 SD) at the 40 μ mole/liter level.

Suspended Sediments. Suspended sediments were determined by weighing the material collected on 2 µm polyvinyl chloride filters. Dissolved salts were rinsed out by washing with 10 ml of deionised water. Samples were dried at 80°C for 1 hour prior to weighing on a Mettler H207 balance.

Water Transparency. Water transparency was determined by Secchi disk to ± 0.1 m.

pH. pH (-log hydrogen ion activity) was determined using a Metrohm/Brinkman 103 pH meter and a combination calomel-glass electrode pair. Beckman pH standards of 7.00 and 9.18 were used in calibration so that a slope correction was applied. Samples and standards were temperature equilibrated at 20°C for 20 minutes before analysis.

Alkalinity. Alkalinity was determined by the pH method of Anderson and Robinson (1946) by adding a precisely known volume of 0.100 N HCl to 50.0 ml of filtered sample and reading the final pH on the Metrohm/Brinkman pH meter.

III. Discussion of Results

Observations were made during two years having markedly different rainfall: the winter of 1974-75 had near-normal rainfall, while 1975-76 was abnormally dry (Table 1, Fig. 2a). Mean monthly air temperatures were similar during both years (Table 1, Fig. 2b).

Time series studies at stations 3 and 5 (Fig. 1) were made in October 1974 (during a dry period) and in April 1975 (during a rainy period) to determine tidal and diurnal variability of selected chemical and physical parameters (Appendix 1, Figs. 3 through 10). These results show that large daily variations occurred for all parameters, but that some covaried primarily with the tide (with a 12 hour period), while those parameters that are influenced strongly by the daily photosynthetic cycle showed predominantly daily variability. Selected parameters for the two time series studies were fit to a 2-component harmonic equation,

$$X = X_m + A_{12} \cos(N_{12}\{t - L_{12}\}) + A_{24} \cos(N_{24}\{t - L_{24}\}),$$

by the method of least squares (Bliss, 1970). In the harmonic equation above, X is the independent variable, X_m the harmonic mean, A_{12} and A_{24} the amplitudes of the 12.42 and 24.84 hour constituents, t the time in hours, L_{12} and L_{24} the phase lags of the two harmonics, and N_{12} and N_{24} the speed number in radians/hr for the respective periods.

Results of the harmonic regressions (Table 2) show that nearly all the variables exhibited highly significant harmonic correlations. For most of the observations, the critical F ratio (which expresses the ratio of the variance explained by the harmonic partial regression coefficients to the unexplained variance) is $F_{.05} = 3.4$. Thus with the few exceptions noted in Table 2, the variations in these parameters were highly correlated with tidal (12.42 or 24.84 hour) or diel (24.00 hour) processes. With these

Table 1. Monthly rainfall and mean monthly temperature at Watsonville.

	Month	Monthly Rainfall (inches)	Mean Monthly Temperature (°F)
1974	July	1.27	61.8
	August	0.00	61.6
	September	0.00	61.0
	October	1.70	60.5
	November	0.89	53.7
	December	2.76	48.1
1975	January	1.01	49.5
	February	5.58	50.7
	March	4.70	51.1
	April	1.65	50.5
	May	0.03	56.8
	June	0.16	58.4
	July	0.09	60.4
	August	0.31	61.1
	September	0.02	60.7
	October	2.95	57.2
	November	0.37	52.3
	December	0.24	49.8
1976	January	0.27	50.3
	February	1.04	50.9
	March	2.07	51.4
	April	1.14	53.3
	May	0.00	58.2
	June	0.09	63.0

Table 2. Harmonic analysis results. Elkhorn Slough: 16-17 October 1974, 4-5 April 1975. F = ratio of explained variances for 12.42 or 24.84 hour constituents, R = total correlation coefficient. Other parameters are explained in the text. All regression coefficients are significant (P<0.05) except those noted.

Parameter	Stn	Date	X_m	A_{12}	L_{12}	F_{12}	A_{24}	L_{24}	F_{24}	R
Tide		Oct	2.86	2.11	10.88		1.65	18.84		
(ft)		Apr	2.69	1.27	6.84		1.05	13.26		
Salinity	3	Oct	34.463	0.507	6.27	98.7	0.294	10.52	32.9	0.964
(^{o}/oo)	5	Oct	33.712	0.261	5.55	7.8	0.155	5.69	2.5[a]	0.691
	3	Apr	27.710	1.596	8.11	60.0	1.085	14.61	28.7	0.951
	5	Apr	31.401	0.703	7.89	57.8	0.689	13.93	58.3	0.962
Temperature	3	Oct	20.04	0.61	5.97	16.0	1.06	7.25	44.7	0.921
(^{o}C)	5	Oct	18.36	1.48	5.33	28.1	1.40	8.21	24.7	0.910
	3	Apr	14.47	0.51	4.67	10.9	1.04	6.88	43.5	0.908
	5	Apr	15.14	0.53	5.14	4.5	0.81	9.09	10.1	0.751
Oxygen	3	Oct	106	10.2	5.83	8.1	19.8	7.35	27.8	0.876
(% Sat)	5	Oct	104	12.6	1.16	7.5	20.3	3.74	18.9	0.733
	3	Apr	87	6.5	3.87	1.1[b]	31.0	6.95	23.0	0.822
	5	Apr	88	7.5	8.48	2.3[c]	6.8	9.34	2.1[c]	0.707
Phosphate	3	Oct	2.24	0.11	5.40	0.8[d]	0.35	8.25	7.9	0.668
(μ mole/l)	5	Oct	1.34	0.35	5.52	7.5	0.42	12.90	11.3	0.810
	3	Apr	1.11	0.08	1.35	1.1[b]	0.23	0.39	9.3	0.714
	5	Apr	1.80	0.24	6.52	7.8	0.39	14.86	19.8	0.861
Ammonia	3	Oct	3.1	2.2	0.92	12.9	1.0	11.22	2.6[a]	0.756
(μ mole/l)	5	Oct	3.1	1.9	5.67	14.5	1.5	14.06	8.7	0.838
	3	Apr	1.5	0.1	9.37	0.6[d]	0.8	23.14	3.4	0.476
	5	Apr	6.0	1.2	7.07	4.6	2.0	15.70	13.4	0.808

a. (P<0.1)
b. (P<0.4)
c. (P<0.15)
d. (P<0.5)

time series it is not possible to differentiate between 24.00 and 24.84 hour harmonics.

Salinity exhibited highest correlations of any parameters, and both the 12 and 24 hour constituents were highly significant ($P<.001$). In October the ratio of the 12 and 24 hour salinity amplitudes was similar to the 12 and 24 hour tidal height amplitudes. This suggests that salinity was predominantly controlled by the tide. Temperature, on the other hand, showed high correlation coefficients, but the daily (24 hour) amplitude was larger than the semi-daily amplitude in the upper Slough (station 3). This difference between temperature and salinity suggests that diurnal warming and cooling contributed significantly fo temperature variations. In the lower Slough (station 5) the greater influence of offshore waters decreased the diurnal warming effect. Though it is difficult to separate the 24.00 hour (solar warming) effect from the 24.84 (lunar diurnal tidal) effect, an estimate of the daily warming-cooling amplitude in the upper Slough can be made. Assuming that the 12 hour temperature amplitude is solely due to the tide, and that the tidally-controlled temperature amplitude ratio is similar to the salinity ratio, a tidally modulated temperature amplitude of 0.35°C would be expected. Thus daily warming and cooling could account for the remaining 0.7°C daily temperature amplitude observed at Station 3 in October.

During October upper Slough salinities were higher than offshore waters, and highest salinities occurred at both station 3 and 5 during ebbing tides. During April, the opposite salinity distribution was observed due to the influx of fresh water in the upper Slough, and the tidal variation was just the opposite of that observed in October (Figs. 2, 4, 6, and 8). Temperature showed similar variations with warmer water in the upper Slough in October and the reverse in April.

Oxygen saturation variations showed predominantly diurnal periodicity since the 24 hour amplitudes were about twice the 12 hour amplitudes (Table 2). Because the mean oxygen saturation values were about the same at stations 3 and 5, tidal effects would be minimal, and the 24-hour amplitude represents primarily biological effects.

Phosphate and ammonia variations showed highest harmonic correlation coefficients at station 5 (Table 2). This suggests that lateral gradients were higher near station 5 than near station 3. This is consistent with our monthly observation (Figs. 14 and 17) and with Smith's (1973) results. During October, phosphate concentrations in the upper Slough were higher than in the lower Slough. This produces a net diffusive transport of inorganic phosphorous out of the Slough as demonstrated by Smith (1973). The 24 hour harmonic amplitude for phosphorous is higher than the 12 hour amplitude. This suggests that phosphate variations were biologically controlled similar to oxygen. Ammonia, however, appeared to be controlled primarily by the tide, since its semi-daily amplitude exceeded the daily amplitude. This is somewhat surprising because both phosphorous and nitrogen are micro-nutrient elements essential for plant growth.

Results of the seasonal studies (Appendix 2, Figs. 11 through 20) show the variations in chemical and physical water characteristics during the 24 months of the study. In many respects these results agree generally with observations made by Broenkow and Smith (1972) as described by Smith (1973), but differences from previous observations are also apparent. This can be expected because no two years have precisely similar climatic conditions.

Three major water types were evident in the Slough-Harbor system:
1) Offshore Water was characterized by cool temperatures (12 to 16^{o}C) and near uniform salinities (33.3 to 33.9 $^{o}/oo$) (Figs. 11 and 12). Dissolved

oxygen (Fig. 13) was generally near the 100% saturation level in offshore surface waters. Phosphate and nitrate (Figs. 14 and 15) varied seasonally from about 1 to 2 and 5 to 15 μ moles/liter respectively from non-upwelling periods (in fall and winter) to upwelling (spring) periods.

2) South Moss Landing Harbor Water was a mixture of offshore water, fresh water that drains from agricultural fields, and treated domestic sewage that enters the Old Salinas River channel from Castroville via Tembladero Slough and Salinas via the tide gate near the Salinas River mouth. The South Harbor water was of low salinity (19 to 31 ^{o}/oo) throughout the year (Fig. 12); it contained large concentrations of phosphate (often exceeding 10 μ moles/liter and up to 40 μ moles/liter; Fig. 14); it contained large nitrate and ammonia concentrations (40 to 75 μ moles/liter and 10 to 60 μ moles/liter respectively; Figs. 15 and 17). These high nutrient levels in the South Harbor Water probably result from the influx of both domestic sewage and agricultural fertilizers.

3) Upper Slough Water varied in characteristics seasonally depending on evaporation, precipitation and runoff rates. During periods of maximum rains (February and March 1975) lowest salinities in upper Slough were about 17^{o}/oo, while yearly maximum salinities of 35.7 and 37.4 ^{o}/oo were found at Station 1 in September 1975 and June 1976 respectively (Fig. 12). The Slough varies in characteristics from estuarine during rainy periods to an evaporative basin during other periods. Upper Slough waters were generally warmer than offshore waters in summer (21 vs 14 ^{o}C June 1975; 27 vs 16^{o} C June 1976) and cooler or about the same temperature as offshore waters during winter (Fig. 11). Dissolved oxygen concentrations in the Slough were often lower than 100% saturation (Fig. 13), but because of the strong daily variation, our monthly surveys may not represent accurately daily mean concentrations even though we normalized our sampling time with high slack tide. The time

of sampling varied widely: during 14 months samples were taken between 1000 and 1300 hours local time, while during the remaining months sampling was done between 1300 and 1700 hours. Nutrient ions in Upper Slough Waters (Stations 1, 2, 3, and 4) were generally present in concentrations sufficient for phytoplankton growth, and the following modal concentrations were found: phosphate 2 μ moles/liter (range 0.7 to 6); nitrate 5 μ moles/liter (range 0 to 47); nitrite 0.5 μ moles/liter (range 0.1 to 2.1); ammonia 1.5 μ moles/liter (range 0.2 to 35); and silica 30 μ moles/liter (range 6 to 100).

These recent observations agree generally with those of Broenkow and Smith (1972) as described in Smith 1973: "Elkhorn Slough and Moss Landing Harbor are essentially two separate systems. The Old Salinas River channel and Tembladero Slough supply to the harbor fresh water having a high nutrient content throughout the year. This water is of low density and flows into the harbor forming a surface layer. Often at low tide a plume of the low density waters can be seen extending out the harbor entrance into Monterey Bay where it is mixed and carried southward. In the harbor itself, industrial pumping plays an important role in flushing the harbor and maintaining a net flow of Monterey Bay waters into the harbor. Pacific Gas and Electric alone removes 10 times the low water volume of the south harbor daily. Elkhorn Slough, except under unusual conditions is isolated from the harbor system. The slough is shallow, five m at the mouth to less than one m at the head, and tidal currents keep its water vertically well mixed. The tides are the dominant mixing mechanism for the slough, removing over 3/4 of the mean high water volume daily. While this is a large fraction of the total volume of the slough, only a small portion of the waters inland of the shoreward extent of the tidal prism are flushed from the slough daily."

"In Elkhorn Slough the waters above the tidal prism have a long residence time, and its chemistry develops somewhat independently of offshore conditions. Longitudinal gradients of most parameters are indicative of mixing between the upper slough and offshore waters."

"In addition to tidal influences, large seasonal variations were observed. The apparent nitrogen to phosphate ratio for the harbor source waters varied from 1:16 in the winter to 1:5 in the summer, indicating increased relative influence of sewage on the composition of fresh waters entering the harbor. Most of the longitudinal gradients in Elkhorn Slough reversed from winter to summer. During the winter, conditions responded rapidly to variations in precipitation and local runoff." Smith (1973) observed that the first heavy rain of the season resulted in a sudden rise in nutrient levels of the upper Slough. During the present study, only silica showed a large increase following the heavy rains of February 1975. Smith further observed: "During the summer, evaporation controlled salinity distributions, and the upper slough became a semi-closed system. Under these conditions, a tidal diffusion model was formulated based on a salt budget involving estimated evaporation rates and observed salinity distributions. Tidal diffusion coefficients were calculated at various distances inland. The mean diffusion coefficients ranged from 430×10^4 cm^2/sec two km inland of the slough entrance to 5.9×10^4 cm^2/sec nine km inland. These diffusivities lead to a residence time in excess of 300 days for the waters inland of the mean diurnal tidal prism."

"The seasonal variations in the nutrient distributions in Elkhorn Slough are more complex, involving biochemical and inorganic processes as well as tidal diffusion. Phosphate concentrations increased landward throughout the study periods. During the summer months, a mean rate of phosphate diffusion from the upper Slough was calculated to be 12 kg PO_4^{3-}/day. Unlike phosphate, nitrogen gradients were not consistent through the year. Throughout the study period, maximum concentrations of reduced nitrogen (ammonia and nitrite) were observed in the mid-slough region, correlating with the presence of dairy farms in this area."

Smith concluded: "Tidal variations were the single most important factor in determining the instantaneous solute distribution. The area above the tidal prism (about 4.8 km inland) is essentially isolated from offshore influence and develops its own chemical identity. In this area, significant diurnal variations occur in the dissolved oxygen concentrations, and to a lesser extent, in phosphate levels. A net production rate of about 50 mg-at O_2-O/m^2 hr were estimated from these observations in March and August 1971, respectively. Even though this area is highly productive, judging from the annual phosphate and oxygen distributions, the upper slough appears to be dominated by respiration or decomposition. This is reasonable considering the quantity of detrital organic material contributed by the adjacent marsh areas."

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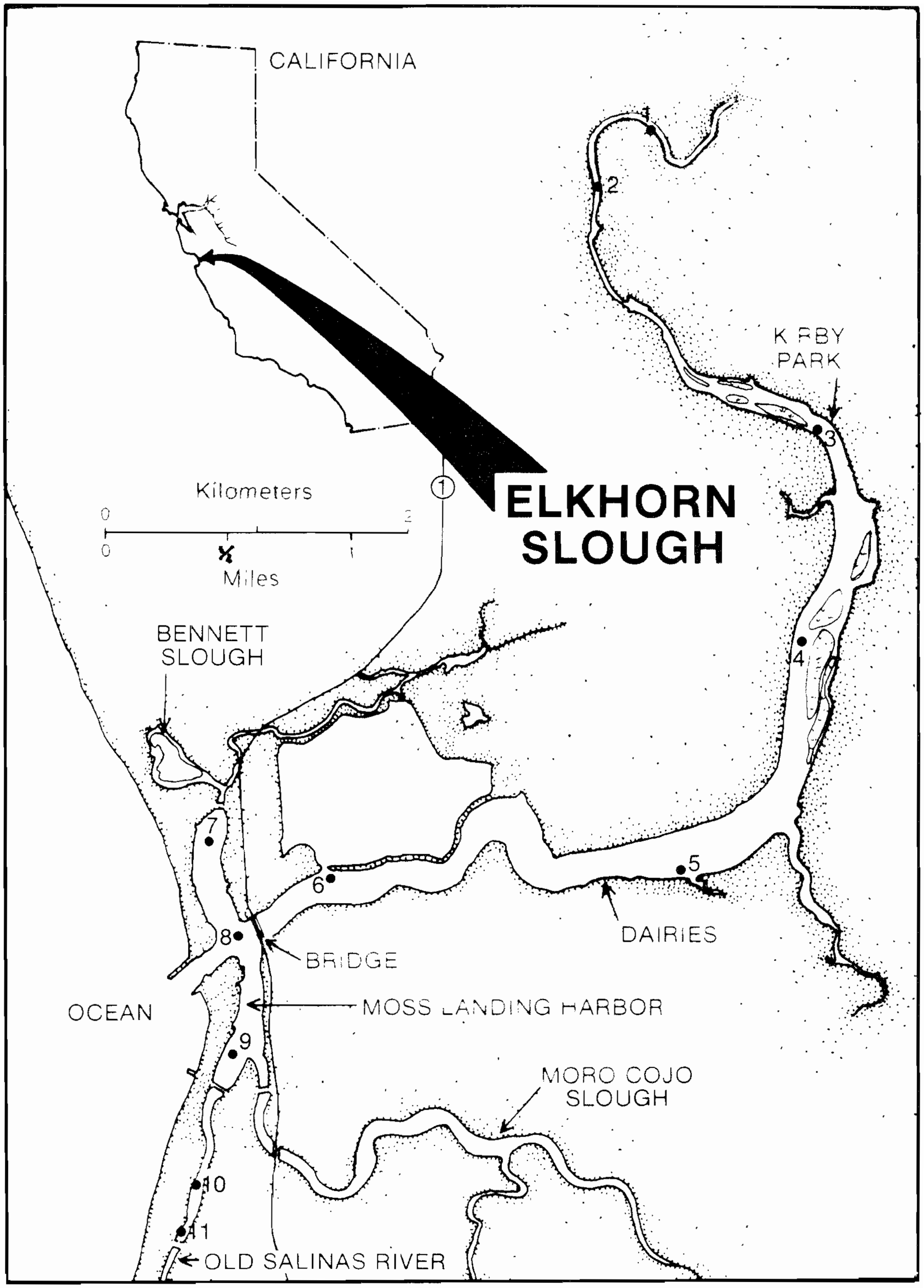


FIGURE 1. Hydrographic sampling stations.

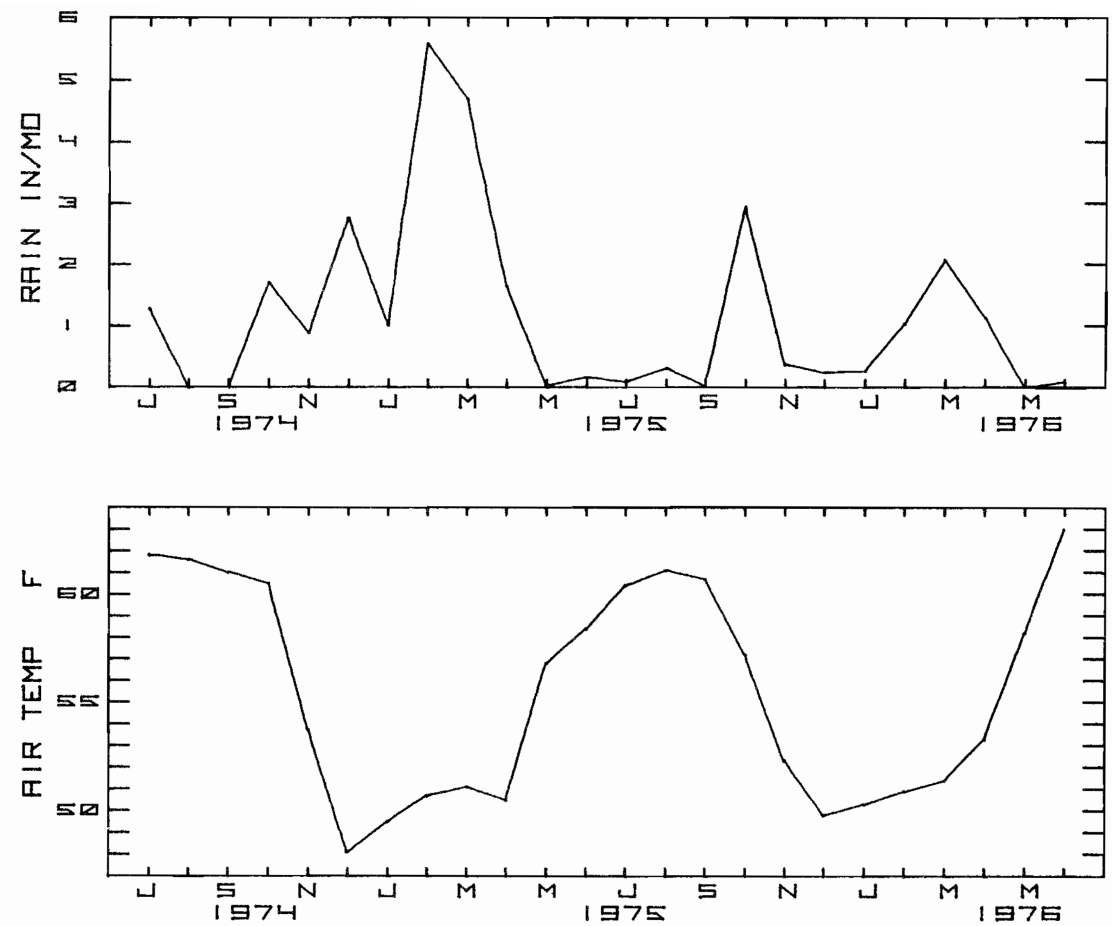


FIGURE 2. Monthly rainfall at Watsonville (upper).

Monthly mean air temperature at Watsonville (lower).

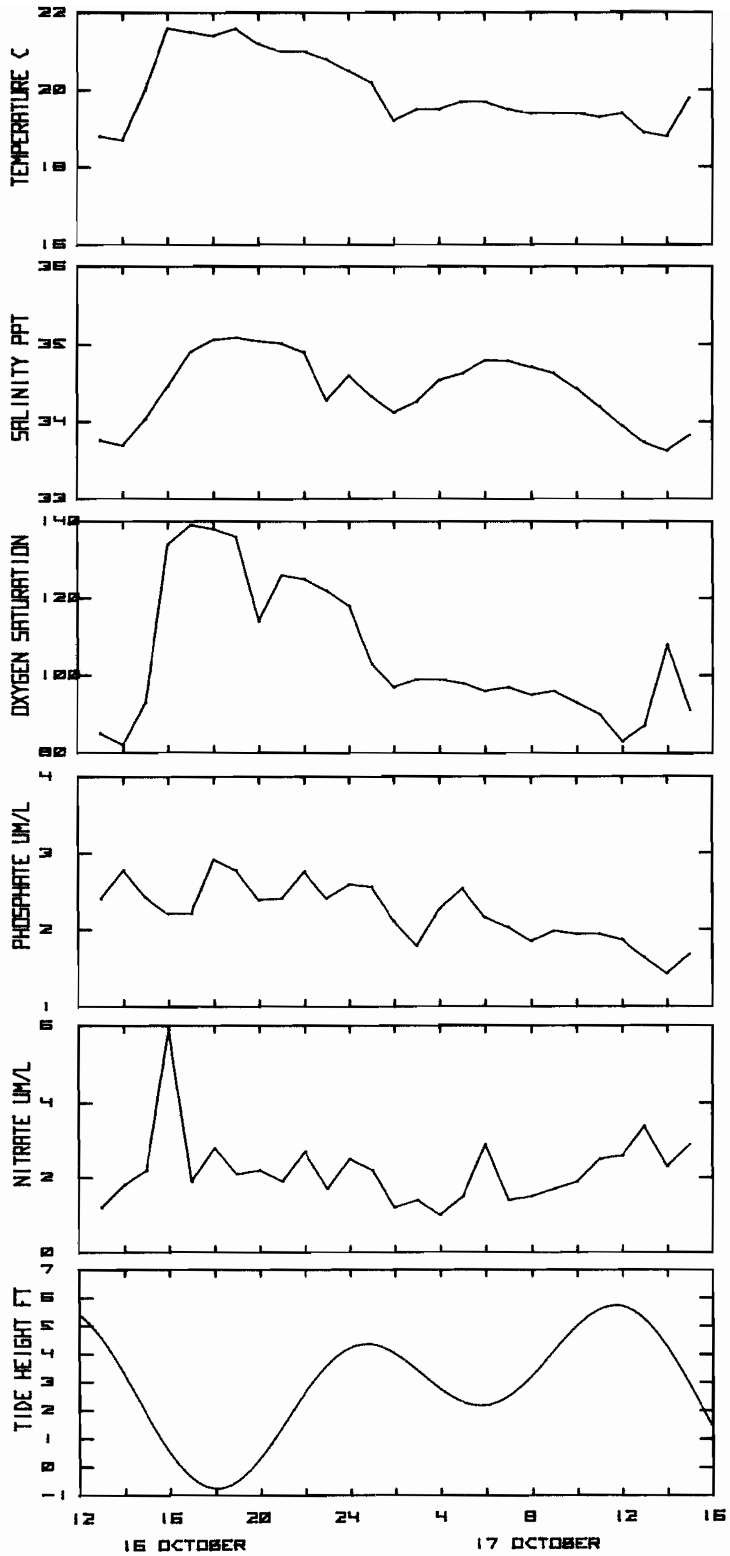


FIGURE 3. Time series study 16-17 October 1974. 1 m depth, Station 3. Kirby Park, Elkhorn Slough.

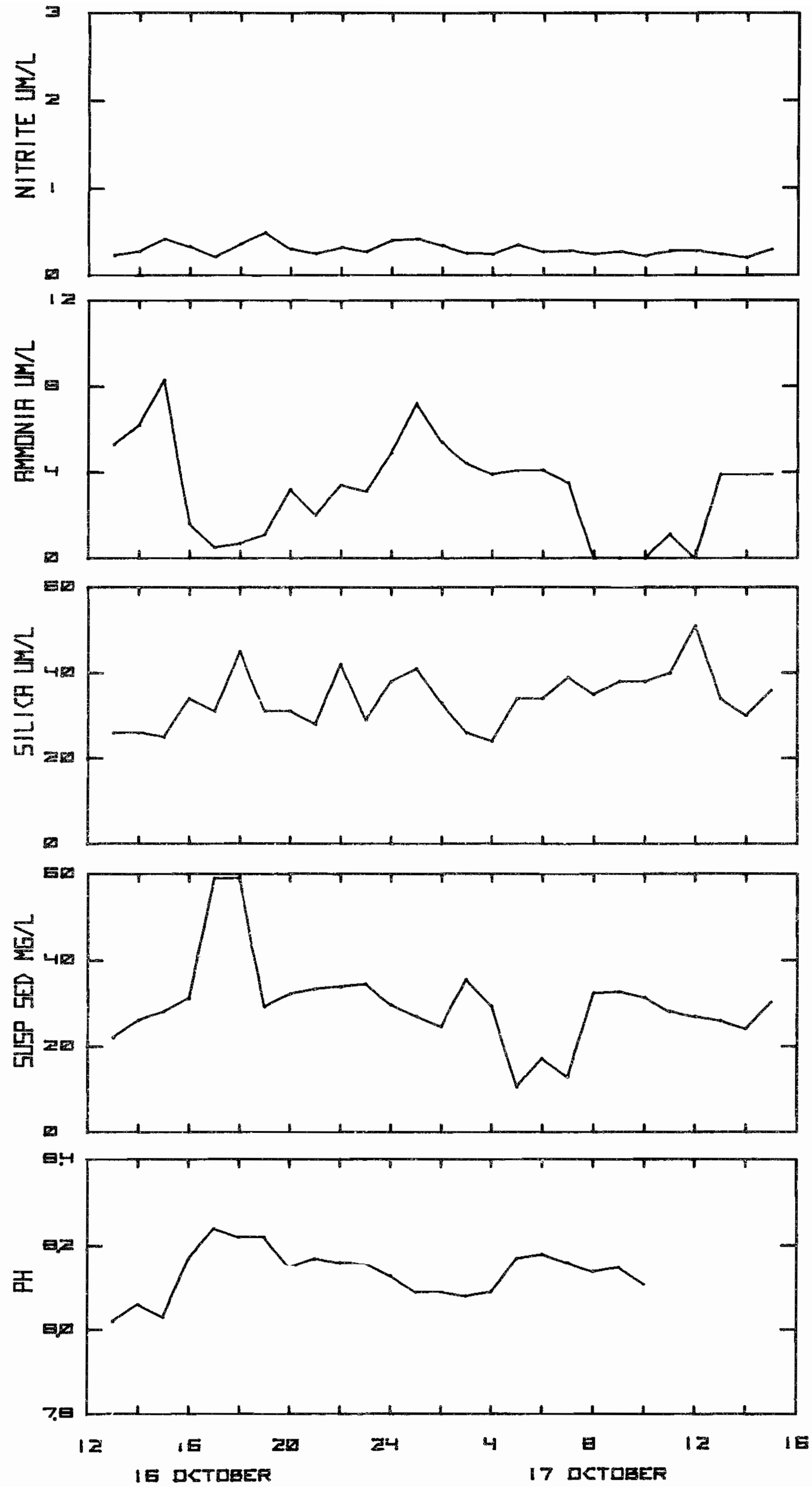


FIGURE 4. Time series study 16-17 October 1974. 1 m depth, Station 3, Kirby Park, Elkhorn Slough.

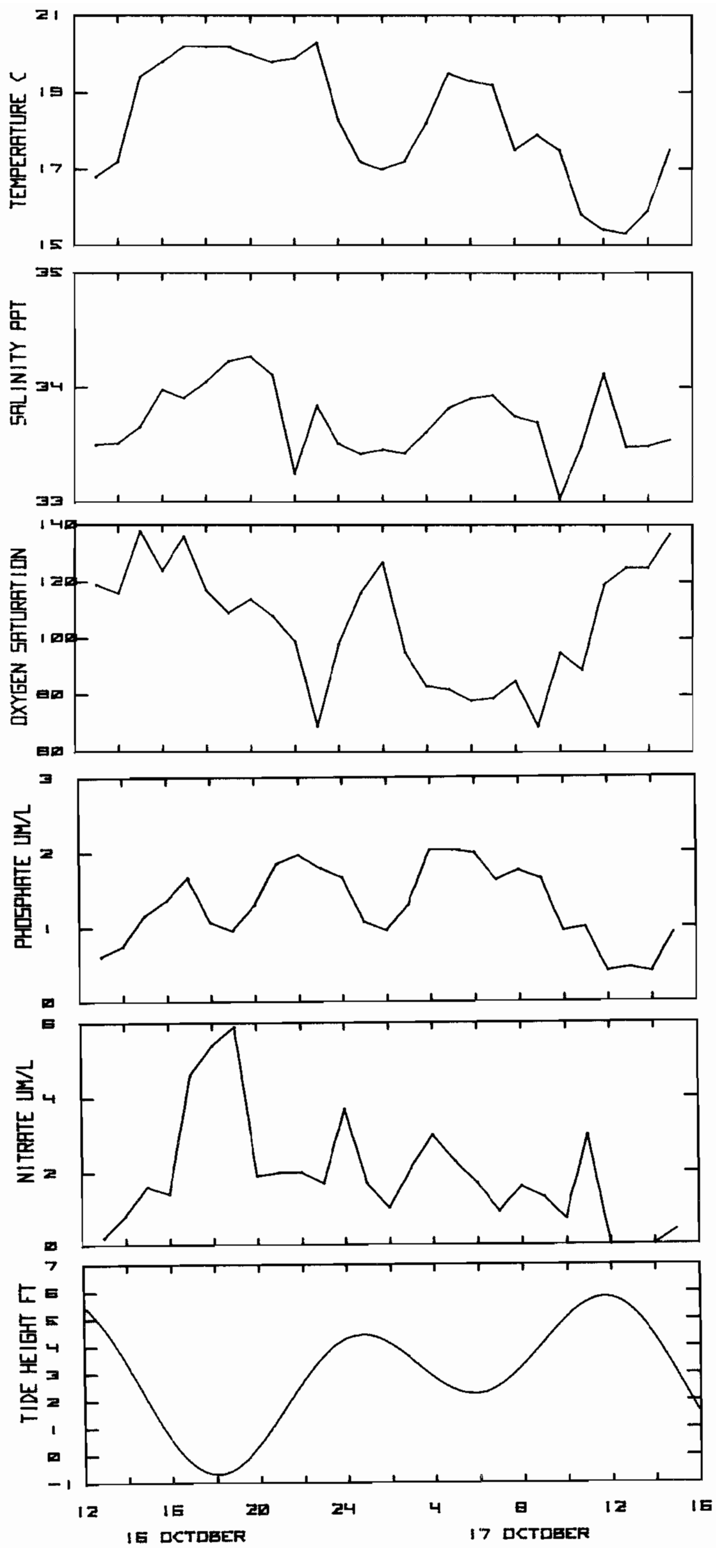


FIGURE 5. Time series study 16-17 October 1974. 1 m depth, Station 5, Oyster Farm, Elkhorn Slough.

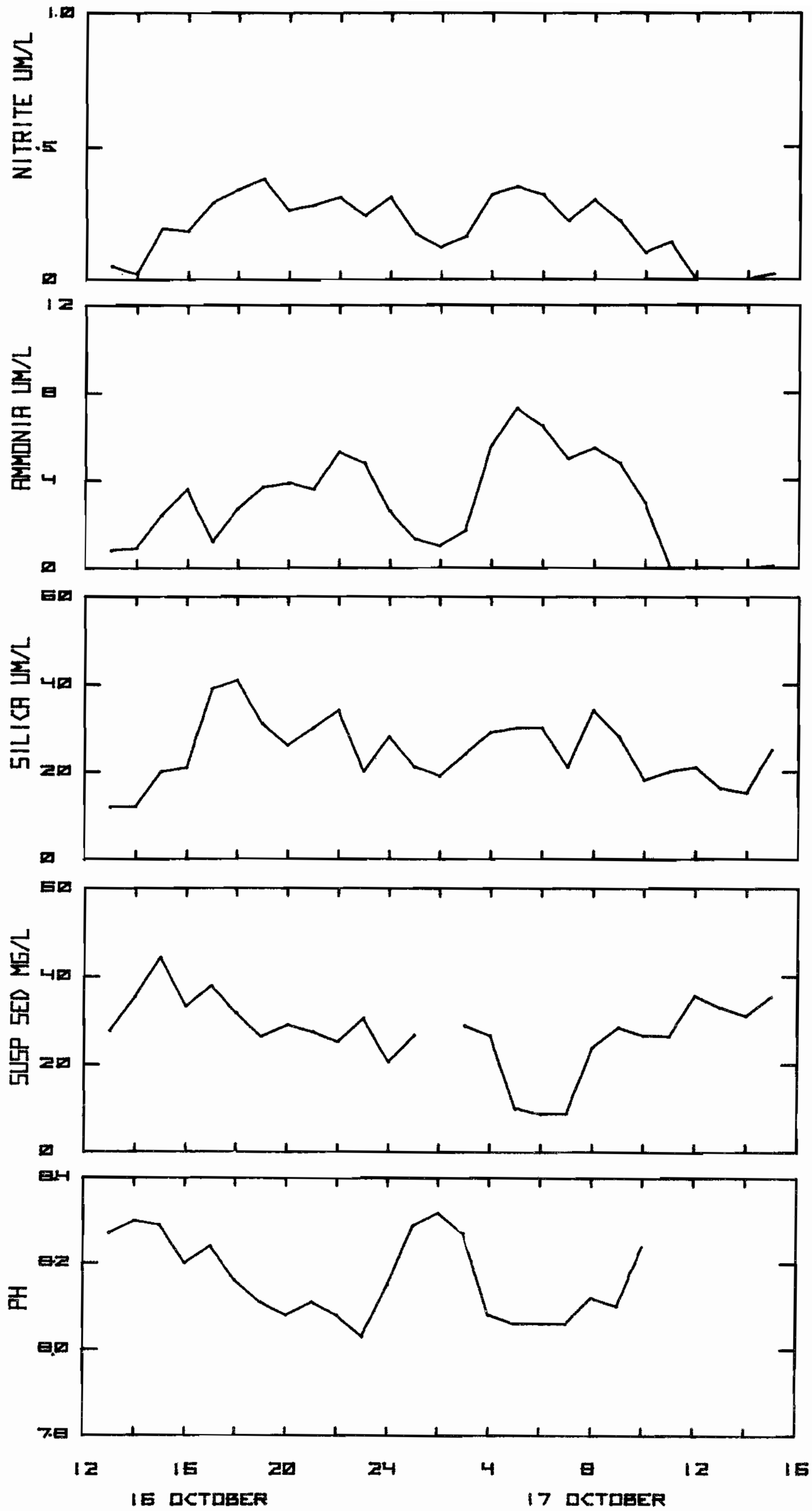
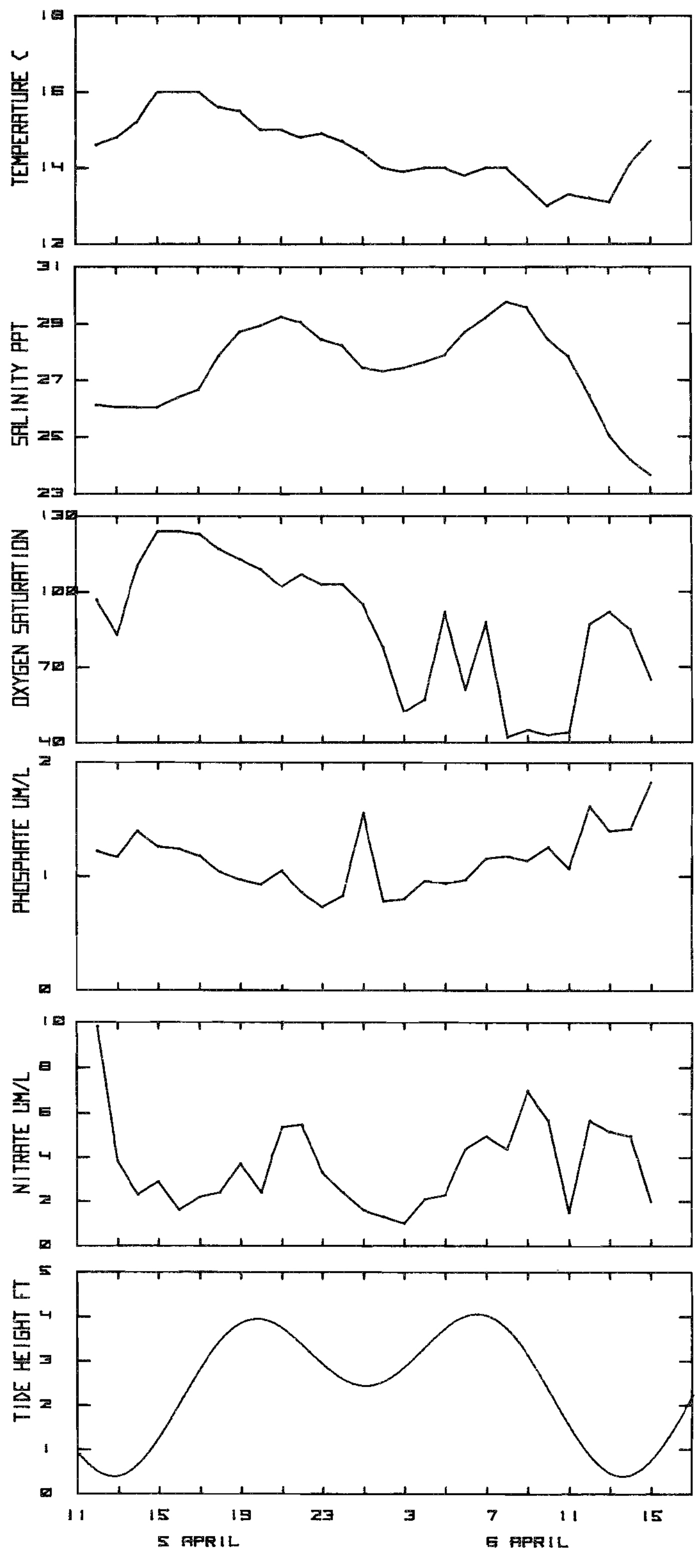


FIGURE 6. Time series study 16-17 October 1974. 1 m depth, Station 5, Oyster Farm, Elkhorn Slough



IGURE 7. Time series study 4-5 April 1975. 1 m depth, Station 3,

Kirby Park, Elkhorn Slough

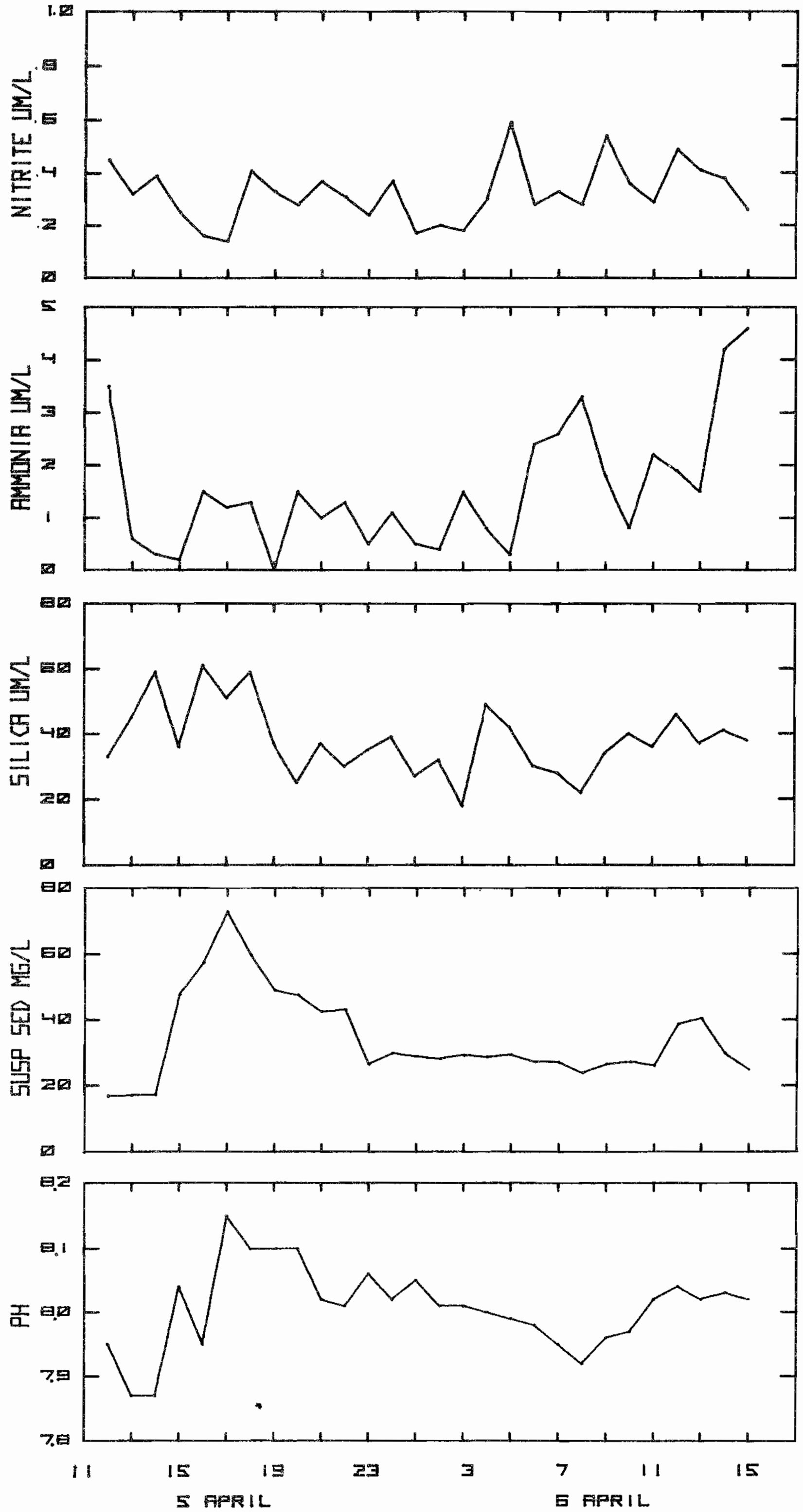


FIGURE 8. Time series study 4-5 April 1975. 1 m depth, Station 3, Kirby Park, Elkhorn Slough.

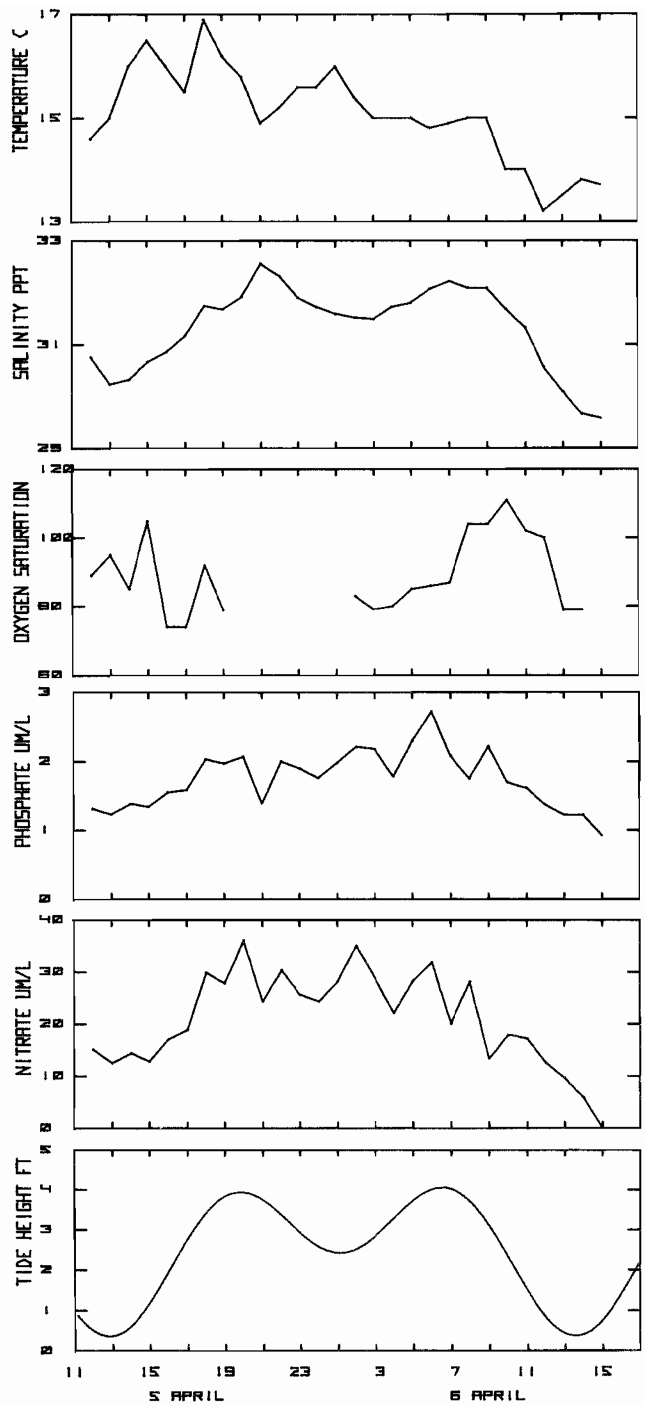


FIGURE 9. Time series study 4-5 April 1975. 1 m depth, Station 5, Oyster Farm, Elkhorn Slough.

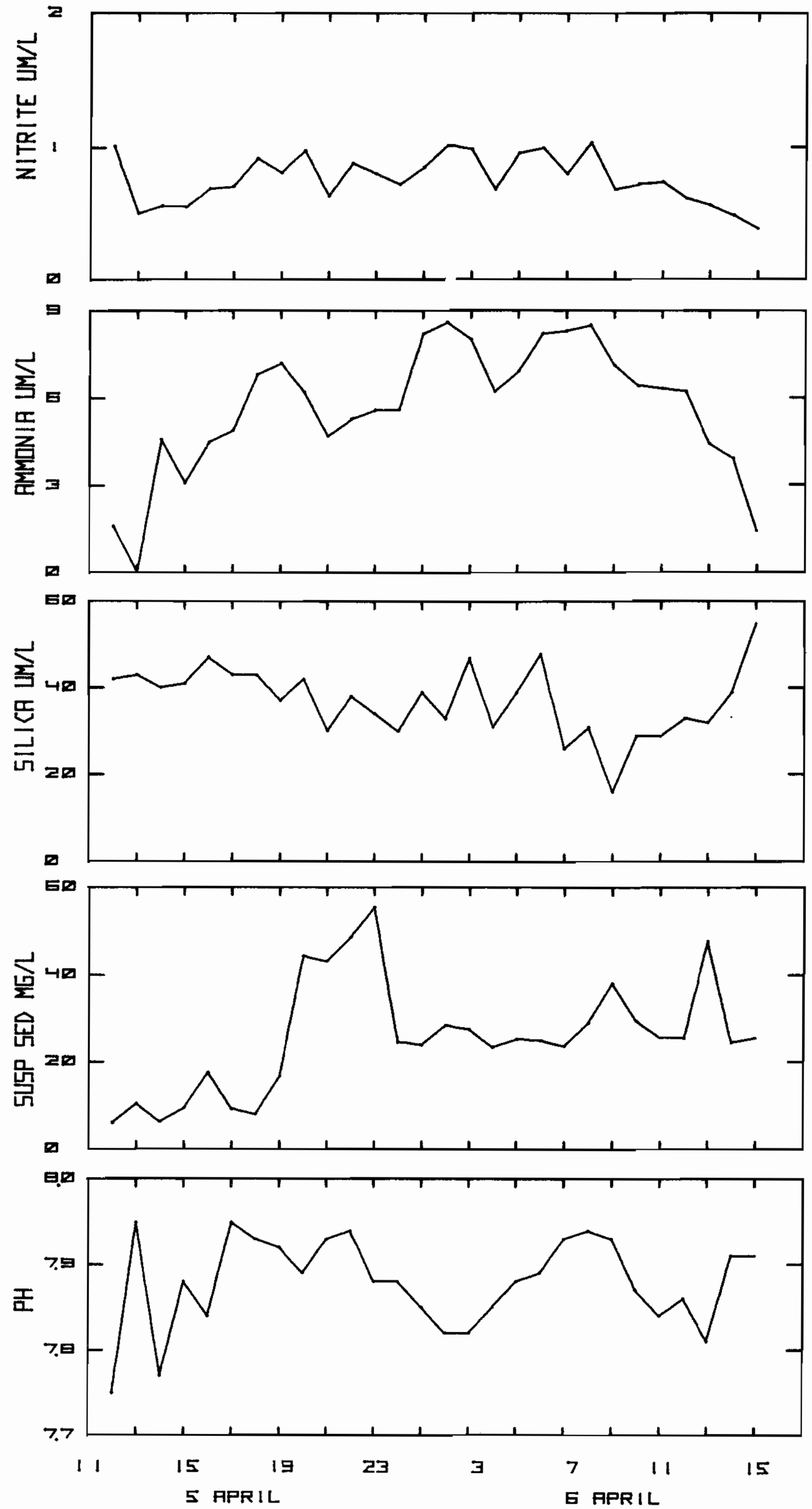


FIGURE 10. Time series study 4-5 April 1975. 1 m depth, Station 5, Oyster Farm, Elkhorn Slough.

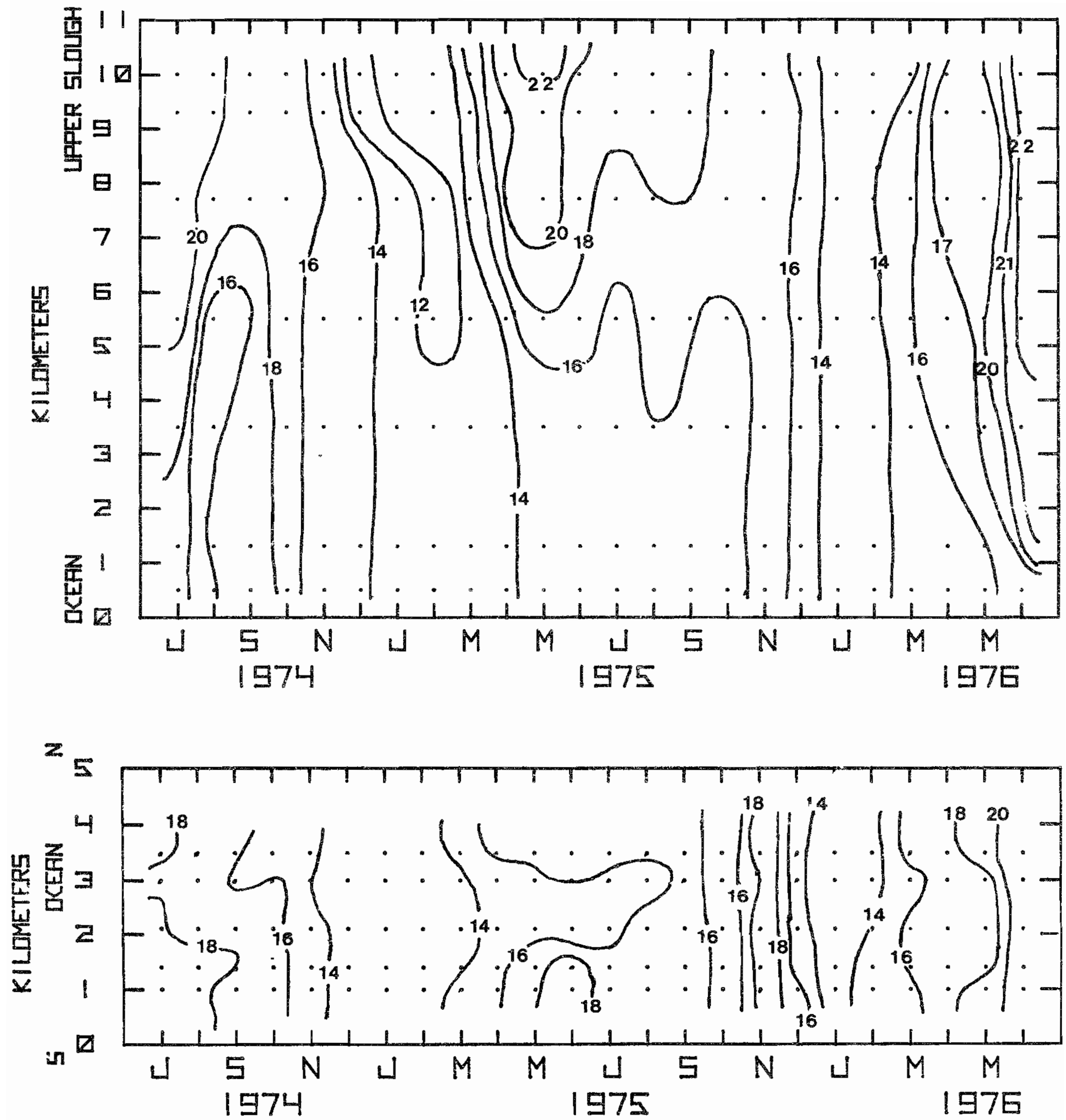


FIGURE 11. Temperature (°C) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

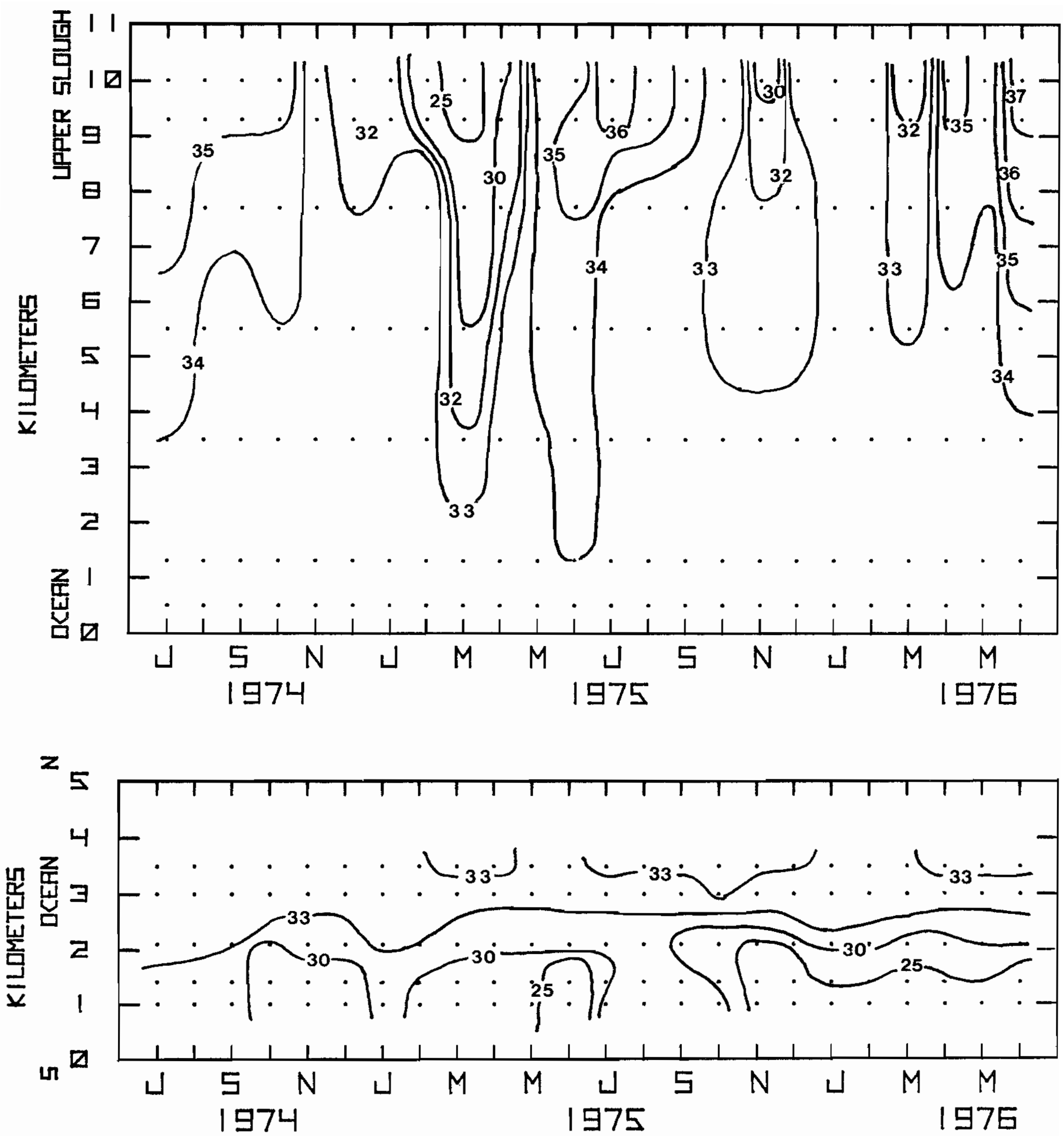
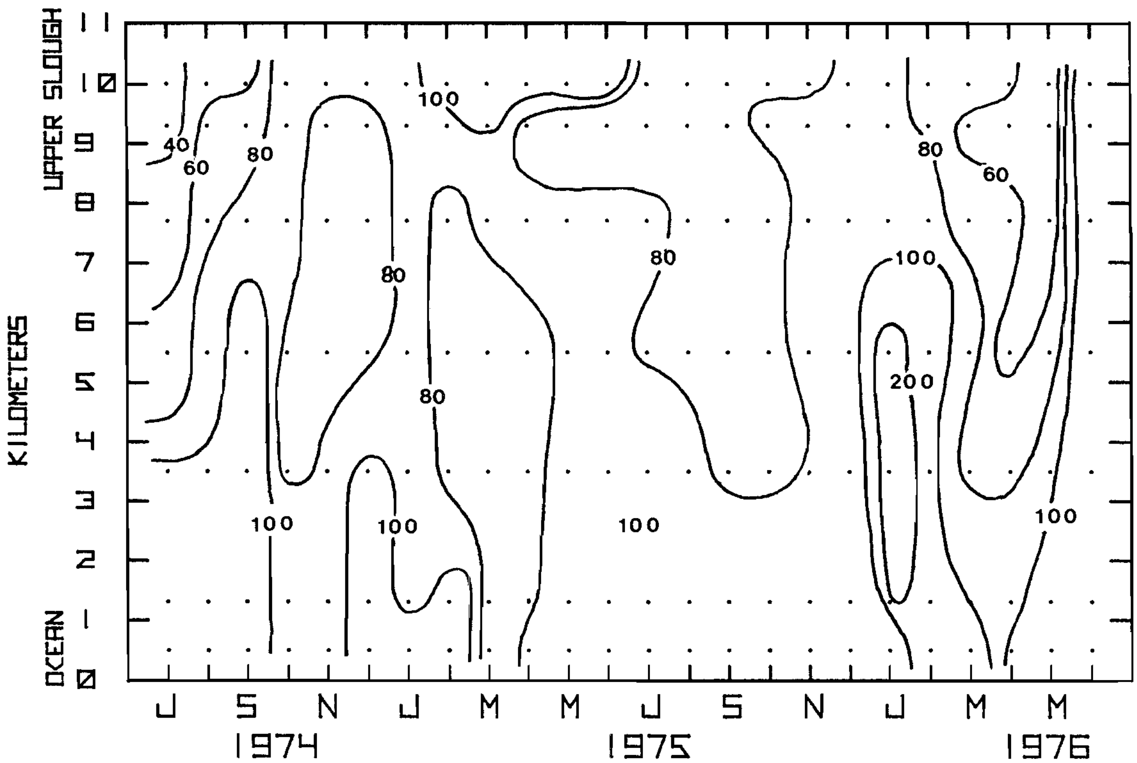


FIGURE 12. Salinity ($^{o}/oo$) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).



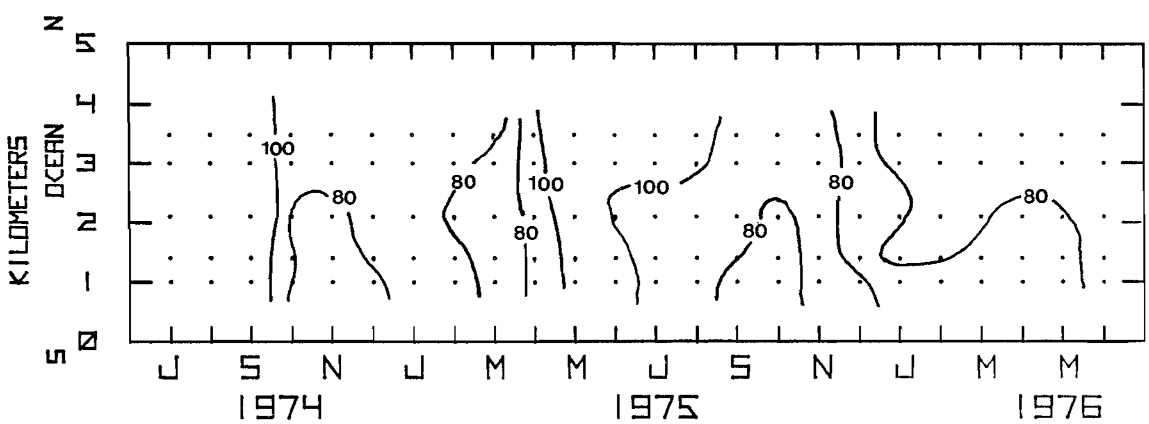


FIGURE 13. Dissolved oxygen (% saturation) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

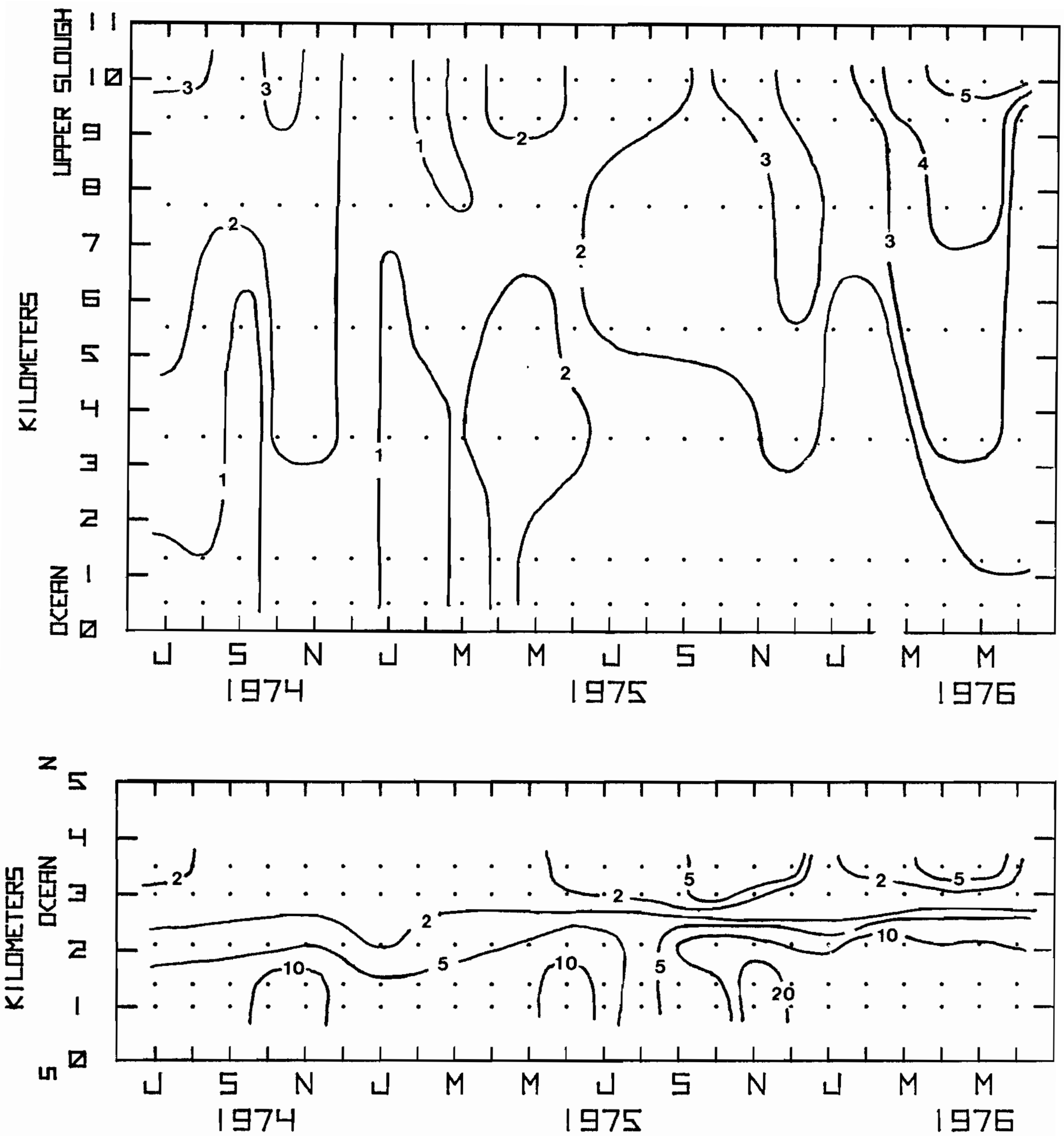


FIGURE 14. Phosphate (μ moles/liter) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

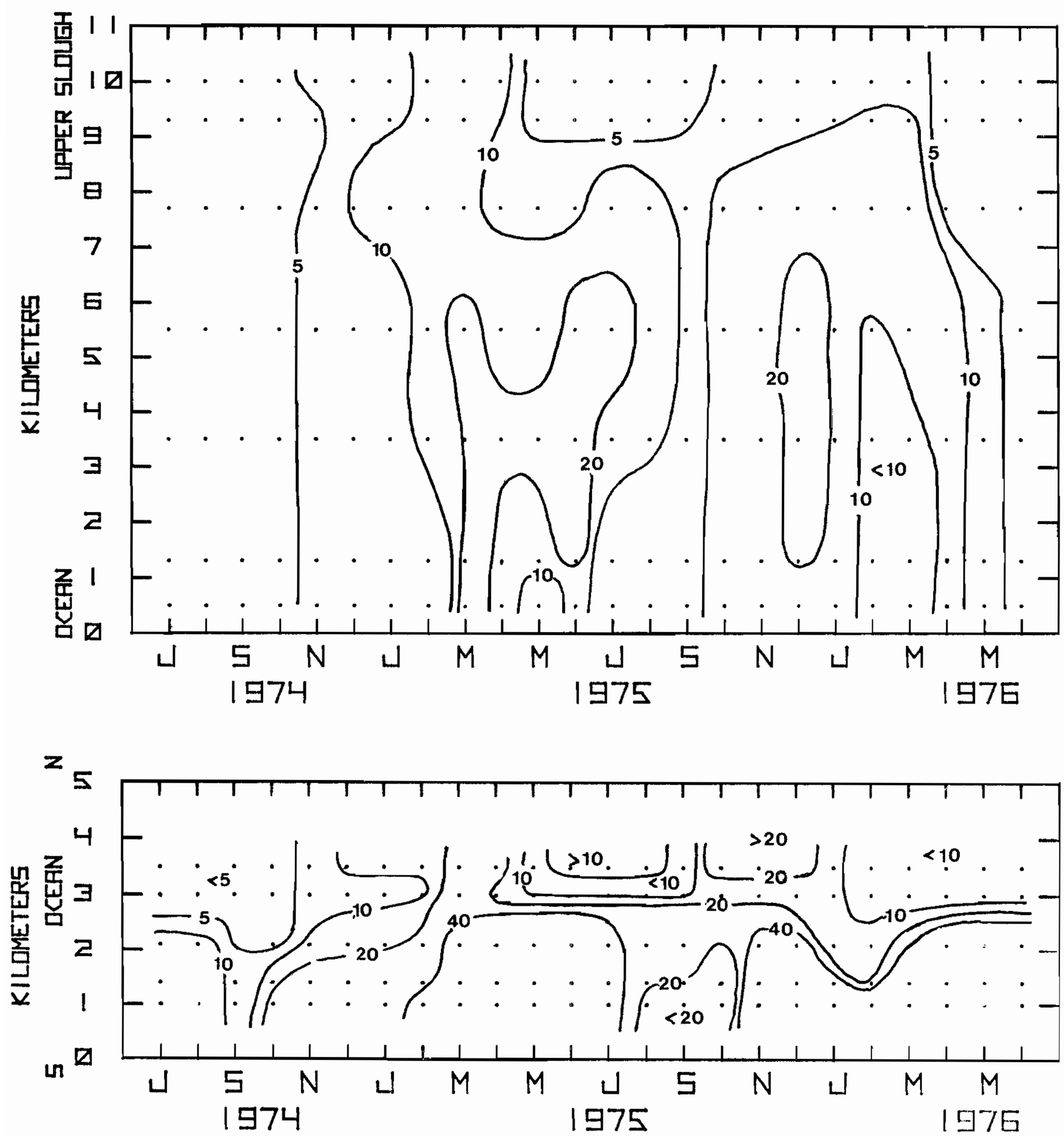


FIGURE 15. Nitrate (µ moles/liter) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

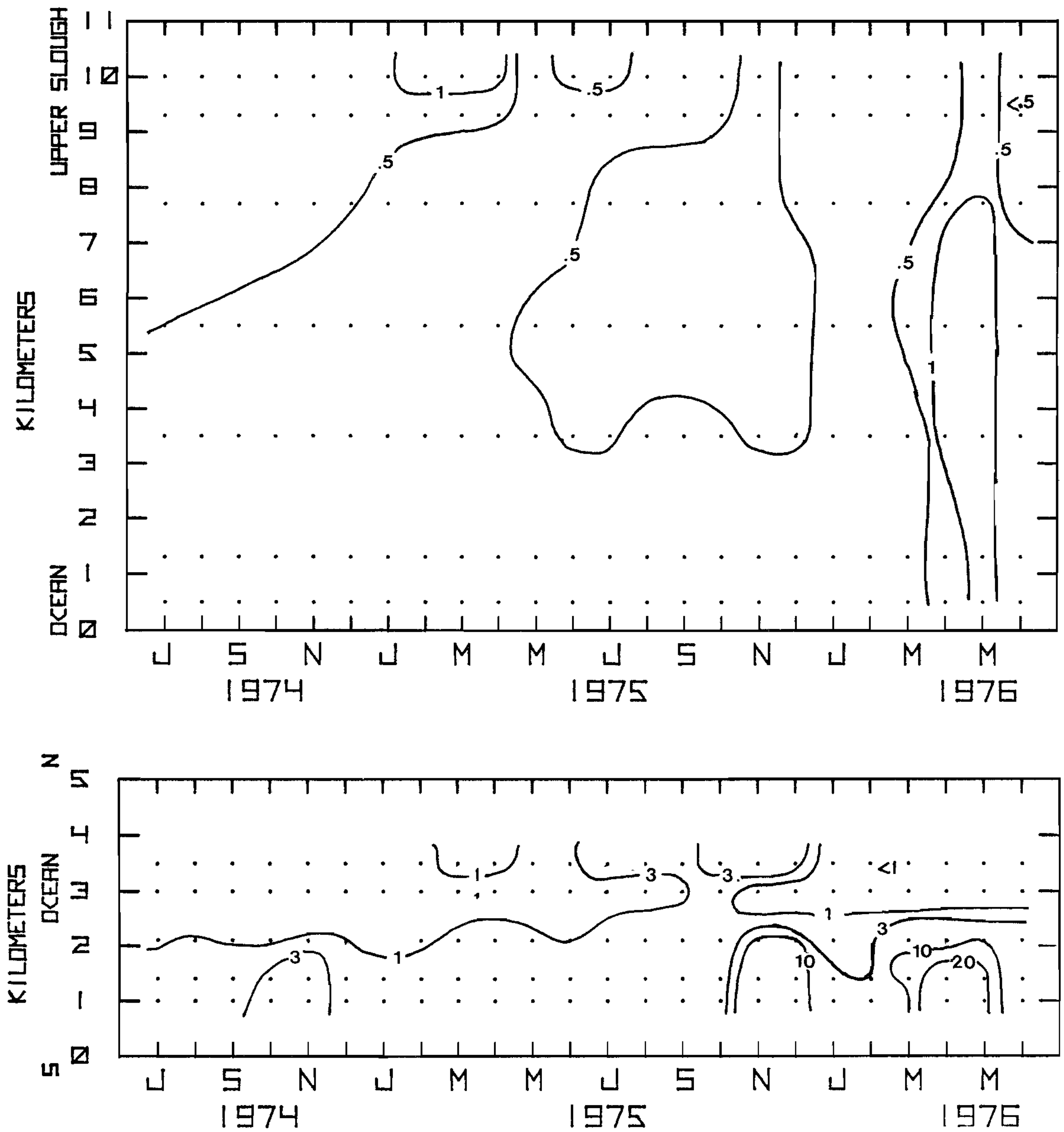


FIGURE 16. Nitrite (µ moles/liter) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

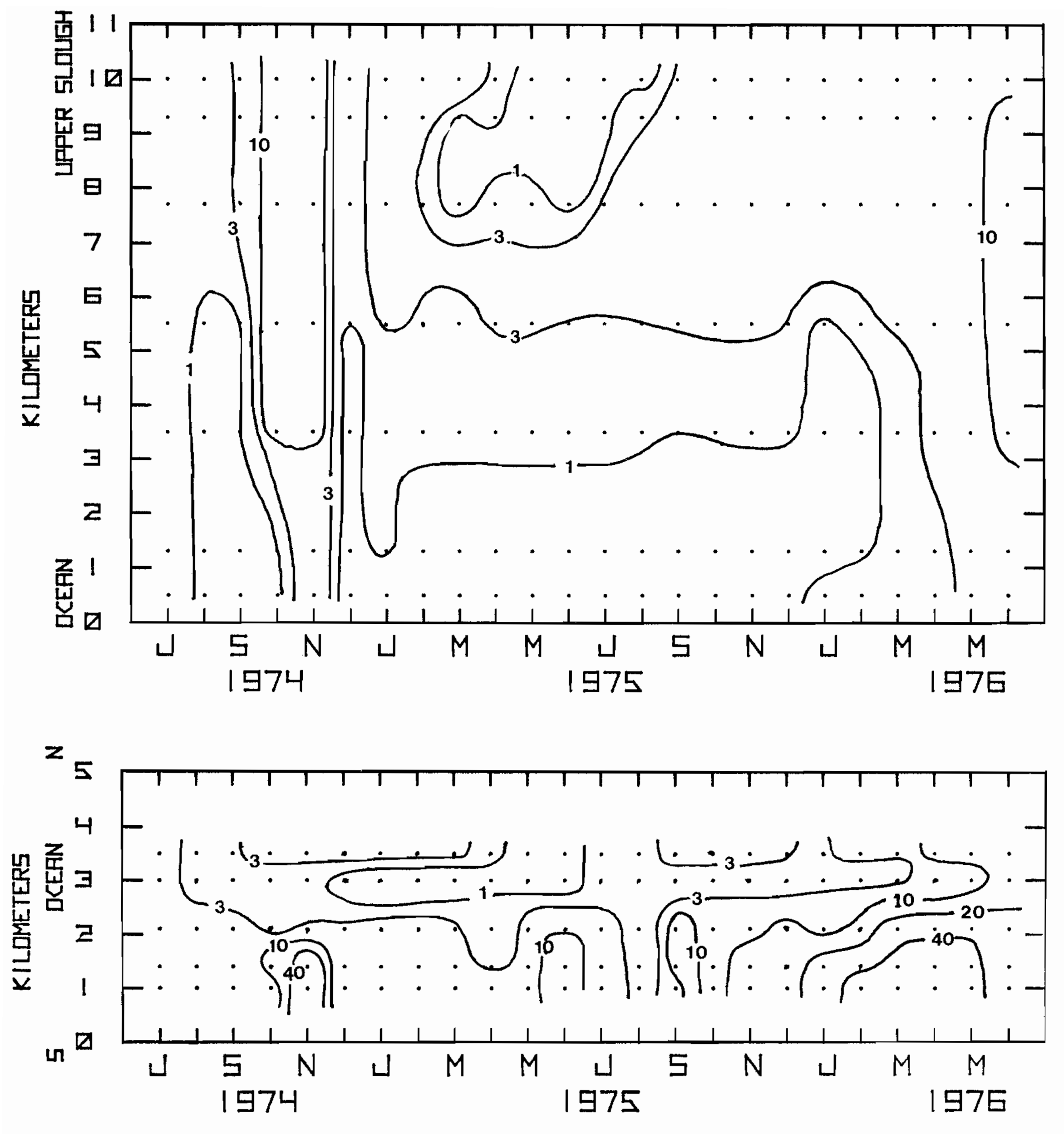


FIGURE 17. Ammonia (µ moles/liter) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

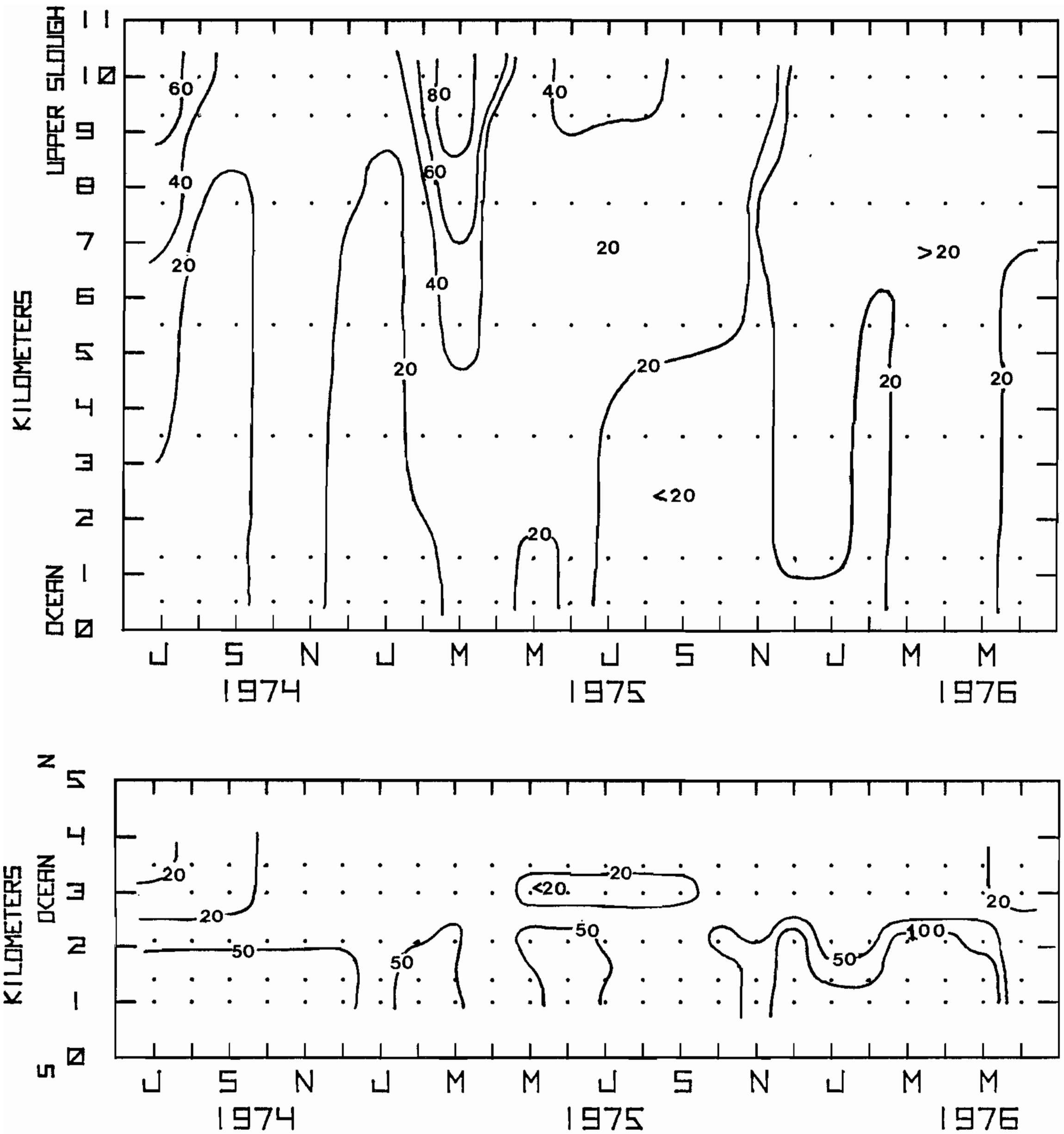


FIGURE 18. Silica (μ moles/liter) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

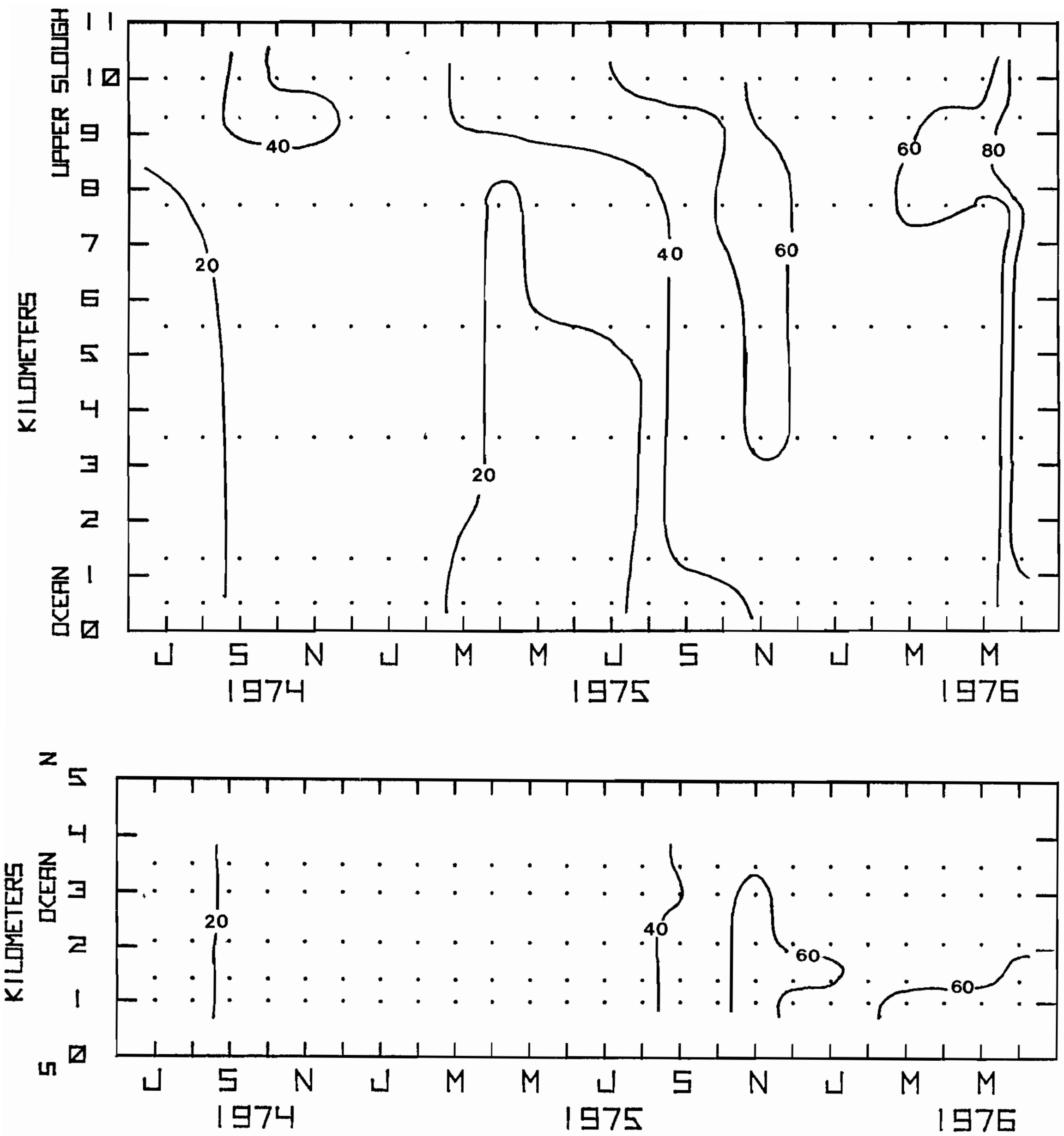


FIGURE 19. Suspended sediment (mg/liter) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

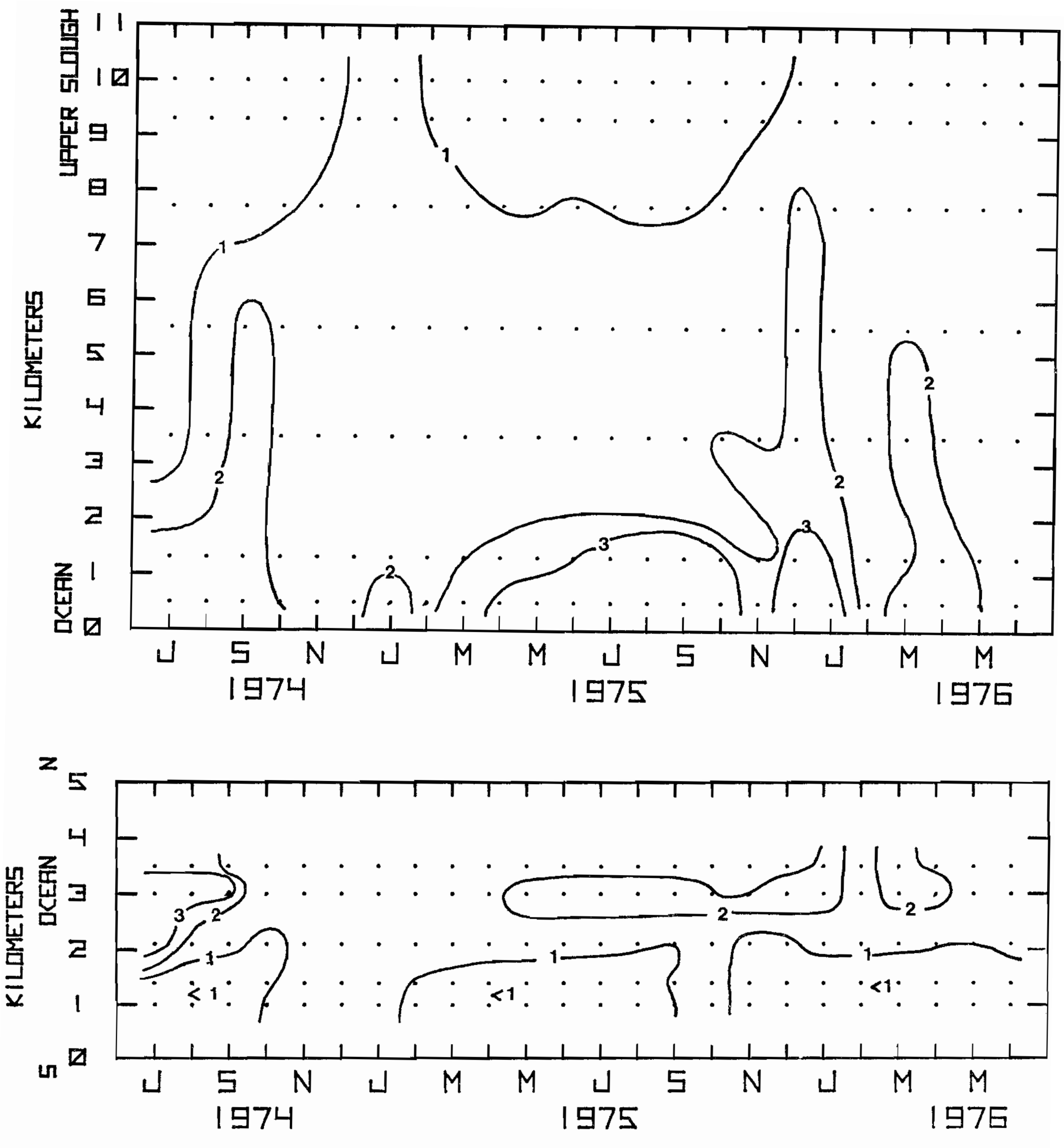


FIGURE 20. Secchi disk transparency (m) in Elkhorn Slough (upper) and Moss Landing Harbor (lower).

EXPLANATION OF APPENDICES

TIDE	
ht	Predicted high tide in feet at Monterey closest to sampling time.
time	Local time of predicted high tide at Monterey.
STN	Elkhorn Slough permanent station number.
TIME	Pacific Standard Time (+8) of sampling.
TEMP	*In situ* water temperature in degrees centigrade.
SALIN	Salinity in grams/kilogram (^{o}/oo or ppt).
OXYGEN	Dissolved oxygen utilization in ml(STP)/liter.
AOU	Apparent oxygen utilization in µg-atoms O_2-O/liter: the difference between the observed oxygen concentration and the oxygen solubility computed from the *in situ* temperature and salinity using the equations of Truesdale, *et al*. (1955).
SAT	Percent of oxygen saturation computed from the *in situ* temperature and salinity using the equations of Truesdale, *et al*., (1955).
PHOSPHATE	Concentration of reactive phosphate in µ moles PO_4-P/liter.
NITRATE	Concentration of dissolved nitrate in µ moles NO_3-N/liter.
NITRITE	Concentration of dissolved nitrite in µ moles NO_2-N/liter.
AMMONIA	Concentration of dissolved ammonia in µ moles NH_3-N/liter.
SILICA	Concentration of reactive silica in µ moles SiO_2-Si/liter.
SUSP SED	Suspended sediment concentration in mg/liter.
SECCHI	Secchi disk transparency in m.
pH	Seawater pH ($-\log A_{H+}$).
ALK	Seawater total alkalinity in m equivalents/liter.

Appendix 1. Time Series Studies Hydrographic Data Summaries 16 - 17 October 1974 Stations 3 and 5 and 4 - 5 April 1975 Stations 3 and 5.

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 16 OCT 1974   SAMPLING DEPTH 1.0 m   TIDE 1.8 ft 447 PST
5.8 ft 1110 PST
-.8 ft 1748 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
							ug-atoms/liter								
3	1300	18.8	33.758	4.39	70	85	2.41	1.2	.23	5.3	26	22.1		8.02	1.77
3	1400	18.7	33.690	4.26	82	82	2.78	1.8	.28	6.2	26	26.1		8.06	1.86
3	1500	20.0	34.035	4.69	32	93	2.42	2.2	.42	8.3	25	28.1		8.03	1.65
3	1600	21.6	34.458	6.57	-148	134	2.21	6.6	.33	1.6	34	31.2		8.17	1.95
3	1700	21.5	34.904	6.86	-175	140	2.21	1.9	.21	.5	31	60.6		8.24	1.70
3	1800	21.4	35.058	6.74	-164	138	2.92	2.8	.36	.7	45	63.6		8.22	
3	1900	21.6	35.089	6.65	-157	136	2.78	2.1	.49	1.1	31	29.2		8.22	1.99
3	2000	21.2	35.042	5.60	-60	114	2.39	2.2	.30	3.2	31	32.2		8.15	1.90
3	2100	21.0	35.012	6.23	-115	126	2.41	1.9	.25	2.0	28	33.4		8.17	1.67
3	2200	21.0	34.898	6.18	-110	125	2.76	2.7	.32	3.4	42	33.9		8.16	2.23
3	2300	20.8	34.276	6.04	-96	122	2.41	1.7	.27	3.1	29	34.5		8.16	1.77
3	2400	20.5	34.599	5.87	-78	118	2.59	2.5	.40	4.9	38	29.7		8.13	2.26

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 17 OCT 1974 SAMPLING DEPTH 1.0 m

TIDE
4.5 ft 39 PST
2.2 ft 529 PST
5.7 ft 1147 PST
-.7 ft 1833 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
							ug-atoms/liter								
3	100	20.2	34.330	5.18	-13	103	2.56	2.2	.42	7.2	41	27.0		8.09	
3	200	19.2	34.119	4.99	12	97	2.11	1.2	.34	5.4	33	24.6		8.09	2.16
3	300	19.5	34.262	5.02	6	99	1.79	1.4	.25	4.4	26	35.5		8.08	1.63
3	400	19.5	34.542	5.04	3	99	2.27	1.0	.24	3.9	24	29.4		8.09	1.78
3	500	19.7	34.627	4.98	7	98	2.54	1.5	.35	4.1	34	10.5		8.17	2.31
3	600	19.7	34.792	4.87	16	96	2.16	2.9	.27	4.1	34	17.2		8.18	1.73
3	700	19.5	34.785	4.93	13	97	2.03	1.4	.28	3.5	39	12.8		8.16	2.12
3	800	19.4	34.708	4.85	21	95	1.85	1.5	.24	.0	35	32.4		8.14	1.57
3	900	19.4	34.630	4.90	17	96	1.98	1.7	.27	.0	38	32.7		8.15	1.51
3	1000	19.4	34.434	4.76	30	93	1.94	1.9	.22	.0	38	31.4		8.11	1.32
3	1100	19.3	34.200	4.61	45	90	1.94	2.5	.28	1.1	40	28.1			2.08
3	1200	19.4	33.955	4.22	79	83	1.87	2.6	.28	.0	51	26.9			1.86
3	1300	18.9	33.733	4.48	61	87	1.64	3.4	.24	3.9	34	26.0			1.74
3	1400	18.8	33.625	5.60	-37	108	1.43	2.3	.20	3.9	30	24.1			2.14
3	1500	19.8	33.829	4.61	42	91	1.68	2.9	.30	3.9	36	30.3			

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 16 OCT 1974 SAMPLING DEPTH 1.0 m TIDE 1.8 ft 447 PST
5.8 ft 1110 PST
-.8 ft 1748 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
							ug-atoms/liter								
5	1300	16.8	33.499	6.42	-92	119	.61	.2	.05	.8	12	27.7		8.27	1.57
5	1400	17.2	33.510	6.21	-77	116	.75	.8	.02	.9	12	35.3		8.30	1.51
5	1500	19.4	33.655	7.08	-174	138	1.16	1.6	.19	2.4	20	44.3		8.29	1.69
5	1600	19.8	33.978	6.29	-108	124	1.36	1.4	.18	3.6	21	33.2		8.20	1.91
5	1700	20.2	33.907	6.84	-160	136	1.67	4.6	.29	1.2	39	37.8		8.24	2.02
5	1800	20.2	34.048	5.91	-77	117	1.07	5.4	.34	2.7	41	31.7		8.16	
5	1900	20.2	34.228	5.48	-39	109	.96	9.7	.38	3.7	31	26.4		8.11	
5	2000	20.0	34.272	5.77	-64	114	1.30	1.9	.26	3.9	26	29.0		8.08	1.63
5	2100	19.8	34.111	5.48	-36	108	1.85	2.0	.28	3.6	30	27.4		8.11	1.81
5	2200	19.9	33.246	5.02	6	99	1.97	2.0	.31	5.3	34	25.2		8.08	1.90
5	2300	20.3	33.842	3.48	138	69	1.79	1.7	.24	4.8	20	30.5		8.03	
5	2400	18.3	33.509	5.14	8	98	1.67	3.7	.31	2.6	28	20.6		8.15	2.22

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 17 OCT 1974 SAMPLING DEPTH 1.0 m TIDE 4.5 ft 39 PST
2.2 ft 529 PST
5.7 ft 1147 PST
-.7 ft 1833 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
							ug-atoms/liter								
5	100	17.2	33.420	5.09	-74	116	1.07	1.7	.17	1.3	21	26.7		8.29	
5	200	17.0	33.456	6.81	-129	127	.96	1.0	.12	1.0	19			8.32	1.69
5	300	17.2	33.424	5.09	22	95	1.30	2.1	.16	1.7	24	28.8		8.27	1.92
5	400	18.2	33.608	4.35	79	83	2.03	3.0	.32	5.6	29	26.6		8.08	1.99
5	500	19.5	33.818	4.19	82	82	2.03	2.3	.35	7.3	30	9.9		8.06	
5	600	19.3	33.903	3.98	102	78	1.99	1.7	.32	6.5	30	8.7		8.06	1.88
5	700	19.2	33.932	4.03	98	79	1.63	.9	.22	5.0	21	8.8		8.06	1.46
5	800	17.5	33.745	4.49	72	85	1.76	1.6	.30	5.5	34	24.0		8.12	2.15
5	900	17.9	33.693	3.62	146	69	1.65	1.3	.22	4.8	28	28.4		8.10	1.57
5	1000	17.5	33.024	5.05	24	95	.95	.7	.10	3.0	18	26.6		8.24	1.32
5	1100	15.8	33.486	4.86	55	89	1.00	3.0	.14	.0	20	26.4			1.65
5	1200	15.4	34.119	6.54	-92	119	.41	.0	.00	.0	21	35.6			1.72
5	1300	15.3	33.478	6.91	-122	125	.45	.0	.00	.0	16	32.9			1.37
5	1400	15.9	33.485	6.83	-120	125	.40	.0	.00	.0	15	31.0			1.42
5	1500	17.5	33.539	7.26	-174	137	.92	.4	.02	.1	25	35.5			2.01

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 16 OCT 1974 SAMPLING DEPTH Bottom TIDE 1.8 ft 447 PST
5.8 ft 1110 PST
-.8 ft 1748 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
5	1300		33.501	6.28			.74	.3	.02	.4	17	24.2		8.27	2.09
5	1400	15.8	33.493	6.69	-107	122	1.05	.4	.03	.9	14	35.3		8.31	1.65
5	1500	17.4	33.678	5.90	-52	111	1.12	1.8	.16	2.9	17	35.2		8.22	1.90
5	1600	18.8	33.773	5.54	-32	107	1.35	1.9	.19	4.8	25	56.4		8.14	1.91
5	1700	19.2	33.978	5.85	-64	114	1.13	3.7	.34	2.7	38	40.5		8.16	2.19
5	1800	20.1	34.186	7.25	-197	144	.91	3.8	.38	3.4	34	31.5		8.12	
5	1900	20.2	34.269	5.52	-43	110	.95	2.8	.39	4.0	45	29.8		8.11	2.29
5	2000	20.3	34.235				2.23	2.5	.37	5.0	30			8.08	2.01
5	2100	20.0	34.067	5.32	-25	106	1.69	1.5	.19	3.7	20	28.1		8.09	1.42
5	2200	19.8	33.945	4.83	22	95	2.01	2.0	.31	5.7	33	30.5		8.07	1.96
5	2300	20.1	33.818	4.35	62	86	1.81	1.9	.25	5.2	19	32.7		8.05	
5	2400	17.8	33.376	5.87	-52	111	1.13	2.2	.18	1.0	20	27.5		8.25	1.59

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 17 OCT 1974 SAMPLING DEPTH Bottom

TIDE
4.5 ft 39 PST
2.2 ft 529 PST
5.7 ft 1147 PST
-.7 ft 1833 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
							ug-atoms/liter								
5	100	17.0	33.427	7.11	-156	133	.91	1.2	.12	.0	21	26.7		8.37	1.84
5	200	17.3	33.453	6.95	-144	130	.95	1.1	.11	1.2	18	20.7		8.36	1.57
5	300	17.0	33.424	5.88	-46	110	1.32	1.9	.21	2.2	23	27.0		8.27	1.90
5	400	18.2	33.677	4.08	103	78	1.88	2.4	.33	5.6	26	30.6		8.04	1.96
5	500	19.3	33.845	3.96	104	77	2.19	2.6	.40	8.4	38	12.5		8.06	2.10
5	600	19.0	33.940	4.13	91	80	1.64	1.3	.27	5.3	30	9.8		8.07	1.72
5	700	19.2	33.921	4.00	101	78	2.10	2.1	.35	7.4	34	10.4		8.06	2.15
5	800	18.0	33.750	4.83	37	92	1.43	.8	.14	5.1	26	14.6		8.08	1.39
5	900	17.5	33.571	4.42	79	83	1.33	1.1	.19	4.0	27	26.8		8.15	1.63
5	1000	17.3	33.424	5.00	29	94	1.16	1.3	.14	3.2	24	27.4		8.24	1.65
5	1100	15.9	33.446	5.35	11	98	.74	.0	.03	.0	17	35.7			1.55
5	1200	15.2	33.468	6.57	-90	118	.41	.0	.00	.0	16	34.3			1.42
5	1300	15.3	33.475	6.85	-116	124	.62	.0	.02	.0	18	31.7			1.29
5	1400	16.0	33.483	7.04	-140	129	.44	.0	.00	.0	22	30.6			1.68
5	1500	17.7	33.541	7.35	-184	139	.79	1.2	.03	.0	26	37.8			2.36

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 4 APR 1975   SAMPLING DEPTH 1.0 m   TIDE 4.2 ft 537 PST
.3 ft 1229 PST
4.0 ft 1936 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
3	1200	14.6	26.132	5.69	18	97	1.22	9.8	.45	3.5	33	16.8	.6	7.95	1.97
3	1300	14.8	26.043	4.87	90	83	1.17	3.8	.32	.6	45	17.0	.6	7.87	2.01
3	1400	15.2	26.032	6.40	-50	110	1.40	2.3	.39	.3	59	17.2	.7	7.87	2.44
3	1500	16.0	26.043	7.09	-120	124	1.26	2.9	.25	.2	36	47.6	.5	8.04	2.65
3	1600	16.0	26.386	7.10	-122	124	1.24	1.6	.16	1.5	61	57.2	.5	7.95	
3	1700	16.0	26.674	7.04	-188	123	1.18	2.2	.14	1.2	51	72.8	.5	8.15	2.54
3	1800	15.6	27.863	6.71	-88	117	1.04	2.4	.41	1.3	59	59.6	.5	8.10	2.14
3	1900	15.5	28.708	6.43	-65	113	.97	3.7	.33	.0	37	48.9	.7	8.10	1.81
3	2000	15.0	28.929	6.24	-44	109	.93	2.4	.28	1.5	25	47.5		8.10	
3	2100	15.0	29.246	5.83	-8	102	1.05	5.4	.37	1.0	37	42.4		8.02	1.82
3	2200	14.8	29.052	6.17	-36	107	.86	5.5	.31	1.3	30	43.1		8.01	1.56
3	2300	14.9	28.449	5.94	-14	103	.73	3.3	.24	.5	35	26.4		8.06	1.64
3	2400	14.7	28.240	5.98	-15	103	.83	2.4	.37	1.1	39	29.8		8.02	

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 5 APR 1975 SAMPLING DEPTH 1.0 m

TIDE		
	2.5 ft	54 PST
	4.1 ft	646 PST
	.4 ft	1322 PST
	4.2 ft	2017 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
							ug-atoms/liter								
3	100	14.4	27.438	5.55	28	95	1.56	1.6	.17	.5	27	28.8		8.05	1.42
3	200	14.0	27.324	4.64	114	78	.78	1.3	.20	.4	32	28.1		8.01	1.66
3	300	13.9	27.436	3.09	253	52	.80	1.0	.18	1.5	18	29.2		8.01	1.42
3	400	14.0	27.640	3.38	229	57	.96	2.1	.30	.8	49	28.6		8.00	2.64
3	500	14.0	27.885	5.43	42	92	.94	2.3	.59	.3	42	29.3		7.99	2.02
3	600	13.8	28.694	3.57	207	61	.97	4.4	.28	2.4	30	27.2		7.98	1.64
3	700	14.0	29.209	5.16	61	88	1.16	5.0	.33	2.6	28	27.0		7.95	1.76
3	800	14.0	29.776	2.47	300	42	1.18	4.4	.28	3.3	22	23.8		7.92	1.42
3	900	13.5	29.585	2.67	288	45	1.14	7.0	.54	1.8	34	26.4		7.96	2.03
3	1000	13.0	28.473	2.58	305	43	1.26	5.7	.36	.8	40	27.2		7.97	2.27
3	1100	13.3	27.849	2.62	301	44	1.07	1.5	.29	2.2	36	26.0		8.02	2.01
3	1200	13.2	26.473	5.29	68	87	1.62	5.7	.49	1.9	46	38.6		8.04	2.17
3	1300	13.1	25.031	5.63	44	92	1.40	5.2	.41	1.5	37	40.4		8.02	1.78
3	1400	14.1	24.199	5.14	79	85	1.42	5.0	.38	4.2	41	29.7		8.03	1.86
3	1500	14.7	23.659	3.90	185	65	1.83	2.0	.26	4.6	38	24.9		8.02	1.89

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 4 APR 1975 SAMPLING DEPTH 1.0 m TIDE 4.2 ft 537 PST
.3 ft 1229 PST
4.0 ft 1936 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
							ug-atoms/liter								
5	1200	14.6	30.753	5.11	54	89	1.31	15.1	1.01	1.6	42	6.0		7.75	2.09
5	1300	15.0	30.235	5.41	25	95	1.23	12.5	.50	.0	43	10.4		7.95	2.15
5	1400	16.0	30.330	4.75	74	85	1.38	14.4	.56	4.6	40	6.2		7.77	2.06
5	1500	16.5	30.667	5.80	-25	105	1.34	12.8	.55	3.1	41	9.4		7.88	2.07
5	1600	16.0	30.861	4.09	131	74	1.55	17.1	.69	4.5	47	17.6		7.84	2.45
5	1700	15.5	31.176	4.14	130	74	1.59	18.9	.71	4.9	43	9.1		7.95	2.36
5	1800	16.9	31.743	4.97	41	92	2.03	29.9	.92	6.8	43	8.0		7.93	2.16
5	1900	16.2	31.678	4.34	104	79	1.97	27.8	.81	7.2	37	16.7		7.92	1.80
5	2000	15.8	31.919				2.07	36.1	4.98	6.2	42	44.3		7.89	2.29
5	2100	14.9	32.559				1.38	24.3	.63	4.7	30	43.1		7.93	1.59
5	2200	15.2	32.320				2.00	30.4	.88	5.3	38	48.6		7.94	2.06
5	2300	15.6	31.901				1.90	25.6	.80	5.6	34	55.4		7.88	1.67
5	2400	15.6	31.721				1.76	24.3	.72	5.6	30	24.6		7.87	1.65

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 5 APR 1975 SAMPLING DEPTH 1.0 m TIDE

2.5 ft	54 PST
4.1 ft	646 PST
.4 ft	1322 PST
4.2 ft	2017 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m	pH	ALK meq/l
5	100	16.0	31.590				1.98	28.2	.85	8.2	39	24.0		7.85	1.97
5	200	15.4	31.519	4.62	87	83	2.21	35.1	1.02	8.6	33	28.5		7.82	2.42
5	300	15.0	31.488	4.43	108	79	2.18	28.8	.99	8.0	47	27.6		7.82	2.37
5	400	15.0	31.729	4.50	101	80	1.78	22.1	.68	6.2	31	23.4		7.85	1.63
5	500	15.0	31.807	4.77	77	85	2.30	28.3	.96	6.9	39	25.3		7.88	2.15
5	600	14.8	32.075	4.85	71	86	2.72	31.9	1.00	8.2	48	25.0		7.89	2.36
5	700	14.9	32.255	4.92	63	87	2.08	20.1	.80	8.3	26	23.7		7.93	1.89
5	800	15.0	32.093	5.84	-19	104	1.75	28.2	1.04	8.5	31	29.0		7.94	1.91
5	900	15.0	32.090	5.84	-19	104	2.22	13.4	.68	7.1	16	38.0		7.93	2.17
5	1000	14.0	31.680	6.40	-57	111	1.69	17.9	.72	6.4	29	29.5		7.87	1.79
5	1100	14.0	31.329	5.90	-11	102	1.61	17.2	.74	6.3	29	25.7		7.84	1.89
5	1200	13.2	30.571	5.92	-2	100	1.37	12.6	.61	6.2	33	25.5		7.86	1.89
5	1300	13.5	30.099	4.63	111	79	1.22	9.6	.56	4.4	32	47.7		7.81	1.93
5	1400	13.8	29.661	4.62	110	79	1.22	5.9	.48	3.9	39	24.5		7.91	1.92
5	1500	13.7	29.580				.92	.0	.38	1.4	55	25.6		7.91	1.60

Appendix 2. Monthly Hydrographic Data Summaries: Elkhorn Slough and Moss Landing Harbor July 1974 to June 1976.

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 7 JUL 1974 SAMPLING DEPTH 1.0 m TIDE 4.0 ft 1115 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1122	21.2	35.385	1.55	299	32	3.29	.0	.70	3.1	69	22.8	.4
2	1133	21.1	35.891	1.72	283	35	2.40	.0	.53	1.3	75	26.2	.4
3	1217	22.0	35.577	2.16	238	45	2.38	1.0	.62	3.8	49	17.8	.5
4	1233	20.5	34.646	3.12	167	63	2.10	1.5	.51	7.5	34	10.6	.6
5	1248	19.3	33.990	5.22	-8	102	1.90	3.7	.39	5.6	26	9.1	.6
6	1302	17.1	33.613	6.57	-109	123	.73	1.0	.15	2.8	10	6.2	2.2
7	1317	19.1	33.682	6.03	-78	117	2.45	4.0	.26	4.0	29	7.6	2.4
8	1311	16.9	33.581	6.65	-106	122	.92	2.3	.69	3.0	9	4.3	4.0
9	1331	18.0	33.682	5.73	-39	108	3.22	13.0	.72	5.0	31	6.5	4.9
10	1349	19.5	30.989	6.56	120	126	5.38	19.4	2.65	4.7	61	7.4	.5
11	1345	18.7	31.841	5.93	-60	113	4.52	17.1	1.74	4.8	48	12.3	.6

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 19 AUG 1974 SAMPLING DEPTH 1.0 m TIDE 5.4 ft 1250 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1243	21.0	35.807	2.76	192	56	2.86	1.3	.71	.0	53	25.0	.3
2	1250	21.0	35.548	3.09	163	63	2.83	1.4	.72	.0	37	22.4	.4
3	1312	19.8	34.570	3.23	163	64	2.56	2.0	.61	2.2	27	28.0	.6
4	1321	16.5	33.778	4.79	54	89	1.57	5.8	.35	.7	15	9.5	1.8
5	1333	16.5	33.650	5.47	-5	101	1.23	6.9	.28	.0	11	6.8	2.3
6	1342	15.9	33.631	5.39	7	99	1.05	6.1	.28	.0	11	4.3	4.2
7	1356	16.8	33.695	5.32	4	99	1.88	4.2	.33	1.2	13	5.2	2.6
8	1350	16.0	33.610	5.53	-6	101	.95	5.4	.32	.0	12	3.3	5.7
9	1422	17.5	32.915	4.96	33	93	2.93	10.7	1.14	3.9	26	7.1	1.5
10	1439	19.0	31.466	5.68	-39	109	5.12	32.7	7.63	5.2	51	7.2	.9
11	1434	18.0	32.908	5.35	-6	101	3.92	12.0	1.09	3.6	29	9.8	.7

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 17 SEP 1974 SAMPLING DEPTH 1.0 m TIDE 5.4 ft 1205 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1243	19.3	35.975	2.88	194	57	2.37	4.4	.67	3.3	33	39.4	.5
2	1302	19.1	35.149	3.47	145	68	2.31	1.6	.44	5.5	22	56.2	.7
3	1325	18.6	34.168	4.54	57	88	2.11	2.7	.45	4.8	17	36.0	1.0
4	1340	16.0	33.654	6.36	-80	117	.80	6.3	.19	1.2	15	35.9	2.3
5	1355	15.8	33.664	6.14	-58	112	.67	2.7	.13	1.3	21	39.8	2.0
6	1412	15.1	33.663	6.35	-70	114	.69	2.4	.13	.7	9	36.6	4.0
7	1448	17.7	33.698	6.15	-77	116	.97	1.2	.15	2.9	17	34.0	1.0
8	1429	15.2	33.663	6.02	-42	109	.68	2.3	.13	1.3	9	36.8	3.0
9	1505	16.8	33.126	6.48	-96	120	2.08	3.4	.61	4.0	27	36.6	1.3
10	1523	18.8	30.052	5.64	-29	106	5.55	9.5	1.72	2.7	62	35.2	1.0
11	1535	17.5	31.795	6.25	-78	116	3.71	8.1	1.42	2.7	41	35.2	1.0

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 23 OCT 1974 SAMPLING DEPTH 1.0 m TIDE 4.1 ft 0743 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1010	17.7	35.156	4.85	34	93	4.24	2.6	.92	22.1	40	29.1	.6
2	1020	17.7	35.246	4.89	30	94	2.97	4.1	.47	14.1	35	53.1	.6
3	1050	18.1	34.620	4.26	84	82	2.73	3.5	.55	18.2	31	31.8	1.0
4	1103	18.2	34.005	4.02	107	77	2.80	2.8	.46	21.4	35	29.3	1.5
5	1113	18.8	33.564	3.19	177	62	2.95	1.8	.35	19.7	33	10.0	1.5
6	1122	18.8	33.297	4.57	55	88	1.78	1.1	.12	.0	23	16.9	1.5
7	1138	16.9	32.888	4.55	75	84	21.10	38.3	3.48	46.6	78	16.9	1.5
8	1130	18.4	33.330	4.61	55	88	1.62	2.7	.03	.0	24	19.8	1.2
9	1153	16.8	28.301	4.36	107	78	3.96	2.3	.39	1.8	47	12.0	1.0
10	1220	17.8	29.399	4.52	80	83	11.90	19.7	2.94	24.8	68	18.9	.6
11	1202	17.3	26.314	4.06	136	73	20.88	46.3	3.38	.0	79	21.9	1.1

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 12 NOV 1974 SAMPLING DEPTH 1.0 m TIDE 6.0 ft 838 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1012	15.0	33.312	5.10	42	92	2.64	6.6	.66	21.5	30	28.6	.8
2	1021	14.9	33.657	4.54	92	81	2.46	3.1	.61	16.8	28	49.0	1.1
3	1031	16.0	33.491	3.73	1	68	2.57	9.9	.53	34.1	26	29.6	1.1
4	1040	15.0	33.605	4.44	100	80	2.25	10.8	.46	19.9	27	29.4	1.3
5	1046	14.5	33.627	4.79	74	85	2.08	9.3	.53	25.1	24	37.5	1.3
6	1052	13.7	33.563	5.21	45	91	1.51	9.0	.34	3.2	21	47.7	1.4
7	1106	15.0	33.483	4.07	134	73	2.62	7.9	.64	33.0	30	28.9	1.3
8	1100	14.0	33.551	4.64	93	82	1.53	9.6	.32	3.0	21	51.4	.9
9	1116	14.7	32.690	4.47	104	79	5.94	11.0	1.09	25.3	34	29.9	1.4
10	1131	14.9	29.138	4.03	153	70	13.53	26.6	3.25	45.6	72	25.7	1.2
11	1127	14.8	29.765	3.75	177	65	16.11	27.3	3.25	72.6	79	24.2	1.3

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 11 DEC 1974 SAMPLING DEPTH 1.0 m TIDE 6.5 ft 811 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	905	10.8	30.333	6.09	11	98	1.31	9.0	.50	1.3	30	25.0	1.6
2	928	11.5	31.372	4.61	131	76	1.10	8.6	1.12	1.1	26	21.3	1.5
3	949	14.2	32.897	3.66	180	64	1.49	10.1	.45	1.4	21	22.0	1.4
4	1000	15.0	33.405	3.95	145	71	.74	7.8	.32	.7	14	23.0	1.5
5	1009	14.2	33.491	5.98	-28	106	1.16	6.2	.26	1.1	12	27.4	1.5
6	1018	14.2	33.510	6.10	-39	108	1.08	5.8	.25	1.0	13	32.8	1.5
7	1038	13.9	33.257	5.12	52	90	1.74	10.6	.94	1.7	22	24.8	1.7
8	1030	14.4	33.524	5.83	-17	103	1.10	5.7	.24	1.1	11	35.7	1.4
9	1055	13.8	32.581	5.55	17	97	2.94	16.9	1.02	2.9	34	22.7	1.9
10	1111	12.8	30.257	4.85	98	81	6.11	38.8	2.41	6.1	63	22.8	1.5
11	1104	13.0	30.702	4.61	116	78	5.59	32.6	2.01	5.6	69	43.0	1.6

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 26 JAN 1975 SAMPLING DEPTH 1.0 m TIDE 6.1 ft 852 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m
1	1051	13.0	33.019	5.11	63	88	1.35	5.7	.41	3.0	23	22.2	1.4
2	1057	13.0	33.177	5.25	50	90	1.35	8.8	.41	5.6	21	23.3	1.7
3	1104	13.5	33.581	5.07	59	88	1.14	10.1	.40	5.6	17	27.1	1.6
4	1111	13.6	33.613	5.45	24	95	.93	9.3	.32	3.5	16	26.6	1.7
5	1117	13.3	33.639	5.33	38	93	.81	8.5	.27	1.5	15	25.3	1.6
6	1124	12.7	33.609	5.67	14	97	.76	9.3	.24	3.2	14	35.1	1.1
7	902	13.8	33.556	5.11	53	90	1.21	12.1	.60	5.4	20	22.2	1.7
8	855	12.5	33.587	6.24	-33	107	.70	8.8	.24	.0	13	16.6	6.2
9	845	13.3	33.172	5.38	35	93	1.93	15.3	.00	5.7	21	20.6	2.0
10	838	13.0	33.207	4.93	79	85	4.88	24.3	1.20	6.1	27	23.6	1.6
11	830	13.0	33.177	4.76	94	82	6.68	28.1	1.40	8.5	28	22.2	1.7

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 25 FEB 1975 SAMPLING DEPTH 1.0 m TIDE 5.8 ft 1028 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1112	13.7	26.662	6.56	-51	110	.82	18.9	1.38	6.6	78	35.4	.6
2	1117	12.9	28.813	5.80	18	97	.79	11.8	.89	7.4	51	37.5	.9
3	1126	12.0	33.838	4.36	142	73	1.79	19.2	.54	5.5	37	19.5	1.0
4	1135	11.2	33.509	4.49	137	75	1.67	19.3	.31	2.3	38	18.1	1.5
5	1142	12.2	33.184	4.24	149	72	.79	11.9	.30	.8	24	23.2	1.3
6	1148	12.4	33.223	6.32	-38	107	.62	7.8	.29	.7	19	33.1	1.6
7	1205	12.0	33.073				1.48	10.4	.72	4.4	24	13.2	1.0
8	1154	12.2	33.304	6.08	-15	103	.72	9.6	.30	2.2	19	39.2	1.9
9	1222	11.5	32.855	3.93	186	65	2.67	32.1	.84	5.7	23	18.5	1.0
10	1236	13.0	30.027	5.95	0	100	5.34	37.6	1.53	3.1	43	22.0	.8
11	1230	13.0	28.756	5.29	62	88	6.58	59.1	2.53	4.0	72	21.4	.9

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 30 MAR 1975 SAMPLING DEPTH 1.0 m TIDE 4.7 ft 1529 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
1	1611	17.0	16.980	7.46	-134	125	1.39	47.2	1.38	3.2	99	44.5	.3
2	1620	15.2	23.316	6.04	-9	102	.99	13.3	.67	.0	87	44.4	.6
3	1632	15.2	25.987	4.96	77	85	.90	16.8	.54	.2	64	31.8	
4	1642	13.5	29.996	4.78	98	81	1.60	21.0	.53	2.2	48	32.0	
5	1651	12.8	32.402	4.96	81	85	2.16	32.6	.52	8.1	39	26.1	
6	1700	12.6	33.441				1.73	30.7	.47	.5	33	17.9	
7	1712	14.9	30.707	5.00	61	88	2.71	50.0	1.56	3.9	60		
8	1705	12.5	33.385	4.08	159	70	1.81	27.4	.52	.5	37	19.3	
9	1725	13.9	29.427	4.10	156	70	4.27	67.0	1.77	8.1	86	19.6	
10	1742	13.5	26.954	4.69	117	78	6.16	63.7	2.69	8.0	138	30.2	
11	1738	14.3	27.604	3.19	240	54	5.77	64.4	2.83	7.8	104	29.0	

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 28 APR 1975 SAMPLING DEPTH 1.0 m TIDE 4.2 ft 1409 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1555	20.5	26.420	4.96	27	94	2.20	35.0	2.13	6.8	71	22.4	.5
2	1605	19.2	30.885	3.66	140	70	2.15	10.1	.54	3.8	30	35.1	.6
3	1635	20.0	31.808	4.92	18	96	1.84	8.7	.41	2.2	22	15.4	.6
4	1645	15.5	32.961	3.01	225	54	2.22	11.0	.44	5.3	20	7.4	1.1
5	1655	13.9	33.610	4.28	126	75	2.17	23.9	.42	2.8	29	8.1	1.7
6	1700	13.6	33.702	3.36	211	59	2.11		.42	.8	33	19.8	2.5
7	1710	18.0	32.949	5.26	1	100	1.62	34.0	2.17	.2	37	22.8	.2
8	1705	13.9	33.649	5.16	47	91	2.02	16.9	.42	1.1	29	8.3	7.0
9	1720	14.8	30.723	4.83	77	85	4.87	63.0		12.8	58	6.9	1.7

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 28 MAY 1975 SAMPLING DEPTH 1.0 m TIDE 4.7 ft 1441 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1504	23.0	34.245	5.89	-97	123	2.42	.5	.11	.0	20	50.6	.4
2	1514	21.9	35.171	2.82	181	58	2.05	3.4	.21	.0	30	63.4	.6
3	1535	22.5	34.900	4.17	57	87	1.88	7.8	.26	2.3	27	58.9	.8
4	1545	18.0		3.81			2.32	17.9	.64	5.9	30	22.7	1.1
5	1555	15.0	33.850	5.85	-25	105	1.68	23.2	.39	1.8	21	19.0	1.8
6	1605	15.0	33.810	7.69	-190	138	.71	13.2	.16	.0	7	21.1	2.1
7	1625	20.0	33.820	6.65	-141	131	1.33	7.2	.72	.0	28	40.4	1.0
8	1615	15.0	33.807	6.11	-49	110	.83	3.6	.21	.9	8	18.3	2.9
9	1633	19.3	30.280	5.60	-31	107	6.20	79.7	3.84	9.9	59	21.7	1.1
10	1650	17.0	31.980	6.71	-115	124	4.60	52.6	2.51	5.7	35	29.2	.5
11	1645	16.9		4.60			3.97	55.3	1.77	6.9	34	32.1	.4

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 25 JUN 1975 SAMPLING DEPTH 1.0 m TIDE 4.4 ft 1335 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m
							ug-atoms/liter						
1	1318	21.0	34.011	6.22	-111	125	1.83	4.7	.84	.0	53	49.7	.3
2	1324	19.8	35.129	3.63	125	72	1.55	.0	.09	.0	40	50.9	.3
3	1346	19.0	35.088	4.54	51	89	1.50	1.8	.24	.0	29	20.1	1.0
4	1352	17.2	34.276	4.41	80	83	1.91	32.3	.60	2.4	29	20.2	1.0
5	1400	14.8	34.013	5.36	19	96	3.04	24.3	.73	2.1	88	22.7	.6
6	1411	13.7	34.007	4.58	100	80	1.58	25.9	.33	.0	27	18.6	2.5
7	1417	15.9	33.934	5.17	25	95	2.53	17.0	.89	1.0	35	17.7	.5
8	1426	16.3	33.970	5.73	-28	106	1.48	10.6	.39	.4	24	21.4	2.0
9	1439	15.9	31.575	4.93	54	89	10.80	60.4	.39	13.6	66	22.4	1.0
10	1454	20.6	14.140	7.39	-154	131	46.00	75.4	2.57	64.0	239	47.9	.5
11	1459	21.2	19.805	7.16	-155	132	42.20	76.8	2.24	58.2	215	22.4	.6

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 14 JUL 1975 SAMPLING DEPTH 1.0 m TIDE 5.9 ft 1550 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/1	AOU ug-at/1	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/1	SECCHI m	pH
1	1430	18.5	36.523	3.40	152	67	1.55	2.9	.55	.0	40	58.8	1.0	7.94
2	1450	18.7	36.073	3.12	177	61	1.46	4.1	.41	1.0	35	54.8	.3	7.97
3	1508	17.2	33.708	4.69	57	88	2.89	15.4	1.35	4.6	34	29.6	.5	8.09
4	1521	14.9	33.527	3.71	167	67	2.09	32.2	.85	3.9	27	20.7	1.5	8.12
5	1542	15.0	33.664	6.71	-102	121	1.57	16.3	.57	1.5	19	21.7	1.5	8.25
6	1557	14.5	33.691	6.94	-117	124	.88	9.8	.37	.7	12	20.3	3.5	8.31
7	1613	15.9	32.618	5.27	21	96	4.72	31.5	2.22	2.4	37	20.5	.7	8.36
8	1627	14.5	33.700	6.26	-57	111	1.00	7.1	.36	1.2	13	20.0	4.0	8.33
9	1640	15.3	31.004	4.98	58	88	5.64	71.6	4.57	5.6	40	51.4	1.0	8.27
10	1725	14.0	28.377	5.04	35	86	9.82	90.8	7.06	5.5	66	37.9	.7	8.34
11	1735	16.0	31.650	4.05	172	73	5.56	47.3	2.29	3.4	40	41.8	1.0	8.23

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 13 AUG 1975 SAMPLING DEPTH 1.0 m TIDE 6.1 ft 1600 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH
							ug-atoms/liter							
1	1530	19.1	35.722	4.93	44	90	1.46	3.4	.12	.2	54	80.6	.6	8.18
2	1540	19.0	35.103	4.58	47	90	1.66	5.1	.35	2.4	39	51.1	.5	8.00
3	1550	18.0	33.812	3.59	148	68	2.30	11.3	.65	5.6	30	31.5	.7	7.98
4	1605	17.0	33.510	3.49	166	65	1.98	17.3	.63	1.7	27	29.7	1.0	8.12
5	1615	16.0	33.817	5.14	27	94	1.07	12.1	.23	3.3	16	20.9	1.4	8.24
6	1625	15.5	33.936	4.69	72	85	.70	5.5	.10	.8	10	20.7	2.5	8.28
7	1635	16.0	31.979	5.35	15	97	4.13	16.4	1.84	2.6	30	30.9	1.5	8.38
8	1645	15.7	33.839	5.53	-4	101	.95	6.4	.20	2.8	13	23.5	2.0	8.27
9	1655	16.6	31.209	3.54	173	65	4.52	26.6	2.36	2.0	37	30.2	1.3	8.31
10	1700	17.0	31.661	4.65	69	86	4.16	31.0	1.78	2.5	36	35.6	.9	8.25
11	1710	17.0	32.693	4.81	51	89	4.29	13.3	1.04	2.0	33	31.0	1.0	8.18

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 10 SEP 1975 SAMPLING DEPTH 1.0 m TIDE 6.0 ft 1427 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m	pH
1	1345	19.3	34.544	3.16	173	62	1.82	2.7	.37	4.2	22	66.1	.8	7.93
2	1351	19.5	34.238	4.14	85	81	2.11	4.7	.44	8.2	25	52.9	.8	7.96
3	1402	18.0	33.153	3.55	153	67	2.78	9.0	.97	9.8	30	52.3	.9	8.07
4	1410	16.0	33.363	3.54	172	65	2.07	9.0	.55	4.1	22	54.1	1.6	8.09
5	1420	15.8	33.583	4.21	113	77	1.13	7.3	.30	1.0	11	49.2	1.7	8.05
6	1437	15.6	33.528	4.75	67	86	1.31	8.9	.29	1.5	12	45.1	4.0	8.20
7	1450	16.9	31.387	4.52	82	83	4.20	6.9	1.58	3.5	26	47.4	1.5	8.36
8	1455	16.1	33.573	4.94	45	91	1.03	3.9	.19	1.4	10	29.0	3.3	8.16
9	1505	16.4	28.145	5.43	16	97	15.33	38.8	6.99	14.6	68	103.0	.8	8.26
10	1525	16.3	30.852	4.48	93	81	6.62	23.2	2.19	10.3	36	53.3	1.0	8.16
11	1515	17.0	31.019	3.37	185	62	5.14	12.8	1.58	7.6	22	49.6	.9	8.12

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 9 OCT 1975 SAMPLING DEPTH 1.0 m TIDE 5.3 ft 1250 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH
							ug-atoms/liter							
1	1230	17.2	33.753	3.57	157	67	2.39	8.6	.25	3.2	15	113.1	.9	8.16
2	1236	17.9	33.366	4.69	52	89	2.32	8.8	.29	3.7	20	59.8	1.0	8.15
3	1245	17.0	32.176	4.24	1	78	3.06	12.2	.91	4.3	29	96.9	1.1	8.08
4	1253	15.8	32.392	4.31	108	78	2.66	12.1	.76	4.2	33	48.2	1.5	8.03
5	1303	15.0	33.206	4.02	139	72	1.04	12.1	.28	1.9	11		2.4	8.12
6	1318	15.0	33.334	4.76	73	85	1.00	10.1	.27	.3	22	44.1	4.6	8.14
7	1325	15.6	25.939	4.13	148	71	13.18	26.5	3.34	3.4	57	47.5	1.5	8.05
8	1335	15.0	28.558	5.51	22	96	8.26	18.0	1.95	1.8	46		3.0	8.07
9	1342	15.6	27.870	3.51	196	61	10.88	21.7	2.97	4.5	65	43.7	1.0	8.03
10	1352	15.4	29.678	4.07	142	72	6.46	17.4	1.45	4.4	43		1.0	8.05
11	1400	15.5	31.821	4.08	133	73	3.97	9.4	.92	4.3	36	49.0	1.0	8.03

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 2 NOV 1975 SAMPLING DEPTH 1.0 m TIDE 6.0 ft 954 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/1	AOU ug-at/1	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/1	SECCHI m	pH
1	1042	18.8	29.421	2.94	212	55	3.35	12.0	1.08	5.7	58	51.2	1.0	7.94
2	1053	18.2	30.245	5.65	-26	106	3.30	9.4	.97	6.8	34	47.2	1.3	7.93
3	1058	18.0	32.114	5.56	-22	105	2.62	15.9	1.10	4.0	23	169.8	1.4	8.03
4	1107	17.7	32.716	4.20	99	79	2.84	14.5	1.00	3.1	18	118.2	1.4	8.05
5	1116	17.3	33.215	5.79	-40	109	2.01	10.3	.63	1.9	16	92.7	1.2	8.11
6	1123	17.0	33.631	4.40	85	82	.97	6.4	.22	1.1	11	52.8	1.4	8.15
7	1140	18.8	29.438	5.85	-46	110	11.02	37.7	4.74	9.4	31	53.0	1.7	8.30
8	1150	17.0	33.564	4.71	57	88	1.68	9.8	.50	1.6	17	78.8	6.0	8.12
9	1207	18.0	16.990	5.56	2	100	18.88	80.2	10.45	7.8	44	99.1	.9	8.44
10	1217	18.5	20.717	5.47	16	97	23.79	70.9	19.36	14.0	69	186.0	.7	8.48
11	1223	18.3	20.541	6.61	-82	116	22.24	80.8	15.59	18.0	55	83.1	.7	8.58

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 1 DEC 1975 SAMPLING DEPTH 1.0 m TIDE 5.1 ft 1154 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH
							ug-atoms/liter							
1	1153	15.7	33.100	7.17	-142	130	1.50	5.7	.20	1.9	20	61.1	1.2	8.31
2	1201	16.0	33.103	5.20	24	95	1.82	6.1	.24	1.2	6	39.7	1.5	8.31
3	1211	15.8	32.556	5.82	-26	106		13.7	.19	2.9	24	37.6	1.9	8.09
4	1225	15.6	32.886	4.79	66	87	2.99	23.7	.58	2.7	25	33.5	1.8	7.97
5	1237	15.4	33.179	3.89	147	70	2.75	31.6	.67	2.0	28	34.5	2.1	7.97
6	1249	15.2	33.561	4.78	68	86	1.34	22.5	.31	.9	25	34.4	3.2	7.97
7	1302	15.6	29.554	4.07	141	72	9.62	33.4	3.61	9.0	59	33.3	1.3	7.97
8	1257	14.8	33.703	3.83	156	69	1.23	15.6	.23	.4	20	34.3	4.2	7.78
9	1323	15.7	23.307	3.29	230	56	18.74	54.8	10.96	18.2	120	57.2	.9	7.96
10	1333	15.2	26.284	3.26	228	56	19.23	58.9	11.78	17.5	124	61.1	.5	7.97
11	1338	17.4	13.039	6.34	-26	105	18.96	72.3	15.15	16.9	207	54.4	.6	8.17

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 17 JAN 1976 SAMPLING DEPTH 1.0 m TIDE 6.3 ft 1005 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m	pH
1	945	12.0	33.311	4.65	114	78	2.35	7.1	.20	3.2	40	37.6	1.3	8.14
2	1005	13.0	33.302	4.37	128	75	2.04	8.3	.25	2.7	21	34.3	1.5	8.07
3	1030	13.0	33.355	4.77	92	82	2.61	10.4	.46	4.1	29	41.8	1.5	7.99
4	1040	12.5	33.665	3.03	252	52	1.37	18.0	.22	.5	21	35.9	1.5	7.96
5	1055	12.0	33.737	3.12	249	53	1.73	19.1	.26	.9	56	46.1	1.8	7.97
6	1103	12.5	33.749	3.57	204	61	1.31	16.8	.17	.2	30	43.8	2.8	7.99
7	1115	12.0	33.659	5.21	63	88	1.76	18.5	.39	2.2	29	45.8	2.2	7.95
8	1130	12.0	33.756	5.55	32	94	1.23	16.8	.16	.0	20	48.9	3.0	7.98
9	1135	12.0	32.971	4.45	133	75	4.33	15.5	.73	6.2	32	45.1	1.8	7.94
10	1150	12.5	28.491	5.04	91	83	13.97	48.9	3.34	24.9	80	68.4	.8	8.02
11	1200	13.0	24.504	4.67	133	76	18.33	41.5	4.07	30.8	94	54.4	.5	8.08

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 15 FEB 1976 SAMPLING DEPTH 1.0 m TIDE 6.2 ft 1057 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH
							ug-atoms/liter							
1	1050	13.0	33.088	4.36	130	75	3.04	.0	.21	8.6	23	34.8	1.5	8.16
2	1104	13.5	33.094	3.90	166	68	2.56		.18	3.0	18	36.2	1.4	8.13
3	1120	14.0	33.026	4.84	77	85	2.39		.45	6.1	23	35.3	1.3	8.08
4	1135	14.0	33.286	5.69		100	1.87	6.1	.33	2.4	17	35.8	1.5	8.12
5	1145	13.8	33.515	5.20	45	91	1.14	4.5	.19	1.1	10	55.9	1.1	8.16
6	1150	13.0	33.587	6.02	-19	104	1.28	6.9	.28	.5	14		1.2	8.16
7	1210	13.8	33.306	4.76	85	83	2.34	6.2	.68	7.5	15		1.0	8.16
8	1220	13.8	33.581	5.73	-2	101	1.44	4.0	.33	1.7	15	36.6	1.0	8.15
9	1240	13.8	30.285	5.16	60	89	9.01	15.5	2.04	13.2	52	32.9	1.2	8.22
10	1250	14.0	27.541	5.45	41	92	9.90	19.5	2.12	21.8	64	39.6		8.25
11	1300	14.1	24.580	4.22	160	70	22.09	3.5	7.36	63.2	122	34.0		8.29

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 17 MAR 1976 SAMPLING DEPTH 1.0 m TIDE 5.6 ft 1032 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m	pH
1	1155	13.0	31.333	3.99	169	68	4.49	9.6	.57	4.3	38	42.6	1.0	7.89
2	1210	14.9	31.623	3.13	225	55	3.97	10.2	.19	3.3	22	47.5	1.0	7.91
3	1220	12.8	32.573	4.08	159	70	3.34	24.1	.41	6.4	27	122.0	1.5	7.93
4	1230	16.1	32.854	4.95	47	90	3.27	18.8	.76	8.8	36	53.8	1.8	7.96
5	1240	14.3	33.443	4.40	111	78	1.61	9.1	.26	1.6	44	43.0	2.6	8.11
6	1420	14.8	33.403	5.94	-30	106	1.71	5.0	.27	2.0	23	39.6	1.8	8.10
7	1425	16.5	33.077	6.44	-90	119	3.12	7.6	.85	9.9	34	53.7	2.0	8.11
8	1435	15.2	33.380	4.65	80	84	1.88	4.5	.28	3.3	23	63.0	2.0	8.12
9	1445	16.5	27.636	4.98	57	89	14.11	48.8	5.84	43.7	120	35.2	1.7	8.19
10	1110	16.0	24.173	4.41	124	76	23.37	39.8	12.78	92.1	147	30.4	.7	8.29
11	1115	15.6	25.253	4.06	156	70	18.13	42.6	6.21	62.6	138	85.2	1.2	8.23

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 29 APR 1976 SAMPLING DEPTH 1.0 m TIDE 4.4 ft 1110 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH
							ug-atoms/liter							
1	1155	18.3	35.799	4.08	95	79	5.63	2.8	.39	3.1	38	58.2	1.0	8.08
2	1205	17.9	35.582	3.07	189	59	4.86	1.9	.24	4.7	31	84.9	1.0	7.99
3	1220	18.5	34.831	4.92	22	95	4.16	2.8	.50	4.6	33	77.7	1.0	8.10
4	1235	16.8	33.791	3.08	204	57	3.86	14.3	1.06	8.9	34	52.0	1.0	7.95
5	1245	17.2	32.838	3.07	204	57	3.45	26.0	1.98	8.1	31	192.4	1.4	8.00
6	1255	15.0	33.394	5.18	35	93	1.67	15.4	.80	2.1	22	93.3	2.5	8.06
7	1305	16.8	30.487	3.47	180	63	5.60	43.8	4.95	14.4	48	54.1	1.0	8.18
8	1312	16.2	33.371	5.86	-36	108	2.07	14.1	.92	2.6	17	43.5	2.5	8.11
9	1318	16.5	28.448	4.01	141	72	8.04	46.8	8.47	23.3	80	53.6	1.0	8.12
10	1210	17.6	20.763	4.61	101	80	15.65	26.8	19.20	50.5	184	58.8	.8	8.36
11	1200	18.9	19.793	4.23	126	75	19.30	58.2	23.10	69.1	185	126.5	.5	8.32

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 12 MAY 1976 SAMPLING DEPTH 1.0 m TIDE 4.8 ft 940 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/l	SECCHI m	pH
							ug-atoms/liter							
1	1015	20.2	34.551	2.76	201	55	5.00		.57	4.3	28	51.7	1.0	7.63
2	1030	19.9	34.547	2.24	250	44	4.33		.64	4.6	27	59.7	1.2	7.66
3	1045	19.7	33.973	2.77	206	55	4.15		1.31	6.3	31	46.6	1.1	7.68
4	1100	20.6	33.331	3.98	93	79	3.74		1.92	8.5	29	51.8	1.0	7.89
5	1115	18.6	33.303	5.02	16	96	3.75		2.02	8.5	34	41.3	1.3	7.88
6	1145	16.0	33.508	5.96	-44	109	2.06		1.23	4.4	23	33.7	1.9	7.94
7	1207	19.3	31.986	5.76	-50	111	6.23		5.20	17.9	47	34.0	1.3	7.94
8	1215	15.9	33.484	5.24	20	96	1.69		1.14	4.9	20		1.9	8.25
9	1230	16.0	30.305	3.81	158	68	11.19		10.81	26.2	78	50.8	1.0	7.85
10	925	16.4	25.986	3.67	180	64	16.40		21.48	46.8	139	51.8	.7	7.89
11	910	17.7	17.985	2.76	274	47	24.10		34.21	78.0	123	33.0	.5	8.00

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 29 JUN 1976 SAMPLING DEPTH 1.0 m TIDE 4.3 ft 1332 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/l	AOU ug-at/l	SAT %	PHOSPHATE ug-atoms/liter	NITRATE ug-atoms/liter	NITRITE ug-atoms/liter	AMMONIA ug-atoms/liter	SILICA ug-atoms/liter	SUSP SED mg/l	SECCHI m	pH
1	1410	27.0	37.455	7.35	-262	167	6.49	.1	.22	2.9	19	155.0	.6	8.29
2	1420	26.1	37.088	4.28	17	96	2.58	.0	.20	17.2	20	152.0	.7	8.03
3	1435	25.5	36.109	5.66	-98	124	2.70	.0	.25	9.8	34	80.0	.5	8.11
4	1450	25.0	34.907	5.19	-50	112	2.14	3.9	.64	20.6	17	127.0	.5	8.14
5	1515	23.1	33.789	5.89	-100	124	2.12	5.1	.92	34.3	14	85.0	.8	8.16
6	1540	22.2	33.617	6.60	-153	135						83.0	1.4	8.27
7	1605	23.1	32.832	6.27	-128	130	3.46	8.0	1.38	13.0	18	82.0	1.0	8.40
8	1615	17.0	33.562	5.18	15	97	1.28	3.8	.55	12.1	10	61.0	1.6	8.31
9	1630	21.0	30.387				8.08	45.7	4.29	31.6	34	41.0	1.3	8.19
10	124	22.0	25.085	5.69	-46	110	11.25	48.1	4.59	363.0	36	68.0	.5	8.43
11	1230	21.5	29.901	4.79	24	95	8.95	44.0	4.59	21.9	36	214.0	.5	8.21

Appendix 3. Ancillary data from adjacent sloughs, September 1975 and March 1976.

Station	N. Latitude	W. Longitude	Description
12	36^0 49.04'	121^0 47.17'	Bennett Slough near Jetty Road
13	36^0 49.32'	121^0 47.00'	Bennett Slough near Struve Road
14	36^0 49.52'	121^0 46.58'	Bennett Slough near Struve Road
15	36^0 47.10'	121^0 46.12'	Moro Cojo Slough south of Kaiser Plant
16	36^0 46.10'	121^0 46.11'	Tembladero Slough near Castroville
17	36^0 45.92'	121^0 47.23'	Tembladero Slough near junction with Old Salinas River Channel
18	36^0 45.74'	121^0 47.24'	Old Salinas River Channel near Molera Road
19	36^0 44.90'	121^0 44.92'	Salinas River near Mulligan Hill

ELKHORN SLOUGH - MOSS LANDING HARBOR DATA SUMMARY

SAMPLE DATE 12 SEP 1975 SAMPLING DEPTH 1.0 m TIDE 5.6 ft 1627 PST

STN	TIME	TEMP °C	SALIN ppt	OXYGEN ml/1	AOU ug-at/1	SAT %	PHOSPHATE	NITRATE	NITRITE	AMMONIA	SILICA	SUSP SED mg/1	SECCHI m	pH
							ug-atoms/liter							
12	1345	17.0	32.917	4.74	57	88	.24	1.8	.04		4	51.9		8.26
13	1358	19.9	38.831	10.98	-542	224	.17	.6	.00	.0	1	112.5		9.37
14	1405	20.5	47.151	5.83	-111	128	.12	.2	.00	.0	1	241.7		9.17
15	1440	23.6	46.275	5.51	-101	126	.20	1.3	.00	.0	10	193.4		9.13
16	1500	18.6	.900	5.04	115	80	4.90	21.7	1.11		63	19.8		7.99
17	1517	18.9	.841	11.72	-484	186	2.72	10.6	1.84	.4	22	37.1		9.39
18	1527	18.5	.646	12.69	-565	200	2.68	11.4	1.90	.8	22	57.7		9.46
19	1540	19.5	.533	12.76	-582	205	3.61	13.3	2.32	1.1	25	83.1		9.45