LARVAL RECRUITMENT

of

ESTUARINE RELATED FISHES AND INVERTEBRATES

of the

TEXAS COAST

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INTRODUCTION

Estuarine related species together comprise an important part of the world's marine fishery resources. Most of these species display a common life history pattern which involves spawning on the continental shelf, passage of juvenile growth stages in the bays and estuaries, and movement of the young adults back out to the continental shelf for spawning. The recruitment of a given year class depends, in great measure, on the transfer success of eggs, larvae, and young juveniles from the spawning grounds on the shelf, through the passes, to the nursery grounds in the estuary. Since eggs are incapable of swimming movements, their inward migration must depend entirely upon passive transport by the prevailing water currents which are determined by astronomical tides, wind forcing, and possibly other factors such as local rainfall and freshwater outflow from streams. To some degree, larval and post-larval transport must be passive, as well, but behavioral factors may play an increasingly significant role as the young increase in age.

During the years prior to 1980 a great deal of information had accumulated concerning the life histories of estuarine dependent species, and some efforts were being made to understand the mechanisms and environmental correlates of the migration phenomenon. For penaeid shrimp Hughes (1969) suggested salinity change as a tidal transport mechanism, and King (1971) correlated young shrimp abundance in a tidal pass with wind speed and direction, tidal amplitude, moon phase, daily sun cycle, cloud cover, and position in the water column. For larvae of portunid crabs Sulkin (1975) studied the influence of light on depth regulation, and Cronin and Forward (1977) concluded that the larvae possess an endogenous rhythm of vertical migration which enhances tidal transport. King (1971) correlated the movements of young crabs through a tidal pass with a variety of environmental factors, and he showed that the results depended upon the stage of the crabs. Many studies were carried out on young fishes. Creutzberg (1961) investigated orientation of eel larvae in relation to current patterns. Gibson (1978) reported on lunar and tidal rhythms in fishes. Nelson et al. (1978) correlated Atlantic menhaden recruitment with hydrographic factors on the continental shelf. Studies on the tidal transport mechanisms of fishes were conducted by Kuipers (1973), Veen (1978), and Weihs (1978). Other aspects of fish migration were reported by Bishai (1960), Creutzberg et al. (1978), and Tsurita (1978). Balchen (1976) published a pioneering paper on the modeling of fish behavior. On the Gulf coast Jannke (1971) and Roessler (1970) provided information on the early life histories of many estuarine related fishes of Florida, Daniels (1977) discussed distribution of fish larvae off Louisiana, Fore and Baxter (1972) reported diel fluctuations in young menhaden catches at the entrance to Galveston Bay, King (1971) studied environmental factors associated with recruitment of young fishes through the Cedar Bayou tidal pass, and Hoese (1965) reported on the spawning seasons of marine fishes off Port Aransas, Texas. By 1980 it had become clear that the transport mechanisms are quite complicated, that different species likely utilize different mechanisms, that both physical factors and behavioral patterns are often involved, and that life history stage is an important factor in determining biological response patterns.

During the past decade efforts to understand the mechanisms of larval recruitment into the estuaries has intensified, and a large body of literature has appeared dealing with many aspects of the subject. Leming and Johnson (1985) and Epifanio (1988) have examined the problem of invertebrate larval recruitment, in general. Rothlisberg et al. (1983) studied migrating shrimp larvae and Johnson, Hester, and McConnaugha (1984), Sulkin (1984) and Sulkin and Epifanio (1986) reported on recruitment of portunid crabs. By far, the bulk of the recent literature has addressed problems of recruitment of estuarine fishes. Extensive literature reviews have been provided by Boehlert and Mundy (1988), Cushing (1986), Leggett (1984), Miller (1988), Miller et al. (1984) Neill (1984), Norcross and Shaw (1984), Pietrafesa and Janowitz (1988), Power (1984), and Sherman et al. (1984). Factors affecting the distribution of estuarine and inshore fishes have been addressed by Blaber and Blaber (1980). Weinstein et al. (1980) discussed factors associated with the retention of post-larval fishes in a well-flushed estuary. The physical and biological factors associated with the actual transport mechanisms have been studied by Bailey (1981), Beckley, (1985), Dodson and Dohse (1984), Fortier and Leggett (1983, 1985), McCleave and Keckner (1982), Melville-Smith et al. (1981), Norcross (1985), Pfeiler (1984), Pollock (1983), Powles (1981), Rijnsdorp et al. (1985), and Tanaka (1985) among others. Studies specific to the Gulf area have been published by Cowan (1985), Guillory et al. (1983), and Shaw et al. (1985, 1988). Recent efforts at modelling and computer simulation of larval transport have been reported by Arnold and Cook (1984), DeAngelis and Yeh (1984), Frank and Leggett (1981), and Taggert and Leggett (1987).

In these studies we see the recruitment phenomenon broken down into three separate problems: movement from spawning grounds to the tidal passes, transport through the passes, and retention within the estuaries. In waters of the continental shelf efforts have been made to apply physical models depicting the movement of water masses to the problem of egg and larval transport toward the entrances of the passes since eggs and early larvae are likely to be the most passive stages of the life histories. Movement of eggs and young through the passes and retention within the estuary generally take account of both physical and biological mechanisms. Among the biological phenomena examined are the use of olfactory and other cues to sense slight changes in water composition, upward and downward vertical migration patterns associated with inward and outward flowing water, and the timing of transformation from planktonic eggs and early larvae to demersal late larvae and early juveniles. Some emphasis has been placed upon the endogenous nature of tidal and lunar biological rhythms and the total spawning and recruitment strategies of individual species. Mathematical modeling efforts have not been highly successful to date, but it is clear that as the underlying problems are more fully understood the modeling efforts will eventually provide extremely useful descriptive and predictive tools. The existing information suggests that each species has evolved its own peculiar strategy for coupling biological adaptations with the physical factors of the environment and that these strategies have been somewhat attuned to the physical variables associated with each local pass/estuary complex.

The present investigation is, in effect, a pioneering effort to provide insight into the nature of the complex physical (and possibly behavioral) mechanisms associated with larval transport through the passes of the Matagorda Bay area of the central Texas coast. From a managerial standpoint, it is particularly important to determine whether or not freshwater inflow from streams plays a significant role in larval recruitment from the continental shelf. Of primary concern are three species of penaeid shrimp, one crab, seven species of sciaenid fishes, and two species of non-sciaenid fishes (Table 1). Of secondary concern are six additional species of sciaenid fishes. In addition to providing preliminary information on the transport mechanisms, the present study aims to develop sufficient insight into the processes so that even more effective and informative studies may be designed for the future. Details of gear type, sampling (locality, depths, times and frequencies), and measurement of physical variables have had to be decided, to some extent, by arbitrary means. However, in hindsight it should be possible to determine the optimal combination of procedures for accomplishing the stated goals.

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In response to House Bill 2 (1985) and Senate Bill 683 (1987), as enacted by the Texas Legislature, the Texas Parks and Wildlife Department and the Texas Water Development Board must maintain a continuous data collection and analytical study program on the effects of and needs for freshwater inflow to the State's bays and estuaries. As part of the mandated study program, this research project was funded through the Board's Water Research and Planning Fund, Authorized under Texas Water Code Sections 15.402 and 16.058(e), and administered by the Department under interagency cooperative contracts No. IAC(86-87)1590, IAC(88-89)0821 and IAC(88-89)1457.

MATERIALS AND METHODS

Study Area. Matagorda Bay lies on the central Texas coast of the Gulf of Mexico where it represents an intermediate condition between the high freshwater input estuaries of the upper coast and the low freshwater input estuaries of the lower Texas coast. It has the advantage of being relatively less influenced by human activities than most other Texas Bays. Although it is not pristine, natural habitats and processes still dominate this system.

As seen in Figure 1, four study sites were selected. Two of these represent passes between the open Gulf and the Bay: the Ship Channel (SC) and Pass Cavallo (PC). These stations were designed to intercept eggs, larvae, and juveniles passing from the Gulf of Mexico into Matagorda Bay. Two additional sites lie in passes along the west side of Matagorda Bay: Saluria Bayou (SB) and the Intracoastal Waterway (ICWW). These were designed to study the passage of eggs, larvae, and juveniles from one bay to another. Saluria Bayou is a major channel connecting Matagorda Bay with Espiritu Santo Bay, and the Intracoastal Waterway connects Matagorda Bay with both Espiritu Santo and San Antonio Bays.

Study Design. The original plan called for monthly sampling at each of the four stations during the period February-August, 1987. At each station paired bongo net samples were to be made at two hour intervals at the surface, mid-depth, and bottom. In the Ship Channel and Pass Cavallo sampling would be carried out for 24-hour periods (two complete tidal cycles), and in Saluria Bayou and the Intracoastal Waterway sampling was to be carried out for 12-hour periods (one complete tidal cycle). Environmental measurements were to include temperature and salinity as well as current speed and direction. Meteorological data were to be obtained from the nearby Coast Guard Station. Problems with weather, boats and gear as well as onsite field experience forced a mid-course modification of the study so that most of the original objectives could still be achieved (Appendix A). The Pass Cavallo station was dropped, and the total number of samples to be taken was reduced.

The modified study plan, developed in June, 1987, was carried out as designed. The numbers of samples and replicates taken during each cruise and locality and with each gear type are summarized in Table 2. Two gear types were employed, and replicates were made to permit determination of catch variability within gear type and between gear types. The replicate samples were taken one after the other with an intervening time interval of 10-30 minutes. Due to sampling difficulties in the exposed channel, the Pass Cavallo station was deleted from the later cruises. Within each of the remaining localities sufficient replicates were made to permit analysis of sample variability by area and depth and, in Saluria Bayou, by position in relation to mid-channel. Since sampling was carried out over complete tidal cycles at all localities, the time variation of catches could be analyzed within and between cruises, and comparisons could be made between different sampling sites. Physical data taken during the cruises, supplemented by additional information from several sources, on tide stage and level, water level, and wind speed and direction would permit determination of the physical correlates of the biological data. In the laboratory the plankton samples were to be processed so that the densities of the eggs, larval, and juveniles of each of the primary and secondary species could be determined in terms of the number/m^3 of water.

Field Methods. In the Matagorda Bay area all field operations were carried out from the Texas Parks & Wildlife Department facilities on the Intracoastal Waterway with permission of the facility Director. Particularly used were storage, docking, boat launching, and parking facilities. All collections in the Ship Channel and some in the Intracoastal Waterway were conducted from larger vessels, but due to the shallowness of the water, all collections in Saluria Bayou and Pass Cavallo had to be made from a 21-foot outboard motorboat. In these shallow waters the 1/2m plankton tow net mounted with a digital flowmeter (General Oceanics, Model 2030) was easily handled from the motorboat and proved to be the gear of choice, but this net was difficult to handle at depth in the Ship Channel. The Tucker Trawl (with square 1/2m x 1/2m mouth), which is used extensively for larval recruitment studies on the East Coast, proved ideal for work in the Ship Channel, but it was cumbersome in the shallower waters of the Intracoastal Waterway, and it could not be handled from a motorboat in Saluria Bayou. The Tucker Trawl became available in time for the July and August cruises. All nets had a mesh size of 335μ which was small enough to capture even the early larvae of penaeid shrimp and portunid crabs. All nets were towed for approximately 5 minutes. Net clogging was generally not a problem but there were occasional difficulties when large jellyfishes (Dactylometra and Stomolophus) were taken. Except when precluded by inclement weather or by vessel or gear failure, samples were taken throughout single tidal cycles at the shallow stations (Pass

Cavallo, Saluria Bayou, and Intracoastal Waterway) and throughout double tidal cycles at the deeper station (Ship Channel). Channel depths and actual sampling depths are given in Table 3. All samples were immediately preserved in buffered 10 percent formalin and labeled. Temperature and conductivity were remotely measured using a Hydrolab 8000 system, and current speed and direction were determined with a Type 923 Endeco remote recording current meter. In a few cases the current meter malfunctioned, and these data have had to be estimated on the basis of the remaining physical data base. Local weather data recorded at the Port O'Connor Coast Guard Station were obtained from the National Climatic Data Center in Asheville, North Carolina. Local tide gauge readings in the Ship Channel and Saluria Bayou were obtained through the courtesy of Mr. Gary Powell of the Environmental Studies Unit, Engineering and Environmental Systems Section, Texas Department of Water Resources. Theoretical tide levels were determined from the standard tide tables published by the U. S. Department of Commerce.

Laboratory Methods. In the laboratory each plankton sample was divided into two equal aliquots by means of a Fulsom plankton splitter. One half of the sample was preserved in buffered formalin, labeled, and kept as an archive collection. The remaining half was rinsed in water and preserved in 70% ethyl alcohol. This sample was then examined for shrimp, crab, and fish eggs and larvae according to the following procedures.

The entire aliquot was first examined for fish eggs and larvae, and these were removed for taxonomic identification and counting. In some cases, where extremely large numbers of fish larvae were encountered, the aliquot was split again, and one quarter of the original sample was sorted for fish eggs and larvae. The sample was then examined for penaeid shrimp and portunid crab larvae. These were sometimes so abundant that several additional sample splits (down to as low as one thirty second or the original plankton sample) had to be made.

Sorting and taxonomic identifications were carried out with the aid of compound microscopes at magnifications from 12x to 50x. Identifications were facilitated by reference to the published literature and, in a few cases, by having other specialists check the identifications. A reference collection of identified specimens was established to further aid in the sorting and identification process. After all identifications and counts were completed, calculations were made so that the data in all cases represent the number of specimens of each taxon present in one cubic meter of water. It was determined that, on the average, the complete processing of each plankton sample by experienced personnel requires about eight hours of effort.

Data analysis Methods. Data obtained from the field and laboratory studies were subjected to a series of statistical manipulations using Statistical Analysis System (SAS) software. Variability of the catch by the 1/2 meter tow net was examined by comparing the mean catch of the first tows with the mean catch of the replicate tows using p-values derived from t-statistics. Comparison of the first and replicate tows was also carried out by regression analysis.

Comparison of the catch by different gear types (1/2 m tow net vs. Tucker Trawl) was carried out by three methods. For replicate samples the mean catches by the two gear types were compared using Student's t-test to determine if the mean values were significantly different. The second method involved regression analysis of replicate samples in which the catch by the Tucker Trawl was treated as the independent variable and catch by the 1/2 m tow net was treated as the dependent variable. These comparisons were carried out separately for biological abundance data expressed in terms of shrimp larvae, crab larvae, all fish eggs, and all fish larvae. The third method of gear type comparison involved the surface catches of shrimp larvae (protozoea) and crab larvae (zoea) from the Ship Channel and Saluria Bayou. Within the Ship Channel the 1/2 m tow net was used during cruises 2, 3, and 4, and the Tucker Trawl was employed on cruises 5 and 6, whereas in Saluria Bayou the 1/2 m tow net was used during cruises 2 through 6. For each location the mean catch of the lumped biological data from cruises 2, 3, and 4 was compared with the mean catch of the lumped data from cruises 5 and 6 using Student's t-test. The question to be answered was whether the variation in the catches made by different gear types (Ship Channel comparison) was greater than variation in catches made by a single gear type (Saluria Bayou comparison).

All subsequent regression analyses were carried out with biological abundance data expressed as log of the number of larvae per m^3 of water. Two methods were employed to test the hypothesis that data from the different stations could be combined without adversely affecting the results. Both methods were applied to every pair of stations for six major biological groups. The first method involved multiple regression with dummy variables. This procedure showed if differences in intercepts or coefficients existed for the two regression models predicting biological abundance at the stations being compared. The existence of significant differences in intercepts or coefficients supported the contention that data from different stations should be analyzed separately. If no differences in intercepts or regression coefficients were found, then the two stations could be analyzed jointly for the biological group under consideration. The second method began with a multiple regression of data from a single station. This resulted in an R^2 value (designated $R^2 old$) which reflected how well abundances predicted by the model agreed with abundances observed at this station. Data concerning physical variables from the second station were put into this first station model to predict biological abundances at the second station. Then a simple regression analysis was carried out using the predicted abundances as independent variables and observed abundances at the second station as dependent variables. This produced an R^2 value (designated as $R^2 new$) which reflected how well predicted abundances (using a model from the first station and physical variable data from the second station) agreed with observed biological abundances at the second station. Interpretation of the new R^2 value was facilitated by a method suggested by Dr. David Hinkley (personal communication). This involved calculation of a third R^2 value (designated $R^2 calculated$), which was derived by the following formula:

$$R^2 calculated = 1 - [\ \{1-R^2 old\} \times \{\ (N+P+1)/(N-P-1)\ \}\ ]$$

where:

N is the total number of data records from the second station and P is the number of physical variables in the original multiple regression.

At this point, $R^2 new$ was compared with $R^2 calculated$. If $R^2 calculated$ was greater than $R^2 new$, then it was assumed that data from the two stations should not be considered jointly (*i.e.*, they should not be lumped for further calculations). However, if $R^2 new$ exceeded the value of $R^2 calculated$, then there was no reason to believe that the data from the two stations should not be lumped. These computations were carried out for every possible combination of stations.

In analyzing the relationships between physical parameters and the catch data, the biological information was considered in three categories: biological groups; shrimp and crab larval stages; and fish species. The biological groups included the following: shrimp larvae, crab larvae, fish eggs, estuarine fish larvae, marine fish larvae, and marine sciaenid larvae. The distinction between estuarine and marine fishes is shown in Table 4. Seven physical parameters were included in the analyses as follows: depth (D), temperature expressed as a square (T), salinity (S), wind velocity as a vector parallel to the channel axis (W), current velocity expressed as a vector parallel to the channel axis (C), light conditions (L), and theoretical tidal height calculated from NOAA tide tables (TH). The positive and negative signs on regression coefficients suggested general relationships with environmental parameters as indicated in Table 5. All seven physical parameters were available for the Matagorda Ship Channel. Only six were available for Saluria Bayou since no night collections were made here, and only five were available for the Intracoastal Waterway since there were no night collections, and a theoretical tidal height could not be calculated for this station.

All regression analyses were carried out twice, each time based upon different assumptions. In the first set all zero occurrences of a biological variable were included. In the second set all zero occurrences were excluded. Since each species tends to appear on a seasonal basis, it was decided to test whether zero occurrence values from the off-season (when the species was unavailable for capture) would affect the results of the analyses.

Stepwise multiple regressions were conducted using the forward, backward, and stepwise procedures defined by SAS. Multiple regressions were carried out using all available physical variable as predictor variables and one biological variable as the dependent variable. All R^2 values given in the tables are adjusted R^2 values.

Several types of regressions were conducted on the data. Multiple regressions were carried out using all available physical variables as predictor variables and one biological variable as the dependent variable. Stepwise multiple regressions were conducted using the forward, backward, stepwise, and maximum R-square procedures defined by SAS.

RESULTS

Gear and Station Comparisons

Before attempting to analyze the relationships of physical factors and biological catch data it is necessary to address three questions: a) for replicate samples by the same gear type, what degree of variability is observed; b) what degree of variability is seen when comparing the catch by different gear types and can such data reasonably be lumped; and c) can data from different stations be combined for further analysis. During the study 21 pairs of replicate samples were taken with the 1/2 m tow net. The sample data were analyzed statistically as indicated previously, and the results are presented in Table 6. All of the p-values resulting from comparisons of mean catch data are above 0.05 indicating that the mean values are not significantly different (although in the cases of shrimp larvae, fish eggs, and marine fish larvae the p-values are not far removed from the 0.05 level). Identical catches in replicate samples would produce a regression line in which the y-intercept would be zero, and the slope of the line would be 1.00 with an R^2 value of 1.00. This was actually achieved in the case of the marine sciaenid larvae (where the number of occurrences was quite low). Outside of this, only the crab larvae and fish egg regressions produced reasonably high R^2 values, and the shrimp larvae and estuarine fish larvae gave very low R^2 values. The picture that emerges is one of a data base with quite high internal variability, and this is borne out by inspection of the sample-to-sample variation in catch densities of the individual groups.

The inter-gear study involved comparison of data taken in 8 pairs of replicate samples. As shown in Table 7, the mean values for estuarine fish larvae were significantly different (p = 0.006), and for crab larvae the p-value was not far removed from 0.05. Nevertheless, the analysis indicates that for four out of the five groups the means were not significantly different, and it should be safe to lump the data from the two gear types. Among the R^2 values only that from the marine fish larvae comparison was reasonably high, but only the R^2 value from comparison of shrimp larvae catches was very low. On the whole, the inter-gear variability was not much different from the variability observed in the intra-gear comparison. However, it is noted that this conclusion is based upon a small number of samples. The slopes of most regression lines suggest that the Tucker Trawl may be somewhat more efficient in collecting organisms of the several biological groups. A further comparison of catch by different gear types was carried out on data from the Ship Channel (where two types of gear were used) and from Saluria Bayou (where only one type of gear was used). Comparison of mean catches of penaeid protozoea and portunid zoea by the different gear types produced p-values above 0.10 in both cases, indicating that the catches by the two different gear types are not significantly different. On the other hand, comparison of means of catches by the same gear type were significantly different, with p-values below 0.005 in both cases. Although it has not been determined categorically that the two types of gear produce identical results, it does seem safe to conclude that the inherent variability of the biological catch data is so great that it masks any variability due to the different gear types. Therefore, it is reasonably safe to combine data taken by the 1/2 m tow net and the Tucker Trawl.

Computations were carried out by the methods indicated earlier to determine whether or not data from the different stations could reasonably be lumped for further analysis, and these comparisons were made for all possible station pairs and all six major biological groups. Comparisons of stations using multiple regression with dummy variables produced the following results. In only four of the 18 tests were no significant differences in intercepts or regression coefficients found. These were the combinations of Saluria Bayou and the Intracoastal Waterway for shrimp larvae, the Intracoastal Waterway and the Ship Channel, and the Intracoastal Waterway and Saluria Bayou for crab larvae, and the Ship Channel and Saluria Bayou for marine sciaenid larvae. In the remainder of the tests significant differences in the intercepts, regression coefficients, or both were found. These results strongly suggest that data from the different stations should not be combined for further analysis.

Comparison of two-station data sets by the second method revealed that in only one instance was the R^2 new consistently higher than the corresponding R^2 calculated, i.e., in relation to Saluria Bayou and the Intracoastal Waterway and involving the crab larvae. When the multiple regression model predicting larval crab abundance in Saluria Bayou was used with physical parameter data from the Intracoastal Waterway, R^2 new was 0.250 and R^2 calculated was 0.249. The reverse calculation (i.e., the model predicting larval crab abundance in the Intracoastal Waterway used with physical data from Saluria Bayou) resulted in values for R^2 new of 0.283 and for R^2 calculated of 0.135. In no other combination would it be appropriate to combine data from two stations for any biological group. Therefore, the data from all stations must be analyzed separately.

Biological Group Data

The present section deals with the catch data for each major biological group: i.e., shrimp larvae, crab larvae, fish eggs, estuarine fish larvae, marine fish larvae, and marine sciaenid larvae. Each group is quite heterogeneous, involving a variety of species and life history stages. High variability in the data is expected. Since data from the different stations cannot be combined, each station must be considered separately.

Shrimp larvae

Shrimp larvae appeared in samples from all stations and all cruises except at Pass Cavallo during cruise 2. Mean densities at all stations and all cruises are provided in Table 8. Low densities were observed at all stations on cruise 3 and at individual stations on other cruises. During cruise 4 mean densities were quite high, exceeding 6,000 larvae/1,000 m^3 at all stations, and the highest observed mean density of 17,575.6/1,000 m^3 occurred in the Ship Channel during this cruise. The percentages of larvae at a given station for each cruise are shown in Table 9. During cruise 3 percentages were never as high as 4.0 percent at any station, but on cruise 4 they exceeded 60.0 percent at all stations.

Multiple regression analyses of the larval shrimp data for the four stations are presented in Tables 10 - 13. Results produced by the methods of analysis, with zero values included and with zero values omitted, are given. In the Ship Channel, by both methods, the factors significantly correlated with shrimp larval abundance included upchannel wind, higher tidal height, and deeper water. Both 3-variable and 5-variable models produced low R^2 values in the range of 0.18 - 0.20. In Saluria Bayou, with zeros included, upchannel wind, shallower water, and upchannel current were significantly correlated with larval abundance, but by the method with zero values omitted, only upchannel wind and deeper water were so correlated. In all instances the models produced R^2 values in the range of 0.44 - 0.49. In the Intracoastal Waterway, with zero values included, no physical parameters were significantly correlated with larval abundance, but with zero values omitted, upchannel current was significantly correlated. With zero values included, the models produced R^2 values of 0.22 and 0.19, but with zero values omitted the R^2 values were 0.27 and 0.23. In Pass Cavallo, with zero values included, higher temperature was significantly correlated with larval abundance, but with zero values omitted, no factors were so correlated. By both methods the 3- and 5-variable models produced quite high R^2 values (0.90 - 0.96). Numerical models giving the best relationships of the physical factors with biological abundance are given in Appendix C.

Crab larvae

Crab larvae were taken at all stations and during all cruises (Table 8). As in the case of the shrimp larvae, there was a tendency to peak during cruise 4. At this time maximum mean densities were observed for all stations except the Ship Channel which achieved maximum mean density during cruise 5. The highest mean density of 31,592.7/m^3 occurred in Saluria Bayou during cruise 4. Mean densities of crab larvae expressed as percentages are presented in Table 9.

Regression analysis revealed that in the Ship Channel the factors of upstream current and higher temperature were significantly correlated with larval crab abundance by both methods of analysis, and the best 3- and 7- variable models produced low R^2 values (0.09 and 0.10). In Saluria Bayou no factors were significantly correlated with larval abundance. By the method with zero values included, R^2 values of 0.32 and 0.33 were somewhat higher than by the method with zero values omitted (0.24 - 0.23). In the Intracoastal Waterway no physical factors were significantly correlated with larval abundance, and both methods yielded models of fairly low R^2 values (0.22 - 0.25). In Pass Cavallo no factors were significantly correlated with larval crab abundance. R^2 values for the best 3- and 5-variable models were high (0.64 - 0.80). Numerical models linking physical factors and biological abundance are given in Appendix C.

Fish eggs

Large numbers of fish eggs appeared in the collections, but the patterns of mean abundance varied considerably from one station to another (Table 8). The highest mean density of 56,241.1/1,000 m^3 appeared in the Intracoastal Waterway on cruise 5. In terms of percentage, in Pass Cavallo the peak occurred on cruise 4, in the Intracoastal Waterway on cruise 5, and in the Ship Channel and Saluria Bayou on cruise 6 (Table 9). Both estuarine and marine species were undoubtedly involved. As shown in Table 10, in the Ship Channel all seven physical parameters were significantly correlated with fish egg abundance by both methods of analysis. The best 3- and 7-variable models produced R^2 values in the range of 0.27 to 0.41. In Saluria Bayou, by both analytical methods, the significant physical parameters were high tidal height, high temperature, downstream current, and shallower depth. The models produced R^2 values ranging from 0.44 to 0.50 (Table 11). In the Intracoastal Waterway no physical parameters were significantly correlated with fish egg abundance. The best 3- and 5-variable models gave R^2 values of 0.16 - 0.25 (Table 12). In Pass Cavallo higher temperature was significantly correlated with fish egg abundance by the method with zero values included, but no factors were significant by the second method. The best 3- and 5-variable models produced extremely high R^2 values (0.86 and 0.92). Numerical models reflecting the best relationships of the physical factors with fish egg abundance are given in Appendix C.

Estuarine fish larvae

As seen in Table 8, no clear seasonal patterns of larval estuarine fish densities are apparent. Each pass exhibits its own pattern. In the Ship Channel mean densities were high during most cruises, reaching a maximum of 6,913.7/1,000 m^3 on cruise 5. Pass Cavallo exhibited both high and low mean densities, and in Saluria Bayou and the Intracoastal Waterway mean densities were consistently low. The lack of clear seasonal trends is particularly apparent when the densities are presented as percentages (Table 9). In the Ship Channel, by both methods of calculation, the following five factors were found to be significantly correlated with larval estuarine fish abundance: low light (night time), higher temperature, greater depth, higher salinity, and higher tidal height. The best 3- and 7-variable models provided R^2 values of 0.37 - 0.41 (Table 10). In Saluria Bayou, by the method with zero values included, lower salinity, lower temperature, and greater depth were significantly correlated with larval abundance, but with zero values omitted, only lower salinity and greater depth were so correlated. R^2 values associated with the best 3- and 6-variable models were quite low (0.04 - 0.11) (Table 11). In the Intracoastal Waterway, by both methods, only greater depth was significantly correlated with larval abundance. The best 3- and 5-variable models produced R^2 values of 0.14 and 0.17 (Table 12). In Pass Cavallo no physical parameters were significantly correlated with larval estuarine fish abundance. R^2 values were low (0.10 - 0.31) (Table 13). Numerical models depicting the best relationships of physical factors with larval estuarine fish abundance are given in Appendix C.

Marine fish larvae

As seen in Table 8, marine fish larvae were encountered at all stations during all cruises. Mean densities varied from less than 100 larvae/1,000 m^3 in Pass Cavallo on cruise 2 to over 1,000 larvae/1,000 m^3 in the Ship Channel on cruises 4 and 6 and in Pass Cavallo on cruise 4. In terms of percentages, there were no real peaks of larval abundance at any station or cruise except in Pass Cavallo on cruise 4 (Table 9). This peak would undoubtedly have been less sharp if collections had been made at this station during cruises 5 and 6.

In the Ship Channel regression analysis, by both methods, revealed the following six physical parameters to be significantly correlated with larval marine fish abundance: higher tidal height, lower light (night time), higher temperature, higher salinity, upchannel wind, and deeper water. Surprisingly, upchannel current was not significantly correlated with larval abundance. The best 3- and 7-variable models produced R^2 values in the range of 0.28 to 0.42 (Table 10). In Saluria Bayou, by the method with zero values included, higher salinity was significantly correlated with larval abundance, but no physical factors were significant when the zero values were omitted. R^2 values ranged from 0.11 to 0.34 (Table 11). In the Intracoastal Waterway no factors were significantly correlated with larval fish abundance by the method with zero values included, but when the zero values were omitted, upchannel current and higher temperature were significantly correlated with larval abundance. R^2 values were low (0.08 - 0.21) (Table 12). In Pass Cavallo, by both methods of analysis, only high temperature was significantly correlated with larval fish abundance. R^2 values were high (0.61 - 0.77) (Table 13). Numerical models showing the best relationships of the physical factors with larval marine fish abundance are given in Appendix C.

Marine sciaenid larvae

Marine sciaenid larvae appeared at all stations during all cruises except in Saluria Bayou during cruises 4 and 6 and the Intracoastal Waterway during cruises 4 and 5 (Table 8). In most instances mean densities were low (less than 100/1,000 m^3), and the highest value of 548.1/1,000 m^3 occurred in the Intracoastal Waterway on cruise 6. Percentagewise, most stations exhibited peaks during cruise 2, but in the Intracoastal Waterway the peak was observed on cruise 6 (Table 9).

In the Ship Channel, with zero values included, five physical factors were significantly correlated with larval sciaenid abundance: low light (night time), low temperature, higher tidal height, lower salinity, and deeper water. With zero values omitted, significant correlations were found only in the cases of low light, lower temperature, higher tidal height, and lower salinity. R^2 values varied from 0.18 and 0.20, with zero values omitted, to 0.32 and 0.36, with zero values included (Table 10). In Saluria Bayou only low temperature was significantly correlated with larval abundance. R^2 values, with zero values included, were low (0.26 - 0.24), but with zero values omitted, the R^2 values were fairly high (0.70 - 0.52) (Table 11). In the Intracoastal Waterway no factors were significantly correlated with larval abundance by either method. R^2 values were moderate (0.44 - 0.38) (Table 12). In Pass Cavallo there were not enough occurrences of marine sciaenid larvae to complete the analysis by the method with zero values omitted. With zero values included, no factors were significantly correlated with larval abundance. The models produced R^2 values of -0.05 and -0.54 (Table 13). Numerical models showing the best relationships of the physical factors with larval marine sciaenid abundance are provided in Appendix C.

Shrimp Larval Stage Data

Brown shrimp (*Penaeus aztecus*)

Larval and post-larval grooved shrimp appear in plankton catches throughout the year, but they are marked by two peaks in abundance, i.e., in spring and fall. The spring influx extends from mid-January to late May with a peak in late March, and the fall influx peaks in September. Details are subject to yearly variation. The early larvae (zoeal and mysis stages) tend to be found near the bottom, but post-larvae are taken primarily in upper levels of the water column, often but not always at night. In his studies in Cedar Bayou King (1971) found higher densities of post-larvae at the west, rather than the east bank, and higher densities at the surface than at the bottom. In his study mean densities of post-larvae varied from 2.71 to 41.23/m^3, and he found the 98.8 percent of the grooved shrimp were brown shrimp. Catch rates were greatest with a prevailing west wind and least with an east wind, and higher catches were made when the water was turbid and had a higher current velocity and when the tide level was high.

In the present study most of the larval shrimp stages were not assignable to individual species. However, since most were evidently brown shrimp, they will all be discussed at this point.

- Penaeidae - protozoea

Penaeid protozoea appeared in samples from all four stations. During cruise 2 none were taken. During cruises 3, 4, and 5 they were present at all stations sampled, and on cruise 6 they appeared only in the Ship Channel. On cruise 4 (April 27, 28) mean densities in excess of 5,000/1,000 m^3 were observed at all stations, and the mean density in the Ship Channel exceeded 13,000/1,000 m^3 (Table 14). Over 96 percent of the protozoea at each station occurred during cruise 4 (Table 15).

Multiple regression analysis (zero values included and zero values omitted) were carried out, and R^2 values were computed. In the Matagorda Ship Channel (with zero values included) high tidal height, upchannel wind, and deeper water were significantly correlated with larval abundance, but the best 3- and 7-variable models gave fairly low R^2 values of 0.30 and 0.32. With zero values omitted, only upchannel wind and higher tidal height were significantly correlated with larval abundance. The best 3- and 7-variable models gave improved R^2 values of 0.41 and 0.44 respectively (Table 16). In Saluria Bayou (zero values included) the significant parameters were lower tidal height and upchannel current with R^2 values of 0.31 and 0.30. With zero values omitted, the significant variables were high salinity and upstream wind vector, and the R^2 values were higher (0.52 and 0.59) (Table 17). In the Intracoastal Waterway (zero values included) upchannel current and upchannel wind were significant with R^2 values of 0.35 and 0.36. With zero values omitted, only upchannel current was significant, and R^2 values were higher (0.67 and 0.68) (Table 18). In Pass Cavallo, with zero values included, the significant parameters were lower salinity and higher temperature, and R^2 values were quite high (0.95 and 0.92). Since penaeid protozoea appeared in only five samples from Pass Cavallo, this high R^2 value must be interpreted with some caution. Larval occurrences were insufficient to permit regression analysis with zero values omitted (Table 19). Numerical models linking physical factors with penaeid protozoea abundance are provided in Appendix D.

- _Penaeus_ - mysis

During the present study _Penaeus_ mysis stages appeared at all stations sampled. They were absent from all stations during cruise 2 and present at all stations during cruises 3 and 4. During cruises 5 and 6 they were taken only in the Ship Channel. As in the case of the protozoea, mean densities at all stations were highest during cruise 4 (May 27-28) where mean densities exceeded 425/1,000 m^3 at all stations. The highest mean density of 3,718/1,000 m^3 occurred in the Ship Channel during this cruise (Table 14). Over 70 percent of the mysis stages taken at each station occurred during this cruise (Table 15).

Regression analyses revealed that in the Ship Channel the significant physical parameters were high tidal height, upchannel current, and greater depth (zero values included) and upchannel wind and higher tidal height (zero values omitted). R^2 values did not exceed 0.24 by either method (Table 16). In Saluria Bayou upchannel current was significantly correlated with larval abundance, with zero values included, but no parameters showed a significant correlation, with zero values omitted. R^2 values were low, with zero values included, but fairly high (0.57 and 0.71), with zero values omitted (Table 17). In the Intracoastal Waterway the same picture emerged. Upchannel current was the only significant parameter, with zero values included, and none were significant by the second method. R^2 values were low, with zero values included, but fairly high (0.58 and 0.76), with zero values omitted (Table 18). In Pass Cavallo no physical parameters were significant by either method, but R^2 values were fairly high (0.78 and 0.68) with zero values included (Table 19). The numerical models linking physical factors with _Penaeus_ mysis abundance are provided in Appendix D.

- _Penaeus_ _aztecus_ - post-larvae

In the present study the shrimp post-larvae were separated into two groups, those which were definitely identifiable as _P. aztecus_ post-larvae and those which were not definitely identifiable as such. The latter category (Penaeus spp. post-larvae) may have included P. duorarum, P. setiferus, and possibly some P. aztecus. Unfortunately, in the very young post-larvae the groove is indistinct, and these post-larvae could not be separated into "grooved" and "non-grooved" categories. The present section will treat only those larvae definitely identified as P. aztecus.

P. aztecus post-larvae were taken at all sampling localities on all cruises except Pass Cavallo on cruise 2, Saluria Bayou on cruise 3, and the Intracoastal Waterway on cruise 4. In the Ship Channel and in Saluria Bayou the highest mean densities of 992 and 2,965/1,000 m^3 respectively were seen on cruise 2 (Table 14). In the Intracoastal Waterway the greatest mean density of 218/1,000 m^3 occurred on cruise 3, and in Pass Cavallo the highest mean density of 469/1,000 m^3 occurred during cruise 4. Percentages by station and cruise are given in Table 15).

Regression analysis revealed that in the Ship Channel lower temperature, higher tidal height, and lower salinity were significantly correlated with post-larval abundance by the method with zero values included, and lower temperature, higher tidal height, and shallower depth were significant when the zero values were excluded. R^2 values were only moderately high by the two methods, ranging from 0.29 to 0.45 (Table 16). In Saluria Bayou only lower temperature was significant, with zero values included, and no parameters were significant by the second method. R^2 values of 0.37 and 0.36 appeared by the first method, and R^2 values of 0.51 and 0.25 occurred by the second method (Table 17). In the Intracoastal Waterway down-channel current and higher salinity were significant by the first method, and no parameters were significant by the second method. R^2 values for the best 3- and 5-variable models gave values of 0.29 by the first method and values of 0.46 and 0.42 by the second method (Table 18). In Pass Cavallo no parameters were significant, and R^2 values of 0.16 and -0.25 were obtained (Table 19). Numerical models for Penaeus aztecus post-larvae are presented in Appendix D.

- Penaeus spp. - post-larvae

As mentioned above, during the present study those post-larvae not definitely identifiable as P. aztecus were assigned to the category Penaeus spp. which may have included any or all of the three species of Penaeus which inhabit the area. This group was barely represented during cruises 2 and 3 but was present at all stations during cruises 4, 5, and 6. In Pass Cavallo the maximum mean density of 1,002/1,000 m^3 occurred on cruise 4 (Table 14). In the Ship Channel and Saluria Bayou the maximum mean densities of 407 and 1,338/1,000 m^3 respectively were achieved on cruise 5, and in the Intracoastal Waterway the maximum mean density of 854/1,000 m^3 appeared on cruise 6. The corresponding percentages are given in Table 15. Considering the seasonal distribution of these unidentified post-larvae, it appears likely that they represent primarily the white shrimp, _P_. _setiferus_, possibly mixed with a few _P_. _aztecus_ and _P. duorarum_ in which the diagnostic characteristics were not clearly discernible.

Regression analysis with the Ship Channel data, with zero values included, revealed that higher temperature, deeper water, and lower light conditions were significantly correlated with post-larval abundance, but with zero values omitted, only deeper water was so correlated. All R^2 values were quite low (0.07 - 0.15) (Table 16). In Saluria Bayou both methods revealed that post-larval abundance was significantly correlated with higher temperature, higher tidal height, greater depth, and upchannel wind. R^2 values by both methods ranged about 0.34 - 0.42 (Table 17). In the Intracoastal Waterway post-larval abundance was significantly correlated only with greater depth. All R^2 values were quite low (-0.07 to 0.08) (Table 18). In Pass Cavallo no physical parameters were significantly correlated with post-larval abundance, and R^2 values by the method with zero values included were moderate (0.37 and 0.06) (Table 19). Numerical models depicting the relationship of physical factors and biological abundance are given in Appendix D.

Pink shrimp (_Penaeus duorarum_)

During their survey of the demersal fauna of the northwest gulf continental shelf, Darnell _et al_. (1983) found that pink shrimp constituted 4.6 percent of the adult population of grooved shrimp, and King (1971) found pink shrimp to make up 1.2 percent of the grooved shrimp emigrating to the shelf through Cedar Bayou. Little is known about the spawning season of this species in Texas waters, but it probably spawns on the continental shelf during the late spring and summer months. In the present study the pink shrimp was not specifically identified, and no new information is available concerning the species.

White Shrimp (Penaeus setiferus)

Baxter and Renfro (1966) found white shrimp post-larvae to be present in Galveston Bay from May to November with a large spring - early summer peak (May - July) and a smaller peak in the fall (September - November). In Cedar Bayou King (1971) collected some post-larvae during all months except March and April. Although white shrimp are taken in some abundance in Texas bays and estuaries, in King's study white shrimp post-larval abundance was only 0.23 percent of that of the brown shrimp, and only 35 juveniles were taken. In the present study white shrimp were not specifically identified, but as noted earlier, the summer influx of post-larvae (identified as Penaeus spp. post-larvae) probably represents primarily the white shrimp.

Crab Larval Stage Data

Blue crab (Callinectes sapidus)

The life history of the blue crab in the northern Gulf of Mexico was originally reported by Darnell (1959). Most larvae are released in the nearshore waters of the gulf, but this may also occur in the lower bays and estuaries if the salinity remains above 20 °/oo. Although some larvae and very young may be taken during all months, in Texas waters there are normally two spawning peaks, one in spring (March - April) and the other in late summer (July - August). This varies from year to year, and there may be as few as one and as many as three spawning peaks. The peaks may begin as early as January and occur as late as October.

In his studies in Cedar Bayou King (1971) obtained no Callinectes zoea, apparently because the large mesh size (1.0 mm) of his nets did not retain these tiny larval stages. However, he did collect over 40 million megalops stages. He found the greatest densities at the surface in mid-channel. Densities were highly correlated with wind direction (west wind greatest, east wind least), and high correlations were also associated with higher salinity, high turbidity, and higher current velocity.

In the present study the crab larvae and juveniles were identified in the following groups: portunid zoea, Callinectes megalops, portunid juveniles, and Callinectes sapidus (young metamorphosed individuals). Each of these groups is discussed separately below. There are several species of portunid crabs in

Texas coastal waters, but most of the larval stages are presumed to represent the blue crab, Callinectes sapidus with some admixture of the closely related Callinectes similis.

\- Portunid zoea

Portunid zoea were present at all stations during all cruises. Mean densities ranged from a low of 24.7/1,000 m^3 on cruise 2 to a high of 31,592.71/1,000 m^3 on cruise 4, both in Saluria Bayou (Table 20). The highest single sample density of 63,641/1,000 m^3 was observed in Saluria Bayou on cruise 4. Over 70 percent of the portunid zoea taken in Saluria Bayou, the Intracoastal Waterway, and Pass Cavallo occurred during cruise 4, but in the Ship Channel there was no definite peak, and the highest percentage (34.9 was seen on cruise 5 (Table 21).

In the Ship Channel the factors high temperature, low tidal height, and high light (daytime) were significantly correlated with larval abundance (zero values included), and the best 3- and 7-variable models produced R^2 values of only 0.18 and 0.21. With zero values excluded, these same variables plus upchannel current were significantly correlated with larval abundance, and again the R^2 values were low (0.16 and 0.20) (Table 16). In Saluria Bayou, by both methods of analysis, low tidal height and upchannel current were significantly correlated with larval abundance, and R^2 values ranged from 0.28 to 0.37 (Table 17). In the Intracoastal Waterway, by both methods, upchannel wind was significantly correlated with larval abundance, and R^2 values ranged from 0.36 to 0.42 (Table 18). In Pass Cavallo, by both methods, higher temperature, upchannel current, down-channel wind, low tidal height, and lower salinity were significantly correlated with larval abundance, and the best models produced R^2 values of 0.94 - 0.99 (Table 19). In view of the small number of samples from Pass Cavallo, little reliance is placed on these correlations. Numerical models depicting the relationships of the physical parameters with portunid zoeal abundance are given in Appendix D.

\- Callinectes megalops

The megalops stage of Callinectes is readily recognized. Most of the identified individuals were certainly C. sapidus with a few C. similis included. In the present study the megalops stage appeared during all cruises in the Ship Channel, but they were absent form some cruises at each of the other stations. Mean densities in excess of 1,000/1,000 m^3 occurred in the Ship Channel, Saluria Bayou, and

Pass Cavallo during cruise 2 and in the Intracoastal Waterway during cruise 6 (Table 20). The highest single sample density of 12,570/1,000 m^3 was observed in the Ship Channel during cruise 2.

Regression analysis revealed that in the Ship Channel (zero values included) down-channel wind, high tidal height, and upchannel current were significantly correlated with megalops abundance, and with zero values omitted no physical factors were significantly correlated with larval abundance. By both methods of analysis the R^2 values were quite low (0.04 - 0.20) (Table 16). In Saluria Bayou (zero values included) high tidal height was significantly correlated with larval abundance, and by both methods the best-model R^2 values were fairly low (0.07 - 0.19)(Table 17). In the Intracoastal Waterway no factors were significantly correlated with larval abundance. With zero values included the R^2 values were quite low (0.10 - 0.08), but with zero values omitted the R^2 values were slightly higher (0.12 - 0.17) indicating greater reliability of the models (Table 18). In Pass Cavallo, with zero values included, no physical factors were significantly correlated with larval abundance, and best-model R^2 values were 0.39 and 0.13 (Table 19). There were too few occurrences at this station to complete the analysis with zero values omitted. Numerical models relating the physical parameters with megalops abundance are provided in Appendix D.

- Portunid juveniles

Juvenile portunid crabs appeared in the Ship Channel during all cruises, but at the other stations they were taken only sporadically. In the Ship Channel mean densities in excess of 200/1,000 m^3 occurred during cruises 2 and 6 (Table 20). The highest single sample density of 1,646/1,000 m^3 was observed in the Ship Channel during cruise 6. Parameters significantly correlated with portunid juvenile abundance in the Ship Channel included low light (night-time) and upchannel current (zero values included) and low light, upchannel current, and deeper water (zero values excluded). R^2 values were low (0.15) by the zero inclusion method, and higher (0.33 - 0.30) by the zero exclusion method (Table 16). In Saluria Bayou (zero values included) high tidal height was significantly correlated with portunid juvenile abundance, and R^2 values were only 0.05 and 0.02. With zero values excluded, deeper water, upchannel current, and shallower water were significantly correlated with juvenile crab abundance. (Table 17). In the Intracoastal Waterway, by the zero inclusion method, no parameters were significantly correlated with juvenile portunid abundance, and the R^2

values were quite low. By the zero exclusion method deeper water and higher salinity were significantly correlated with juvenile abundance. (Table 18). In Pass Cavallo, by the zero inclusion method, no physical factors were significantly correlated with juvenile abundance and the best models produced negative R^2 values of -0.14 and -0.17 (Table 19). Because of insufficient occurrences regression analysis could not be carried out by the zero exclusion method. It is noted that the number of occurrences of juvenile portunids was low in Saluria Bayou, the Intracoastal Waterway, and Pass Cavallo. Hence, regression results from these stations are not really reliable. Numerical models relating the physical variables with juvenile portunid abundance are given in Appendix D.

- *Callinectes sapidus*

During the present study juvenile crabs definitely identified as *Callinectes sapidus* appeared in only a single sample form the surface on an incoming current during cruise 5. Statistical analysis is not warranted.

Fish Larval Data

Sheepshead (*Archosargus probatocephalus*)

In Texas waters the sheepshead spawn from January through May with a peak in March. In his study of Cedar Bayou, King (1971) took a total of 261 post-larval specimens during the period of January-May with the greatest abundance occurring the month of March in both years. Most specimens occurred near the surface and near the east bank. Although no environmental factor correlations were found to be statistically significant, King did note that 64.3 percent were taken during the night-time hours.

In the present study the sheepshead appeared in a single sample in the Intracoastal Waterway on cruise 3 (April 30). The density in this sample was 82/1,000 m^3, and the overall density for this station on cruise 3 and 8.2/1,000 m^3 of water. (Table 20). The species occurred at the surface on an outgoing tide.

Southern flounder (*Paralichthys lethostigma*)

Three species of *Paralichthys* are found in Texas coastal waters, the gulf flounder (*P. albigutta*), southern flounder (*P. lethostigma*), and broad flounder (*P. squamilentus*). Of these three, the southern flounder is the only one likely to be found in any abundance in the bays and estuaries. In his study of Cedar Bayou King (1971) did not distinguish between post-larvae of the three species, but most of his 18,121 specimens certainly were southern flounders. Along the Texas coast this species spawns from December through April with peak spawning activity occurring during the period January-March. King (1971) noted the greatest abundance near the sides rather than in mid-channel, and the specimens appeared in greater abundance near the surface rather than in deeper water. In King's study post-larval abundance was significantly correlated with wind direction (west wind greatest, east wind least), lower wind velocities, higher salinity, higher turbidity, higher tidal amplitude, and longer tidal duration. There was no evidence of day-night or lunar periodicity effects.

The southern flounder was not taken during the present study.

Silver perch (Bairdiella chrysoura)

Along the northern gulf coast the silver perch may spawn inside coastal lagoons, in deep channels of the passes, or in nearshore waters of the gulf. In Texas waters the spawning season extends from April through September with a peak during the period May-July. In his Cedar Bayou studies King (1971) did not report on this species.

During the present study the silver perch was taken at all four sampling localities (Table 22). Mean densities in the Ship Channel and Pass Cavallo were considerably higher than elsewhere. Specimens were taken during cruises 3 through 6 (April 29 - August 16) with highest densities occurring during cruise 4 (May 27-28). Over 90 percent of the silver perch larvae taken in the Ship Channel, Saluria Bayou, and Pass Cavallo appeared in samples from this cruise (Table 23). Multiple regression analysis of the relations of physical variables with larval abundance were carried out by two methods (i.e., with zero values included and with zero values omitted), and in each case R^2 values were computed to determine the amount of variance which is accounted for. In the Ship Channel, with zero values included, up-channel wind and high tidal height were significantly correlated with larval abundance, but the best 3- and 7-variable models gave very low R^2 values (0.13 and 0.14). With zero values omitted only up-channel wind was significantly correlated with larval abundance, but the best 3- and 7-variable models gave high R^2 values (0.65 and 0.70) indicating high reliability of the models (Table 24).

Insufficient samples were available to carry out regression analysis of Saluria Bayou data (Table 25), but the analysis was carried out for Intracoastal Waterway data (Table 26). With zero values included no parameters were significantly correlated with larval abundance, and the best 3- and 5-variable models gave very low R^2 values (0.02 and 0.00). With zero values omitted, higher temperature and down-channel current were significantly correlated with larval abundance, and the best 3- and 5-variable models provided fairly high R^2 values (0.43 and 0.55) indicating fairly reliable models. The numerical models linking the abundance of silver perch larval abundance with the various physical factors in the Ship Channel and the Intracoastal Waterway are provided in Appendix E.

Sand seatrout (Cynoscion arenarius)

The sand seatrout spawns on the continental shelf during the warmer months (March-November) with spring and fall spawning peaks. This species was not discussed by King (1971).

In the present study the sand seatrout appeared in samples form the Matagorda Ship Channel, Saluria Bayou, and the Intracoastal Waterway, but not in samples from Pass Cavallo. It occurred during all cruises except cruise 4 (i.e., from April 1 - August 16, but not during the period May 27-28). The highest mean denisties in samples taken from the Ship Channel and from Saluria Bayou occurred during cruise 2 (April 1-2) indicating a spring spawning peak, and the high percentage in the Intracoastal Waterway in mid-August may represent the beginning of the fall spawning peak (Table 23). The highest single sample density observed during the study (5,696/1,000 m^3) occurred in the Intracoastal Waterway in mid-August.

Multiple regression analysis was carried out for the sand seatrout data from the Ship Channel and the Intracoastal Waterway, but not from Saluria Bayou, where the number of samples occurrence was insufficient. In the Ship Channel, with zero values included, the environmental variables significantly correlated with larval abundance included: low light, low temperature, high tidal height, deeper water, and lower salinity (Table 24). The best 3- and 7-variable models produced R^2 values of 0.22 or less. With zero values omitted, only high tidal height and low light were significantly correlated with larval abundance, and the R^2 values for the best 3-

and 7-variable models were quite low (0.07 or less) indicating low reliability of the models.

For the Intracoastal Waterway, with zero values included, no physical parameters were significantly correlated with larval abundance, and the best 3- and 5-variable models produced low R^2 values of 0.08 and 0.07 (Table 26). With zero values omitted, still no physical parameters were significantly correlated with larval abundance, but the best 3- and 5-variable models produced R^2 values of 0.27 and -0.21 respectively. The best numerical models linking sand seatrout larval abundance with physical factors in the Ship Channel and the Intracoastal Waterway are provided in Appendix E.

Spotted seatrout (<u>Cynoscion nebulosus</u>)

Along the northern gulf coast the spotted seatrout spawns primarily in grassy areas inside the bays and lagoons. The spawning season lasts form March through November with the heaviest spawning activity occurring during the warmest months (June-August). In Cedar Bayou, King (1971) found post-larvae of this species to be most abundant at mid-depths, and the greatest influx was correlated with lower water temperatures. Day and night catches were about equal.

In the present study the spotted seatrout was taken at all localities sampled, and it occurred during all cruises (from April 1 through August 16) (Table 22). In the Ship Channel it appeared in samples from every cruise, and the highest mean densities occurred at this locality. Highest mean densities appeared during cruises 4, 5, and 6 (May 27 - August 16) (Table 23), and the single highest individual sample density (2,703/1,000 m^3) occurred in the Ship Channel on July 30).

Multiple regression analysis was carried out for spotted seatrout data from the Ship Channel, Saluria Bayou, and the Intracoastal Waterway. In the Ship Channel, with zero values included, only high temperature was significantly correlated with larval abundance (Table 24). The best 3- and 7-variable models gave low R^2 values (0.10 or less). With zero values omitted, no physical parameters were significantly correlated with larval abundance, and for the best 3- and 7-variable models the R^2 values were again quite low (0.07 and 0.01). For the Saluria Bayou data, with zero values included, no physical parameters were significantly correlated with larval abundance (Table 25), and the best 3- and 6-variable models produced low R^2 values. With zero values omitted, greater water depth, lower temperature, lower salinity, and up-channel wind were all significantly correlated with larval abundance. The best 3-variable model produced an R^2 of 0.21, but the best 6-variable model gave and R^2 of 0.97, the highest R^2 value produced during the study for any fish species. For the Intracoastal Waterway data, with zero values included, down-channel wind and higher temperature were significantly correlated with larval abundance (Table 26). The best 3- and 5-variable models gave R^2 values of only 0.06 - 0.03. With zero values included, no physical parameters were significantly correlated with larval abundance. The best 3- and 5-variable models produced R^2 values of 0.32 and 0.15, respectively, indicating a moderate degree of reliability. The best numerical models relating spotted seatrout larval abundance with physical factors in the Ship Channel, Saluria Bayou, and the Intracoastal Waterway are presented in Appendix E.

Silver seatrout (Cynoscion nothus)

Little is actually known about the spawning season of the silver seatrout, although on the Texas coast the species appears to spawn in gulf waters during the month of August. The larvae are quite similar to those of the sand seatrout (C. arenarius), and it is likely that they have been confused by previous workers. Since the silver seatrout is largely limited to the continental shelf, few larvae would be expected in the passes. This species was not discussed by King (1971).

During the present study the silver seatrout appeared only in a single sample from the Intracoastal Waterway during cruise 6 (August 14). Its density in this sample was 14/1,000 m^3 and the mean density at this station was 1.0 (Table 22).

Banded drum (Larimus fasciatus)

Along the northern gulf coast the banded drum appears to spawn from May through November. This is not an abundant species, and few larvae would be anticipated in the passes. The species was not discussed by King (1971).

In the present study the banded drum did not appear in any samples.

Spot (Leiostomus xanthurus)

In the northern gulf the spot apparently spawns from nearshore waters out through the mid-shelf area. Spawning occurs during the cooler months (October through March) with peak spawning activity taking place during the period January-March. This species was not discussed by King (1971).

In the present study the spot was taken only from the Matagorda Ship Channel during cruises 2 and 3. Sample densities ranged from 29 to 102/1,000 m^3 of water, and the mean densities for this location were 0.8/1,000 m^3 for cruise 2 and 5.0/1,000 m^3 for cruise 3 (Table 22). The number of occurrences was insufficient for further analysis.

Southern kingfish (Menticirrhus americanus)

Three species of Menticirrhus are present in Texas coastal waters, the southern kingfish (M. americanus), gulf kingfish (M. littoralis), and northern kingfish (M. saxatilis, formerly called M. focaliger). Early life history stages of the three species are difficult to distinguish. Along the Texas coast the southern kingfish apparently spawns throughout the year with diminished intensity during the colder months. Hoese (1965) suggested that spawning takes place in the nearshore gulf waters during the summer and in deeper shelf waters during the spring and fall. In his studies of Cedar Bayou, King (1971) did not discuss this species.

During the present study the southern kingfish occurred only in collections from the Matagorda Ship Channel during cruised 3 and 5 (May 1-2 and July 30 - August 1). Sample densities ranged from 12 to 63/1,000 m^3 of water. Mean density in the Ship Channel on cruise 3 was 2.1/1,000 m^3 and on cruise 5 was 0.2/1,000 m^3 (Table 22).

Gulf kingfish (Menticirrhus littoralis)

The gulf kingfish spawns on the continental shelf from May through August and possibly during the spring and fall. The species is rare along the Texas coast, and it was not included in King's (1971) studies of Cedar Bayou.

The gulf kingfish was not taken during the present study.

Northern kingfish (Menticirrhus saxatilis)

As in the case of the gulf kingfish, the northern kingfish is quite rare in the coastal waters of Texas. It seldom enters the bays and estuaries. Although little is known about its spawning activities in the area, it is likely that the species spawns primarily during the fall, winter, and spring months. This fish was not discussed by King (1971).

During the present study no specimens of the northern kingfish were encountered.

Atlantic croaker (Micropogonias undulatus)

The Atlantic croaker is one of the most numerous fish species in the bays and estuaries of the Texas coast. Spawning takes place on the continental shelf some distance from shore. It occurs during the cooler months from mid-September to early May with peak spawning activity during October and November. King (1971) did not address this species.

During the present study the Atlantic croaker appeared only in collections from the Ship Channel and Saluria Bayou. In the Ship Channel it was taken during cruises 2, 3, and 5 (April 1, May 1-2, and July 30), and in Saluria Bayou it was encountered only during cruise 2 (April 2). Densities in the samples ranged from 18 to 65/1,000 m^3, and the mean station densities for the Ship Channel were 2.9, 5.9, and 0.5/m^3 for cruises 2,3, and 5, respectively. In Saluria Bayou for cruise 2 its mean density was 12.0/1,000 m^3 (Table 22).

Black drum (Pogonias cromis)

In Texas coastal waters the black drum spawns primarily during the spring months (early March through late May), but some spawning may continue through the summer and fall months until November. The primary peak of spawning activity occurs in April, and there may be a secondary peak in late June and early July. Spawning apparently takes place primarily in the deeper channels and passes, inside the bays and estuaries near the passes, or in nearby gulf waters. In his Cedar Bayou study, King (1971) collected 5,172 post-larval black drum, and he found the greatest density to occur at mid-channel near the surface. Post-larval abundance was significantly correlated with lower air temperature, higher turbidity, higher tidal amplitude, and higher current velocity. There appeared to be no significant relationship between post-larval abundance and day-night or lunar phase periodicity.

During the present study black drum were taken at all localities sampled, and they occurred in some samples during all the cruises (March 31 through August 14)(Table 22). Most of the specimens were taken during cruise 2 (March 31-April 2) with smaller numbers during cruise 3 (April 29 - May 2), and only occasional individuals thereafter. Sample densities varied form 33 to 407/1,000 m^3 of water.

Multiple regression analysis was carried out for the black drum data from the Ship Channel and Saluria Bayou, but not from the other localities due to the low number of stations of occurrence. In the Ship Channel, with zero values included, the environmental variables significantly correlated with larval abundance included lower temperature and lower salinity (Table 24). The best 3- and 7-variable models produced R^2 values of 0.44. With zero values omitted, only lower temperature was significantly correlated with larval abundance, and the best 3- and 7-variable models gave R^2 values of only 0.12 and 0.09, indicating low reliability. For Saluria Bayou, with zero values included, lower temperature was significantly correlated with larval abundance, and the best 3- and 6-variable models gave R^2 values of 0.28 and 0.29 (Table 25). With zero values omitted, no physical parameters were significantly correlated with larval abundance, but the best 3- and 6-variable models produced R^2 values of 0.58 and 0.34. The best numerical models linking black drum larval abundance with physical factors in the Ship Channel and in Saluria Bayou are given in Appendix E.

Red drum (Sciaenops ocellatus)

On the Texas coast the red drum spawns in nearshore gulf waters near the passes. Spawning commences around mid-August and continues into December with peak spawning activity occurring during a short period in late September and early October. In Cedar Bayou King (1971) took 1,127 specimens of post-larval red drum. He found that on flood tide the greatest densities occurred in mid-channel at the surface. However, within 30 minutes of the commencement of ebb tide the post-larvae were concentrated in the shallow grassy areas lining the channel banks where they remained until the next flood tide. Abundance was correlated with moon phase as follows: new moon, 0.004/m^3; first quarter moon, 0.005/m^3; full moon, no catch; third quarter moon, 0.499/m^3.

Catches were made only when the wind was from the south or east and were correlated with lower wind velocities and higher current velocities. Post-larval abundance appeared to be independent of other environmental variables.

During the present study red drum occurred only in collections from the Matagorda Ship Channel and from Saluria Bayou during cruises 5 and 6 (July 25 - August 16). Sample densities ranged form 72 to 199/1,000 m^3, and mean cruise/station densities ranged from 2.0 to 9.0/1,000 m^3 (Table 22). Data for this species were insufficient for regression analysis.

Star drum (Stellifer lanceolatus)

In the coastal waters of Texas the star drum spawns from May through September with apparent peaks in late May and in September. Spawning seems to take place in the deep channels of the passes and in nearshore gulf waters. This species was not discussed by King (1971).

In the present study specimens of the star drum were taken only in samples from the Matagorda Ship Channel and from the Intracoastal Waterway. Ship Channel specimens appeared during cruises 4 and 5 (May 28, July 30, and August 1), and the Intracoastal Waterway specimens were taken during cruise 6 (August 14). Densities in individual samples ranged from 8 to 1,512/m^3, and mean station/cruise densities ranged from 24.7 to 84.3/m^3 (Table 22).

Multiple regression analysis was carried out on the Ship Channel data, but occurrences in the Intracoastal Waterway were insufficient for such analysis. Within the Ship Channel, with zero values included, larval abundance was significantly correlated with deeper water. The best 3- and 7-variable models produced very low R^2 values of 0.06 (Table 24). With zero values omitted, larval abundance was again significantly correlated with deeper water, but the best 3- and 7-variable models produced much higher R^2 values (0.32 and 0.25). The best numerical models linking the abundance of star drum larvae with the various physical factors in the Ship Channel are provided in Appendix E.

DATA ANALYSIS

It has previously been shown that the data base is marked by a high degree of internal variability. Characterization of the relationships of physical and biological variables, in many cases, produces low R^2 values. Although two different gear types were employed, any bias due to combining catch data from the different gear types appears to be masked by the inherent variability of the data set itself. Regression analysis has clearly shown that data from the different stations cannot reasonably be combined and that each station must be analyzed independently.

Regression methods. In attempting to characterize the relationships of the physical factors with biological abundance data, multiple regression analysis has been carried out by two methods, i.e., with zero values included and with zero values omitted. A decision must now be made concerning which method most clearly reflects the relationships under consideration and, therefore, merits more serious consideration. Table 27 presents a statistical comparison of the means of the paired R^2 values for the different data subsets (biological group data, shrimp and crab larval stage data, and fish larval data). It is seen that in all cases the mean R^2 values derived by the method with zero values omitted exceeds the values derived by the other method and that the difference between the mean values becomes progressively larger and statistically more significant as one proceeds from the heterogeneous group data, through larval stage data, to the individual species data set. These findings are consistent with our knowledge of the data sets and the natural systems. In the biological group data set many species and life history stages are included and few zero values appear. Hence analysis of the two data sets yields fairly similar results. However, as the data are broken down by larval stages and the individual species (which are generally rarer in occurrence), the frequency of zero values rises, and the analytical results diverge. The presence of many zero values tends to reduce the sharpness of the analysis by including sets of physical conditions which would be ideal for larval transport but for periods during which the organisms were unavailable. Thus, the R^2 values (based upon regression analysis with zero values included) drop because of poorer correlations. The absence of zero values provides a focus upon the physical conditions prevailing when the organisms are actually present, and the R^2 values progressively increase as the biological targets become more sharply defined. For these reasons it is apparent that the most sound basis for judging the relationships of the physical parameters with biological abundance rests in the regression analyses in which the zero values are omitted. These are the regression analyses upon which the remainder of the discussion will be based. In a few instances (primarily in Pass Cavallo) where regression could not proceed by this method due to too few biological occurrences, regression analysis with zero values included had to be used. All such cases are clearly indicated.

Effects of physical factors on overall biological abundance. In order to determine the relationships of the several physical factors on overall biological abundance it is necessary to summarize regression analysis information from the four collecting stations, and it is appropriate to use the data from the six major biological groups (which account for all the species and life history stages taken). The focus here is upon the signs (positive or negative) associated with each physical factor in the various regression models. This information is summarized in Table 28, which also provides the mean R^2 value for each location. Each physical factor will be addressed separately.

- Current. In 79.2 percent of the cases (19 out of 24) upchannel current is correlated with biological abundance, and this pattern is consistent through all station locations. As judged by the z-test for binomial proportions, this percentage differs significantly from an expected 50:50 ratio at the 5 percent level. The data, thus, support the contention that upchannel current is the primary factor involved in larval transport from the continental shelf to the estuary.

- Wind. In 66.7 percent of the cases (16 out of 24) upchannel wind is correlated with biological abundance. This pattern is consistent through three of the stations, but in Pass Cavallo the reverse is true. Here biological abundance is correlated with down-channel wind. Why this should be so is not clear, but it is noted that in Pass Cavallo the same pattern occurs in relation to lower salinity. At this station all samples were taken at the surface, and higher biological abundances appear to be associated with fresher surface water exiting the pass (which definitely occurred when a "norther" hit during cruise 4). Omitting the Pass Cavallo data, the relationship would have been 83.3 percent, strongly in favor of the upchannel wind. The z-test reveals that both the 66.7 and the 83.3 percent values differ significantly from a 50:50 split at the 5 percent level of confidence.

- Tidal height. In only 55.6 percent of the cases (10 out of 18) higher tidal height is correlated with biological abundance, and this pattern is consistent at all three stations for which tidal height information is available. Apparently, the theoretical tidal height based upon astronomical factors is considerably less important in causing larval transport than are upchannel current and upchannel wind. This and the remaining values are not statistically significant.

- Depth. In exactly 50.0 percent of the cases (9 out of 18) deeper water is correlated with biological abundance. Some species and life history stages appear to favor the bottom, others the surface, and the proportion of the two is about equal. In either event, depth, per se, is not a factor forcing larval transport.

- Temperature. In 58.3 percent of the cases (14 out of 24) higher temperature is correlated with larval abundance. This may relate to the fact that the majority of the samples were taken during the summer months or that larvae from summer spawners were numerically more abundant. Taken over the entire period of the study, this tells little about transport mechanisms.

- Salinity. In only 45.8 percent of the cases (11 out of 24) higher salinity is correlated with biological abundance. At most stations the correlations with higher or lower salinity is about even, but in Pass Cavallo the discrepancy is 1:5 in favor or lower salinity. Possible reasons for this are discussed above under the topic, "wind." It does seem quite clear that higher or lower salinity, per se, has little to do with the mechanism of larval transport from the Gulf to the estuary.

- Light. Since night-time collections were made only in the Ship Channel, this is the only location for which a day/night comparison can be made. Here daytime collections are correlated with biological abundance in only 33.3 percent of the cases (2 out of 6). This suggests that larval densities are greater at night, at least in the Ship Channel.

As might be expected in a data base extending over several months and encompassing a diversity of species, the mean R^2 values are low for the Ship Channel, Saluria Bayou, and the Intracoastal Waterway. The mean value for Pass Cavallo is fairly high, and this reflects the fact that fewer collections were made at this station, and these were made only at the surface.

Effects of physical factors on major biological groups. In the previous section we examined relationships between the several physical factors and the major biological groups, as a whole. Herein, each of the major groups is examined separately to gain an overview of the factors correlated with each group in the four passes. An arbitrary but convenient frame of reference is employed, as follows. A clear case of correlation is defined as one in which the factor is correlated with biological abundance in at least 75 percent of the cases (given at least three opportunities to occur). A less clear correlation is one in which the factor is correlated with biological abundance in less than 75 percent of the cases (or in which there are fewer than three occurrences). No predominant correlation exists where the number of positive and negative correlations is equal.

- Shrimp larvae. As shown in Table 29, the abundance of shrimp larvae is primarily correlated with upchannel current, upchannel wind, lower temperature, and lower salinity. Abundance is less clearly correlated with higher tidal height, shallower depth, and daytime conditions. R^2 values vary from 0.23 to 0.97, with a mean value of 0.51.

- Crab larvae. The abundance of crab larvae is primarily correlated with upchannel current, upchannel wind, lower tidal height, shallower depth, and higher temperature. Daytime conditions are less clearly correlated with crab larval abundance, and lower and higher salinity are equally correlated with abundance. R^2 values range from 0.13 to 0.87, with a mean value of 0.40.

- Fish eggs. The abundance of fish eggs is most clearly correlated with higher temperature and higher salinity. Less clear correlations are associated with higher tidal height, shallower depth and lower light (night time) conditions. Correlations involving current and wind show equal correlations with the upchannel and down channel directions. Since eggs of both estuarine and marine species are likely involved, lack of a clear correlation with wind and current direction is not unexpected. R^2 values vary from 0.23 to 0.95, with a mean value of 0.54.

- Estuarine fish larvae. The abundance of estuarine fish larvae is primarily correlated with upchannel current, greater depth, higher temperature, and higher salinity. Less clear correlations are associated with higher tidal height and lower light (night time) conditions. Correlations with up and down channel wind vectors are equal. R^2 values range from 0.21 to 0.59, with a mean value of 0.36.

- <u>Marine fish larvae</u>. The abundance of marine fish larvae is most clearly correlated with upchannel current, higher temperature, and higher salinity. Less clear correlations occur in relation to higher tidal height, greater depth, and lower light (night time) conditions. R^2 values range from 0.23 to 0.86, with a mean value of 0.45.

- <u>Marine sciaenid larvae</u>. The abundance of marine sciaenid larvae is most clearly correlated with upchannel wind, lower temperature, and lower salinity. Less clear relationships exist with lower tidal height, shallower depth, and lower light (night time) conditions. R^2 values range from 0.26 to 0.81, with a mean value of 0.51.

In general, greater reliance should be placed on the data from the Ship Channel where the largest number of samples was taken and least upon the data from Pass Cavallo where the least number of samples was taken and where none were made in the near bottom waters. The importance of upchannel current and upchannel wind is evident for most of the groups, especially if the anomalous groups, fish eggs and estuarine fish larvae, are dropped from consideration.

<u>Effects of physical factors on shrimp and crab larval stages</u>. Summariza-tion of the regression information concerning shrimp and crab larval stages is presented in Tables 30 and 31. This information will be evaluated by the methods discussed in the previous section.

- <u>Penaeidae - protozoea</u>. The abundance of penaeid protozoea is primarily correlated with upchannel current and higher temperature. Abundance is less clearly correlated with higher tidal height, shallower depth, and higher light (daytime) conditions. Up vs. down-channel wind, and higher vs. lower salinity are equally correlated with abundance. R^2 values vary from 0.48 to 0.97, with a mean value of 0.72.

- <u>Penaeid - mysis</u>. The abundance of mysis stage penaeids is most clearly correlated with upchannel wind, higher tidal height, higher temperature, and lower salinity. There is less clear correlation with higher light (daytime) conditions. Of equal correlation are up vs. down-channel current and deeper vs. shallower water. R^2 values vary from 0.28 to 0.90, with a mean value of 0.72.

- Penaeus aztecus - post-larvae. The abundance of Penaeus aztecus post-larvae is primarily correlated with down-channel current, shallower depth, and lower temperature. Abundance is less clearly correlated with higher tidal height and higher light (daytime) conditions. Equal correlations exist for up vs. down-channel wind and higher vs. lower salinity. R^2 values range from 0.38 to 0.66, with a mean value of 0.53.

- Penaeus spp. - post-larvae. The abundance of unidentified larvae of the genus Penaeus is most clearly correlated with upchannel current, higher temperature, and lower salinity. Abundance is less clearly correlated with higher tidal height, greater depth, and lower light (night time) conditions. Equal correlations exist for up vs. down-channel wind. R^2 values range from 0.11 to 0.58, with a mean value of 0.33.

- Portunid - zoea. The abundance of portunid crab zoea is primarily correlated with upchannel current, upchannel wind, lower tidal height, and shallower depth. Abundance is less clearly associated with higher light (daytime) conditions. Of equal correlation are higher vs. lower temperature and higher vs. lower salinity. R^2 values vary from 0.23 - 1.00, with a mean value of 0.50.

- Callinectes - megalops. The abundance of Callinectes megalops stage crabs is most clearly correlated with upchannel current, down-channel wind, higher tidal height, and lower temperature. Abundance is less clearly correlated with greater depth and higher light (daytime) conditions. Equal correlation frequencies are shown by higher vs. lower salinity. R^2 values range from 0.10 to 0.61, with a mean value of 0.35.

- Portunid - juveniles. The abundance of portunid juveniles is most clearly correlated with greater depth. Less clear correlations exist in the cases of upchannel current, upchannel wind, greater tidal height, lower temperature, higher salinity, and lower light (night time) conditions. R^2 values vary from 0.38 to 1.00, with a mean value of 0.72.

Effects of physical factors on larvae of individual fish species. The larvae of 15 species of fishes were to be considered in the present study. For four of these species (Paralichthys lethostigma, Larimus fasciatus, Menticirrhus littoralis, and Menticirrhus saxatilis) no specimens were taken. For six of the species (Archosargus probatocephalus, Cynoscion nothus, Leiostomus xanthurus, Menticirrhus americanus, Micropogonias undulatus, and Sciaenops ocellatus) some larvae were captured, but they were not taken with a frequency sufficient for regression analysis. For the remaining five species (Bairdiella chrysoura, Cynoscion arenarius, Cynoscion nebulosus, Pogonias cromis, and Stellifer lanceolatus) the occurrences were sufficient to permit regression analysis at one or more stations. Summarization of the regression information for the larvae of these five species is presented in Table 32. Since the data are not sufficient for evaluation by the methods employed in the previous sections, the results will simply be discussed.

- Bairdiella chrysoura. Larvae of the silver perch were taken in the Ship Channel and the Intracoastal Waterway. In both locations larval abundance is correlated with higher salinity. Larval abundance is correlated with higher tidal height and higher light (daytime) conditions in the Ship Channel. Mixed correlations occur in the cases of current, wind, depth, and temperature. R^2 values are in the range of 0.77 and 0.81, with a mean R^2 value of 0.79.

- Cynoscion arenarius. Larvae of the sand seatrout also occurred in the Ship Channel and the Intracoastal Waterway. At both locations larval abundance is correlated with upchannel current, upchannel wind, greater depth, and lower salinity. In the Ship Channel only, larval abundance is correlated with higher tidal height and lower light (night time) conditions. Temperature shows a mixed correlation. R^2 values range from 0.15 to 0.55, with a mean value of 0.35.

- Cynoscion nebulosus. Larvae of the spotted seatrout appeared in collections from the Ship Channel, Saluria Bayou, and the Intracoastal Waterway. Larval abundance is not consistently correlated with any of the physical factors. In the Ship Channel larval abundance is correlated with higher light (daytime) conditions. Among the mixed correlations, two out of three favor the following physical factors: upchannel current, down-channel wind, greater depth, lower temperature, and lower salinity. Correlations equally favor higher and lower tidal height. R^2 values range form 0.14 to 0.98, with a mean value of 0.58.

- Pogonias cromis. Larvae of the black drum were taken in the Ship Channel and Saluria Bayou. At both locations larval abundance is correlated with upchannel wind, higher tidal height, lower temperature, and lower salinity. In the Ship Channel alone it is correlated with lower light (night time) conditions. Mixed correlations occur in the cases of current and depth. R^2 values range from 0.21 to 0.90, with a mean value of 0.56.

- Stellifer lanceolatus. Larvae of the star drum occurred in the Ship Channel. Larval abundance at this station is correlated with down-channel current, upchannel wind, higher tidal height, greater depth, lower temperature, lower salinity, and lower light (night time) conditions. The R^2 value is 0.62.

An overview of the correlation data shows that fish larval abundance is correlated with upchannel current in 60.0 percent of the cases, upchannel wind in 70.0 percent, and higher tidal height in 85.7 percent of the cases. Correlation with greater depth gives 70.0 percent, higher temperature and higher salinity give 30.0 percent each, and higher light (daytime) conditions gives 40.0 percent. Among the five fish species for which regression analysis was carried out, only Cynoscion arenarius likely spawns strictly on the continental shelf. Any species which spawns partly or wholly in the passes or bays would be expected to exhibit mixed correlations, low R^2 values, or both.

DISCUSSION

The present study was designed to provide information concerning the physical factors responsible for the transport of larval shrimp, crabs, and fishes from the spawning grounds in the Gulf of Mexico into Matagorda Bay and between Matagorda and Espiritu Santo Bays. Field studies were carried out during the spring and summer months of 1987. These resulted in the collection of 378 plankton samples, each accompanied by appropriate physical environmental data. In the laboratory the plankton samples were sorted, and the organisms were identified to the lowest feasible taxonomic levels. The counts were recorded in terms of density, i.e., the number of individuals of each taxonomic unit/m^3 of water sampled. The information was entered into a computer data file and subjected to a series of statistical treatments.

Comparison of paired samples made by the same gear type revealed a high level of internal variability in the data base. Comparison of catches by different gear types indicated that any bias due to gear type is masked by the high internal variability of the data set itself. Regression analysis revealed that the data set from each collecting station is so distinct that it would not be statistically reasonable to combine the data from any pair of stations. Thus, it has been necessary to analyze the data from each station separately.

Regression analysis of biological abundance vs. the various physical factors was carried out by two methods (with zero values present and with zero values omitted). Comparison of the results obtained by the two methods support the conclusion that the method of analysis with zero values omitted provides the most sound basis for judging the relationships of biological abundance with the physical parameters. Therefore, all conclusions are based upon regressions employing the latter method of analysis.

An overview of the relationships between the abundance of the major biological groups and the various physical factors has revealed that upchannel current and upchannel wind are the factors most frequently correlated with biological abundance. Theoretical tide height (calculated from tide tables) shows a somewhat lower frequency of correlation with biological abundance. The factors of water depth, temperature, and salinity show mixed correlations since in about half the cases biological abundance is correlated with a higher value, and in the other half it is correlated with a lower value of the particular factor. In two-thirds of the cases the larvae were more abundant at night. Of particular interest is the factor of salinity. It cannot be concluded from the data on hand that salinity, per se, plays any major role in causing the transport of larvae through the passes. This observation is relevant to the question of whether streamflow entering the upper estuary is important in relation to the larval transport mechanisms.

Results of the regression analyses were examined to determine the most reasonable conclusions which could be reached concerning the relationships of the various physical factors with each major biological group, each larval stage, and each fish species. The results are summarized in Table 33. Since the information for each group, stage, and species has been discussed in the preceding sections, it will not be reiterated here. Mathematical models relating larval abundance with the various physical factors are provided in Appendices C, D, and E.

One of the primary aims of the present study was to determine whether or not freshwater inflow from streams entering the upper bays plays a significant role in larval recruitment. If freshwater inflow were important in determining recruitment, this effect should be manifested in one or the other (or both) of the following ways:

a) high freshwater input should result in stratified flow through the passes, with strong low salinity outflow at the surface and strong saltwater inflow (laden with larvae) in the botton layer, and/or

b) higher larval abundance levels should be correlated with lower salinity levels in the passes (due, possibly, to an attraction effect upon the larvae).

Figure 2 provides information on daily streamflow of the Guadalupe River (which enters upper San Antonio Bay) and the Lavaca River (which enters upper Matagorda Bay) during all of 1987. The actual sampling periods employed in the present study are indicated as black bars along the time axis. None of the sampling periods coincided with high inflows of the Lavaca River, but cruises 5 and 6 did occur during a period of fairly high inflow of the Guadalupe River. Careful analysis of top and bottom salinity levels during all cruises revealed that the channels were well-mixed most of the time. However, some vertical salinity stratification was observed in the Matagorda Ship Channel during cruise 5 and in Saluria Bayou and the Intracoastal Waterway during cruise 6. These stratifications were due, in part, to temperature effects during late July and early August.

In the Ship Channel on cruise 5 several groups (shrimp larvae, estuarine fish larvae, marine fish larvae, and marine sciaenid larvae) did show significantly higher concentrations in bottom waters than in surface waters, but these high bottom concentrations persisted during both inflowing and outflowing currents. In Saluria Bayou and the Intracoastal Waterway on cruise 6 no groups showed significantly higher concentrations in the bottom waters. These mixed results suggest that the salinity-induced countercurrent mechanism proposed in a (above) is probably not responsible for larval recruitment during most of the year, and this is underlined by the fact that salinity stratification was so rarely observed.

The second potential mechanism would involve high larval abundances associated with lower salinity conditions in the passes. However, it was earlier pointed out that, except in the case of Pass

Cavallo, high larval abundances were about equally correlated with high and low salinities. In Pass Cavallo the correlation of high larval abundance with lower salinity was primarily due to the effect of strong offshore winds during one cruise period. Thus, low salinity per se cannot be invoked as a mechanism for bringing larvae from the shelf to the estuary.

Whatever role streamflow may ploy in creating favorable habitat within the bays and estuaries, it does not appear to have an important direct role in transporting larvae from the Gulf of Mexico into Matagorda Bay or between Matagorda and adjacent bays. Possible indirect roles through freshwater effects upon circulation processes within the bays or through modification of larval behavior patterns have not been investigated.

As in other ecological systems each species has had to develop its own unique life history strategy in order to achieve long term survival under the prevailing environmental conditions. Therefore, the coastal invertebrates and fishes display a great diversity of spawning seasons; spawning locations; and relations with depth, temperature, salinity, and light conditions. However, the major life history "bottleneck" for all the estuary related species is the problem of traversing the passes, and here we observe a commonality in the adaptations of the various species. Upchannel current, upchannel wind, and increased tidal height all appear to be involved in moving the larvae through the tidal passes. Dissection of the relationships of these three factors lies more in the realm of physics than of biology. However, as noted earlier, the larvae may not be entirely passive. Behavior may play a significant role, particularly among the older larvae and the juvenile stages. As pointed out in the introduction, a number of related investigations have recently been completed or are currently in progress. Results published to date tend to substantiate the conclusions reached in the present study concerning the importance of upchannel current, upchannel wind, and higher tidal height as primary controlling factors in larval transport.

In the present study samples were taken periodically through a period of half a year, and attention has been directed toward nineteen different species including (for the shrimp and crabs) several larval stages. Since fine-mesh nets were employed, tows had to be relatively short which resulted in the capture of few larvae of the target fish species. Knowledge and experience gained from this study now permits us to define more precisely the types of future investigations required to provide the most useful picture of larval recruitment. Any follow-up studies should take into account the following suggestions.

1. Concentrate on target species rather than upon all species which traverse the pass.

2. Plan a sampling strategy which takes into account the full breeding season of the species.

   a. The 24-hour study routine was demonstrably successful in the present effort, but for a single species the sampling periods should be spaced three and a half days apart. This would ensure the taking of adequate samples during the periods of larval peak abundance, and it would take into account the different phases of the lunar tide.

   b. The sampling interval during the present study was two hours. It is recommended that the interval be increased to three hours but that the length of each tow be doubled (i.e., from five to ten minutes per tow) in order to increase the yield of fish larvae within each sample.

   c. In the present study the mesh of the net was quite fine (335 μ) in order to retain small eggs and invertebrate larvae. For most fish species the eggs are not identifiable, hence a coarser mesh net (505 μ) should be employed whenever the study permits. This would still capture the fish larvae, but it would permit many of the eggs and invertebrate larvae to pass through the mesh. Thus, laboratory sorting and sample processing time would be greatly reduced.

   d. Base the study entirely upon a single type of collecting gear. The Tucker Trawl is recommended. This gear was successfully used in the Ship Channel and the Intracoastal Waterway. With a properly powered and rigged boat it could also have been used in Saluria Bayou.

   e. Carry out adequate numbers of replicate samples for the study of sample variability. With the Tucker Trawl triplicate samples could be taken in immediate time sequence. A minimum of twenty such triplicate samplings is recommended.

f. Measure environmental parameters as was done in the present study, but allow for a back-up set of measuring apparatus so that an entire cruise does not have to be scrubbed in the event of apparatus malfunction.

As a final note, it seems clear that the types of field study already carried out and outlined above will eventually produce multiple regression models highly useful for resource management purposes. However, the most precise general models for groups of species will have to be built up from high quality individual species models. Since individual species spawn at different seasons and since environmental parameters vary throughout the year, it is anticipated that several different models will ultimately have to be employed to describe the parameters associated with egg and larval transport throughout the year.

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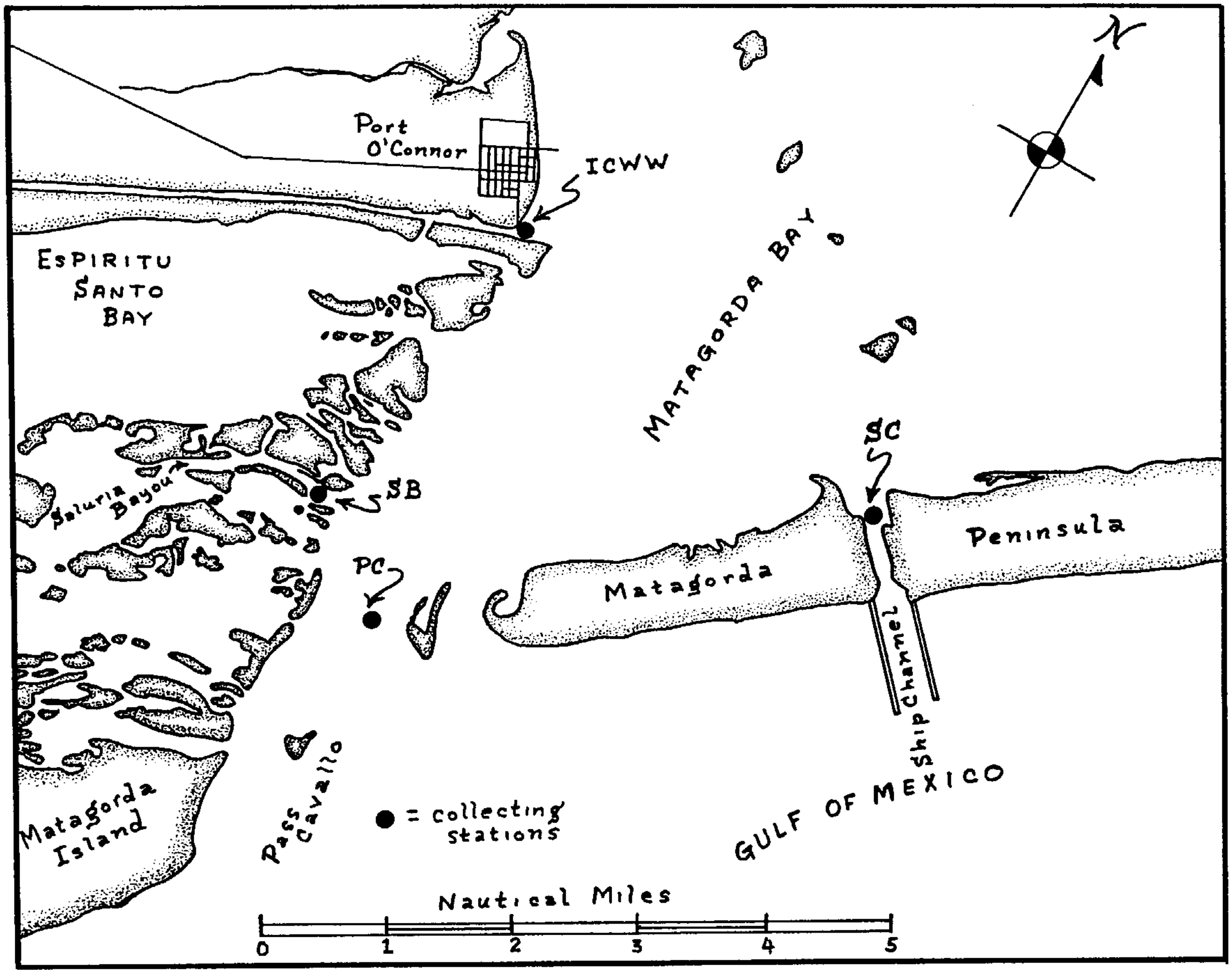


Figure 1. Map of study area showing the collecting stations. SC = Ship Channel, SB = Saluria Bayou, PC = Pass Cavallo, and ICWW = Intracoastal Waterway.

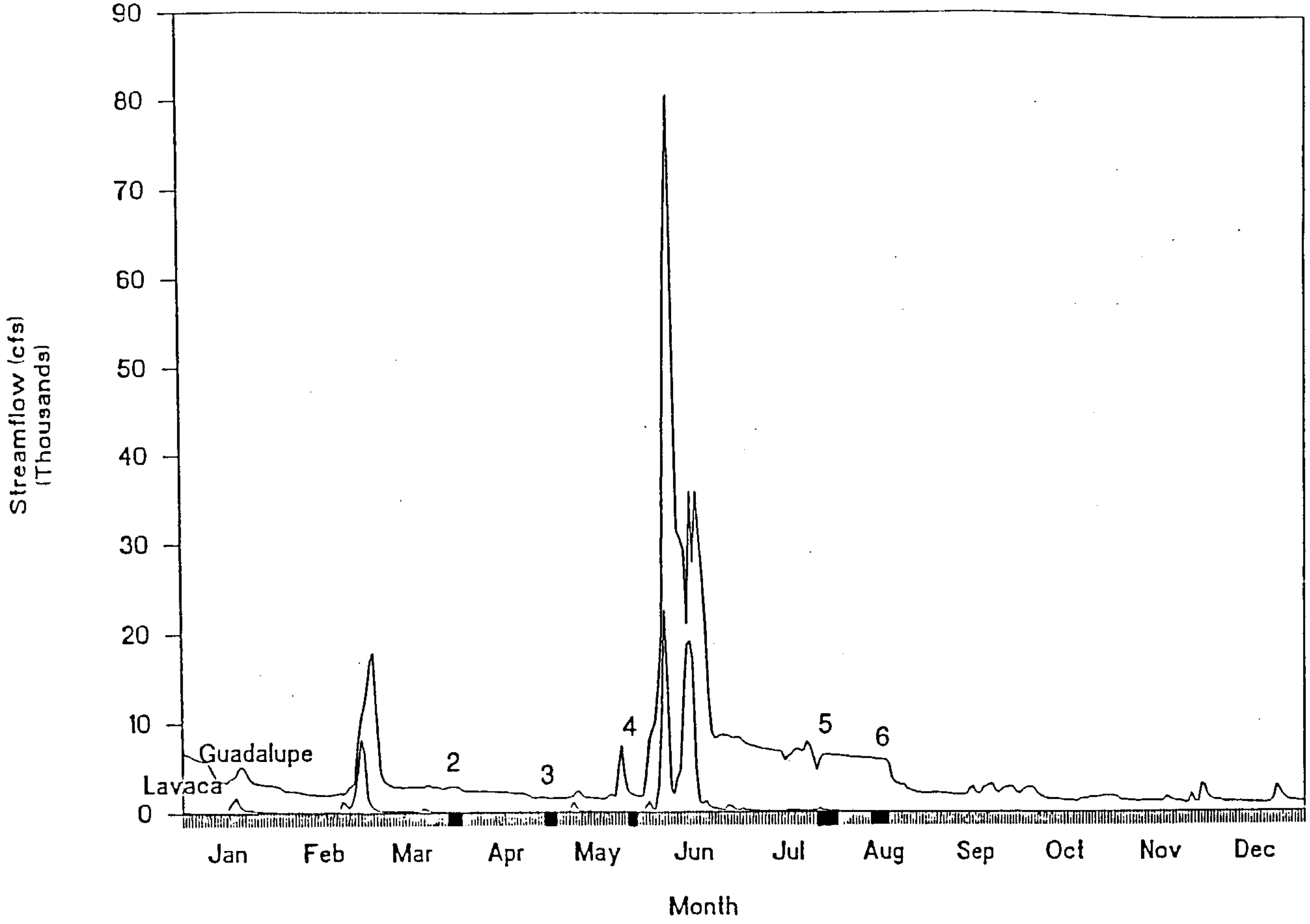


Figure 2. Cruise dates in relation to the mean daily stream flow of the Guadalupe and Lavaca rivers for the period January 1 - December 31, 1987. The dates for cruises 2 - 6 are blocked in and numbered above the x-axis.

Table 1. Species of primary and secondary concern in the present study.

Species of Primary Concern	
Invertebrates	
Penaeus aztecus	Brown shrimp
Penaeus duorarum	Pink shrimp
Penaeus setiferus	White shrimp
Callinectes sapidus	Blue crab
Fishes	
- Non-sciaenid	
Archosargus probatocephalus	Sheepshead
Paralichthys lethostigma	Southern flounder
- Sciaenid	
Cynoscion arenarius	Sand seatrout
Cynoscion nebulosus	Spotted seatrout
Menticirrhus americanus	Southern kingfish
Menticirrhus littoralis	Gulf kingfish
Micropogonias undulatus	Atlantic croaker
Pogonias cromis	Black drum
Sciaenops ocellatus	Red drum
Species of Secondary Concern	
Bairdiella chrysoura	Silver perch
Cynoscion nothus	Silver seatrout
Larimus fasciatus	Banded drum
Leiostomus xanthurus	Spot
Menticirrhus saxatilis	Northern kingfish
Stellifer lanceolatus	Star drum

Table 2. Summary of all samples taken during the Matagorda Bay larval recruitment project. Abbreviations: s = surface, m = mid-depth, b = bottom.

Cruise No. and dates	Ship Channel	Saluria Bayou	Intracoastal Waterway	Pass Cavallo
Cruise 2 3/31-4/2	10 stations x 3 (s,m,b) 3 replicates x 3 (s,m,b) 1/2 m net	3 stations (s) no replicates 1/2 m net	5 stations (s) 5 replicates 1/2 m net	2 stations (s) no replicates 1/2 m net
Cruise 3 4/29-5/2	10 stations x 3 (s,m,b) no replicates 1/2 m net	5 stations (s) no replicates 1/2 m net	5 stations (s) 5 replicates 1/2 m net	5 stations (s) no replicates 1/2 m net
Cruise 4 5/26-5/28	2 stations x 3 (s,m,b) no replicates 1/2 m net	5 stations (s) 5 replicates 1/2 m net	5 stations (s) 5 replicates 1/2 m net	3 stations (s) no replicates 1/2 m net
Cruise 5 7/25-8/1	24 stations x 3 (s,m,b) 3 replicates x 3 (s,m,b) Tucker trawl	Center of Channel (SBC) 12 stations x 2 (s,b) 3 sets of replicates (s,b) 1/2 m net	12 stations x 2 (s,b) no replicates 1/2 m net	No samples
		Side of Channel (SBS) 12 stations x 2 (s,b) 3 sets of replicates (s,b) 1/2 m net		
Cruise 6 8/13-8/16	12 stations x 3 (s,m,b,) no replicates Tucker trawl	Center of Channel (SBC) 6 stations x 2 (s,b) no replicates 1/2 m net	6 stations x 2 (s,b) Tucker trawl	No samples
		Side of Channel (SBS) 6 stations x 2 (s,b) no replicates 1/2 m net	4 replicates x 2 (s,b) 1/2 m net	
Total samples	174 + 18 replicates	85 + 17 replicates	51 + 23 replicates	10 + 0 replicates

In the present context, "replicates" refers to samples taken one immediately after the other.

Table 3. Actual depth range of passes and depths of samples taken in the passes. All depths are given in feet.

Pass	Bottom depth	Sample Depths		
		"Surface"	"Mid-depth"	"Bottom"
Ship Channel	50-70	2	20	40
Saluria Bayou	8-10	2	-	6
Intracoastal Waterway	12-14	2	-	6
Pass Cavallo	10-35	2	-	-

Table 4. Fishes classified as estuarine or marine in the present analysis.

Estuarine fishes

Brevoortia patronus
Engraulidae
Anchoa mitchilli
Anchoa hepsetus
Gobiesox strumosus
Atherinidae
Menidia beryllina
Syngnathidae
Blenniidae
Eleotridae
Gobiidae
Gobiosoma spp.
Gobiosoma bosci
Gobionellus hastatus
Gobionellus boleosoma
Microgobius spp.
Trinectes maculatus

Marine fishes

Elops saurus
Ophichthidae
Myrophis punctatus
Clupeidae
Harengula jaguana
Synodontidae
Hyporhamphus unifasciatus
Triglidae
Prionotus martis
Rachycentron canadum
Carangidae
Chloroscombrus chrysurus
Gerreidae
Haemulidae
Sparidae
Lagodon rhomboides
Archosargus probatocephalus
Sciaenidae
Bairdiella chrysoura
Cynoscion spp.
Cynoscion arenarius
Cynoscion nebulosus
Cynoscion nothus
Larimus fasciatus
Leiostomus xanthurus
Menticirrhus spp.
Menticirrhus americanus
Menticirrhus littoralis
Menticirrhus saxatilis
Pogonias cromis
Sciaenops ocellatus
Stellifer lanceolatus
Micropogonias undulatus
Mugillidae
Chaetodipterus faber
Scombridae
Peprilus burti
Peprilus paru
Bothidae
Citharichthys spp.
Etropus crossotus
Paralichthys lethostigma
Soleidae
Cynoglossidae
Symphurus plagiusa
Monacanthidae
Tetraodontidae
Sphoeroides parvus
Sphoeroides spp.

Table 5. Relationships between physical parameters and positive or negative regression coefficients.

Parameter	Positive relationship	Negative relationship
Depth	High abundance at the bottom	High abundance at the surface
Temperature	High abundance at high temperature	High abundance at low temperature
Salinity	High abundance at high salinity	High abundance at low salinity
Wind velocity	High abundance when the wind vector is upstream (*i.e.*, from the Gulf toward the Bay)	High abundance when the wind vector is downstream (*i.e.*, from the Bay toward the Gulf)
Current velocity	High abundance when the current vector is upstream (*i.e.*, from the Gulf toward the Bay)	High abundance when the current vector is downstream (*i.e.*, from the Bay toward the Gulf)
Light	High abundance during the daylight hours	High abundance during the night
Tidal height	High abundance at high water levels (as calculated from NOAA tide tables)	High abundance at low water levels (as calculated from NOAA tide tables)

Table 6. Comparison of catches from 21 replicate samples made by the 1/2 m tow net. p - values of 0.05 or greater indicate that the replicate samples are not significantly different. In the regression equations X represents the catch in the first sample, and Y is the catch in the second sample.

Biological group	p - value	Regression equation	R^2
Shrimp larvae	0.080	Y = 0.957 + 1.153 X	0.18
Crab larvae	0.284	Y = 0.802 + 1.604 X	0.69
Fish eggs	0.072	Y = 0.059 + 1.087 X	0.72
Est. fish larvae	0.197	Y = 1.891 + 0.632 X	0.09
Mar. fish larvae	0.053	Y = -0.081 + 2.205 X	0.54
Mar. sciaenid larvae	0.41	Y = 0.000 + 1.000 X	1.00

Table 7. Comparison of catches from paired samples made by different gear types. p - values of 0.05 or greater indicate that the samples are not significantly different. In the regression equations X represents the catch made by the Tucker Trawl, and Y is the catch made in the corresponding 1/2 m net.

Biological group	p - value	Regression equation	R^2
Shrimp larvae	0.188	$Y = 0.020 - 0.004X$	0.15
Crab larvae	0.077	$Y = 0.257 + 0.173X$	0.47
Fish eggs	0.625	$Y = -0.184 + 2.253X$	0.34
Est. fish larvae	0.006	$Y = 0.266 + 0.075X$	0.44
Mar. fish larvae	0.183	$Y = -0.021 + 0.095X$	0.71
Mar. sciaenid larvae*	---	-------	---

* No marine sciaenid larvae were taken in the 1/2 m net tows during the paired sampling.

Table 8. Distribution of mean catch density of major biological groups given by station and cruise. The data are expressed as the number of organisms/ 1,000 m^3 of water. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Group	Location	Cruise number				
		2	3	4	5	6
Shrimp larvae	Ship Channel	993.0	457.4	17,575.6	989.2	437.8
	Saluria Bayou	2,965.0	130.4	7,101.4	1,402.2	223.0
	ICWW	135.1	295.5	6,363.7	333.3	858.5
	Pass Cavallo	0.0	236.2	7,790.0	---	---
Crab larvae	Ship Channel	1,651.5	2,516.4	2,838.9	4,733.5	2,878.3
	Saluria Bayou	1,176.7	1,630.6	31,592.7	1,950.7	212.7
	ICWW	245.7	1,896.2	9,341.3	1,181.9	1,814.1
	Pass Cavallo	4,967.5	1,978.4	16,744.0	---	---
Fish eggs	Ship Channel	1,885.8	11,332.0	1,062.0	18,877.1	28,082.4
	Saluria Bayou	144.0	10,526.4	4,148.3	14,701.3	26,731.7
	ICWW	4,047.8	20,317.9	1,964.3	56,241.1	729.4
	Pass Cavallo	17.0	1,656.6	8,046.3	---	---
Estuarine fish larvae	Ship Channel	792.8	5,713.3	6,913.7	5,147.3	6,176.3
	Saluria Bayou	469.3	403.6	704.6	400.7	344.9
	ICWW	524.9	974.8	594.6	947.5	5,046.1
	Pass Cavallo	151.5	2,302.4	1,620.0	---	---
Marine fish larvae	Ship Channel	283.8	277.3	1,392.5	633.2	1,005.7
	Saluria Bayou	252.7	245.4	633.6	314.7	45.8
	ICWW	144.1	298.4	715.3	318.5	662.2
	Pass Cavallo	33.0	559.0	1,470.3	---	---

Table 8. (continued)

Marine sciaenid larvae	Ship Channel	509.5	133.4	16.0	<u>68.6</u>	<u>42.0</u>
	Saluria Bayou	226.7	37.2	0.0	14.0	0.0
	ICWW	20.8	20.4	0.0	0.0	<u>548.1</u>
	Pass Cavallo	220.0	62.6	24.7	---	---

Table 9. Distribution of mean catch density of major biological groups (expressed as a percent of the sum of the means) given by station and cruise. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Group	Location	Cruise number				
		2	3	4	5	6
Shrimp larvae	Ship Channel	4.9	2.2	85.9	4.8	2.1
	Saluria Bayou	25.1	1.1	60.1	11.9	1.9
	ICWW	1.7	3.7	79.7	4.2	10.7
	Pass Cavallo	0.0	2.9	97.1	---	---
Crab larvae	Ship Channel	11.3	17.2	19.4	32.4	19.7
	Saluria Bayou	3.2	4.5	86.4	5.3	0.6
	ICWW	1.7	13.1	64.5	8.2	12.5
	Pass Cavallo	21.0	8.4	70.7	---	---
Fish eggs	Ship Channel	3.1	18.5	1.7	30.8	45.9
	Saluria Bayou	0.3	18.7	7.4	26.1	47.5
	ICWW	4.9	24.4	2.4	67.5	0.9
	Pass Cavallo	0.2	17.0	82.8	---	---
Estuarine fish larvae	Ship Channel	3.2	23.1	27.9	20.8	25.0
	Saluria Bayou	20.2	17.4	30.3	17.2	14.8
	ICWW	6.5	12.1	7.4	11.7	62.4
	Pass Cavallo	3.7	56.5	39.8	---	---
Marine fish larvae	Ship Channel	7.9	7.7	38.8	17.6	28.0
	Saluria Bayou	16.9	16.4	42.5	21.1	3.1
	ICWW	6.7	14.0	33.4	14.9	31.0
	Pass Cavallo	1.6	27.1	71.3	---	---

Table 9. (continued)

Marine sciaenid larvae	Ship Channel	66.2	17.3	2.1	8.9	5.5
	Saluria Bayou	81.6	13.4	0.0	5.0	0.0
	ICWW	3.5	3.5	0.0	0.0	93.0
	Pass Cavallo	71.6	20.4	8.0	---	---

Table 10. Results of multiple regression analysis of major biological group data from the Matagorda Ship Channel. Environmental parameters are defined as follows: C=current velocity, D=depth, L=light, S=salinity, T=temperature, TH=tidal height, and W=wind velocity. Positive and negative values are defined in Table 5. Significance of the parameters is defined at the 5-percent level.

Measure	All values included		Zero values omitted	
			Shrimp larvae	
Significant parameters	W^+,TH^+,D^+		W^+,TH^+,D^+	
Best 3-variable model	W^+,TH^+,D^+	(R^2=0.20)	W^+,TH^+,D^+	(R^2=0.18)
Best 7-variable model	$W^+,TH^+,D^+,C^+,L^+,T^-,S^-$	(R^2=0.20)	$W^+,TH^+,D^+,C^+,L^+,S^-,T^-$	(R^2=0.19)
			Crab larvae	
Significant parameters	C^+,T^+		C^+,T^+	
Best 3-variable model	C^+,T^+,S^-	(R^2=0.09)	C^+,T^+,S^-	(R^2=0.09)
Best 7-variable model	$C^+,T^+,S^-,D^-,L^+,TH^-,W^+$	(R^2=0.10)	$D^-,T^+,S^-,C^+,TH^-,W^+,L^+$	(R^2=0.09)
			Fish eggs	
Significant parameters	$W^-,S^+,T^+,C^-,D^-,TH^-,L^-$		$W^-,S^+,T^+,C^-,D^-,L^-,TH^-$	
Best 3-variable model	W^-,S^+,T^+	(R^2=0.27)	W^-,S^+,T^+	(R^2=0.28)
Best 7-variable model	$W^-,S^+,T^+,C^-,D^-,TH^-,L^-$	(R^2=0.39)	$W^-,S^+,T^+,C^-,D^-,L^-,TH^-$	(R^2=0.41)
			Estuarine fish larvae	
Significant parameters	L^-,T^+,D^+,S^+,TH^+		L^-,T^+,S^+,D^+,TH^+	
Best 3-variable model	L^-,T^+,S^+	(R^2=0.37)	L^-,T^+,S^+	(R^2=0.38)
Best 7-variable model	$L^-,T^+,S^+,D^+,C^+,TH^+,W^+$	(R^2=0.41)	$D^+,T^+,S^+,C^+,TH^+,W^+,L^-$	(R^2=0.41)
			Marine fish larvae	
Significant parameters	TH^+,L^-,T^+,S^+,W^+,D^+		L^-,T^+,S^+,TH^+,W^+,D^+	
Best 3-variable model	T^+,S^+,L^+	(R^2=0.35)	L^-,T^+,TH^+	(R^2=0.28)
Best 7-variable model	T+,S+,L+,TH+,D+,C+,W+	(R2=0.42)	$L^-,T^+,TH^+,D^+,S^+,W^+,C^+$	(R^2=0.42)
			Marine sciaenid larvae	
Significant parameters	L^-,T^-,TH^+,S^-,D^+		T^-,TH^+,L^-,S^-	
Best 3-variable model	L^-,T^-,W-	(R^2=0.32)	T^-,TH^+,L^-	(R^2=0.18)
Best 7-variable model	$L^-,T^-,W^-,C^-,D^+S^-,TH^+$	(R^2=0.36)	$T^-,TH^+,L^-,D^+,S^-,C^-,W^+$	(R^2=0.20)

Table 11. Results of multiple regression analysis of major biological group data from Saluria Bayou. Environmental parameters are defined in Table 10, and positive and negative values are defined in Table 5. Significance of the parameters is defined at the 5-percent level.

Measure	All values included		Zero values omitted	
			<u>Shrimp larvae</u>	
Significant parameters	W^+,D^-,C^+		W^+,D^-	
Best 3-variable model	W^+,D^-,C^+	(R^2=0.49)	W^+,D^-,C^+	(R^2=0.47)
Best 6-variable model	W^+,D^-,C^+,T^-,S^+,TH^-	(R^2=0.47)	D^-,T^-,S^-,C^+,TH^-,W^+	(R^2=0.44)
			<u>Crab larvae</u>	
Significant parameters	none		none	
Best 3-variable model	D^-,S^+,C^-	(R^2=0.32)	S^+,C^+,TH^-	(R^2=0.24)
Best 6-variable model	D^-,S^+,C^-,W^+,T^-,TH^-	(R^2=0.33)	S^+,C^+,TH^-,D^-,T^-,W^+	(R^2=0.23)
			<u>Fish eggs</u>	
Significant parameters	TH^+,T^+,C^-,D^-		TH^+,C^-,T^+,D^-	
Best 3-variable model	TH^+,T^+,C^-	(R^2=0.44)	TH^+,C^-,T^+	(R^2=0.44)
Best 6-variable model	TH^+,T^+,C^-,D^-,W^+,S^+	(R^2=0.50)	TH^+,C^-,T^+,D^-,W^+,S^+	(R^2=0.50)
			<u>Estuarine fish larvae</u>	
Significant parameters	S^-,T^-,D^+		S^-,D^+	
Best 3-variable model	D^+,T^-,C^+	(R^2=0.04)	C^+,D^+,T^-	(R^2=0.07)
Best 6-variable model	D^+,T^-,C^+,S^-,TH^+,W^+	(R^2=0.09)	D^+,T^-,S^-,C^+,TH^+,W^+	(R^2=0.11)
			<u>Marine fish larvae</u>	
Significant parameters	S^+		none	
Best 3-variable model	S^+,D^-,W^+	(R^2=0.34)	S^+,D^-,TH^-	(R^2=0.13)
Best 5-variable model	S^+,D^-,W^+,C^+,TH^-,T^+	(R^2=0.34)	D^-,T^+,S^+,C^+,TH^-,W^+	(R^2=0.11)
			<u>Marine sciaenid larvae</u>	
Significant parameters	T^-		T^-	
Best 3-variable model	T^-,D^+,W^+	(R^2=0.26)	T^-,W^+,TH^+	(R^2=0.70)
Best 6-variable model	T^-,D^+,W^+,C^-,S^-,TH^+	(R^2=0.24)	T^-,W^+,C^+,D^+,S^-,TH^+	(R^2=0.52)

Table 12. Results of multiple regression analysis of major biological group data from the Intracoastal Waterway. Environmental parameters are defined in Table 10, and positive and negative values are defined in Table 5. Significance of the parameters is defined at the 5-percent level.

Measure	All values included		Zero values omitted	
			<u>Shrimp larvae</u>	
Significant parameters	none		C^+	
Best 3-variable model	C^+,D^-,W^+	(R^2=0.22)	C^+,T^+D^-	(R^2=0.27)
Best 5-variable model	D^-,T^+,S^-,C^+,W^+	(R^2=0.19)	D^-,T^+,S^-,C^+,W^+	(R^2=0.23)
			<u>Crab larvae</u>	
Significant parameters	none		none	
Best 3-variable model	C^+,S^+,W^+	(R^2=0.25)	S^+,W^+,C^+	(R^2=0.25)
Best 5-variable model	D^-,T^+,S^+,C^+,W^+	(R^2=0.25)	D^-,T^+,S^+,C^+,W^+	(R^2=0.22)
			<u>Fish eggs</u>	
Significant parameters	none		none	
Best 3-variable model	C^+,S^+,W^-	(R^2=0.21)	C^+,S^+,D^+	(R^2=0.25)
Best 5-variable model	D^-,T^-,S^+,C^+,W^-	(R^2=0.18)	D^+,T^-,S^+,C^+,W^+	(R^2=0.16)
			<u>Estuarine fish larvae</u>	
Significant parameters	D^+		D^+	
Best 3-variable model	D^+,C^-,S^+	(R^2=0.16)	D^+,C^-,T^+	(R^2=0.17)
Best 5-variable model	D^+,T^+,S^+,C^-,W^-	(R^2=0.14)	D^+T^+,S^+,C^-,W^-	(R^2=0.14)
			<u>Marine fish larvae</u>	
Significant parameters	none		C^+,T^+	
Best 3-variable model	C^+,D^+,T^+	(R^2=0.10)	C^+,T^+,W^-	(R^2=0.21)
Best 5-variable model	D^+,T^+,S^+,C^+,W^-	(R^2=0.08)	D^+,T^+,S^+,C^+,W^-	(R^2=0.19)
			<u>Marine sciaenid larvae</u>	
Significant parameters	none		none	
Best 3-variable model	C^-,D^+,S^+	(R^2=0.11)	D^+,T^-,C^-	(R^2=0.44)
Best 5-variable model	D^+,T^+,S^+,C^-,W^-	(R^2=0.09)	D^-,T^-,S^-,C^+,W^+	(R^2=0.38)

Table 13. Results of multiple regression analysis of major biological group data from Pass Cavallo. Environmental parameters are defined as in Table 10, and positive and negative values are defined in Table 5. Significance of all parameters is defined at the 5-percent level.

Measure	All values included		Zero values omitted	
	Shrimp larvae			
Significant parameters	T^+		none	
Best 3-variable model	T^+,S^-,W^-	($R^2 = 0.93$)	S^-,C^+,W^-	($R^2 = 0.96$)
Best 5-variable model	T^+,S^-,W^-,C^+,TH^+	($R^2 = 0.90$)	S^-,C^+,W^-,T^-,TH^+	($R^2 = 0.91$)
	Crab larvae			
Significant parameters	none		none	
Best 3-variable model	T^+,S^-,C^+	($R^2 = 0.80$)	S^-,C^+,T^+	($R^2 = 0.75$)
Best 5-variable model	T^+,S^-,C^+,W^-,TH^-	($R^2 = 0.75$)	S^-,C^+,T^+,W^-,TH^-	($R^2 = 0.64$)
	Fish eggs			
Significant parameters	T^+		none	
Best 3-variable model	T^+,W^-,TH^+	($R^2 = 0.92$)	T^+,W^-,TH^+	($R^2 = 0.90$)
Best 5-variable model	T^+,W^-,TH^+,S^-,C^+	($R^2 = 0.90$)	T^+,W^-,TH^+,S^-,C^+	($R^2 = 0.86$)
	Estuarine fish larvae			
Significant parameters	none		none	($R^2 = 0.22$)
Best 3-variable model	S^+,C^+,TH^-	($R^2 = 0.31$)	T^+,S^+,TH^-	($R^2 = 0.11$)
Best 5-variable model	S^+,C^+,TH^-,T^-,W^+	($R^2 = 0.10$)	T^+,S^+,TH^-,C^+,W^-	
	Marine fish larvae			
Significant parameters	T^+		T^+	
Best 3-variable model	T^+,C^+,W^-	($R^2 = 0.77$)	T^+,C^+,W^-	($R^2 = 0.72$)
Best 5-variable model	T^+,C^+,W^-,S^-,TH^+	($R^2 = 0.69$)	T^+,C^+,W^-,S^-,TH^+	($R^2 = 0.61$)
	Marine sciaenid larvae			
Significant parameters	none		(insufficient occurrences)	
Best 3-variable model	T^-,C^-,W^+	($R^2 = 0.05$)		
Best 5-variable model	T^-,C^-,W^+,S^-,TH^-	($R^2 = 0.54$)		

Table 14. Distribution of mean catch density of shrimp larval stages given by station and cruise. The data are expressed as the number of orgamisms/1,000 m^3 of water. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Stage	Location	Cruise number				
		2	3	4	5	6
Penaeidae - protozoea	Ship Channel	0.0	107.8	13,785.0	266.1	179.5
	Saluria Bayou	0.0	89.4	6,260.1	54.2	0.0
	ICWW	0.0	18.3	5,675.6	42.2	0.0
	Pass Cavallo	0.0	48.4	5,892.7	---	---
Penaeus - mysis	Ship Channel	0.0	337.8	3,718.0	302.4	80.3
	Saluria Bayou	0.0	41.0	617.0	0.0	2.8
	ICWW	0.0	51.3	651.5	0.0	0.0
	Pass Cavallo	0.0	179.0	425.7	---	---
Penaeus aztecus- post-larvae	Ship Channel	991.6	11.8	41.3	13.5	3.6
	Saluria Bay	2,965.0	0.0	141.0	10.5	36.8
	ICWW	135.1	217.7	0.0	23.4	4.9
	Pass Cavallo	0.0	8.8	469.3	---	---
Penaeus spp. - post-larvae	Ship Channel	1.4	0.0	31.3	407.2	174.4
	Saluria Bayou	0.0	0.0	83.3	1,337.5	188.4
	ICWW	0.0	8.2	36.6	267.7	853.6
	Pass Cavallo	0.0	0.0	1,002.3	---	---

Table 15. Distribution of mean catch density of shrimp larval stages expressed as a percent of the sum of the means) given by station and cruise. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Stage	Location	Cruise number				
		2	3	4	5	6
Penaeidae - protozoea	Ship Channel	0.0	0.8	96.1	1.9	1.3
	Saluria Bayou	0.0	1.4	97.8	0.8	0.0
	ICWW	0.0	0.3	98.9	0.7	0.0
	Pass Cavallo	0.0	0.8	99.2	---	---
Penaeus - mysis	Ship Channel	0.0	7.6	83.8	6.8	1.8
	Saluria Bayou	0.0	6.2	93.4	0.0	0.4
	ICWW	0.0	7.3	92.7	0.0	0.0
	Pass Cavallo	0.0	29.6	70.4	---	---
Penaeus aztecus- post-larvae	Ship Channel	93.4	1.1	3.9	1.3	0.3
	Saluria Bayou	94.0	0.0	4.5	0.3	1.2
	ICWW	35.5	57.1	0.0	6.1	1.3
	Pass Cavallo	0.0	1.8	98.7	---	---
Penaeus spp. - post-larvae	Ship Channel	0.2	0.0	5.1	66.3	28.4
	Saluria Bayou	0.0	0.0	5.2	83.1	11.7
	ICWW	0.0	0.7	3.1	23.0	73.2
	Pass Cavallo	0.0	0.0	100.0	---	---

Table 16. Results of multiple regression analysis of shrimp and crab larval stage data from the Matagorda Ship Channnel. Environmental parameters are defined as in Table 6, and positive and negative values are defined in Table 5. Significance of all parameters is defined at the 5-percent level.

Measure	All values included		Zero values excluded	
Penaeidae - protozoea				
Significant parameters	TH^+,W^+,D^+		W^+,TH^+	
Best 3-variable model	TH^+,W^+,D^+	$(R^2 = 0.30)$	W^+,TH^+,T^+	$(R^2 = 0.41)$
Best 7-variable model	$TH^+,W^+,D^+,T^+,C^+,S^-,L^+$	$(R^2 = 0.32)$	$W^+,TH^+,T^+,D^+,C^+,S^-,L^+$	$(R^2 = 0.44)$
Penaeus - mysis				
Significant parameters	W^+,TH^+,D^+		W^+,TH^+	
Best 3-variable model	W^+,TH^+,D^+	$(R^2 = 0.18)$	W^+,TH^+,D^+	$(R^2 = 0.24)$
Best 7-variable model	$W^+,TH^+,D^+,T^+,C^+,S^-,L^+$	$(R^2 = 0.18)$	$W^+,TH^+,D^+,T^+,C^+,S^-,L^+$	$(R^2 = 0.21)$
Penaeus aztecus - postlarvae				
Significant parameters	T^-,TH^+,S^-		T^-,TH^+,D^-	
Best 3-variable model	T^-,TH^+,S^-	$(R^2 = 0.45)$	T^-,TH^+,D^-	$(R^2 = 0.33)$
Best 7-variable model	$T^-,TH^+,S^-,D^-,C^-,W^-,L^+$	$(R^2 = 0.45)$	$T^-,TH^+,D^-,S^-,C^-,W^-,L^+$	$(R^2 = 0.29)$
Penaeus spp. - postlarvae				
Significant parameters	T^+,D^+,L^-		D^+	
Best 3-variable model	D^+,T^+,L^-	$(R^2 = 0.15)$	D^+,T^+,C^+	$(R^2 = 0.12)$
Best 7-variable model	$D^+,T^+,L^-,S^+,C^+,W^-,TH^+$	$(R^2 = 0.15)$	$D^+,T^+,C^+,S^-,W^+,TH^-,L^-$	$(R^2 = 0.07)$
Portunid - zoea				
Significant parameters	T^+,TH^-,L^+		T^+,L^+,TH^-,C^+	
Best 3-variable model	T^+,TH^-,L^+	$(R^2 = 0.16)$	T^+,L^+,TH^-	$(R^2 = 0.18)$
Best 7-variable model	$T,TH^-,L^+,D^-,S^-,C^+,W^+$	$(R^2 = 0.18)$	$T^+,L^+,TH^-,D^-,S^-,C^+,W^+$	$(R^2 = 0.20)$
Callinectes - megalops				
Significant parameters	W^-,TH^+,C^+		none	
Best 3-variable model	W^-,TH^+,C^+	$(R^2 = 0.18)$	D^+,C^+,TH^+	$(R^2 = 0.06)$
Best 7-variable model	$W^-,TH^+,C^+,D^+,T^-,S^-,L^-$	$(R^2 = 0.20)$	$D^+,C^+,TH^+,T^-,S^+,W^-,L^+$	$(R^2 = 0.04)$
Portunid juveniles				
Significant parameters	L^-,C^+		L^-,C^+,D^+	
Best 3-variable model	L^-,C^+,D^+	$(R^2 = 0.15)$	L^-,C^+,D^+	$(R^2 = 0.33)$
Best 7-variable model	$L^-,C^+,D^+,T^-,S^+,W^-,TH^+$	$(R^2 = 0.15)$	$L^-,C^+,D^+,T^-,S^-,W^+,TH^+$	$(R^2 = 0.30)$

Table 17. Results of multiple regression analysis of shrimp and crab larval stage data from the Saluria Bayou. Environmental parameters are defined as in Table 6, and positive and negative values are defined in Table 5. Significance of all parameters is defined at the 5-percent level.

Measure	All values included		Zero values excluded	
		Penaeidae - protozoea		
Significant parameters	TH^-,C^+		S^+,W^+	
Best 3-variable model	TH^-,C^+,D^-	$(R^2 = 0.31)$	S^+,W^+,C^+	$(R^2 = 0.52)$
Best 6-variable model	TH^-,C^+,D^-,T^-,S^-,W^+	$(R^2 = 0.30)$	S^+,W^+,C^+,D^-,T^+,TH^-	$(R^2 = 0.59)$
		Penaeus - mysis		
Significant parameters	C^+		none	
Best 3-variable model	C^+,T^-,TH^-	$(R^2 = 0.25)$	D^-,T^-,S^-	$(R^2 = 0.57)$
Best 6-variable model	C^+,T^-,TH^-,D^-,S^-,W^+	$(R^2 = 0.24)$	D^-,T^+,S^-,C^-,W^+,TH^+	$(R^2 = 0.71)$
		Penaeus aztecus - postlarvae		
Significant parameters	T^-		none	
Best 3-variable model	T^-,S^-,C^+	$(R^2 = 0.37)$	T^-,S^-,W^+	$(R^2 = 0.51)$
Best 6-variable model	T^-,S^-,C^+,D^+,W^+,TH^-	$(R^2 = 0.36)$	T^-,S^-,W^+,D^-,C^-,TH^+	$(R^2 = 0.25)$
		Penaeus spp. - postlarvae		
Significant parameters	T^+,TH^+,D^-,W^+		D^-,TH^+,W^+,T^+	
Best 3-variable model	T^+,TH^+,W^+	$(R^2 = 0.37)$	D^-,TH^+,W^+	$(R^2 = 0.34)$
Best 6-variable model	T^+,TH^+,W^+,D^-,S^+,C^-	$(R^2 = 0.42)$	D^-,TH^+,W^+,T^+,S^+,C^-	$(R^2 = 0.36)$
		Portunid - zoea		
Significant parameters	TH^-,C^+		TH^-,C^+	
Best 3-variable model	TH^-,C^+,S^+	$(R^2 = 0.37)$	TH^-,C^+,T^-	$(R^2 = 0.29)$
Best 6-variable model	TH^-,C^+,S^+,D^-,T^+,W^+	$(R^2 = 0.37)$	TH^-,C^+,T^-,D^-,S^+,W^+	$(R^2 = 0.28)$
		Callinectes - megalops		
Significant parameters	TH^+		none	
Best 3-variable model	TH^+,S^+,C^-	$(R^2 = 0.19)$	T^-,C^-,TH^+	$(R^2 = 0.18)$
Best 6-variable model	TH^+,S^+,C^-,D^+,T^-,W^+	$(R^2 = 0.14)$	T^-,C^-,TH^+,D^-,S^+,W^-	$(R^2 = 0.07)$
		Portunid juveniles		
Significant parameters	TH^+		D^+,C^+,TH^-	
Best 3-variable model	TH^+,T^+,C^-	$(R^2 = 0.05)$	D^+,C^+,TH^-	
Best 6-variable model	TH^+,T^+,C^-,D^-,S^+,W^-	$(R^2 = 0.02)$		

Table 18. Results of multiple regression analysis of shrimp and crab larval stage data from the Intracoastal Waterway. Environmental parameters are defined as in Table 6, and positive and negative values are defined in Table 5. Significance of all parameters is defined at the 5-percent level.

Measure	All values included		Zero values excluded	
		Penaeidae - protozoea		
Significant parameters	C^+,W^+		C^+	
Best 3-variable model	C^+,W^+,D^-	$(R^2 = 0.36)$	C^+,S^+,W^-	$(R^2 = 0.68)$
Best 5-variable model	C^+,W^+,D^-,T^+,S^-	$(R^2 = 0.35)$	C^+,S^+,W^-,D^-,T^-	$(R^2 = 0.67)$
		Penaeus - mysis		
Significant parameters	C^+		none	
Best 3-variable model	C^+,D^-,W^+	$(R^2 = 0.29)$	T^-,S^-,C^+	$(R^2 = 0.58)$
Best 5-variable model	C^+,D^-,W^+,T^-,S^-	$(R^2 = 0.27)$	T^-,S^-,C^+,W^+	$(R^2 = 0.76)$*
		Penaeus aztecus - postlarvae		
Significant parameters	C^-,S^+		none	
Best 3-variable model	C^-,S^+,T^-	$(R^2 = 0.29)$	D^-,T^+,S^+	$(R^2 = 0.46)$
Best 5-variable model	C^-,S^+,T^-,D^-,W^-	$(R^2 = 0.29)$	D^-,T^+,S^+,C^-,W^-	$(R^2 = 0.42)$
		Penaeus spp. - postlarvae		
Significant parameters	D^+		none	
Best 3-variable model	D^+,T^+,S^-	$(R^2 = 0.08)$	D^+,C^+,W^-	$(R^2 = 0.01)$
Best 5-variable model	D^+,T^+,S^-,C^+,W^+	$(R^2 = 0.05)$	D^+,C^+,W^-,T^-,S^-	$(R^2 = -0.07)$
		Portunid - zoea		
Significant parameters	W^+		W^+	
Best 3-variable model	W^+,T^-,C^+	$(R^2 = 0.42)$	W^+,D^-,S^+	$(R^2 = 0.38)$
Best 5-variable model	W^+,T^-,C^+,D^-,S^+	$(R^2 = 0.40)$	W^+,D^-,S^+,T^-,C^+	$(R^2 = 0.36)$
		Callinectes - megalops		
Significant parameters	none		none	
Best 3-variable model	D^+,T^+,W^-	$(R^2 = 0.10)$	D^+,T^-,S^-	$(R^2 = 0.12)$
Best 5-variable model	D^+,T^+,W^-,S^+,C^-	$(R^2 = 0.08)$	D^+,T^-,S^-,C^+,W^-	$(R^2 = 0.17)$
		Portunid juveniles		
Significant parameters	none		D^+,S^+	
Best 3-variable model	D^+,S^+,W^-	$(R^2 = 0.03)$	D^+,S^+	
Best 5-variable model	D^+,S^+,W^-,T^+,C^-	$(R^2 = 0.01)$		

* 4-variable model.

Table 19. Results of multiple regression analysis of shrimp and crab larval stage data from Pass Cavallo. Environmental parameters are defined as in Table 6, and positive and negative values are defined in Table 5. Significance of all parameters is defined at the 5-percent level.

Measure	All values included		Zero values excluded	
		Penaeidae - protozoea		
Significant parameters	S^-,T^+		(insufficient occurrences)	
Best 3-variable model	S^-,T^+,W^-	($R^2 =$ 0.95)		
Best 5-variable model	S^-,T^+,W^-,C^+,TH^+	($R^2 =$ 0.92)		
		Penaeus - mysis		
Significant parameters	none		none	
Best 3-variable model	T^+,C^+,W^-	($R^2 =$ 0.78)	T^+,S^+,W^-	($R^2 =$ 0.58)
Best 5-variable model	T^+,C^+,W^-,S^+,TH^+	($R^2 =$ 0.68)	T^+,S^+,W^-,C^-,TH^+	($R^2 =$ - 0.02)
		Penaeus aztecus - postlarvae		
Significant parameters	none		(insufficient occurrences)	
Best 3-variable model	C^-,W^+,TH^-	($R^2 =$ 0.16)		
Best 5-variable model	C^-,W^+,TH^-,T^-,S^+	($R^2 =$ - 0.25)		
		Penaeus spp. - postlarvae		
Significant parameters	none		(insufficient occurrences)	
Best 3-variable model	T^+,S^-,TH^+	($R^2 =$ 0.37)		
Best 5-variable model	T^+,S^-,TH^+,C^+,W^-	($R^2 =$ 0.06)		
		Portunid - zoea		
Significant parameters	T^+,C^+,W^-,TH^-,S^-		T^+,C^+,W^-,TH^-,S^-	
Best 3-variable model	T^+,C^+,TH^-	($R^2 =$ 0.99)	T^+,C^+,TH^-	($R^2 =$ 0.94)
Best 5-variable model	T^+,C^+,TH^-,C^+,S^-	($R^2 =$ 0.99)	T^+,C^+,TH^-,W^-,S^-	($R^2 =$ 0.99)
		Callinectes - megalops		
Significant parameters	none		(insufficient occurrences)	
Best 3-variable model	T^-,S^-,W^+	($R^2 =$ 0.39)		
Best 5-variable model	T^-,S^-,W^+,C^+,TH^+	($R^2 =$ 0.13)		
		Portunid juveniles		
Significant parameters	none		(insufficient occurrences)	
Best 3-variable model	T^-,W^+,TH^+	($R^2 =$ - 0.14)		
Best 5-variable model	T^-,W^+,TH^+,S^+,C^-	($R^2 =$ - 0.17)		

Table 20. Distribution of mean catch density of crab larval stages given by station and cruise. The data are expressed as the number of organisms/1,000 m^2 of water. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Stage	Location	Cruise number				
		2	3	4	5	6
Portunid - zoea	Ship Channel	356.5	2,446.4	2,771.8	4,181.2	2,231.4
	Saluria Bayou	24.7	1,630.6	31,592.7	1,578.6	89.8
	ICWW	238.2	1,896.2	9,341.3	1,137.0	652.5
	Pass Cavallo	50.5	1,973.6	16,210.7	---	---
Callinectes - megalops	Ship Channel	1,074.7	61.6	31.3	512.7	431.5
	Saluria Bayou	1,140.0	0.0	0.0	356.3	122.9
	ICWW	0.0	0.0	0.0	44.9	1,151.1
	Pass Cavallo	4,917.0	0.0	533.3	---	---
Portunid - juveniles	Ship Channel	220.3	8.4	35.8	39.5	215.4
	Saluria Bayou	12.0	0.0	0.0	15.9	0.0
	ICWW	7.5	0.0	0.0	0.0	10.5
	Pass Cavallo	0.0	4.8	0.0	---	---
Callinectes sapidus	Ship Channel	0.0	0.0	0.0	0.1	0.0
	Saluria Bayou	0.0	0.0	0.0	0.0	0.0
	ICWW	0.0	0.0	0.0	0.0	0.0
	Pass Cavallo	0.0	0.0	0.0	---	---

Table 21. Distribution of mean catch density of crab larval stages (expressed as a percent of the sum of the means) given by station and cruise. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Stage	Location	Cruise number				
		2	3	4	5	6
Portunid - zoea	Ship Channel	3.0	20.4	23.1	34.9	18.6
	Saluria Bayou	0.1	4.7	90.5	4.5	0.3
	ICWW	1.8	14.3	70.4	8.6	4.9
	Pass Cavallo	0.3	10.8	88.9	---	---
Callinectes - megalops	Ship Channel	50.9	2.9	1.5	24.3	20.4
	Saluria Bayou	70.4	0.0	0.0	22.0	7.6
	ICWW	0.0	0.0	0.0	3.8	96.2
	Pass Cavallo	90.2	0.0	9.8	---	---
Portunid - juveniles	Ship Channel	42.4	1.6	6.9	7.6	41.5
	Saluria Bayou	43.0	0.0	0.0	57.0	0.0
	ICWW	41.7	0.0	0.0	0.0	58.3
	Pass Cavallo	0.0	100.0	0.0	---	---
Callinectes sapidus	Ship Channel	0.0	0.0	0.0	100.0	0.0
	Saluria Bayou	0.0	0.0	0.0	0.0	0.0
	ICWW	0.0	0.0	0.0	0.0	0.0
	Pass Cavallo	0.0	0.0	0.0	---	--

Table 22. Distribution of mean catch density of larvae of each fish species given by station and cruise. The data are expressed as the number of organisms/1,000 m^3 of water. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Taxon	Location	Cruise number				
		2	3	4	5	6
A. probatocephalus	ICWW	0.0	8.2	0.0	0.0	0.0
P. lethostigma	---	0.0	0.0	0.0	0.0	0.0
B. chrysoura	Ship Channel	0.0	1.7	300.3	11.1	7.7
	Saluria Bayou	0.0	0.0	64.3	1.0	1.5
	ICWW	0.0	9.2	89.9	0.0	35.9
	Pass Cavallo	0.0	0.0	213.0	---	---
C. arenarius	Ship Channel	256.1	68.3	0.0	60.5	33.1
	Saluria Bayou	12.0	0.0	0.0	3.2	0.0
	ICWW	0.0	4.3	0.0	0.0	542.5
C. nebulosus	Ship Channel	15.1	7.0	26.5	135.2	78.6
	Saluria Bayou	0.0	0.0	30.1	14.8	0.0
	ICWW	0.0	6.8	26.9	25.6	44.4
	Pass Cavallo	0.0	4.8	74.0	---	---
C. nothus	ICWW	0.0	0.0	0.0	0.0	1.0
L. fasciatus	---	0.0	0.0	0.0	0.0	0.0
L. xanthurus	Ship Channel	0.8	5.0	0.0	0.0	0.0

(Table 22 Continued)

M. americanus	Ship Channel	0.0	2.1	0.0	0.2	0.0
M. littoralis	---	0.0	0.0	0.0	0.0	0.0
M. saxatilis	---	0.0	0.0	0.0	0.0	0.0
M. undulatus	Ship Channel	2.9	5.9	0.0	0.5	0.0
	Saluria Bayou	12.0	0.0	0.0	0.0	0.0
P. cromis	Ship Channel	244.9	45.7	16.0	2.6	0.0
	Saluria Bayou	202.7	37.2	0.0	8.4	0.0
	ICWW	23.4	16.1	0.0	0.0	4.7
	Pass Cavallo	220.0	62.6	24.7	---	---
S. ocellatus	Ship Channel	0.0	0.0	0.0	2.5	9.0
	Saluria Bayou	0.0	0.0	0.0	2.4	0.0
S. lanceolatus	Ship Channel	0.0	0.0	84.3	59.9	0.0
	ICWW	0.0	0.0	0.0	0.0	24.7

Table 23. Distribution of mean catch density of larvae of each fish species (expressed as a percent of the sum of the means) given by station and cruise. All catches were made by the 1/2 m tow net except those which are underlined, and these were made by the Tucker Trawl.

Taxon	Location	Cruise number				
		2	3	4	5	6
A. probatocephalus	ICWW	0.0	100.0	0.0	0.0	0.0
P. lethostigma	---	0.0	0.0	0.0	0.0	0.0
B. chrysoura	Ship Channel	0.0	0.5	93.6	3.5	2.4
	Saluria Bayou	0.0	0.0	96.3	1.5	2.2
	ICWW	0.0	6.8	66.6	0.0	26.6
	Pass Cavallo	0.0	0.0	100.0	---	---
C. arenarius	Ship Channel	61.3	16.3	0.0	14.5	7.9
	Saluria Bayou	78.9	0.0	0.0	21.1	0.0
	ICWW	0.0	0.8	0.0	0.0	99.2
C. nebulosus	Ship Channel	5.8	2.7	10.1	51.5	30.0
	Saluria Bayou	0.0	0.0	67.0	33.0	0.0
	ICWW	0.0	6.6	25.9	24.7	42.8
	Pass Cavallo	0.0	6.1	93.9	---	---
C. nothus	ICWW	0.0	0.0	0.0	0.0	100.0
L. fasciatus	---	0.0	0.0	0.0	0.0	0.0
L. xanthurus	Ship Channel	13.8	86.2	0.0	0.0	0.0

(Table 23 Continued)

M. americanus	Ship Channel	0.0	91.3	0.0	8.7	0.0
M. littoralis	---	0.0	0.0	0.0	0.0	0.0
M. saxatilis	---	0.0	0.0	0.0	0.0	0.0
M. undulatus	Ship Channel	31.2	63.4	0.0	5.4	0.0
	Saluria Bayou	100.0	0.0	0.0	0.0	0.0
P. cromis	Ship Channel	79.2	14.8	5.2	0.8	0.0
	Saluria Bayou	81.6	15.0	0.0	3.4	0.0
	ICWW	52.9	36.4	0.0	0.0	10.6
	Pass Cavallo	71.6	20.4	8.0	---	---
S. ocellatus	Ship Channel	0.0	0.0	0.0	21.7	78.3
	Saluria Bayou	0.0	0.0	0.0	100.0	0.0
S. lanceolatus	Ship Channel	0.0	0.0	58.5	41.5	0.0
	ICWW	0.0	0.0	0.0	0.0	100.0

Table 24. Results of multiple regression analysis for the larvae of individual fish species from the Matagorda Ship Channel. Environmental parameters are defined in Table 10, and positive and negative values are defined in Table 5. Significance of the parameters is defined at the 5-percent level. Regression models are given in Appendix E.

Measure	All values included		Zero values omitted	
		Bairdiella chrysoura		
Significant parameters	W^+,TH^+		W^+	
Best 3-variable model	D^+,W^+,TH^+	(R^2=0.13)	D^+,W^+,TH^+	(R^2=0.70)
Best 7-variable model	$D^+,W^+,TH^+,T^-,S^-,L^+,C^+$	(R^2=0.14)	$D^+,W^+,TH^+,T^-,S^+,C^+,L^+$	(R^2=0.65)
		Cynoscion arenarius		
Significant parameters	L^-,T^-,TH^+,D^+,S^-		TH^+,L^-	
Best 3-variable model	T^-,TH^+,L^-	(R^2=0.18)	T^-,TH^+,L^-	(R^2=0.07)
Best 7-variable model	$T^-,TH^+{\cdot}L^-,D^+,S^-,C^-,W^-$	(R^2=0.22)	$T^-,TH^+,L^-,D^+,S^-,C^+,W^+$	(R^2=0.05)
		Cynoscion nebulosus		
Significant parameters	T^+		none	
Best 3-variable model	D^+,T^+,W^-	(R^2=0.10)	D^+,T^-,S^-	(R^2=0.07)
Best 7-variable model	$D^+,T^+,W^-,S^+,C^+,TH^+,L^-$	(R^2=0.08)	$D^+,T^-,S^-,C^+,W^-,TH^+,L^+$	(R^2=0.01)
		Pogonias cromis		
Significant parameters	T^-,S^-		T^-	
Best 3-variable model	T^-,S^-,TH^+	(R^2=0.44)	D^-,T^-,L^-	R^2= 0.12)
Best 7-variable model	$T^-,S^-,TH^+,D^-,C^-,W^-,L^-$	(R^2=0.44)	$D^-{\cdot}T^-,L^-,S^-,C^-,W^+,TH^+$	(R^2=0.09)
		Stellifer lanceolatus		
Significant parameters	D^+		D^+	
Best 3-variable model	D^+,S^-,L^-	(R^2=0.06)	D^+,T^-,S^-	(R^2=0.32)
Best 7-variable model	$D^+,S^-,L^-,T^+,C^-,W^+,TH^+$	(R^2=0.06)	$D^+,T^-,S^-,C^-,W^+,TH^+,L^-$	(R^2=0.25)

Table 25. Results of multiple regression analysis for the larvae of individual fish species from Saluria Bayou. Environmental parameters are defined in Table 10, and positive and negative values are defined in Table 5. Significance of the parameters is defined at the 5 - percent level. Regression models are given in Appendix E.

Measure	All values included		Zero values omitted	
		Cynoscion nebulosus		
Significant parameters	none		D^+,T^-,S^-,W^+	
Best 3-variable model	D^+,C^+,TH^-	$(R^2=0.09)$	C^+,W^+,TH^+	$(R^2=0.21)$
Best 6-variable model	D^+,C^+,TH^-,T^+,S^+,W^-	$(R^2=0.05)$	C^+,W^+,TH^-,D^+,T^-,S^-	$(R^2=0.97)$
		Pogonias cromis		
Significant parameters	T^-		none	
Best 3-variable model	T^-,S^-,W^+	$(R^2=0.29)$	D^+,T^-,W^+	$(R^2=0.58)$
Best 6-variable model	T^-,S^-,W^+,D^+,C^+,TH^+	$(R^2=0.28)$	D^+,T^-,W^+,S^-,C^+,TH^+	$(R^2=0.34)$

Table 26. Results of multiple regression analysis for the larvae of individual fish species from the Intracoastal Waterway. Environmental parameters are defined in Table 10, and postive and negative values are defined in Table 5. Significance of the parameters is defined at the 5-percent level. Regression models are given in Appendix E.

Measure	All values included		Zero values omitted	
		<u>Bairdiella chrysoura</u>		
Significant parameters	none		T^+,C^-	
Best 3-variable model	T^+,C^+,W^-	$(R^2=0.02)$	D^-,T^+,C^-	$(R^2=0.43)$
Best 5-variable model	$T^+,C^+,W^-.D^-,S^+$	$(R^2=0.00)$	D^-,T^+,C^-,S^+,W^-	$(R^2=0.55)$
		<u>Cynoscion arenarius</u>		
Significant parameters	none		none	
Best 3-variable model	D^+,T^+,C^-	$(R^2=0.08)$	D^+,S^-,W^+	$(R^2=0.27)$
Best 5-variable model	D^+,T^+,C^-,S^+,W^-	$(R^2=0.07)$	D^+,S^-,W^+,T^+,C^+	$(R^2=0.21)$
		<u>Cynoscion nebulosus</u>		
Significant parameters	W^-,T^+		none	
Best 3-variable model	T^+,S^+,W^-	$(R^2=0.06)$	D^+,T^+,S^+	$(R^2=0.32)$
Best 5-variable model	T^+,S^+,W^-,D^-,C^-	$(R^2=0.03)$	D^-,T^+,S^+,C^-,W^-	$(R^2=0.15)$

Table 27. Comparison of mean R^2 values derived by the two methods (zero values included and zero values omitted) for the data sets involving the major biological groups, shrimp and crab larval stages, and larvae of the individual fish species.

Data sets	Zero values included	Zero values omitted	p - values
Biological group data	0.44	0.47	0.697
Shrimp/crab larvae	0.34	0.54	0.015
Fish larvae	0.20	0.58	0.002

Table 28. Summarization of physical factor signs and mean R^2 values for each sampling location based upon best regression models for the six major biological groups. All models are derived by the method with zero values omitted except in the case of marine sciaenid larvae in Pass Cavallo.

Location	Physical factors							R^2
	C	W	TH	D	T	S	L	$\bar{x}$
Ship Channel	$4^+/2^-$	$5^+/1^-$	$4^+/2^-$	$4^+/2^-$	$4^+/2^-$	$3^+/3^-$	$2^+/4^-$	.29
Saluria Bayou	$5^+/1^-$	$6^+/0^-$	$3^+/3^-$	$2^+/4^-$	$2^+/4^-$	$3^+/3^-$	- -	.32
ICWW	$5^+/1^-$	$4^+/2^-$	- -	$3^+/3^-$	$4^+/2^-$	$4^+/2^-$	- -	.22
Pass Cavallo	$5^+/1^-$	$1^+/5^-$	$3^+/3^-$	- -	$4^+/2^-$	$1^+/5^-$	- -	.40
Total	$19^+/5^-$	$16^+/8^-$	$10^+/8^-$	$9^+/9^-$	$14^+/10^-$	$11^+/13^-$	$2^+/4^-$	.31
Positive (%)	79.2	66.7	55.6	50.0	58.3	45.8	33.3	- -

Table 29. Major biological group data. Summaryu of physical factor signs and R^2 values from regression model, given by station location. Station names are abbreviated as follows: SC= Ship Channel, SB = Saluria Bayou, ICWW = Intracoastal Waterway, and PC = Pass Cavallo.

Group	Station	Physical factors							R^2
		C	W	TH	D	T	S	L	
Shrimp larvae	SC	+	+	+	+	-	-	+	.19
	SB	+	+	-	-	-	-		.44
	ICWW	+	+		-	+	-		.23
	PC	+	-	+		-	-		.91
Crab larvae	SC	+	+	-	-	+	-	+	.09
	SB	+	+	-	-	-	+		.23
	ICWW	+	+		-	+	+		.22
	PC	+	-	-		+	-		.64
Fish eggs	SC	-	-	-	-	+	+	-	.41
	SB	-	+	+	-	+	+		.50
	ICWW	+	+		+	-	+		.16
	PC	+	-	+		+	-		.86
Est. fish larvae	SC	+	+	+	+	+	+	-	.41
	SB	+	+	+	+	-	-		.11
	ICWW	-	-		+	+	+		.14
	PC	+	-	-		+	+		- .11
Mar. fish larvae	SC	+	+	+	+	+	+	-	.42
	SB	+	+	-	-	+	+		.11
	ICWW	+	-		+	+	+		.19
	PC	+	-	+		+	-		.61

Table 29 (continued)

Mar. sciaenid larvae	SC	-	+	-	+	-	-	-	.20
	SB	+	+	+	+	-	-		.52
	ICWW	+	+		-	-	-		.38
	PC	-	+	-		-	-		- .54

Table 30. Shrimp larval stage data. Summary of physical factor signs and R^2 values from regression models, given by station location. Station names are abbreviated as in Table 29.

Stage	Station	Physical factors							R^2
		C	W	TH	D	T	S	L	
Penaeidae-protozoea	SC	+	+	+	+	+	-	+	.44
	SB	+	+	-	-	+	+		.59
	ICWW	+	-		-	-	+		.67
	PC	+	-	+		+	-		.92
Penaeid - mysis	SC	+	+	+	+	+	-	+	.21
	SB	-	+	+	-	+	-		.71
	ICWW	+	+			-	-		.76
	PC	-	-	+		+	+		- .02
P. aztecus post-larvae	SC	-	-	+	-	-	-	+	.29
	SB	-	+	+	-	-	-		.25
	ICWW	-	-		-	+	+		.42
	PC	-	+	-		-	+		- .25
Penaeus spp.-post-larvae	SC	+	+	-	+	+	-	-	.07
	SB	-	+	+	-	+	+		.36
	ICWW	+	-		+	-	-		- .07
	PC	+	-	+		+	-		.06
Positive (%)		56.3	56.3	75.0	36.4	62.5	37.5	75.0	

Table 31. Crab larval stage data. Summary of physical factor signs and R^2 values from regression models, given by station location. Station names are abbreviated as in Table 29.

Stage	Station	Physical factors							R^2
		C	W	TH	D	T	S	L	
Portunid-zoea	SC	+	+	-	-	+	-	+	.20
	SB	+	+	-	-	-	+		.28
	ICWW	+	+		-	-	+		.36
	PC	+	-	-		+	-		.99
Callinectes - megalops	SC	+	-	+	+	-	+	+	.04
	SB	-	-	+	-	-	+		.07
	ICWW	+	-		+	-	-		.17
	PC	+	+	+		-	-		.13
Portunid - juveniles	SC	+	+	+	+	-	-	-	.30
	SB	+		-	+				.02
	ICWW				+		+		.01
	PC		+	+		-	+		- .17
Positive (%)		90.0	60.0	55.6	55.6	20.0	54.5	66.7	

Table 32. Fish larval data. Summary of physical factor signs and R^2 values from regression models, given by station location. Station names are abbreviated as in Table 29.

Species	Station	Physical factors							R^2
		C	W	TH	D	T	S	L	
Bairdiella chrysoura	SC	+	+	+	+	-	+	+	.65
	ICWW	-	-		-	+	+		.55
Cynoscion arenarius	SC	+	+	+	+	-	-	-	.05
	ICWW	+	+		+	+	-		- .21
Cynoscion nebulosus	SC	+	-	+	+	-	-	+	.05
	SB	+	+	-	+	-	-		.97
	ICWW	-	-		-	+	+		.15
Pogonias cromis	SC	-	+	+	-	-	-	-	.09
	SB	+	+	+	+	-	-		.34
Stellifer lanceolatus	SC	-	+	+	+	-	-	-	.25
Positive (%)		60.0	70.0	85.7	70.0	30.0	30.0	40.0	

Table 33. Summary of the most frequently occurring (positive and negative) signs associated with the regression equations relating physical factors and biological abundance at the four collecting stations. + indicates that the relationship was most frequently positive. - indicates that the relationship was most frequently negative. 0 indicates that the frequency of positive and negative correlations was equal. R^2 values represent the mean R^2 values associated with regression analysis at the four stations.

Biological group	Physical factors							R^2
	C	W	TH	D	T	S	L	$\bar{x}$
Major Group								
Shrimp larvae	+	+	+	-	-	-	+	.44
Crab larvae	+	+	-	-	+	0	+	.30
Fish eggs	0	0	+	-	+	+	-	.48
Est. fish larvae	+	+	+	+	+	+	-	.14
Mar. fish larvae	+	0	+	+	+	+	-	.33
Mar. sciaaenid larvae	0	+	-	+	-	-	-	.14
Shrimp larval stages								
Penaeid - protozoea	+	0	+	-	+	0	+	.66
Penaeid - mysis	0	+	+	0	+	-	+	.42
P. aztecus - postlarvae	-	0	+	-	-	0	+	.18
Penaeus spp. - postlarvae	+	0	+	+	+	-	-	.11
Crab larval stages								
Portunid - zoea	+	+	-	-	0	0	+	.46
Callinectes - megalops	+	-	+	+	-	0	+	.11
Portunid juveniles	+	+	+	+	-	+	-	.04
Fish larvae								
B. chrysoura	0	0	+	0	0	+	+	.60
C. arenarius	+	+	+	+	0	-	-	- 0.08
C. nebulosus	+	-	0	+	-	-	+	.39
P. cromis	0	+	+	0	-	-	-	.22
S. lanceolatus	-	+	+	+	-	-	-	.25

APPENDIX A

HISTORY OF THE PROJECT

Pre-project History. In June, 1986 a pre-proposal was submitted to Dr. Gary Powell, Head, Environmental Studies Unit, Texas Department of Water Resources. The proposed study was to be carried out in Galveston Bay and was to address the transport of eggs and larvae of 11 species of sciaenid fishes. No shrimp or crab larvae were to be examined. A total of 240 plankton samples was to be taken and processed. The original sampling design focused upon the larval transport mechanisms from the continental shelf into the bay, and it subordinated attention on transport within the bay. It included a strong focus on replicate sampling in the pass to provide a solid basis for statistical conclusions. It was to be conducted in an area where physical data were readily accessible and where historical biological data were available to aid in pinning down the transport mechanisms.

By studying Galveston Bay and working out of the local Texas A&M facilities, the following advantages would have been achieved:

a) Boat running time to and from the study area would have been negligible,

b) Any boat and gear malfunctions could have been handled quickly and cheaply at our docks and shops,

c) Since we would have been working out of our home base, it would have been relatively easy to work around bad weather conditions, and

d) Housing costs would have been reduced since we would have stayed at the local Texas A&M dormitories.

By taking a realistic number of plankton samples and analyzing only for fish larvae, the plankton samples would have been processed between collecting trips. Thus, there is every reason to believe that the objectives of the original project could have been met on schedule and within budget and that the goal of elucidating the transport mechanisms would have been accomplished.

Project History. During the fall of 1986 jurisdiction for all coastal biological studies was recognized to lie within the Texas Parks and Wildlife Department. In February, 1987, in conference between the Texas A&M investigators and personnel of the Parks and Wildlife Department, the proposal was modified, and it was resubmitted with the following new requirements:

a) Movement of the study area from Galveston Bay to Matagorda Bay,

b) Increase in the number of plankton samples from 240 to 1,520 (a 6.3 fold increase), and

c) Increase in the number of fish species from 11 to 15 and addition of penaeid shrimp and blue crab larvae.

Equipment and gear problems plagued the February, March, April, and May cruises, and bad weather further affected the March and May cruises. During mid-June a conference was held between the investigators and personnel of the Texas Parks and Wildlife Department to modify the sampling program. At this time it was decided to drop the Pass Cavallo collecting site (which had proven to be both difficult and dangerous) and to reduce the number of samples to a total of 378. The revised plan was designed to accomplish most of the original study objectives, although it would lack the seasonal component. During the period June-August the weather was good, and despite some minor gear problems all the proposed samples were taken. However, since much time had been spent in the field, by the end of August most of the summer samples remained to be processed in the laboratory. In the fall of 1987, after another conference, a second contract was negotiated to permit completion of the sample sorting and beginning of data analysis. All samples were completely analyzed by mid-January, 1988. Several subsequent meetings were held between the investigators and personnel of the Texas Parks and Wildlife Department concerning procedures to be followed in the data analysis. A third contract was negotiated in October, 1988 to complete the data analyses, draft the final report, and prepare a set of 35mm slides presenting data collection methods, data analysis procedures, results, and conclusions.

APPENDIX B

MEAN DENSITY (NUMBER OF ORGANISMS/1,000 M^3) AND STANDARD ERRORS FOR ALL SAMPLES (t = < 0.5).

Group	Ship Channel		Saluria Bayou		Intracoastal Waterway		Pass Cavallo	
	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.	$\bar{x}$	s.e.
Group Data								
Shrimp larvae	1,331 ±	307	1,826 ±	331	1,127 ±	269	2,455 ±	1,222
Crab larvae	3,392 ±	383	5,156 ±	1,569	2,242 ±	396	7,017 ±	2,411
Fish eggs	15,469 ±	1,896	14,806 ±	2,437	22,813 ±	6,800	3,246 ±	1,205
Est. fish larvae	4,617 ±	542	430 ±	59	2,012 ±	432	1,668 ±	760
Mar. fish larvae	602 ±	54	287 ±	34	435 ±	88	727 ±	223
Mar. sciaenid larvae	160 ±	25	22 ±	9	160 ±	89	83 ±	47
Shrimp Data								
Penaeidae - protozoea	598 ±	235	805 ±	289	675 ±	235	1,792 ±	912
Penaeus - mysis	313 ±	77	80 ±	28	83 ±	29	217 ±	58
P. aztecus - post-larvae	208 ±	54	187 ±	108	56 ±	20	145 ±	125
Penaeus spp. - post-larvae	206 ±	63	754 ±	165	342 ±	122	301 ±	213
Crab Data								
Portunid zoea	2,714 ±	382	4,874 ±	1,578	1,898 ±	382	5,860 ±	2,416
Callinectes megalops	523 ±	105	273 ±	83	349 ±	160	1,143 ±	970
Portunid juveniles	79 ±	14	9 ±	5	4 ±	3	2 ±	2
Callinectes sapidus	t ±	t	0 ±	0	0 ±	0	0 ±	0

Fish Data

Archosargus probatocephalus	0 ± 0	0 ± 0	1 ± 1	0 ± 0
Paralichthys lethostigma	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Bairdiella chrysoura	16 ± 6	9 ± 6	22 ± 7	64 ± 39
Cynoscion arenarius	94 ± 18	2 ± 1	158 ± 91	0 ± 0
Cynoscion nebulosus	77 ± 18	11 ± 4	25 ± 13	25 ± 22
Cynoscion nothus	0 ± 0	0 ± 0	2 ± t	0 ± 0
Larimus fasciatus	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Leiostomus xanthurus	1 ± 1	0 ± 0	0 ± 0	0 ± 0
Menticirrhus americanus	t ± t	0 ± 0	0 ± 0	0 ± 0
Menticirrhus littoralis	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Menticirrhus saxatilis	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Micropogonias undulatus	2 ± 1	1 ± 1	0 ± 0	0 ± 0
Pogonias cromis	58 ± 10	18 ± 8	6 ± 3	83 ± 47
Sciaenops ocellatus	3 ± 2	1 ± 1	0 ± 0	0 ± 0
Stellifer lanceolatus	28 ± 11	0 ± 0	7 ± 7	0 ± 0

APPENDIX C

PHYSICAL MODELS FOR MAJOR BIOLOGICAL GROUPS

This section includes the numerical models derived by stepwise multiple regression techniques for the major biological groups. These are the models with highest R^2 values based upon the method in which the zero values are excluded. In all cases y represents biological abundance expressed as the log of the number of larvae per cubic meter of water. In the models the numbers have been rounded off to five decimal places.

Ship Channel

Shrimp larvae

$$y = 0.13532 + 0.02705\ D - 0.00002\ T^2 - 0.01156\ S + 0.03020\ C + 0.22041\ TH + 0.02164\ W + 0.01535\ L$$

Crab larvae

$$y = 0.56485 - 0.00423\ D + 0.00027\ T^2 - 0.00932\ S + 0.06101\ C - 0.10455\ TH + 0.00386\ W + 0.02069\ L$$

Fish eggs

$$y = -\ 1.84405 - 0.06463\ D + 0.00162\ T^2 + 0.08152\ S - 0.09884\ C - 0.23995\ TH - 0.03732\ W - 0.04385\ L$$

Estuarine fish larvae

$$y = -\ 0.92684 + 0.04611\ D + 0.00074\ T^2 + 0.03057\ S + 0.01578\ C + 0.14743\ TH + 0.00731\ W - 0.08131\ L$$

Marine fish larvae

$$y = -0.52049 + 0.01261\ D + 0.00032\ T^2 + 0.01347\ S + 0.01091\ C + 0.10562\ TH + 0.00463\ W - 0.02652\ L$$

Marine sciaenid larvae

$$y = 0.48915 + 0.00985\ D - 0.00022\ T^2 - 0.01049\ S - 0.00008\ C + 0.09664\ TH + 0.00123\ W - 0.01823\ L$$

Saluria Bayou

Shrimp larvae

$$y = 0.51691 - 0.05595\ D - 0.00023\ T^2 - 0.00067\ S + 0.11283\ C - 0.02026\ TH + 0.02500\ W$$

Crab larvae

$$y = 0.13511 - 0.03974\ D - 0.00019\ T^2 + 0.01708\ S + 0.20409\ C - 0.19682\ TH + 0.00594\ W$$

Fish eggs

$$y = -1.40861 - 0.06340\ D + 0.00224\ T^2 + 0.01080\ S - 0.33034\ C + 0.49791\ TH + 0.00702\ W$$

Estuarine fish larvae

$$y = 0.40973 + 0.01717\ D - 0.00025\ T^2 - 0.00641\ S + 0.04882\ C + 0.03413\ TH + 0.00651\ W$$

Marine fish larvae

$$y = -0.01673 - 0.00919\ D + 0.00004\ T^2 + 0.00485\ S + 0.00583\ C - 0.02898\ TH + 0.00152\ W$$

Marine sciaenid larvae

$$y = 0.20715 + 0.00226\,D - 0.00023\,T^2 - 0.00288\,S + 0.00561\,C + 0.01937\,TH + 0.01083\,W$$

Intracoastal Waterway

Shrimp larvae

$$y = 0.11638 - 0.02879\,D + 0.00038\,T^2 - 0.00142\,S + 0.21618\,C + 0.00205\,W$$

Crab larvae

$$y = 0.18959 - 0.00099\,D + 0.00005\,T^2 + 0.00678\,S + 0.04406\,C - 0.01737\,W$$

Fish eggs

$$y = 0.57152 + 0.01608\,D - 0.00012\,T^2 + 0.01476\,S + 0.28627\,C + 0.00650\,W$$

Estuarine fish larvae

$$y = 0.08875 + 0.06212\,D + 0.00009\,T^2 + 0.00143\,S - 0.09996\,C - 0.00045\,W$$

Marine fish larvae

$$y = -0.03230 + 0.00243\,D + 0.00026\,T^2 + 0.00085\,S + 0.10895\,C - 0.00616\,W$$

Marine sciaenid larvae

$$y = 0.50638 + 0.15304\,D - 0.00042\,T^2 - 0.01969\,S + 0.03494\,C + 0.02586\,W$$

Pass Cavallo

Shrimp larvae

$$y = 25.25801 - 0.00242\ T^2 - 0.70557\ S + 0.08167\ C - 0.01419\ W + 0.04231\ TH$$

Crab larvae

$$y = 7.01946 + 0.00216\ T^2 - 0.22043\ S + 0.39431\ C - 0.01664\ W - 0.22153\ TH$$

Fish eggs

$$y = -1.30775 + 0.00487\ T^2 - 0.02056\ S + 0.08585\ C - 0.04684\ W + 0.33589\ TH$$

Estuarine fish larvae

$$y = -3.52217 + 0.00280\ T^2 + 0.09334\ S + 0.17230\ C - 0.04321\ W - 0.25728\ TH$$

Marine fish larvae

$$y = -0.20713 + 0.00363\ T^2 - 0.03048\ S + 0.11686\ C - 0.05641\ W + 0.05175\ TH$$

Marine sciaenid larvae

$$y = 0.30475 - 0.00041\ T^2 - 0.00260\ S - 0.04692\ C + 0.00543\ W - 0.01893\ TH^*$$

*This model is based upon the method with zero values included.

APPENDIX D

PHYSICAL MODELS FOR SHRIMP AND CRAB LIFE HISTORY STAGES

This section includes the numerical models derived by stepwise multiple regression techniques for the larval stages of the shrimp and crabs. These are the models with highest R^2 values based upon the method in which the zero values are omitted except in Pass Cavallo where models based upon the method in which zero values are included had to be used in five instances. These are marked by an asterisk (*). In all cases y represents biological abundance expressed as the log of the number of larvae per cubic meter of water. In the models the numbers have been rounded off to five decimal places.

Ship Channel

Penaeidae - protozoea

$$y = -0.53575 + 0.01980\ D + 0.00037\ T^2 - 0.00685\ S + 0.00001\ C + 0.03560\ W + 0.20215\ TH + 0.02399\ L$$

Penaeus - mysis

$$y = -0.6641 + 0.01827\ D + 0.00029\ T^2 - 0.00930\ S + 0.00682\ C + 0.01608\ W + 0.14545\ TH + 0.00715\ L$$

Penaeus aztecus - post-larvae

$$y = 0.30799 - 0.02684\ D - 0.00037\ T^2 - 0.00061\ S - 0.01001\ C - 0.00329\ W + 0.15257\ TH + 0.00366\ L$$

Penaeus spp. - post-larvae

$$y = -0.20790 + 0.03938\ D + 0.00031\ T^2 - 0.00122\ S + 0.04054\ C + 0.00376\ W - 0.02116\ TH - 0.00892\ L$$

Portunid - zoea

$$y = 0.28963 - 0.01067\ D + 0.00043\ T^2 - 0.00681\ S + 0.04259\ C + 0.00963\ W - 0.19530\ TH + 0.03627\ L$$

Callinectes - megalops

$$y = 0.00474 + 0.01110\ D - 0.00002\ T^2 + 0.00394\ S + 0.03040\ C - 0.00417\ W + 0.05293\ TH + 0.00300\ L$$

Portunid - juveniles

$$y = 0.08252 + 0.01542\ D - 0.00004\ T^2 - 0.00139\ S + 0.03576\ C + 0.00149\ W + 0.04495\ TH - 0.02268\ L$$

Saluria Bayou

Penaeidae - protozoea

$$y = -6.06806 - 0.04901\ D + 0.00111\ T^2 + 0.17354\ S + 0.16189\ C + 0.02644\ W - 0.08377\ TH$$

Penaeus - mysis

$$y = 2.30404 - 0.27058\ D + 0.00056 T^2 - 0.07430\ S - 0.08390\ C + 0.00449\ W + 0.19618\ TH$$

Penaeus aztecus - post-larvae

$$y = 1.03362 - 0.00237\ D - 0.00091\ T^2 - 0.01699\ S - 0.08142\ C + 0.02322\ W + 0.20207\ TH$$

Penaeus spp. post-larvae

$$y = -1.43747 - 0.04833\ D + 0.00156\ T^2 + 0.00636\ S - 0.04234\ C + 0.01670\ W + 0.18066\ TH$$

Portunid - zoea

$$y = 0.89190 - 0.03324\ D - 0.00066\ T^2 + 0.01166\ S + 0.23016\ C + 0.00981\ W - 0.28985\ TH$$

Callinectes - megalops

$$y = -0.05043 - 0.00778\ D - 0.00019\ T^2 + 0.00494\ S - 0.03765\ C - 0.00160\ W + 0.24698\ TH$$

Portunid - juveniles

$$y = 0.67451 + 0.09825\ D + 0.31977\ C - 0.63117\ TH$$

Intracoastal Waterway

Penaeidae - protozoea

$$y = -0.69565 - 0.03701\ D - 0.00039\ T^2 + 0.04293\ S + 0.80829\ C - 0.03020\ W$$

Penaeus - mysis

$$y = 37.76897 - 0.00935\ T^2 - 0.99347\ S + 0.50638\ C + 0.10544\ W$$

Penaeus aztecus - post larvae

$$y = -0.16201 - 0.05554\ D + 0.00023\ T^2 + 0.00904\ S - 0.02412\ C - 0.00639\ W$$

Penaeus spp. - post-larvae

$$y = 0.16929 + 0.01966\ D + 0.01975\ C - 0.01175\ W$$

Portunid - zoea

$$y = 0.31767 - 0.01002\ D - 0.00009\ T^2 + 0.00472\ S + 0.06038\ C + 0.02473\ W$$

Callinectes - megalops

$$y = 2.78408 + 0.10750\ D - 0.00243\ T^2 - 0.03800\ S + 0.25711\ C - 0.01816\ W$$

Portunid - juveniles

$$y = -0.04169 + 0.00451\ D + 0.00353\ S$$

Pass Cavallo

Penaeidae - protozoea *

$$y = 2.30762 + 0.00378\ T^2 - 0.11699\ S + 0.00873\ C - 0.03163\ W + 0.06540\ TH$$

Penaeus - mysis

$$y = -9.05858 + 0.00337\ T^2 + 0.22368\ S - 0.00954\ C - 0.01807\ W + 0.02320\ TH$$

Penaeus aztecus - post-larvae *

$$y = 0.00610 - 0.00016\ T^2 + 0.00458\ S - 0.08977\ C + 0.00927\ W - 0.12449\ TH$$

Penaeus spp. - post-larvae*

$$y = 0.94437 + 0.00116\ T^2 - 0.04581\ S + 0.00464\ C - 0.00843\ W + 0.09612\ TH$$

Portunid - zoea

$$y = 0.51960 + 0.00582\ T^2 - 0.06738\ S + 0.38378\ C - 0.06534\ W - 0.29791\ TH$$

Callinectes - megalops *

$$y = 7.42694 - 0.00257\ T^2 - 0.19644\ S + 0.04471\ C + 0.03597\ W + 0.15825\ TH$$

Portunid - juveniles *

$$y = -0.03075 - 0.00004\ T^2 + 0.00134\ S - 0.00352\ C + 0.00096\ W + 0.00135\ TH$$

APPENDIX E

PHYSICAL MODELS FOR INDIVIDUAL FISH SPECIES

This section includes the actual physical regression models derived by stepwise multiple regression techniques for the larvae of the individual fish species listed in Table 13. These are the models with highest R^2 values based upon the method in which zero values are omitted. In all cases y represents biological abundance expressed as the log of the number of larvae per cubic meter of water. In the models the numbers have been rounded off to five decimal places.

Ship Channel

Bairdiella chrysoura

$$y = -0.43339 + 0.00265\,D - 0.00003\,T^2 + 0.01041\,S + 0.00197\,C + 0.00510\,W + 0.09796\,TH + 0.01822\,L$$

Cynoscion arenarius

$$y = 0.27941 + 0.00881\,D - 0.00011\,T^2 - 0.00663\,S + 0.00021\,C + 0.00003\,W + 0.00970\,TH - 0.01610\,L$$

Cynoscion nebulosus

$$y = 0.46477 + 0.02503\,D - 0.00013\,T^2 - 0.01268\,S + 0.00016\,C - 0.00016\,W + 0.02746\,TH + 0.00221\,L$$

Pogonias cromis

$$y = 0.30506 - 0.00457\,D - 0.00016\,T^2 - 0.00485\,S + 0.00317\,C - 0.00194\,W + 0.03510\,TH + 0.01100\,L$$

Stellifer lanceolatus

$$y = 5.30228 + 0.13625\,D - 0.00356\,T^2 - 0.9565\,S - 0.01170\,C + 0.00250\,W + 0.21755\,TH - 0.03022\,L$$

Saluria Bayou

Cynoscion nebulosus

$$y = 1.64433 + 0.01510\ D - 0.00095\ T^2 - 0.00291\ S + 0.00174\ C + 0.00333\ W - 0.00117\ TH$$

Pogonias cromis

$$y = 0.37631 + 0.00636\ D - 0.00629\ T^2 - 0.00872\ S + 0.00750\ C + 0.00984\ W + 0.44920\ TH$$

Intracoastal Waterway

Bairdiella chrysoura

$$y = -\ 0.45390 - 0.04939\ D + 0.00064\ T^2 + 0.00671\ S - 0.12042\ C - 0.00548\ W$$

Cynoscion arenarius

$$y = -\ 0.25376 + 0.14334\ D + 0.00049\ T^2 - 0.01574\ S + 0.07970\ C + 0.03972\ W$$

Cynoscion nebulosus

$$y = -\ 0.05830 - 0.03818\ D + 0.00066\ T^2 + 0.01080\ S - 0.13554\ C - 0.01114\ W$$

LARVAL RECRUITMENT

OF

ESTUARINE RELATED FISHES AND INVERTEBRATES

OF THE

TEXAS COAST

- - - - - - - - - - - - -

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The present study was designed to provide information concerning the physical factors responsible for the transport of larval shrimp, crabs, and fishes from the spawning grounds in the Gulf of Mexico into Matagorda Bay and between Matagorda and Espiritu Santo Bays. Field studies were carried out during the spring and summer months of 1987. These resulted in the collection of 378 plankton samples, each accompanied by appropriate physical environmental data. In the laboratory the plankton samples were sorted, and the organisms were identified to the lowest feasible taxonomic levels. The counts were recorded in terms of density, i.e., the number of individuals of each taxonomic unit per cubic meter of water sampled. The information was entered into a computer data file and subjected to a series of statistical treatments.

Analysis of Methodology

Comparison of paired samples made by the same gear type revealed a high level of internal variability in the data base. Comparison of catches by different gear types indicated that any bias due to gear types is masked by the high internal variability of the data base itself. Regression analysis revealed that the data set from each collecting station is so distinct that it would not be statistically reasonable to combine the data from any pair of stations. Thus, it has been necessary to analyze the data from each station separately.

Regression analysis of biological abundance vs. the various physical factors was carried out by two methods (with zero occurrence values included and with zero values omitted). Comparison of the results obtained by the two methods support the conclusion that the method of analysis with zero values omitted provides the most sound basis for judging the relationships of biological abundance with the physical parameters. Therefore, all conclusions are based upon regressions employing this method of analysis.

Relationship of Each Physical Factor with Biological Abundance

Determination of the overall relationship of the several physical factors with biological abundance has involved averaging the relationships from the four collecting stations. Biological abundance includes the six major biological groups (see below) which account for all the species and life history stages taken. Each physical factor is considered separately.

Current. In 79.2 percent of the cases upchannel current is correlated with biological abundance, and this pattern is consistent through all station locations. The data support the contention that upchannel current is the primary factor involved in the transport of larvae from the continental shelf to the estuary and from one estuary to another.

Wind. In 66.7 percent of the cases upchannel wind is correlated with biological abundance. This pattern is consistent through three of the stations, but in Pass Cavallo the correlation is with down-channel wind. The Pass Cavallo station is anomalous in that no bottom samples were taken, fewer samples were taken, and during one cruise samples were taken during a strong north wind ("norther"). Omitting the Pass Cavallo data, the relationship would have been 83.3 percent, strongly in favor of upchannel wind. There can be no doubt that, under normal conditions, upchannel wind is a major factor associated with larval transport through the passes.

Tidal height. In 55.6 percent of the cases higher tidal height is correlated with biological abundance, and this pattern is consistent at all three stations for which tidal height information is available. Thus, the analysis based upon major biological group data suggest that higher tidal height is of secondary importance in transport of the larvae. However, examination of the relationships using data from individual species and particular larval stages (rather than major groups) shows that higher tidal height is correlated with biological abundance in 77.8 percent of the cases, indicating that it may play a substantial role in the transport of larvae through the passes.

Water depth. Biological abundance is correlated with deeper water in 50.0 percent of the cases. Some species and life history stages favor the bottom and others the surface waters, and the proportion of the two appears to be about equal. in either event, depth *per se* is not a factor responsible for larval transport.

Temperature. In 58.3 percent of the cases higher temperature is correlated with biological abundance. This may relate to the fact that the majority of the samples were taken during the summer months or that larvae from summer spawners were numerically more abundant. However, temperature itself does not appear to be a factor important in relation to larval transport.

Salinity. In only 45.8 percent of the cases was higher salinity correlated with biological abundance. From the data on hand, there is no evidence that salinity has anything to do with the mechanisms of larval transport through the passes.

Light. Since night-time collections were made only in the Ship Channel, this is the only location for which a day/night comparison can be made. Here, daytime collections are correlated with biological abundance in only 33.3 percent of the cases. In the Ship Channel larval densities are higher at night in the majority of the cases.

From the above discussion it is clear that the physical factors most frequently correlated with larval abundance in the passes include upchannel current, upchannel wind, and higher tidal height. The factors of water depth, temperature, and salinity exhibit mixed correlations since about half the cases are correlated with a higher value and half are correlated with a lower value of the particular factor. In two-thirds of the cases the larvae were more abundant at night.

Analysis of Biological Groups, Larval Stages, and Individual Species

Major Biological Groups

The data were first analyzed by major biological group to determine correlation patterns associated with the multi-species groups. The groups included shrimp larvae, crab larvae, fish eggs, estuarine fish larvae, marine fish larvae, and marine sciaenid larvae. For each group the physical factor correlations with biological abundance will be presented as primary (most frequent correlations) and secondary (less frequent correlations).

Shrimp larvae. Factors primarily correlated with biological abundance include upchannel current, upchannel wind, lower temperature, and lower salinity. Factors secondarily correlated with biological abundance include higher tidal height, shallower depth, and daytime conditions.

Crab larvae. Primary factors include upchannel current, upchannel wind, lower tidal height, shallower depth, and higher temperature. A secondary factor is daytime conditions.

Fish eggs. Primary factors include higher temperature and higher salinity. Secondary factors include higher tidal height, shallower depth, and night-time conditions.

Estuarine fish larvae. Primary factors include upchannel current, greater depth, higher temperature, and higher salinity. Secondary factors include higher tidal height and night-time conditions.

Marine sciaenid larvae. Primary factors include upchannel wind, lower temperature, and lower salinity. Secondary factors include lower tidal height, shallower depth, and night-time conditions.

Shrimp Larval Stages

Penaeidae - protozoea. Primary factors include upchannel current and higher temperature. Secondary factors include higher tidal height, shallower depth, and daytime conditions.

Penaeid - mysis. Primary factors include upchannel wind, higher tidal height, higher temperature, and lower salinity. A secondary factor is daytime conditions.

Penaeus aztecus -postlarvae. Primary factors include down-channel current, shallower depth, and lower temperature. Secondary factors include higher tidal height and daytime conditions.

Penaeus spp. - postlarvae. Primary factors include upchannel current, higher temperature, and lower salinity. Secondary factors include higher tidal height, greater depth, and night-time conditions.

Crab Larval Stages

Portunid - zoea. Primary factors include upchannel current, upchannel wind, lower tidal height, and shallower depth. A secondary factor is daytime conditions.

Callinectes - megalops. Primary factors include upchannel current, down-channel wind, higher tidal height, and lower temperature. Secondary factors include greater depth and daytime conditions.

Portunid - juveniles. A primary factor is greater depth. Secondary factors include upchannel current, upchannel wind, greater tidal height, lower temperature, higher salinity, and night-time conditions.

Individual Fish Species

Of the fifteen target fish species the larvae of only five were taken with sufficient frequency for use in regression analysis.

Bairdiella chrysoura (silver perch). A primary factor is higher salinity. Secondary factors include higher tidal height and daytime conditions.

Cynoscion arenarius (Sand seatrout). Primary factors include upchannel current, upchannel wind, greater depth, and lower salinity. Secondary factors include higher tidal height and night-time conditions.

Cynoscion nebulosus (spotted seatrout). In the case of this species there are no primary factors. Secondary factors include upchannel current, down-channel wind, greater depth, lower temperature, lower salinity, and daytime conditions.

Pogonias cromis (black drum). Primary factors include upchannel wind, higher tidal height, lower temperature, and lower salinity. A secondary factor is night-time conditions.

Stellifer lanceolatus (star drum). Primary factors include down-channel current, upchannel wind, higher tidal height, greater depth, lower temperature, lower salinity, and night-time conditions. For this species there are no secondary factors.

Concluding Remarks

For each major biological group, life history stage, and individual species listed above there is provided a mathematical model expressing the relationships of biological abundance with the various physical factors, and each regression equation is accompanied by a measure of the reliability of the estimates of the relationships. Suggestions are provided concerning the design of future studies dealing with the problem of larval transport through the passes. The problem of larval transport across the continental shelf to the passes has not been addressed. Nor has attention been given to the matter of larval behavior which may be important, particularly in the older larval and early juvenile stages.

As in other ecological systems each species has had to develop its own unique life history strategy in order to achieve long term survival under the prevailing environmental conditions. Therefore, the coastal invertebrates and fishes display a great diversity of spawning seasons, spawning locations, and relations with depth, temperature, salinity, and light conditions. However, the major life history bottleneck for all the estuary related species which spawn in the gulf is the problem of traversing the passes, and here we observe a commonality in the adaptions of the various species. Upchannel current, upchannel wind, and increased tidal height all appear to be involved in a major way in moving the larvae through the passes. There is no evidence from the present study that the factor of salinity plays a significant role in larval transport, and this finding has a bearing upon the question of the importance of freshwater release from streams entering the upper reaches of the estuaries.

SUPPLEMENT I

PLOTS OF BIOLOGICAL GROUP DATA AND PHYSICAL DATA VS. EACH PHYSICAL FACTOR BY COLLECTING STATION

MATAGORDA BAY LARVAL STUDY

Explanation of Plots

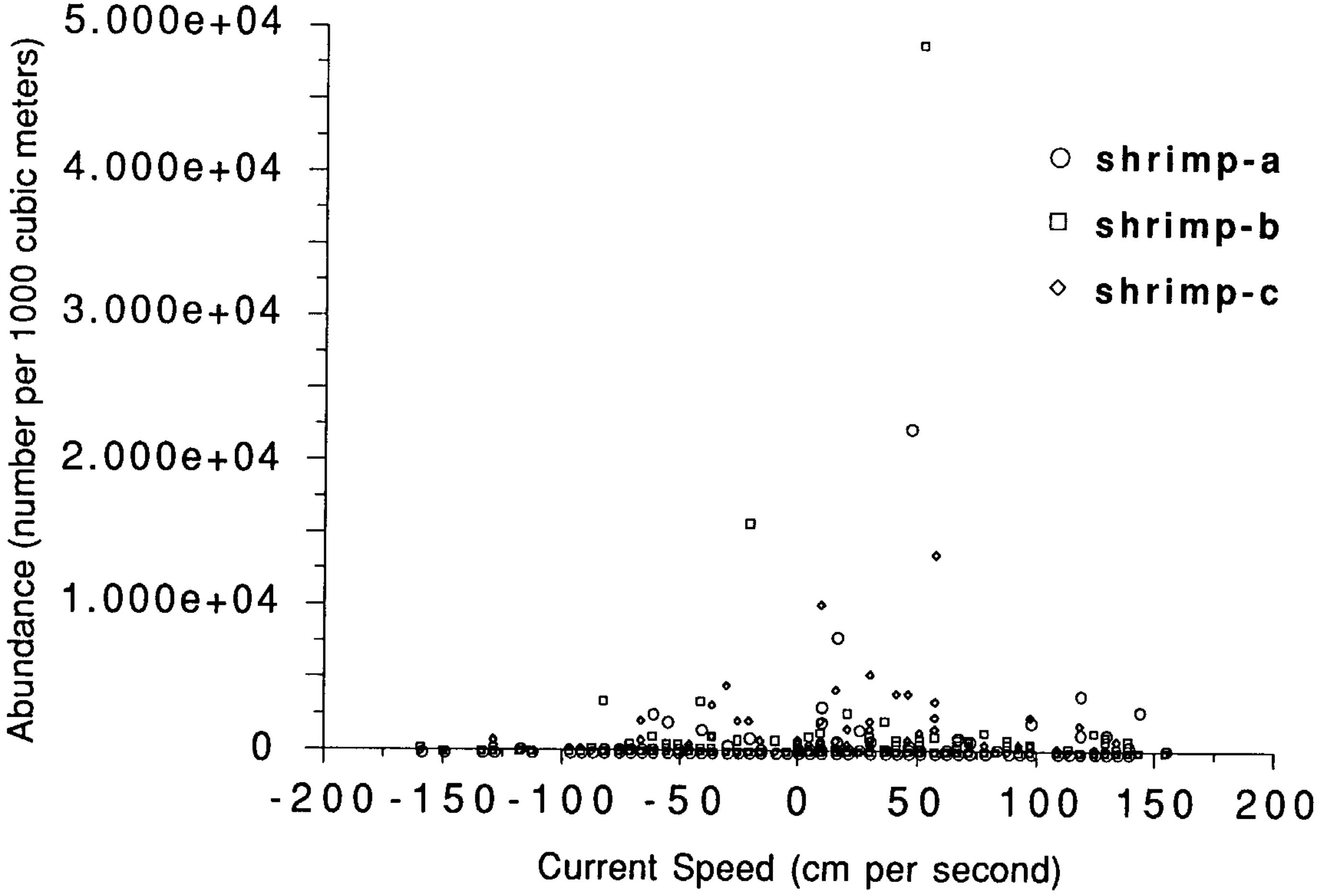
In the accompanying plots the following notation is employed:

a = surface samples,
b = mid-depth samples,
c = near-bottom samples.

In every case the first depth at a station is indicated by a circle, the second by a square, and the third by a diamond, regardless of depth.

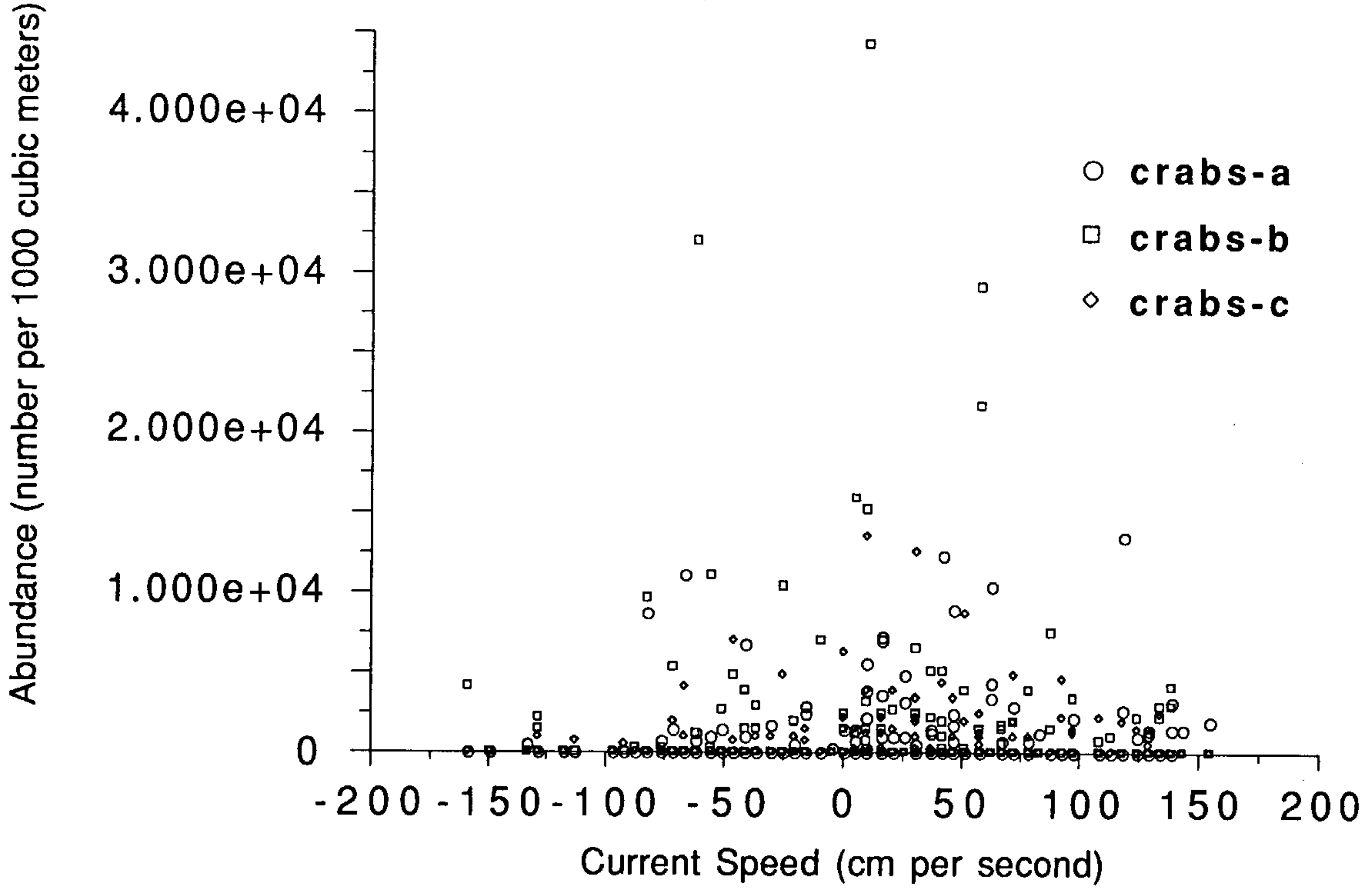
SHIP CHANNEL

Current speed vs shrimp abundance



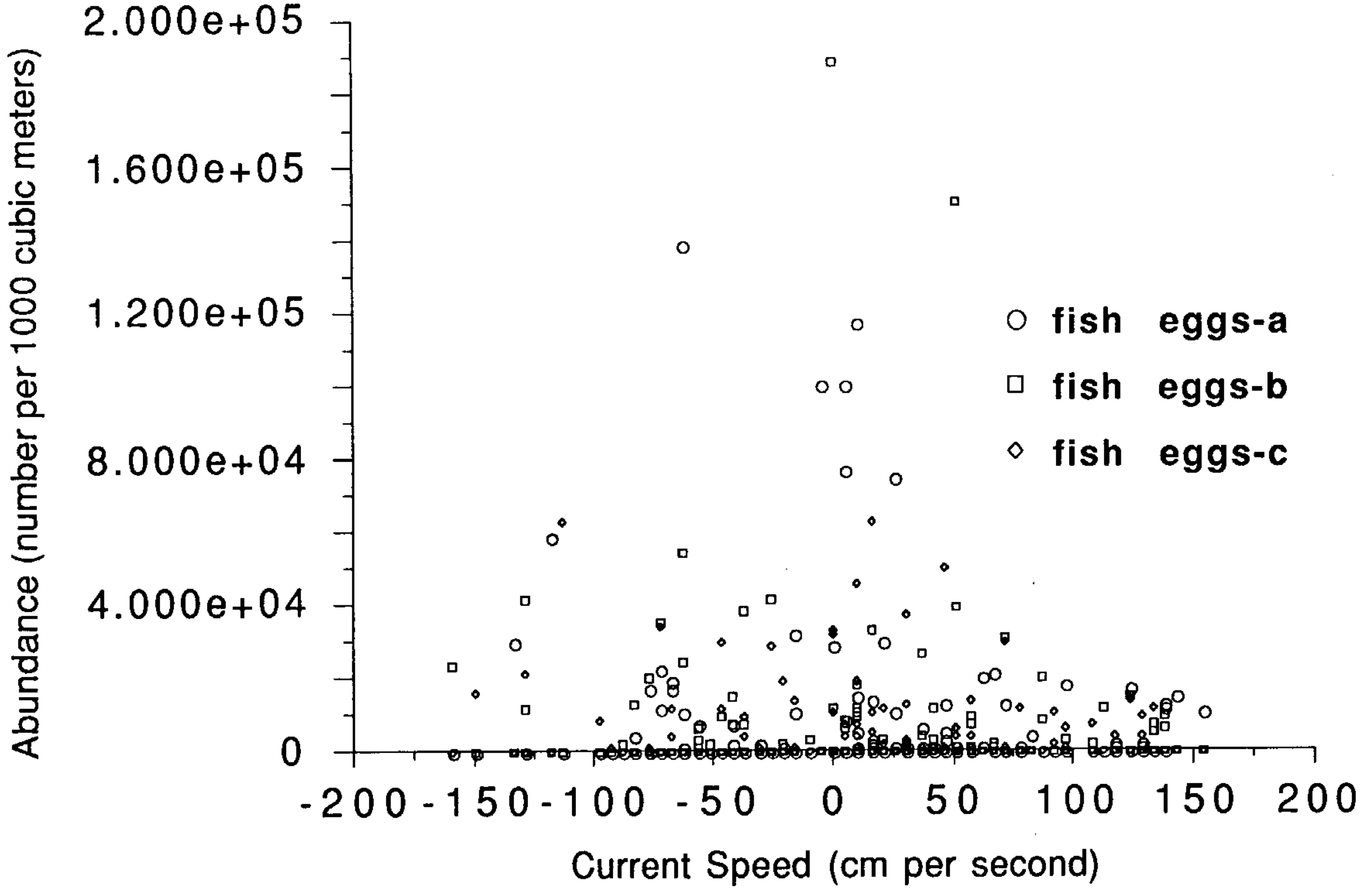
SHIP CHANNEL

Current speed vs crab abundance

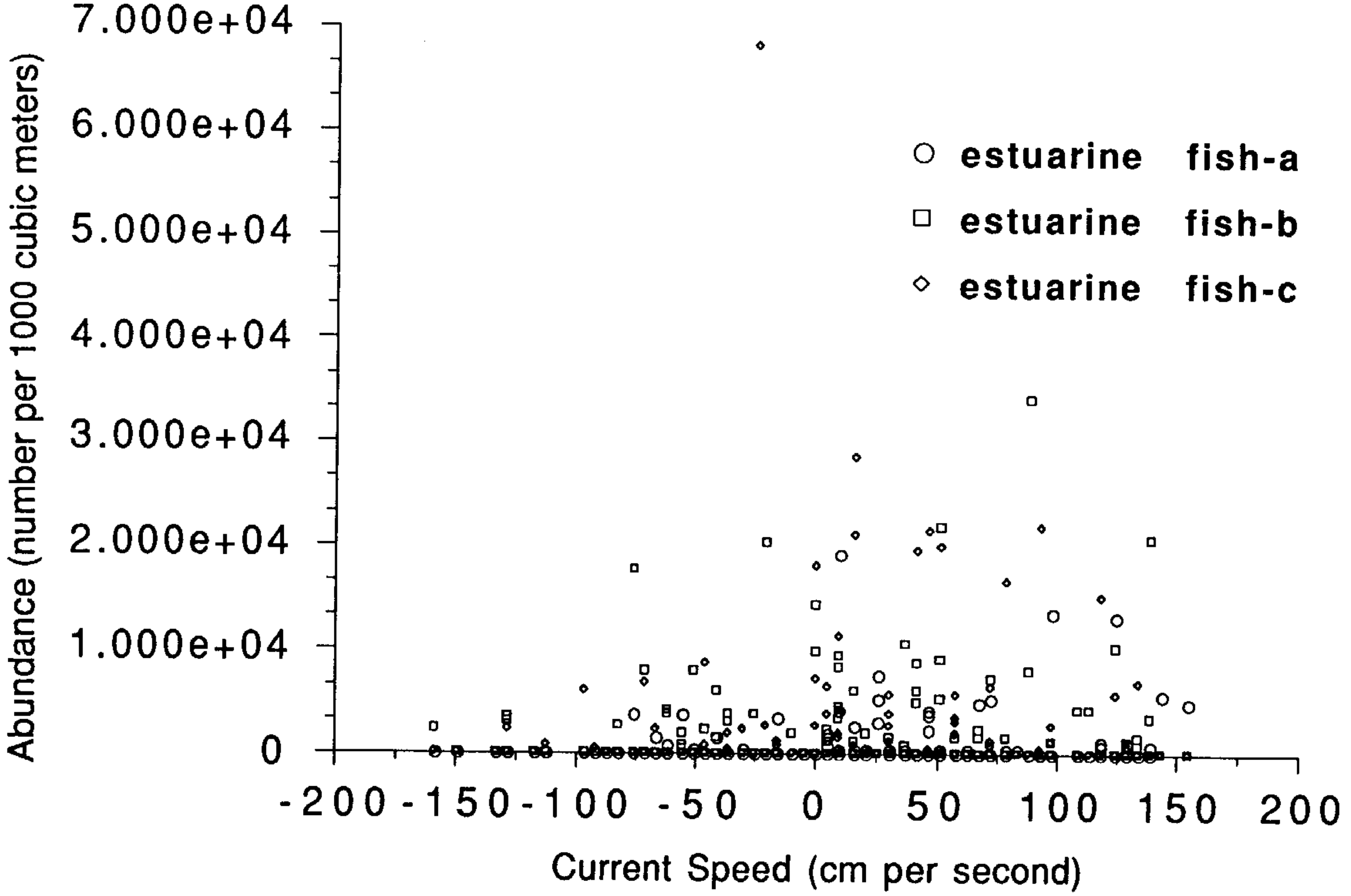


SHIP CHANNEL

Current speed vs fish egg abundance

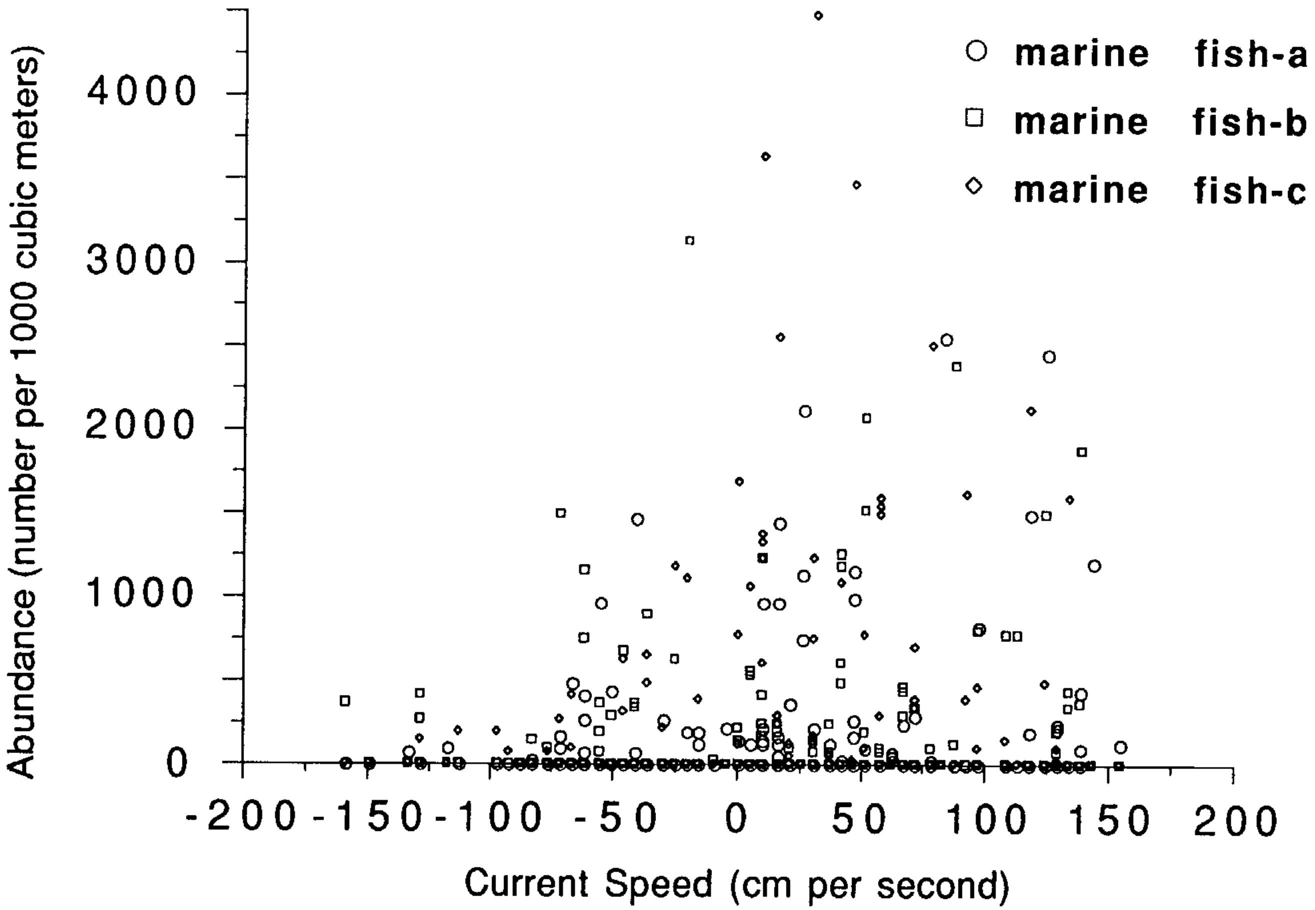


SHIP CHANNEL
Current speed vs estuarine fish abundance



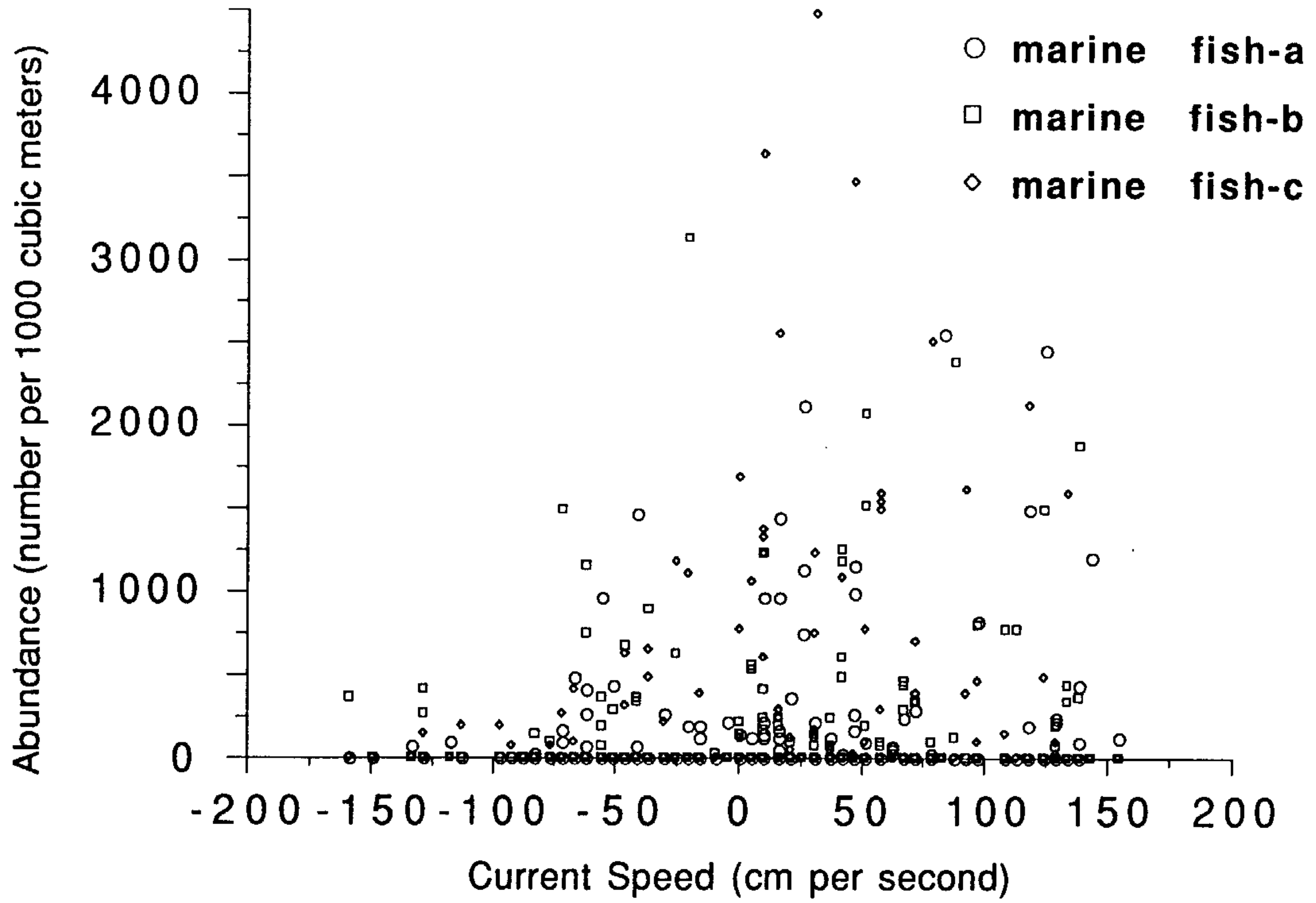
SHIP CHANNEL

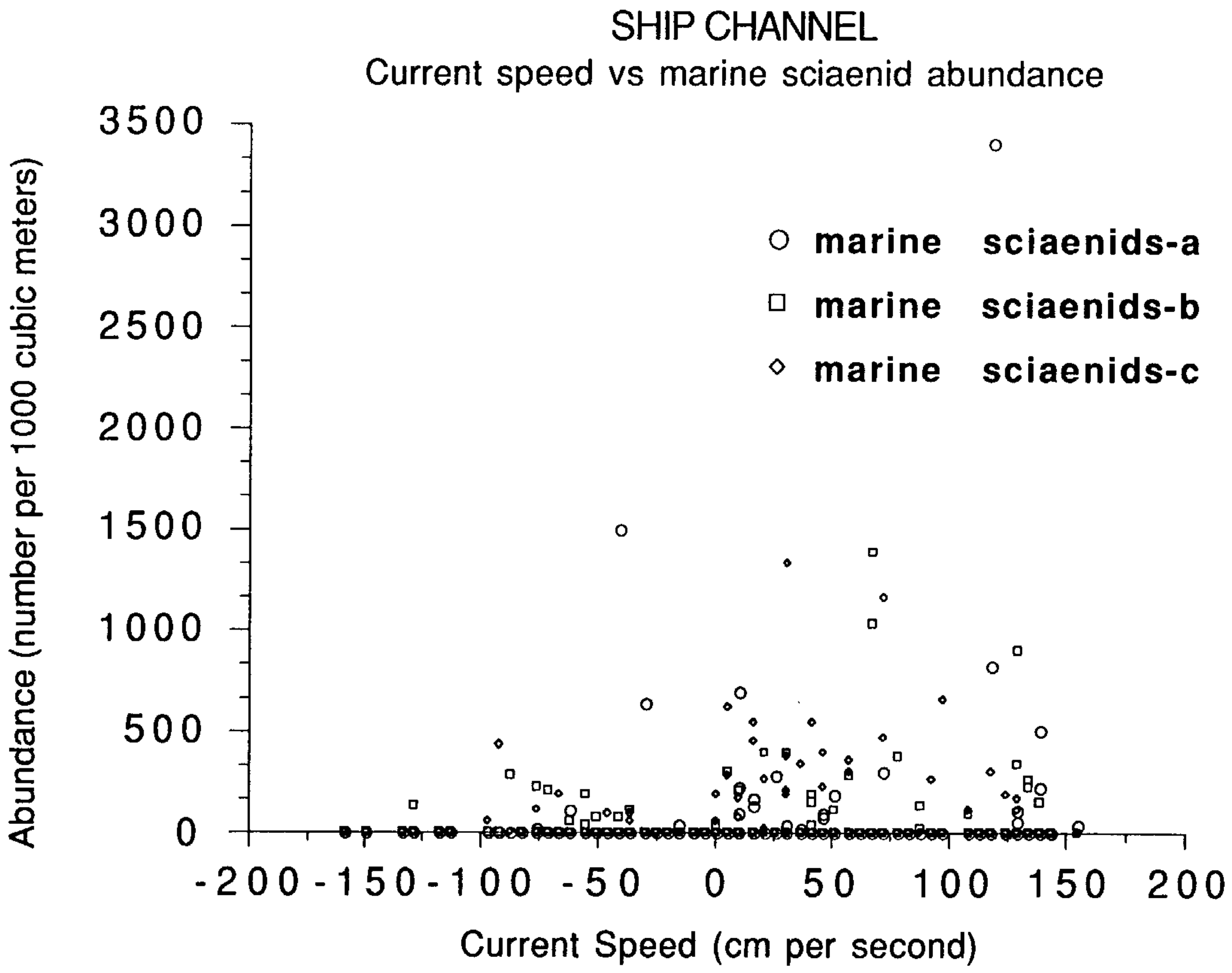
Current speed vs marine fish abundance



SHIP CHANNEL

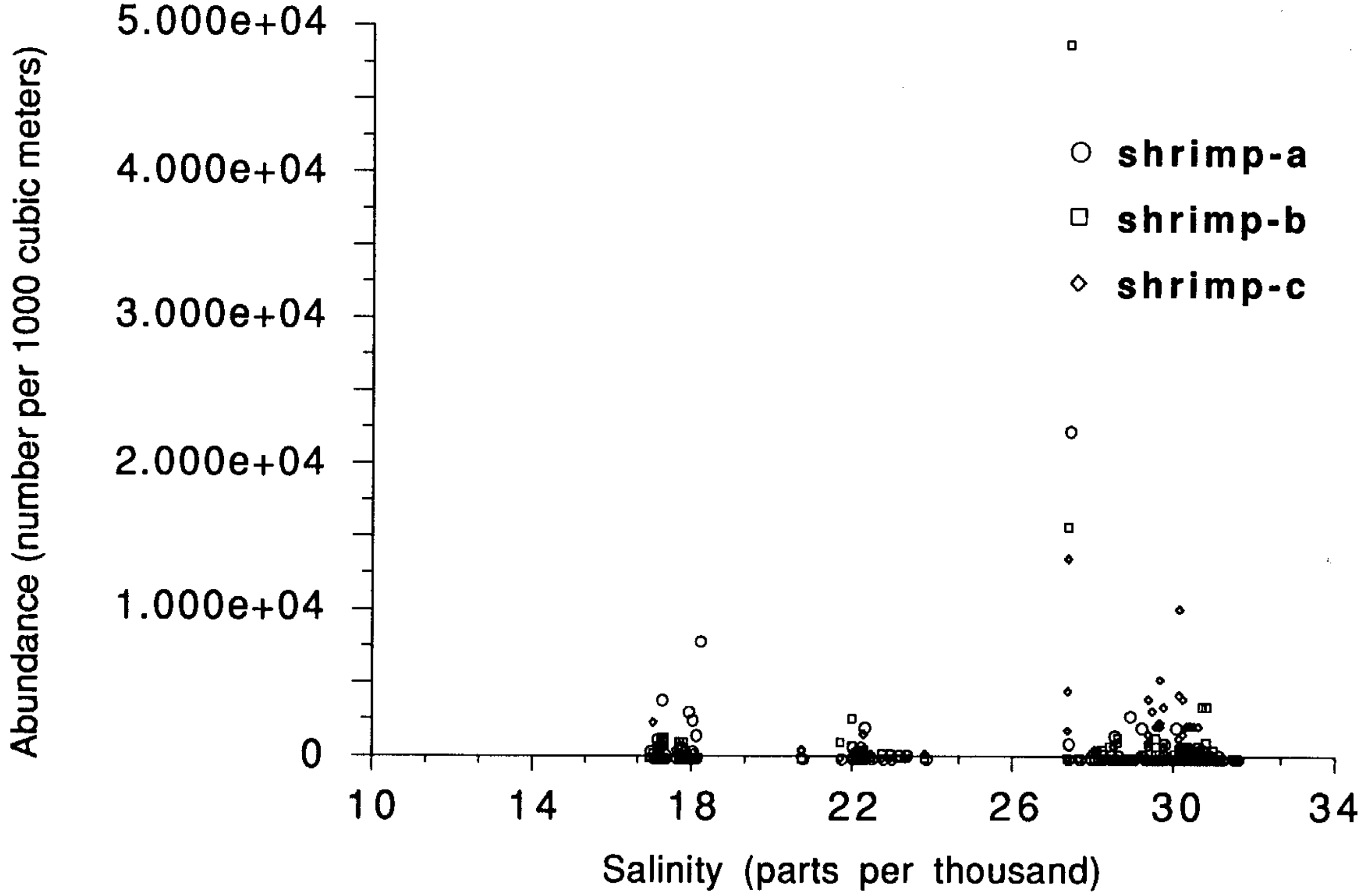
Current speed vs marine fish abundance




SHIP CHANNEL
Current speed vs marine sciaenid abundance
Abundance (number per 1000 cubic meters)
3500
3000
2500
2000
1500
1000
500
0
-200
-150
-100
-50
0
50
100
150
200
Current Speed (cm per second)
○ marine sciaenids-a
□ marine sciaenids-b
◇ marine sciaenids-c

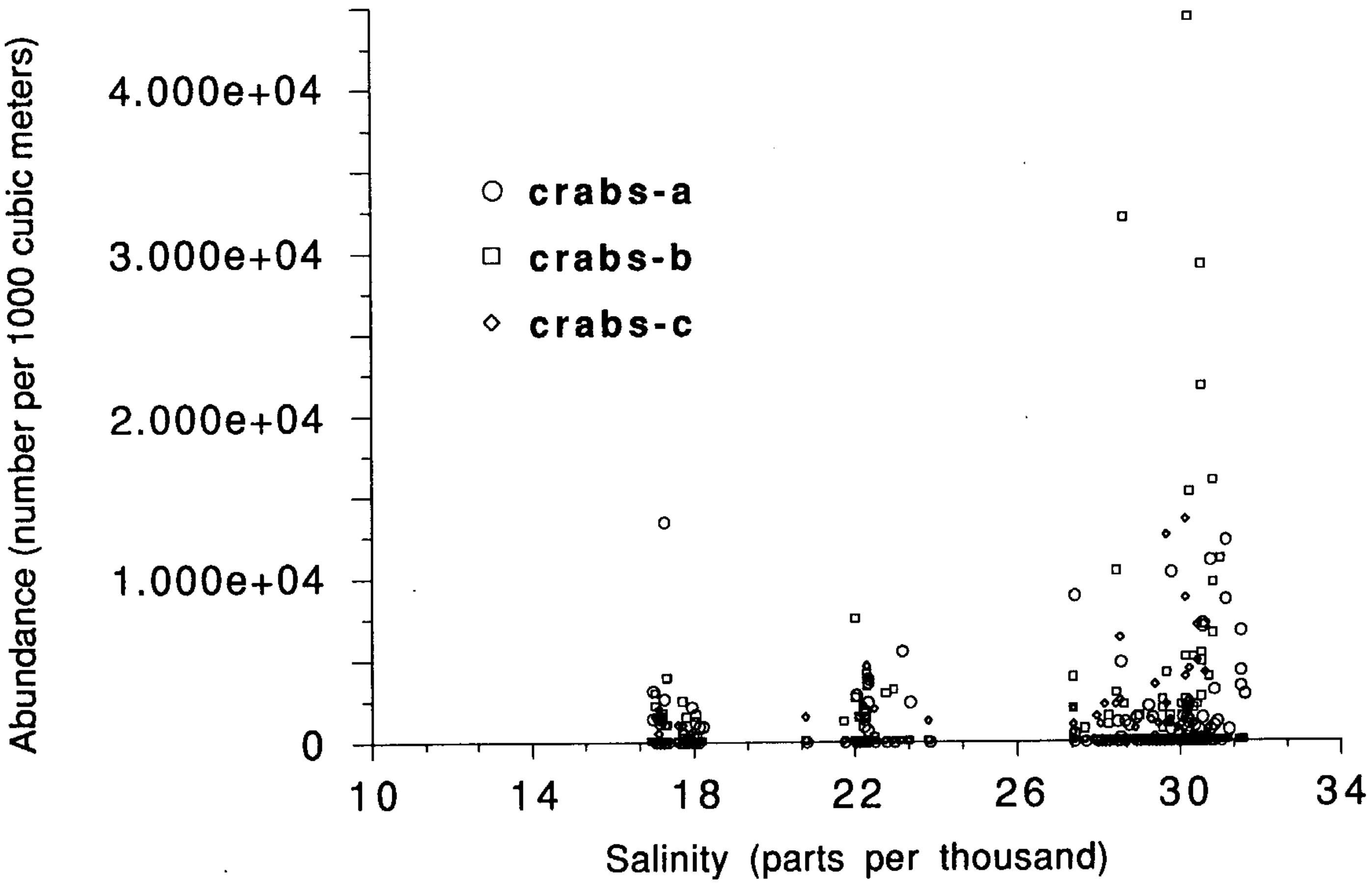
SHIP CHANNEL

Salinity vs shrimp abundance



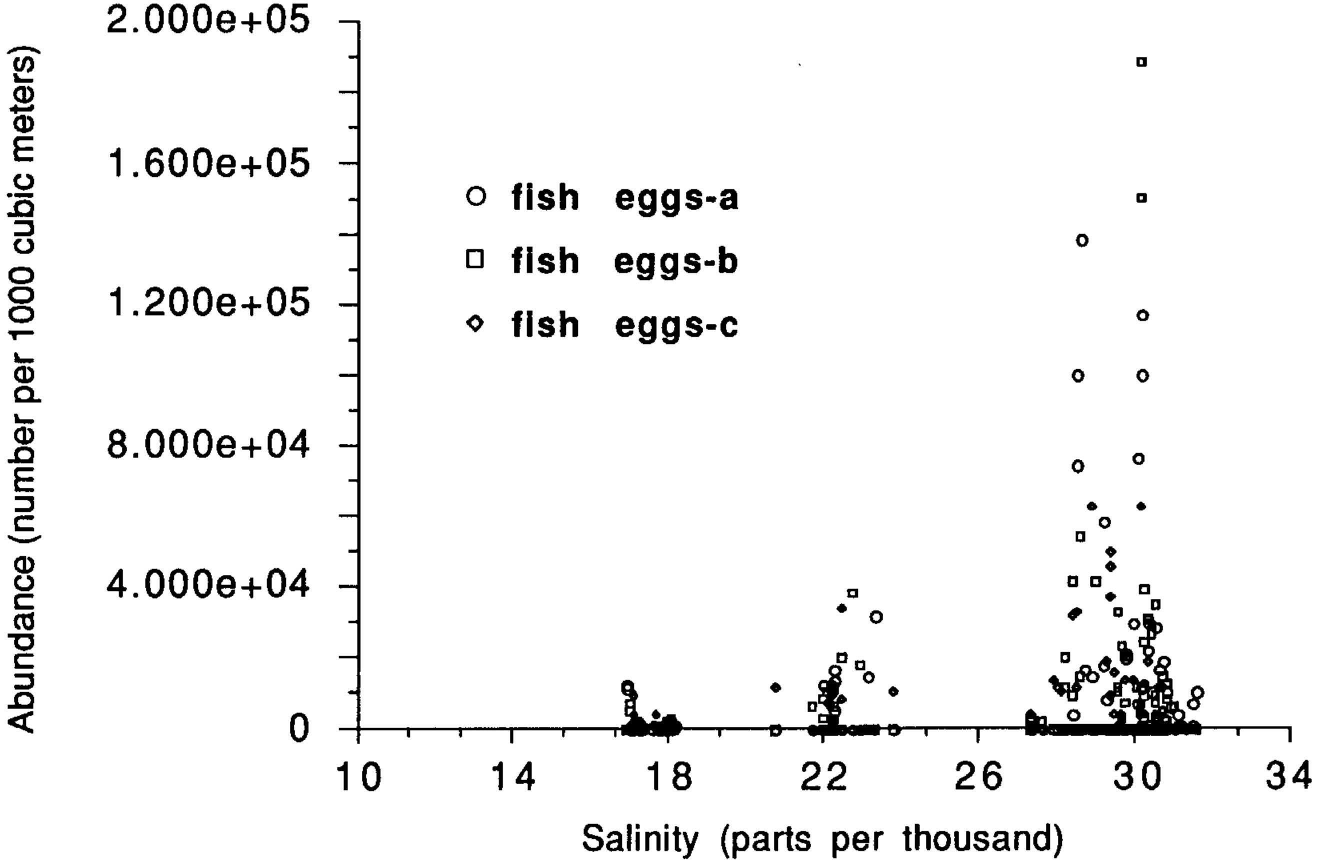
SHIP CHANNEL

Salinity vs crab abundance



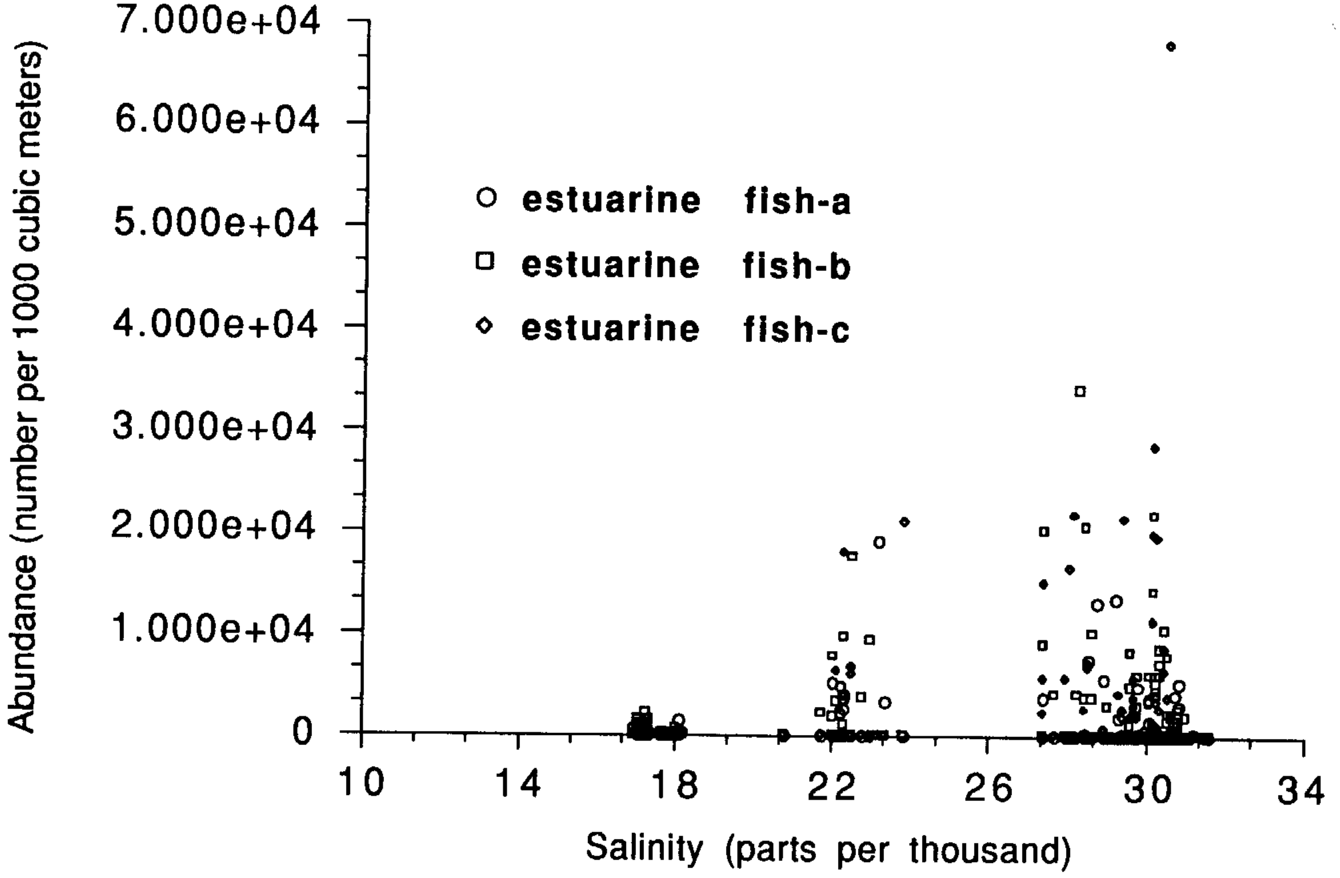
SHIP CHANNEL

Salinity vs fish egg abundance



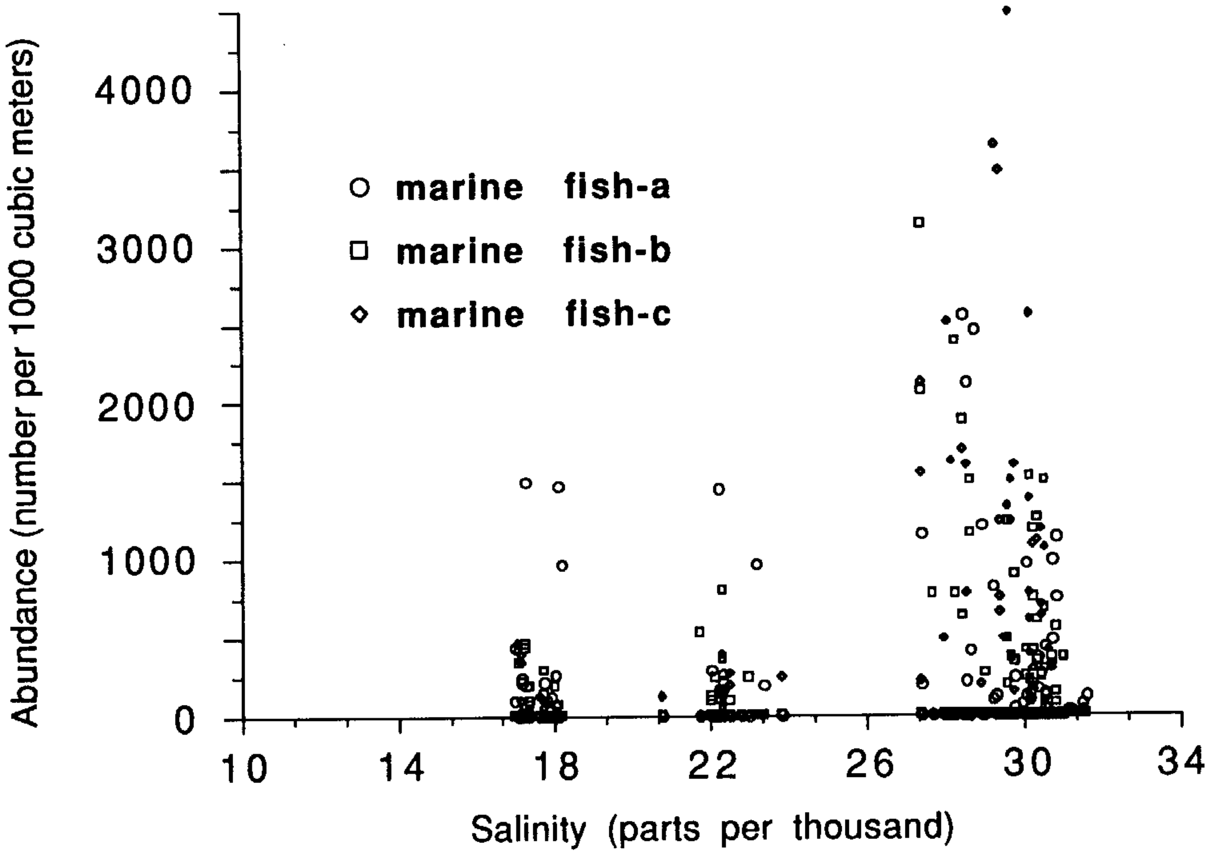
SHIP CHANNEL

Salinity vs estuarine fish abundance



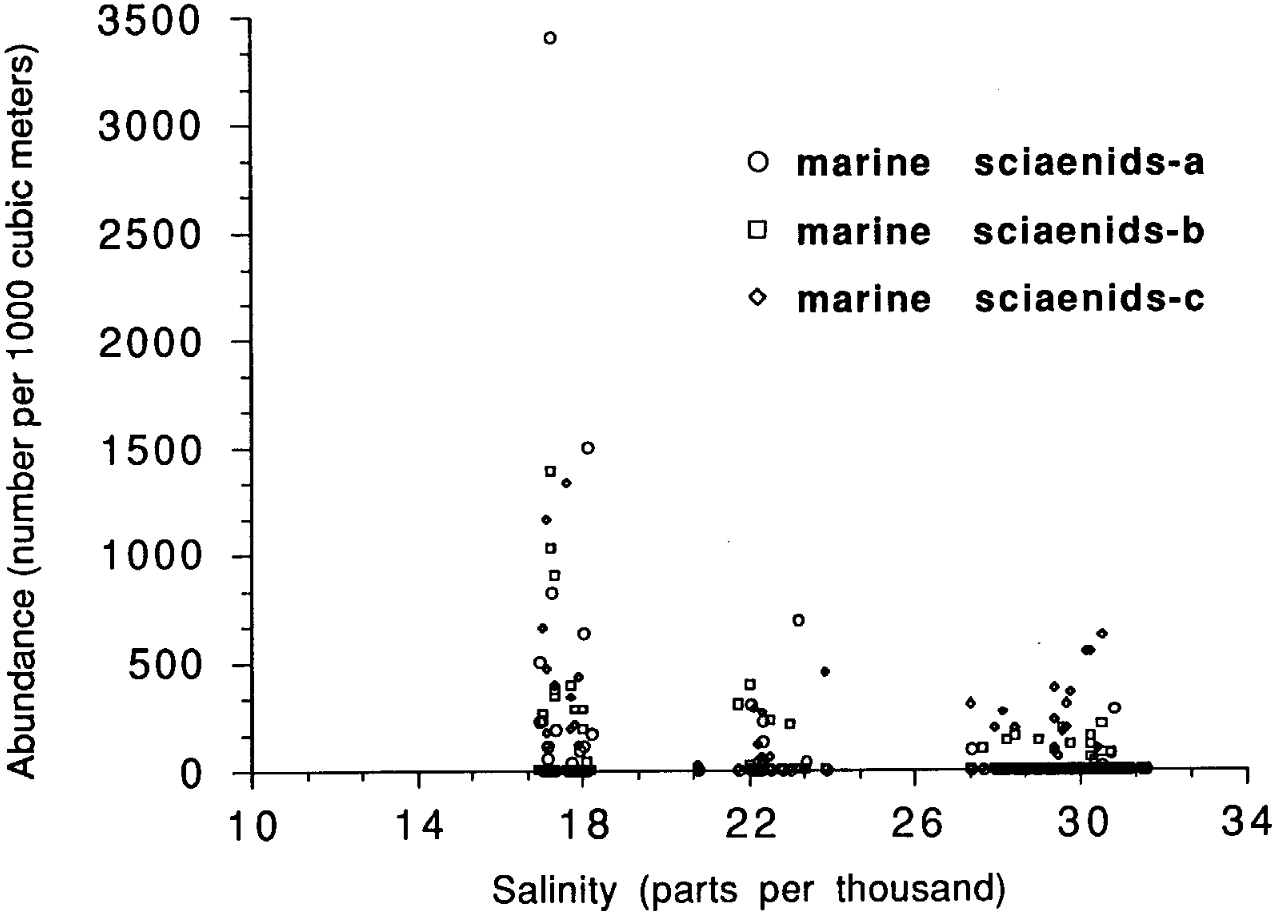
SHIP CHANNEL

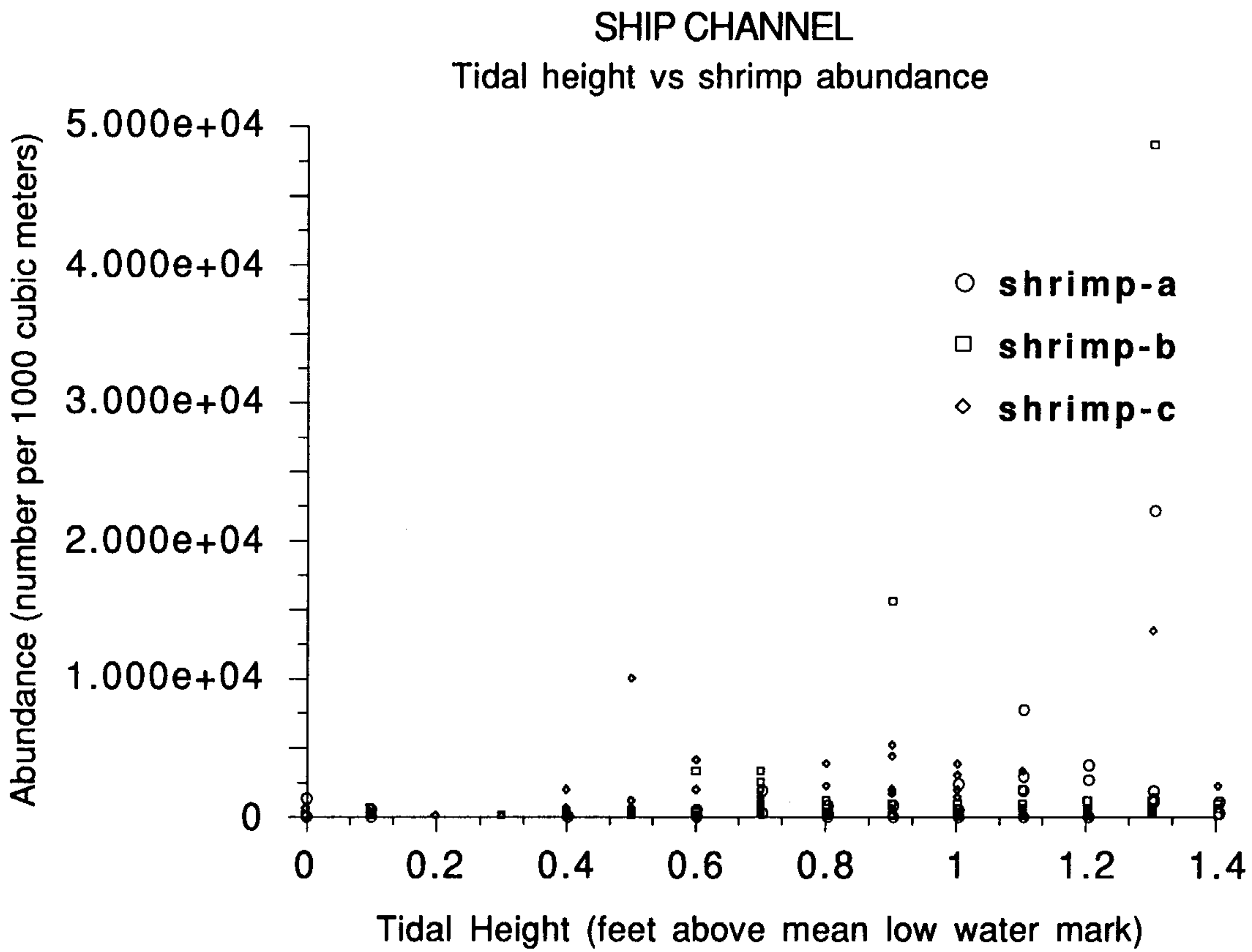
Salinity vs marine fish abundance



SHIP CHANNEL

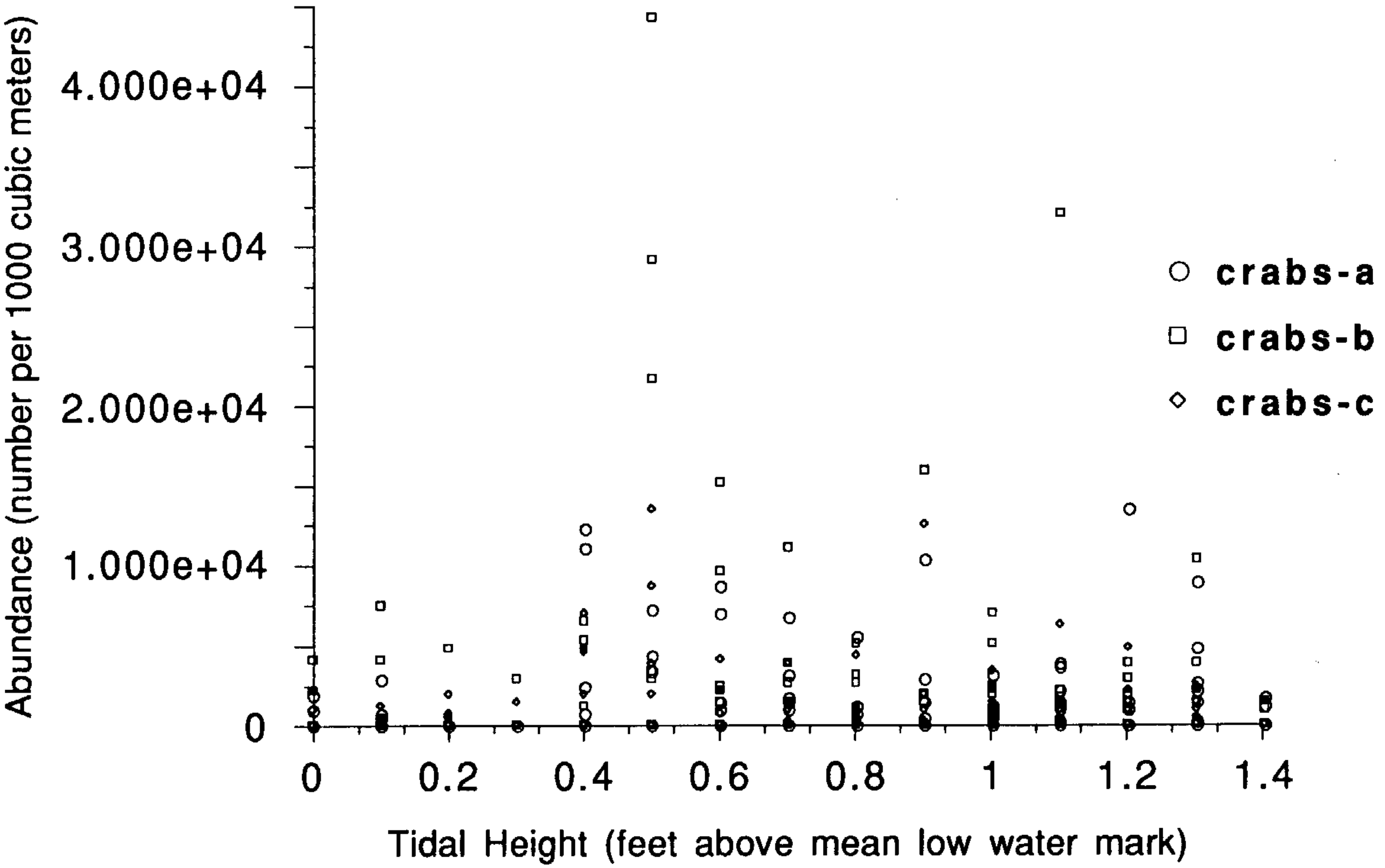
Salinity vs marine sciaenid abundance

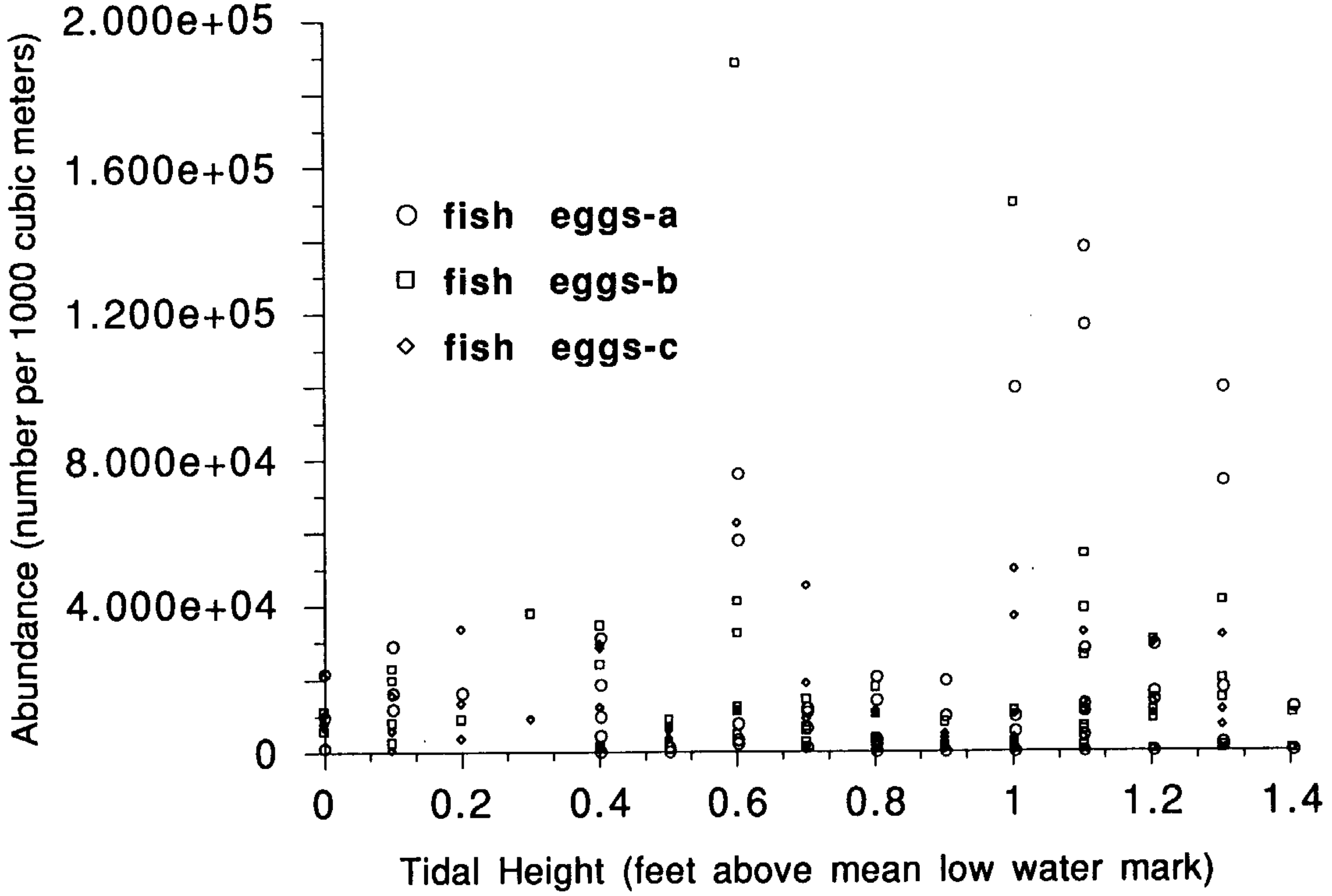



SHIP CHANNEL
Tidal height vs shrimp abundance

SHIP CHANNEL

Tidal height vs crab abundance



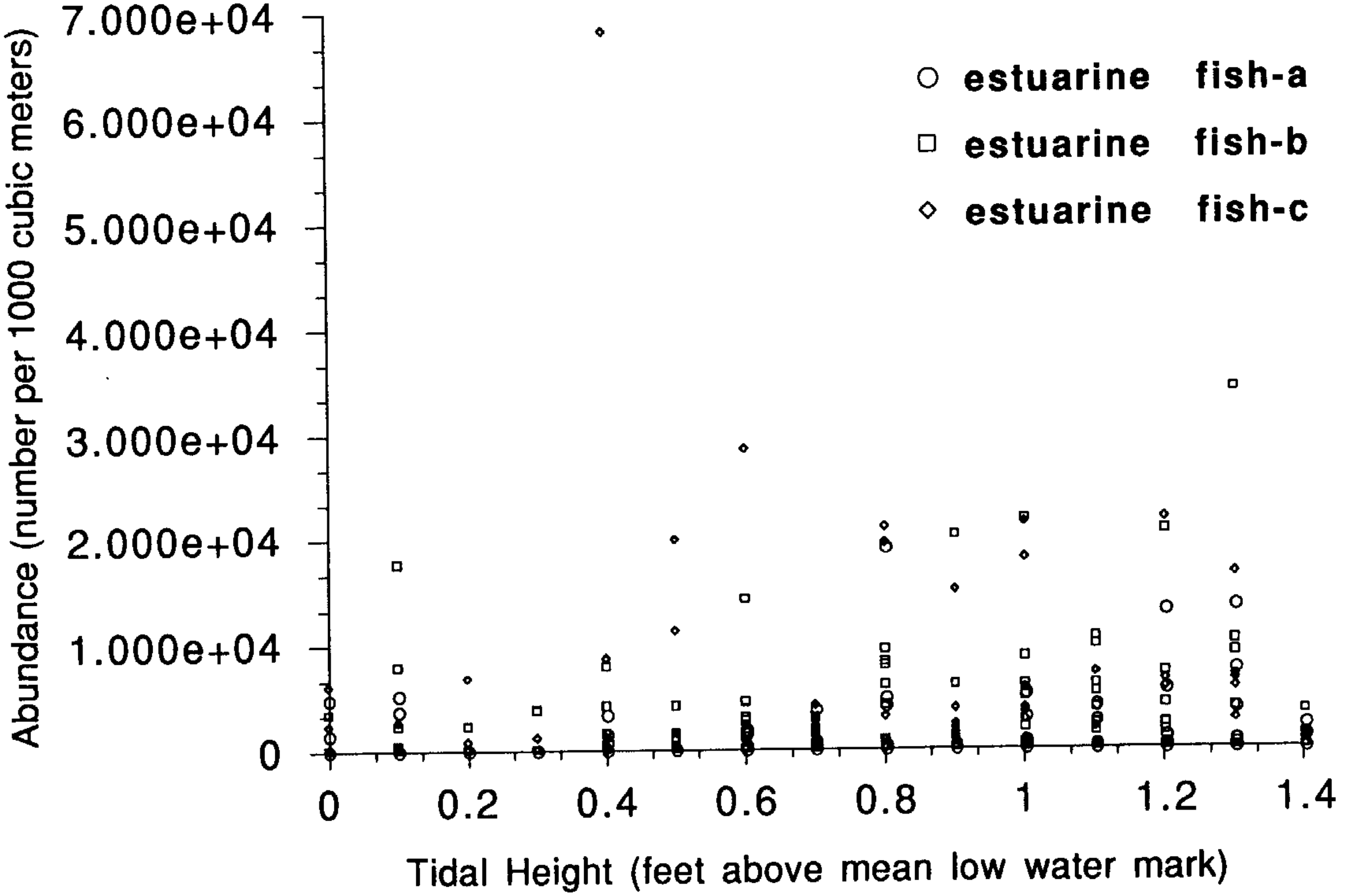


SHIP CHANNEL

Tidal height vs fish egg abundance

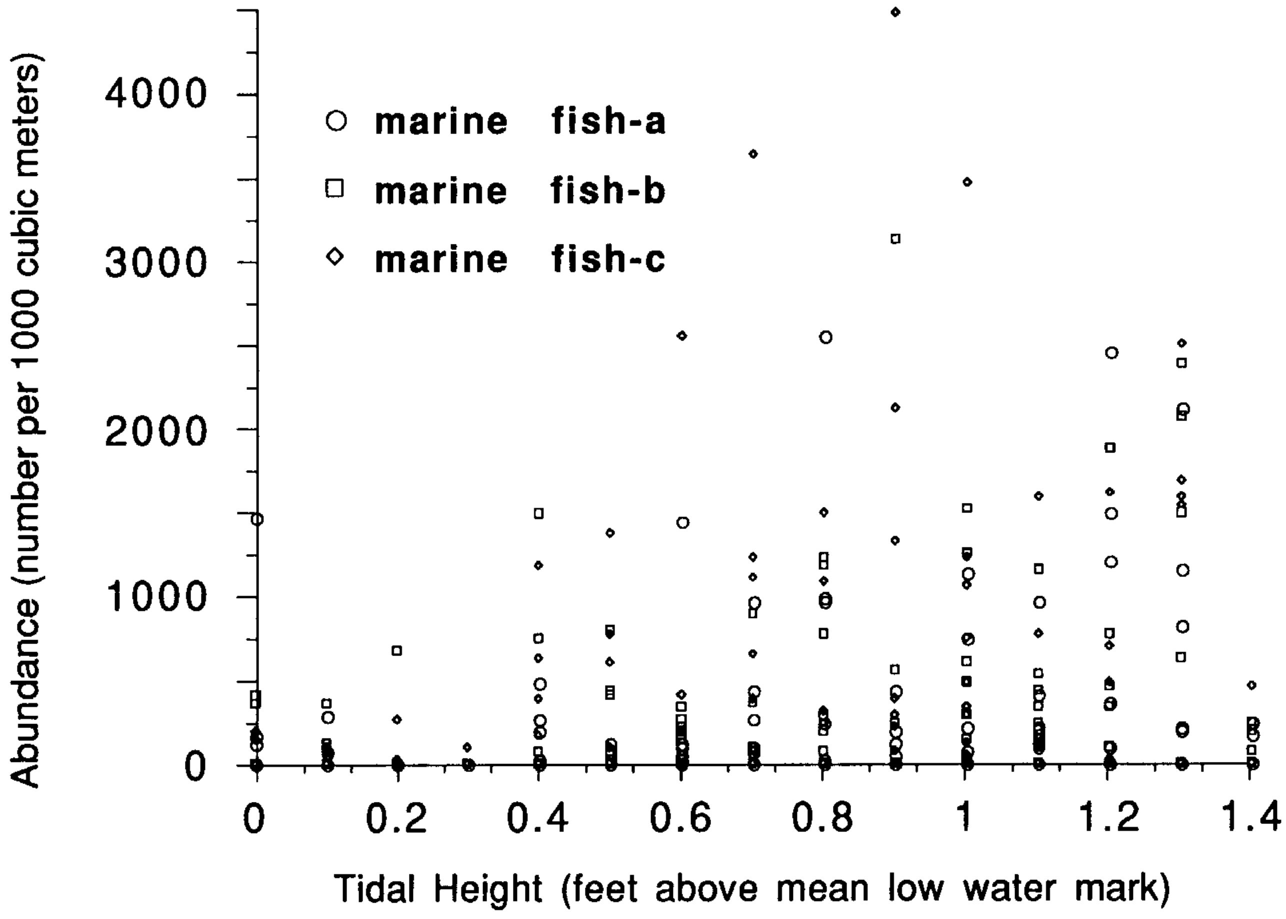
SHIP CHANNEL

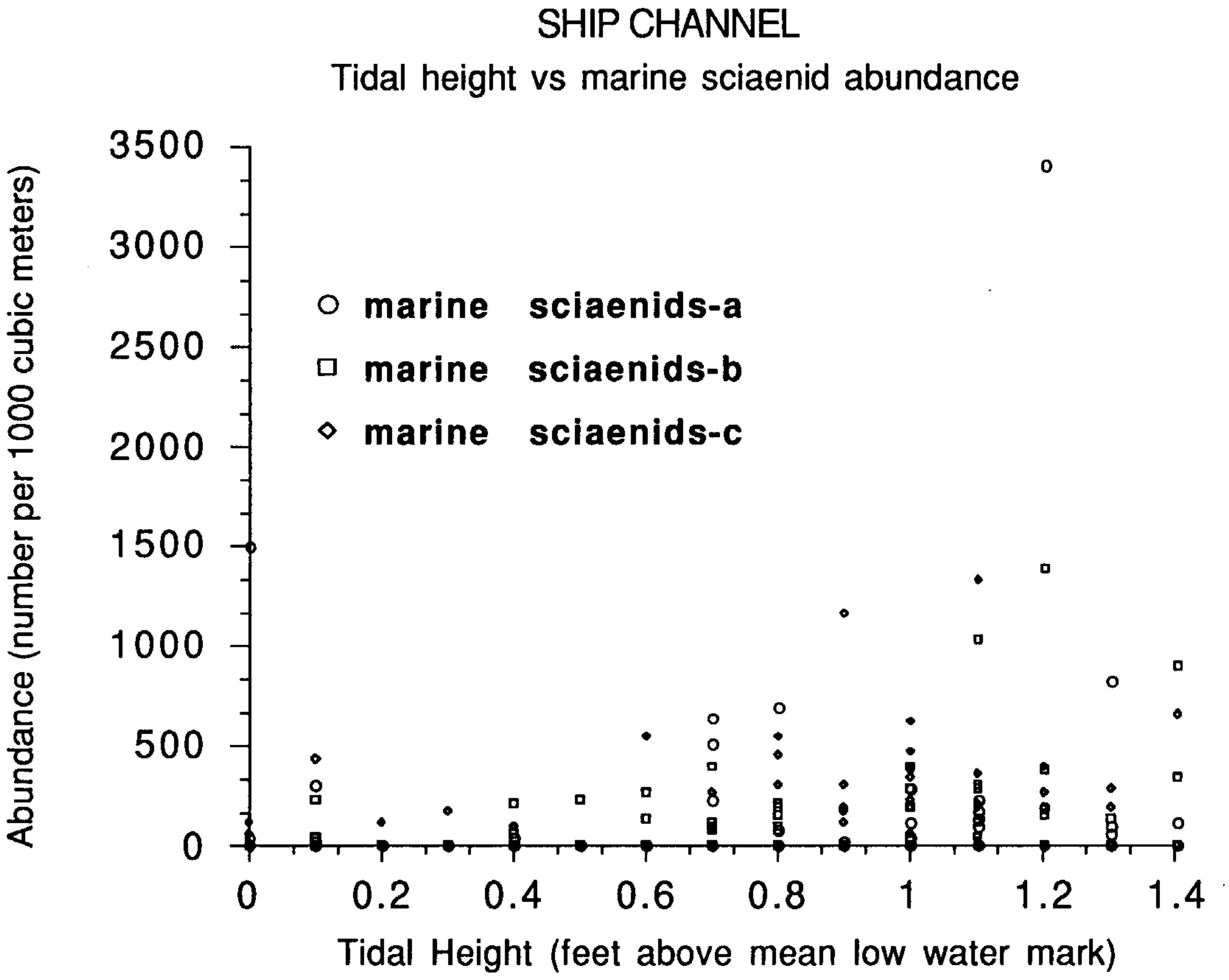
Tidal height vs estuarine fish abundance



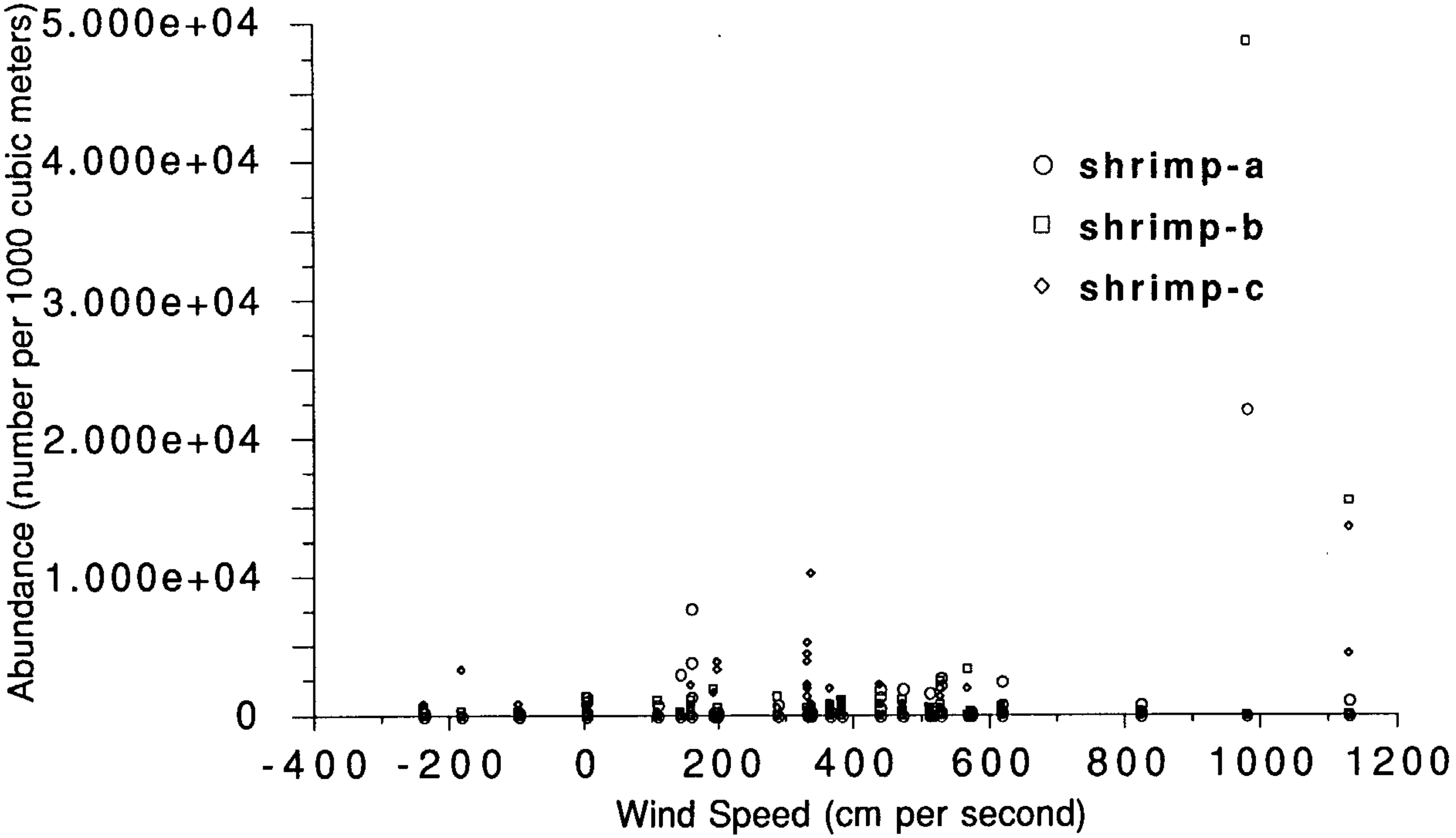
SHIP CHANNEL

Tidal height vs marine fish abundance

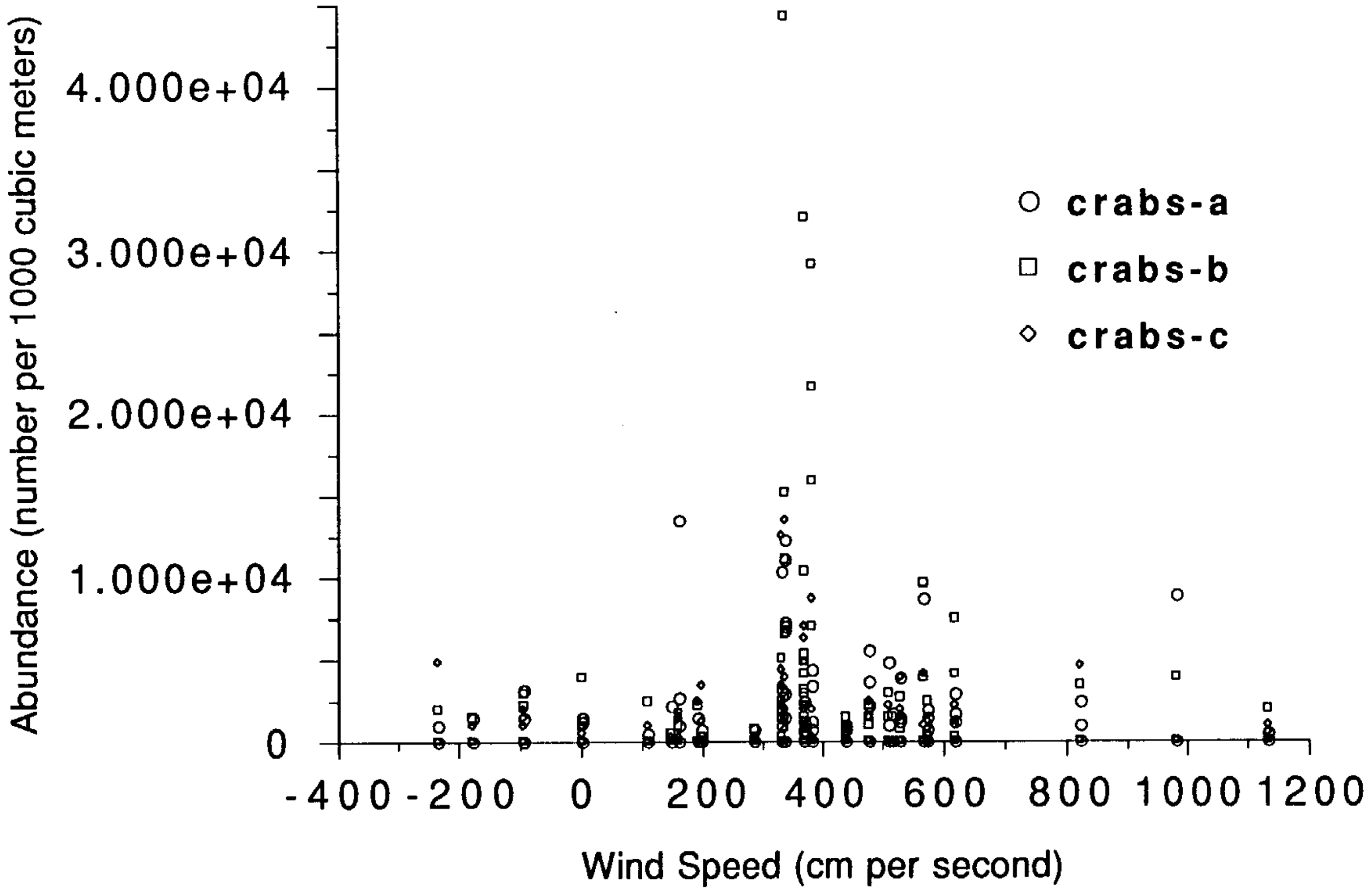



SHIP CHANNEL
Tidal height vs marine sciaenid abundance
marine sciaenids-a
marine sciaenids-b
marine sciaenids-c
3500
3000
2500
2000
1500
1000
500
0
Abundance (number per 1000 cubic meters)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Tidal Height (feet above mean low water mark)

SHIP CHANNEL
Wind speed vs shrimp abundance

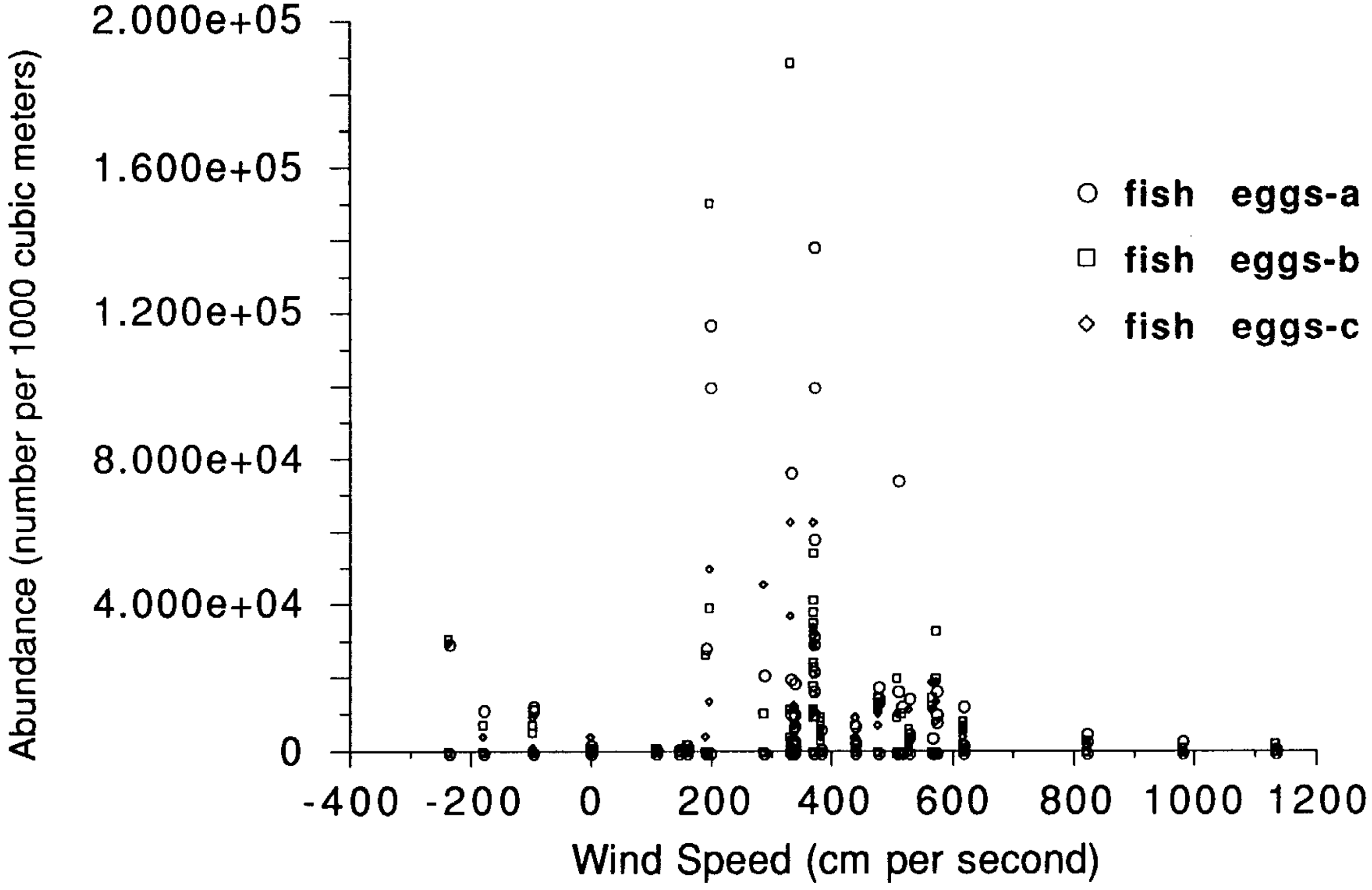


SHIP CHANNEL
Wind speed vs crab abundance



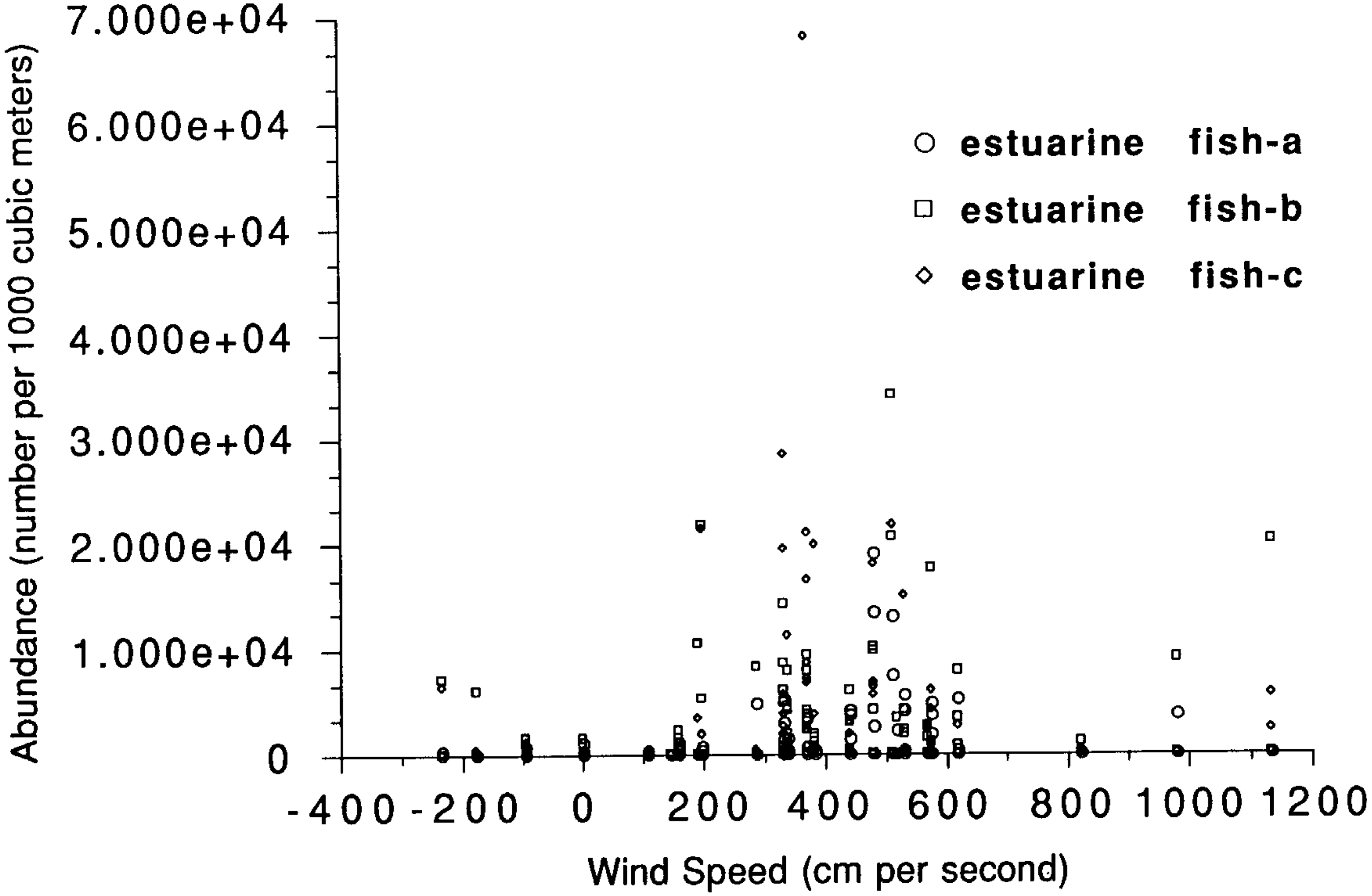
SHIP CHANNEL

Wind speed vs fish egg abundance

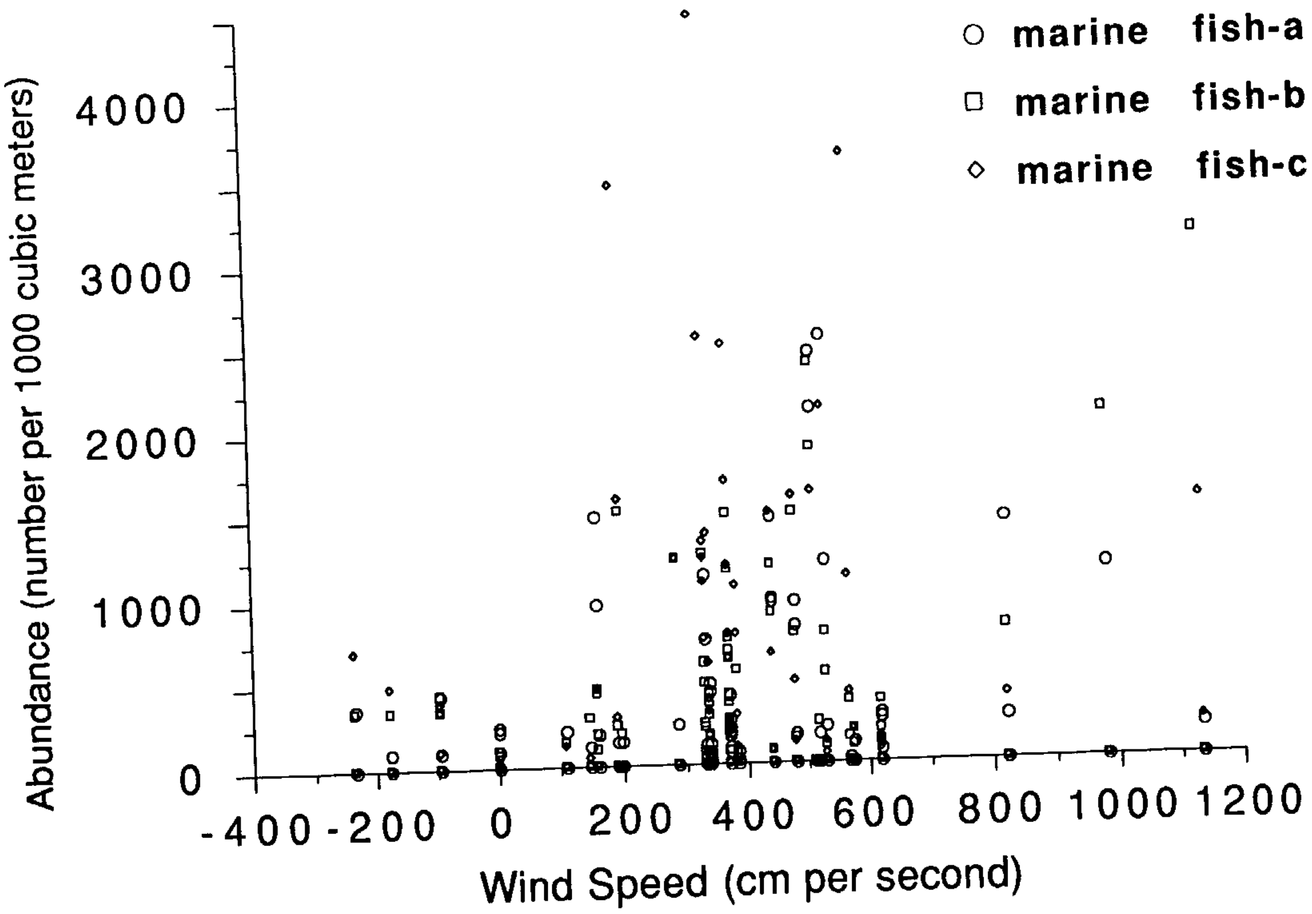


SHIP CHANNEL

Wind speed vs estuarine fish abundance

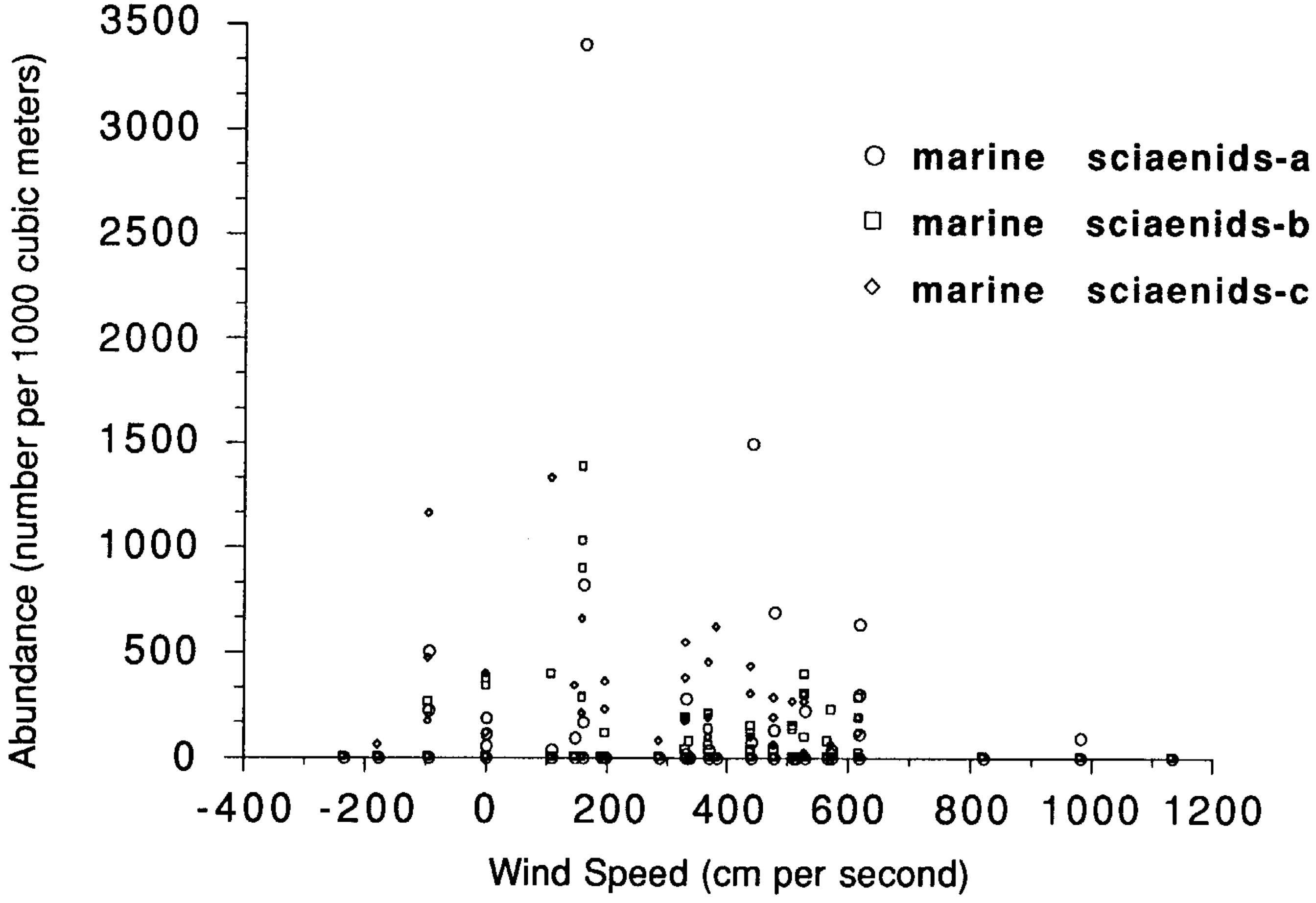


SHIP CHANNEL
Wind speed vs marine fish abundance

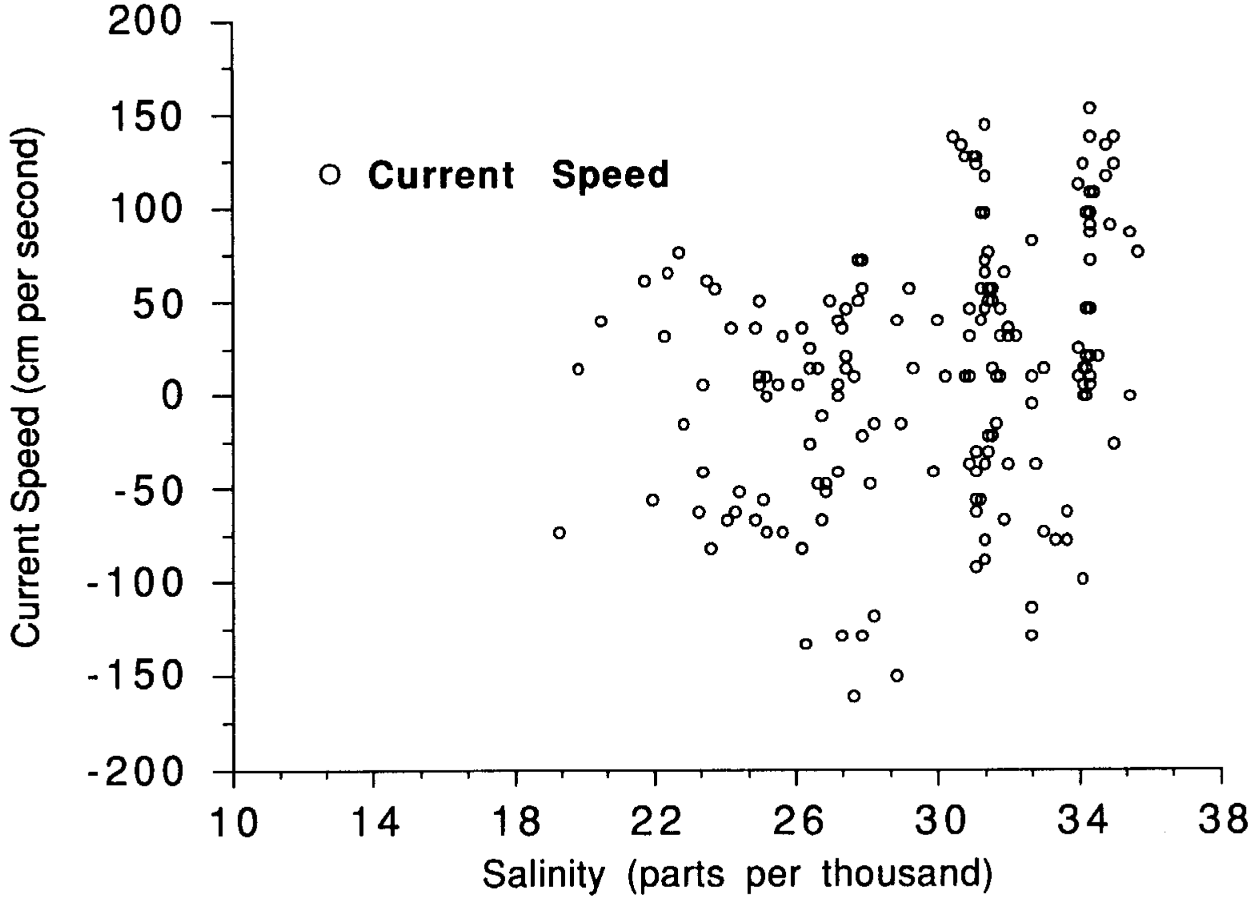


SHIP CHANNEL

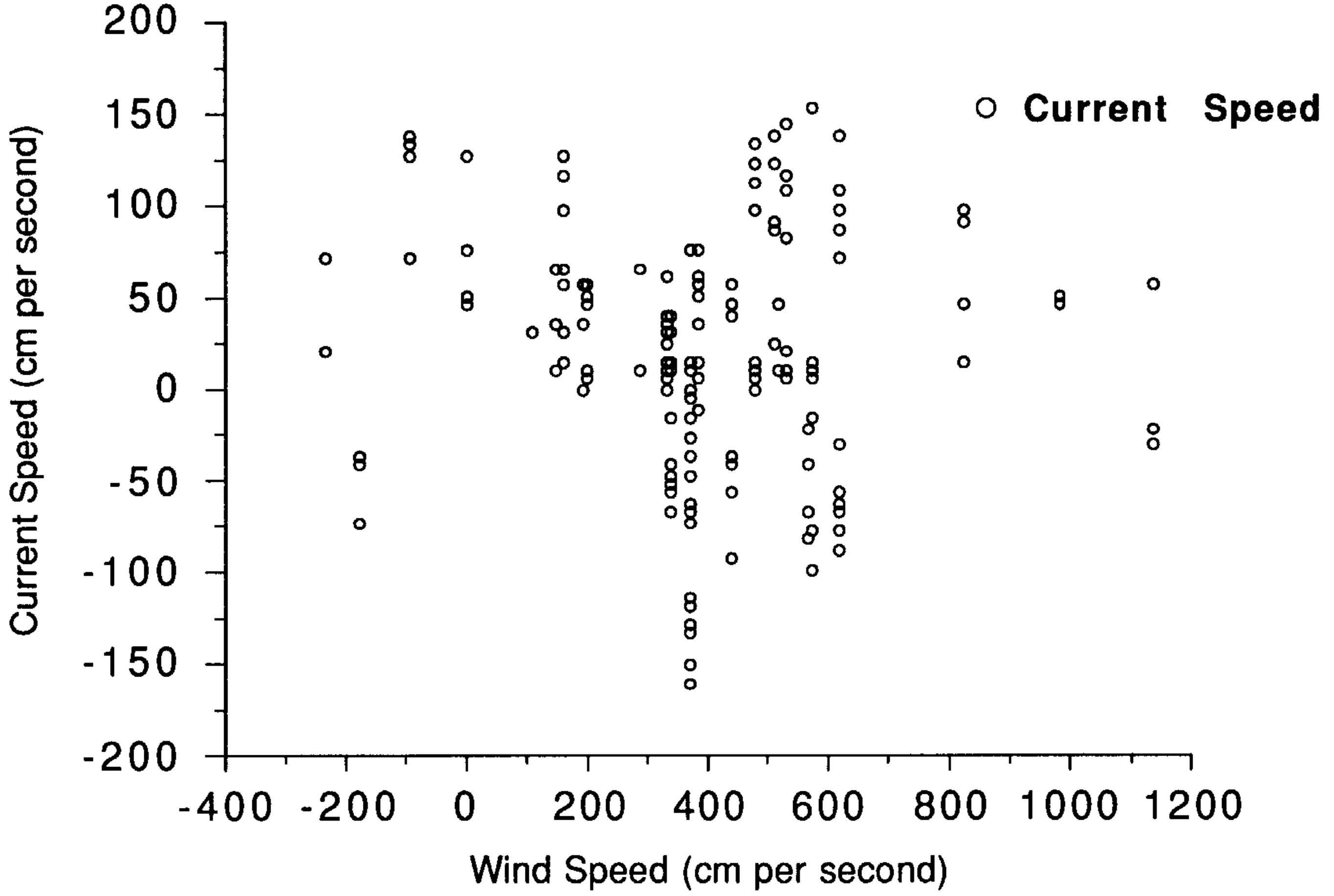
Wind speed vs marine sciaenid abundance



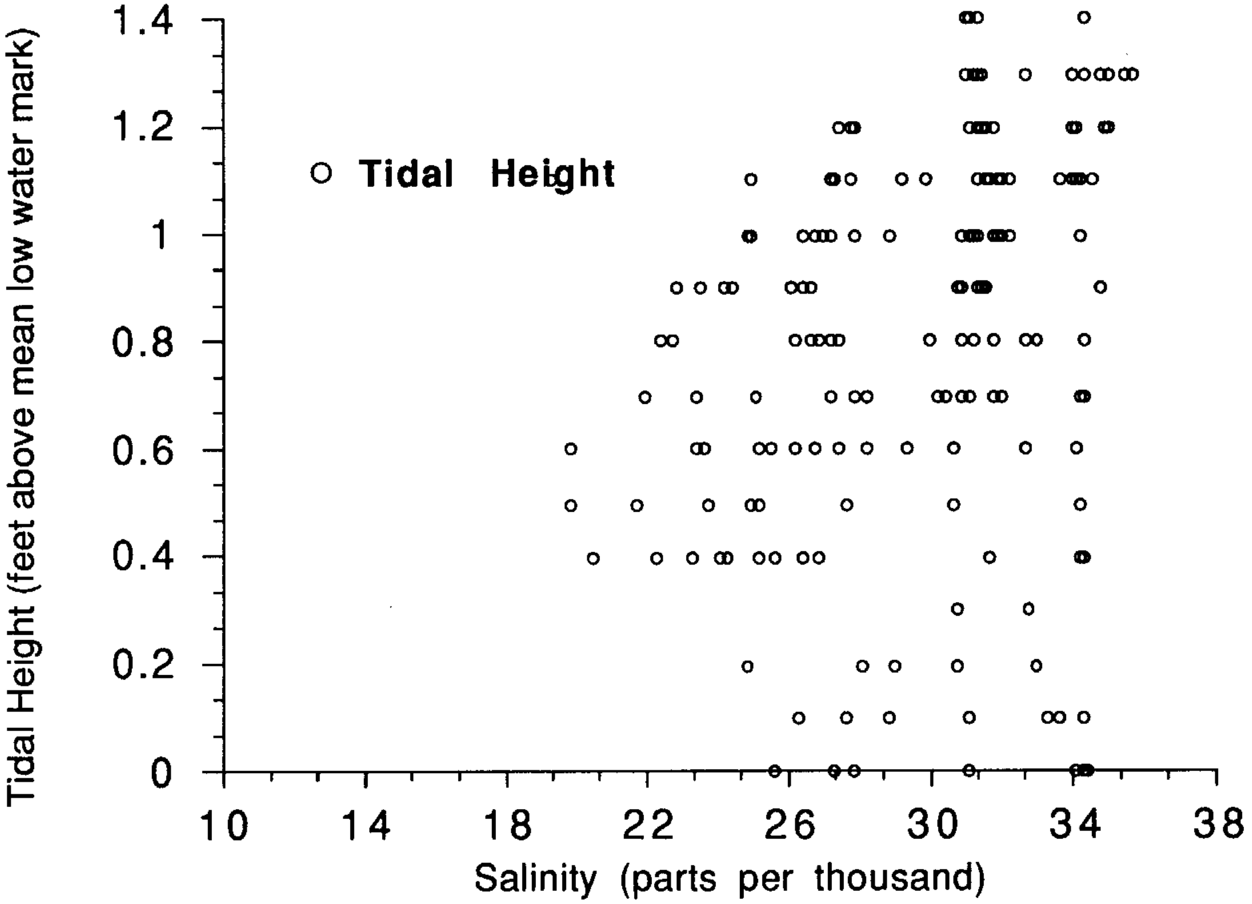
SHIP CHANNEL
Current speed vs salinity



SHIP CHANNEL
Current speed vs wind speed

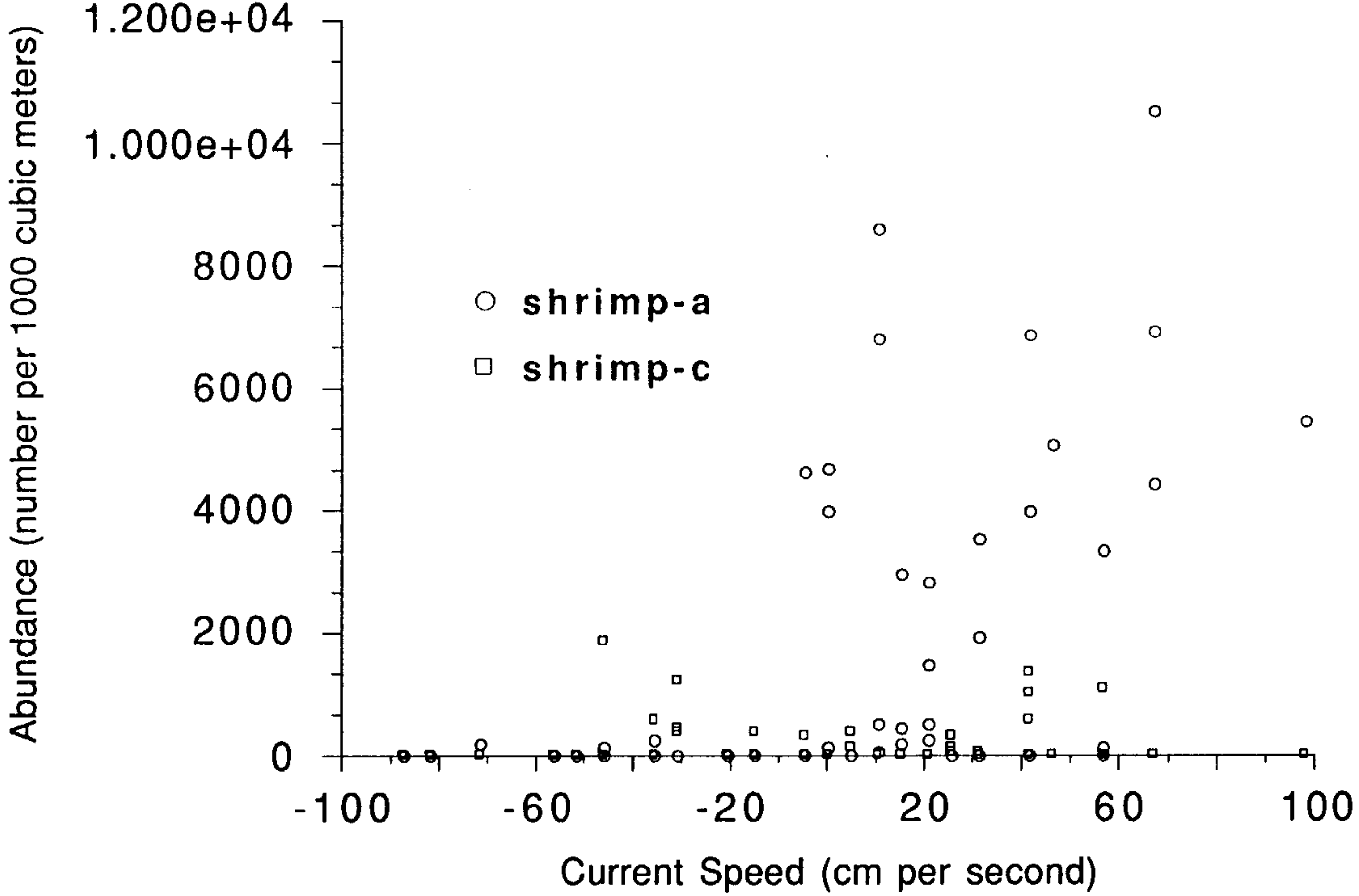


SHIP CHANNEL
Tidal height vs salinity



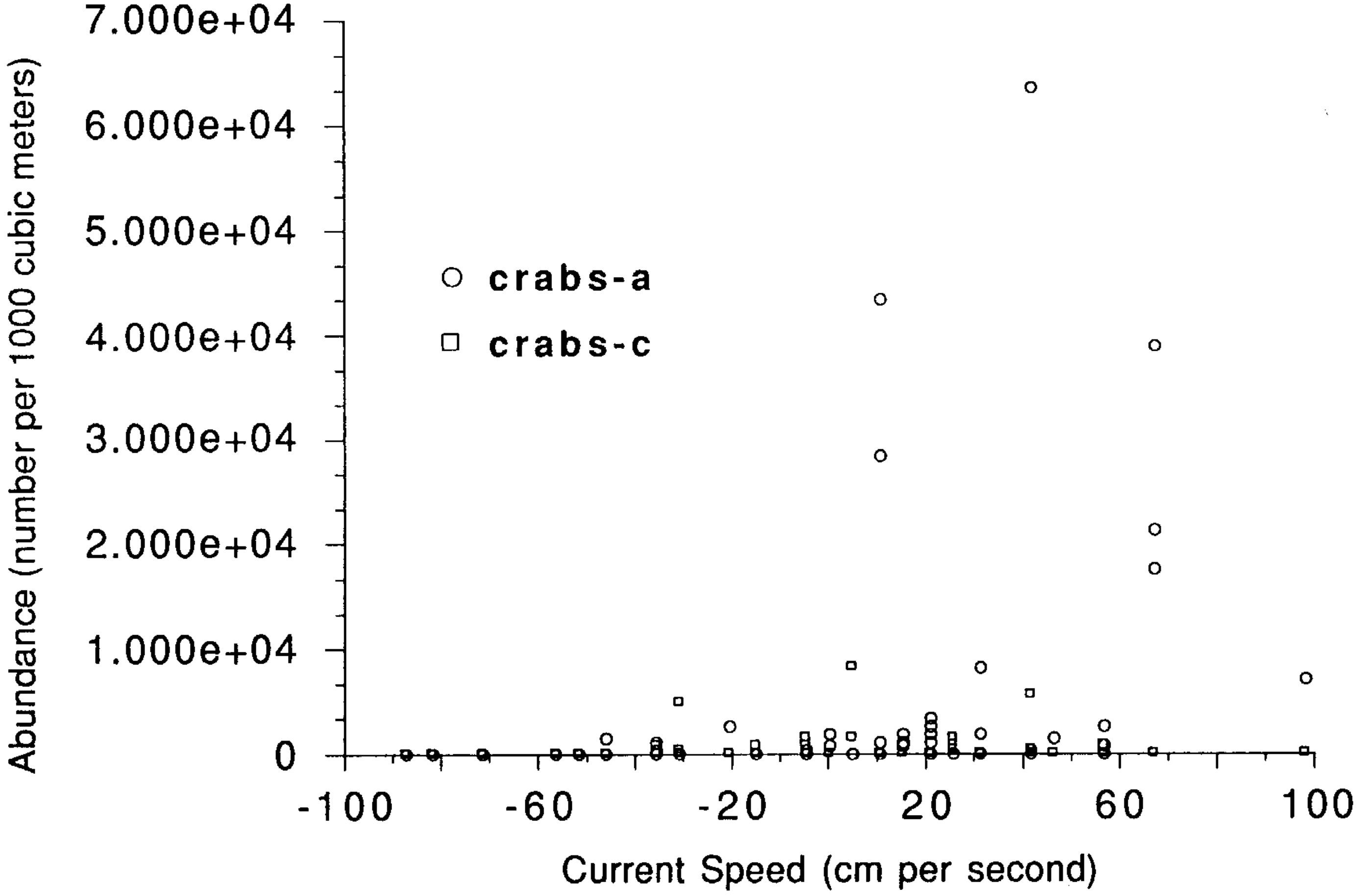
SALURIA BAYOU

Current speed vs shrimp abundance



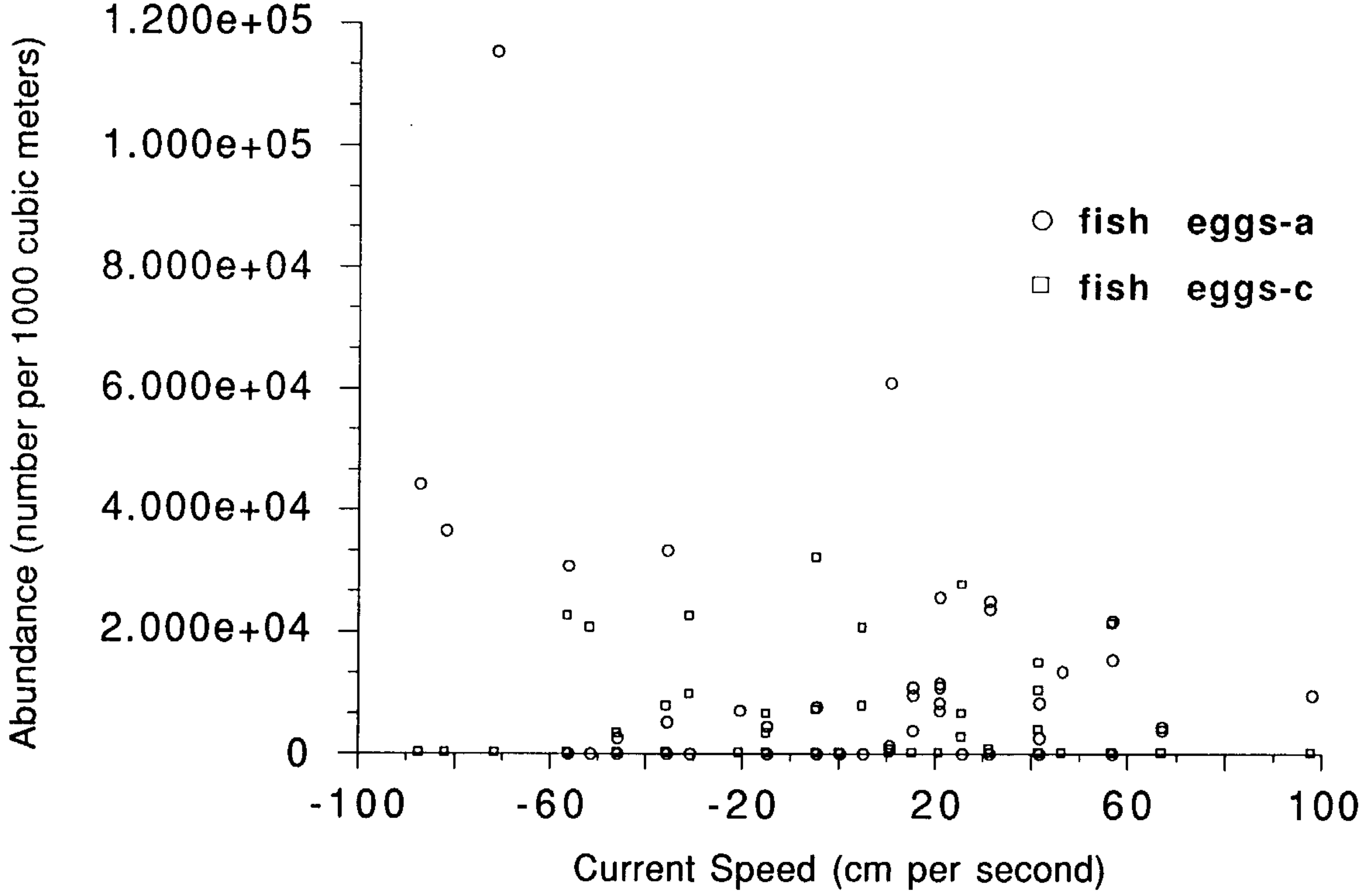
SALURIA BAYOU

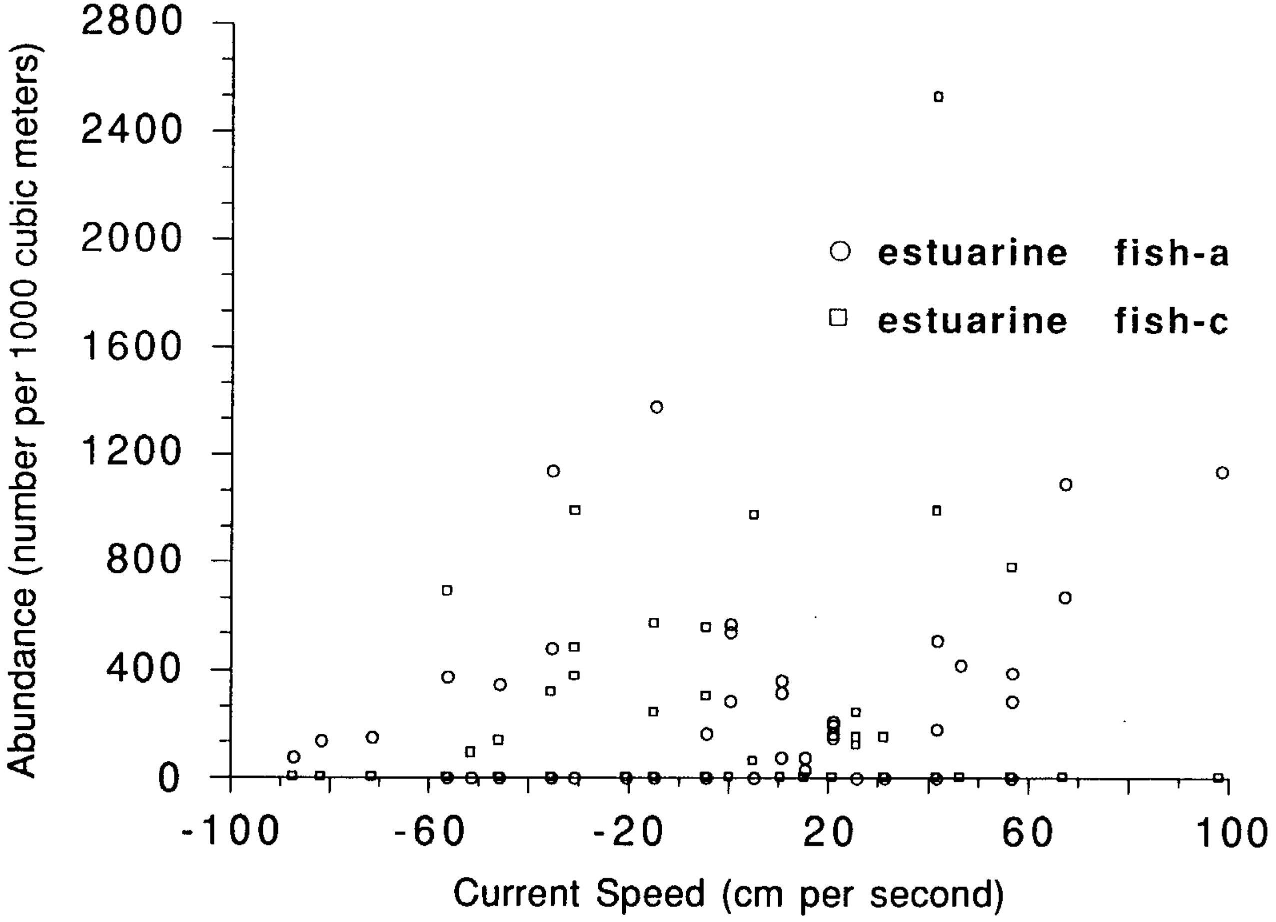
Current speed vs crab abundance



SALURIA BAYOU

Current speed vs fish egg abundance



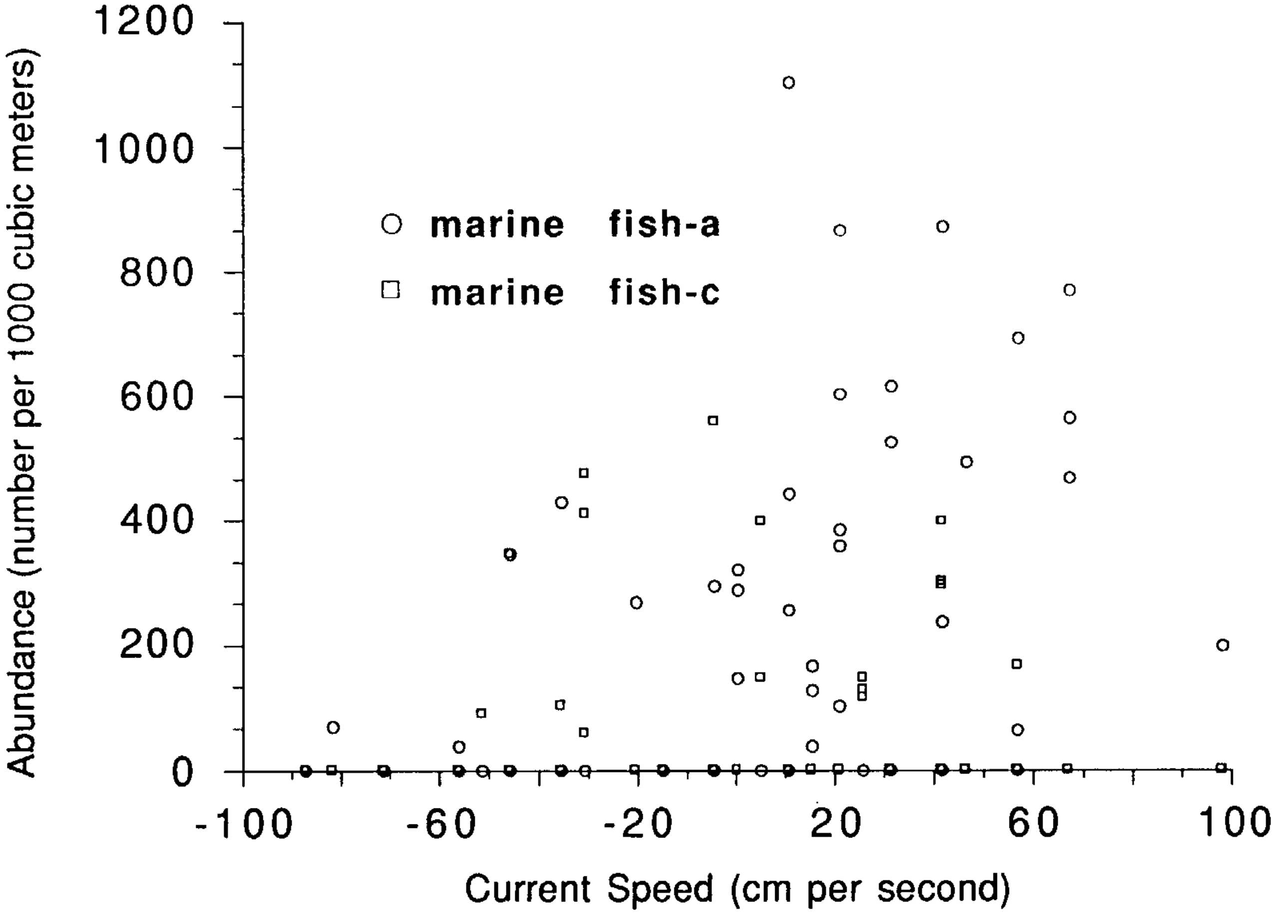


SALURIA BAYOU

Current speed vs estuarine fish abundance

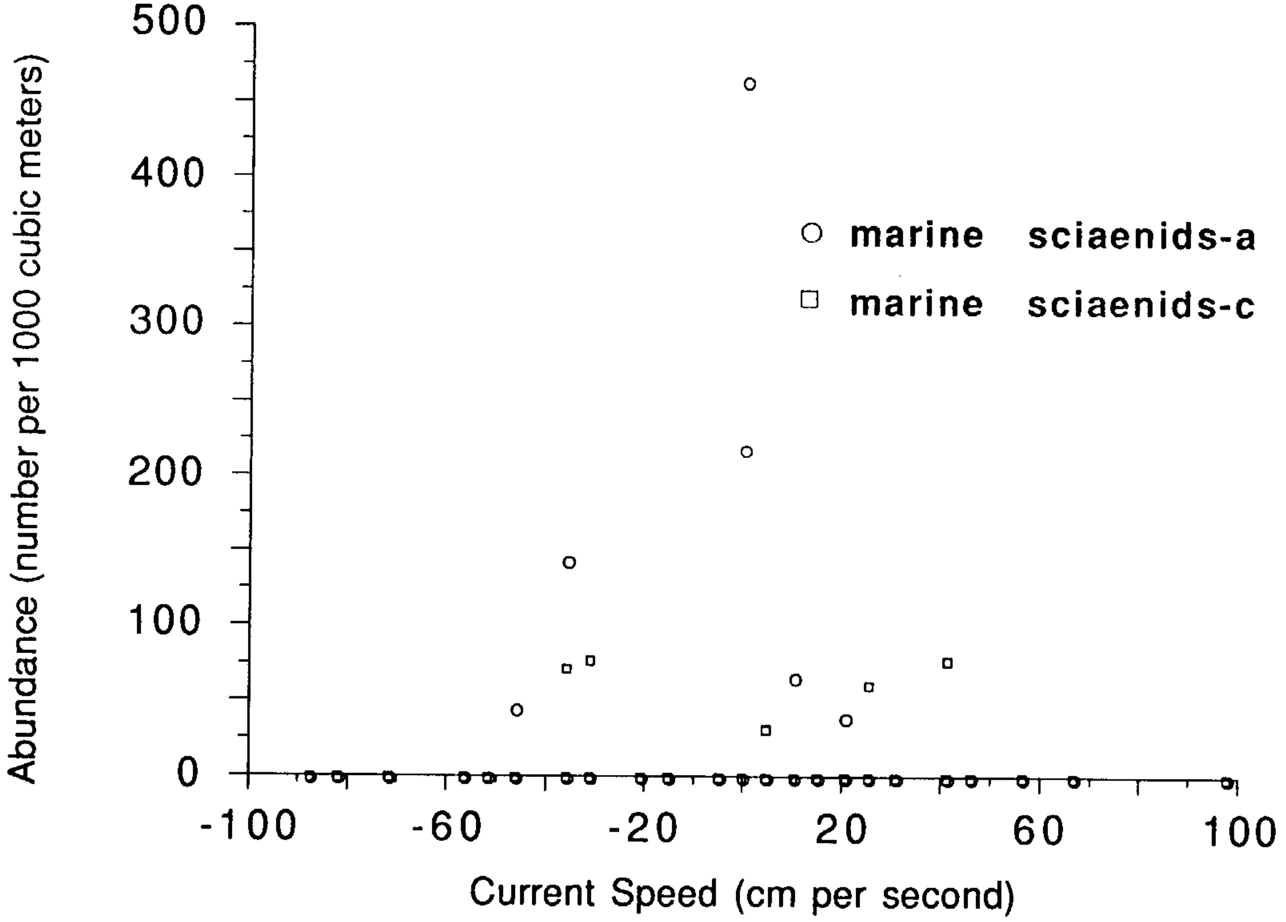
SALURIA BAYOU

Current speed vs marine fish abundance



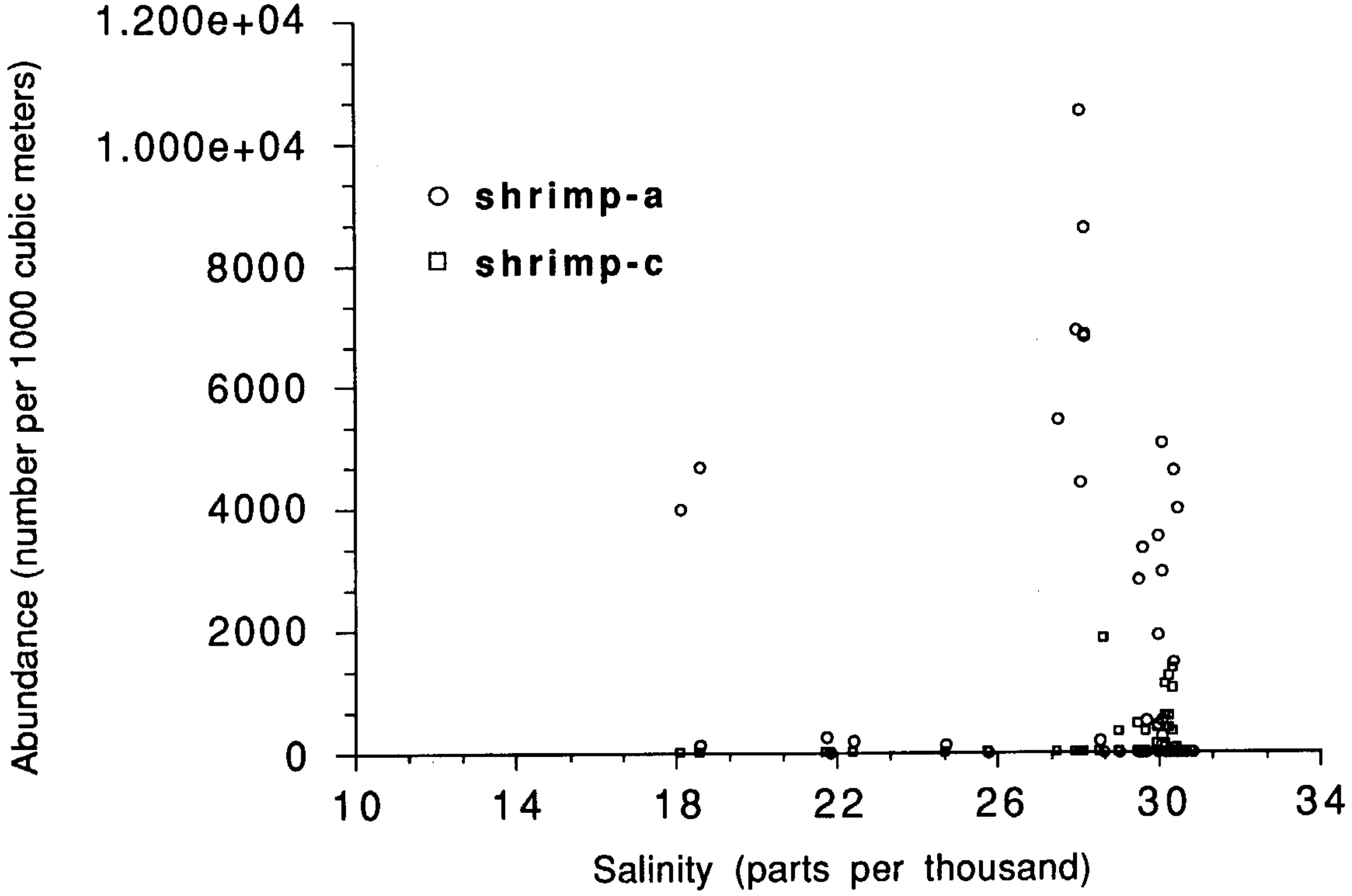
SALURIA BAYOU

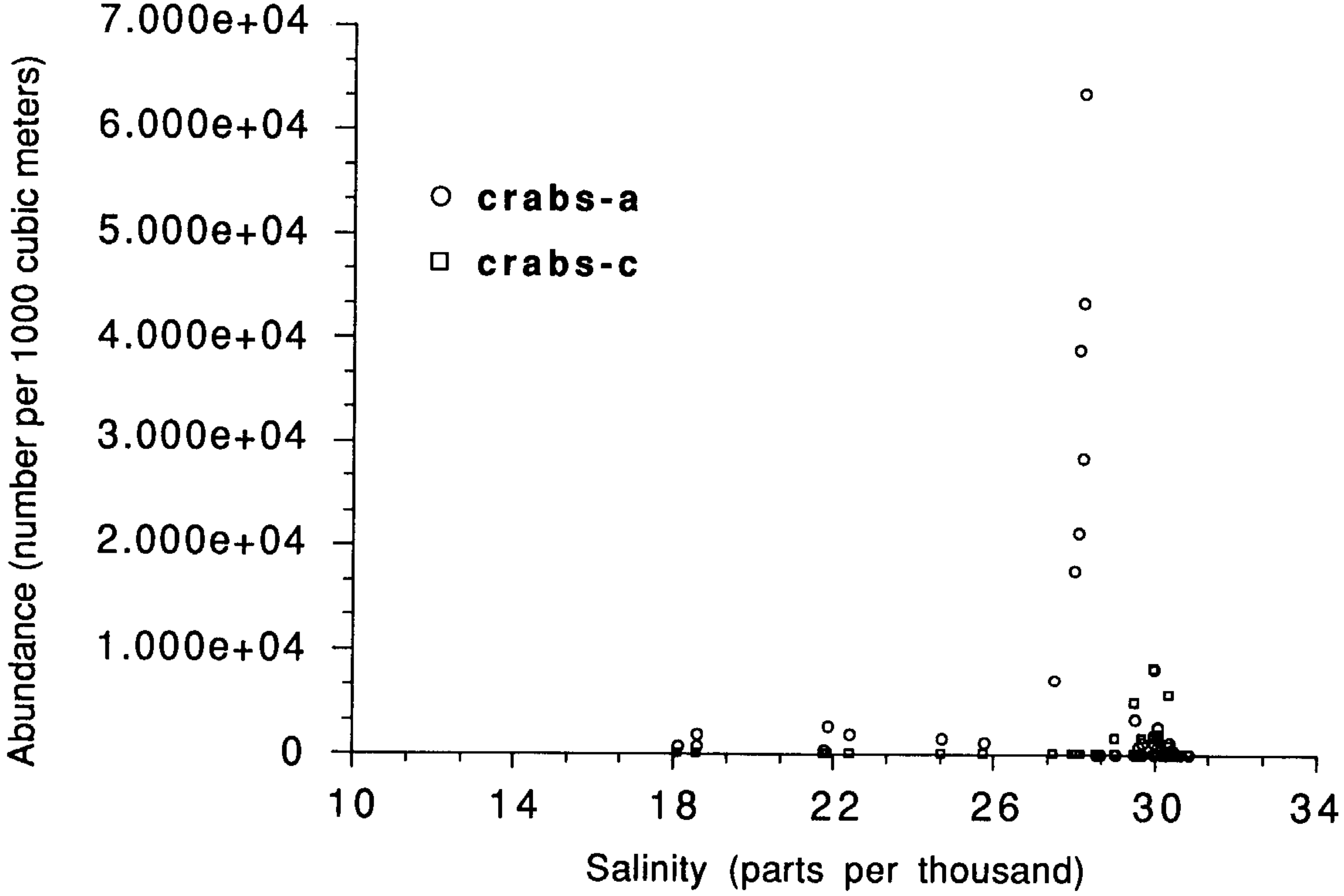
Current speed vs marine sciaenid abundance



SALURIA BAYOU

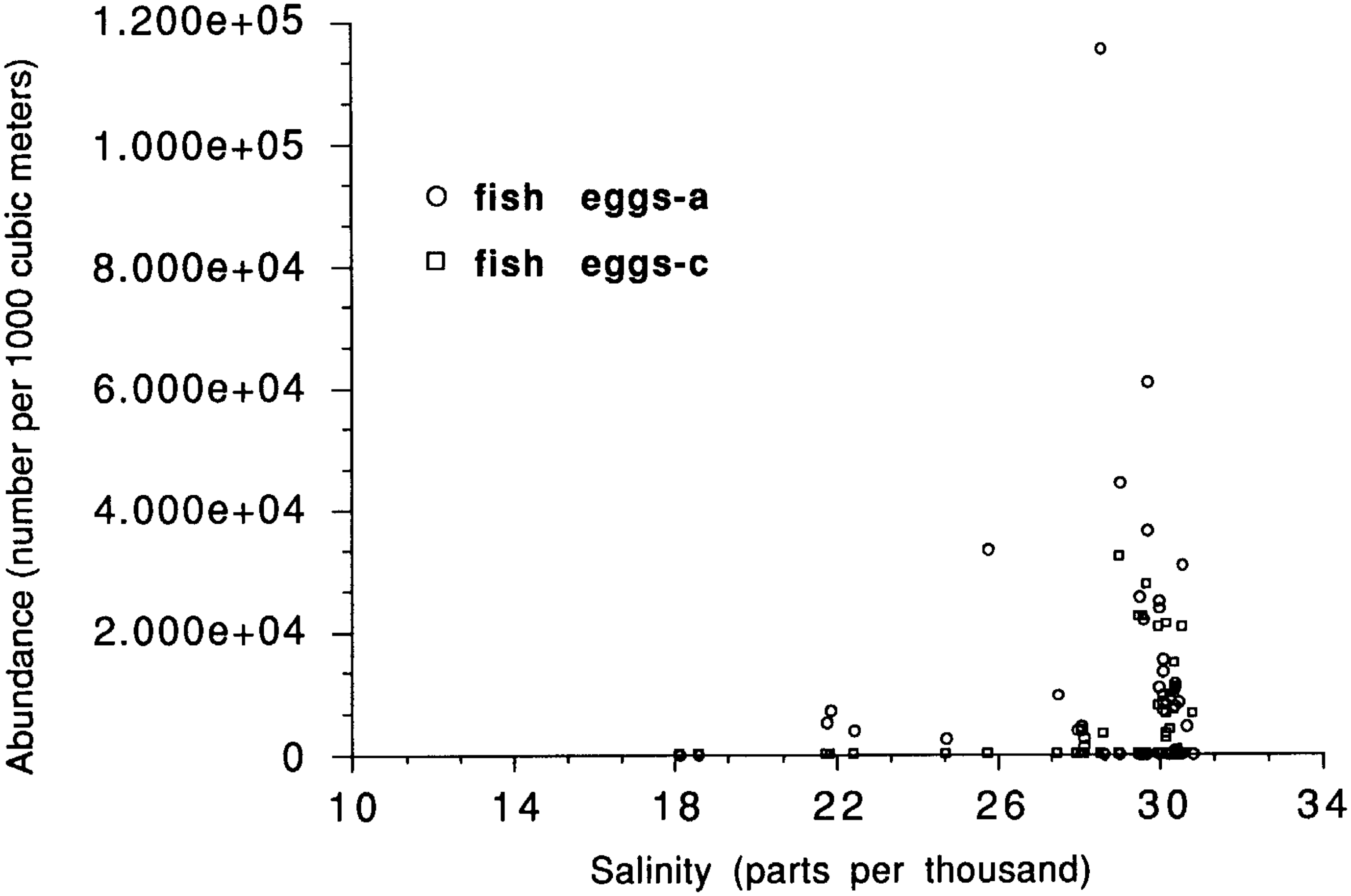
Salinity vs shrimp abundance





SALURIA BAYOU

Salinity vs crab abundance

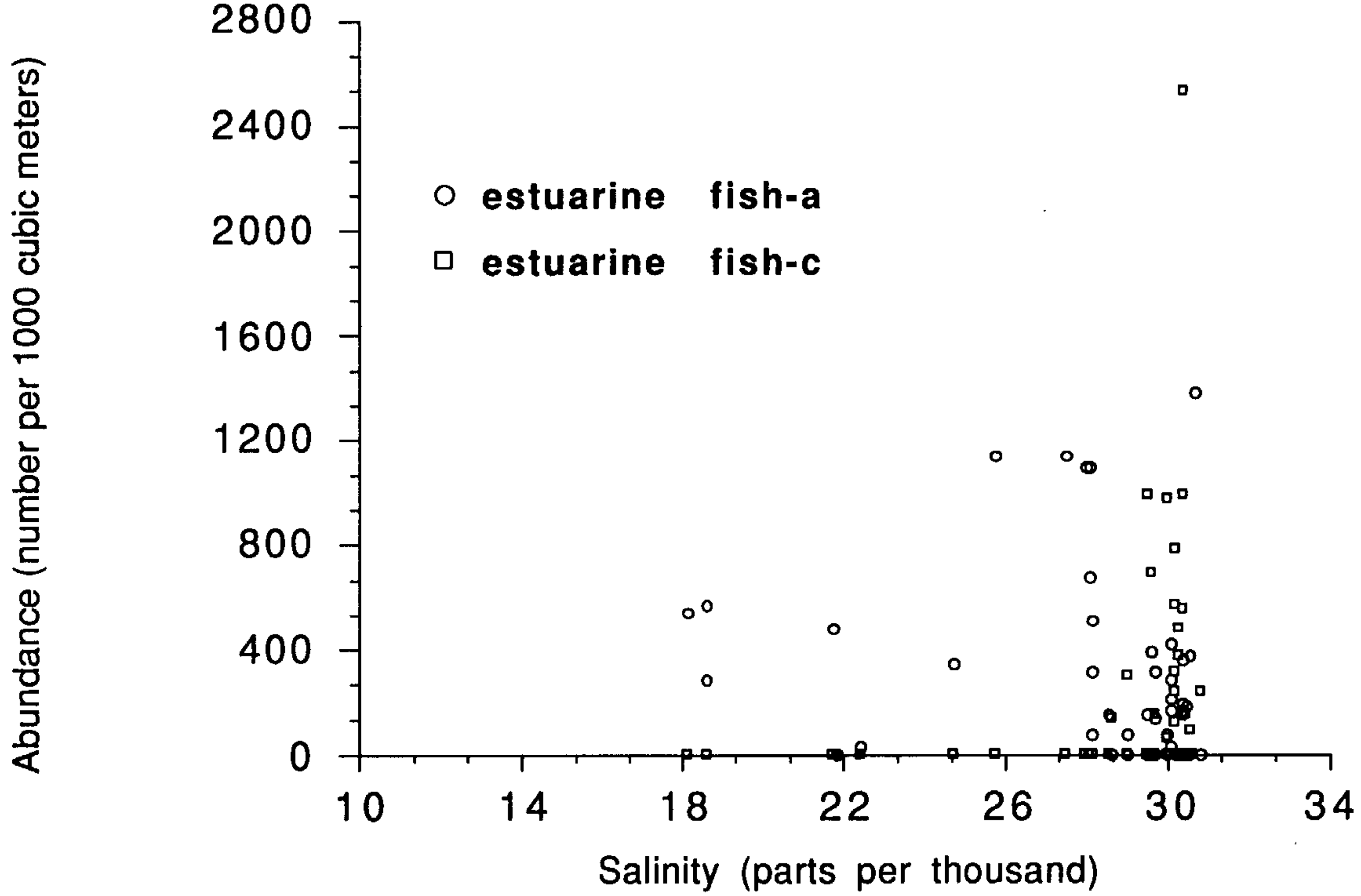


SALURIA BAYOU

Salinity vs fish egg abundance

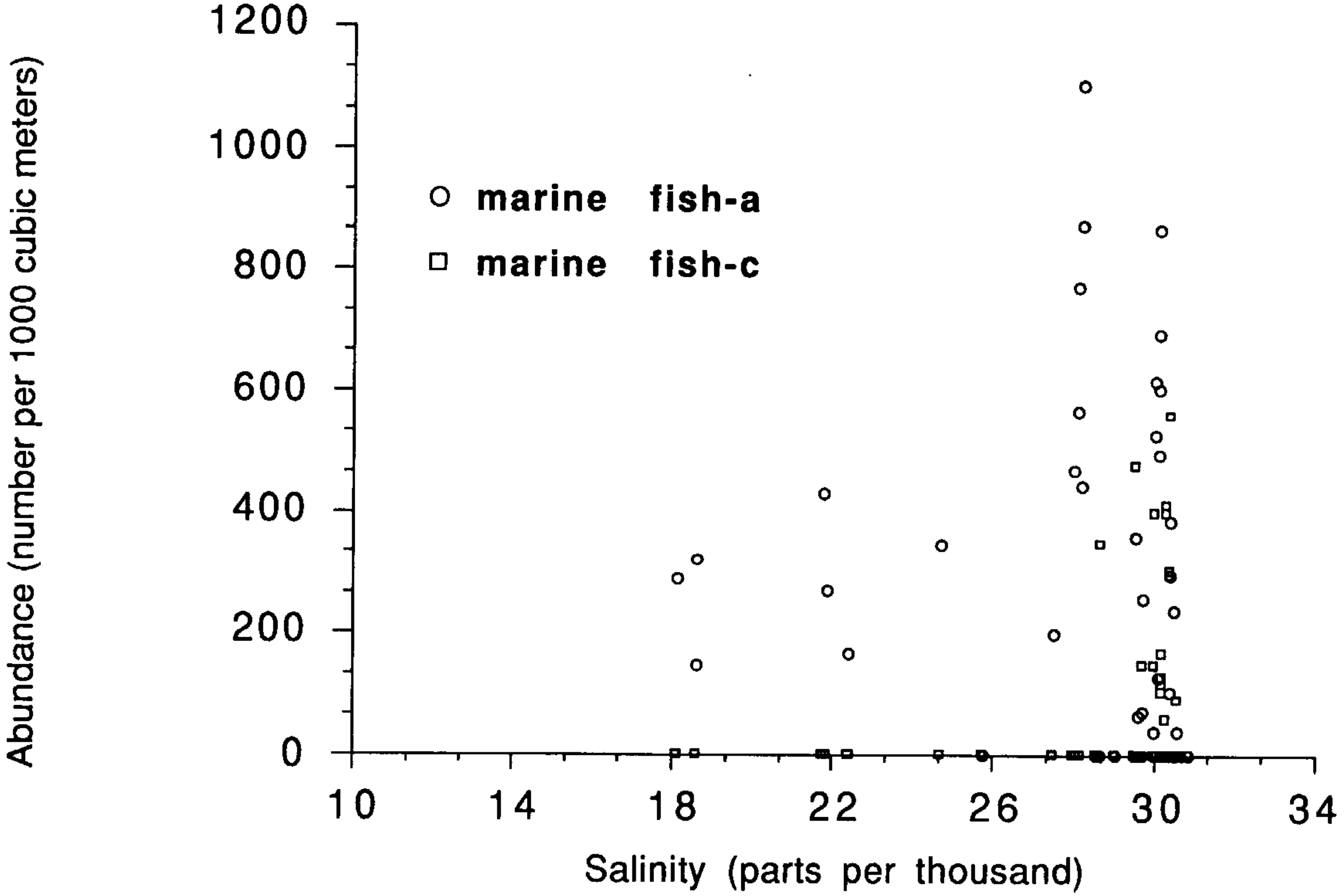
SALURIA BAYOU

Salinity vs estuarine fish abundance



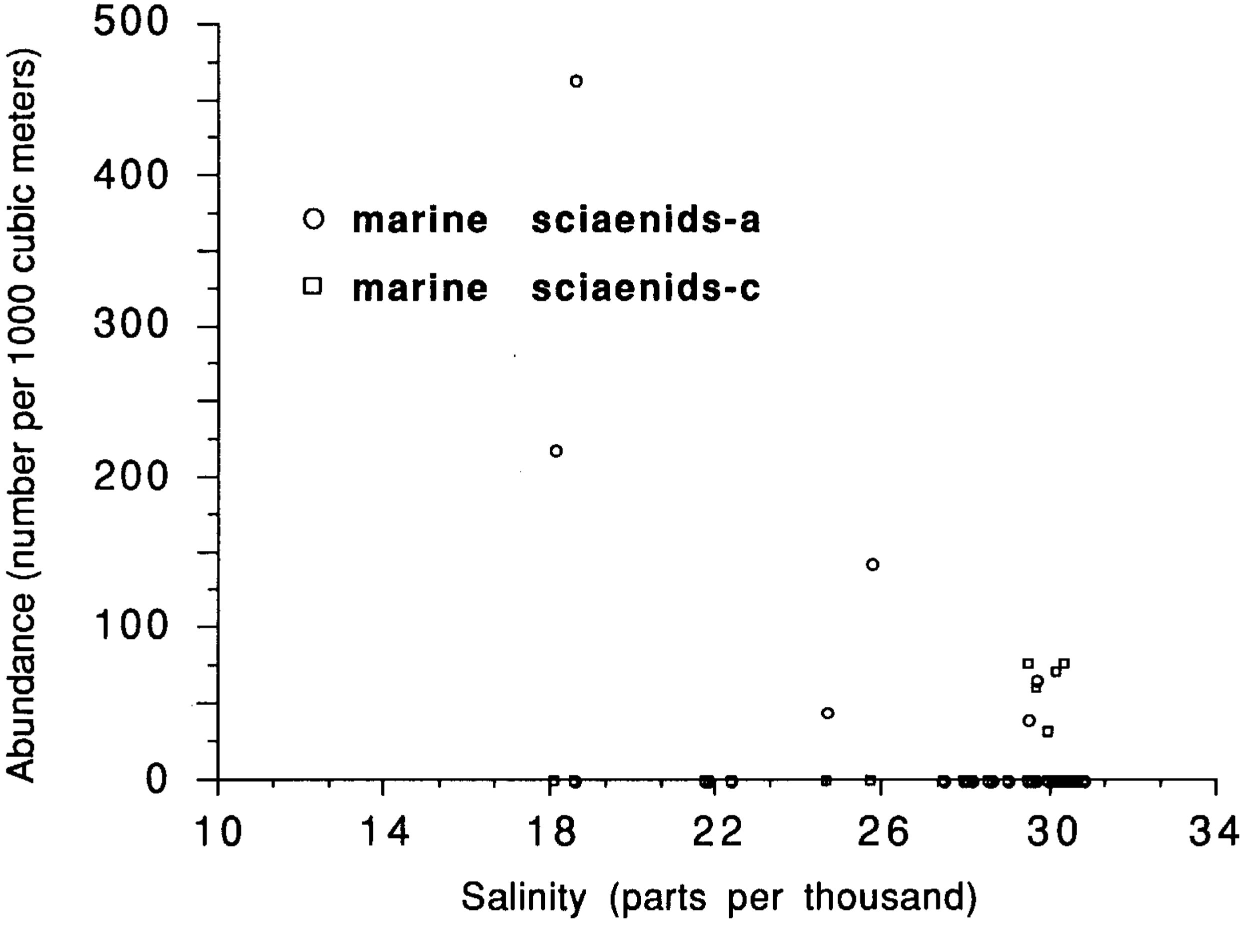
SALURIA BAYOU

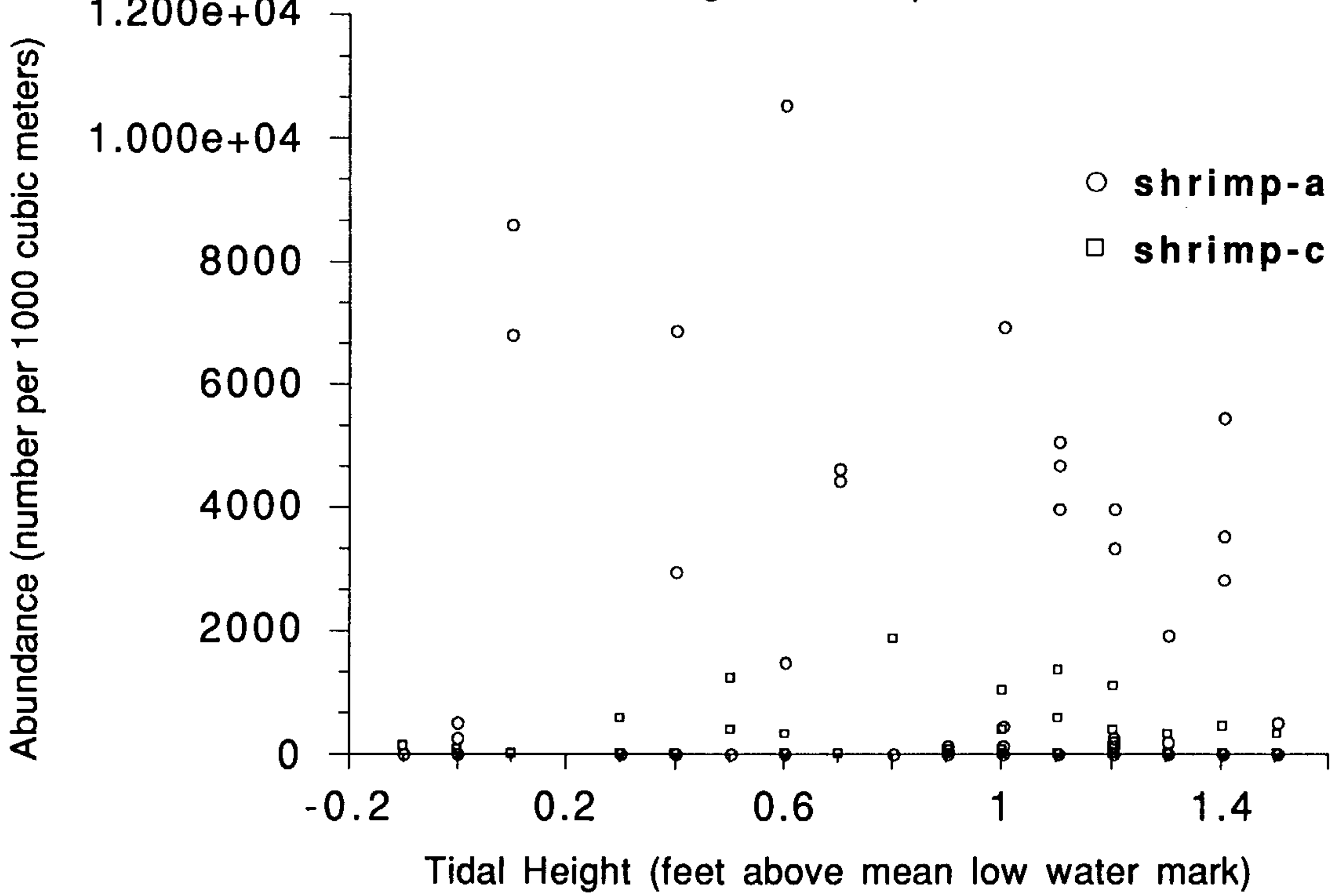
Salinity vs marine fish abundance



SALURIA BAYOU

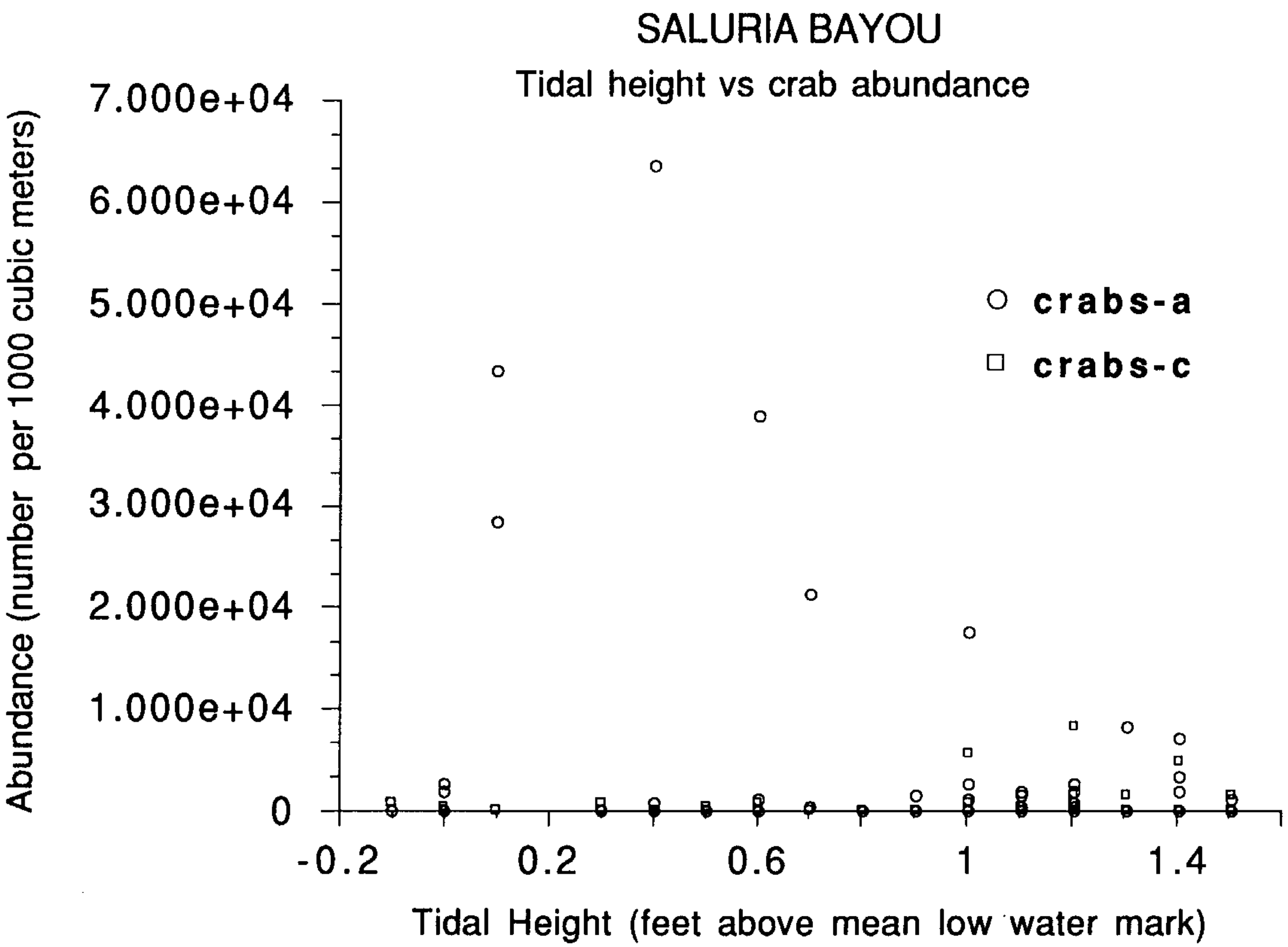
Salinity vs marine sciaenid abundance





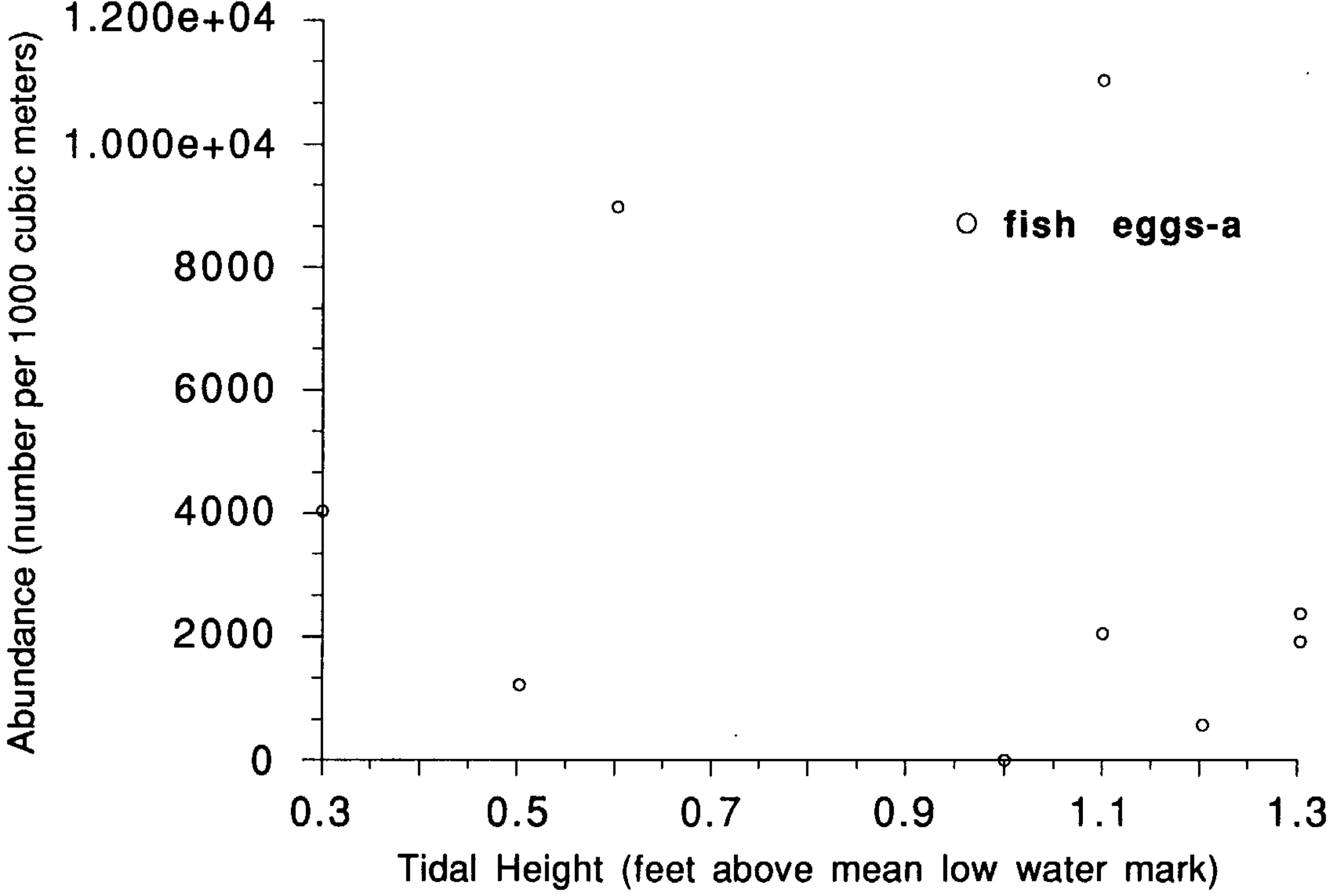
SALURIA BAYOU

Tidal height vs shrimp abundance


SALURIA BAYOU
Tidal height vs crab abundance
○ crabs-a
□ crabs-c
Abundance (number per 1000 cubic meters)
7.000e+04
6.000e+04
5.000e+04
4.000e+04
3.000e+04
2.000e+04
1.000e+04
0
-0.2
0.2
0.6
1
1.4
Tidal Height (feet above mean low water mark)

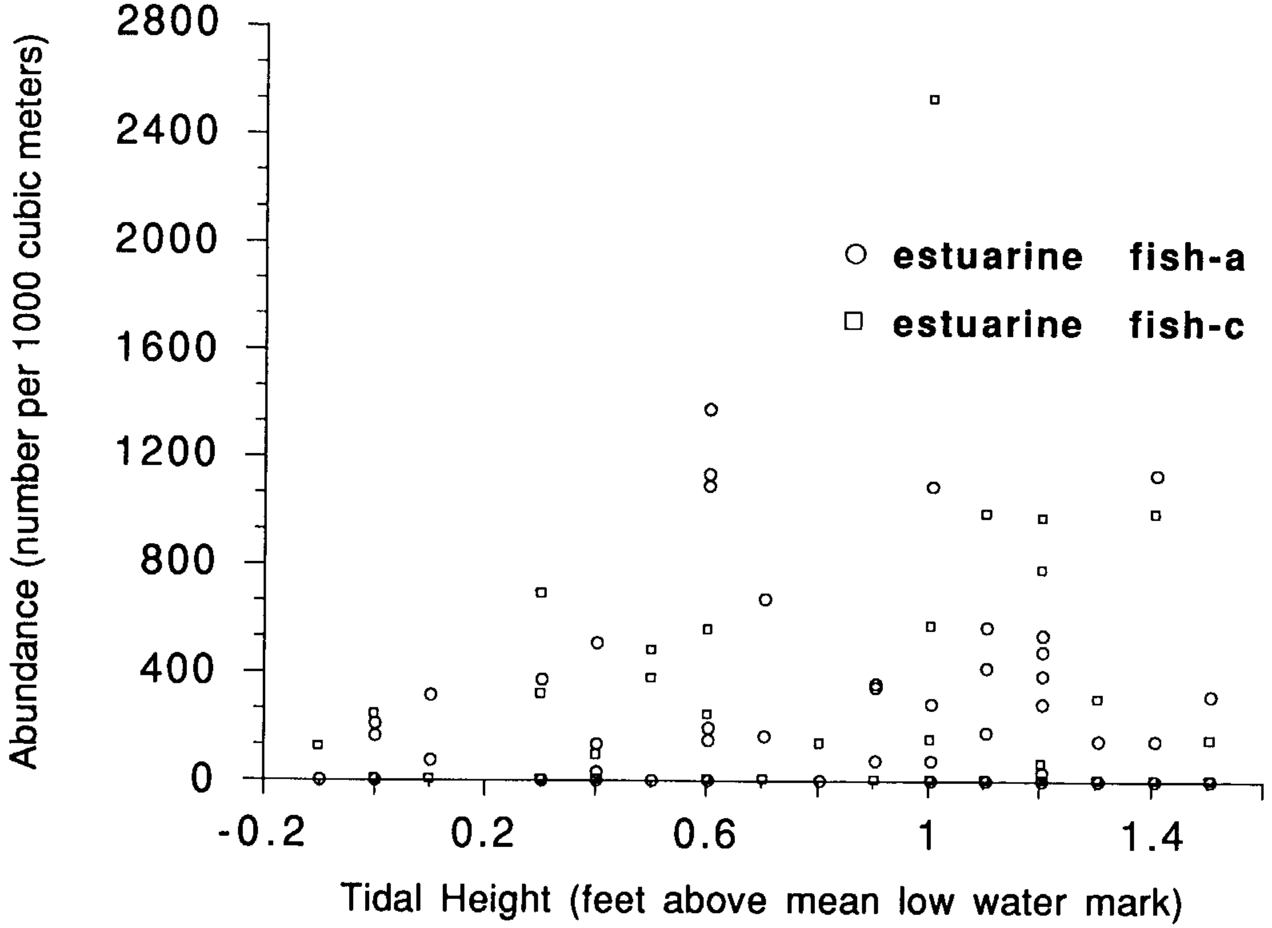
PASS CAVALLO

Tidal height vs fish egg abundance



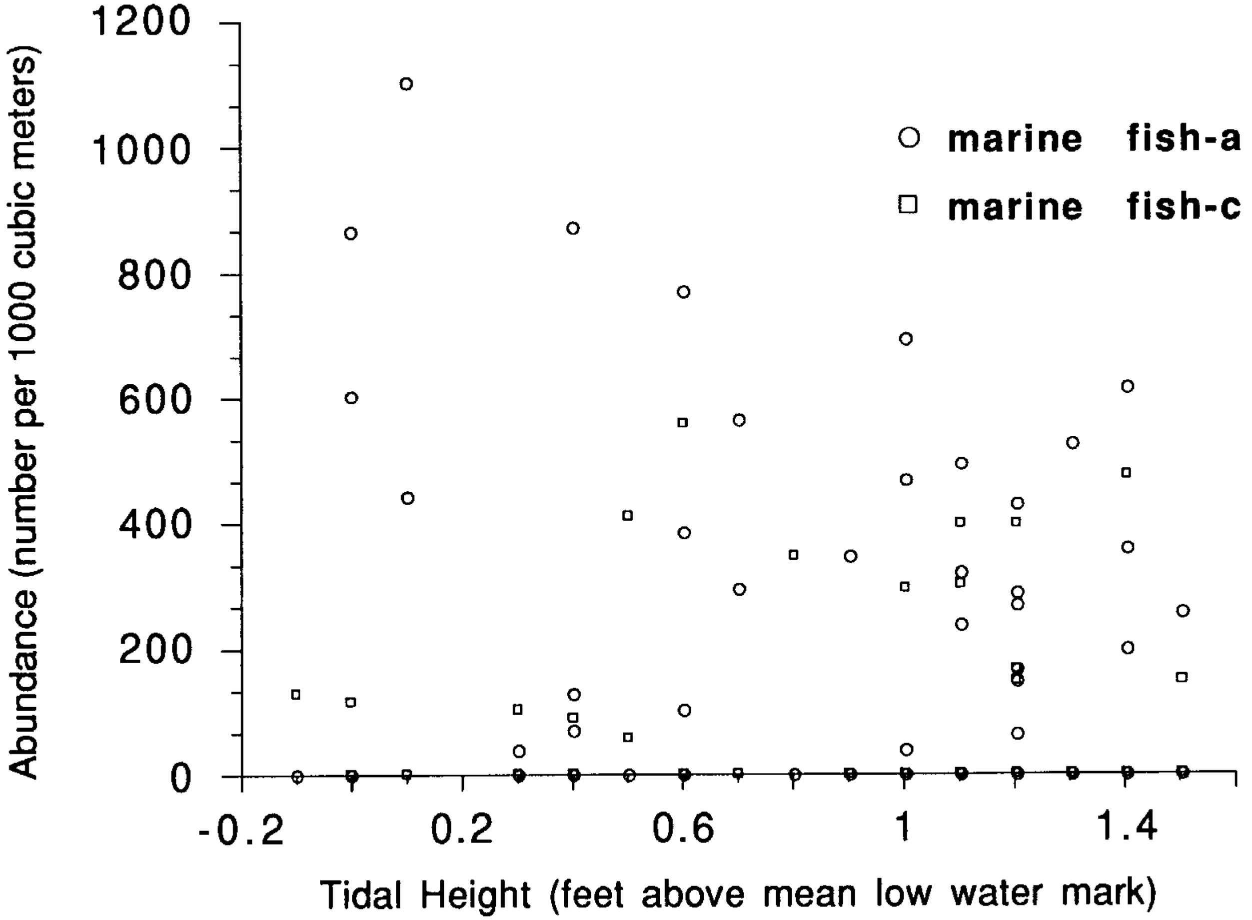
SALURIA BAYOU

Tidal height vs estuarine fish abundance



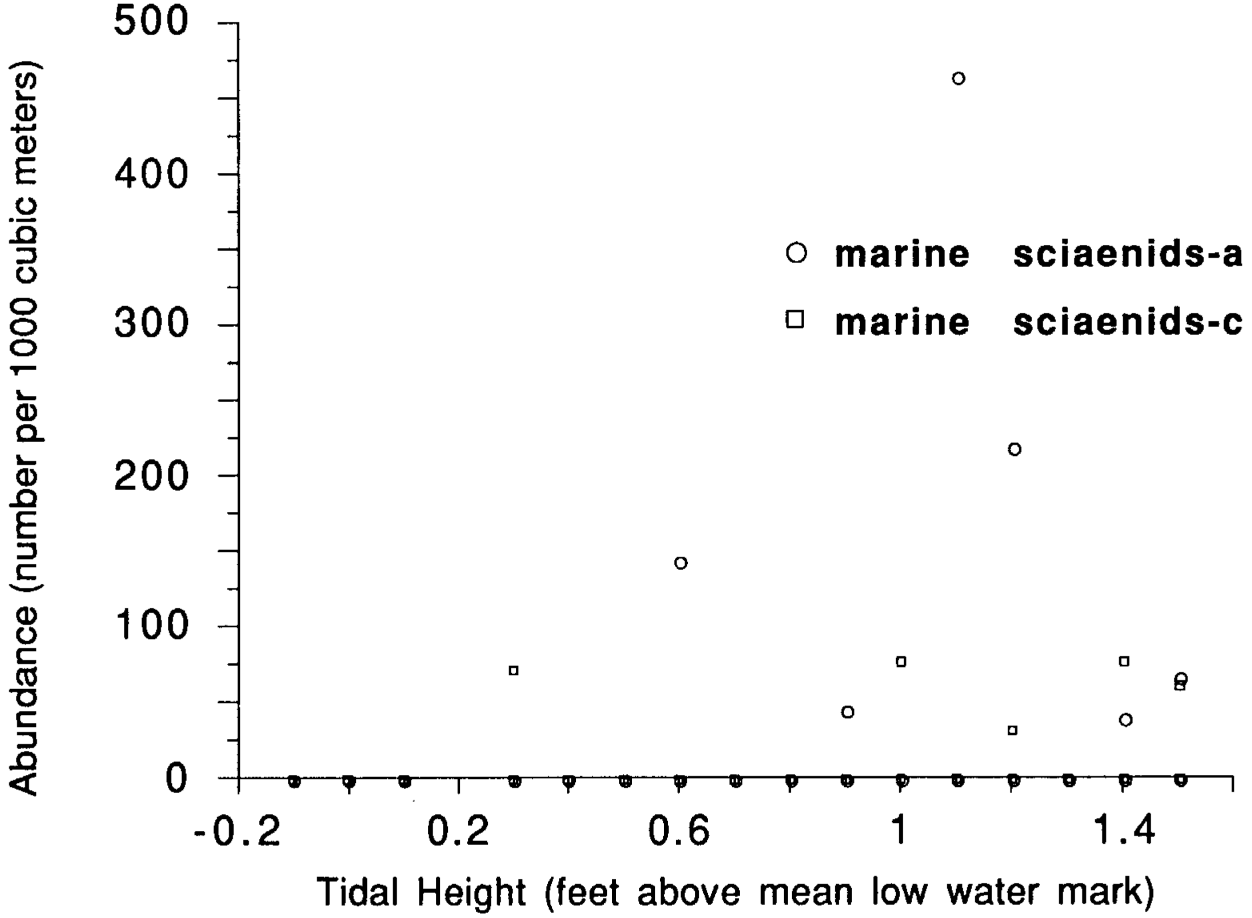
SALURIA BAYOU

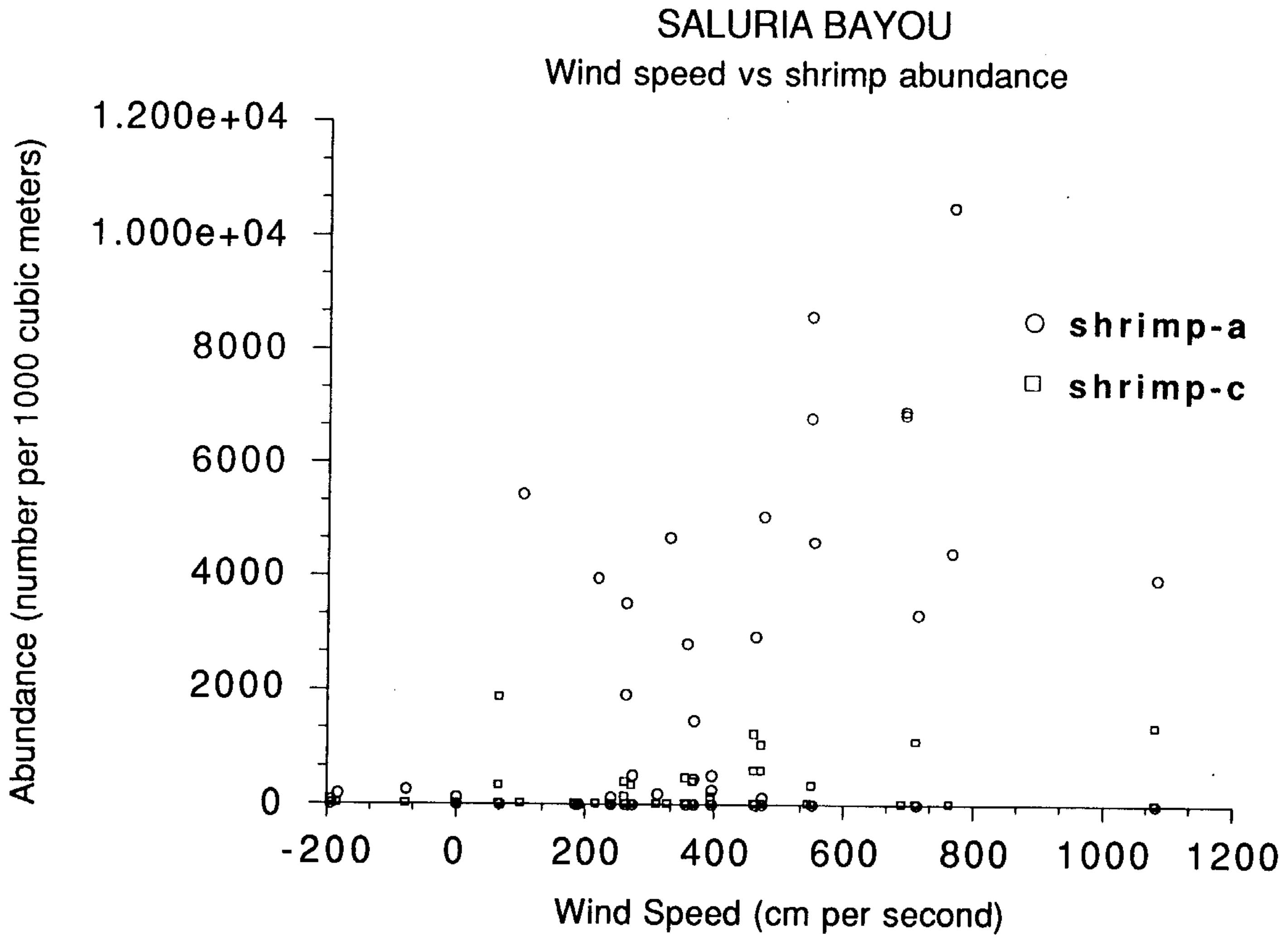
Tidal height vs marine fish abundance

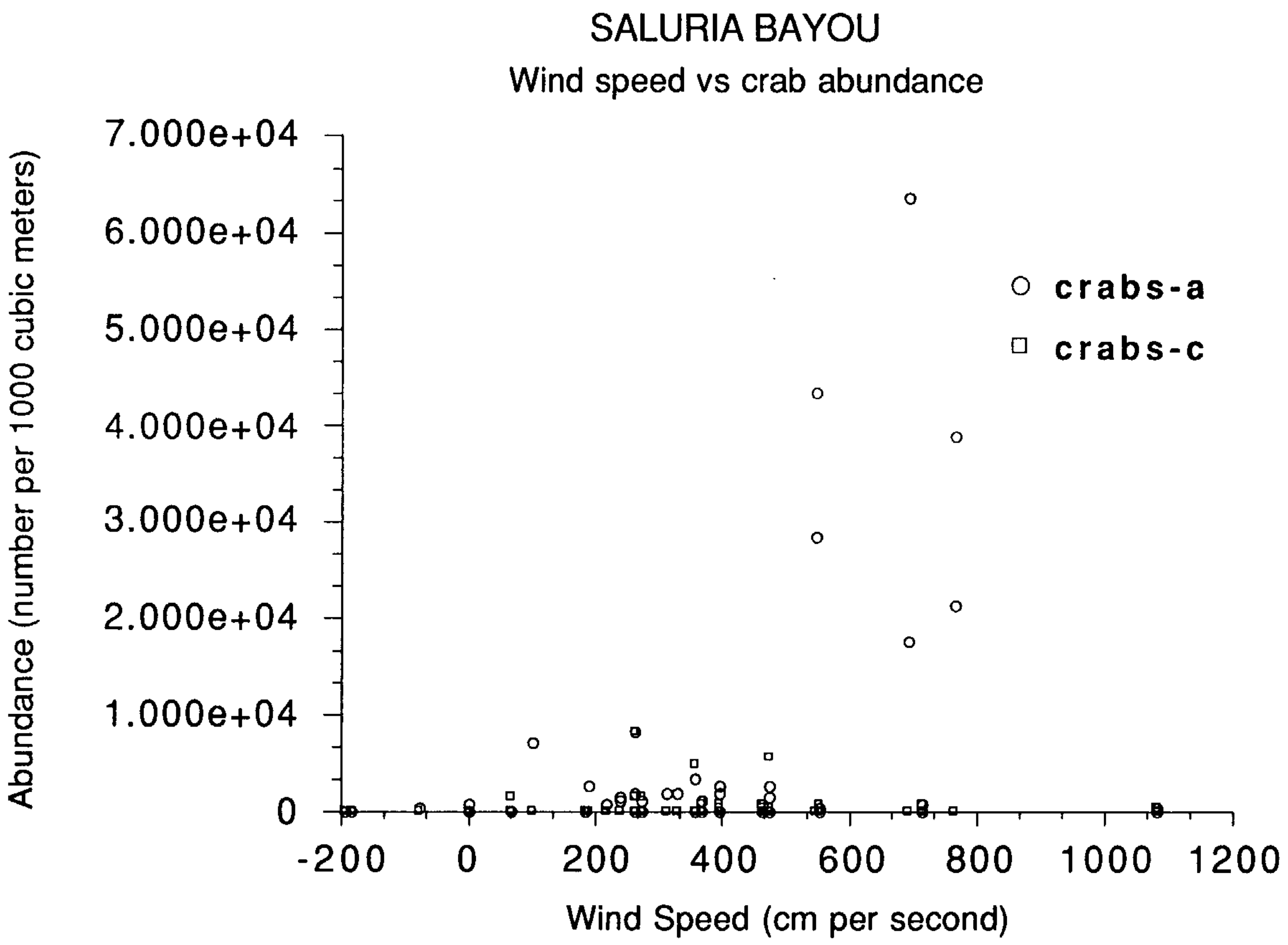


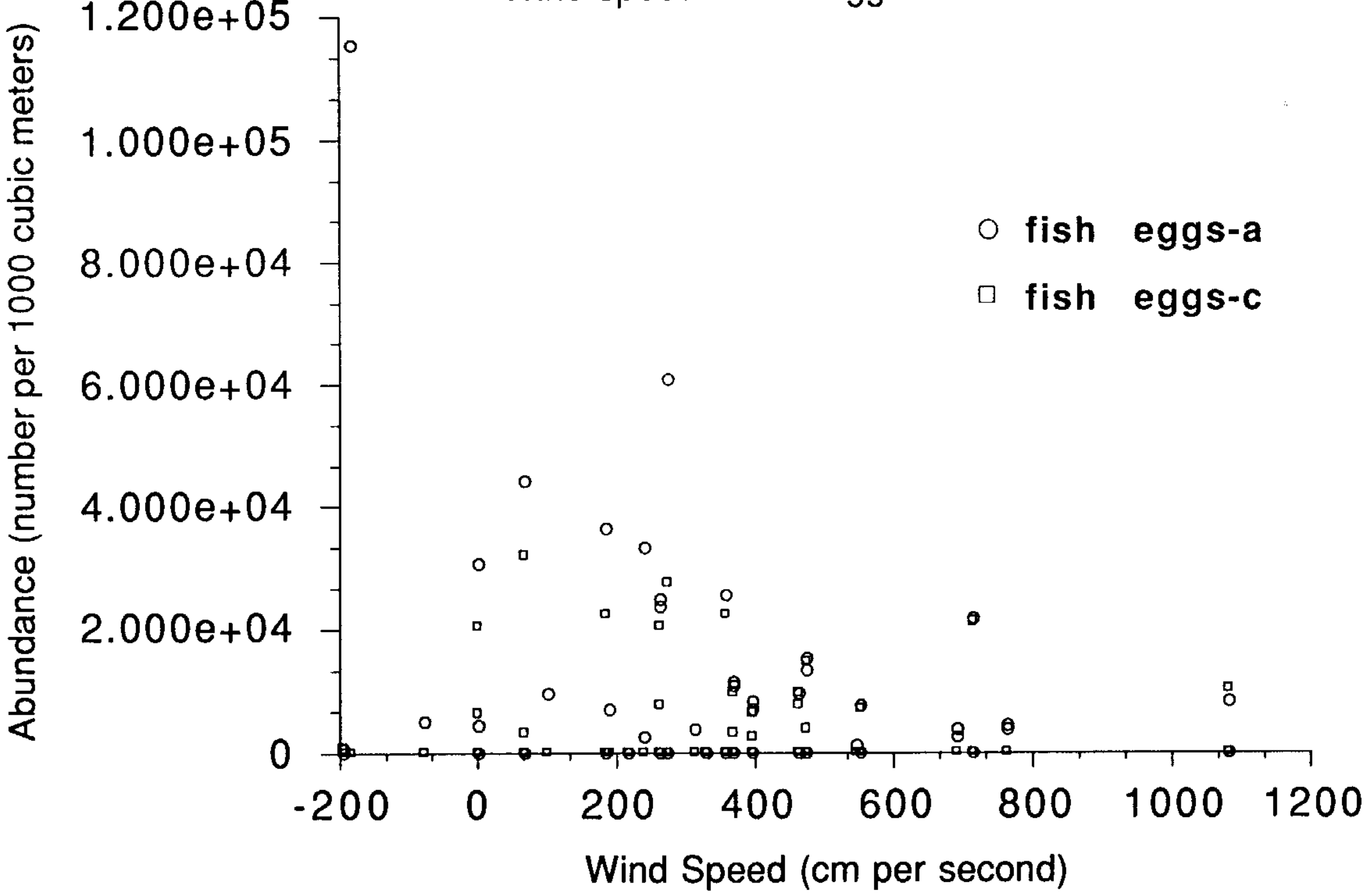
SALURIA BAYOU

Tidal height vs marine sciaenid abundance



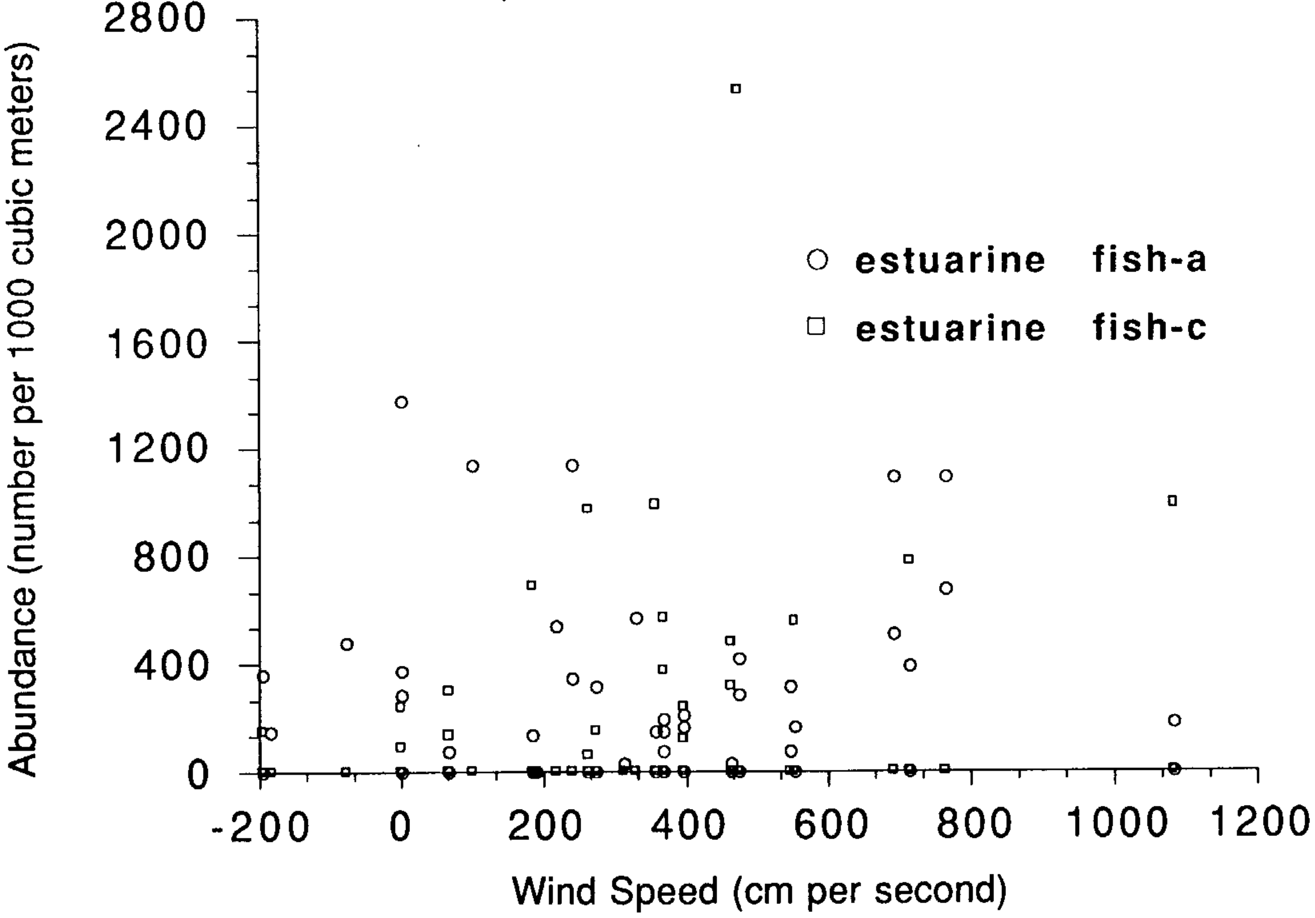

SALURIA BAYOU
Wind speed vs shrimp abundance
Abundance (number per 1000 cubic meters)
1.200e+04
1.000e+04
8000
6000
4000
2000
0
-200
0
200
400
600
800
1000
1200
Wind Speed (cm per second)
○ shrimp-a
□ shrimp-c


SALURIA BAYOU
Wind speed vs crab abundance
Abundance (number per 1000 cubic meters)
7.000e+04
6.000e+04
5.000e+04
4.000e+04
3.000e+04
2.000e+04
1.000e+04
0
-200
0
200
400
600
800
1000
1200
Wind Speed (cm per second)
○ crabs-a
□ crabs-c



SALURIA BAYOU

Wind speed vs fish egg abundance

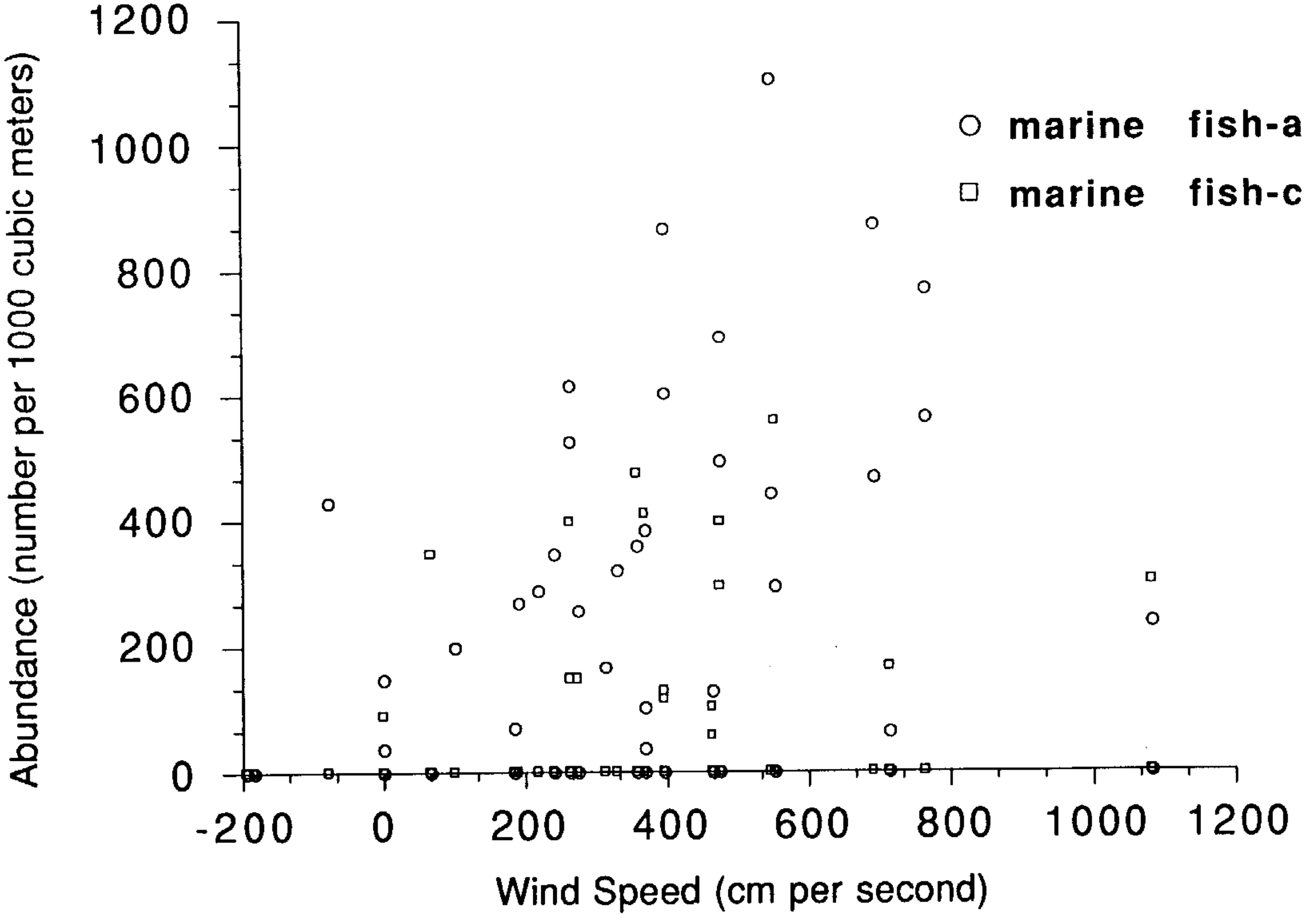


SALURIA BAYOU

Wind speed vs estuarine fish abundance

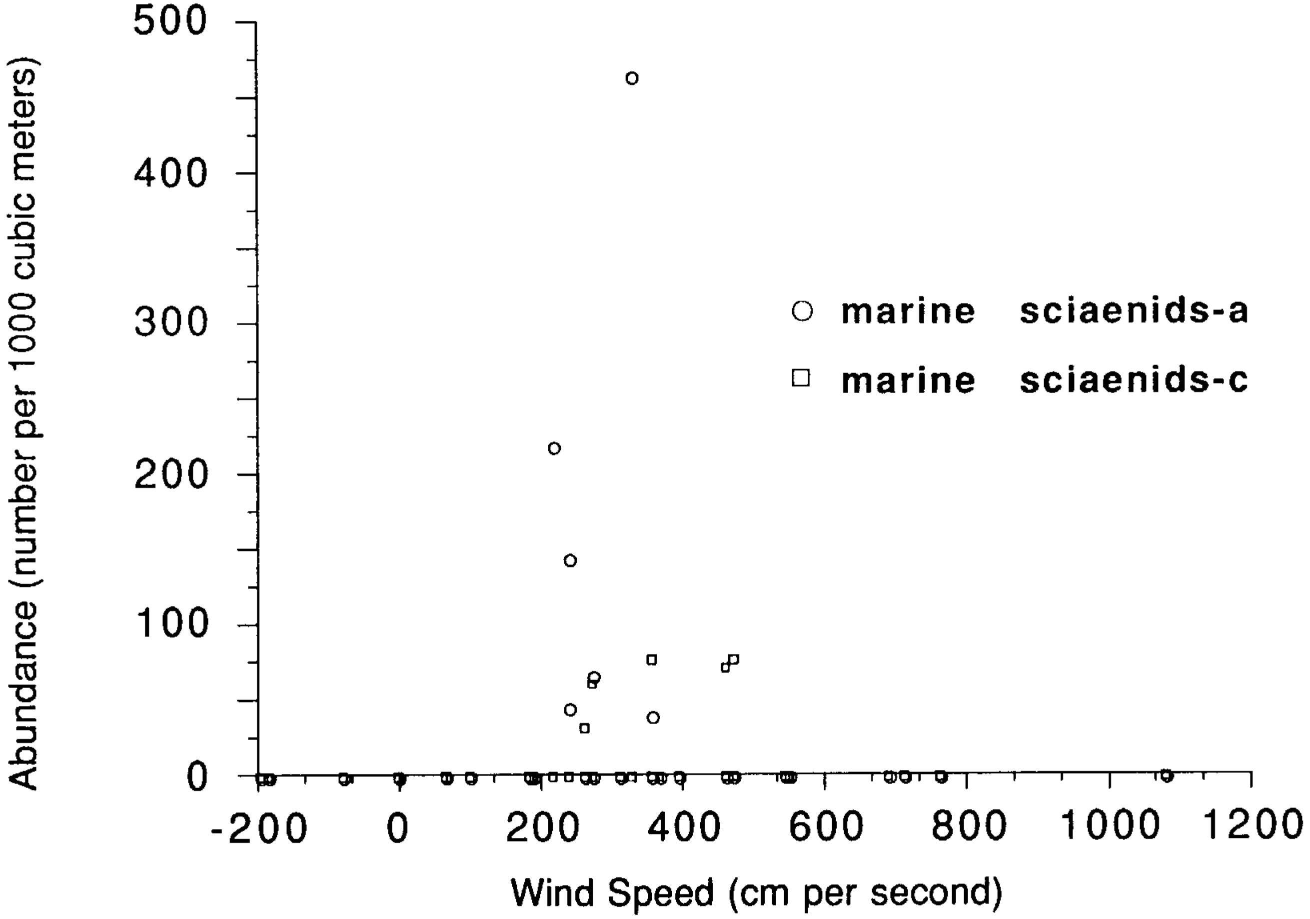
SALURIA BAYOU

Wind speed vs marine fish abundance



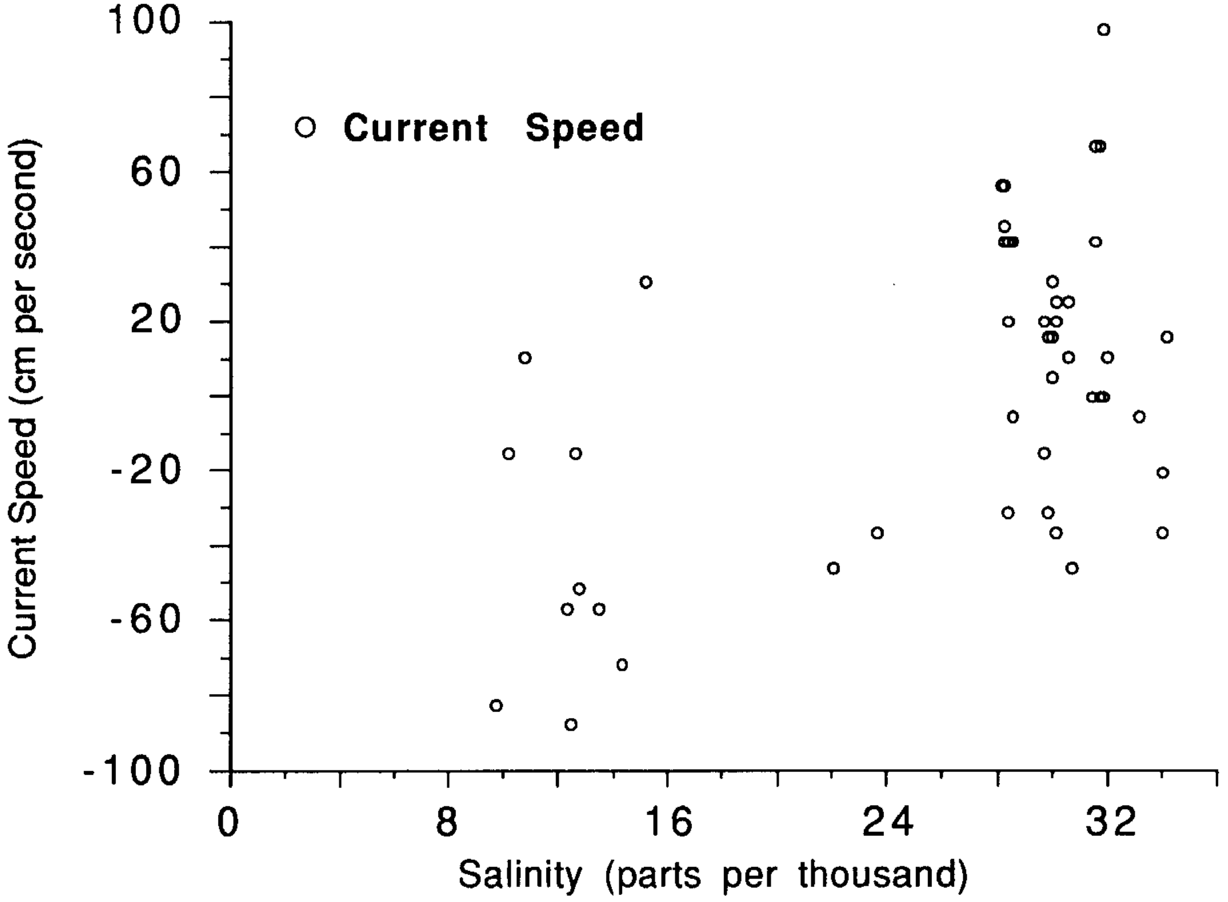
SALURIA BAYOU

Wind speed vs marine sciaenid abundance

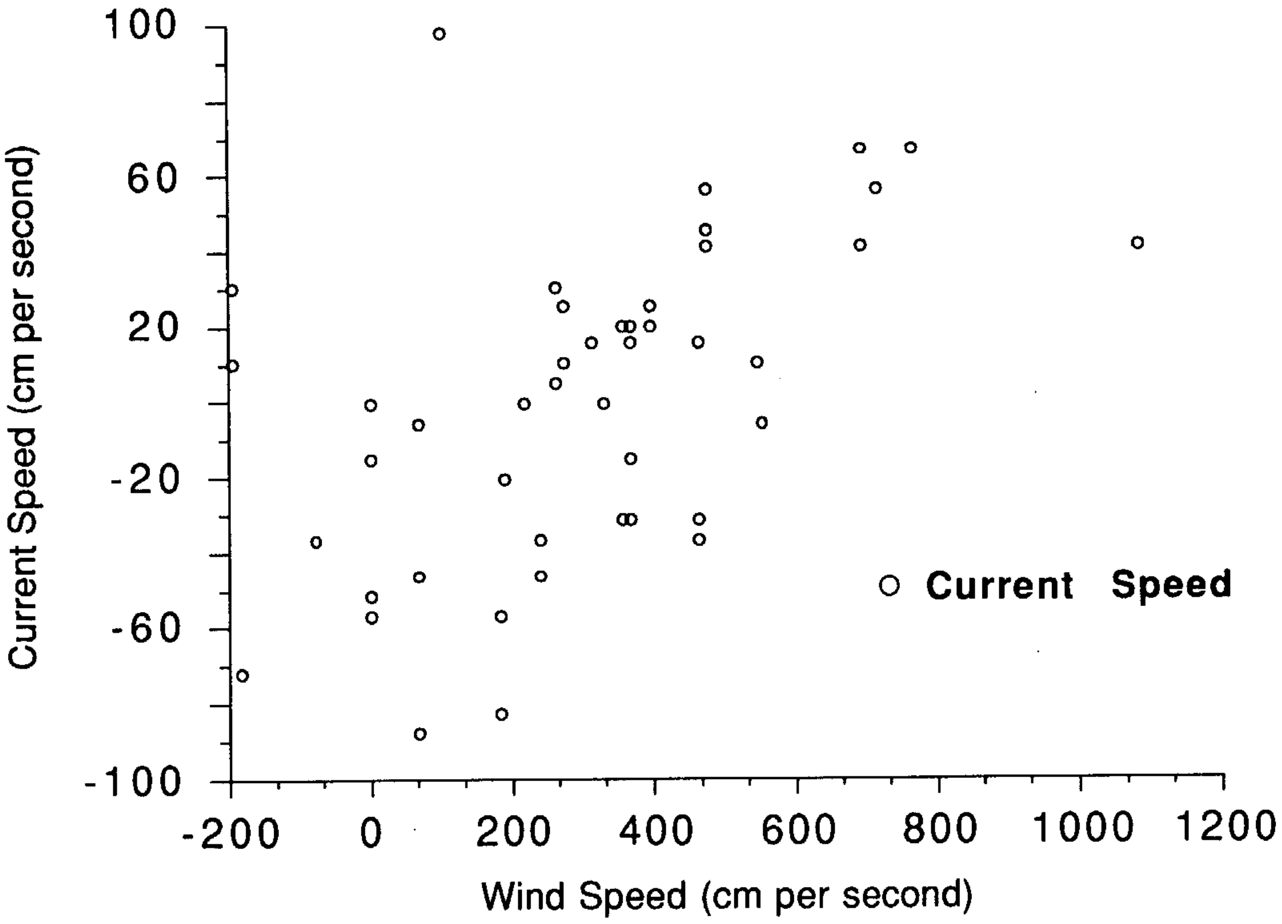


SALURIA BAYOU

Current speed vs salinity

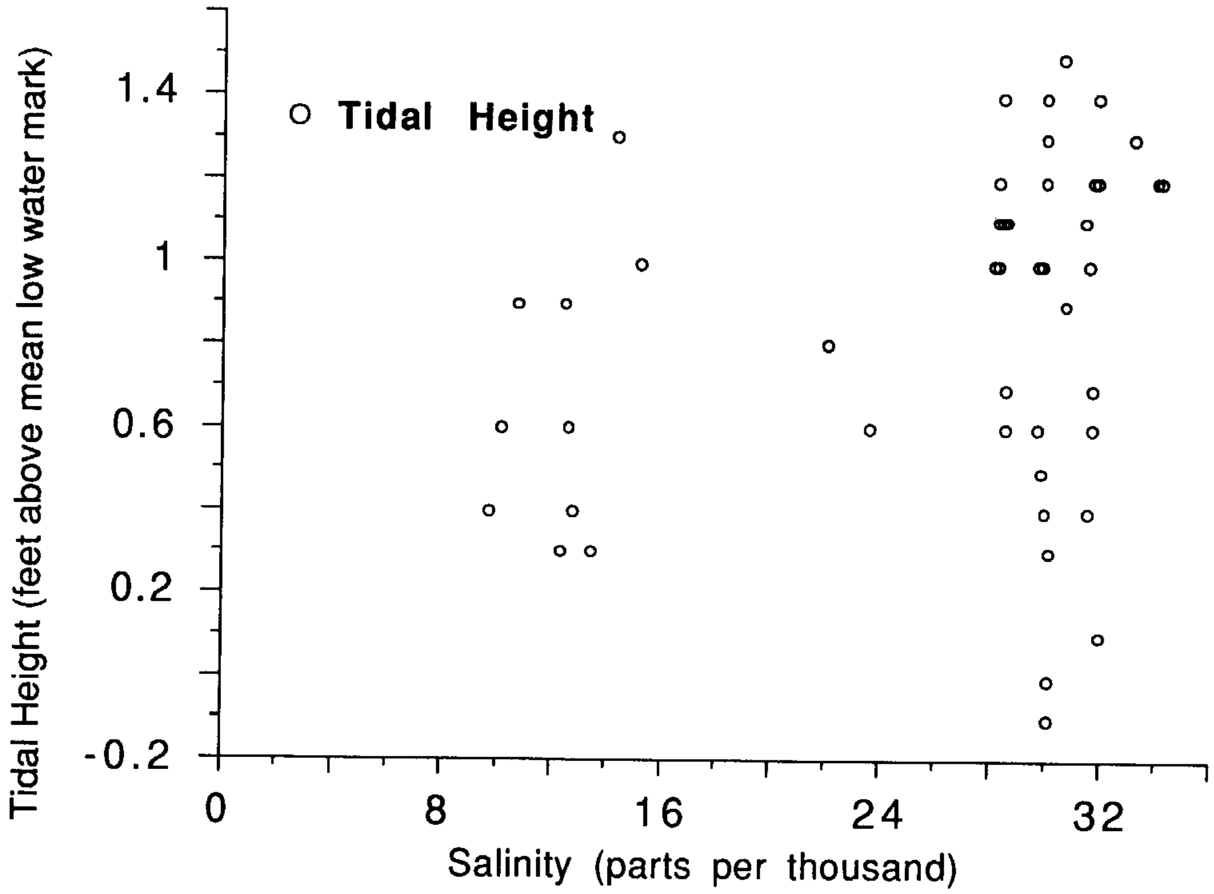


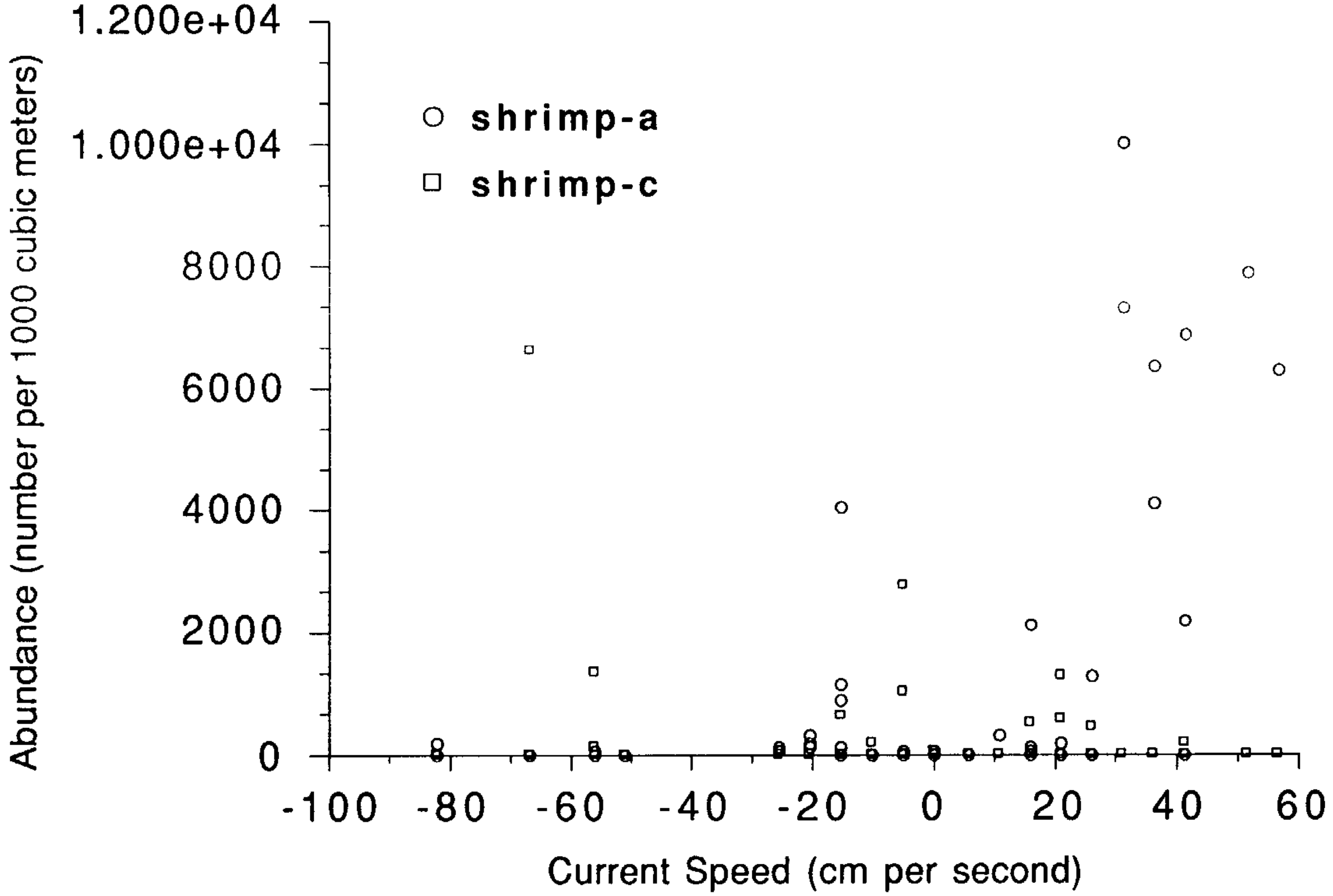
SALURIA BAYOU
Current speed vs wind speed



SALURIA BAYOU

Tidal height vs salinity



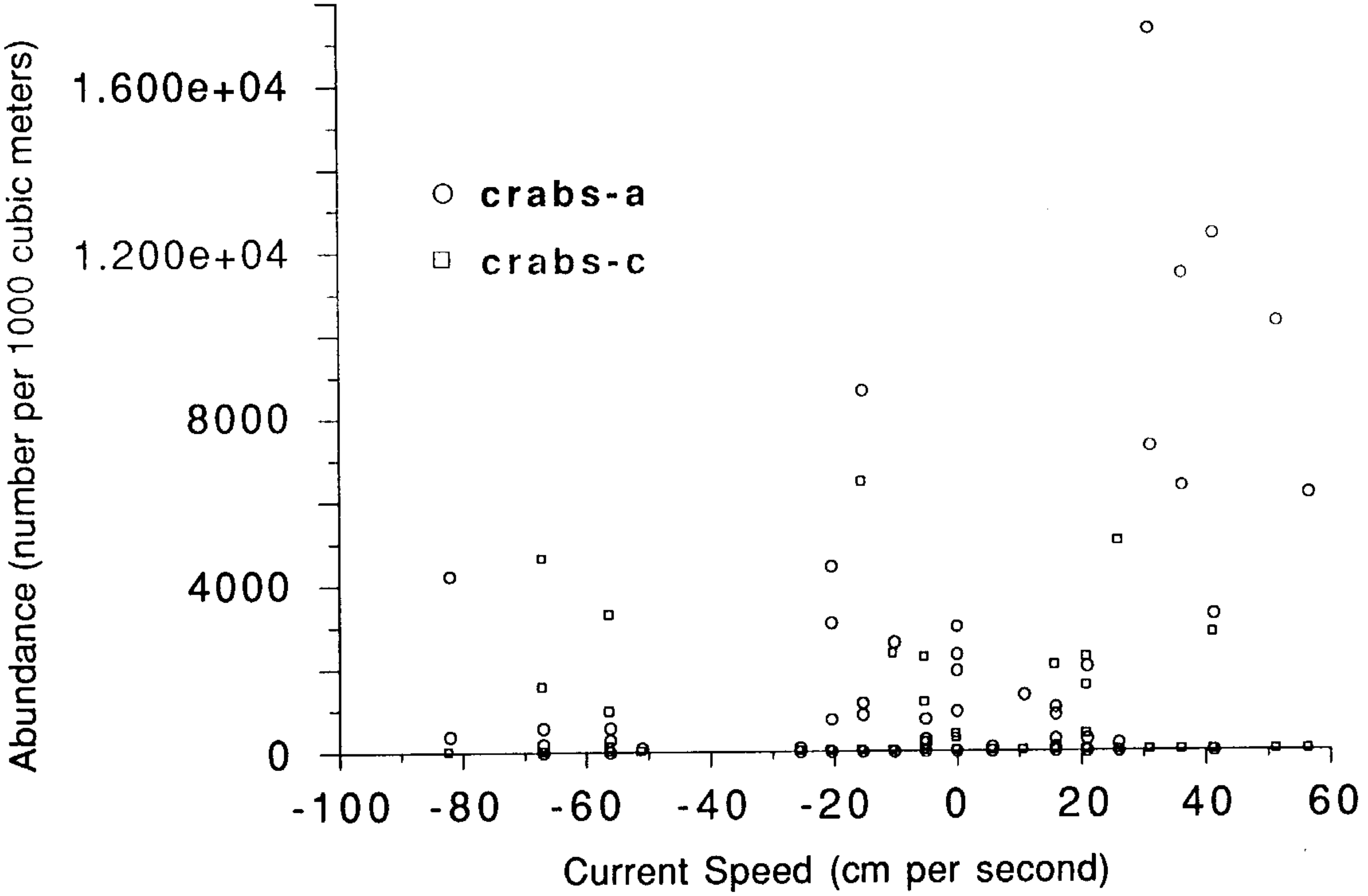


INTRACOASTAL WATERWAY

Current speed vs shrimp abundance

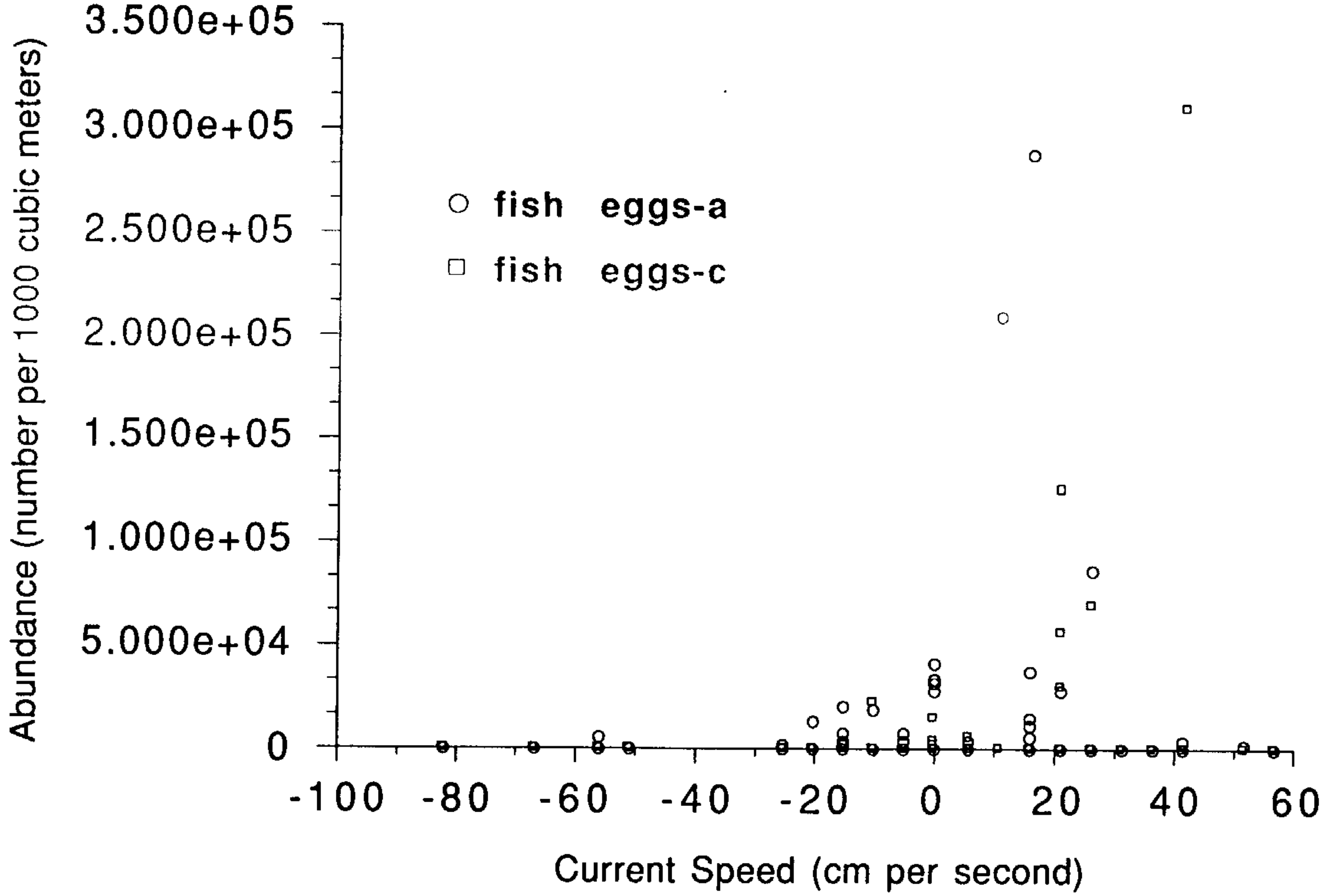
INTRACOASTAL WATERWAY

Current speed vs crab abundance



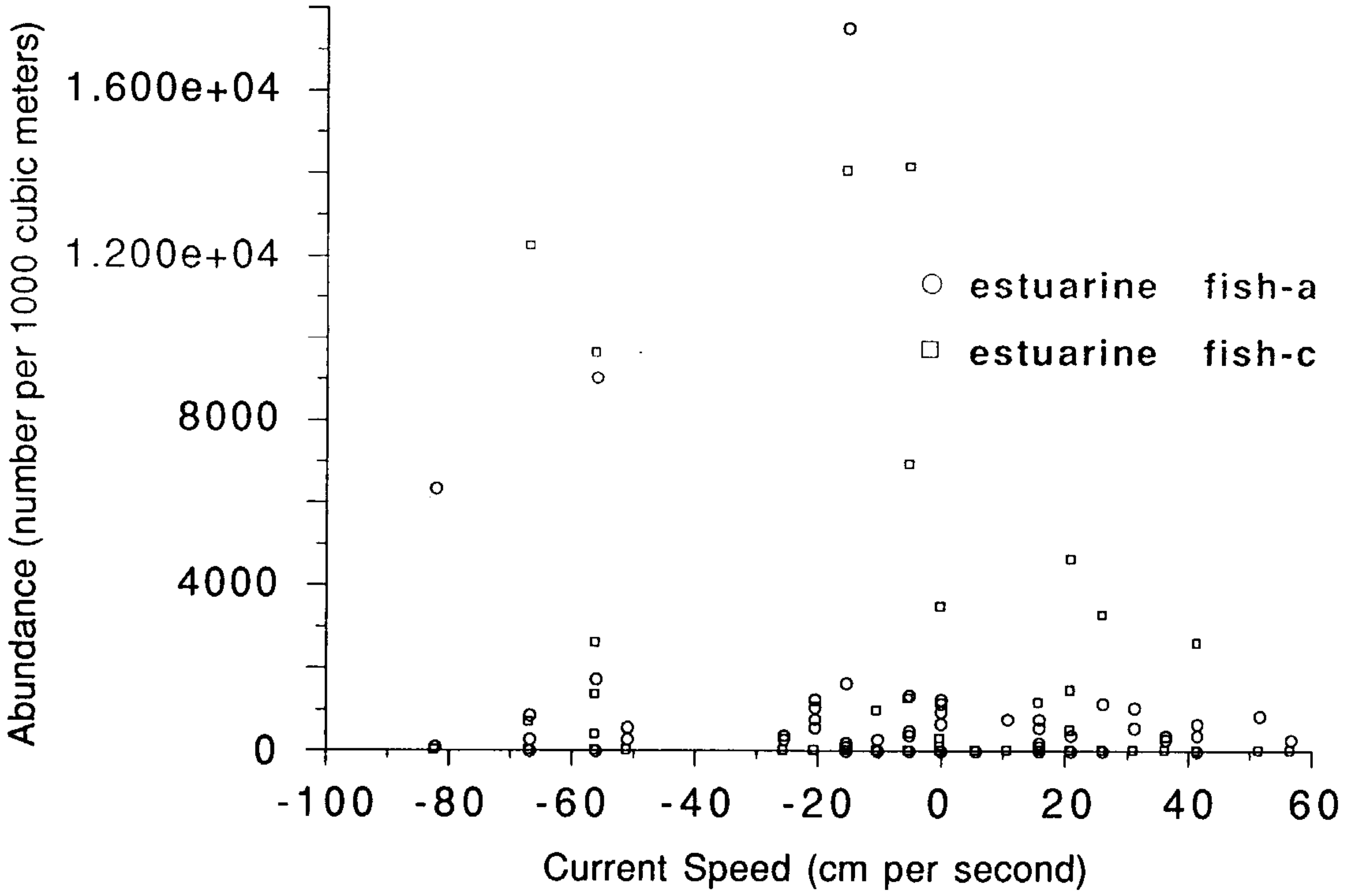
INTRACOASTAL WATERWAY

Current speed vs fish egg abundance



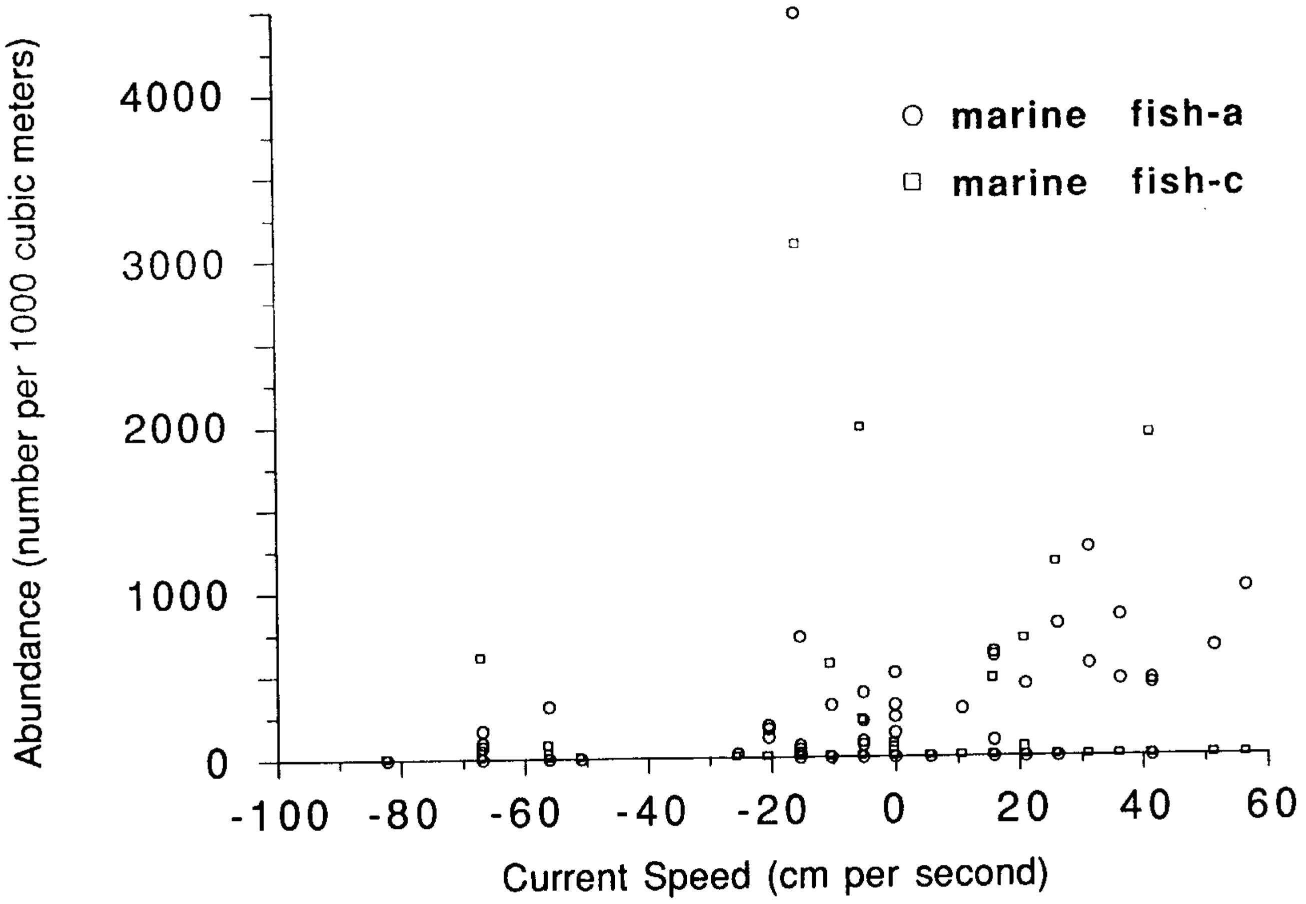
INTRACOASTAL WATERWAY

Current speed vs estuarine fish abundance



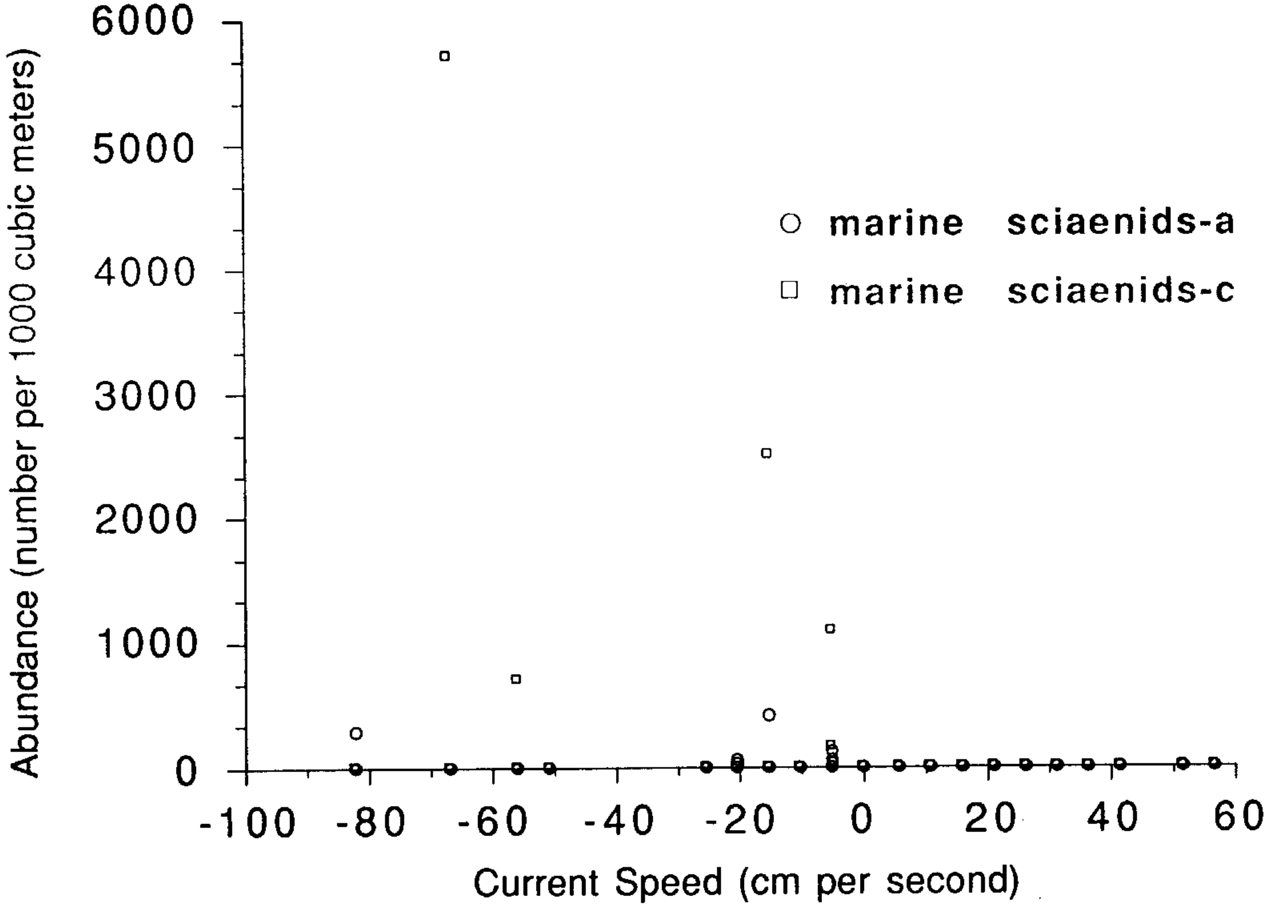
INTRACOASTAL WATERWAY

Current speed vs marine fish abundance



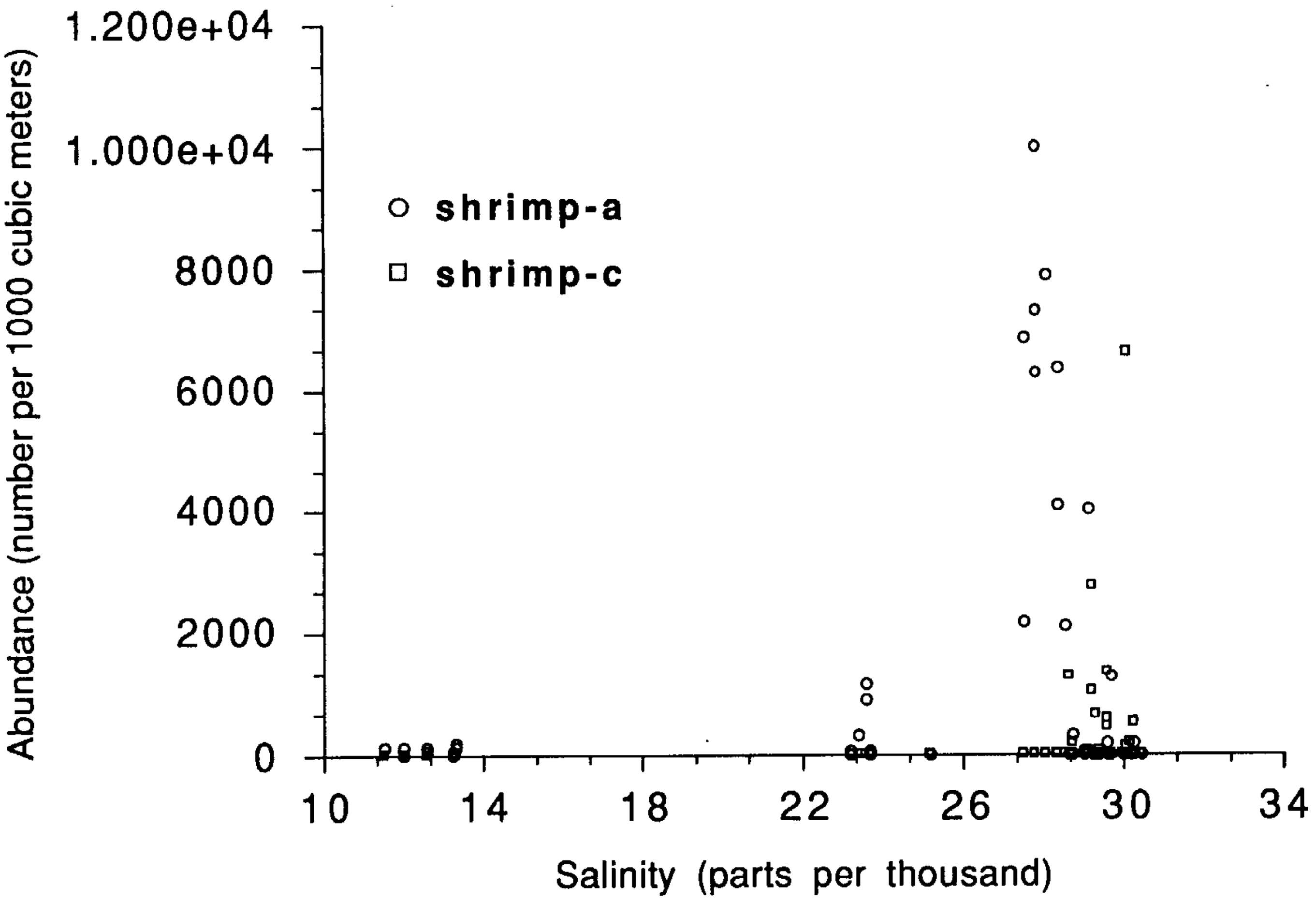
INTRACOASTAL WATERWAY

Current speed vs marine scieanid abundance



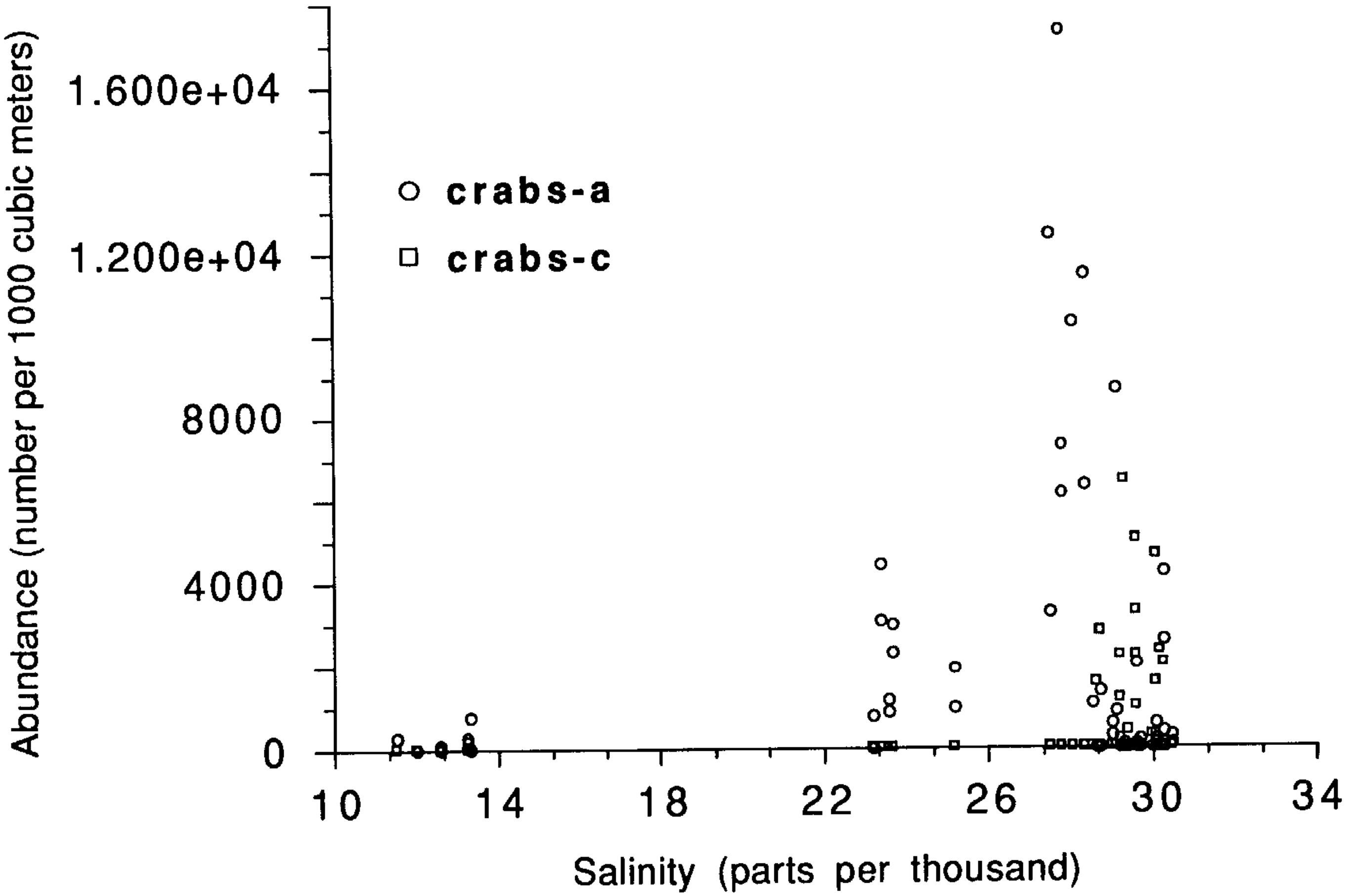
INTRACOASTAL WATERWAY

Salinity vs shrimp abundance



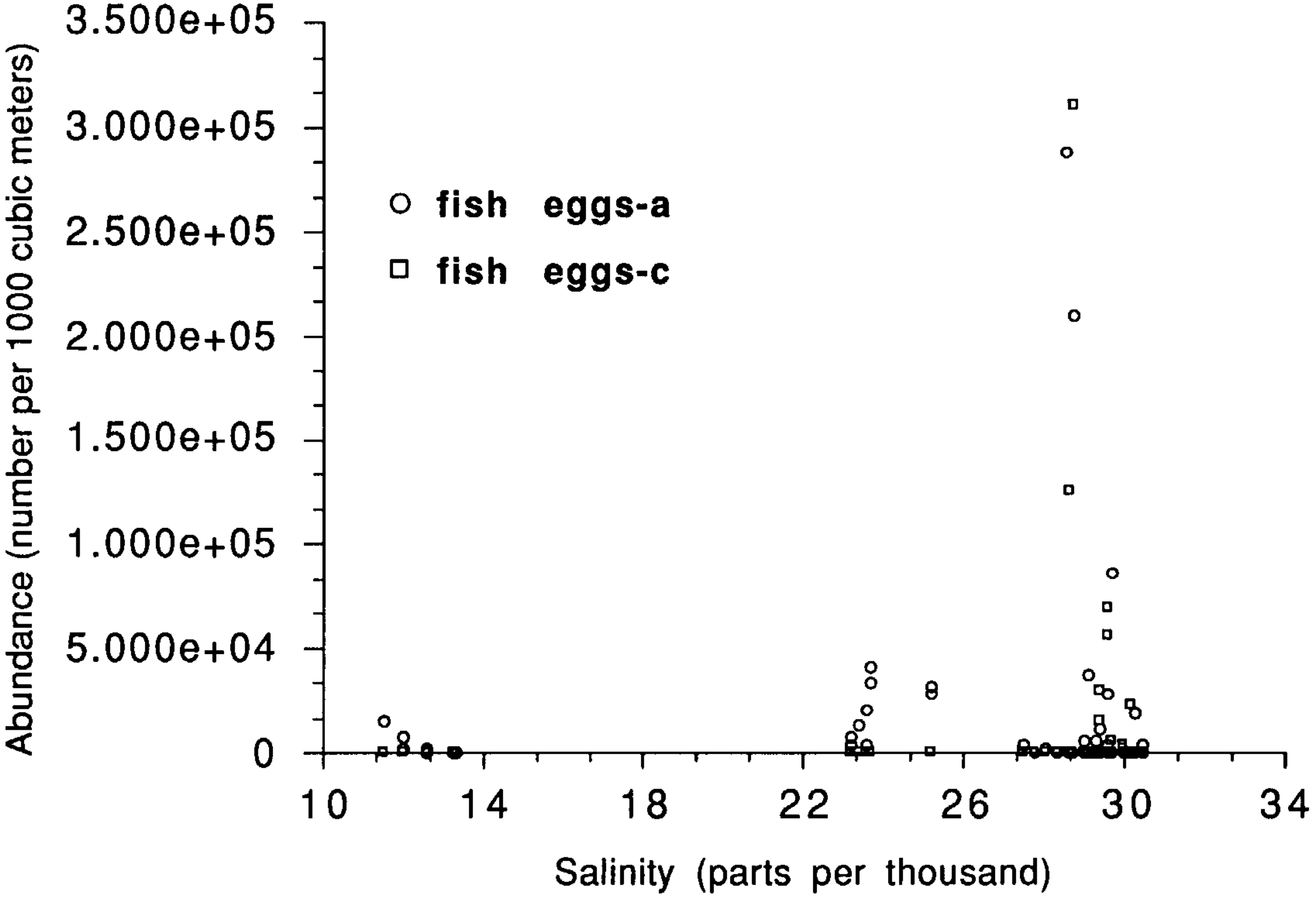
INTRACOASTAL WATERWAY

Salinity vs crab abundance



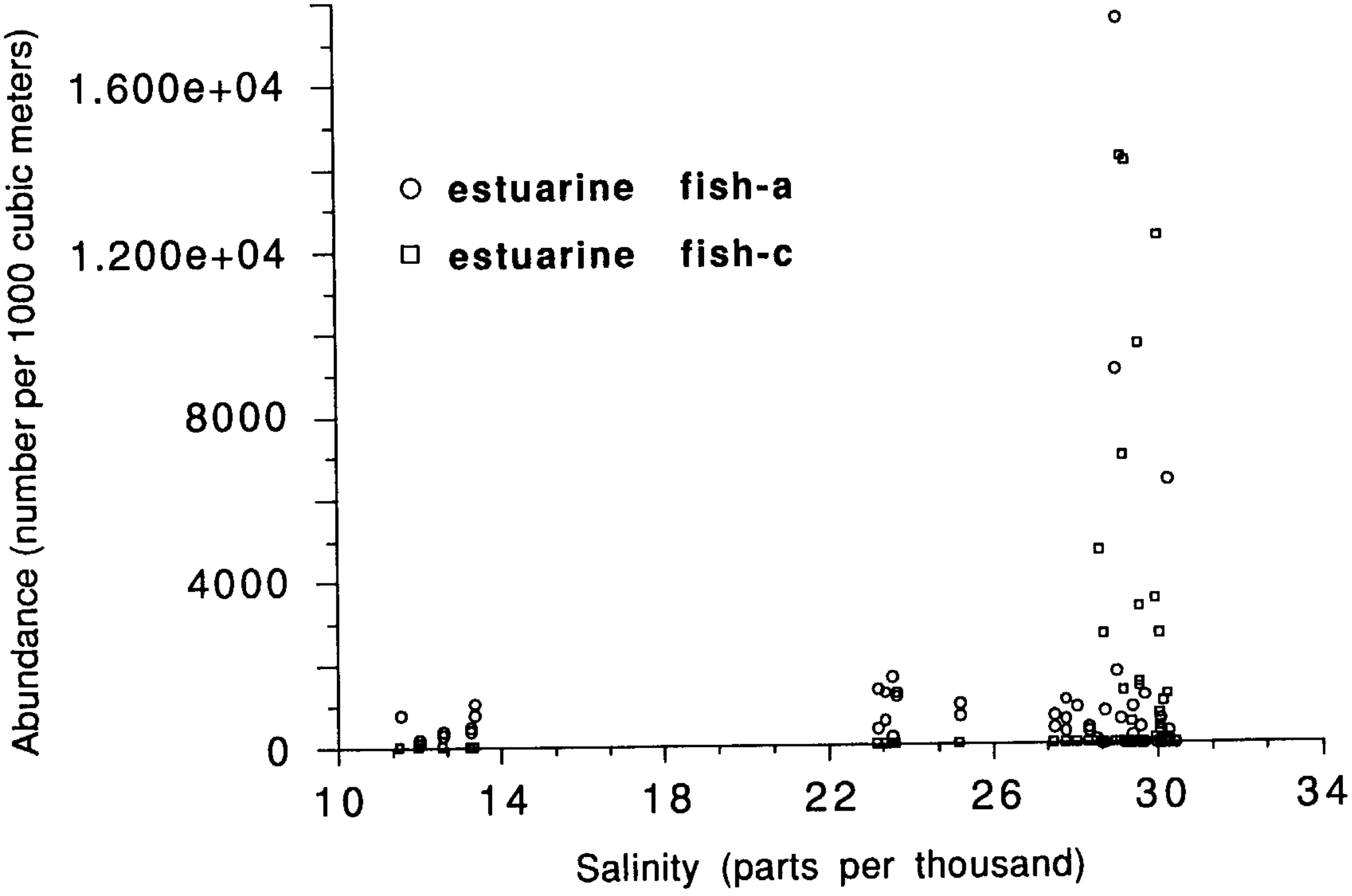
INTRACOASTAL WATERWAY

Salinity vs fish egg abundance



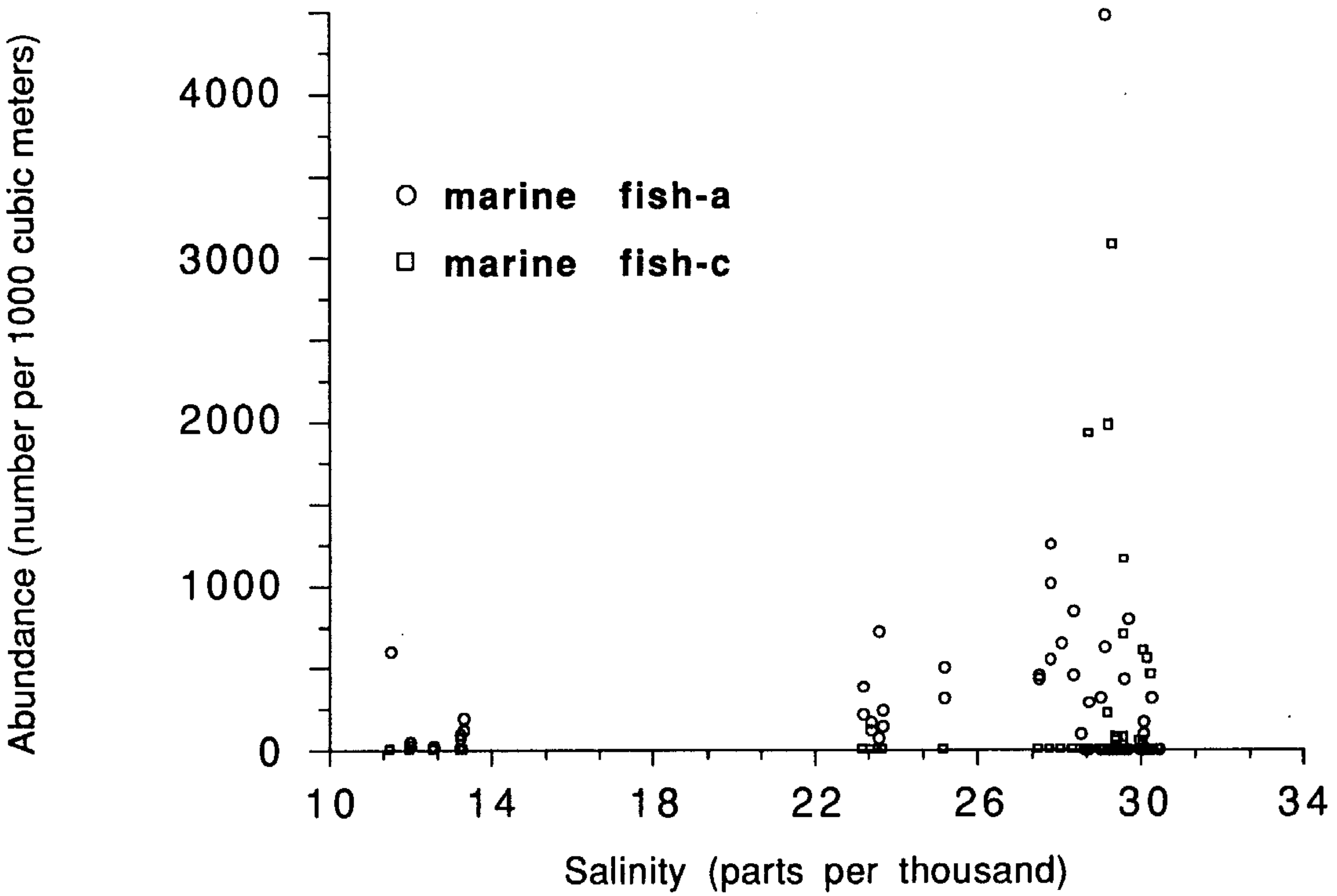
INTRACOASTAL WATERWAY

Salinity vs estuarine fish abundance



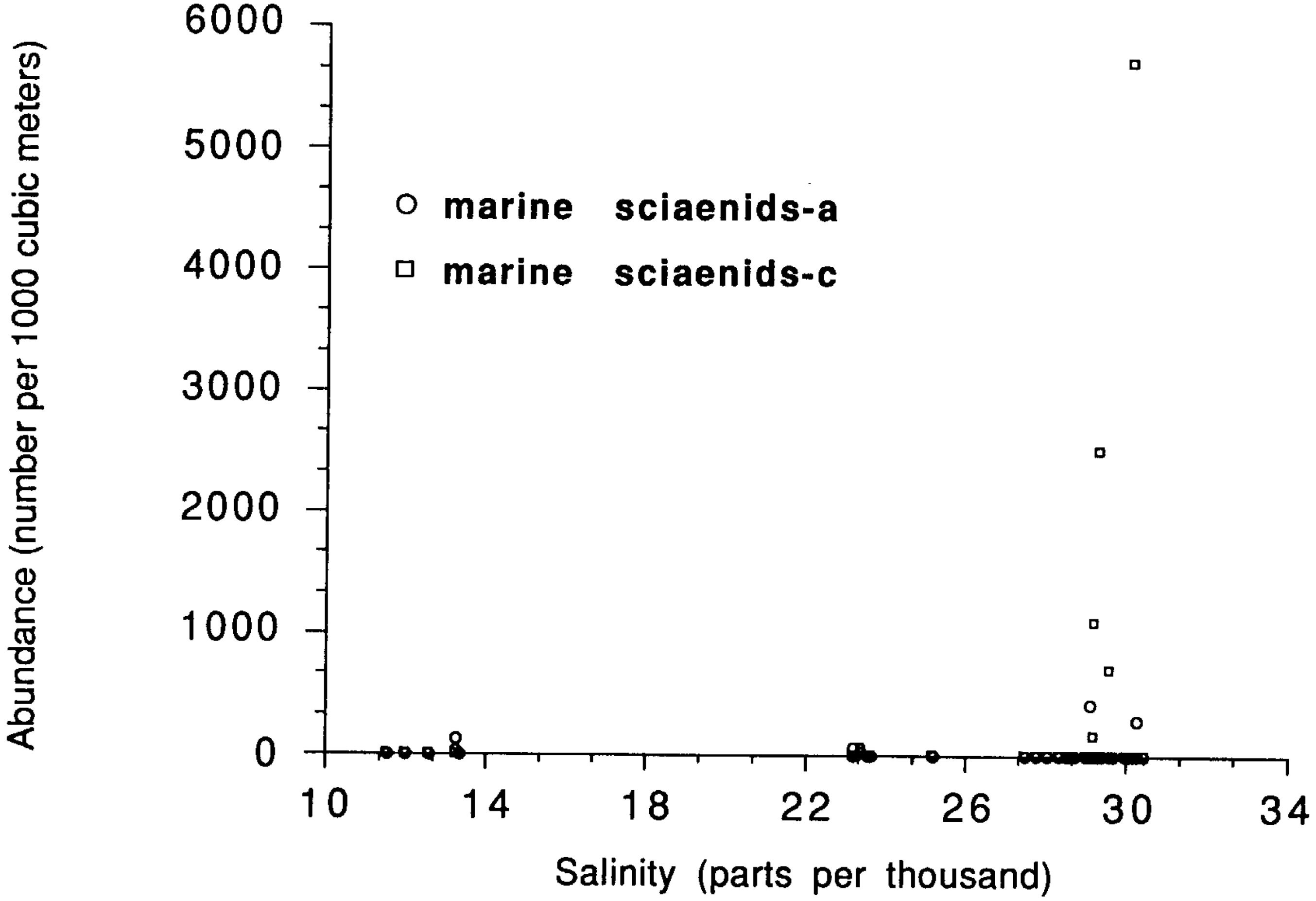
INTRACOASTAL WATERWAY

Salinity vs marine fish abundance



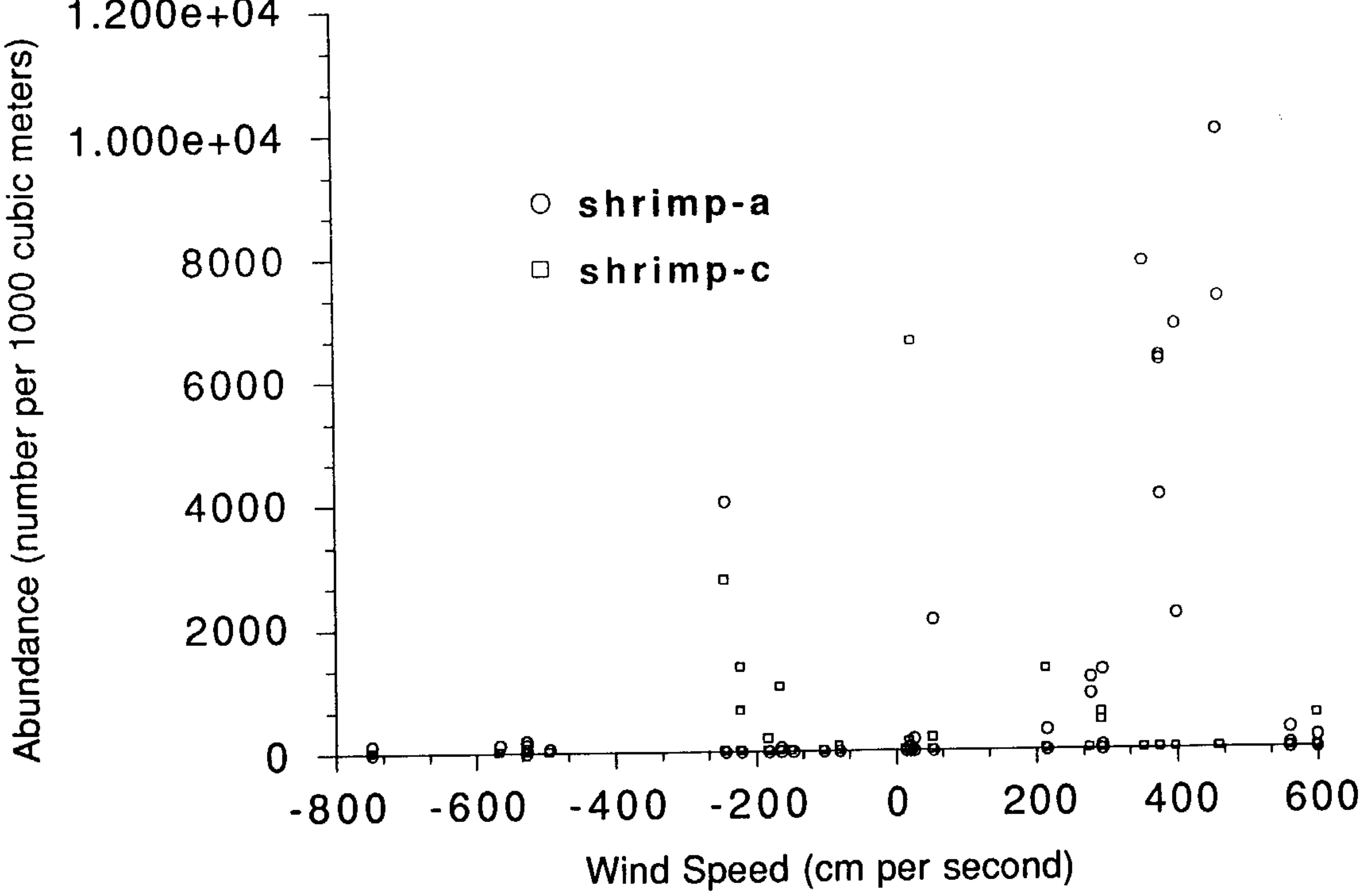
INTRACOASTAL WATERWAY

Salinity vs marine sciaenid abundance



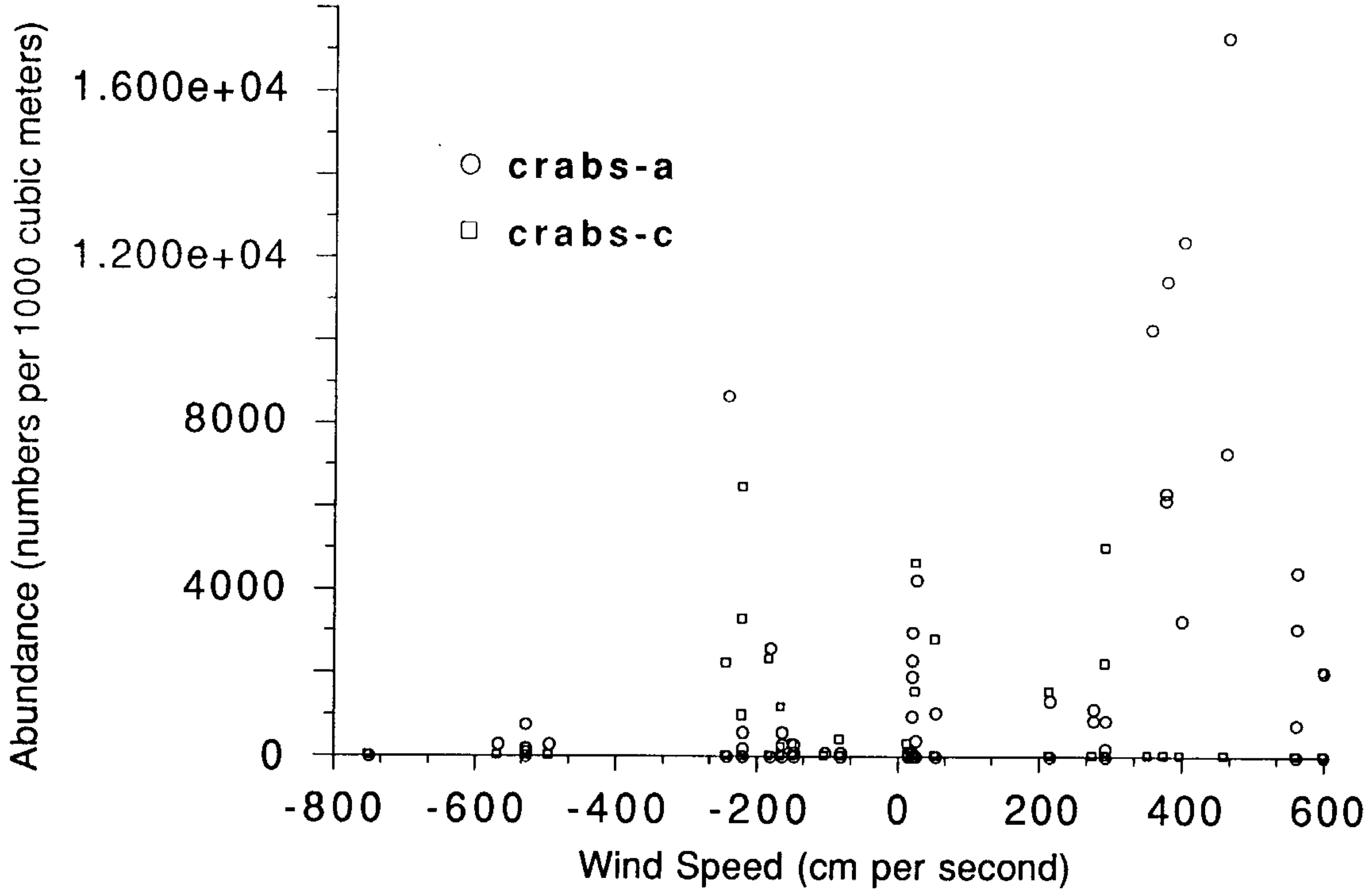
INTRACOASTAL WATERWAY

Wind speed vs shrimp abundance



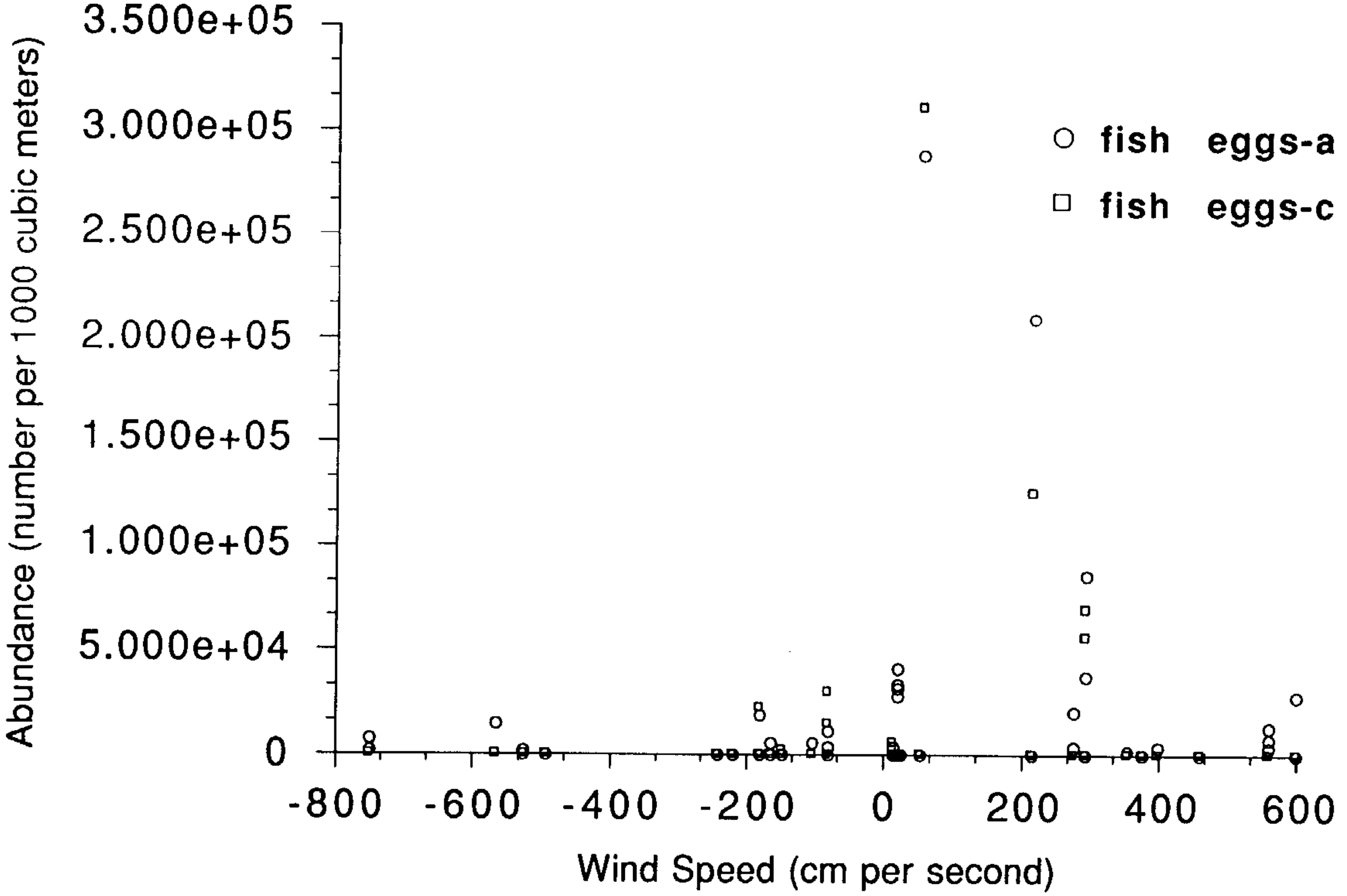
INTRACOASTAL WATERWAY

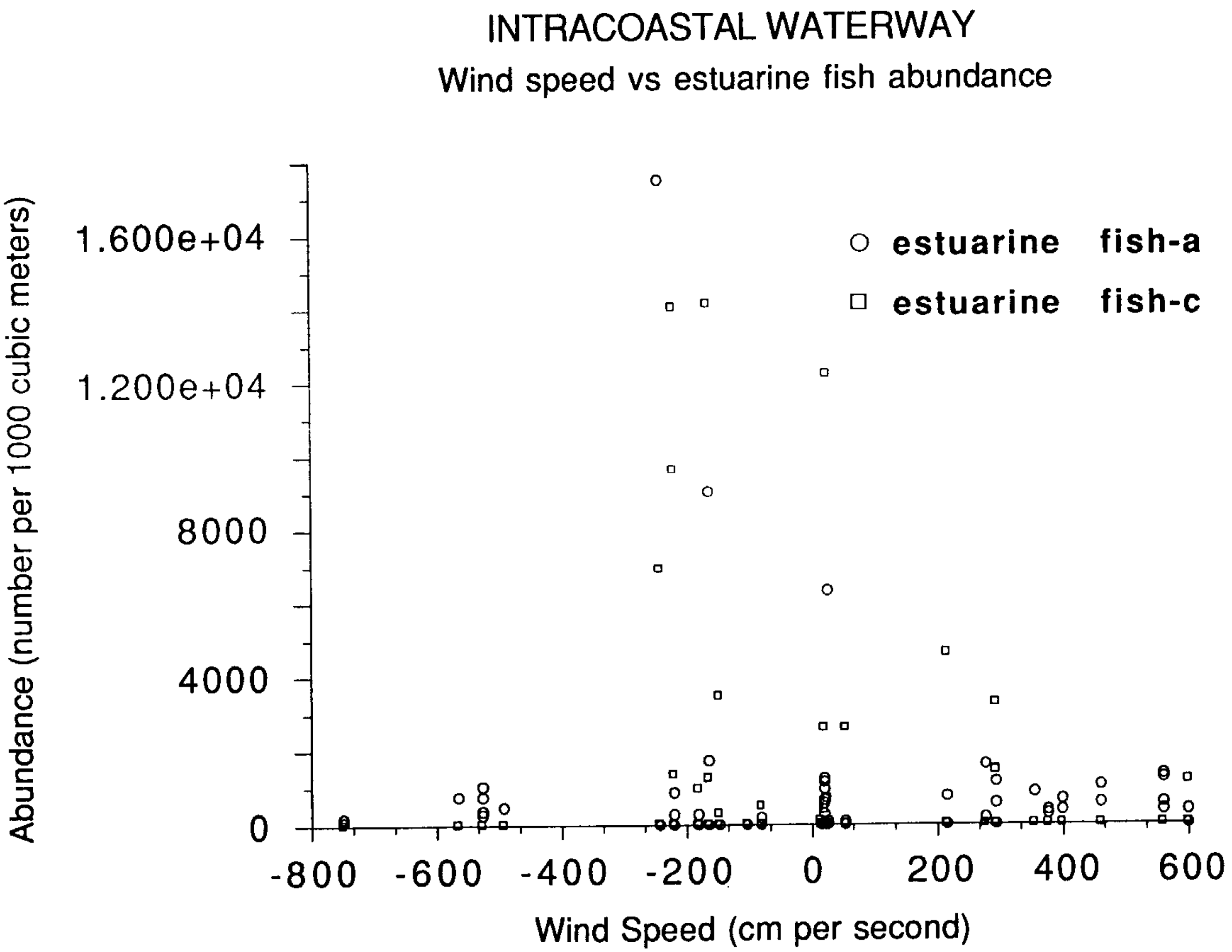
Wind speed vs crab abundance



INTRACOASTAL WATERWAY

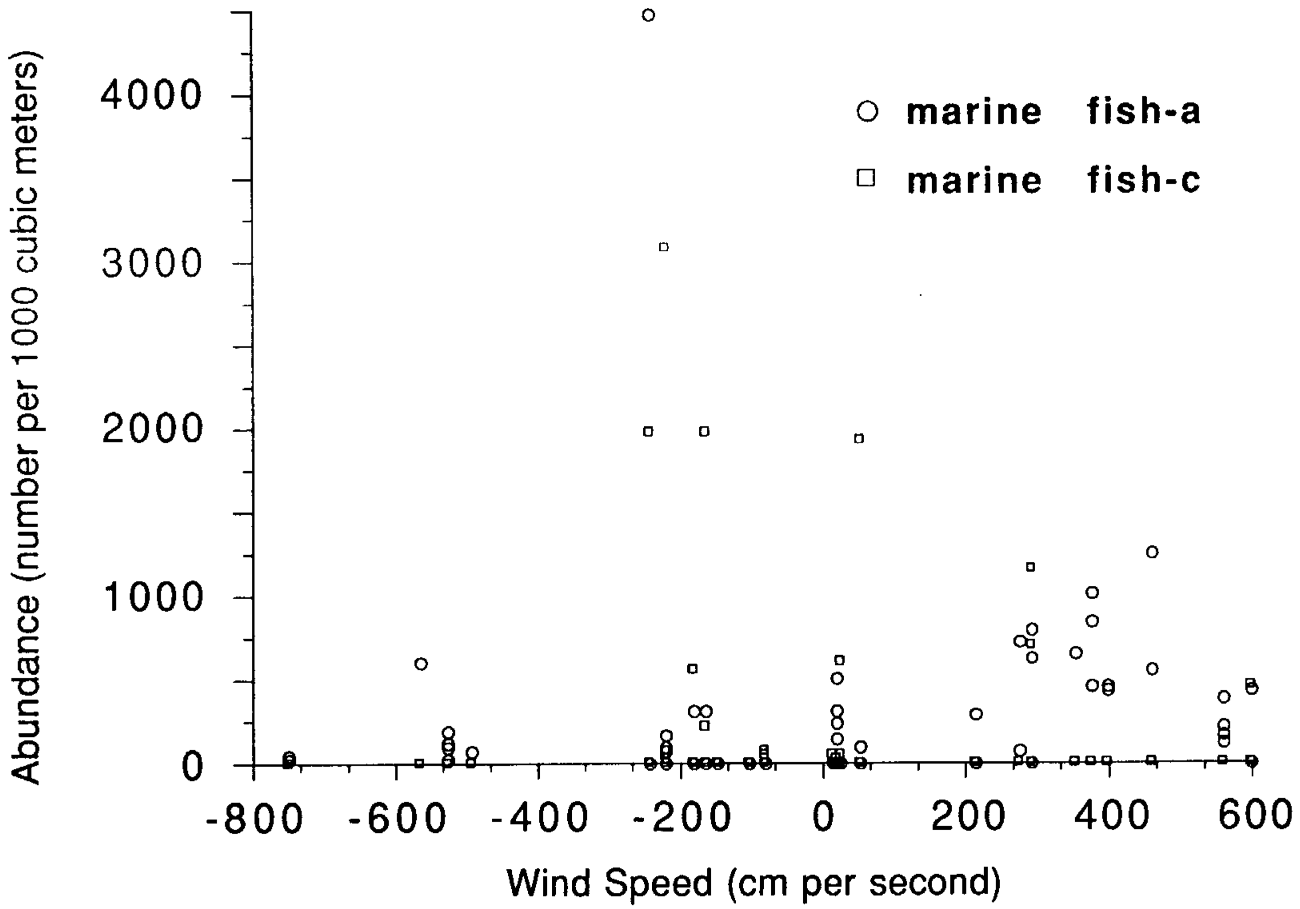
Wind speed vs fish egg abundance




INTRACOASTAL WATERWAY
Wind speed vs estuarine fish abundance
○ estuarine fish-a
□ estuarine fish-c
Abundance (number per 1000 cubic meters)
1.600e+04
1.200e+04
8000
4000
0
-800
-600
-400
-200
0
200
400
600
Wind Speed (cm per second)

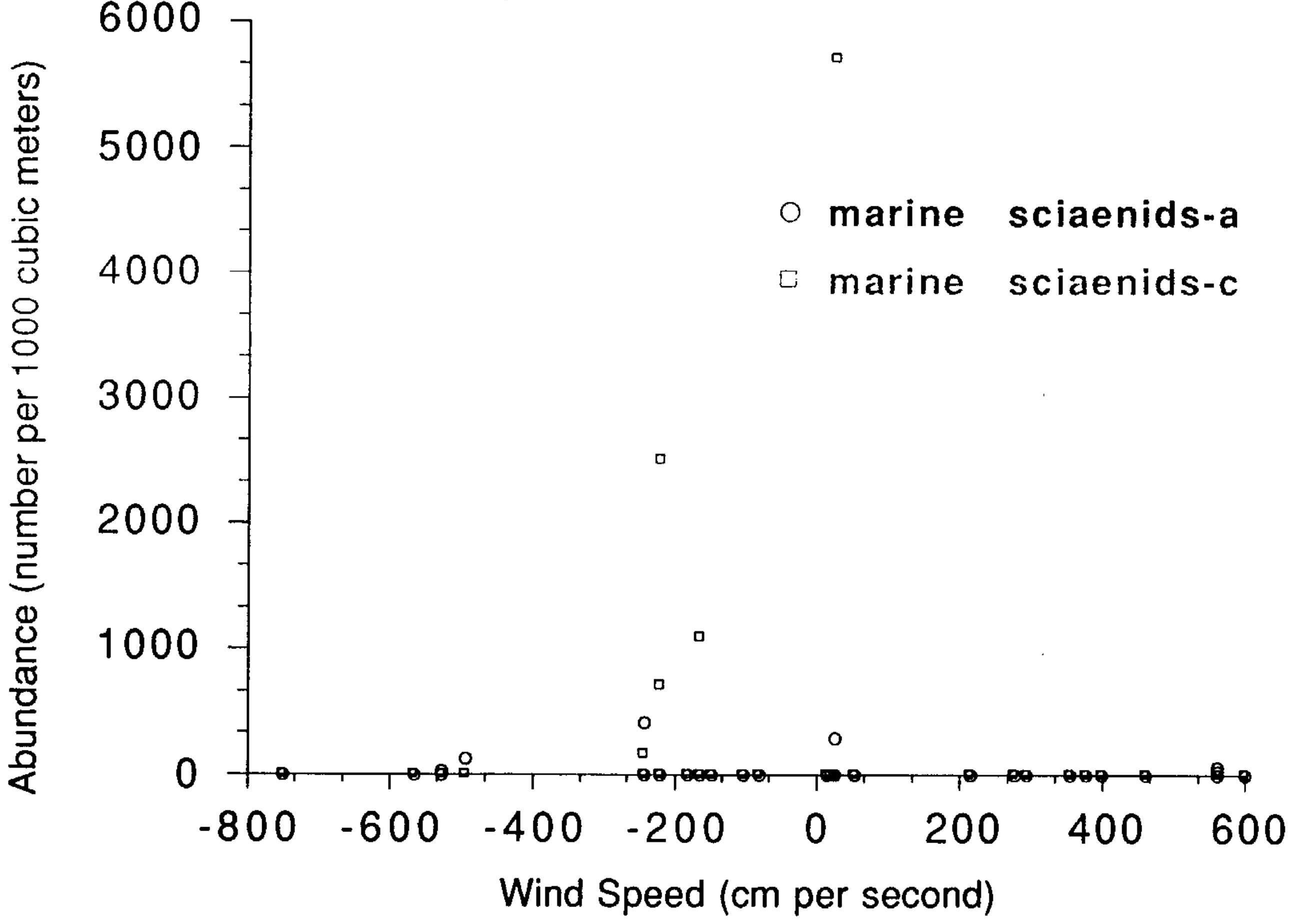
INTRACOASTAL WATERWAY

Wind speed vs marine fish abundance



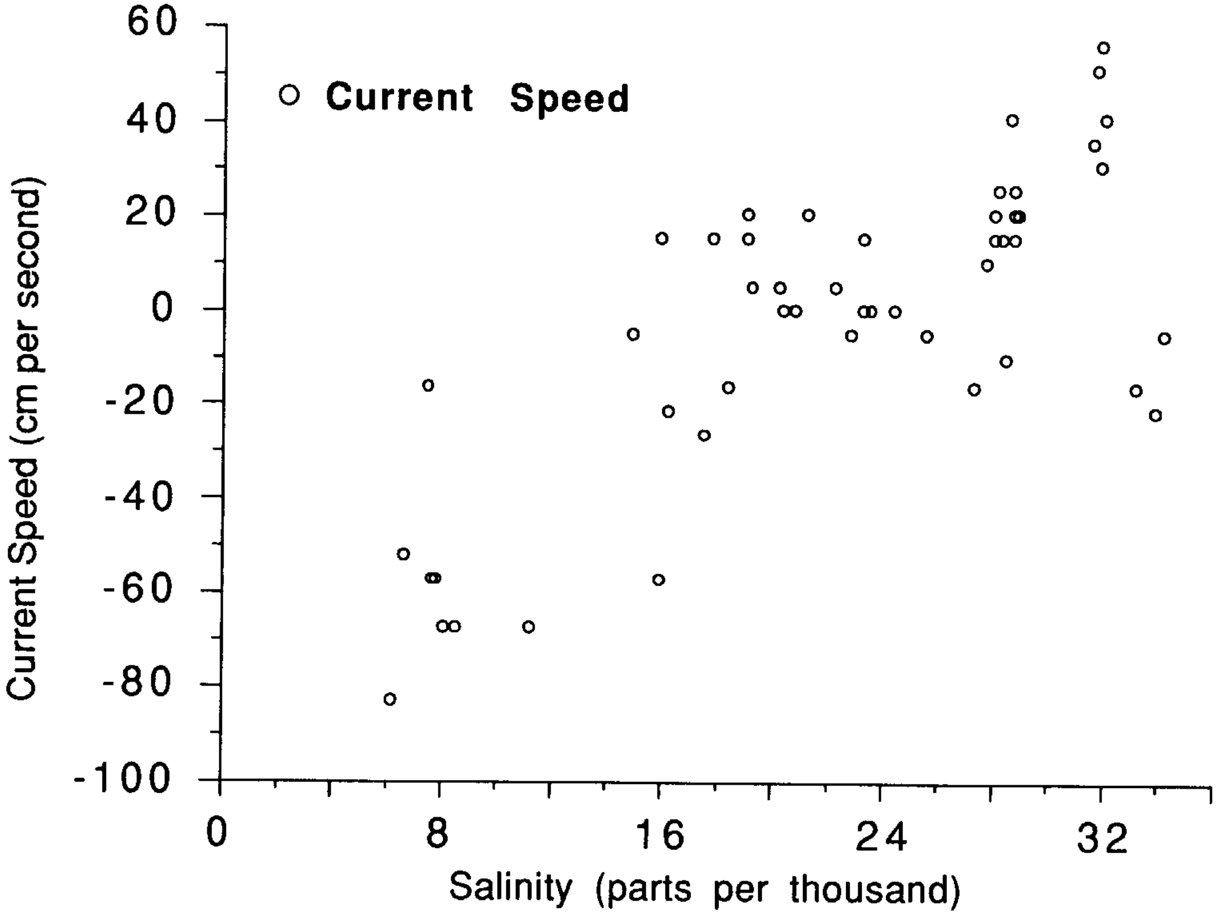
INTRACOASTAL WATERWAY

Wind speed vs marine sciaenid abundance



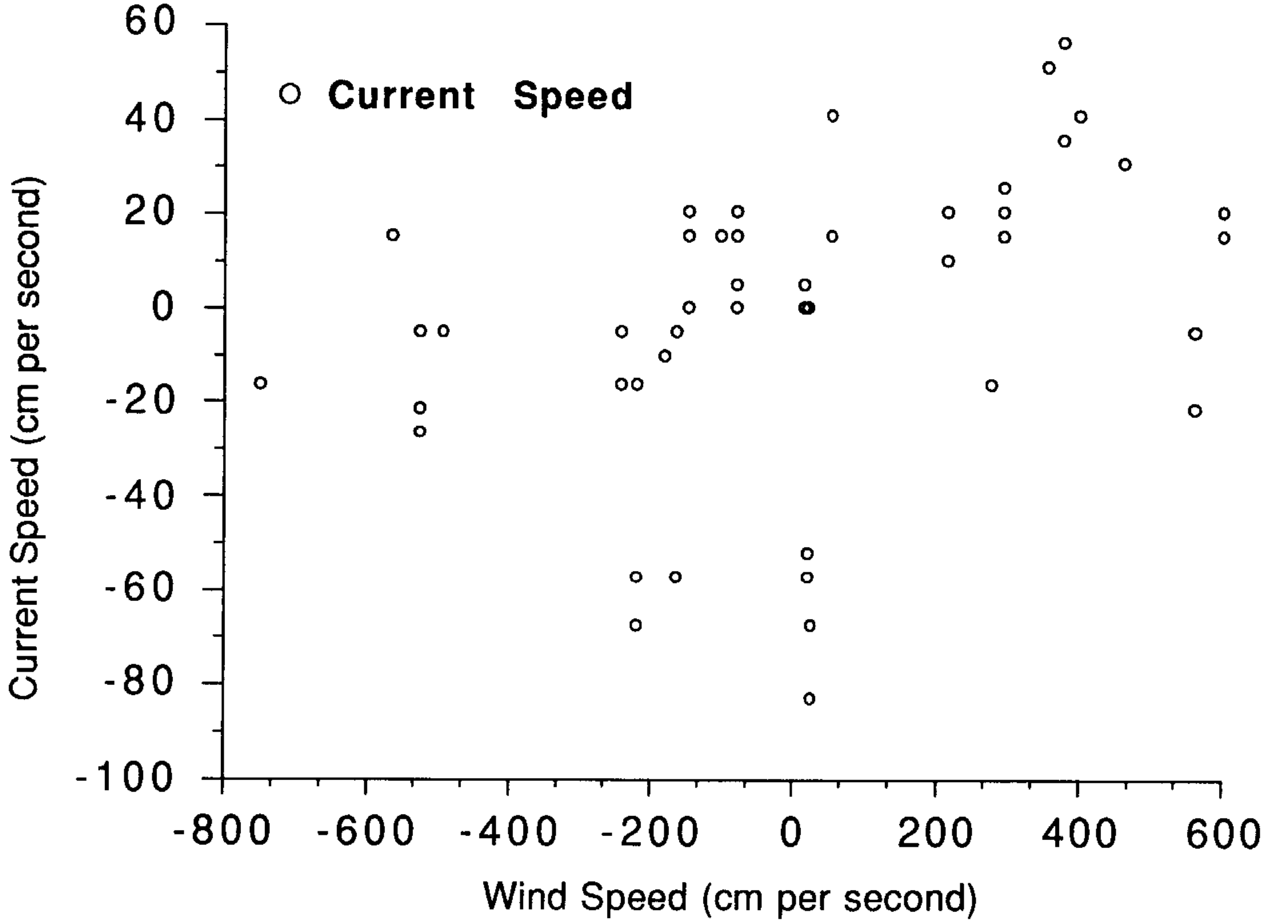
INTRACOASTAL WATERWAY

Current speed vs salinity



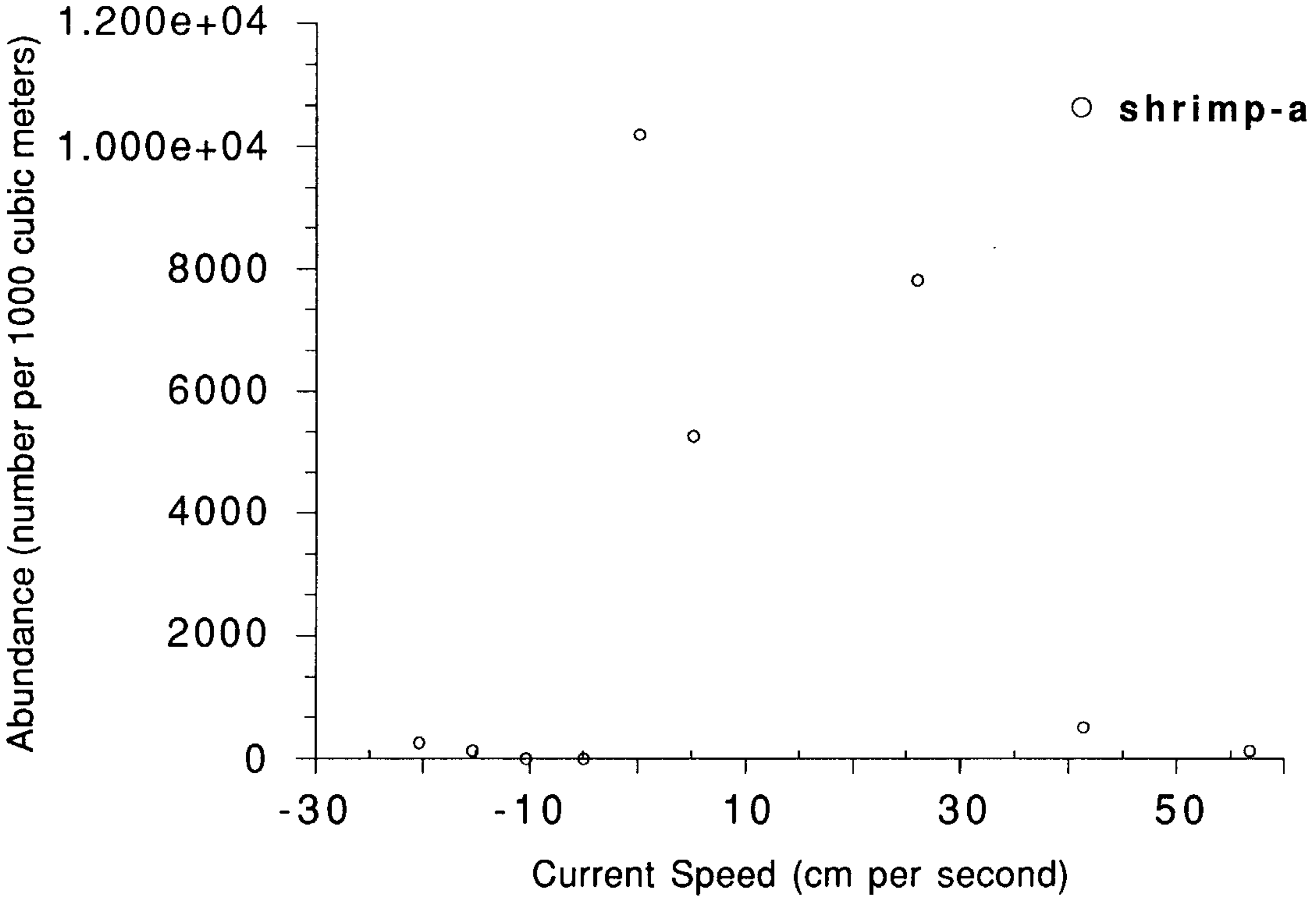
INTRACOASTAL WATERWAY

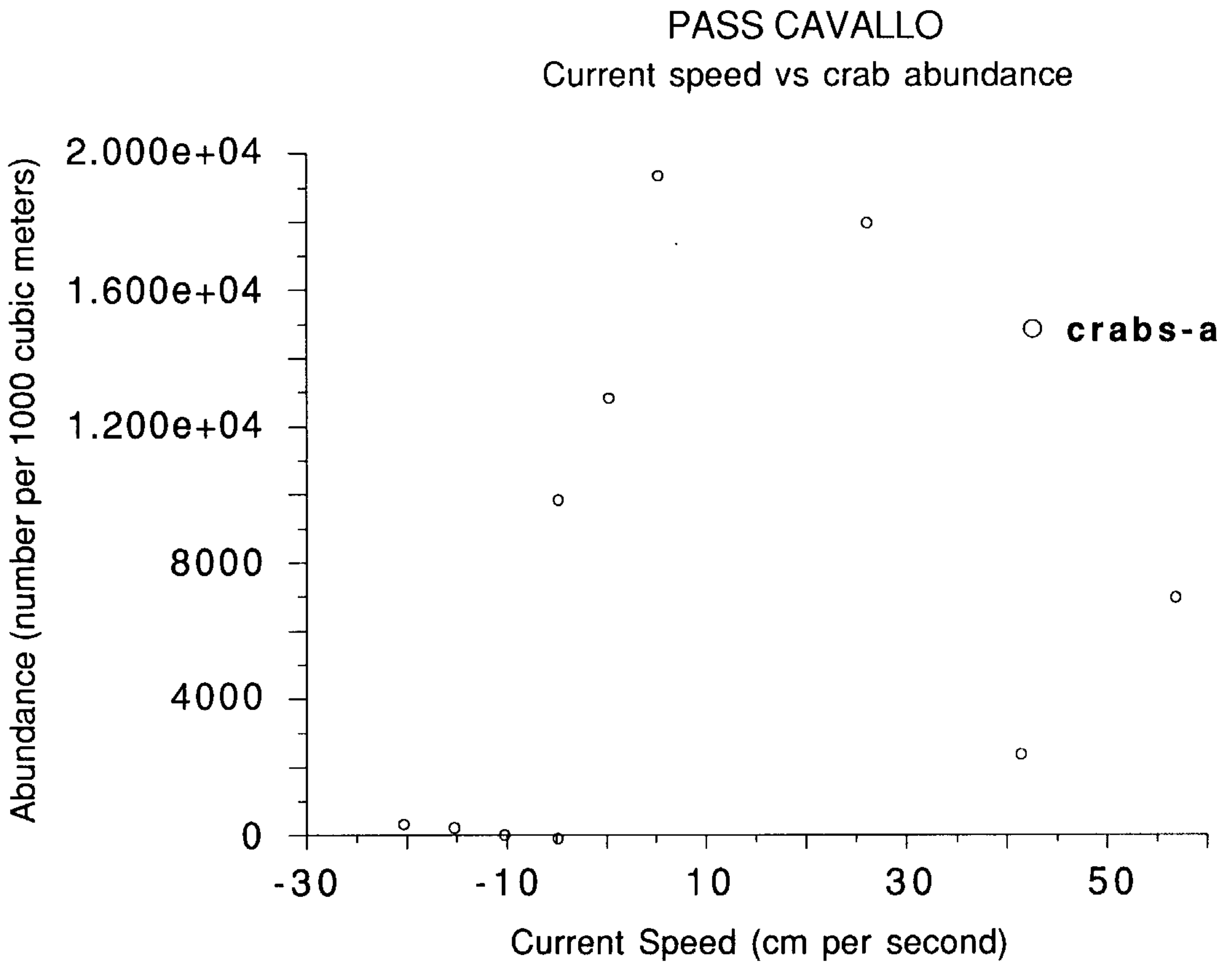
Current speed vs wind speed



PASS CAVALLO

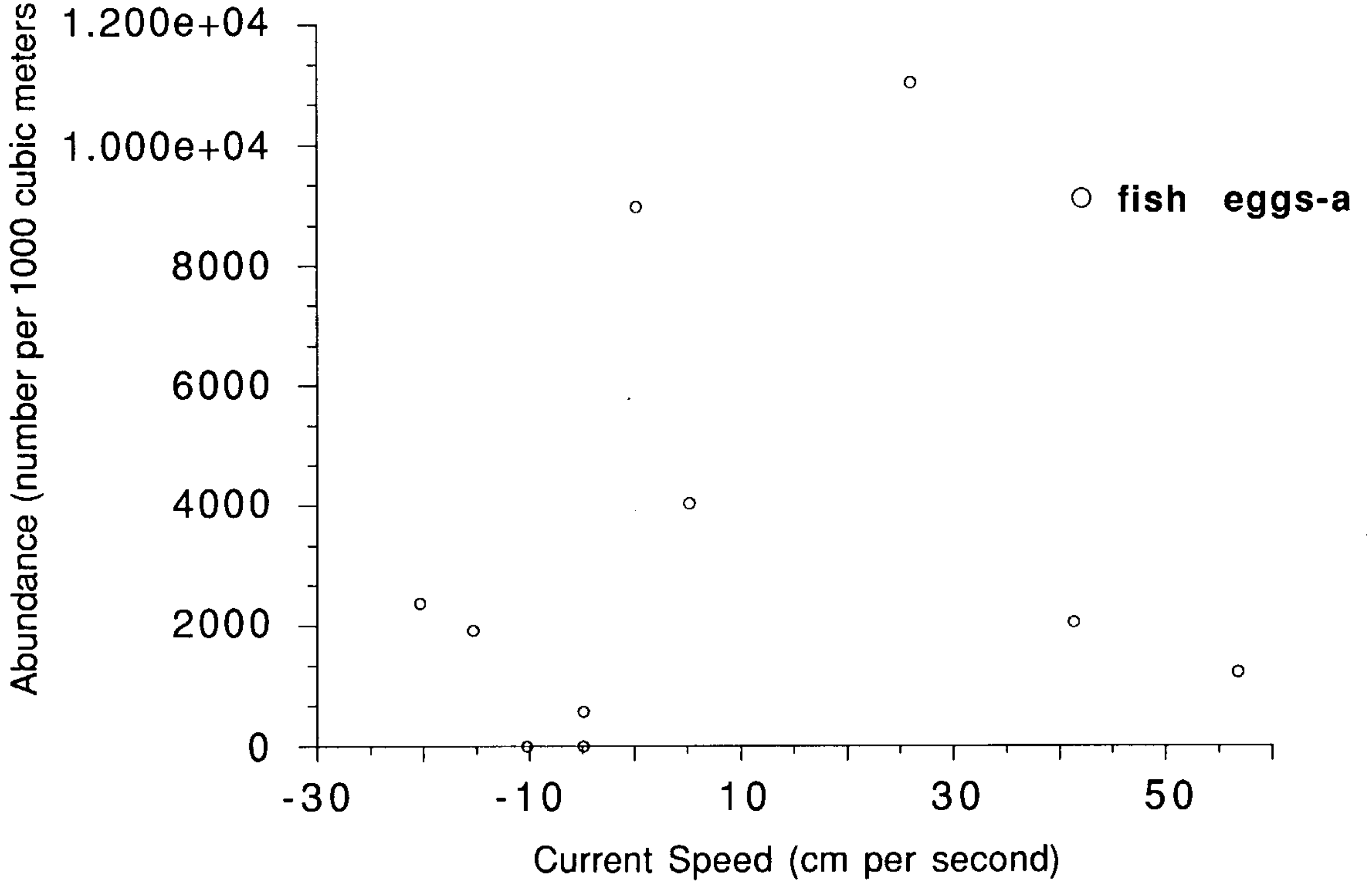
Current speed vs shrimp abundance




PASS CAVALLO
Current speed vs crab abundance
Abundance (number per 1000 cubic meters)
2.000e+04
1.600e+04
1.200e+04
8000
4000
0
-30
-10
10
30
50
Current Speed (cm per second)
○ crabs-a

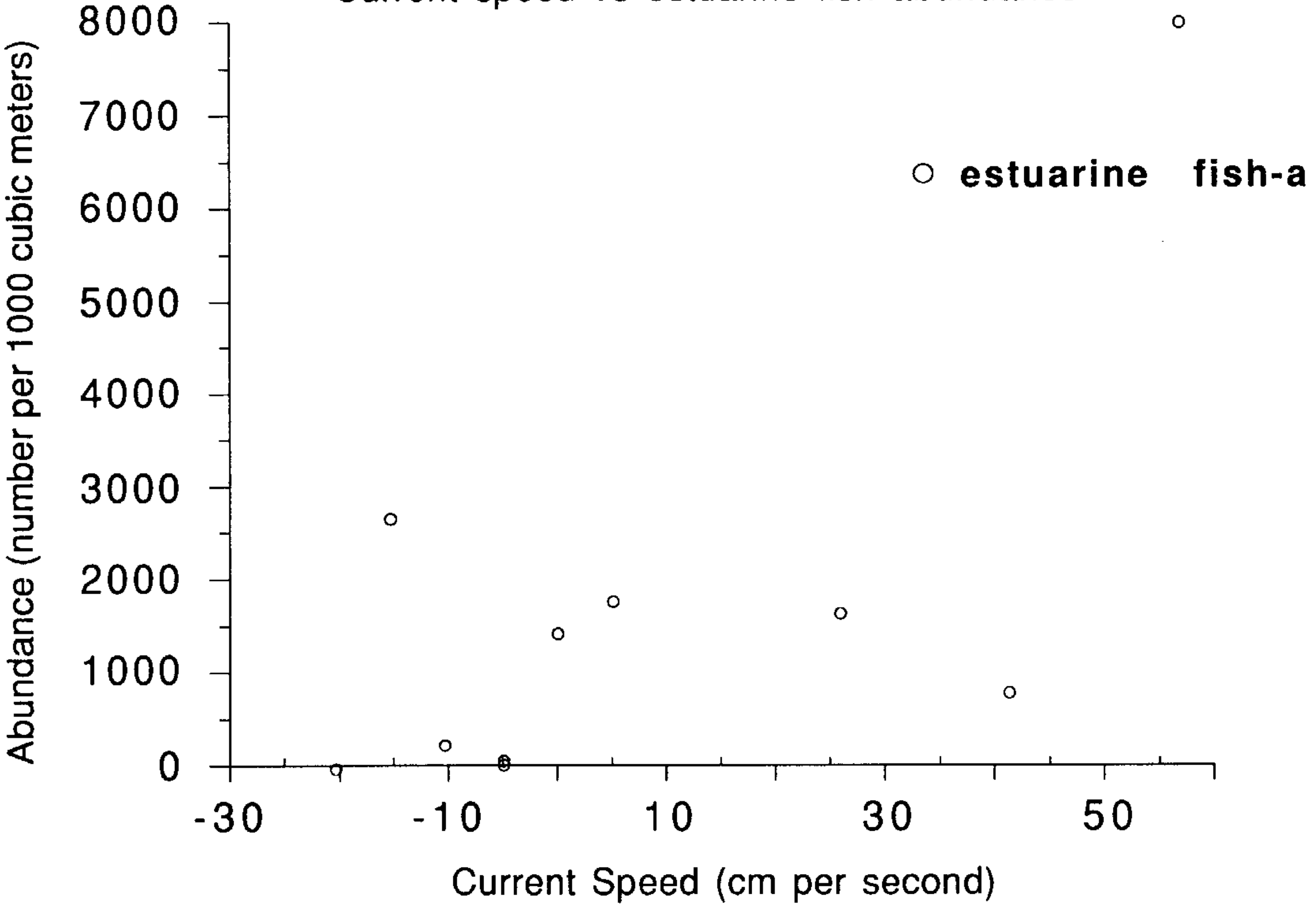
PASS CAVALLO

Current speed vs fish egg abundance



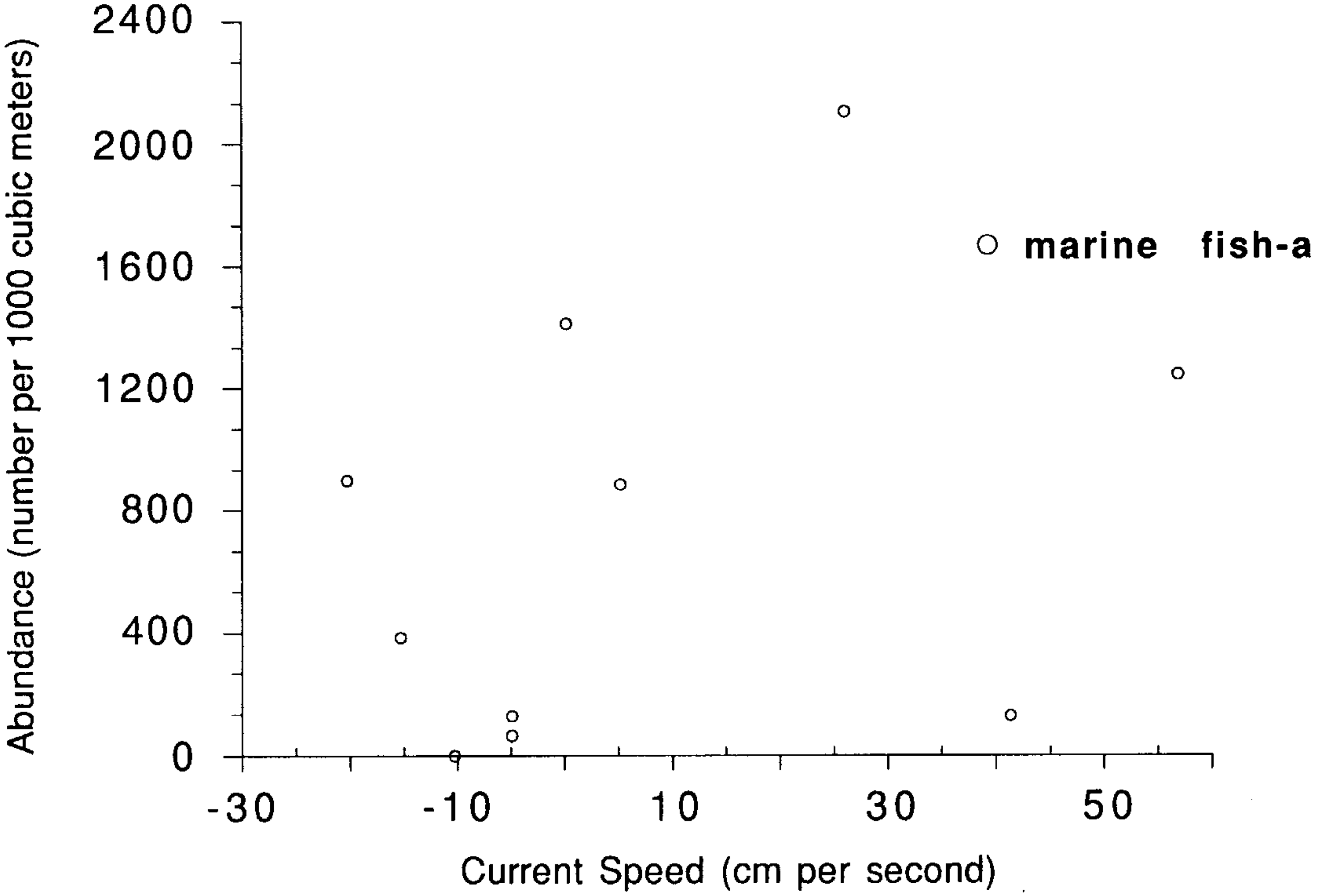
PASS CAVALLO

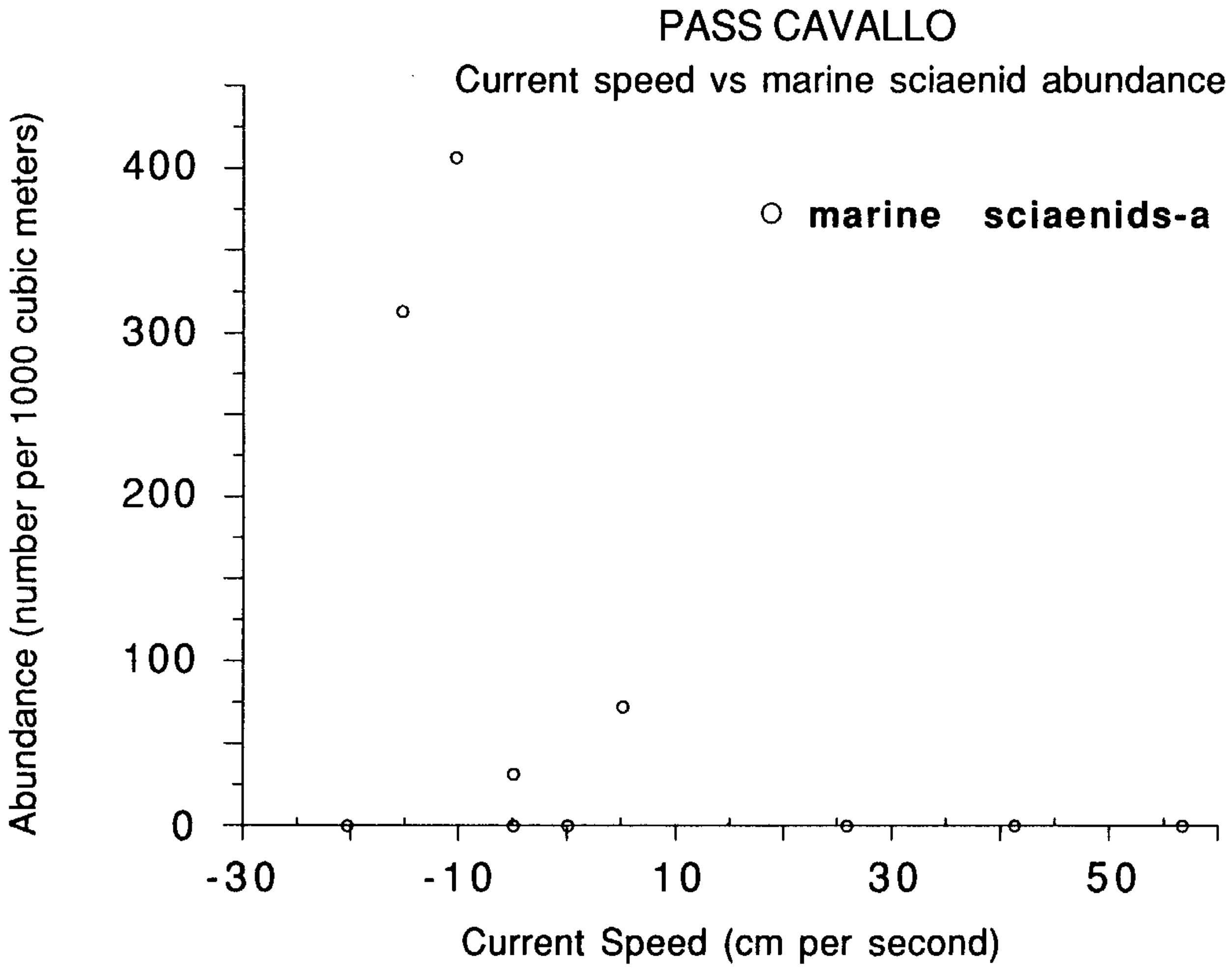
Current speed vs estuarine fish abundance



PASS CAVALLO

Current speed vs marine fish abundance



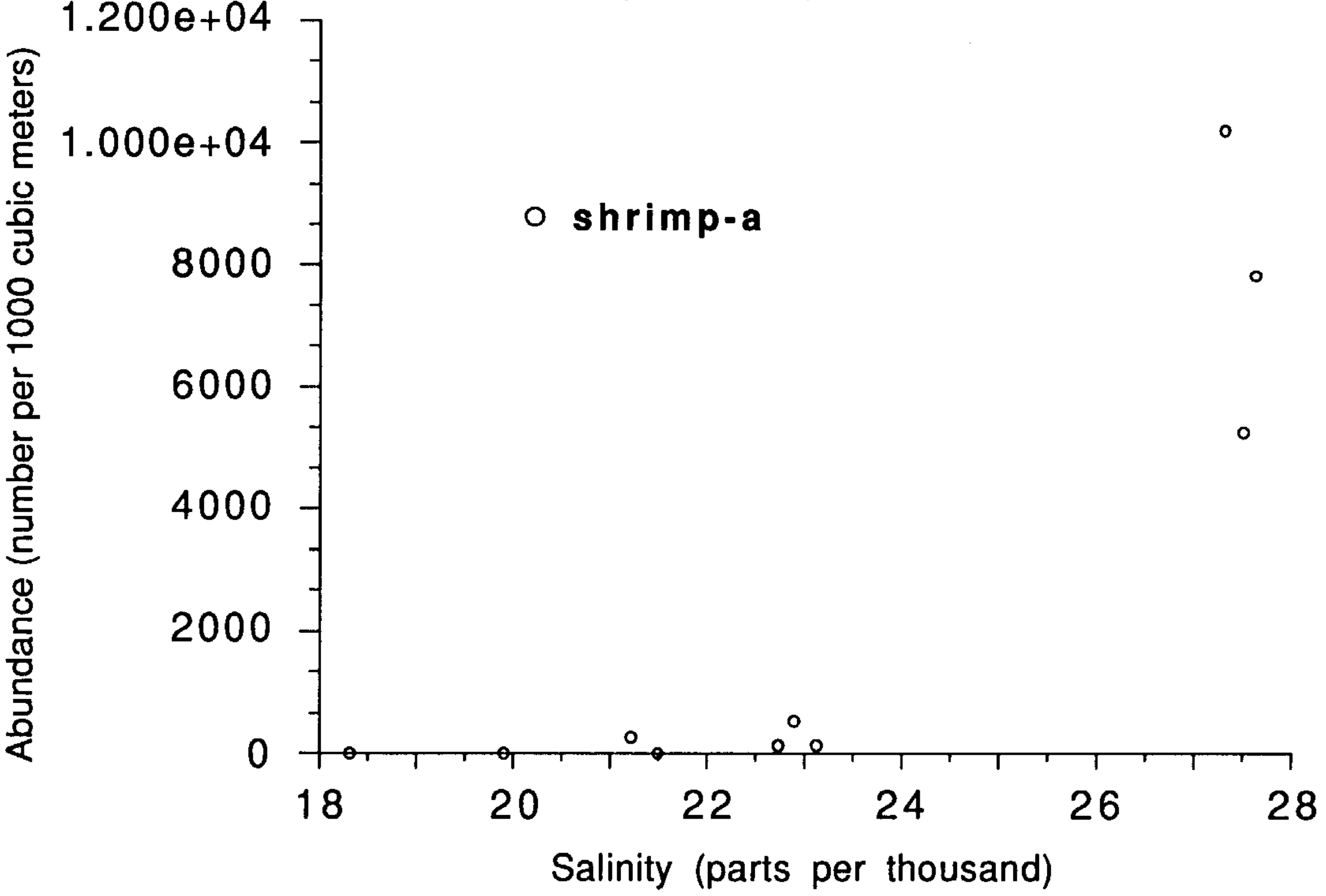


PASS CAVALLO

Current speed vs marine sciaenid abundance

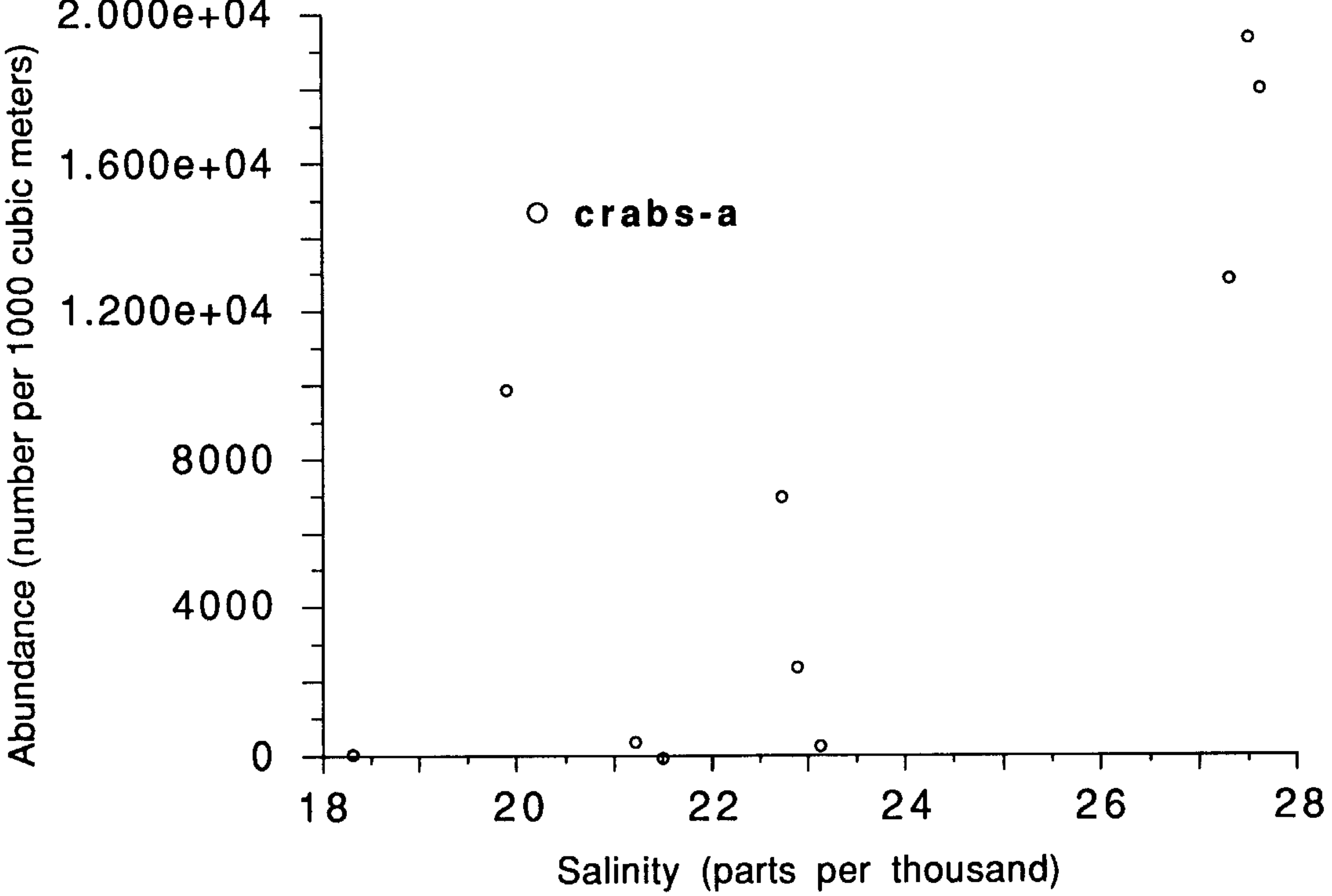
PASS CAVALLO

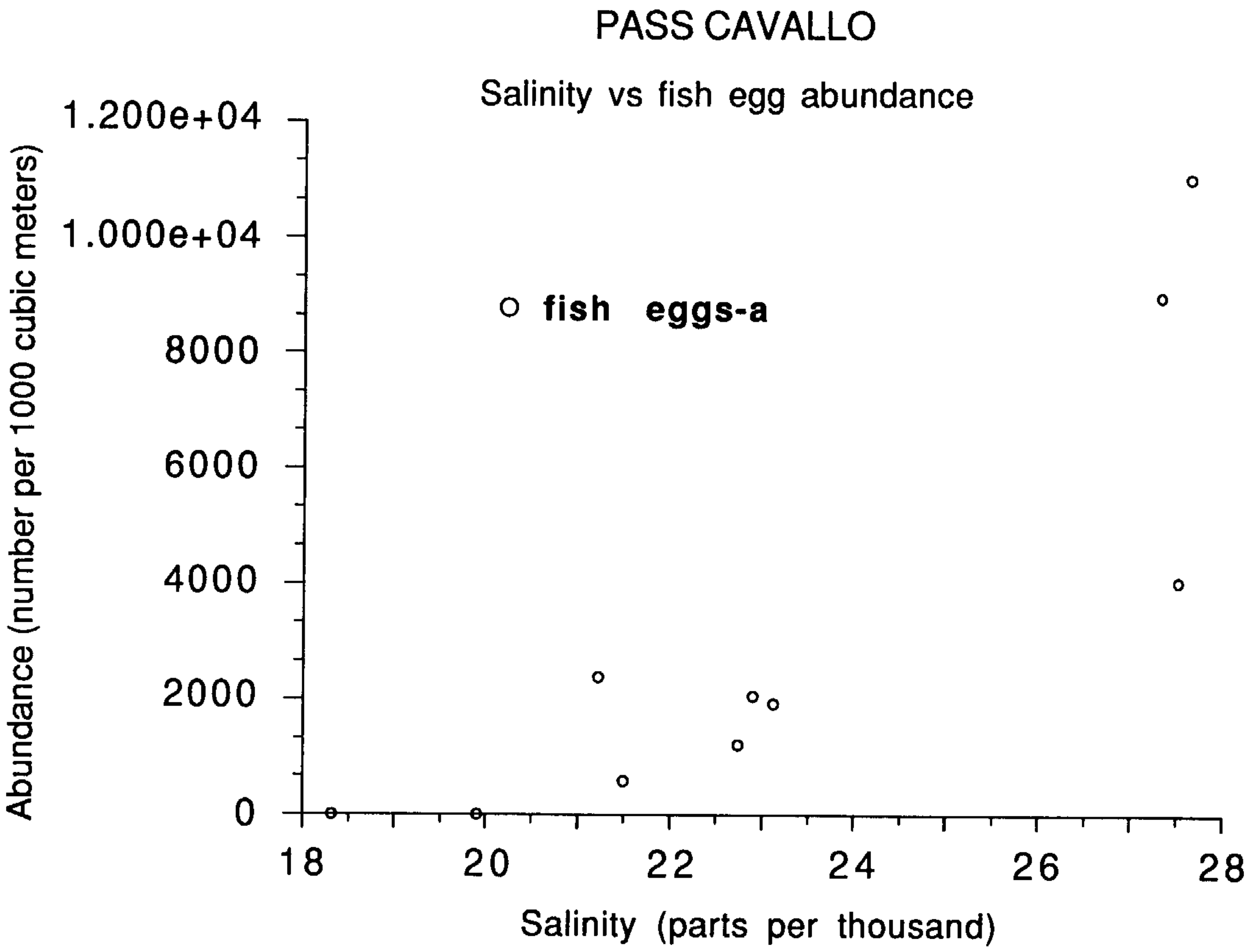
Salinity vs shrimp abundance



PASS CAVALLO

Salinity vs crab abundance



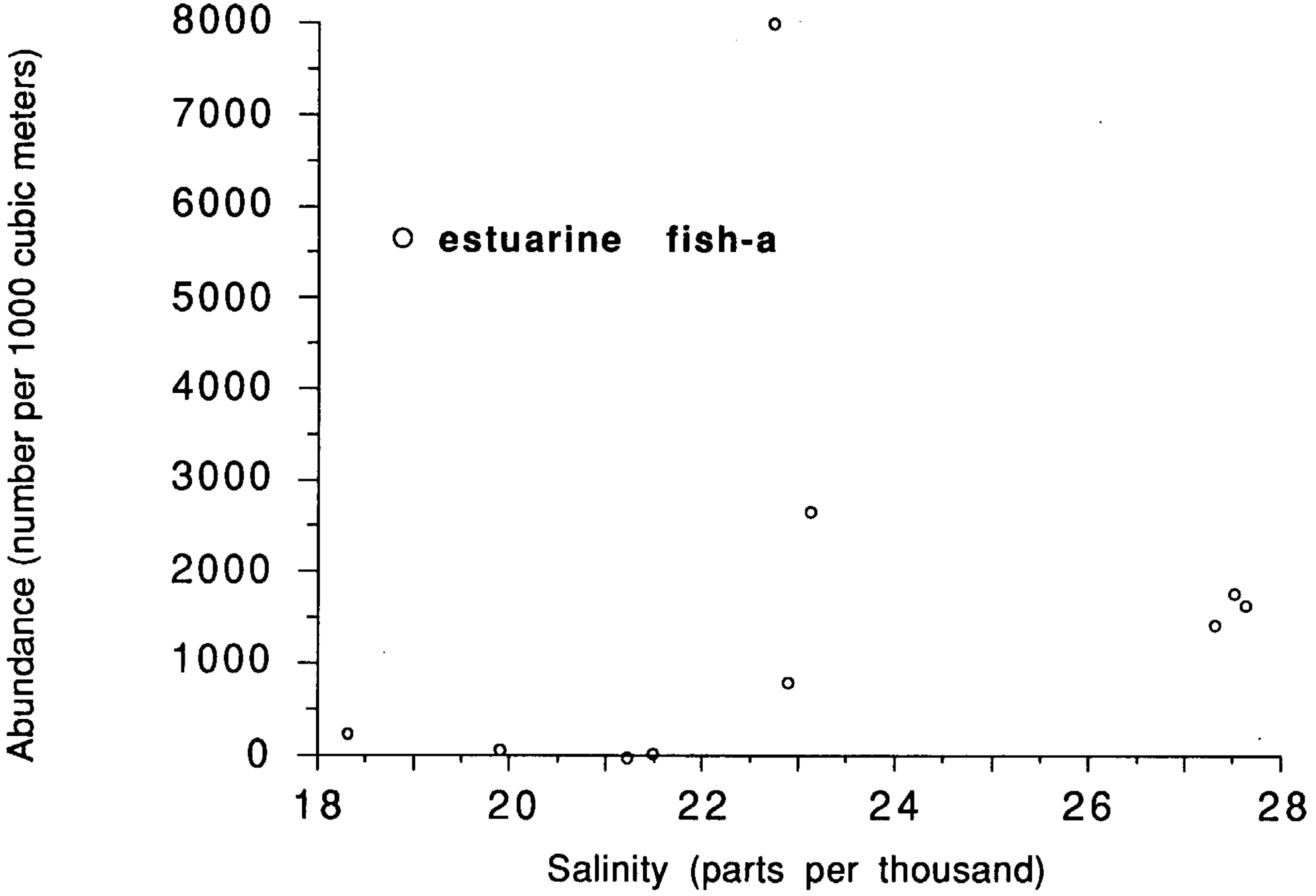


PASS CAVALLO

Salinity vs fish egg abundance

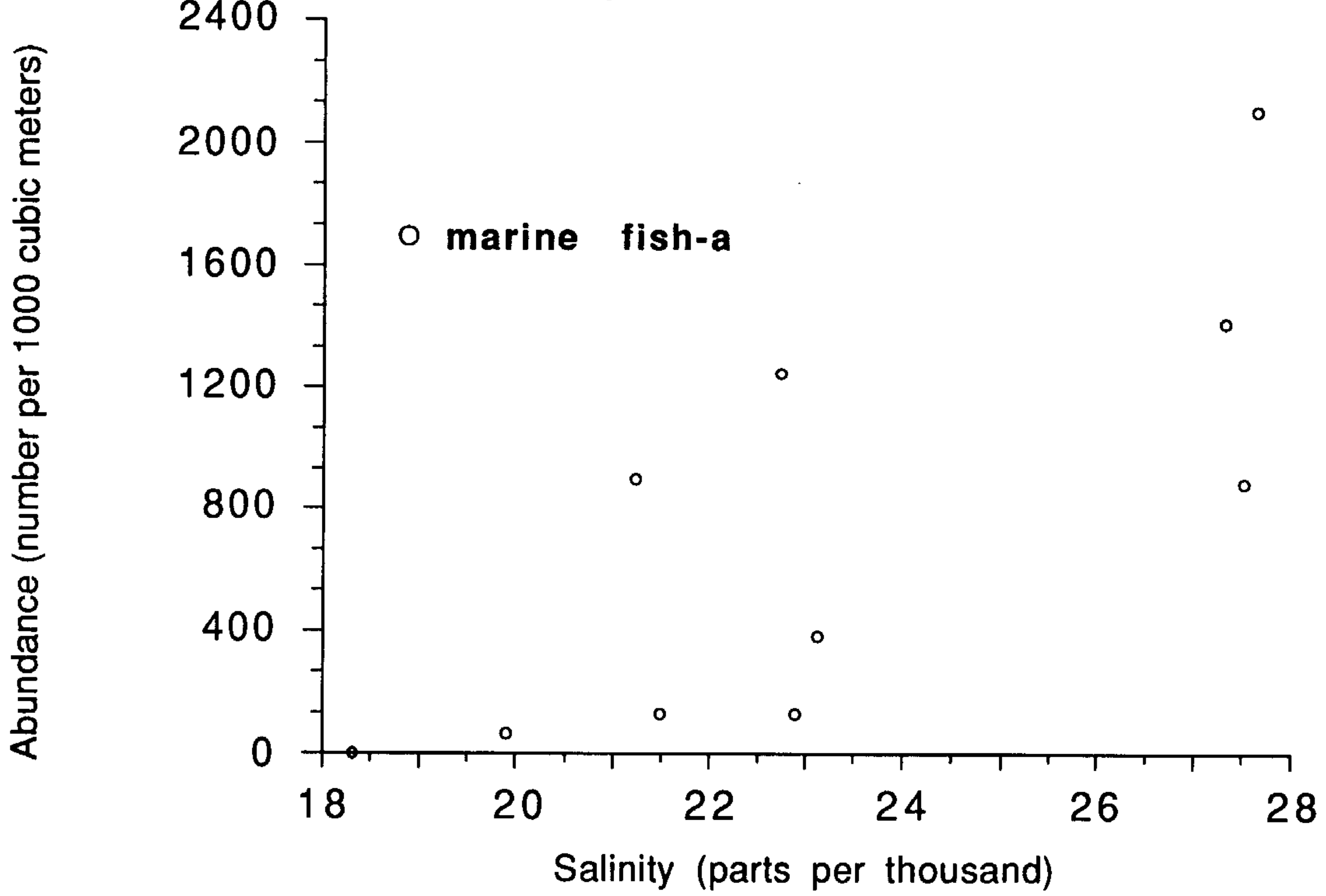
PASS CAVALLO

Salinity vs estuarine fish abundance



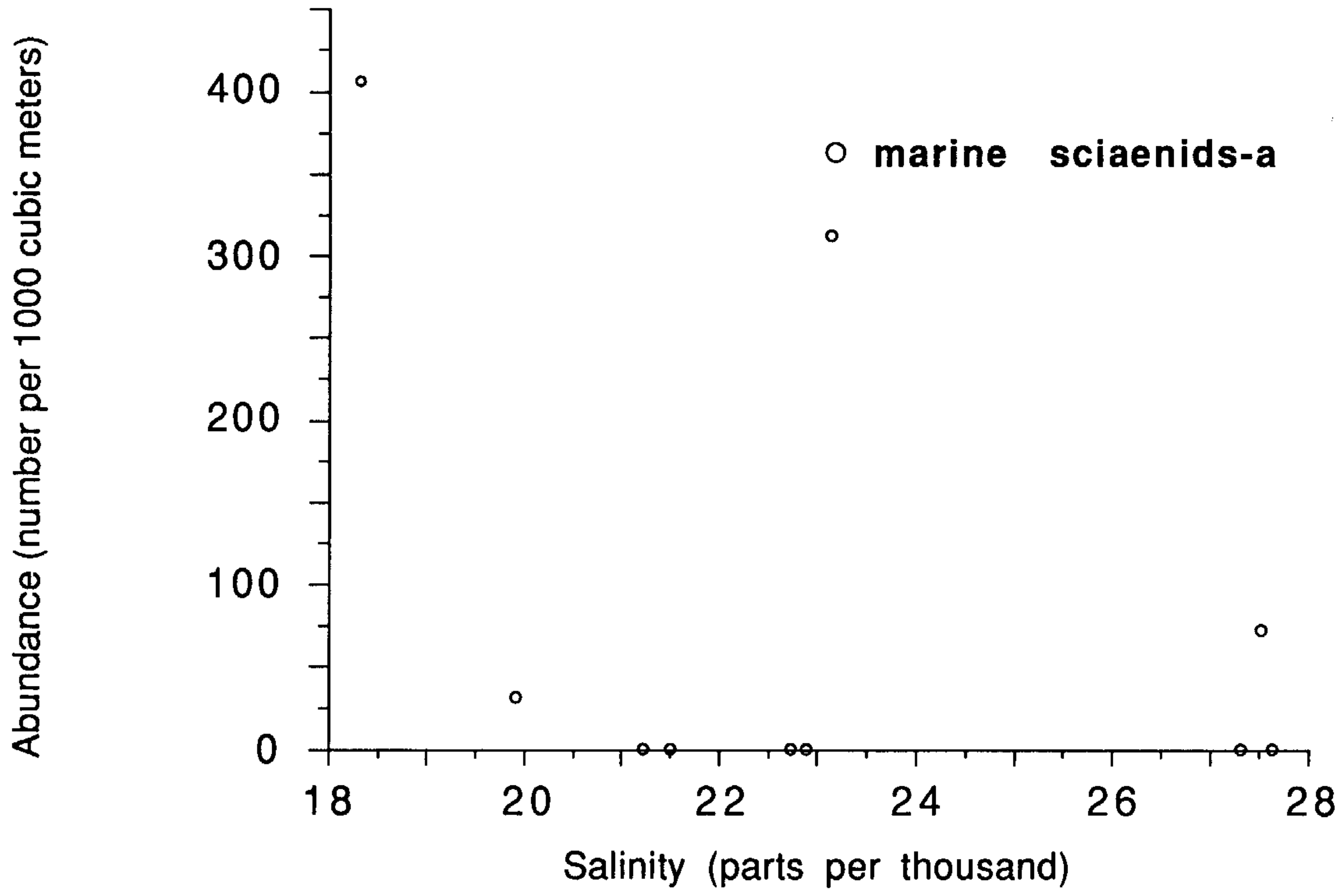
PASS CAVALLO

Salinity vs marine fish abundance



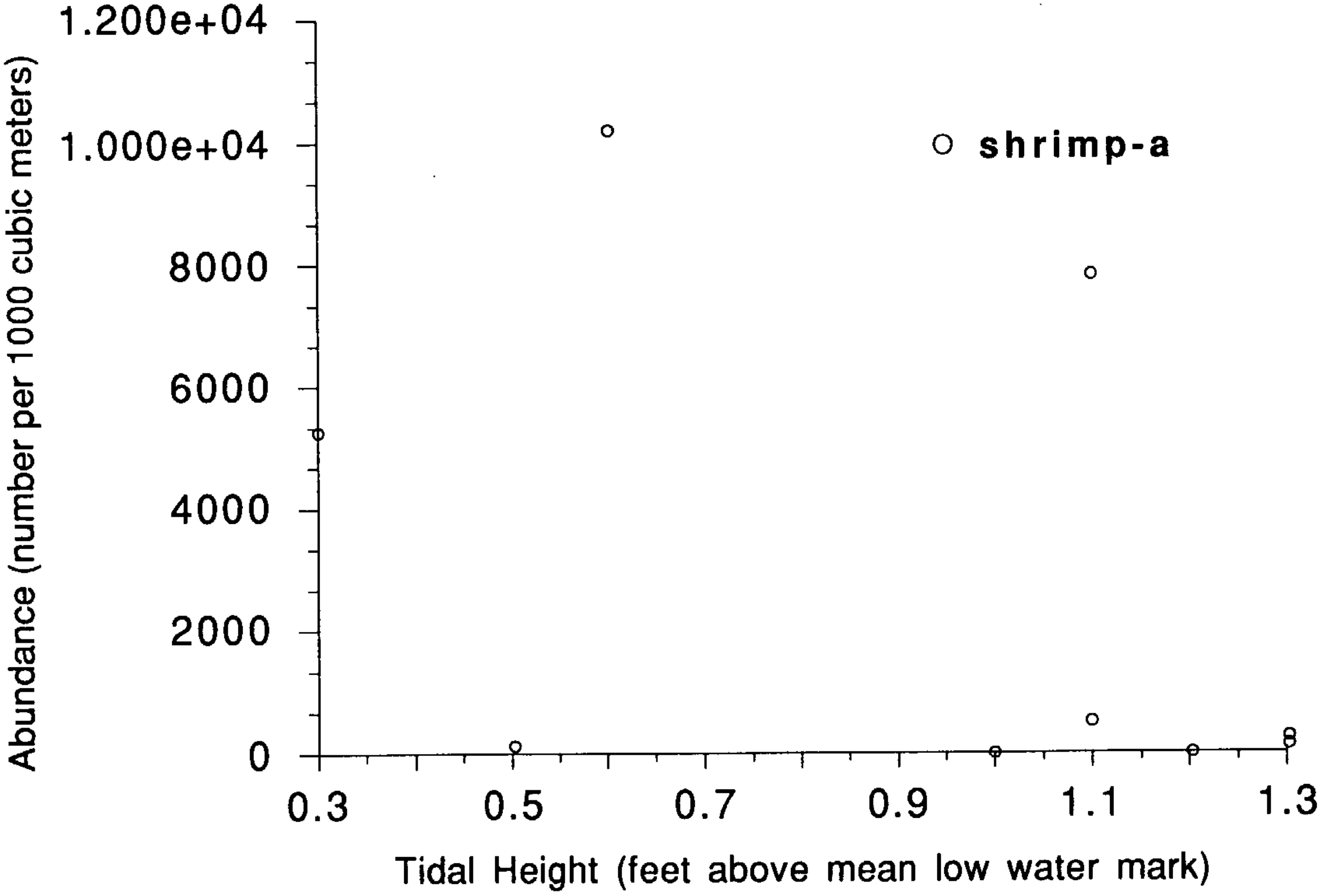
PASS CAVALLO

Salinity vs marine sciaenid abundance



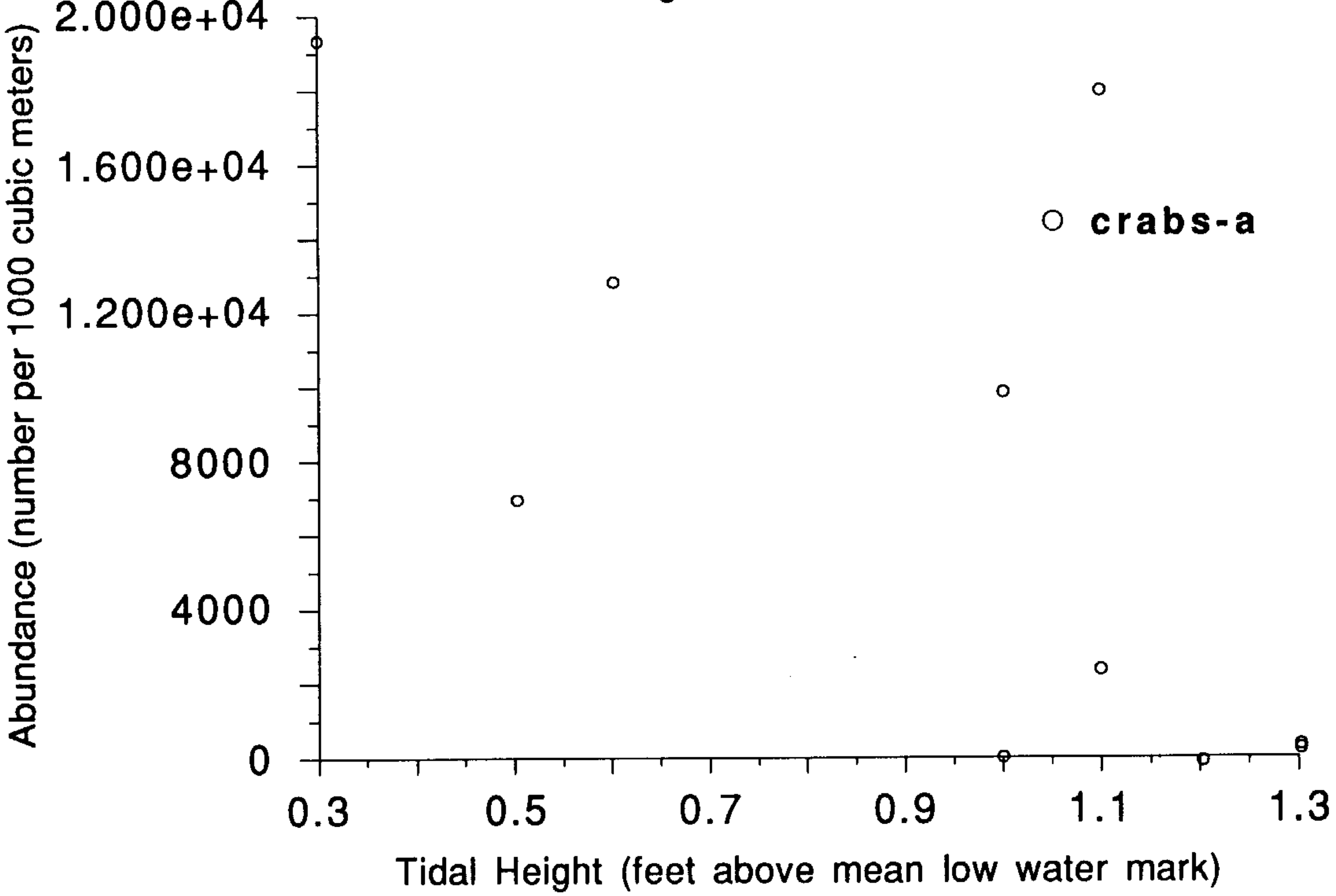
PASS CAVALLO

Tidal height vs shrimp abundance



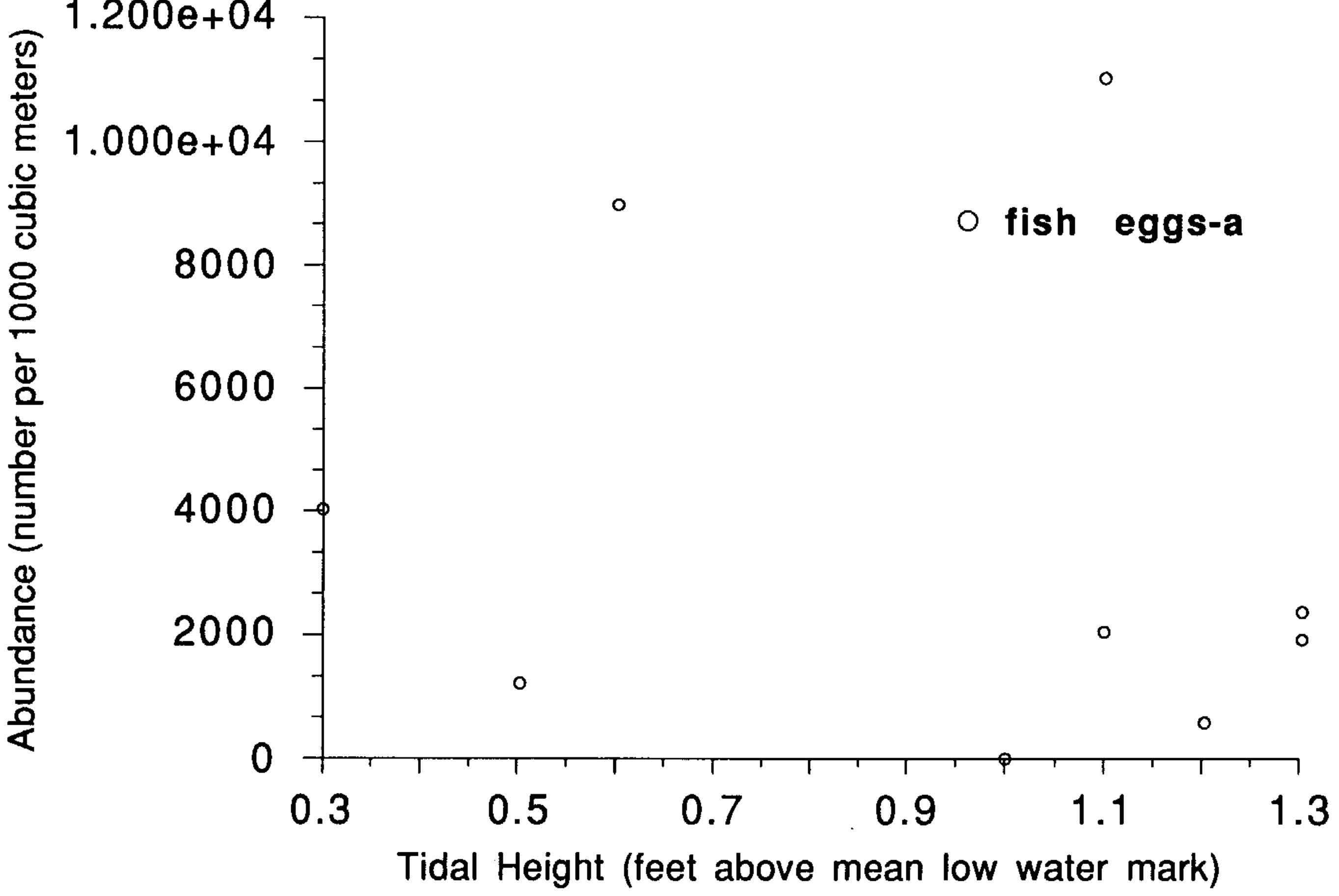
PASS CAVALLO

Tidal height vs crab abundance



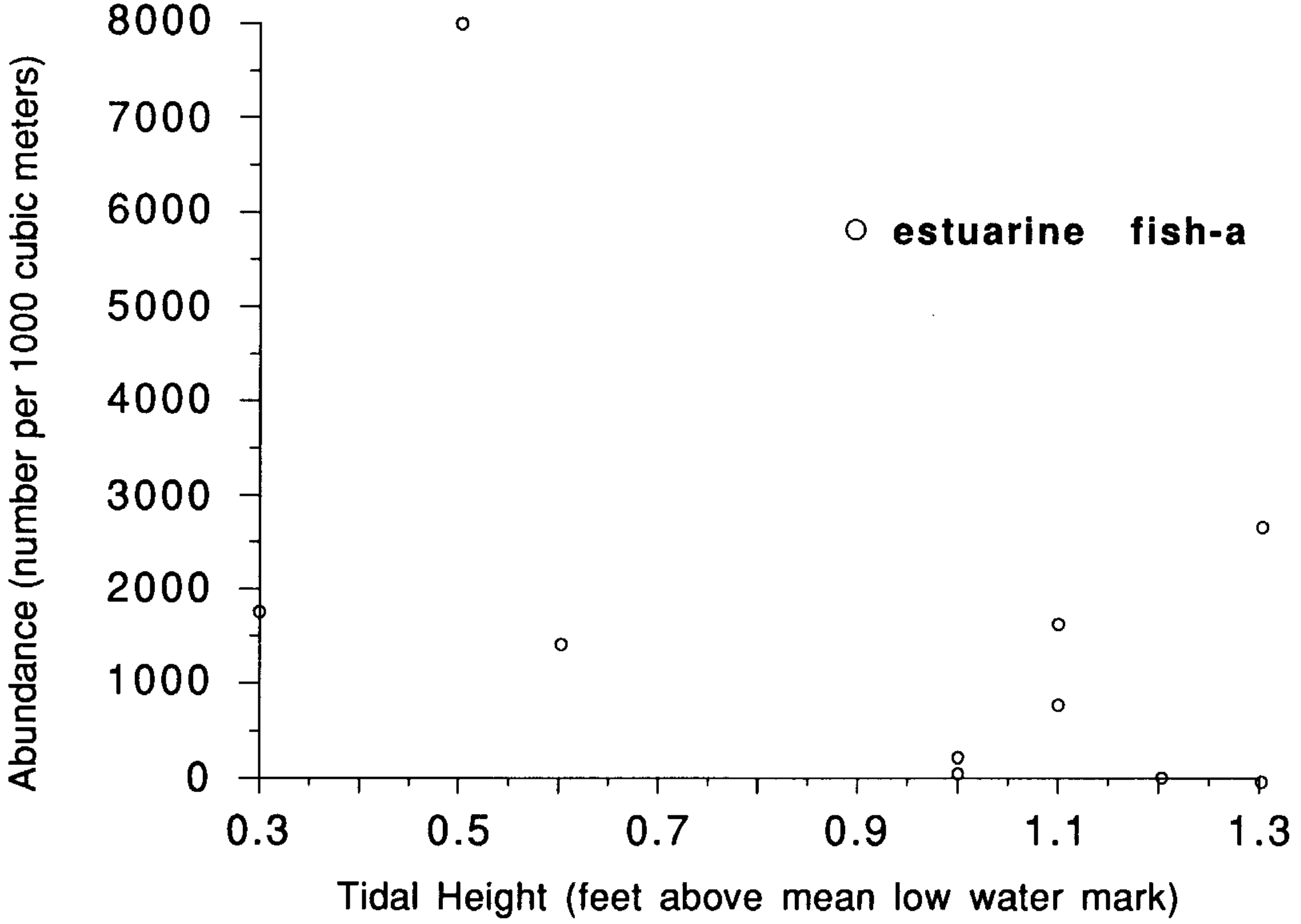
PASS CAVALLO

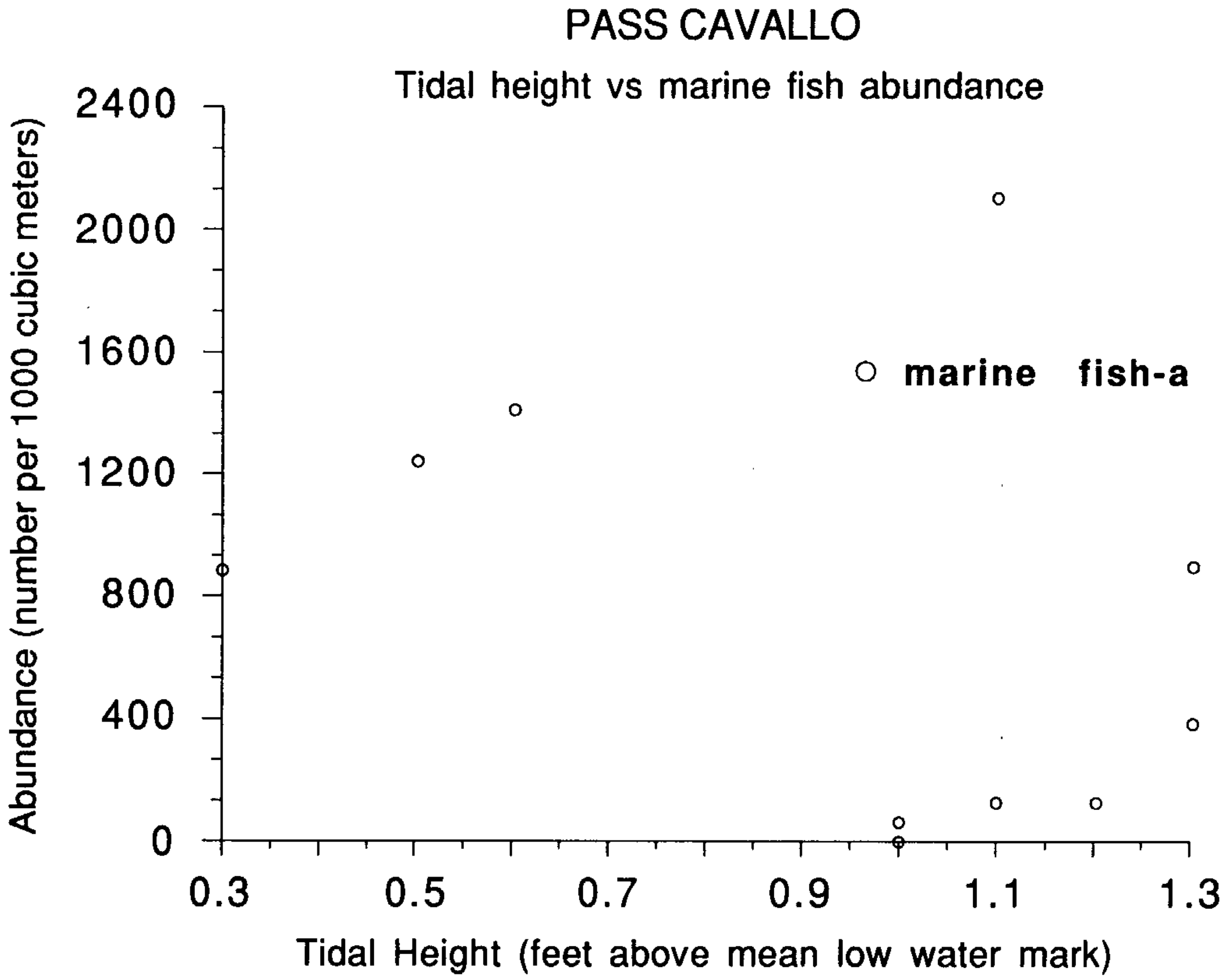
Tidal height vs fish egg abundance



PASS CAVALLO

Tidal height vs estuarine fish abundance



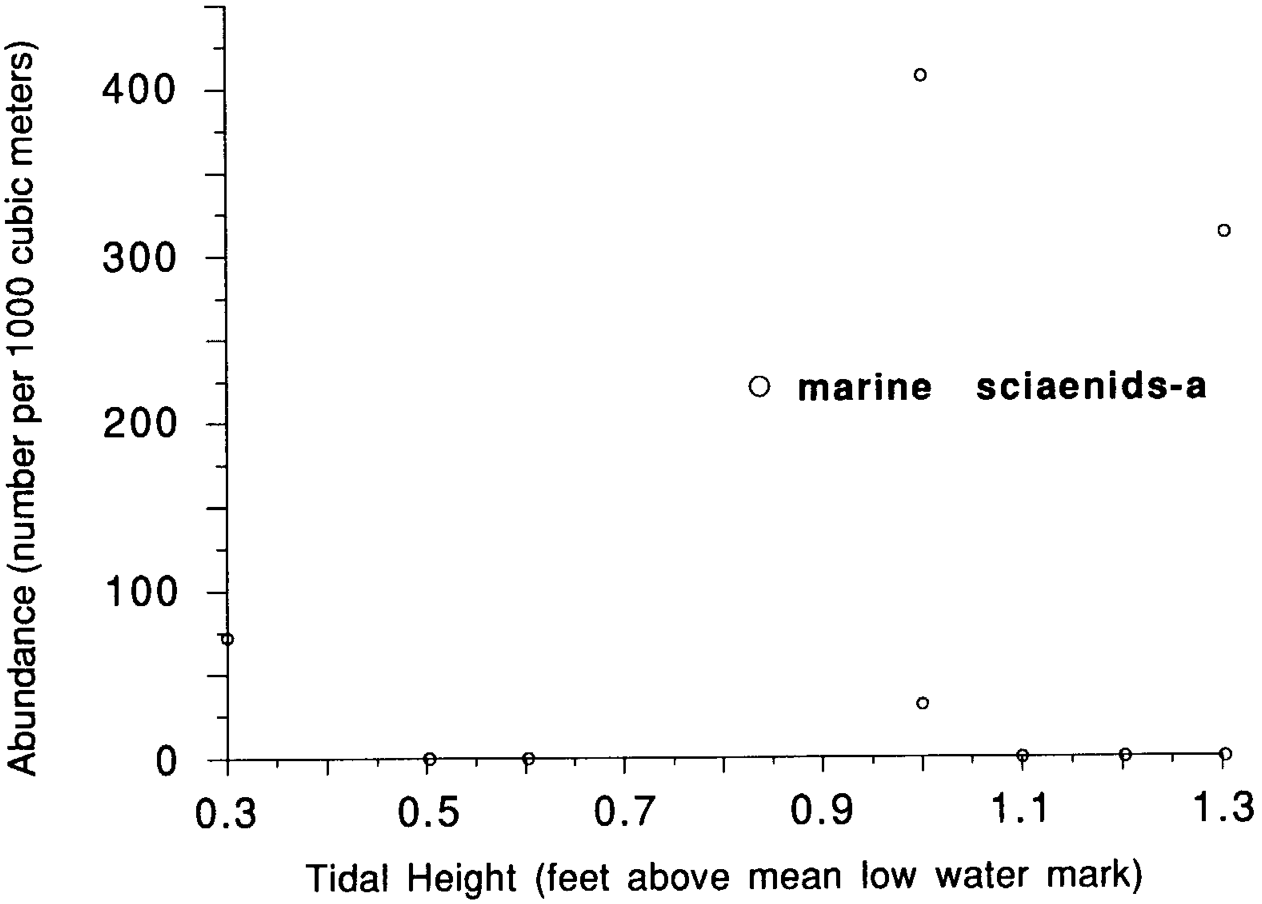


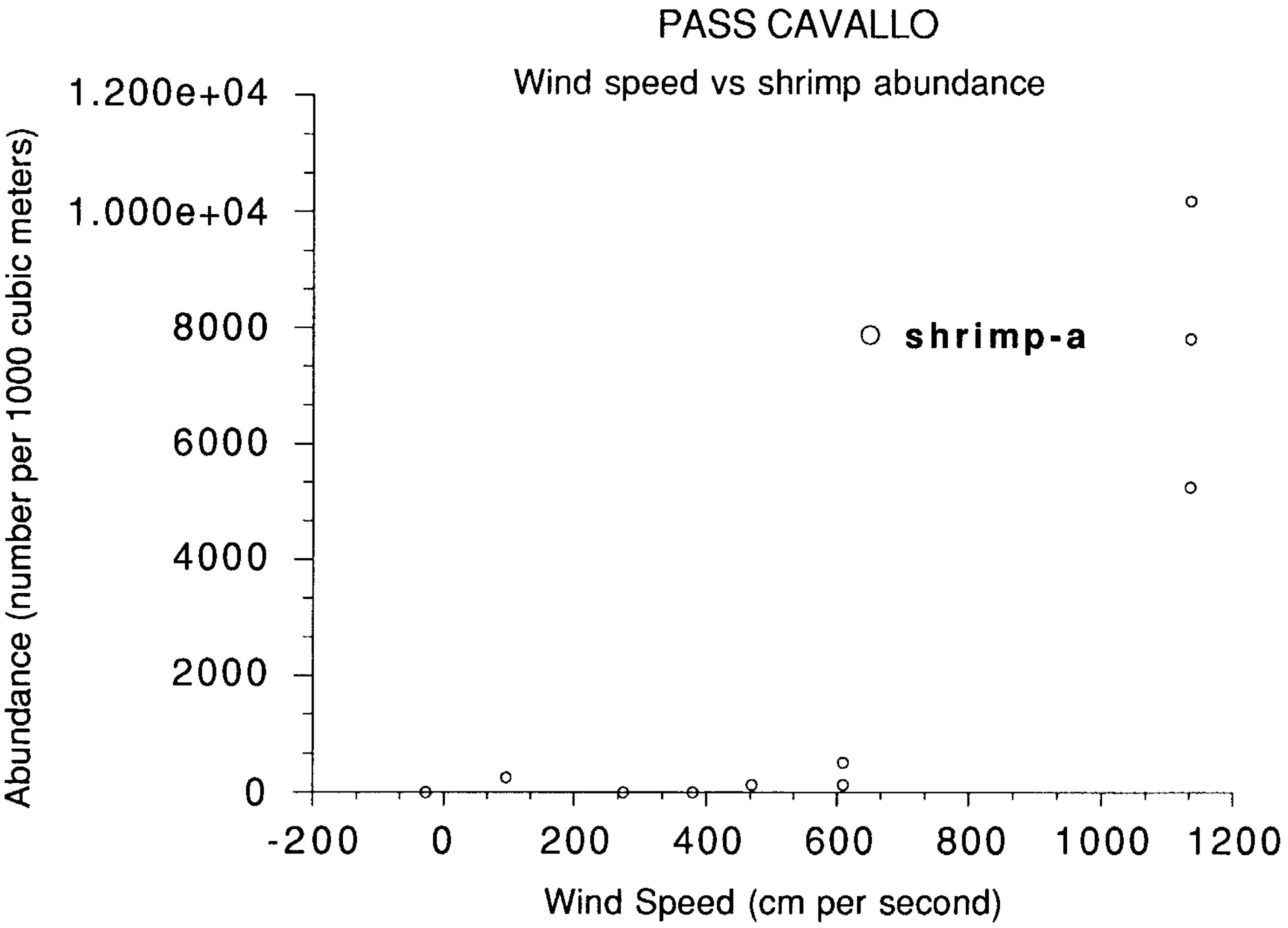
PASS CAVALLO

Tidal height vs marine fish abundance

PASS CAVALLO

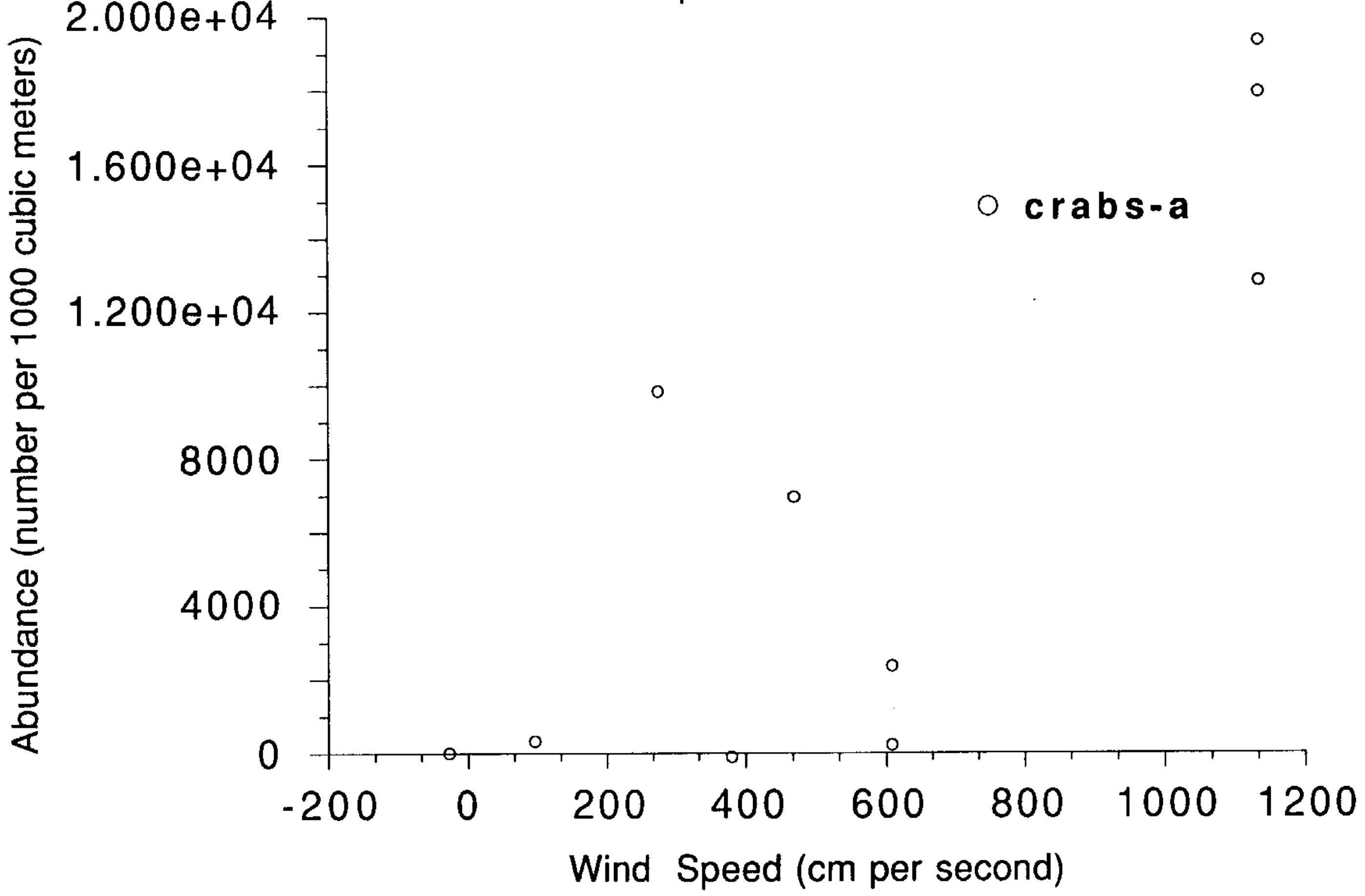
Tidal height vs marine sciaenid abundance

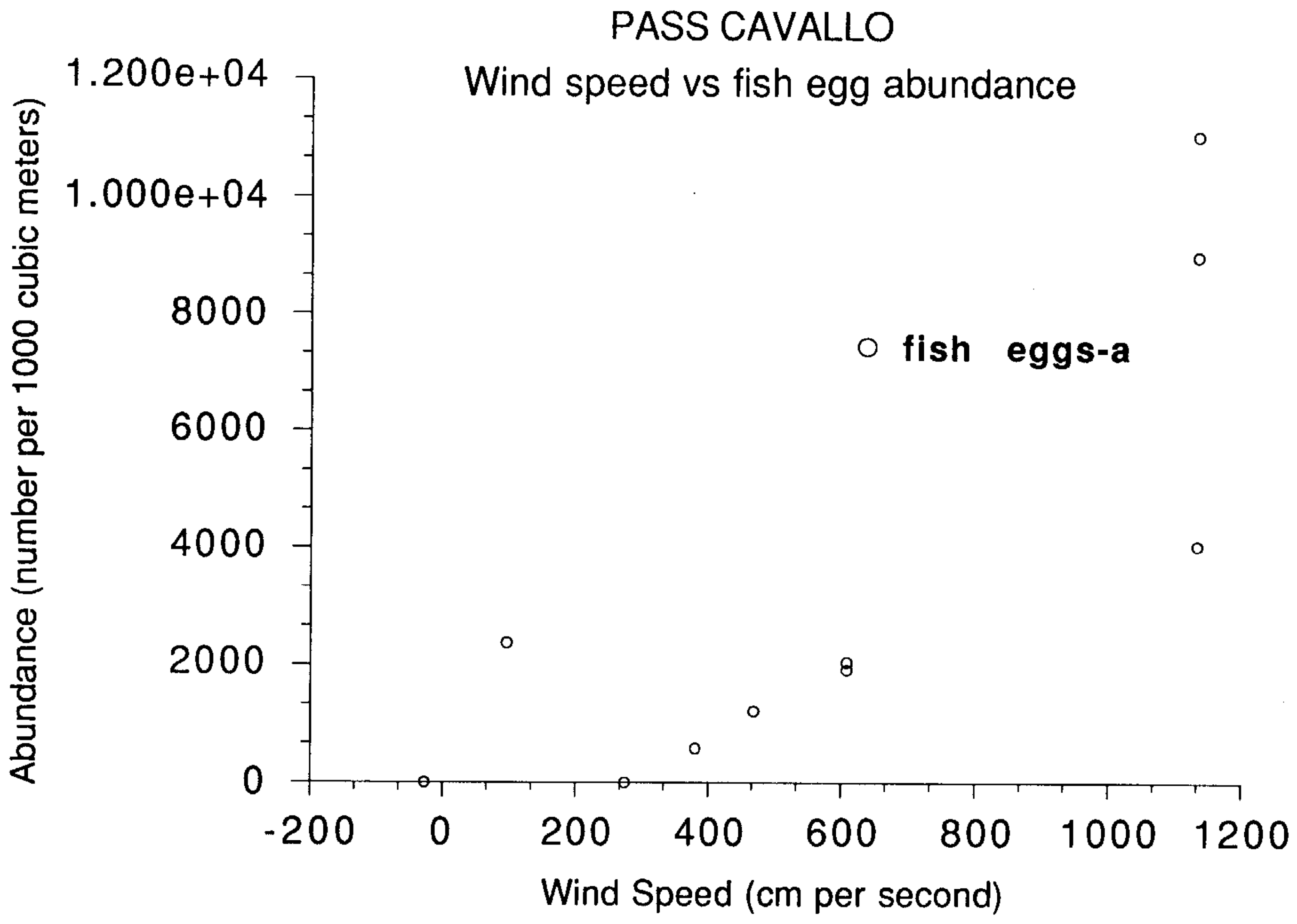



PASS CAVALLO
Wind speed vs shrimp abundance
○ shrimp-a
Abundance (number per 1000 cubic meters)
1.200e+04
1.000e+04
8000
6000
4000
2000
0
-200
0
200
400
600
800
1000
1200
Wind Speed (cm per second)

PASS CAVALLO

Wind speed vs crab abundance



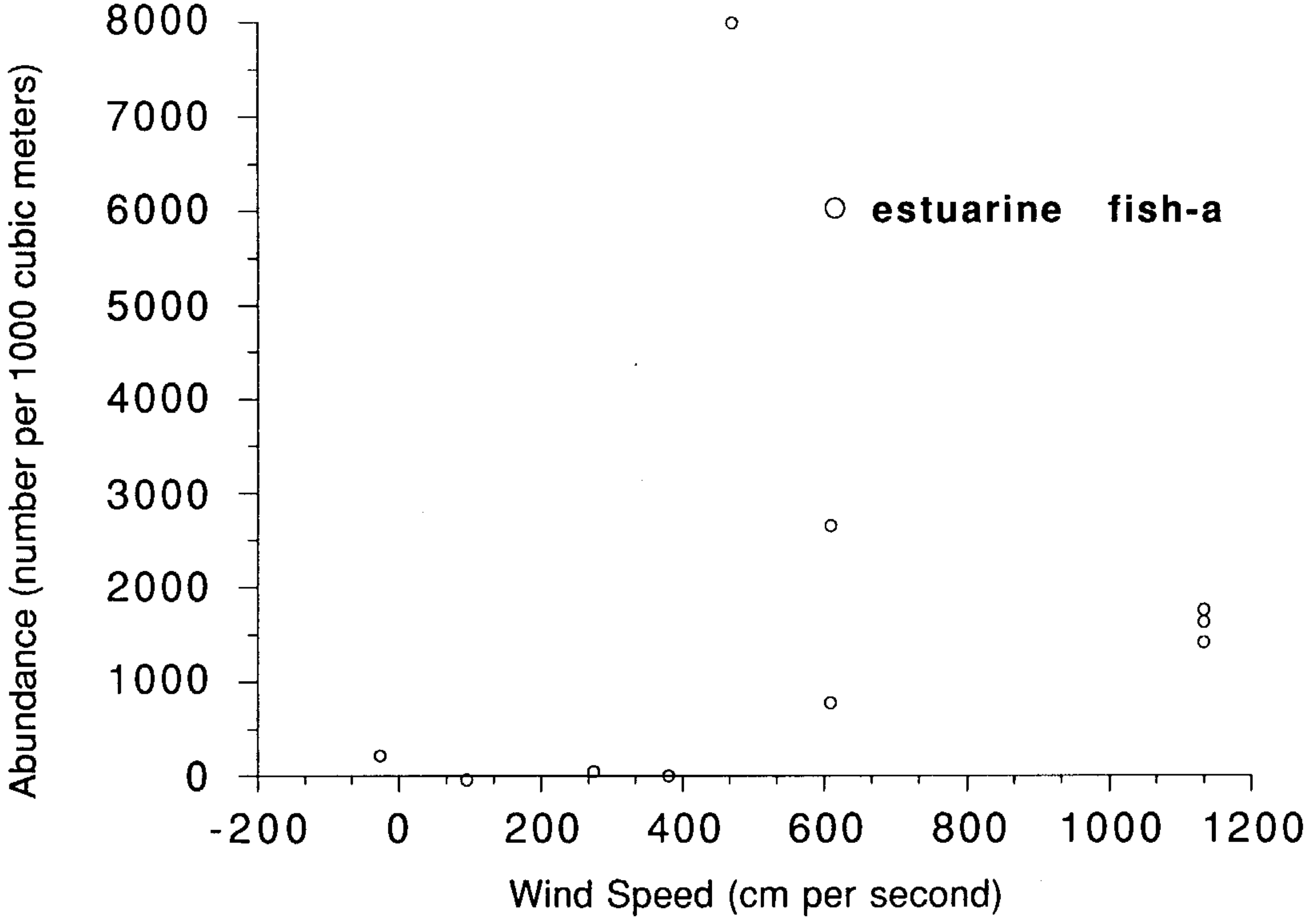


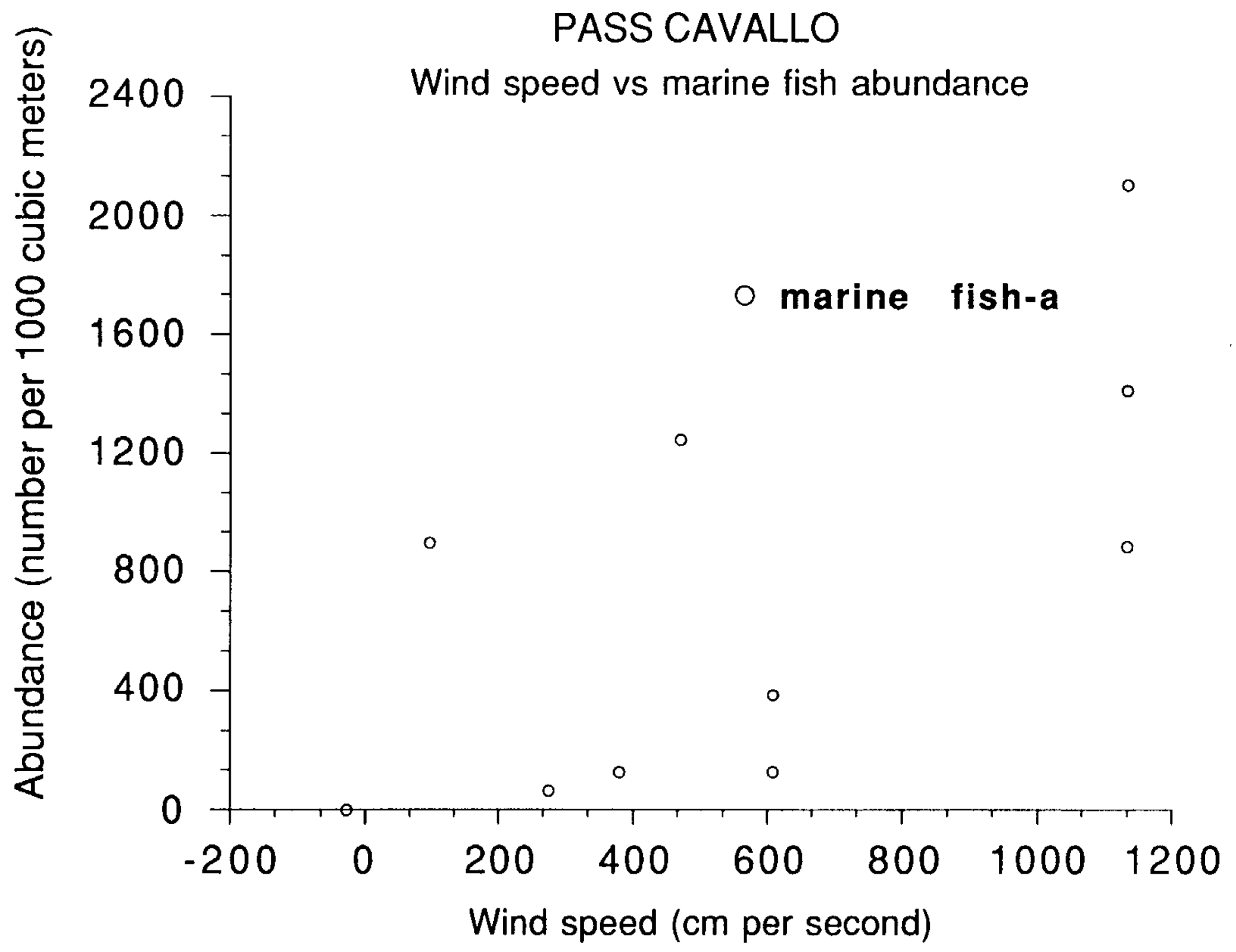
PASS CAVALLO

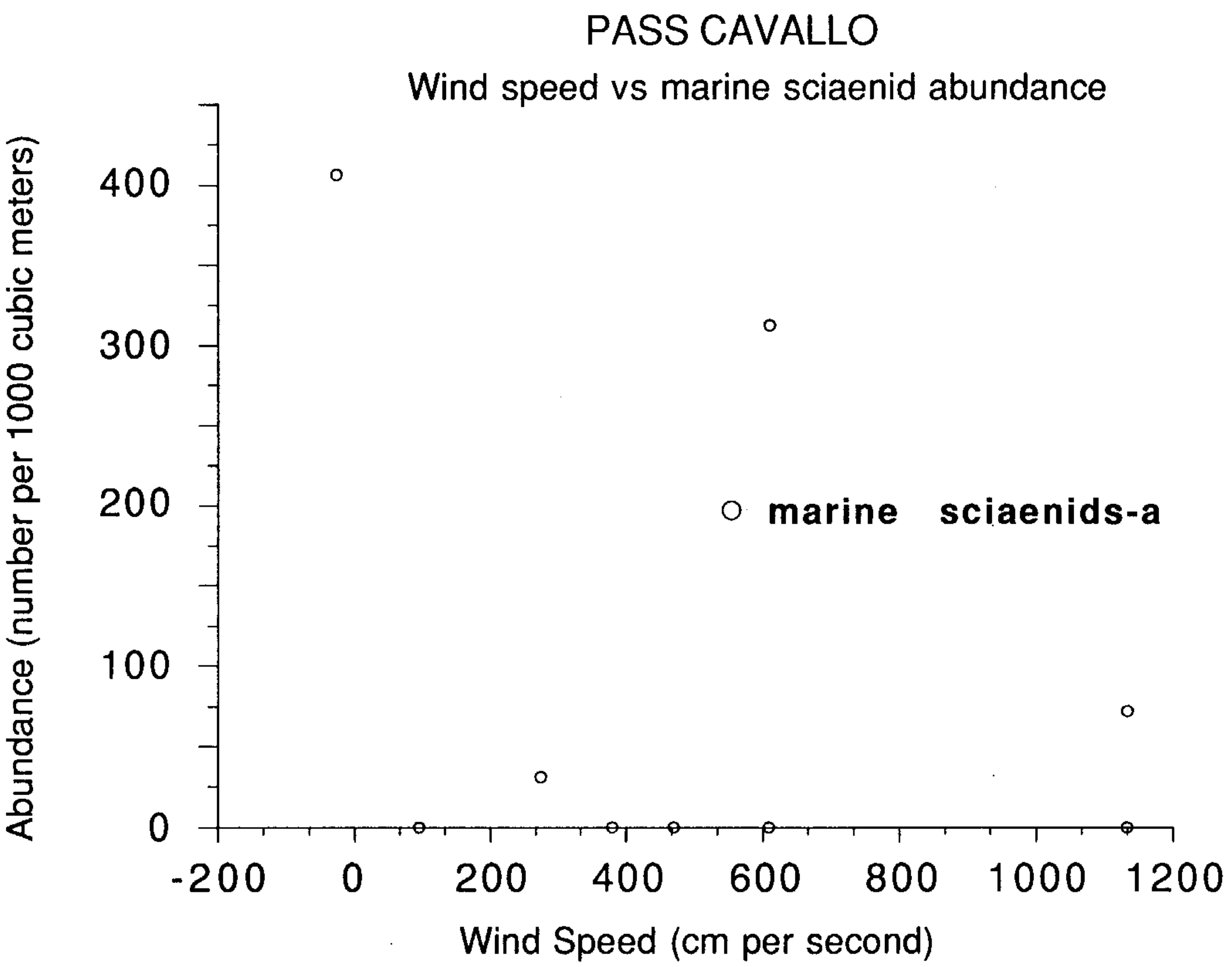
Wind speed vs fish egg abundance

PASS CAVALLO

Wind speed vs estuarine fish abundance

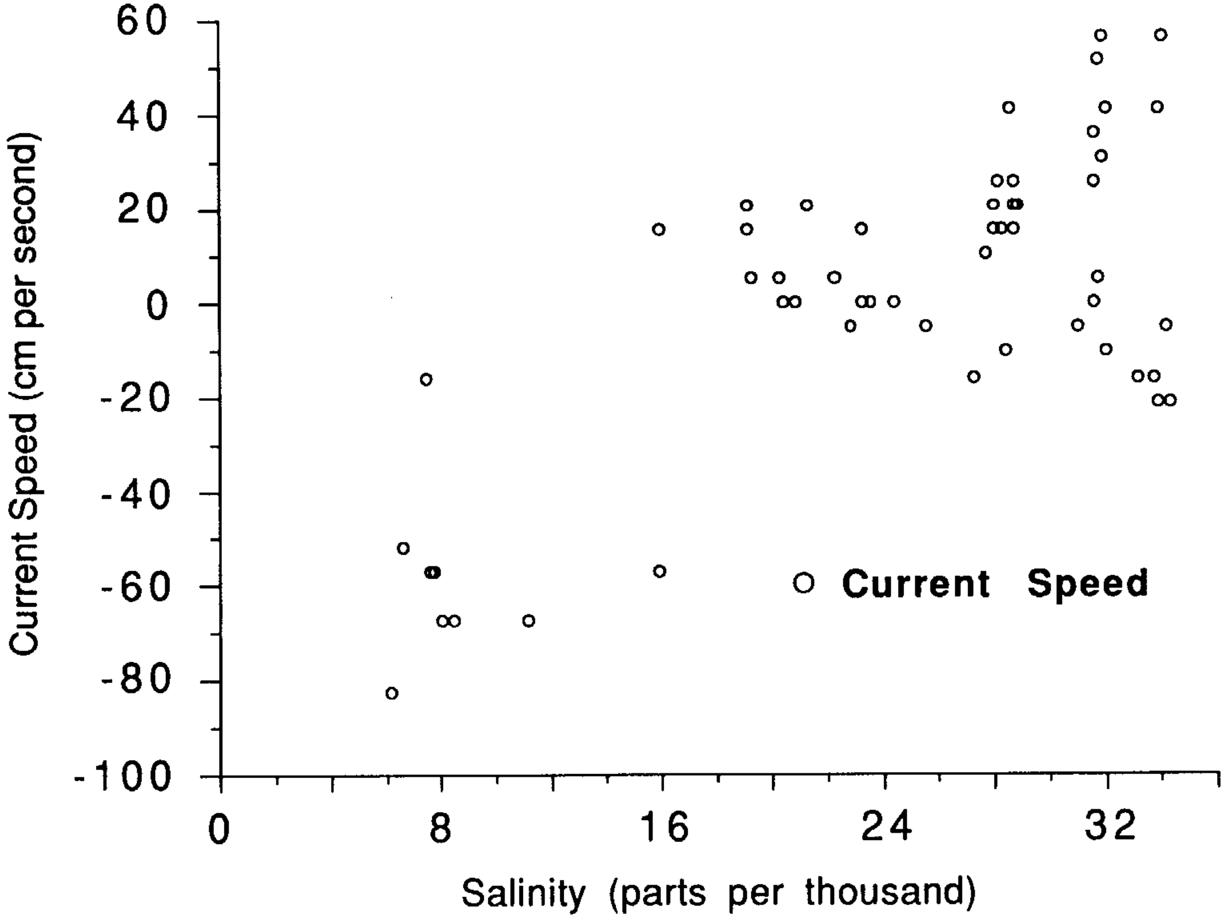



PASS CAVALLO
Wind speed vs marine fish abundance
○ marine fish-a
Abundance (number per 1000 cubic meters)
2400
2000
1600
1200
800
400
0
-200
0
200
400
600
800
1000
1200
Wind speed (cm per second)



PASS CAVALLO

Wind speed vs marine sciaenid abundance

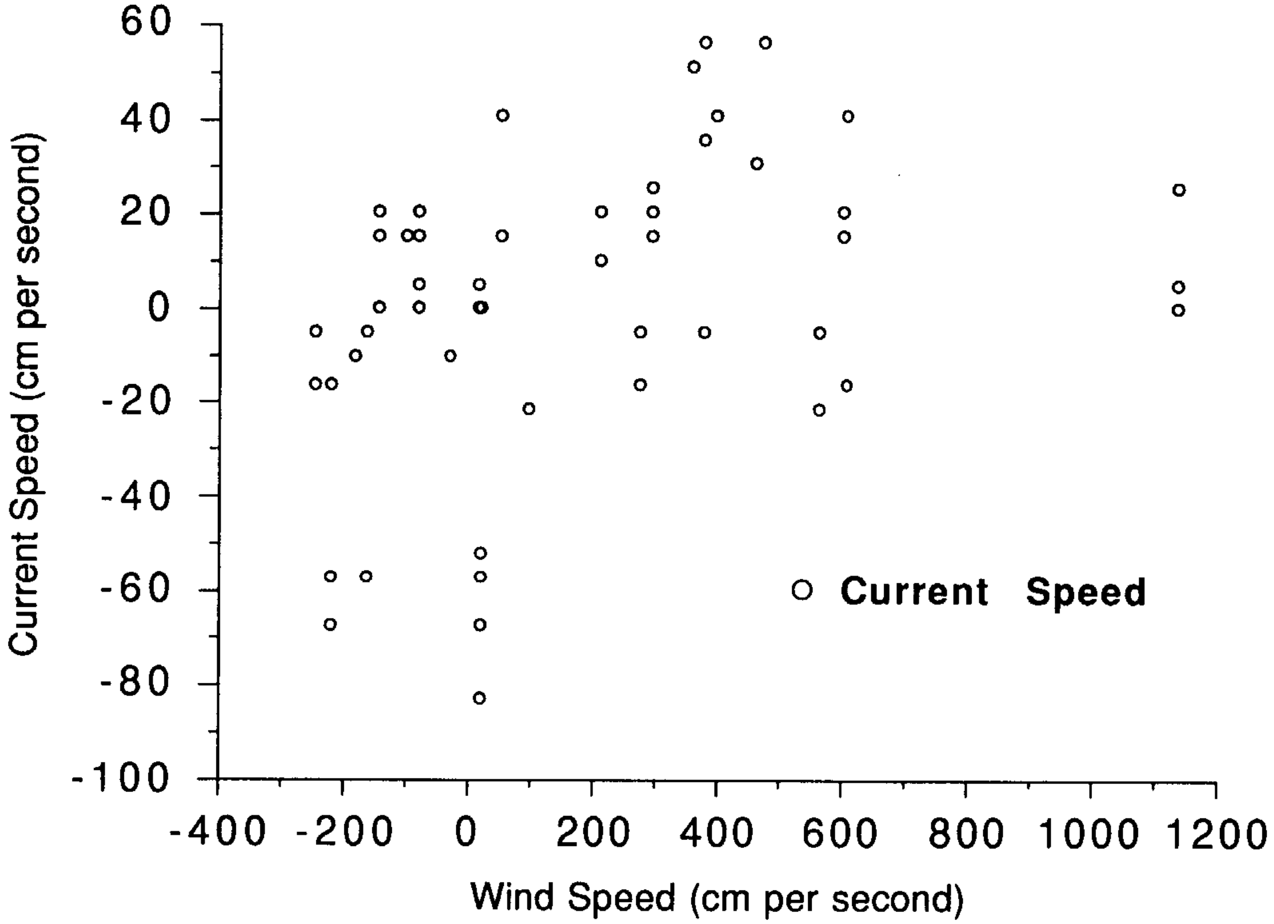


PASS CAVALLO

Current speed vs salinity

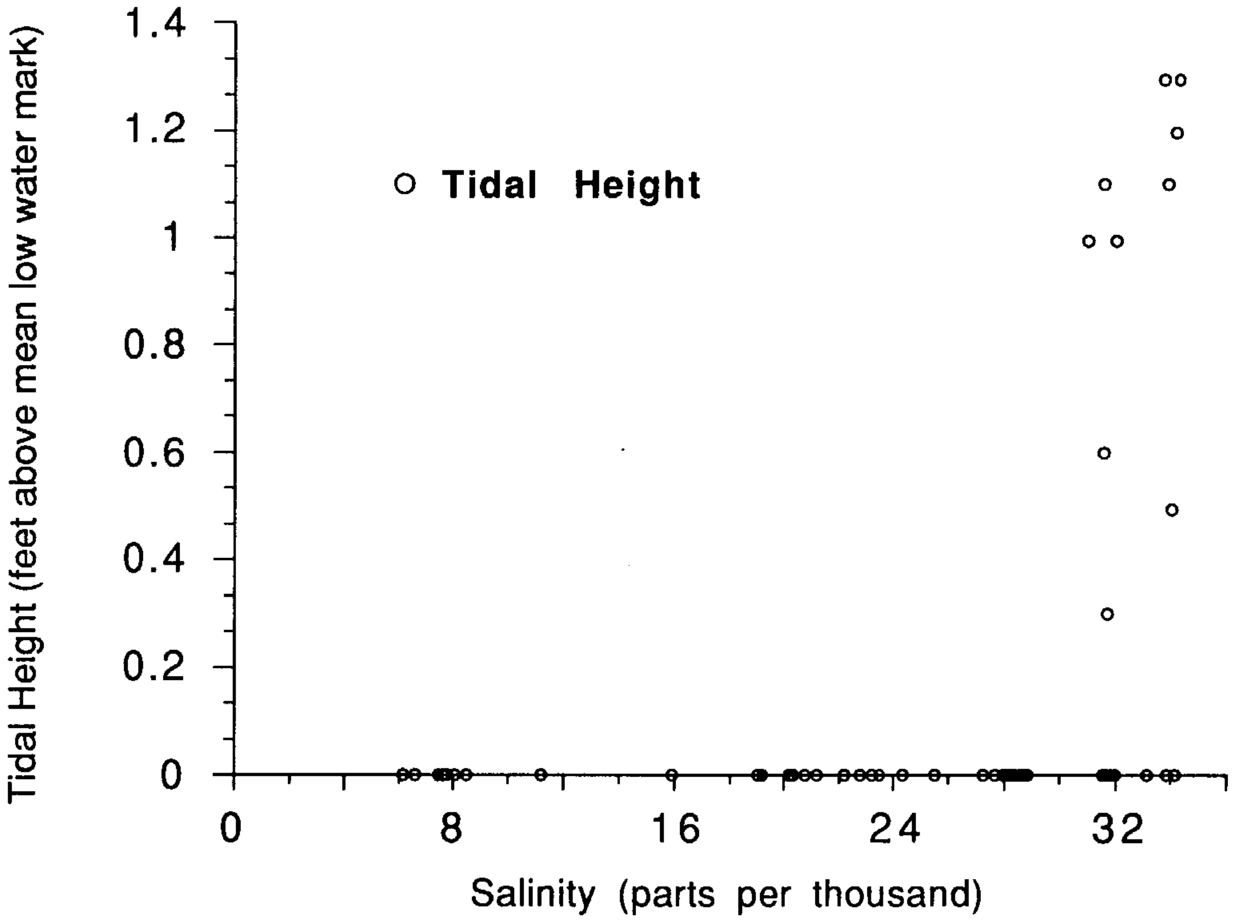
PASS CAVALLO

Current speed vs wind speed



PASS CAVALLO

Tidal height vs salinity



SUPPLEMENT II

BIOLOGICAL AND PHYSICAL DATA (MEANS AND STANDARD ERRORS) GIVEN BY STATION, CRUISE, DEPTH, AND CURRENT DIRECTION, INCLUDING CORRELATION MATRICES OF PHYSICAL FACTORS BY STATION

MATAGORDA BAY LARVAL STUDY

Explanation of Tables

The collecting stations are numbered as follows:

Station 1 = Ship Channel
Station 2 = Saluria Bayou
Station 4 = The Intracoastal Waterway
Station 5 = Pass Cavallo.

Mean densities are expressed as the number of organisms per 1,000 cubic meters of water sampled. Cruise dates (in 1987) are given as follows:

Cruise 2 = March 31 - April 2
Cruise 3 = April 29 - May 2
Cruise 4 = May 27 - May 28
Cruise 5 = July 25 - August 1
Cruise 6 = August 13 - August 16.

MEAN DENSITIES AND STANDARD ERRORS

FOR SHRIMP
BY STATION

STATION 1

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		SHRIMP		SHRIMP		SHRIMP	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	593.22	223.23	664.80	126.84	2012.60	746.43
	OUT	287.67	208.17	151.33	38.92	1434.67	647.40
3	IN	472.86	175.57	680.43	319.29	561.63	244.49
	OUT	60.00	27.00	67.00	67.00	162.00	3.00
	SLA	190.00	.	386.00	.	.	.
4	IN	13557.00	.	48657.00	.	22201.00	.
	OUT	4517.00	.	15564.00	.	958.00	.
5	IN	2378.16	551.41	515.29	126.49	144.29	50.50
	OUT	1418.75	362.12	1069.22	427.75	302.75	246.07
	SLA	.	.	393.00	.	114.00	.
6	IN	617.33	259.08	400.83	187.32	1103.83	483.05
	OUT	181.50	181.50	270.67	139.86	15.00	12.09
	SLA	295.00	295.00	.	.	.	.

MEAN DENSITIES AND STANDARD ERRORS

FOR CRABS
BY STATIONS

STATION 1

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		CRABS		CRABS		CRABS	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	1009.33	191.51	1922.90	312.68	2766.70	1232.19
	OUT	603.33	290.42	260.33	16.18	1395.33	237.58
3	IN	2334.29	518.97	3413.86	789.97	2933.50	509.82
	OUT	1086.00	890.00	1660.50	1307.50	1754.50	848.50
	SLA	1603.00	.	1522.00	.	.	.
4	IN	671.00	.	3934.00	.	8995.00	.
	OUT	950.00	.	2017.00	.	517.00	.
5	IN	3650.16	895.63	9071.41	3026.48	3429.06	887.10
	OUT	2603.75	876.72	4898.44	1222.97	4280.63	1430.24
	SLA	.	.	2591.00	.	1606.00	.
6	IN	1769.50	246.55	1841.33	342.94	2110.83	564.71
	OUT	727.75	214.15	9211.67	4732.48	428.50	176.65
	SLA	4269.00	2021.00	.	.	.	.

MEAN DENSITIES AND STANDARD ERRORS

FOR FISH EGGS
BY STATIONS

STATION 1

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		EGGS		EGGS		EGGS	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	1621.33	981.51	1495.50	770.95	2884.00	1531.51
	OUT	1749.00	1030.66	1591.67	510.32	1084.33	419.28
3	IN	6426.57	1459.94	7408.71	1953.22	9245.38	1601.48
	OUT	21050.00	13011.00	28806.00	9229.00	24395.50	7670.50
	SLA	9778.00	.	10869.00	.	.	.
4	IN	101.00	.	758.00	.	2871.00	.
	OUT	323.00	.	1750.00	.	569.00	.
5	IN	15383.53	4408.71	18910.65	8637.99	22818.76	9052.00
	OUT	14199.13	3775.13	12182.44	3606.22	8565.25	2006.11
	SLA	.	.	188734.00	.	27992.00	.
6	IN	11415.83	2011.98	14601.67	4258.73	22413.33	10525.00
	OUT	28154.00	11574.95	29795.33	7461.33	60686.83	20061.50
	SLA	32436.00	586.00	.	.	.	.

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                                   MEAN DENSITIES AND STANDARD ERRORS                    19:54 MONDAY, MAY 8, 1989

                                          FOR ESTUARINE FISH
                                              BY STATION

STATION 1
--------------------------------------------------------------------------------------------------------------------
|                                |                                      DEPTH                                      |
|                                |---------------------------------------------------------------------------------|
|                                |         BOTTOM          |         MID-DEP          |         SURFACE          |
|                                |-------------------------+--------------------------+--------------------------|
|                                |         ESTFIS          |         ESTFIS           |         ESTFIS           |
|                                |-------------------------+--------------------------+--------------------------|
|                                |    MEAN    |   STDERR   |    MEAN    |   STDERR    |    MEAN    |   STDERR    |
|--------------------------------+------------+------------+------------+-------------+------------+-------------|
|CRUISE          |CURRENT        |            |            |            |             |            |             |
|----------------+---------------|            |            |            |             |            |             |
|2               |IN             |      714.56|      147.36|     1070.40|       237.53|      798.00|       127.35|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |OUT            |      326.33|      173.39|      482.67|       245.21|      862.00|       451.97|
|----------------+---------------+------------+------------+------------+-------------+------------+-------------|
|3               |IN             |     4535.43|     2906.41|     4290.00|      1229.40|     4908.38|      2161.77|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |OUT            |     6554.50|      345.50|    10903.00|      6885.00|     3751.50|        64.50|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |SLA            |    18031.00|           .|     9904.00|            .|           .|            .|
|----------------+---------------+------------+------------+------------+-------------+------------+-------------|
|4               |IN             |     5671.00|           .|     9226.00|            .|     3828.00|            .|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |OUT            |     2222.00|           .|    20250.00|            .|      285.00|            .|
|----------------+---------------+------------+------------+------------+-------------+------------+-------------|
|5               |IN             |     7362.68|     1947.04|     5967.41|      1207.44|     1417.53|       428.45|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |OUT            |    10804.75|     8231.12|     4248.44|       856.67|      890.13|       475.62|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |SLA            |           .|           .|    14250.00|            .|      306.00|            .|
|----------------+---------------+------------+------------+------------+-------------+------------+-------------|
|6               |IN             |    11789.50|     2909.74|    12447.67|      5200.22|     7146.83|      2282.86|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |OUT            |     1068.25|      514.08|     3194.67|       294.39|       86.17|        31.10|
|                |---------------+------------+------------+------------+-------------+------------+-------------|
|                |SLA            |     5041.50|     2231.50|           .|            .|           .|            .|
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 1                                   MEAN DENSITIES AND STANDARD ERRORS          19:01 WEDNESDAY, APRIL 26, 1989

                                                  FOR MARINE FISH
                                                    BY STATIONS

           STATION 1
           --------------------------------------------------------------------------------------------
           |                          |                             DEPTH                             |
           |                          |---------------------------------------------------------------|
           |                          |      BOTTOM         |      MID-DEP        |      SURFACE        |
           |                          |---------------------+---------------------+---------------------|
           |                          |      MARFIS         |      MARFIS         |      MARFIS         |
           |                          |---------------------+---------------------+---------------------|
           |                          |   MEAN   |  STDERR  |   MEAN   |  STDERR  |   MEAN   |  STDERR  |
           |-------------+------------+----------+----------+----------+----------+----------+----------|
           |CRUISE       |CURRENT     |          |          |          |          |          |          |
           |-------------+------------|          |          |          |          |          |          |
           |2            |IN          |    179.11|     59.01|    263.50|     47.95|    416.60|    144.48|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |OUT         |     87.33|      8.35|     96.33|     50.81|    606.33|    435.20|
           |-------------+------------+----------+----------+----------+----------+----------+----------|
           |3            |IN          |    156.57|     51.26|    350.29|     92.55|    465.50|    171.18|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |OUT         |    237.00|     25.00|     47.00|     47.00|    103.50|    103.50|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |SLA         |    126.00|         .|    145.00|         .|         .|         .|
           |-------------+------------+----------+----------+----------+----------+----------+----------|
           |4            |IN          |   1545.00|         .|   2086.00|         .|   1160.00|         .|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |OUT         |    216.00|         .|   3141.00|         .|    207.00|         .|
           |-------------+------------+----------+----------+----------+----------+----------+----------|
           |5            |IN          |   1298.95|    258.58|    515.71|    117.20|    256.35|     86.16|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |OUT         |    650.12|    114.54|    525.89|    150.39|    315.50|    110.05|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |SLA         |         .|         .|    236.00|         .|    153.00|         .|
           |-------------+------------+----------+----------+----------+----------+----------+----------|
           |6            |IN          |   1994.67|    430.68|   1255.83|    333.69|   1554.83|    400.59|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |OUT         |     85.75|     50.68|    592.00|    131.41|    167.67|     59.17|
           |             |------------+----------+----------+----------+----------+----------+----------|
           |             |SLA         |   1235.50|    449.50|         .|         .|         .|         .|
           --------------------------------------------------------------------------------------------
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MEAN DENSITIES AND STANDARD ERRORS

FOR MARINE SCIAENIDS
BY STATIONS

STATION 1

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		MARSCI		MARSCI		MARSCI	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	544.67	146.60	524.70	138.59	567.10	324.81
	OUT	249.33	97.22	175.67	66.49	755.33	404.13
3	IN	164.14	67.13	138.00	64.71	175.38	84.79
	OUT	32.50	32.50	117.50	117.50	36.50	4.50
	SLA	63.00	.	48.00	.	.	.
4	IN	0.00	.	0.00	.	96.00	.
	OUT	0.00	.	0.00	.	0.00	.
5	IN	193.26	49.29	34.59	15.62	22.94	17.07
	OUT	32.38	16.46	64.67	24.52	0.00	0.00
	SLA	.	.	0.00	.	0.00	.
6	IN	129.17	59.18	67.50	31.59	1.67	1.67
	OUT	0.00	0.00	22.67	22.67	0.00	0.00
	SLA	93.50	93.50	.	.	.	.

MEANS AND STANDARD ERRORS

FOR PENAEIDAE PROTOZOEA
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	197.71	99.46	154.00	37.49	63.25	15.09
	OUT	43.50	43.50	44.50	44.50	20.50	20.50
	SLA	0.00	.	48.00	.	.	.
4	IN	8859.00	.	36272.00	.	21244.00	.
	OUT	2366.00	.	13063.00	.	906.00	.
5	IN	392.79	152.82	246.18	92.29	13.56	7.89
	OUT	564.25	164.95	500.56	208.40	27.11	21.00
	SLA	.	.	157.00	.	0.00	.
6	IN	187.00	62.52	233.67	114.78	254.67	119.30
	OUT	109.00	109.00	228.00	134.16	2.67	2.67
	SLA	295.00	295.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR PENAEUS MYSIS
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	253.43	88.26	520.43	290.68	482.37	245.35
	OUT	16.50	16.50	22.50	22.50	125.50	1.50
	SLA	190.00	.	338.00	.	.	.
4	IN	4698.00	.	12259.00	.	861.00	.
	OUT	2151.00	.	2313.00	.	26.00	.
5	IN	598.11	156.65	140.82	47.46	42.25	29.87
	OUT	585.88	289.22	479.44	254.50	53.44	53.44
	SLA	.	.	236.00	.	38.00	.
6	IN	50.33	50.33	0.00	0.00	395.33	294.68
	OUT	36.25	36.25	12.00	12.00	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR PENAEUS AZTECUS POSTLARVAE
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	590.00	224.06	664.80	126.84	2010.00	747.08
	OUT	287.67	208.17	151.33	38.92	1434.67	647.40
3	IN	21.71	21.71	6.00	6.00	16.00	11.34
	OUT	0.00	0.00	0.00	0.00	16.00	16.00
	SLA	0.00	.	0.00	.	.	.
4	IN	0.00	.	126.00	.	96.00	.
	OUT	0.00	.	0.00	.	26.00	.
5	IN	16.16	13.42	11.71	11.71	8.44	6.32
	OUT	28.37	28.38	0.00	0.00	15.44	9.42
	SLA	.	.	0.00	.	76.00	.
6	IN	0.00	0.00	9.50	9.50	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	12.33	12.33
	SLA	0.00	0.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR PENAEUS SPP POSTLARVAE
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	3.22	3.22	0.00	0.00	2.60	2.60
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	.	0.00	.	.	.
4	IN	0.00	.	0.00	.	0.00	.
	OUT	0.00	.	188.00	.	0.00	.
5	IN	1371.11	558.41	98.71	32.48	89.06	33.23
	OUT	154.38	69.35	55.89	24.45	186.89	145.60
	SLA	.	.	0.00	.	0.00	.
6	IN	380.00	217.52	157.67	123.47	453.83	228.26
	OUT	36.25	36.25	30.67	30.67	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR PORTUNID ZOEA
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	157.67	27.85	275.90	80.40	529.20	166.45
	OUT	184.00	85.59	91.00	69.06	1084.00	386.76
3	IN	2284.00	532.74	3374.00	784.98	2910.88	504.50
	OUT	1042.00	879.00	1637.50	1308.50	1662.50	899.50
	SLA	1524.00	.	290.00	.	.	.
4	IN	671.00	.	3918.00	.	8995.00	.
	OUT	717.00	.	1813.00	.	517.00	.
5	IN	1987.37	586.41	8798.12	3068.25	2833.18	884.43
	OUT	2345.00	871.85	4732.00	1257.80	3726.56	1348.65
	SLA	.	.	2512.00	.	1606.00	.
6	IN	265.67	128.44	708.17	377.55	866.00	209.61
	OUT	727.75	214.15	9211.67	4732.48	428.50	176.65
	SLA	4269.00	2021.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR CALLINECTES MEGALOPA
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	507.44	99.50	1296.20	311.72	2081.10	1192.84
	OUT	406.33	337.83	142.33	77.35	284.00	125.51
3	IN	35.14	27.59	16.43	11.13	16.38	11.46
	OUT	38.50	5.50	0.00	0.00	84.00	43.00
	SLA	0.00	.	1111.00	.	.	.
4	IN	0.00	.	0.00	.	0.00	.
	OUT	0.00	.	188.00	.	0.00	.
5	IN	1615.84	678.90	232.18	107.06	158.94	44.60
	OUT	136.75	125.31	142.67	108.28	152.00	84.52
	SLA	.	.	79.00	.	0.00	.
6	IN	947.17	223.44	514.17	145.10	1127.83	610.18
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

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                                      MEANS AND STANDARD ERRORS                      10:11 THURSDAY, APRIL 27, 1989
 1
                                        FOR PORTUNID JUVENILES
                                         IN THE SHIP CHANNEL

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  |                              |                                  DEPTH                                   |
  |                              |--------------------------------------------------------------------------|
  |                              |         BOTTOM          |         MID-DEP         |        SURFACE         |
  |                              |-------------------------+-------------------------+------------------------|
  |                              |         DENSITY         |         DENSITY         |        DENSITY         |
  |                              |-------------------------+-------------------------+------------------------|
  |                              |    MEAN    |   STDERR   |    MEAN    |   STDERR   |    MEAN    |  STDERR   |
  |------------------------------+------------+------------+------------+------------+------------+-----------|
  |CRUISE         |CURRENT       |            |            |            |            |            |           |
  |---------------+--------------|            |            |            |            |            |           |
  |2              |IN            |      193.63|       73.79|      184.63|       72.71|      104.27|      59.23|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |OUT           |        9.75|        9.75|       20.25|       20.25|       20.50|      20.50|
  |---------------+--------------+------------+------------+------------+------------+------------+-----------|
  |3              |IN            |        6.37|        6.38|        5.25|        5.25|        0.00|       0.00|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |OUT           |        0.00|        0.00|        0.00|        0.00|        0.00|       0.00|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |SLA           |       31.50|       31.50|       48.50|       48.50|           .|          .|
  |---------------+--------------+------------+------------+------------+------------+------------+-----------|
  |4              |IN            |        0.00|           .|        0.00|           .|        0.00|          .|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |OUT           |      107.50|      107.50|        0.00|           .|        0.00|          .|
  |---------------+--------------+------------+------------+------------+------------+------------+-----------|
  |5              |IN            |       37.17|       22.26|       31.23|       13.60|       18.42|      14.64|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |OUT           |       88.73|       62.19|       21.40|       21.40|        4.00|       4.00|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |SLA           |           .|           .|        0.00|           .|        0.00|          .|
  |---------------+--------------+------------+------------+------------+------------+------------+-----------|
  |6              |IN            |      278.33|      123.41|      337.64|      157.16|       87.75|      58.78|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |OUT           |        0.00|        0.00|        0.00|        0.00|        0.00|       0.00|
  |               |--------------+------------+------------+------------+------------+------------+-----------|
  |               |SLA           |        0.00|        0.00|           .|           .|           .|          .|
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MEANS AND STANDARD ERRORS

FOR BAIRDIELLA CHRYSOURA
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	0.00	0.00	6.00	6.00	1.13	1.13
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	.	0.00	.	.	.
4	IN	671.00	.	506.00	.	0.00	.
	OUT	0.00	.	625.00	.	0.00	.
5	IN	33.79	16.47	0.00	0.00	2.31	1.58
	OUT	25.75	17.32	0.00	0.00	0.00	0.00
	SLA	.	.	0.00	.	0.00	.
6	IN	0.00	0.00	31.83	31.83	14.17	14.17
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR CYNOSCION ARENARIUS
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	362.44	112.36	215.20	83.24	312.90	253.01
	OUT	69.67	18.62	70.33	14.86	256.33	177.89
3	IN	109.00	60.66	24.14	24.14	135.75	85.23
	OUT	0.00	0.00	0.00	0.00	16.00	16.00
	SLA	0.00	.	0.00	.	.	.
4	IN	0.00	.	0.00	.	0.00	.
	OUT	0.00	.	0.00	.	0.00	.
5	IN	182.68	50.33	18.00	8.77	23.19	18.17
	OUT	25.13	16.45	54.78	25.28	0.00	0.00
	SLA	.	.	0.00	.	0.00	.
6	IN	129.17	59.18	67.50	31.59	1.67	1.67
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR CYNOSCION NEBULOSUS
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	0.00	0.00	57.20	57.20	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	10.71	10.71	6.71	6.71	10.88	10.88
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	.	0.00	.	.	.
4	IN	0.00	.	63.00	.	96.00	.
	OUT	0.00	.	0.00	.	0.00	.
5	IN	260.68	139.86	141.29	70.71	2.13	1.45
	OUT	287.38	115.49	71.11	37.40	10.67	10.67
	SLA	.	.	393.00	.	0.00	.
6	IN	21.00	21.00	108.17	76.60	82.67	82.67
	OUT	47.50	27.47	178.50	50.53	17.00	17.00
	SLA	98.50	98.50	.	.	.	.

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                                MEANS AND STANDARD ERRORS                     10:20 THURSDAY, APRIL 27, 1989
  1
                                FOR LEIOSTOMUS XANTHURUS
                                  IN THE SHIP CHANNEL

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|                              |                                   DEPTH                                |
|                              |------------------------------------------------------------------------|
|                              |        BOTTOM         |        MID-DEP        |        SURFACE         |
|                              |-----------------------+-----------------------+------------------------|
|                              |        DENSITY        |        DENSITY        |        DENSITY         |
|                              |-----------------------+-----------------------+------------------------|
|                              |   MEAN    |  STDERR   |   MEAN    |  STDERR   |   MEAN    |  STDERR    |
|------------------------------+-----------+-----------+-----------+-----------+-----------+------------|
|CRUISE         |CURRENT       |           |           |           |           |           |            |
|---------------+--------------|           |           |           |           |           |            |
|2              |IN            |       3.22|       3.22|       0.00|       0.00|       0.00|        0.00|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |OUT           |       0.00|       0.00|       0.00|       0.00|       0.00|        0.00|
|---------------+--------------+-----------+-----------+-----------+-----------+-----------+------------|
|3              |IN            |      14.57|      14.57|       0.00|       0.00|       0.00|        0.00|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |OUT           |       0.00|       0.00|       0.00|       0.00|       0.00|        0.00|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |SLA           |       0.00|          .|      48.00|          .|          .|           .|
|---------------+--------------+-----------+-----------+-----------+-----------+-----------+------------|
|4              |IN            |       0.00|          .|       0.00|          .|       0.00|           .|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |OUT           |       0.00|          .|       0.00|          .|       0.00|           .|
|---------------+--------------+-----------+-----------+-----------+-----------+-----------+------------|
|5              |IN            |       0.00|       0.00|       0.00|       0.00|       0.00|        0.00|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |OUT           |       0.00|       0.00|       0.00|       0.00|       0.00|        0.00|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |SLA           |          .|          .|       0.00|          .|       0.00|           .|
|---------------+--------------+-----------+-----------+-----------+-----------+-----------+------------|
|6              |IN            |       0.00|       0.00|       0.00|       0.00|       0.00|        0.00|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |OUT           |       0.00|       0.00|       0.00|       0.00|       0.00|        0.00|
|               |--------------+-----------+-----------+-----------+-----------+-----------+------------|
|               |SLA           |       0.00|       0.00|          .|          .|          .|           .|
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MEANS AND STANDARD ERRORS

FOR MENTICIRRHUS AMERICANUS
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	63.00	.	0.00	.	.	.
4	IN	0.00	.	0.00	.	0.00	.
	OUT	0.00	.	0.00	.	0.00	.
5	IN	0.63	0.63	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	.	.	0.00	.	0.00	.
6	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR POGONIAS CROMIS
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	182.22	40.31	280.80	78.89	254.20	81.63
	OUT	179.67	97.67	105.33	54.61	487.33	229.11
3	IN	55.14	35.66	55.86	43.57	39.63	23.91
	OUT	0.00	0.00	117.50	117.50	20.50	20.50
	SLA	0.00	.	0.00	.	.	.
4	IN	0.00	.	0.00	.	96.00	.
	OUT	0.00	.	0.00	.	0.00	.
5	IN	0.00	0.00	4.88	4.88	1.19	1.19
	OUT	2.38	2.38	9.89	9.89	0.00	0.00
	SLA	.	.	0.00	.	0.00	.
6	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

MEANS AND STANDARD ERRORS

FOR SCIAENOPS OCELLATUS
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	.	0.00	.	.	.
4	IN	0.00	.	0.00	.	0.00	.
	OUT	0.00	.	0.00	.	0.00	.
5	IN	0.00	0.00	11.71	11.71	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	.	.	0.00	.	0.00	.
6	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	22.67	22.67	0.00	0.00
	SLA	93.50	93.50	.	.	.	.

MEANS AND STANDARD ERRORS

FOR STELLIFER LANCEOLATUS
IN THE SHIP CHANNEL

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		DENSITY		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
3	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	.	0.00	.	.	.
4	IN	0.00	.	506.00	.	0.00	.
	OUT	0.00	.	0.00	.	0.00	.
5	IN	178.89	88.84	0.00	0.00	0.50	0.50
	OUT	141.00	112.18	28.56	23.66	0.00	0.00
	SLA	.	.	0.00	.	0.00	.
6	IN	0.00	0.00	0.00	0.00	0.00	0.00
	OUT	0.00	0.00	0.00	0.00	0.00	0.00
	SLA	0.00	0.00	.	.	.	.

```
                                  MEANS AND STANDARD ERRORS                 10:27 THURSDAY, APRIL 27, 1989
1
                                 FOR MICROPOGONIAS UNDULATUS
                                    IN THE SHIP CHANNEL

 ----------------------------------------------------------------------------------------------------
 |                              |                              DEPTH                                |
 |                              |-------------------------------------------------------------------|
 |                              |        BOTTOM        |        MID-DEP        |       SURFACE       |
 |                              |----------------------+-----------------------+---------------------|
 |                              |       DENSITY        |        DENSITY        |       DENSITY       |
 |                              |----------------------+-----------------------+---------------------|
 |                              |   MEAN    |  STDERR  |   MEAN    |  STDERR   |   MEAN   |  STDERR  |
 |--------------+---------------+-----------+----------+-----------+-----------+----------+----------|
 |CRUISE        |CURRENT        |           |          |           |           |          |          |
 |--------------+---------------|           |          |           |           |          |          |
 |2             |IN             |       0.00|      0.00|       7.70|       5.97|      0.00|      0.00|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |OUT            |       0.00|      0.00|       0.00|       0.00|     11.67|     11.67|
 |--------------+---------------+-----------+----------+-----------+-----------+----------+----------|
 |3             |IN             |       0.00|      0.00|       0.00|       0.00|      0.00|      0.00|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |OUT            |      32.50|     32.50|       0.00|       0.00|      0.00|      0.00|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |SLA            |      63.00|         .|      48.00|          .|         .|         .|
 |--------------+---------------+-----------+----------+-----------+-----------+----------+----------|
 |4             |IN             |       0.00|         .|       0.00|          .|      0.00|         .|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |OUT            |       0.00|         .|       0.00|          .|      0.00|         .|
 |--------------+---------------+-----------+----------+-----------+-----------+----------+----------|
 |5             |IN             |       0.00|      0.00|       0.00|       0.00|      0.00|      0.00|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |OUT            |       4.88|      4.88|       0.00|       0.00|      0.00|      0.00|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |SLA            |          .|         .|       0.00|          .|      0.00|         .|
 |--------------+---------------+-----------+----------+-----------+-----------+----------+----------|
 |6             |IN             |       0.00|      0.00|       0.00|       0.00|      0.00|      0.00|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |OUT            |       0.00|      0.00|       0.00|       0.00|      0.00|      0.00|
 |              |---------------+-----------+----------+-----------+-----------+----------+----------|
 |              |SLA            |       0.00|      0.00|          .|          .|         .|         .|
 ----------------------------------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR TEMPERATURE
IN DEGREES CENTIGRADE

STATION 1

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		TEMP		TEMP		TEMP	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	17.31	0.10	17.35	0.09	17.35	0.14
	OUT	17.83	0.07	18.03	0.03	18.03	0.03
3	IN	22.24	0.33	22.20	0.15	22.34	0.13
	OUT	22.50	0.00	22.65	0.15	22.80	0.50
	SLA	22.30	.	22.30	.	.	.
4	IN	27.40	.	27.40	.	27.40	.
	OUT	27.40	.	27.40	.	27.40	.
5	IN	29.97	0.09	30.24	0.08	30.59	0.13
	OUT	30.18	0.17	30.43	0.14	30.74	0.21
	SLA	.	.	30.10	.	30.50	.
6	IN	28.20	0.26	28.43	0.27	28.83	0.15
	OUT	29.53	0.22	29.37	0.34	29.52	0.36
	SLA	28.45	0.05	.	.	.	.

FOR SALINITY
IN PARTS PER THOUSAND

STATION 1

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		SALINITY		SALINITY		SALINITY	
		MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT						
2	IN	31.43	0.17	31.24	0.15	31.15	0.14
	OUT	31.34	0.24	31.14	0.05	31.03	0.03
3	IN	34.13	0.20	33.98	0.24	33.84	0.32
	OUT	33.50	0.52	33.20	0.44	32.43	0.84
	SLA	34.16	.	34.16	.	.	.
4	IN	31.37	.	31.37	.	31.29	.
	OUT	31.37	.	31.37	.	31.44	.
5	IN	28.51	0.53	26.91	0.61	23.61	0.60
	OUT	28.19	0.78	26.85	0.73	22.79	0.58
	SLA	.	.	25.16	.	27.16	.
6	IN	34.01	0.80	33.75	0.94	30.89	1.19
	OUT	29.55	1.05	30.66	1.40	28.46	1.53
	SLA	34.73	0.68	.	.	.	.

MEANS AND STANDARD ERRORS

FOR CURRENT VELOCITY
IN CM PER SECOND

STATION 1

		DEPTH					
		BOTTOM		MID-DEP		SURFACE	
		VELOCITY		VELOCITY		VELOCITY	
CRUISE	CURRENT	MEAN	STDERR	MEAN	STDERR	MEAN	STDERR
2	IN	71.45	13.13	89.00	12.10	87.97	17.07
	OUT	-78.88	7.47	-66.88	10.29	-44.59	9.07
3	IN	51.44	17.17	52.91	20.45	46.30	17.34
	OUT	-84.88	12.86	-56.59	20.58	-46.30	30.87
	SLA	0.00	.	0.00	.	.	.
4	IN	56.59	.	51.44	.	46.30	.
	OUT	-30.87	.	-20.58	.	-20.58	.
5	IN	33.30	4.71	35.71	4.74	36.01	5.63
	OUT	-36.65	5.87	-50.30	7.11	-55.95	7.30
	SLA	.	.	0.00	.	0.00	.
6	IN	92.60	18.55	97.74	17.87	79.74	22.26
	OUT	-101.60	29.66	-91.74	22.08	-76.31	18.66
	SLA	0.00	0.00	.	.	.	.

```
1989  1                         MEANS AND STANDARD ERRORS                        17:13 FRIDAY, JULY 14

                                    FOR WIND VELOCITY
                                     IN CM PER SECOND

                  STATION 1
                  -----------------------------------------------------------
                  |                                 |           WIND          |
                  |                                 |-------------------------|
                  |                                 |    MEAN     |  STDERR   |
                  |---------------------------------+-------------+-----------|
                  |CRUISE          |CURRENT         |             |           |
                  |----------------+----------------|             |           |
                  |2               |IN              |        51.98|      19.69|
                  |                |----------------+-------------+-----------|
                  |                |OUT             |       557.31|      30.01|
                  |----------------+----------------+-------------+-----------|
                  |3               |IN              |       579.69|      29.19|
                  |                |----------------+-------------+-----------|
                  |                |OUT             |       468.14|      46.01|
                  |                |----------------+-------------+-----------|
                  |                |SLA             |       473.29|       0.00|
                  |----------------+----------------+-------------+-----------|
                  |4               |IN              |      1028.89|      51.44|
                  |                |----------------+-------------+-----------|
                  |                |OUT             |      1131.78|       0.00|
                  |----------------+----------------+-------------+-----------|
                  |5               |IN              |       292.17|      20.01|
                  |                |----------------+-------------+-----------|
                  |                |OUT             |       339.33|      42.82|
                  |                |----------------+-------------+-----------|
                  |                |SLA             |       259.79|      69.45|
                  |----------------+----------------+-------------+-----------|
                  |6               |IN              |       505.01|      11.33|
                  |                |----------------+-------------+-----------|
                  |                |OUT             |       378.12|      12.86|
                  |                |----------------+-------------+-----------|
                  |                |SLA             |       365.26|       0.00|
                  -----------------------------------------------------------
```

```
                              MEANS AND STANDARD ERRORS

                                 FOR TIDAL HEIGHT
                          IN FEET ABOVE MEAN LOW WATER MARK

               STATION 1
               ------------------------------------------------------------
               |                             |           TIDEHT           |
               |                             |----------------------------|
               |                             |     MEAN     |   STDERR    |
               |-----------------------------+--------------+-------------|
               |CRUISE        |CURRENT       |              |             |
               |--------------+--------------|              |             |
               |2             |IN            |         1.02|         0.06|
               |              |--------------+--------------+-------------|
               |              |OUT           |         0.63|         0.15|
               |--------------+--------------+--------------+-------------|
               |3             |IN            |         0.66|         0.10|
               |              |--------------+--------------+-------------|
               |              |OUT           |         0.18|         0.06|
               |              |--------------+--------------+-------------|
               |              |SLA           |         1.05|         0.05|
               |--------------+--------------+--------------+-------------|
               |4             |IN            |         1.30|         0.00|
               |              |--------------+--------------+-------------|
               |              |OUT           |         0.90|         0.00|
               |--------------+--------------+--------------+-------------|
               |5             |IN            |         0.81|         0.03|
               |              |--------------+--------------+-------------|
               |              |OUT           |         0.70|         0.04|
               |              |--------------+--------------+-------------|
               |              |SLA           |         0.85|         0.25|
               |--------------+--------------+--------------+-------------|
               |6             |IN            |         1.08|         0.06|
               |              |--------------+--------------+-------------|
               |              |OUT           |         0.47|         0.12|
               |              |--------------+--------------+-------------|
               |              |SLA           |         1.20|         0.10|
               ------------------------------------------------------------
```

```
                                    CORRELATION MATRIX FOR                    13:30 FRIDAY, JULY 14
1989  1
                                     PHYSICAL PARAMETERS
                                  IN MATAGORDA BAY SHIP CHANNEL

                 PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 190

                          TEMPSQ     SALIN   TIDALHT      WIND   CURRENT     LIGHT     DEPTH


                 TEMPSQ  1.00000  -0.59403  -0.10025   0.13137  -0.28236   0.08885  -0.02086
                          0.0000    0.0001    0.1687    0.0708    0.0001    0.2228    0.7751

                 SALIN  -0.59403   1.00000   0.24120   0.21722   0.26355  -0.20726   0.27696
                          0.0001    0.0000    0.0008    0.0026    0.0002    0.0041    0.0001

                 TIDALHT -0.10025   0.24120   1.00000  -0.18781   0.36534   0.15661  -0.04268
                          0.1687    0.0008    0.0000    0.0095    0.0001    0.0309    0.5588

                 WIND     0.13137   0.21722  -0.18781   1.00000  -0.19088   0.03058  -0.00356
                          0.0708    0.0026    0.0095    0.0000    0.0083    0.6753    0.9611

                 CURRENT -0.28236   0.26355   0.36534  -0.19088   1.00000  -0.26070  -0.00441
                          0.0001    0.0002    0.0001    0.0083    0.0000    0.0003    0.9518

                 LIGHT    0.08885  -0.20726   0.15661   0.03058  -0.26070   1.00000   0.00667
                          0.2228    0.0041    0.0309    0.6753    0.0003    0.0000    0.9273

                 DEPTH   -0.02086   0.27696  -0.04268  -0.00356  -0.00441   0.00667   1.00000
                          0.7751    0.0001    0.5588    0.9611    0.9518    0.9273    0.0000
```

```
                MEAN DENSITIES AND STANDARD ERRORS          18:12 WEDNESDAY, APRIL 26, 1989  2
                           FOR SHRIMP
                           BY STATION

STATION 2
-----------------------------------------------------------------------------------------------
|                                  |                          DEPTH                           |
|                                  |----------------------------------------------------------|
|                                  |           BOTTOM            |           SURFACE          |
|                                  |-----------------------------+----------------------------|
|                                  |           SHRIMP            |           SHRIMP           |
|                                  |-----------------------------+----------------------------|
|                                  |     MEAN     |    STDERR    |     MEAN     |    STDERR   |
|----------------------------------+--------------+--------------+--------------+-------------|
|CRUISE           |CURRENT         |              |              |              |             |
|-----------------+----------------|              |              |              |             |
|2                |SLA             |             .|             .|       2965.00|      1423.04|
|-----------------+----------------+--------------+--------------+--------------+-------------|
|3                |IN              |             .|             .|        210.00|            .|
|                 |----------------+--------------+--------------+--------------+-------------|
|                 |OUT             |             .|             .|        110.50|        60.43|
|-----------------+----------------+--------------+--------------+--------------+-------------|
|4                |IN              |             .|             .|       7101.43|       759.16|
|-----------------+----------------+--------------+--------------+--------------+-------------|
|5                |IN              |        580.33|        162.84|       2051.43|       425.29|
|                 |----------------+--------------+--------------+--------------+-------------|
|                 |OUT             |        584.67|        139.81|       4615.00|            .|
|-----------------+----------------+--------------+--------------+--------------+-------------|
|6                |IN              |         60.00|             .|        108.00|            .|
|                 |----------------+--------------+--------------+--------------+-------------|
|                 |OUT             |        452.00|        363.08|         62.40|        44.90|
-----------------------------------------------------------------------------------------------
```

```
                                MEAN DENSITIES AND STANDARD ERRORS
                                           FOR CRABS
                                          BY STATIONS

STATION 2
-----------------------------------------------------------------------------------------
|                              |                         DEPTH                          |
|                              |--------------------------------------------------------|
|                              |          BOTTOM           |          SURFACE           |
|                              |---------------------------+----------------------------|
|                              |          CRABS            |           CRABS            |
|                              |---------------------------+----------------------------|
|                              |     MEAN    |   STDERR    |     MEAN     |   STDERR    |
|------------------------------+-------------+-------------+--------------+-------------|
|CRUISE         |CURRENT       |             |             |              |             |
|---------------+--------------|             |             |              |             |
|2              |SLA           |            .|            .|      1176.67|       390.42|
|---------------+--------------+-------------+-------------+--------------+-------------|
|3              |IN            |            .|            .|      1975.00|            .|
|               |--------------+-------------+-------------+--------------+-------------|
|               |OUT           |            .|            .|      1544.50|       498.34|
|---------------+--------------+-------------+-------------+--------------+-------------|
|4              |IN            |            .|            .|     31592.71|      7092.65|
|---------------+--------------+-------------+-------------+--------------+-------------|
|5              |IN            |      2283.22|       942.58|      2080.21|       540.20|
|               |--------------+-------------+-------------+--------------+-------------|
|               |OUT           |      1404.00|       727.34|       427.00|            .|
|---------------+--------------+-------------+-------------+--------------+-------------|
|6              |IN            |         0.00|            .|         0.00|            .|
|               |--------------+-------------+-------------+--------------+-------------|
|               |OUT           |       441.00|       276.93|        69.40|        58.80|
-----------------------------------------------------------------------------------------
```

```
                    MEAN DENSITIES AND STANDARD ERRORS
                              FOR FISH EGGS
                               BY STATIONS

STATION 2
---------------------------------------------------------------------------------------------
|                                 |                        DEPTH                            |
|                                 |---------------------------------------------------------|
|                                 |          BOTTOM            |          SURFACE           |
|                                 |----------------------------+----------------------------|
|                                 |           EGGS             |           EGGS             |
|                                 |----------------------------+----------------------------|
|                                 |    MEAN     |    STDERR    |    MEAN     |    STDERR    |
|---------------------------------+-------------+--------------+-------------+--------------|
|CRUISE          |CURRENT         |             |              |             |              |
|----------------+----------------|             |              |             |              |
|2               |SLA             |            .|             .|       144.00|         73.75|
|----------------+----------------+-------------+--------------+-------------+--------------|
|3               |IN              |            .|             .|      3992.00|             .|
|                |----------------+-------------+--------------+-------------+--------------|
|                |OUT             |            .|             .|     12160.00|       7256.70|
|----------------+----------------+-------------+--------------+-------------+--------------|
|4               |IN              |            .|             .|      4148.29|       1117.74|
|----------------+----------------+-------------+--------------+-------------+--------------|
|5               |IN              |     13028.00|       2914.29|     18216.14|       3738.14|
|                |----------------+-------------+--------------+-------------+--------------|
|                |OUT             |     10178.33|       2736.60|      7692.00|             .|
|----------------+----------------+-------------+--------------+-------------+--------------|
|6               |IN              |       599.00|             .|       940.00|             .|
|                |----------------+-------------+--------------+-------------+--------------|
|                |OUT             |     17170.40|       5345.82|     46677.80|      18526.89|
---------------------------------------------------------------------------------------------
```

```
                    MEAN DENSITIES AND STANDARD ERRORS                19:54 MONDAY, MAY 8, 1989  2
                           FOR ESTUARINE FISH
                               BY STATION

STATION 2
-------------------------------------------------------------------------------
|                                   |                  DEPTH                  |
|                                   |-----------------------------------------|
|                                   |       BOTTOM       |       SURFACE      |
|                                   |--------------------+--------------------|
|                                   |       ESTFIS       |       ESTFIS       |
|                                   |--------------------+--------------------|
|                                   |   MEAN   |  STDERR  |   MEAN   |  STDERR  |
|-----------------------------------+---------+----------+---------+----------|
|CRUISE           |CURRENT          |         |          |         |          |
|-----------------+-----------------|         |          |         |          |
|2                |SLA              |        .|         .|   469.33|     86.99|
|-----------------+-----------------+---------+----------+---------+----------|
|3                |IN               |        .|         .|    42.00|         .|
|                 |-----------------+---------+----------+---------+----------|
|                 |OUT              |        .|         .|   494.00|    237.74|
|-----------------+-----------------+---------+----------+---------+----------|
|4                |IN               |        .|         .|   704.57|    160.19|
|-----------------+-----------------+---------+----------+---------+----------|
|5                |IN               |   653.67|    270.21|   188.14|     35.63|
|                 |-----------------+---------+----------+---------+----------|
|                 |OUT              |   555.50|     97.59|   171.00|         .|
|-----------------+-----------------+---------+----------+---------+----------|
|6                |IN               |   150.00|         .|   361.00|         .|
|                 |-----------------+---------+----------+---------+----------|
|                 |OUT              |   298.00|    105.24|   427.60|    243.85|
-------------------------------------------------------------------------------
```

```
                    MEAN DENSITIES AND STANDARD ERRORS
                           FOR MARINE FISH
                             BY STATIONS

STATION 2
-----------------------------------------------------------------------
|                          |                  DEPTH                   |
|                          |------------------------------------------|
|                          |       BOTTOM        |       SURFACE      |
|                          |---------------------+--------------------|
|                          |       MARFIS        |       MARFIS       |
|                          |---------------------+--------------------|
|                          |   MEAN   |  STDERR  |   MEAN   |  STDERR |
|--------------------------+----------+----------+----------+---------|
|CRUISE      |CURRENT      |          |          |          |         |
|------------+-------------|          |          |          |         |
|2           |SLA          |         .|         .|    252.67|    53.05|
|------------+-------------+----------+----------+----------+---------|
|3           |IN           |         .|         .|    168.00|        .|
|            |-------------+----------+----------+----------+---------|
|            |OUT          |         .|         .|    264.75|    94.24|
|------------+-------------+----------+----------+----------+---------|
|4           |IN           |         .|         .|    633.57|   114.79|
|------------+-------------+----------+----------+----------+---------|
|5           |IN           |    237.00|     38.38|    385.00|    68.99|
|            |-------------+----------+----------+----------+---------|
|            |OUT          |    270.00|     98.88|    299.00|        .|
|------------+-------------+----------+----------+----------+---------|
|6           |IN           |      0.00|         .|      0.00|        .|
|            |-------------+----------+----------+----------+---------|
|            |OUT          |     88.40|     67.78|     21.60|    14.16|
-----------------------------------------------------------------------
```

MEAN DENSITIES AND STANDARD ERRORS
FOR MARINE SCIAENIDS
BY STATIONS

STATION 2

		DEPTH			
		BOTTOM		SURFACE	
		MARSCI		MARSCI	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	SLA	.	.	226.67	133.74
3	IN	.	.	0.00	.
	OUT	.	.	46.50	33.48
4	IN	.	.	0.00	0.00
5	IN	18.44	9.99	7.50	5.26
	OUT	24.83	15.72	0.00	.
6	IN	0.00	.	0.00	.
	OUT	0.00	0.00	0.00	0.00

```
                              MEANS AND STANDARD ERRORS                  9:10 THURSDAY, APRIL 27, 1989

                              FOR PENAEIDAE PROTOZOEA
                                 IN SALURIA BAYOU

--------------------------------------------------------------------------------
|                         |                        DEPTH                        |
|                         |-----------------------------------------------------|
|                         |         BOTTOM           |         SURFACE          |
|                         |--------------------------+--------------------------|
|                         |         DENSITY          |         DENSITY          |
|                         |--------------------------+--------------------------|
|                         |    MEAN     |   STDERR   |    MEAN     |   STDERR   |
|-------------------------+-------------+------------+-------------+------------|
|CRUISE       |CURRENT    |             |            |             |            |
|-------------+-----------|             |            |             |            |
|2            |SLA        |            .|           .|         0.00|        0.00|
|-------------+-----------+-------------+------------+-------------+------------|
|3            |IN         |            .|           .|       168.00|           .|
|             |-----------+-------------+------------+-------------+------------|
|             |OUT        |            .|           .|        69.75|       30.42|
|-------------+-----------+-------------+------------+-------------+------------|
|4            |IN         |            .|           .|      6260.14|      833.45|
|-------------+-----------+-------------+------------+-------------+------------|
|5            |IN         |        45.44|       13.79|        60.50|       24.64|
|             |-----------+-------------+------------+-------------+------------|
|             |OUT        |        47.33|       41.27|        85.00|           .|
|-------------+-----------+-------------+------------+-------------+------------|
|6            |IN         |         0.00|           .|         0.00|           .|
|             |-----------+-------------+------------+-------------+------------|
|             |OUT        |         0.00|        0.00|         0.00|        0.00|
--------------------------------------------------------------------------------
```

```
                                   MEANS AND STANDARD ERRORS                    9:25 THURSDAY, APRIL 27, 1989
  1
                                      FOR PENAEUS MYSIS
                                       IN SALURIA BAYOU

               ------------------------------------------------------------------------------------
               |                               |                      DEPTH                       |
               |                               |--------------------------------------------------|
               |                               |         BOTTOM          |         SURFACE        |
               |                               |-------------------------+------------------------|
               |                               |         DENSITY         |         DENSITY        |
               |                               |-------------------------+------------------------|
               |                               |    MEAN    |   STDERR   |    MEAN    |   STDERR  |
               |-------------------------------+------------+------------+------------+-----------|
               |CRUISE         |CURRENT        |            |            |            |           |
               |---------------+---------------|            |            |            |           |
               |2              |SLA            |           .|           .|        0.00|       0.00|
               |---------------+---------------+------------+------------+------------+-----------|
               |3              |IN             |           .|           .|       42.00|          .|
               |               |---------------+------------+------------+------------+-----------|
               |               |OUT            |           .|           .|       40.75|      40.75|
               |---------------+---------------+------------+------------+------------+-----------|
               |4              |IN             |           .|           .|      617.00|      75.74|
               |---------------+---------------+------------+------------+------------+-----------|
               |5              |IN             |        0.00|        0.00|        0.00|       0.00|
               |               |---------------+------------+------------+------------+-----------|
               |               |OUT            |        0.00|        0.00|        0.00|          .|
               |---------------+---------------+------------+------------+------------+-----------|
               |6              |IN             |        0.00|           .|        0.00|          .|
               |               |---------------+------------+------------+------------+-----------|
               |               |OUT            |        7.40|        7.40|        0.00|       0.00|
               ------------------------------------------------------------------------------------
```

```
                                       MEANS AND STANDARD ERRORS                     9:16 THURSDAY, APRIL 27, 1989
  1
                                     FOR PENAEUS AZTECUS POSTLARVAE
                                            IN SALURIA BAYOU

                  --------------------------------------------------------------------------
                  |                             |                    DEPTH                  |
                  |                             |-------------------------------------------|
                  |                             |        BOTTOM        |       SURFACE      |
                  |                             |----------------------+--------------------|
                  |                             |        DENSITY       |       DENSITY      |
                  |                             |----------------------+--------------------|
                  |                             |    MEAN   |  STDERR  |   MEAN   |  STDERR |
                  |-----------------------------+-----------+----------+----------+---------|
                  |CRUISE        |CURRENT       |           |          |          |         |
                  |--------------+--------------|           |          |          |         |
                  |2             |SLA           |          .|         .|   2965.00|  1423.04|
                  |--------------+--------------+-----------+----------+----------+---------|
                  |3             |IN            |          .|         .|      0.00|        .|
                  |              |--------------+-----------+----------+----------+---------|
                  |              |OUT           |          .|         .|      0.00|     0.00|
                  |--------------+--------------+-----------+----------+----------+---------|
                  |4             |IN            |          .|         .|    141.00|    50.12|
                  |--------------+--------------+-----------+----------+----------+---------|
                  |5             |IN            |       0.00|      0.00|     20.29|    14.71|
                  |              |--------------+-----------+----------+----------+---------|
                  |              |OUT           |       5.33|      5.33|      0.00|        .|
                  |--------------+--------------+-----------+----------+----------+---------|
                  |6             |IN            |       0.00|         .|      0.00|        .|
                  |              |--------------+-----------+----------+----------+---------|
                  |              |OUT           |      88.40|     88.40|      0.00|     0.00|
                  --------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR PENAEUS SPP POSTLARVAE
IN SALURIA BAYOU

		DEPTH			
		BOTTOM		SURFACE	
		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	SLA	.	.	0.00	0.00
3	IN	.	.	0.00	.
	OUT	.	.	0.00	0.00
4	IN	.	.	83.29	53.98
5	IN	534.89	167.27	1970.64	437.50
	OUT	532.00	146.68	4530.00	.
6	IN	60.00	.	108.00	.
	OUT	356.20	269.53	62.40	44.90

```
1                              MEANS AND STANDARD ERRORS                9:16 THURSDAY, APRIL 27, 1989

                                   FOR PORTUNID ZOEA
                                    IN SALURIA BAYOU

        ----------------------------------------------------------------------------------
        |                              |                    DEPTH                        |
        |                              |-------------------------------------------------|
        |                              |         BOTTOM         |        SURFACE         |
        |                              |------------------------+------------------------|
        |                              |         DENSITY        |        DENSITY         |
        |                              |------------------------+------------------------|
        |                              |    MEAN    |  STDERR   |    MEAN    |  STDERR   |
        |------------------------------+------------+-----------+------------+-----------|
        |CRUISE         |CURRENT       |            |           |            |           |
        |---------------+--------------|            |           |            |           |
        |2              |SLA           |           .|          .|       24.67|      24.67|
        |---------------+--------------+------------+-----------+------------+-----------|
        |3              |IN            |           .|          .|     1975.00|          .|
        |               |--------------+------------+-----------+------------+-----------|
        |               |OUT           |           .|          .|     1544.50|     498.34|
        |---------------+--------------+------------+-----------+------------+-----------|
        |4              |IN            |           .|          .|    31592.71|    7092.65|
        |---------------+--------------+------------+-----------+------------+-----------|
        |5              |IN            |     2180.89|     917.33|     1614.36|     491.86|
        |               |--------------+------------+-----------+------------+-----------|
        |               |OUT           |      783.67|     177.95|      427.00|          .|
        |---------------+--------------+------------+-----------+------------+-----------|
        |6              |IN            |        0.00|          .|        0.00|          .|
        |               |--------------+------------+-----------+------------+-----------|
        |               |OUT           |      153.60|      64.50|       61.80|      51.30|
        ----------------------------------------------------------------------------------
```

```
 1                                   MEANS AND STANDARD ERRORS                     9:17 THURSDAY, APRIL 27, 1989

                                     FOR CALLINECTES MEGALOPA
                                          IN SALURIA BAYOU

            -------------------------------------------------------------------------------------
            |                                   |                     DEPTH                     |
            |                                   |-----------------------------------------------|
            |                                   |        BOTTOM         |        SURFACE        |
            |                                   |-----------------------+-----------------------|
            |                                   |        DENSITY        |        DENSITY        |
            |                                   |-----------------------+-----------------------|
            |                                   |   MEAN    |  STDERR   |   MEAN    |  STDERR   |
            |-----------------------------------+-----------+-----------+-----------+-----------|
            |CRUISE           |CURRENT          |           |           |           |           |
            |-----------------+-----------------|           |           |           |           |
            |2                |SLA              |          .|          .|    1140.00|     407.83|
            |-----------------+-----------------+-----------+-----------+-----------+-----------|
            |3                |IN               |          .|          .|       0.00|          .|
            |                 |-----------------+-----------+-----------+-----------+-----------|
            |                 |OUT              |          .|          .|       0.00|       0.00|
            |-----------------+-----------------+-----------+-----------+-----------+-----------|
            |4                |IN               |          .|          .|       0.00|       0.00|
            |-----------------+-----------------+-----------+-----------+-----------+-----------|
            |5                |IN               |     102.33|      46.84|     448.36|     179.64|
            |                 |-----------------+-----------+-----------+-----------+-----------|
            |                 |OUT              |     581.83|     545.18|       0.00|          .|
            |-----------------+-----------------+-----------+-----------+-----------+-----------|
            |6                |IN               |       0.00|          .|       0.00|          .|
            |                 |-----------------+-----------+-----------+-----------+-----------|
            |                 |OUT              |     287.40|     231.36|       7.60|       7.60|
            -------------------------------------------------------------------------------------
```

```
                              MEANS AND STANDARD ERRORS

                              FOR PORTUNID JUVENILES
                                 IN SALURIA BAYOU

---------------------------------------------------------------------------------
|                            |                      DEPTH                       |
|                            |--------------------------------------------------|
|                            |         BOTTOM          |        SURFACE         |
|                            |-------------------------+------------------------|
|                            |         DENSITY         |        DENSITY         |
|                            |-------------------------+------------------------|
|                            |    MEAN    |   STDERR   |    MEAN    |  STDERR   |
|----------------------------+------------+------------+------------+-----------|
|CRUISE         |CURRENT     |            |            |            |           |
|---------------+------------|            |            |            |           |
|2              |SLA         |           .|           .|       12.00|      12.00|
|---------------+------------+------------+------------+------------+-----------|
|3              |IN          |           .|           .|        0.00|          .|
|               |------------+------------+------------+------------+-----------|
|               |OUT         |           .|           .|        0.00|       0.00|
|---------------+------------+------------+------------+------------+-----------|
|4              |IN          |           .|           .|        0.00|       0.00|
|---------------+------------+------------+------------+------------+-----------|
|5              |IN          |        0.00|        0.00|       17.50|      14.70|
|               |------------+------------+------------+------------+-----------|
|               |OUT         |       38.50|       38.50|        0.00|          .|
|---------------+------------+------------+------------+------------+-----------|
|6              |IN          |        0.00|           .|        0.00|          .|
|               |------------+------------+------------+------------+-----------|
|               |OUT         |        0.00|        0.00|        0.00|       0.00|
---------------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR BAIRDIELLA CHRYSOURA
IN SALURIA BAYOU

		DEPTH			
		BOTTOM		SURFACE	
		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	SLA	.	.	0.00	0.00
3	IN	.	.	0.00	.
	OUT	.	.	0.00	0.00
4	IN	.	.	64.29	48.49
5	IN	3.33	3.33	0.00	0.00
	OUT	0.00	0.00	0.00	.
6	IN	0.00	.	0.00	.
	OUT	3.60	3.60	0.00	0.00

MEANS AND STANDARD ERRORS

FOR CYNOSCION ARENARIUS
IN SALURIA BAYOU

		DEPTH			
		BOTTOM		SURFACE	
		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	SLA	.	.	12.00	12.00
3	IN	.	.	0.00	.
	OUT	.	.	0.00	0.00
4	IN	.	.	0.00	0.00
5	IN	3.33	3.33	4.64	4.64
	OUT	0.00	0.00	0.00	.
6	IN	0.00	.	0.00	.
	OUT	0.00	0.00	0.00	0.00

```
                                MEANS AND STANDARD ERRORS                 9:45 THURSDAY, APRIL 27, 1989

                                FOR CYNOSCION NEBULOSUS
                                    IN SALURIA BAYOU

          ------------------------------------------------------------------------------------
          |                               |                       DEPTH                       |
          |                               |---------------------------------------------------|
          |                               |         BOTTOM          |         SURFACE         |
          |                               |-------------------------+-------------------------|
          |                               |         DENSITY         |         DENSITY         |
          |                               |-------------------------+-------------------------|
          |                               |    MEAN    |   STDERR   |    MEAN    |   STDERR   |
          |-------------------------------+------------+------------+------------+------------|
          |CRUISE          |CURRENT       |            |            |            |            |
          |----------------+--------------|            |            |            |            |
          |2               |SLA           |           .|           .|        0.00|        0.00|
          |----------------+--------------+------------+------------+------------+------------|
          |3               |IN            |           .|           .|        0.00|           .|
          |                |--------------+------------+------------+------------+------------|
          |                |OUT           |           .|           .|        0.00|        0.00|
          |----------------+--------------+------------+------------+------------+------------|
          |4               |IN            |           .|           .|       30.14|       15.75|
          |----------------+--------------+------------+------------+------------+------------|
          |5               |IN            |       33.22|       15.99|        2.71|        2.71|
          |                |--------------+------------+------------+------------+------------|
          |                |OUT           |       17.83|        8.03|        0.00|           .|
          |----------------+--------------+------------+------------+------------+------------|
          |6               |IN            |        0.00|           .|        0.00|           .|
          |                |--------------+------------+------------+------------+------------|
          |                |OUT           |        0.00|        0.00|        0.00|        0.00|
          ------------------------------------------------------------------------------------
```

```
                                   MEANS AND STANDARD ERRORS                  9:43 THURSDAY, APRIL 27, 1989
 1
                                      FOR CYNOSCION NOTHUS
                                        IN SALURIA BAYOU

          ---------------------------------------------------------------------------------
          |                              |                    DEPTH                       |
          |                              |-----------------------------------------------|
          |                              |        BOTTOM          |       SURFACE          |
          |                              |-----------------------+-----------------------|
          |                              |        DENSITY         |       DENSITY          |
          |                              |-----------------------+-----------------------|
          |                              |   MEAN    |  STDERR    |   MEAN    |  STDERR    |
          |------------------------------+-----------+-----------+-----------+-----------|
          |CRUISE        |CURRENT        |           |           |           |           |
          |--------------+---------------|           |           |           |           |
          |2             |SLA            |          .|          .|       0.00|       0.00|
          |--------------+---------------+-----------+-----------+-----------+-----------|
          |3             |IN             |          .|          .|       0.00|          .|
          |              |---------------+-----------+-----------+-----------+-----------|
          |              |OUT            |          .|          .|       0.00|       0.00|
          |--------------+---------------+-----------+-----------+-----------+-----------|
          |4             |IN             |          .|          .|       0.00|       0.00|
          |--------------+---------------+-----------+-----------+-----------+-----------|
          |5             |IN             |       0.00|       0.00|       0.00|       0.00|
          |              |---------------+-----------+-----------+-----------+-----------|
          |              |OUT            |       0.00|       0.00|       0.00|          .|
          |--------------+---------------+-----------+-----------+-----------+-----------|
          |6             |IN             |       0.00|          .|       0.00|          .|
          |              |---------------+-----------+-----------+-----------+-----------|
          |              |OUT            |       0.00|       0.00|       0.00|       0.00|
          ---------------------------------------------------------------------------------
```

```
                                 MEANS AND STANDARD ERRORS

                                  FOR LARIMUS FASCIATUS
                                     IN SALURIA BAYOU

--------------------------------------------------------------------------
|                               |                 DEPTH                  |
|                               |----------------------------------------|
|                               |       BOTTOM       |      SURFACE      |
|                               |--------------------+-------------------|
|                               |      DENSITY       |      DENSITY      |
|                               |--------------------+-------------------|
|                               |   MEAN   |  STDERR |   MEAN  |  STDERR |
|-------------------------------+----------+---------+---------+---------|
|CRUISE         |CURRENT        |          |         |         |         |
|---------------+---------------|          |         |         |         |
|2              |SLA            |         .|        .|     0.00|     0.00|
|---------------+---------------+----------+---------+---------+---------|
|3              |IN             |         .|        .|     0.00|        .|
|               |---------------+----------+---------+---------+---------|
|               |OUT            |         .|        .|     0.00|     0.00|
|---------------+---------------+----------+---------+---------+---------|
|4              |IN             |         .|        .|     0.00|     0.00|
|---------------+---------------+----------+---------+---------+---------|
|5              |IN             |      0.00|     0.00|     0.00|     0.00|
|               |---------------+----------+---------+---------+---------|
|               |OUT            |      0.00|     0.00|     0.00|        .|
|---------------+---------------+----------+---------+---------+---------|
|6              |IN             |      0.00|        .|     0.00|        .|
|               |---------------+----------+---------+---------+---------|
|               |OUT            |      0.00|     0.00|     0.00|     0.00|
--------------------------------------------------------------------------
```

```
                         MEANS AND STANDARD ERRORS

                           FOR POGONIAS CROMIS
                            IN SALURIA BAYOU

---------------------------------------------------------------------------
|                        |                     DEPTH                      |
|                        |------------------------------------------------|
|                        |         BOTTOM         |        SURFACE        |
|                        |------------------------+-----------------------|
|                        |        DENSITY         |        DENSITY        |
|                        |------------------------+-----------------------|
|                        |    MEAN    |  STDERR   |    MEAN    |  STDERR  |
|------------------------+------------+-----------+------------+----------|
|CRUISE      |CURRENT    |            |           |            |          |
|------------+-----------|            |           |            |          |
|2           |SLA        |           .|          .|      202.67|    113.10|
|------------+-----------+------------+-----------+------------+----------|
|3           |IN         |           .|          .|        0.00|         .|
|            |-----------+------------+-----------+------------+----------|
|            |OUT        |           .|          .|       46.50|     33.48|
|------------+-----------+------------+-----------+------------+----------|
|4           |IN         |           .|          .|        0.00|      0.00|
|------------+-----------+------------+-----------+------------+----------|
|5           |IN         |       15.11|      10.06|        2.86|      2.86|
|            |-----------+------------+-----------+------------+----------|
|            |OUT        |       12.83|      12.83|        0.00|         .|
|------------+-----------+------------+-----------+------------+----------|
|6           |IN         |        0.00|          .|        0.00|         .|
|            |-----------+------------+-----------+------------+----------|
|            |OUT        |        0.00|       0.00|        0.00|      0.00|
---------------------------------------------------------------------------
```

```
                               MEANS AND STANDARD ERRORS

                               FOR SCIAENOPS OCELLATUS
                                   IN SALURIA BAYOU

 ---------------------------------------------------------------------------
 |                            |                    DEPTH                   |
 |                            |--------------------------------------------|
 |                            |        BOTTOM        |       SURFACE       |
 |                            |----------------------+---------------------|
 |                            |       DENSITY        |       DENSITY       |
 |                            |----------------------+---------------------|
 |                            |   MEAN    |  STDERR  |   MEAN   |  STDERR  |
 |----------------------------+-----------+----------+----------+----------|
 |CRUISE       |CURRENT       |           |          |          |          |
 |-------------+--------------|           |          |          |          |
 |2            |SLA           |          .|         .|      0.00|      0.00|
 |-------------+--------------+-----------+----------+----------+----------|
 |3            |IN            |          .|         .|      0.00|         .|
 |             |--------------+-----------+----------+----------+----------|
 |             |OUT           |          .|         .|      0.00|      0.00|
 |-------------+--------------+-----------+----------+----------+----------|
 |4            |IN            |          .|         .|      0.00|      0.00|
 |-------------+--------------+-----------+----------+----------+----------|
 |5            |IN            |       0.00|      0.00|      0.00|      0.00|
 |             |--------------+-----------+----------+----------+----------|
 |             |OUT           |      12.00|     12.00|      0.00|         .|
 |-------------+--------------+-----------+----------+----------+----------|
 |6            |IN            |       0.00|         .|      0.00|         .|
 |             |--------------+-----------+----------+----------+----------|
 |             |OUT           |       0.00|      0.00|      0.00|      0.00|
 ---------------------------------------------------------------------------
```

```
                        MEANS AND STANDARD ERRORS

                      FOR MICROPOGONIAS UNDULATUS
                            IN SALURIA BAYOU

-------------------------------------------------------------------------
|                               |                 DEPTH                 |
|                               |---------------------------------------|
|                               |       BOTTOM       |     SURFACE      |
|                               |--------------------+------------------|
|                               |      DENSITY       |     DENSITY      |
|                               |--------------------+------------------|
|                               |   MEAN   |  STDERR |   MEAN  | STDERR |
|-------------------------------+----------+---------+---------+--------|
|CRUISE         |CURRENT        |          |         |         |        |
|---------------+---------------|          |         |         |        |
|2              |SLA            |         .|        .|    12.00|   12.00|
|---------------+---------------+----------+---------+---------+--------|
|3              |IN             |         .|        .|     0.00|       .|
|               |---------------+----------+---------+---------+--------|
|               |OUT            |         .|        .|     0.00|    0.00|
|---------------+---------------+----------+---------+---------+--------|
|4              |IN             |         .|        .|     0.00|    0.00|
|---------------+---------------+----------+---------+---------+--------|
|5              |IN             |      0.00|     0.00|     0.00|    0.00|
|               |---------------+----------+---------+---------+--------|
|               |OUT            |      0.00|     0.00|     0.00|       .|
|---------------+---------------+----------+---------+---------+--------|
|6              |IN             |      0.00|        .|     0.00|       .|
|               |---------------+----------+---------+---------+--------|
|               |OUT            |      0.00|     0.00|     0.00|    0.00|
-------------------------------------------------------------------------
```

```
                      MEANS AND STANDARD ERRORS                15:38 FRIDAY, JULY 14
                           FOR TEMPERATURE
                         IN DEGREES CENTIGRADE

STATION 2
--------------------------------------------------------------------------------------
|                                |                        DEPTH                      |
|                                |---------------------------------------------------|
|                                |          BOTTOM          |         SURFACE        |
|                                |--------------------------+------------------------|
|                                |           TEMP           |          TEMP          |
|                                |--------------------------+------------------------|
|                                |     MEAN    |   STDERR   |    MEAN    |   STDERR  |
|--------------------------------+-------------+------------+------------+-----------|
|CRUISE          |CURRENT        |             |            |            |           |
|----------------+---------------|             |            |            |           |
|2               |SLA            |            .|           .|       18.43|       0.17|
|----------------+---------------+-------------+------------+------------+-----------|
|3               |IN             |            .|           .|       22.40|          .|
|                |---------------+-------------+------------+------------+-----------|
|                |OUT            |            .|           .|       23.48|       1.02|
|----------------+---------------+-------------+------------+------------+-----------|
|4               |IN             |            .|           .|       27.96|       0.08|
|----------------+---------------+-------------+------------+------------+-----------|
|5               |IN             |        30.07|        0.07|       29.96|       0.07|
|                |---------------+-------------+------------+------------+-----------|
|                |OUT            |        30.07|        0.12|       30.30|          .|
|----------------+---------------+-------------+------------+------------+-----------|
|6               |IN             |        30.40|           .|       30.30|          .|
|                |---------------+-------------+------------+------------+-----------|
|                |OUT            |        29.70|        0.42|       29.66|       0.41|
--------------------------------------------------------------------------------------
```

```
                    MEANS AND STANDARD ERRORS
                          FOR SALINITY
                     IN PARTS PER THOUSAND

STATION 2
---------------------------------------------------------------------
|                               |               DEPTH               |
|                               |-----------------------------------|
|                               |     BOTTOM      |     SURFACE     |
|                               |-----------------+-----------------|
|                               |    SALINITY     |    SALINITY     |
|                               |-----------------+-----------------|
|                               |  MEAN  | STDERR |  MEAN  | STDERR |
|-------------------------------+--------+--------+--------+--------|
|CRUISE         |CURRENT        |        |        |        |        |
|---------------+---------------|        |        |        |        |
|2              |SLA            |       .|       .|   31.59|    0.11|
|---------------+---------------+--------+--------+--------+--------|
|3              |IN             |       .|       .|   34.08|       .|
|               |---------------+--------+--------+--------+--------|
|               |OUT            |       .|       .|   30.51|    2.41|
|---------------+---------------+--------+--------+--------+--------|
|4              |IN             |       .|       .|   31.68|    0.06|
|---------------+---------------+--------+--------+--------+--------|
|5              |IN             |   29.28|    0.32|   29.34|    0.22|
|               |---------------+--------+--------+--------+--------|
|               |OUT            |   29.34|    0.31|   28.46|       .|
|---------------+---------------+--------+--------+--------+--------|
|6              |IN             |   15.17|       .|   10.76|       .|
|               |---------------+--------+--------+--------+--------|
|               |OUT            |   18.73|    3.99|   11.75|    0.84|
---------------------------------------------------------------------
```

```
                           MEANS AND STANDARD ERRORS                  17:13 FRIDAY, JULY 14
                             FOR CURRENT VELOCITY
                              IN CM PER SECOND

STATION 2
-----------------------------------------------------------------------------------
|                                 |                    DEPTH                      |
|                                 |-----------------------------------------------|
|                                 |       BOTTOM          |       SURFACE         |
|                                 |-----------------------+-----------------------|
|                                 |      VELOCITY         |      VELOCITY         |
|                                 |-----------------------+-----------------------|
|                                 |   MEAN    |  STDERR   |   MEAN    |  STDERR   |
|---------------------------------+-----------+-----------+-----------+-----------|
|CRUISE          |CURRENT         |           |           |           |           |
|----------------+----------------|           |           |           |           |
|2               |SLA             |          .|          .|       0.00|       0.00|
|----------------+----------------+-----------+-----------+-----------+-----------|
|3               |IN              |          .|          .|      15.43|          .|
|                |----------------+-----------+-----------+-----------+-----------|
|                |OUT             |          .|          .|     -34.73|       5.30|
|----------------+----------------+-----------+-----------+-----------+-----------|
|4               |IN              |          .|          .|      51.44|      12.30|
|----------------+----------------+-----------+-----------+-----------+-----------|
|5               |IN              |      29.72|       5.74|      29.03|       4.09|
|                |----------------+-----------+-----------+-----------+-----------|
|                |OUT             |     -24.86|       4.87|      -5.14|          .|
|----------------+----------------+-----------+-----------+-----------+-----------|
|6               |IN              |      30.87|          .|      10.29|          .|
|                |----------------+-----------+-----------+-----------+-----------|
|                |OUT             |     -34.98|      10.34|     -62.76|      12.95|
-----------------------------------------------------------------------------------
```

```
                      MEANS AND STANDARD ERRORS
                         FOR WIND VELOCITY
                          IN CM PER SECOND

STATION 2
------------------------------------------------------------
|                                |           WIND          |
|                                |-------------------------|
|                                |    MEAN    |   STDERR   |
|--------------------------------+------------+------------|
|CRUISE          |CURRENT        |            |            |
|----------------+---------------|            |            |
|2               |SLA            |      181.77|       96.58|
|----------------+---------------+------------+------------|
|3               |IN             |      308.67|           .|
|                |---------------+------------+------------|
|                |OUT            |      146.62|       75.39|
|----------------+---------------+------------+------------|
|4               |IN             |      584.26|       87.91|
|----------------+---------------+------------+------------|
|5               |IN             |      459.42|       48.21|
|                |---------------+------------+------------|
|                |OUT            |      444.63|       32.26|
|----------------+---------------+------------+------------|
|6               |IN             |     -195.49|        0.00|
|                |---------------+------------+------------|
|                |OUT            |       37.55|       33.07|
------------------------------------------------------------
```

MEANS AND STANDARD ERRORS
FOR TIDAL HEIGHT
IN FEET ABOVE MEAN LOW WATER MARK

STATION 2

		TIDEHT	
		MEAN	STDERR
CRUISE	CURRENT		
2	SLA	1.17	0.03
3	IN	1.20	.
	OUT	0.98	0.14
4	IN	0.61	0.18
5	IN	0.90	0.11
	OUT	0.71	0.14
6	IN	0.95	0.05
	OUT	0.69	0.12

```
                                   CORRELATION MATRIX FOR                        14:19 FRIDAY, JULY 14
1989  1
                                   PHYSICAL PARAMETERS
                                    IN SALURIA BAYOU

                 PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 57

                      TEMPSQ     SALIN   TIDALHT      WIND   CURRENT     LIGHT     DEPTH

  TEMPSQ             1.00000  -0.33935  -0.26145   0.18337   0.09816   0.00000   0.37405
                      0.0000    0.0098    0.0495    0.1721    0.4676    1.0000    0.0042

  SALIN             -0.33935   1.00000   0.18837   0.52424   0.53031   0.00000  -0.07899
                      0.0098    0.0000    0.1605    0.0001    0.0001    1.0000    0.5592

  TIDALHT           -0.26145   0.18837   1.00000  -0.11647   0.19462   0.00000  -0.05002
                      0.0495    0.1605    0.0000    0.3882    0.1469    1.0000    0.7117

  WIND               0.18337   0.52424  -0.11647   1.00000   0.54659   0.00000  -0.00857
                      0.1721    0.0001    0.3882    0.0000    0.0001    1.0000    0.9496

  CURRENT            0.09816   0.53031   0.19462   0.54659   1.00000   0.00000  -0.12721
                      0.4676    0.0001    0.1469    0.0001    0.0000    1.0000    0.3457

  LIGHT              0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
                      1.0000    1.0000    1.0000    1.0000    1.0000    1.0000    1.0000

  DEPTH              0.37405  -0.07899  -0.05002  -0.00857  -0.12721   0.00000   1.00000
                      0.0042    0.5592    0.7117    0.9496    0.3457    1.0000    0.0000
```

MEAN DENSITIES AND STANDARD ERRORS
FOR SHRIMP
BY STATION

STATION 4

		DEPTH			
		BOTTOM		SURFACE	
		SHRIMP		SHRIMP	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	121.00	.
	OUT	.	.	120.00	24.48
3	OUT	.	.	478.67	187.01
	SLA	.	.	30.75	19.29
4	IN	.	.	6390.63	842.07
5	IN	458.29	164.85	375.64	211.98
	OUT	202.00	.	52.00	.
	SLA	18.25	18.25	.	.
6	OUT	1268.90	660.33	448.00	404.64

```
                MEAN DENSITIES AND STANDARD ERRORS
                             FOR CRABS
                            BY STATIONS

STATION 4
--------------------------------------------------------------------------------
|                                |                   DEPTH                      |
|                                |----------------------------------------------|
|                                |        BOTTOM         |       SURFACE        |
|                                |-----------------------+----------------------|
|                                |        CRABS          |        CRABS         |
|                                |-----------------------+----------------------|
|                                |   MEAN    |  STDERR   |   MEAN    |  STDERR  |
|--------------------------------+-----------+-----------+-----------+----------|
|CRUISE         |CURRENT         |           |           |           |          |
|---------------+----------------|           |           |           |          |
|2              |IN              |          .|          .|     302.00|         .|
|               |----------------+-----------+-----------+-----------+----------|
|               |OUT             |          .|          .|     208.13|    100.86|
|---------------+----------------+-----------+-----------+-----------+----------|
|3              |OUT             |          .|          .|    1766.83|    684.59|
|               |----------------+-----------+-----------+-----------+----------|
|               |SLA             |          .|          .|    2095.75|    420.95|
|---------------+----------------+-----------+-----------+-----------+----------|
|4              |IN              |          .|          .|    9341.25|   1573.54|
|---------------+----------------+-----------+-----------+-----------+----------|
|5              |IN              |    2036.57|     627.86|     600.18|    198.62|
|               |----------------+-----------+-----------+-----------+----------|
|               |OUT             |    2324.00|          .|    2593.00|         .|
|               |----------------+-----------+-----------+-----------+----------|
|               |SLA             |     352.50|      29.78|          .|         .|
|---------------+----------------+-----------+-----------+-----------+----------|
|6              |OUT             |    2081.70|     675.83|    1547.80|    884.95|
--------------------------------------------------------------------------------
```

MEAN DENSITIES AND STANDARD ERRORS
FOR FISH EGGS
BY STATIONS

STATION 4

		DEPTH			
		BOTTOM		SURFACE	
		EGGS		EGGS	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	15469.00	.
	OUT	.	.	2620.13	893.15
3	OUT	.	.	11125.50	2694.24
	SLA	.	.	34106.50	2576.54
4	IN	.	.	1964.25	628.87
5	IN	86089.00	40966.48	61864.36	29384.92
	OUT	22963.00	.	19860.00	.
	SLA	5958.00	3286.81	.	.
6	OUT	351.40	150.28	1107.30	641.45

MEAN DENSITIES AND STANDARD ERRORS
FOR ESTUARINE FISH
BY STATION

```
STATION 4
-----------------------------------------------------------------------------------
|                               |                     DEPTH                       |
|                               |-------------------------------------------------|
|                               |         BOTTOM         |        SURFACE         |
|                               |------------------------+------------------------|
|                               |         ESTFIS         |         ESTFIS         |
|                               |------------------------+------------------------|
|                               |    MEAN    |   STDERR  |    MEAN    |   STDERR  |
|-------------------------------+------------+-----------+------------+-----------|
|CRUISE          |CURRENT       |            |           |            |           |
|----------------+--------------|            |           |            |           |
|2               |IN            |           .|          .|      786.00|          .|
|                |--------------+------------+-----------+------------+-----------|
|                |OUT           |           .|          .|      492.25|     110.66|
|----------------+--------------+------------+-----------+------------+-----------|
|3               |OUT           |           .|          .|      925.67|     233.32|
|                |--------------+------------+-----------+------------+-----------|
|                |SLA           |           .|          .|     1048.50|     126.71|
|----------------+--------------+------------+-----------+------------+-----------|
|4               |IN            |           .|          .|      594.63|     100.71|
|----------------+--------------+------------+-----------+------------+-----------|
|5               |IN            |     1968.57|     616.57|      330.82|     121.10|
|                |--------------+------------+-----------+------------+-----------|
|                |OUT           |     1010.00|          .|      311.00|          .|
|                |--------------+------------+-----------+------------+-----------|
|                |SLA           |     1000.00|     844.43|           .|          .|
|----------------+--------------+------------+-----------+------------+-----------|
|6               |OUT           |     6351.80|    1823.91|     3740.30|    1813.08|
-----------------------------------------------------------------------------------
```

MEAN DENSITIES AND STANDARD ERRORS
FOR MARINE FISH
BY STATIONS

STATION 4

		DEPTH			
		BOTTOM		SURFACE	
		MARFIS		MARFIS	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	604.00	.
	OUT	.	.	86.63	21.56
3	OUT	.	.	289.50	99.62
	SLA	.	.	311.75	75.56
4	IN	.	.	715.25	107.39
5	IN	621.71	275.12	206.18	88.42
	OUT	572.00	.	311.00	.
	SLA	35.25	20.38	.	.
6	OUT	808.10	354.18	516.30	442.64

MEAN DENSITIES AND STANDARD ERRORS
FOR MARINE SCIAENIDS
BY STATIONS

STATION 4

		DEPTH			
		BOTTOM		SURFACE	
		MARSCI		MARSCI	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	0.00	.
	OUT	.	.	23.37	19.10
3	OUT	.	.	34.00	16.26
	SLA	.	.	0.00	0.00
4	IN	.	.	0.00	0.00
5	IN	0.00	0.00	0.00	0.00
	OUT	0.00	.	0.00	.
	SLA	0.00	0.00	.	.
6	OUT	1022.00	579.97	74.20	48.45

```
                                   MEANS AND STANDARD ERRORS                    8:37 THURSDAY, APRIL 27, 1989
  1
                                   FOR PENAEIDAE PROTOZOEA
                                 IN THE INTRACOASTAL WATERWAY

          ------------------------------------------------------------------------------------
          |                               |                      DEPTH                        |
          |                               |---------------------------------------------------|
          |                               |          BOTTOM          |         SURFACE        |
          |                               |--------------------------+------------------------|
          |                               |          DENSITY         |         DENSITY        |
          |                               |--------------------------+------------------------|
          |                               |     MEAN    |   STDERR   |    MEAN    |   STDERR  |
          |-------------------------------+-------------+------------+------------+-----------|
          |CRUISE          |CURRENT       |             |            |            |           |
          |----------------+--------------|             |            |            |           |
          |2               |IN            |            .|           .|        0.00|          .|
          |                |--------------+-------------+------------+------------+-----------|
          |                |OUT           |            .|           .|        0.00|       0.00|
          |----------------+--------------+-------------+------------+------------+-----------|
          |3               |OUT           |            .|           .|       16.67|      12.36|
          |                |--------------+-------------+------------+------------+-----------|
          |                |SLA           |            .|           .|       20.75|      12.00|
          |----------------+--------------+-------------+------------+------------+-----------|
          |4               |IN            |            .|           .|     5675.63|     768.44|
          |----------------+--------------+-------------+------------+------------+-----------|
          |5               |IN            |        12.71|       12.71|       69.40|      35.75|
          |                |--------------+-------------+------------+------------+-----------|
          |                |OUT           |       135.00|           .|       52.00|          .|
          |                |--------------+-------------+------------+------------+-----------|
          |                |SLA           |         0.00|        0.00|           .|          .|
          |----------------+--------------+-------------+------------+------------+-----------|
          |6               |OUT           |         0.00|        0.00|        0.00|       0.00|
          ------------------------------------------------------------------------------------
```

```
                                   MEANS AND STANDARD ERRORS                 8:38 THURSDAY, APRIL 27, 1989
 1
                                       FOR PENAEUS MYSIS
                                  IN THE INTRACOASTAL WATERWAY

             --------------------------------------------------------------------------------
             |                              |                     DEPTH                     |
             |                              |-----------------------------------------------|
             |                              |        BOTTOM         |        SURFACE        |
             |                              |-----------------------+-----------------------|
             |                              |        DENSITY        |        DENSITY        |
             |                              |-----------------------+-----------------------|
             |                              |   MEAN    |  STDERR   |   MEAN    |  STDERR   |
             |------------------------------+-----------+-----------+-----------+-----------|
             |CRUISE        |CURRENT        |           |           |           |           |
             |--------------+---------------|           |           |           |           |
             |2             |IN             |          .|          .|       0.00|          .|
             |              |---------------+-----------+-----------+-----------+-----------|
             |              |OUT            |          .|          .|       0.00|       0.00|
             |--------------+---------------+-----------+-----------+-----------+-----------|
             |3             |OUT            |          .|          .|      85.50|      51.21|
             |              |---------------+-----------+-----------+-----------+-----------|
             |              |SLA            |          .|          .|       0.00|       0.00|
             |--------------+---------------+-----------+-----------+-----------+-----------|
             |4             |IN             |          .|          .|     651.50|     135.72|
             |--------------+---------------+-----------+-----------+-----------+-----------|
             |5             |IN             |       0.00|       0.00|       0.00|       0.00|
             |              |---------------+-----------+-----------+-----------+-----------|
             |              |OUT            |       0.00|          .|       0.00|          .|
             |              |---------------+-----------+-----------+-----------+-----------|
             |              |SLA            |       0.00|       0.00|          .|          .|
             |--------------+---------------+-----------+-----------+-----------+-----------|
             |6             |OUT            |       0.00|       0.00|       0.00|       0.00|
             --------------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR PENAEUS AZTECUS POSTLARVAE
IN THE INTRACOASTAL WATERWAY

		DEPTH			
		BOTTOM		SURFACE	
		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	121.00	.
	OUT	.	.	120.00	24.48
3	OUT	.	.	362.83	178.13
	SLA	.	.	0.00	0.00
4	IN	.	.	0.00	0.00
5	IN	0.00	0.00	53.90	53.90
	OUT	0.00	.	0.00	.
	SLA	0.00	0.00	.	.
6	OUT	9.70	9.70	0.00	0.00

```
1                    MEANS AND STANDARD ERRORS                 8:41 THURSDAY, APRIL 27, 1989

                        FOR PENAEUS SPP POSTLARVAE
                       IN THE INTRACOASTAL WATERWAY

----------------------------------------------------------------------------------
|                                |                     DEPTH                      |
|                                |------------------------------------------------|
|                                |       BOTTOM          |        SURFACE         |
|                                |-----------------------+------------------------|
|                                |       DENSITY         |        DENSITY         |
|                                |-----------------------+------------------------|
|                                |   MEAN    |  STDERR   |   MEAN    |   STDERR   |
|--------------------------------+-----------+-----------+-----------+------------|
|CRUISE          |CURRENT        |           |           |           |            |
|----------------+---------------|           |           |           |            |
|2               |IN             |          .|          .|       0.00|           .|
|                |---------------+-----------+-----------+-----------+------------|
|                |OUT            |          .|          .|       0.00|        0.00|
|----------------+---------------+-----------+-----------+-----------+------------|
|3               |OUT            |          .|          .|      13.67|       13.67|
|                |---------------+-----------+-----------+-----------+------------|
|                |SLA            |          .|          .|       0.00|        0.00|
|----------------+---------------+-----------+-----------+-----------+------------|
|4               |IN             |          .|          .|      36.63|       21.11|
|----------------+---------------+-----------+-----------+-----------+------------|
|5               |IN             |     445.57|     163.18|     289.90|      177.44|
|                |---------------+-----------+-----------+-----------+------------|
|                |OUT            |      67.00|          .|       0.00|           .|
|                |---------------+-----------+-----------+-----------+------------|
|                |SLA            |      18.25|      18.25|          .|           .|
|----------------+---------------+-----------+-----------+-----------+------------|
|6               |OUT            |    1259.20|     661.37|     448.00|      404.64|
----------------------------------------------------------------------------------
```

```
                                     MEANS AND STANDARD ERRORS                  8:42 THURSDAY, APRIL 27, 1989
 1
                                         FOR PORTUNID ZOEA
                                    IN THE INTRACOASTAL WATERWAY

          -------------------------------------------------------------------------------------------
          |                                 |                         DEPTH                         |
          |                                 |-------------------------------------------------------|
          |                                 |          BOTTOM           |          SURFACE          |
          |                                 |---------------------------+---------------------------|
          |                                 |          DENSITY          |          DENSITY          |
          |                                 |---------------------------+---------------------------|
          |                                 |     MEAN    |   STDERR    |     MEAN    |   STDERR    |
          |---------------------------------+-------------+-------------+-------------+-------------|
          |CRUISE           |CURRENT        |             |             |             |             |
          |-----------------+---------------|             |             |             |             |
          |2                |IN             |            .|            .|       242.00|            .|
          |                 |---------------+-------------+-------------+-------------+-------------|
          |                 |OUT            |            .|            .|       208.13|       100.86|
          |-----------------+---------------+-------------+-------------+-------------+-------------|
          |3                |OUT            |            .|            .|      1763.17|       685.55|
          |                 |---------------+-------------+-------------+-------------+-------------|
          |                 |SLA            |            .|            .|      2095.75|       420.95|
          |-----------------+---------------+-------------+-------------+-------------+-------------|
          |4                |IN             |            .|            .|      9341.25|      1573.54|
          |-----------------+---------------+-------------+-------------+-------------+-------------|
          |5                |IN             |      1984.71|       604.88|       585.36|       202.24|
          |                 |---------------+-------------+-------------+-------------+-------------|
          |                 |OUT            |      2290.00|            .|      2593.00|            .|
          |                 |---------------+-------------+-------------+-------------+-------------|
          |                 |SLA            |       234.25|        74.49|            .|            .|
          |-----------------+---------------+-------------+-------------+-------------+-------------|
          |6                |OUT            |       633.00|       224.19|       672.00|       395.68|
          -------------------------------------------------------------------------------------------
```

```
                         MEANS AND STANDARD ERRORS                   14:04 TUESDAY, MAY 9, 1989

                         FOR CALLINECTES MEGALOPA
                        IN THE INTRACOASTAL WATERWAY

--------------------------------------------------------------------------------
|                              |                    DEPTH                      |
|                              |-----------------------------------------------|
|                              |        BOTTOM         |        SURFACE        |
|                              |-----------------------+-----------------------|
|                              |        DENSITY        |        DENSITY        |
|                              |-----------------------+-----------------------|
|                              |    MEAN   |  STDERR   |    MEAN   |  STDERR   |
|------------------------------+-----------+-----------+-----------+-----------|
|CRUISE        |CURRENT        |           |           |           |           |
|--------------+---------------|           |           |           |           |
|2             |IN             |          .|          .|       0.00|          .|
|              |---------------+-----------+-----------+-----------+-----------|
|              |OUT            |          .|          .|       0.00|       0.00|
|--------------+---------------+-----------+-----------+-----------+-----------|
|3             |OUT            |          .|          .|       0.00|       0.00|
|              |---------------+-----------+-----------+-----------+-----------|
|              |SLA            |          .|          .|       0.00|       0.00|
|--------------+---------------+-----------+-----------+-----------+-----------|
|4             |IN             |          .|          .|       0.00|       0.00|
|--------------+---------------+-----------+-----------+-----------+-----------|
|5             |IN             |      60.50|      31.74|      14.82|       8.26|
|              |---------------+-----------+-----------+-----------+-----------|
|              |OUT            |      34.00|          .|       0.00|          .|
|              |---------------+-----------+-----------+-----------+-----------|
|              |SLA            |     118.25|      51.72|          .|          .|
|--------------+---------------+-----------+-----------+-----------+-----------|
|6             |OUT            |    1426.40|     644.98|     875.80|     837.06|
--------------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR PORTUNID JUVENILES
IN THE INTRACOASTAL WATERWAY

		DEPTH			
		BOTTOM		SURFACE	
		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	60.00	.
	OUT	.	.	0.00	0.00
3	OUT	.	.	0.00	0.00
	SLA	.	.	0.00	0.00
4	IN	.	.	0.00	0.00
5	IN	0.00	0.00	0.00	0.00
	OUT	0.00	.	0.00	.
	SLA	0.00	0.00	.	.
6	OUT	21.00	19.19	0.00	0.00

```
                                   MEANS AND STANDARD ERRORS                 8:45 THURSDAY, APRIL 27, 1989
   1
                                FOR ARCHOSARGUS PROBATOCEPHALUS
                                 IN THE INTRACOASTAL WATERWAY

            --------------------------------------------------------------------------------
            |                              |                     DEPTH                     |
            |                              |-----------------------------------------------|
            |                              |        BOTTOM         |        SURFACE        |
            |                              |-----------------------+-----------------------|
            |                              |        DENSITY        |        DENSITY        |
            |                              |-----------------------+-----------------------|
            |                              |    MEAN   |  STDERR   |    MEAN   |  STDERR   |
            |------------------------------+-----------+-----------+-----------+-----------|
            |CRUISE        |CURRENT        |           |           |           |           |
            |--------------+---------------|           |           |           |           |
            |2             |IN             |          .|          .|       0.00|          .|
            |              |---------------+-----------+-----------+-----------+-----------|
            |              |OUT            |          .|          .|       0.00|       0.00|
            |--------------+---------------+-----------+-----------+-----------+-----------|
            |3             |OUT            |          .|          .|      13.67|      13.67|
            |              |---------------+-----------+-----------+-----------+-----------|
            |              |SLA            |          .|          .|       0.00|       0.00|
            |--------------+---------------+-----------+-----------+-----------+-----------|
            |4             |IN             |          .|          .|       0.00|       0.00|
            |--------------+---------------+-----------+-----------+-----------+-----------|
            |5             |IN             |       0.00|       0.00|       0.00|       0.00|
            |              |---------------+-----------+-----------+-----------+-----------|
            |              |OUT            |       0.00|          .|       0.00|          .|
            |              |---------------+-----------+-----------+-----------+-----------|
            |              |SLA            |       0.00|       0.00|          .|          .|
            |--------------+---------------+-----------+-----------+-----------+-----------|
            |6             |OUT            |       0.00|       0.00|       0.00|       0.00|
            --------------------------------------------------------------------------------
```

```
                          MEANS AND STANDARD ERRORS              8:49 THURSDAY, APRIL 27, 1989
1
                          FOR BAIRDIELLA CHRYSOURA
                        IN THE INTRACOASTAL WATERWAY

    --------------------------------------------------------------------------
    |                                  |                 DEPTH               |
    |                                  |-------------------------------------|
    |                                  |      BOTTOM      |      SURFACE     |
    |                                  |------------------+------------------|
    |                                  |     DENSITY      |     DENSITY      |
    |                                  |------------------+------------------|
    |                                  |   MEAN  | STDERR |   MEAN  | STDERR |
    |----------------------------------+---------+--------+---------+--------|
    |CRUISE           |CURRENT         |         |        |         |        |
    |-----------------+----------------|         |        |         |        |
    |2                |IN              |        .|       .|     0.00|       .|
    |                 |----------------+---------+--------+---------+--------|
    |                 |OUT             |        .|       .|     0.00|    0.00|
    |-----------------+----------------+---------+--------+---------+--------|
    |3                |OUT             |        .|       .|     8.33|    8.33|
    |                 |----------------+---------+--------+---------+--------|
    |                 |SLA             |        .|       .|    10.50|   10.50|
    |-----------------+----------------+---------+--------+---------+--------|
    |4                |IN              |        .|       .|    89.88|   29.25|
    |-----------------+----------------+---------+--------+---------+--------|
    |5                |IN              |     0.00|    0.00|     0.00|    0.00|
    |                 |----------------+---------+--------+---------+--------|
    |                 |OUT             |     0.00|       .|     0.00|       .|
    |                 |----------------+---------+--------+---------+--------|
    |                 |SLA             |     0.00|    0.00|        .|       .|
    |-----------------+----------------+---------+--------+---------+--------|
    |6                |OUT             |    71.70|   37.80|     0.00|    0.00|
    --------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR CYNOSCION ARENARIUS
IN THE INTRACOASTAL WATERWAY

		DEPTH			
		BOTTOM		SURFACE	
		DENSITY		DENSITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	0.00	.
	OUT	.	.	0.00	0.00
3	OUT	.	.	7.17	7.17
	SLA	.	.	0.00	0.00
4	IN	.	.	0.00	0.00
5	IN	0.00	0.00	0.00	0.00
	OUT	0.00	.	0.00	.
	SLA	0.00	0.00	.	.
6	OUT	1010.80	579.96	74.20	48.45

```
                                   MEANS AND STANDARD ERRORS             8:51 THURSDAY, APRIL 27, 1989
 1
                                    FOR CYNOSCION NEBULOSUS
                                  IN THE INTRACOASTAL WATERWAY

          --------------------------------------------------------------------------
          |                           |                   DEPTH                    |
          |                           |--------------------------------------------|
          |                           |        BOTTOM         |      SURFACE       |
          |                           |-----------------------+--------------------|
          |                           |        DENSITY        |      DENSITY       |
          |                           |-----------------------+--------------------|
          |                           |   MEAN    |  STDERR   |   MEAN   |  STDERR |
          |---------------------------+-----------+-----------+----------+---------|
          |CRUISE        |CURRENT     |           |           |          |         |
          |--------------+------------|           |           |          |         |
          |2             |IN          |          .|          .|      0.00|        .|
          |              |------------+-----------+-----------+----------+---------|
          |              |OUT         |          .|          .|      0.00|     0.00|
          |--------------+------------+-----------+-----------+----------+---------|
          |3             |OUT         |          .|          .|      4.17|     4.17|
          |              |------------+-----------+-----------+----------+---------|
          |              |SLA         |          .|          .|     10.75|    10.75|
          |--------------+------------+-----------+-----------+----------+---------|
          |4             |IN          |          .|          .|     26.88|    12.25|
          |--------------+------------+-----------+-----------+----------+---------|
          |5             |IN          |       0.00|       0.00|      0.00|     0.00|
          |              |------------+-----------+-----------+----------+---------|
          |              |OUT         |       0.00|          .|      0.00|        .|
          |              |------------+-----------+-----------+----------+---------|
          |              |SLA         |     147.00|     147.00|         .|        .|
          |--------------+------------+-----------+-----------+----------+---------|
          |6             |OUT         |      88.80|      61.59|      0.00|     0.00|
          --------------------------------------------------------------------------
```

```
                              MEANS AND STANDARD ERRORS                    9:02 THURSDAY, APRIL 27, 1989
   1
                                FOR CYNOSCION NOTHUS
                              IN THE INTRACOASTAL WATERWAY

         ---------------------------------------------------------------------------------------------
         |                                      |                           DEPTH                     |
         |                                      |-----------------------------------------------------|
         |                                      |          BOTTOM          |          SURFACE         |
         |                                      |--------------------------+--------------------------|
         |                                      |         DENSITY          |         DENSITY          |
         |                                      |--------------------------+--------------------------|
         |                                      |    MEAN     |   STDERR   |    MEAN     |   STDERR   |
         |--------------------------------------+-------------+------------+-------------+------------|
         |CRUISE            |CURRENT            |             |            |             |            |
         |------------------+-------------------|             |            |             |            |
         |2                 |IN                 |            .|           .|         0.00|           .|
         |                  |-------------------+-------------+------------+-------------+------------|
         |                  |OUT                |            .|           .|         0.00|        0.00|
         |------------------+-------------------+-------------+------------+-------------+------------|
         |3                 |OUT                |            .|           .|         0.00|        0.00|
         |                  |-------------------+-------------+------------+-------------+------------|
         |                  |SLA                |            .|           .|         0.00|        0.00|
         |------------------+-------------------+-------------+------------+-------------+------------|
         |4                 |IN                 |            .|           .|         0.00|        0.00|
         |------------------+-------------------+-------------+------------+-------------+------------|
         |5                 |IN                 |         0.00|        0.00|         0.00|        0.00|
         |                  |-------------------+-------------+------------+-------------+------------|
         |                  |OUT                |         0.00|           .|         0.00|           .|
         |                  |-------------------+-------------+------------+-------------+------------|
         |                  |SLA                |         0.00|        0.00|            .|           .|
         |------------------+-------------------+-------------+------------+-------------+------------|
         |6                 |OUT                |         1.80|        1.80|         0.00|        0.00|
         ---------------------------------------------------------------------------------------------
```

```
                              MEANS AND STANDARD ERRORS                    8:54 THURSDAY, APRIL 27, 1989

                               FOR LARIMUS FASCIATUS
                              IN THE INTRACOASTAL WATERWAY

---------------------------------------------------------------------------------------
|                               |                        DEPTH                        |
|                               |-----------------------------------------------------|
|                               |          BOTTOM          |         SURFACE          |
|                               |--------------------------+--------------------------|
|                               |         DENSITY          |         DENSITY          |
|                               |--------------------------+--------------------------|
|                               |    MEAN     |   STDERR   |    MEAN     |   STDERR   |
|-------------------------------+-------------+------------+-------------+------------|
|CRUISE          |CURRENT       |             |            |             |            |
|----------------+--------------|             |            |             |            |
|2               |IN            |            .|           .|         0.00|           .|
|                |--------------+-------------+------------+-------------+------------|
|                |OUT           |            .|           .|         0.00|        0.00|
|----------------+--------------+-------------+------------+-------------+------------|
|3               |OUT           |            .|           .|         0.00|        0.00|
|                |--------------+-------------+------------+-------------+------------|
|                |SLA           |            .|           .|         0.00|        0.00|
|----------------+--------------+-------------+------------+-------------+------------|
|4               |IN            |            .|           .|         0.00|        0.00|
|----------------+--------------+-------------+------------+-------------+------------|
|5               |IN            |         0.00|        0.00|         0.00|        0.00|
|                |--------------+-------------+------------+-------------+------------|
|                |OUT           |         0.00|           .|         0.00|           .|
|                |--------------+-------------+------------+-------------+------------|
|                |SLA           |         0.00|        0.00|            .|           .|
|----------------+--------------+-------------+------------+-------------+------------|
|6               |OUT           |         0.00|        0.00|         0.00|        0.00|
---------------------------------------------------------------------------------------
```

```
                                 MEANS AND STANDARD ERRORS                         9:01 THURSDAY, APRIL 27, 1989
  1
                                    FOR POGONIAS CROMIS
                                 IN THE INTRACOASTAL WATERWAY

            -------------------------------------------------------------------------------
            |                              |                    DEPTH                     |
            |                              |----------------------------------------------|
            |                              |        BOTTOM          |       SURFACE       |
            |                              |------------------------+---------------------|
            |                              |        DENSITY         |       DENSITY       |
            |                              |------------------------+---------------------|
            |                              |    MEAN    |  STDERR   |   MEAN    |  STDERR |
            |------------------------------+------------+-----------+-----------+---------|
            |CRUISE        |CURRENT        |            |           |           |         |
            |--------------+---------------|            |           |           |         |
            |2             |IN             |           .|          .|       0.00|        .|
            |              |---------------+------------+-----------+-----------+---------|
            |              |OUT            |           .|          .|      23.37|    19.10|
            |--------------+---------------+------------+-----------+-----------+---------|
            |3             |OUT            |           .|          .|      26.83|    17.03|
            |              |---------------+------------+-----------+-----------+---------|
            |              |SLA            |           .|          .|       0.00|     0.00|
            |--------------+---------------+------------+-----------+-----------+---------|
            |4             |IN             |           .|          .|       0.00|     0.00|
            |--------------+---------------+------------+-----------+-----------+---------|
            |5             |IN             |        0.00|       0.00|       0.00|     0.00|
            |              |---------------+------------+-----------+-----------+---------|
            |              |OUT            |        0.00|          .|       0.00|        .|
            |              |---------------+------------+-----------+-----------+---------|
            |              |SLA            |        0.00|       0.00|          .|        .|
            |--------------+---------------+------------+-----------+-----------+---------|
            |6             |OUT            |        9.40|       9.40|       0.00|     0.00|
            -------------------------------------------------------------------------------
```

```
                                   MEANS AND STANDARD ERRORS                    9:06 THURSDAY, APRIL 27, 1989
 1
                                    FOR STELLIFER LANCEOLATUS
                                   IN THE INTRACOASTAL WATERWAY

             -----------------------------------------------------------------------------------
             |                                  |                      DEPTH                   |
             |                                  |----------------------------------------------|
             |                                  |        BOTTOM         |       SURFACE        |
             |                                  |-----------------------+----------------------|
             |                                  |        DENSITY        |       DENSITY        |
             |                                  |-----------------------+----------------------|
             |                                  |   MEAN    |  STDERR   |   MEAN    |  STDERR  |
             |----------------------------------+-----------+-----------+-----------+----------|
             |CRUISE          |CURRENT          |           |           |           |          |
             |----------------+-----------------|           |           |           |          |
             |2               |IN               |          .|          .|       0.00|         .|
             |                |-----------------+-----------+-----------+-----------+----------|
             |                |OUT              |          .|          .|       0.00|      0.00|
             |----------------+-----------------+-----------+-----------+-----------+----------|
             |3               |OUT              |          .|          .|       0.00|      0.00|
             |                |-----------------+-----------+-----------+-----------+----------|
             |                |SLA              |          .|          .|       0.00|      0.00|
             |----------------+-----------------+-----------+-----------+-----------+----------|
             |4               |IN               |          .|          .|       0.00|      0.00|
             |----------------+-----------------+-----------+-----------+-----------+----------|
             |5               |IN               |       0.00|       0.00|       0.00|      0.00|
             |                |-----------------+-----------+-----------+-----------+----------|
             |                |OUT              |       0.00|          .|       0.00|         .|
             |                |-----------------+-----------+-----------+-----------+----------|
             |                |SLA              |       0.00|       0.00|          .|         .|
             |----------------+-----------------+-----------+-----------+-----------+----------|
             |6               |OUT              |       1.30|       1.30|      48.00|     48.00|
             -----------------------------------------------------------------------------------
```

```
                          MEANS AND STANDARD ERRORS                   15:38 FRIDAY, JULY 14
                               FOR TEMPERATURE
                            IN DEGREES CENTIGRADE

STATION 4
-----------------------------------------------------------------------------------
|                                |                     DEPTH                      |
|                                |------------------------------------------------|
|                                |         BOTTOM          |       SURFACE        |
|                                |-------------------------+----------------------|
|                                |          TEMP           |         TEMP         |
|                                |-------------------------+----------------------|
|                                |    MEAN    |   STDERR   |   MEAN    |  STDERR  |
|--------------------------------+------------+------------+-----------+----------|
|CRUISE         |CURRENT         |            |            |           |          |
|---------------+----------------|            |            |           |          |
|2              |IN              |           .|           .|      11.50|         .|
|               |----------------+------------+------------+-----------+----------|
|               |OUT             |           .|           .|      12.75|      0.20|
|---------------+----------------+------------+------------+-----------+----------|
|3              |OUT             |           .|           .|      23.33|      0.06|
|               |----------------+------------+------------+-----------+----------|
|               |SLA             |           .|           .|      24.40|      0.46|
|---------------+----------------+------------+------------+-----------+----------|
|4              |IN              |           .|           .|      27.84|      0.11|
|---------------+----------------+------------+------------+-----------+----------|
|5              |IN              |       29.40|        0.21|      29.54|      0.19|
|               |----------------+------------+------------+-----------+----------|
|               |OUT             |       30.10|           .|      30.20|         .|
|               |----------------+------------+------------+-----------+----------|
|               |SLA             |       29.80|        0.14|          .|         .|
|---------------+----------------+------------+------------+-----------+----------|
|6              |OUT             |       29.61|        0.12|      29.69|      0.16|
-----------------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS
FOR SALINITY
IN PARTS PER THOUSAND

STATION 4

		DEPTH			
		BOTTOM		SURFACE	
		SALINITY		SALINITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	17.72	.
	OUT	.	.	16.69	0.49
3	OUT	.	.	33.67	0.18
	SLA	.	.	22.37	1.16
4	IN	.	.	31.71	0.07
5	IN	26.14	1.49	23.61	1.44
	OUT	28.39	.	28.39	.
	SLA	22.93	0.78	.	.
6	OUT	17.00	2.43	7.28	0.28

MEANS AND STANDARD ERRORS
FOR CURRENT VELOCITY
IN CM PER SECOND

STATION 4

		DEPTH			
		BOTTOM		SURFACE	
		VELOCITY		VELOCITY	
		MEAN	STDERR	MEAN	STDERR
CRUISE	CURRENT				
2	IN	.	.	15.43	.
	OUT	.	.	-16.72	2.88
3	OUT	.	.	-13.72	2.87
	SLA	.	.	0.00	0.00
4	IN	.	.	40.51	3.29
5	IN	21.31	4.11	14.97	1.89
	OUT	-10.29	.	-10.29	.
	SLA	0.00	0.00	.	.
6	OUT	-39.10	8.68	-59.68	6.05

MEANS AND STANDARD ERRORS
FOR WIND VELOCITY
IN CM PER SECOND

STATION 4

		WIND	
		MEAN	STDERR
CRUISE	CURRENT		
2	IN	-565.89	.
	OUT	-580.68	37.45
3	OUT	464.71	60.73
	SLA	15.43	0.00
4	IN	398.69	13.71
5	IN	125.75	55.47
	OUT	-185.20	0.00
	SLA	-92.60	37.75
6	OUT	-116.78	25.85

```
                    MEANS AND STANDARD ERRORS                        15:58 FRIDAY, JULY 14
                        FOR TIDAL HEIGHT
                 IN FEET ABOVE MEAN LOW WATER MARK

STATION 4
------------------------------------------------------------
|                                |         TIDEHT          |
|                                |-------------------------|
|                                |    MEAN    |   STDERR   |
|--------------------------------+------------+------------|
|CRUISE          |CURRENT        |            |            |
|----------------+---------------|            |            |
|2               |IN             |           .|           .|
|                |---------------+------------+------------|
|                |OUT            |           .|           .|
|----------------+---------------+------------+------------|
|3               |OUT            |           .|           .|
|                |---------------+------------+------------|
|                |SLA            |           .|           .|
|----------------+---------------+------------+------------|
|4               |IN             |           .|           .|
|----------------+---------------+------------+------------|
|5               |IN             |           .|           .|
|                |---------------+------------+------------|
|                |OUT            |           .|           .|
|                |---------------+------------+------------|
|                |SLA            |           .|           .|
|----------------+---------------+------------+------------|
|6               |OUT            |           .|           .|
------------------------------------------------------------
```

```
                                   CORRELATION MATRIX FOR                    14:55 FRIDAY, JULY 14
1989  1
                                    PHYSICAL PARAMETERS
                                IN THE INTRACOASTAL WATERWAY

                PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 69

                             TEMPSQ     SALIN      WIND   CURRENT     DEPTH


                  TEMPSQ    1.00000  -0.06650   0.42074  -0.03640   0.40152
                             0.0000    0.5872    0.0003    0.7665    0.0006

                  SALIN    -0.06650   1.00000   0.59649   0.77358  -0.01428
                             0.5872    0.0000    0.0001    0.0001    0.9073

                  WIND      0.42074   0.59649   1.00000   0.37692  -0.04596
                             0.0003    0.0001    0.0000    0.0014    0.7077

                  CURRENT  -0.03640   0.77358   0.37692   1.00000  -0.06346
                             0.7665    0.0001    0.0014    0.0000    0.6044

                  DEPTH     0.40152  -0.01428  -0.04596  -0.06346   1.00000
                             0.0006    0.9073    0.7077    0.6044    0.0000
```

```
                    MEAN DENSITIES AND STANDARD ERRORS
                               FOR SHRIMP
                               BY STATION

STATION 5
-------------------------------------------------------------
|                                  |          DEPTH         |
|                                  |------------------------|
|                                  |         SURFACE        |
|                                  |------------------------|
|                                  |         SHRIMP         |
|                                  |------------------------|
|                                  |    MEAN    |  STDERR   |
|----------------------------------+------------+-----------|
|CRUISE           |CURRENT         |            |           |
|-----------------+----------------|            |           |
|2                |OUT             |       0.00|       0.00|
|-----------------+----------------+------------+-----------|
|3                |IN              |     353.00|     175.00|
|                 |----------------+------------+-----------|
|                 |OUT             |     158.33|      75.82|
|-----------------+----------------+------------+-----------|
|4                |IN              |    6567.00|    1299.00|
|                 |----------------+------------+-----------|
|                 |SLA             |   10236.00|          .|
-------------------------------------------------------------
```

```
                 MEAN DENSITIES AND STANDARD ERRORS
                             FOR CRABS
                            BY STATIONS

STATION 5
--------------------------------------------------------------------
|                                    |            DEPTH            |
|                                    |-----------------------------|
|                                    |           SURFACE           |
|                                    |-----------------------------|
|                                    |            CRABS            |
|                                    |-----------------------------|
|                                    |     MEAN     |    STDERR    |
|------------------------------------+--------------+--------------|
|CRUISE            |CURRENT          |              |              |
|------------------+-----------------|              |              |
|2                 |OUT              |       4967.50|       4899.50|
|------------------+-----------------+--------------+--------------|
|3                 |IN               |       4667.00|       2288.00|
|                  |-----------------+--------------+--------------|
|                  |OUT              |        222.67|        123.60|
|------------------+-----------------+--------------+--------------|
|4                 |IN               |      18659.50|        709.50|
|                  |-----------------+--------------+--------------|
|                  |SLA              |      12913.00|             .|
--------------------------------------------------------------------
```

```
                 MEAN DENSITIES AND STANDARD ERRORS
                           FOR FISH EGGS
                            BY STATIONS

STATION 5
-----------------------------------------------------------
|                               |          DEPTH          |
|                               |-------------------------|
|                               |         SURFACE         |
|                               |-------------------------|
|                               |          EGGS           |
|                               |-------------------------|
|                               |    MEAN    |   STDERR   |
|-------------------------------+------------+------------|
|CRUISE         |CURRENT        |            |            |
|---------------+---------------|            |            |
|2              |OUT            |       17.00|       17.00|
|---------------+---------------+------------+------------|
|3              |IN             |     1657.00|      413.00|
|               |---------------+------------+------------|
|               |OUT            |     1656.33|      554.97|
|---------------+---------------+------------+------------|
|4              |IN             |     7581.00|     3499.00|
|               |---------------+------------+------------|
|               |SLA            |     8977.00|           .|
-----------------------------------------------------------
```

```
                    MEAN DENSITIES AND STANDARD ERRORS
                           FOR ESTUARINE FISH
                               BY STATION

STATION 5
--------------------------------------------------------------------
|                                  |             DEPTH             |
|                                  |-------------------------------|
|                                  |            SURFACE            |
|                                  |-------------------------------|
|                                  |            ESTFIS             |
|                                  |-------------------------------|
|                                  |     MEAN      |    STDERR     |
|----------------------------------+---------------+---------------|
|CRUISE           |CURRENT         |               |               |
|-----------------+----------------|               |               |
|2                |OUT             |         151.50|          85.50|
|-----------------+----------------+---------------+---------------|
|3                |IN              |        4396.50|        3603.50|
|                 |----------------+---------------+---------------|
|                 |OUT             |         906.33|         884.42|
|-----------------+----------------+---------------+---------------|
|4                |IN              |        1721.50|          59.50|
|                 |----------------+---------------+---------------|
|                 |SLA             |        1417.00|              .|
--------------------------------------------------------------------
```

```
                    MEAN DENSITIES AND STANDARD ERRORS              19:01 WEDNESDAY, APRIL 26, 1989  4
                             FOR MARINE FISH
                               BY STATIONS

STATION 5
-----------------------------------------------------------
|                                |           DEPTH          |
|                                |--------------------------|
|                                |          SURFACE         |
|                                |--------------------------|
|                                |          MARFIS          |
|                                |--------------------------|
|                                |    MEAN     |   STDERR   |
|--------------------------------+-------------+------------|
|CRUISE          |CURRENT        |             |            |
|----------------+---------------|             |            |
|2               |OUT            |        33.00|       33.00|
|----------------+---------------+-------------+------------|
|3               |IN             |       688.50|      556.50|
|                |---------------+-------------+------------|
|                |OUT            |       472.67|      225.71|
|----------------+---------------+-------------+------------|
|4               |IN             |      1497.50|      607.50|
|                |---------------+-------------+------------|
|                |SLA            |      1416.00|           .|
-----------------------------------------------------------
```

```
                    MEAN DENSITIES AND STANDARD ERRORS                    19:05 WEDNESDAY, APRIL 26, 1989   4
                          FOR MARINE SCIAENIDS
                              BY STATIONS

STATION 5
--------------------------------------------------------------------------------
|                                      |                DEPTH                  |
|                                      |---------------------------------------|
|                                      |               SURFACE                 |
|                                      |---------------------------------------|
|                                      |               MARSCI                  |
|                                      |---------------------------------------|
|                                      |       MEAN       |      STDERR        |
|--------------------------------------+------------------+--------------------|
|CRUISE            |CURRENT            |                  |                    |
|------------------+-------------------|                  |                    |
|2                 |OUT                |            220.00|              187.00|
|------------------+-------------------+------------------+--------------------|
|3                 |IN                 |              0.00|                0.00|
|                  |-------------------+------------------+--------------------|
|                  |OUT                |            104.33|              104.33|
|------------------+-------------------+------------------+--------------------|
|4                 |IN                 |             37.00|               37.00|
|                  |-------------------+------------------+--------------------|
|                  |SLA                |              0.00|                   .|
--------------------------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR PENAEIDAE PROTOZOEA
IN PASS CAVALLO

		DEPTH	
		SURFACE	
		DENSITY	
		MEAN	STDERR
CRUISE	CURRENT		
2	OUT	0.00	0.00
3	IN	110.00	110.00
	OUT	7.33	7.33
4	IN	5532.00	1005.00
	SLA	6614.00	.

```
                    MEANS AND STANDARD ERRORS                 8:12 THURSDAY, APRIL 27, 1989

                         FOR PENAEUS MYSIS
                          IN PASS CAVALLO

   -------------------------------------------------------------
   |                                  |           DEPTH          |
   |                                  |--------------------------|
   |                                  |          SURFACE         |
   |                                  |--------------------------|
   |                                  |          DENSITY         |
   |                                  |--------------------------|
   |                                  |    MEAN     |   STDERR   |
   |----------------------------------+-------------+------------|
   |CRUISE           |CURRENT         |             |            |
   |-----------------+----------------|             |            |
   |2                |OUT             |         0.00|        0.00|
   |-----------------+----------------+-------------+------------|
   |3                |IN              |       221.00|       43.00|
   |                 |----------------+-------------+------------|
   |                 |OUT             |       151.00|       82.48|
   |-----------------+----------------+-------------+------------|
   |4                |IN              |       481.00|       38.00|
   |                 |----------------+-------------+------------|
   |                 |SLA             |       315.00|           .|
   -------------------------------------------------------------
```

```
                         MEANS AND STANDARD ERRORS

                      FOR PENAEUS AZTECUS POSTLARVAE
                             IN PASS CAVALLO

---------------------------------------------------------------------
|                                   |            DEPTH              |
|                                   |-------------------------------|
|                                   |           SURFACE             |
|                                   |-------------------------------|
|                                   |           DENSITY             |
|                                   |-------------------------------|
|                                   |     MEAN      |    STDERR     |
|-----------------------------------+---------------+---------------|
|CRUISE           |CURRENT          |               |               |
|-----------------+-----------------|               |               |
|2                |OUT              |           0.00|           0.00|
|-----------------+-----------------+---------------+---------------|
|3                |IN               |          22.00|          22.00|
|                 |-----------------+---------------+---------------|
|                 |OUT              |           0.00|           0.00|
|-----------------+-----------------+---------------+---------------|
|4                |IN               |          74.00|          74.00|
|                 |-----------------+---------------+---------------|
|                 |SLA              |        1260.00|              .|
---------------------------------------------------------------------
```

```
                              MEANS AND STANDARD ERRORS                    8:16 THURSDAY, APRIL 27, 1989
  1
                             FOR PENAEUS SPP POSTLARVAE
                                  IN PASS CAVALLO

              -----------------------------------------------------------------
              |                              |            DEPTH               |
              |                              |--------------------------------|
              |                              |           SURFACE              |
              |                              |--------------------------------|
              |                              |           DENSITY              |
              |                              |--------------------------------|
              |                              |      MEAN      |    STDERR     |
              |------------------------------+----------------+---------------|
              |CRUISE        |CURRENT        |                |               |
              |--------------+---------------|                |               |
              |2             |OUT            |            0.00|           0.00|
              |--------------+---------------+----------------+---------------|
              |3             |IN             |            0.00|           0.00|
              |              |---------------+----------------+---------------|
              |              |OUT            |            0.00|           0.00|
              |--------------+---------------+----------------+---------------|
              |4             |IN             |          480.00|         406.00|
              |              |---------------+----------------+---------------|
              |              |SLA            |         2047.00|              .|
              -----------------------------------------------------------------
```

```
                                 MEANS AND STANDARD ERRORS                 8:17 THURSDAY, APRIL 27, 1989
  1
                                   FOR PORTUNID ZOEA
                                    IN PASS CAVALLO

                    --------------------------------------------------------
                    |                              |          DEPTH         |
                    |                              |------------------------|
                    |                              |         SURFACE        |
                    |                              |------------------------|
                    |                              |         DENSITY        |
                    |                              |------------------------|
                    |                              |    MEAN    |   STDERR  |
                    |------------------------------+------------+-----------|
                    |CRUISE         |CURRENT       |            |           |
                    |---------------+--------------|            |           |
                    |2              |OUT           |       50.50|      17.50|
                    |---------------+--------------+------------+-----------|
                    |3              |IN            |     4612.00|    2321.00|
                    |               |--------------+------------+-----------|
                    |               |OUT           |      214.67|     123.27|
                    |---------------+--------------+------------+-----------|
                    |4              |IN            |    18253.00|     968.00|
                    |               |--------------+------------+-----------|
                    |               |SLA           |    12126.00|          .|
                    --------------------------------------------------------
```

```
                                  MEANS AND STANDARD ERRORS                    8:17 THURSDAY, APRIL 27, 1989
    1
                                  FOR CALLINECTES MEGALOPA
                                       IN PASS CAVALLO

                  --------------------------------------------------------------
                  |                                 |           DEPTH          |
                  |                                 |--------------------------|
                  |                                 |          SURFACE         |
                  |                                 |--------------------------|
                  |                                 |          DENSITY         |
                  |                                 |--------------------------|
                  |                                 |    MEAN     |   STDERR   |
                  |---------------------------------+-------------+------------|
                  |CRUISE          |CURRENT         |             |            |
                  |----------------+----------------|             |            |
                  |2               |OUT             |      4917.00|     4917.00|
                  |----------------+----------------+-------------+------------|
                  |3               |IN              |         0.00|        0.00|
                  |                |----------------+-------------+------------|
                  |                |OUT             |         0.00|        0.00|
                  |----------------+----------------+-------------+------------|
                  |4               |IN              |       406.50|      258.50|
                  |                |----------------+-------------+------------|
                  |                |SLA             |       787.00|           .|
                  --------------------------------------------------------------
```

```
                               MEANS AND STANDARD ERRORS                      8:18 THURSDAY, APRIL 27, 1989
  1
                                FOR PORTUNID JUVENILES
                                   IN PASS CAVALLO

                ------------------------------------------------------------
                |                                |          DEPTH          |
                |                                |-------------------------|
                |                                |         SURFACE         |
                |                                |-------------------------|
                |                                |         DENSITY         |
                |                                |-------------------------|
                |                                |    MEAN    |   STDERR   |
                |--------------------------------+------------+------------|
                |CRUISE          |CURRENT        |            |            |
                |----------------+---------------|            |            |
                |2               |OUT            |        0.00|        0.00|
                |----------------+---------------+------------+------------|
                |3               |IN             |        0.00|        0.00|
                |                |---------------+------------+------------|
                |                |OUT            |        8.00|        8.00|
                |----------------+---------------+------------+------------|
                |4               |IN             |        0.00|        0.00|
                |                |---------------+------------+------------|
                |                |SLA            |        0.00|           .|
                ------------------------------------------------------------
```

```
                                MEANS AND STANDARD ERRORS                   8:19 THURSDAY, APRIL 27, 1989
 1
                                FOR BAIRDIELLA CHRYSOURA
                                    IN PASS CAVALLO

                    ------------------------------------------------------------
                    |                                |          DEPTH          |
                    |                                |-------------------------|
                    |                                |         SURFACE         |
                    |                                |-------------------------|
                    |                                |         DENSITY         |
                    |                                |-------------------------|
                    |                                |    MEAN    |   STDERR   |
                    |--------------------------------+------------+------------|
                    |CRUISE          |CURRENT        |            |            |
                    |----------------+---------------|            |            |
                    |2               |OUT            |        0.00|        0.00|
                    |----------------+---------------+------------+------------|
                    |3               |IN             |        0.00|        0.00|
                    |                |---------------+------------+------------|
                    |                |OUT            |        0.00|        0.00|
                    |----------------+---------------+------------+------------|
                    |4               |IN             |      241.00|      130.00|
                    |                |---------------+------------+------------|
                    |                |SLA            |      157.00|           .|
                    ------------------------------------------------------------
```

MEANS AND STANDARD ERRORS

FOR CYNOSCION NEBULOSUS
IN PASS CAVALLO

		DEPTH	
		SURFACE	
		DENSITY	
		MEAN	STDERR
CRUISE	CURRENT		
2	OUT	0.00	0.00
3	IN	0.00	0.00
	OUT	8.00	8.00
4	IN	111.00	111.00
	SLA	0.00	.

```
                          MEANS AND STANDARD ERRORS

                            FOR POGONIAS CROMIS
                              IN PASS CAVALLO

----------------------------------------------------------------------
|                                      |           DEPTH             |
|                                      |-----------------------------|
|                                      |          SURFACE            |
|                                      |-----------------------------|
|                                      |          DENSITY            |
|                                      |-----------------------------|
|                                      |     MEAN     |    STDERR    |
|--------------------------------------+--------------+--------------|
|CRUISE            |CURRENT            |              |              |
|------------------+-------------------|              |              |
|2                 |OUT                |        220.00|        187.00|
|------------------+-------------------+--------------+--------------|
|3                 |IN                 |          0.00|          0.00|
|                  |-------------------+--------------+--------------|
|                  |OUT                |        104.33|        104.33|
|------------------+-------------------+--------------+--------------|
|4                 |IN                 |         37.00|         37.00|
|                  |-------------------+--------------+--------------|
|                  |SLA                |          0.00|             .|
----------------------------------------------------------------------
```

```
                         MEANS AND STANDARD ERRORS
                              FOR TEMPERATURE
                           IN DEGREES CENTIGRADE

STATION 5
----------------------------------------------------------------
|                                |             DEPTH           |
|                                |-----------------------------|
|                                |            SURFACE          |
|                                |-----------------------------|
|                                |             TEMP            |
|                                |-----------------------------|
|                                |     MEAN     |    STDERR    |
|--------------------------------+--------------+--------------|
|CRUISE          |CURRENT        |              |              |
|----------------+---------------|              |              |
|2               |OUT            |         19.10|          0.80|
|----------------+---------------+--------------+--------------|
|3               |IN             |         22.80|          0.10|
|                |---------------+--------------+--------------|
|                |OUT            |         21.93|          0.59|
|----------------+---------------+--------------+--------------|
|4               |IN             |         27.55|          0.05|
|                |---------------+--------------+--------------|
|                |SLA            |         27.30|             .|
----------------------------------------------------------------
```

```
                    MEANS AND STANDARD ERRORS
                           FOR SALINITY
                      IN PARTS PER THOUSAND

STATION 5
------------------------------------------------------------
|                                 |         DEPTH          |
|                                 |------------------------|
|                                 |        SURFACE         |
|                                 |------------------------|
|                                 |        SALINITY        |
|                                 |------------------------|
|                                 |    MEAN    |  STDERR   |
|---------------------------------+------------+-----------|
|CRUISE           |CURRENT        |            |           |
|-----------------+---------------|            |           |
|2                |OUT            |       31.44|       0.51|
|-----------------+---------------+------------+-----------|
|3                |IN             |       33.83|       0.04|
|                 |---------------+------------+-----------|
|                 |OUT            |       33.94|       0.15|
|-----------------+---------------+------------+-----------|
|4                |IN             |       31.52|       0.07|
|                 |---------------+------------+-----------|
|                 |SLA            |       31.51|          .|
------------------------------------------------------------
```

```
                  MEANS AND STANDARD ERRORS
                     FOR CURRENT VELOCITY
                       IN CM PER SECOND

STATION 5
--------------------------------------------------------------
|                                  |           DEPTH         |
|                                  |-------------------------|
|                                  |          SURFACE        |
|                                  |-------------------------|
|                                  |          VELOCITY       |
|                                  |-------------------------|
|                                  |    MEAN    |   STDERR   |
|----------------------------------+------------+------------|
|CRUISE           |CURRENT         |            |            |
|-----------------+----------------|            |            |
|2                |OUT             |       -7.72|        2.57|
|-----------------+----------------+------------+------------|
|3                |IN              |       48.87|        7.72|
|                 |----------------+------------+------------|
|                 |OUT             |      -13.72|        4.54|
|-----------------+----------------+------------+------------|
|4                |IN              |       15.43|       10.29|
|                 |----------------+------------+------------|
|                 |SLA             |        0.00|           .|
--------------------------------------------------------------
```

```
                           MEANS AND STANDARD ERRORS                    17:13 FRIDAY, JULY 14
                               FOR WIND VELOCITY
                                IN CM PER SECOND

STATION 5
-------------------------------------------------------------
|                                 |           WIND          |
|                                 |-------------------------|
|                                 |    MEAN    |   STDERR   |
|---------------------------------+------------+------------|
|CRUISE          |CURRENT         |            |            |
|----------------+----------------|            |            |
|2               |OUT             |      120.89|      151.76|
|----------------+----------------+------------+------------|
|3               |IN              |      537.59|       69.45|
|                |----------------+------------+------------|
|                |OUT             |      358.40|      148.75|
|----------------+----------------+------------+------------|
|4               |IN              |     1131.78|        0.00|
|                |----------------+------------+------------|
|                |SLA             |     1131.78|           .|
-------------------------------------------------------------
```

```
                    MEANS AND STANDARD ERRORS
                        FOR TIDAL HEIGHT
                IN FEET ABOVE MEAN LOW WATER MARK

STATION 5
-------------------------------------------------------------
|                                 |         TIDEHT          |
|                                 |-------------------------|
|                                 |    MEAN    |   STDERR   |
|---------------------------------+------------+------------|
|CRUISE          |CURRENT         |            |            |
|----------------+----------------|            |            |
|2               |OUT             |        1.00|        0.00|
|----------------+----------------+------------+------------|
|3               |IN              |        0.80|        0.30|
|                |----------------+------------+------------|
|                |OUT             |        1.27|        0.03|
|----------------+----------------+------------+------------|
|4               |IN              |        0.70|        0.40|
|                |----------------+------------+------------|
|                |SLA             |        0.60|           .|
-------------------------------------------------------------
```

```
1989  1                        CORRELATION MATRIX FOR                    14:10 FRIDAY, JULY 14

                                PHYSICAL PARAMETERS
                                  IN PASS CAVALLO

         PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER H0:RHO=0 / N = 10

                    TEMPSQ     SALIN   TIDALHT      WIND   CURRENT     LIGHT     DEPTH

        TEMPSQ     1.00000  -0.35367  -0.49298   0.97714   0.26454   0.00000   0.00000
                    0.0000    0.3161    0.1477    0.0001    0.4601    1.0000    1.0000

        SALIN     -0.35367   1.00000   0.39817  -0.39982   0.12967   0.00000   0.00000
                    0.3161    0.0000    0.2545    0.2523    0.7211    1.0000    1.0000

        TIDALHT   -0.49298   0.39817   1.00000  -0.49493  -0.40589   0.00000   0.00000
                    0.1477    0.2545    0.0000    0.1458    0.2445    1.0000    1.0000

        WIND       0.97714  -0.39982  -0.49493   1.00000   0.30658   0.00000   0.00000
                    0.0001    0.2523    0.1458    0.0000    0.3889    1.0000    1.0000

        CURRENT    0.26454   0.12967  -0.40589   0.30658   1.00000   0.00000   0.00000
                    0.4601    0.7211    0.2445    0.3889    0.0000    1.0000    1.0000

        LIGHT      0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
                    1.0000    1.0000    1.0000    1.0000    1.0000    1.0000    1.0000

        DEPTH      0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
                    1.0000    1.0000    1.0000    1.0000    1.0000    1.0000    1.0000
```