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THE DIETS OF THE SHINER SURFPERCH (*Cymatogaster aggregata* Gibbons) AND THE STAGHORN SCULPIN (*Leptocottus armatus* Girard) IN THE UMPQUA RIVER ESTUARY, OREGON 1981-1982

by

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ABSTRACT

This was the first diet study on the shiner surfperch and the staghorn sculpin in the Umpqua River Estuary, Oregon. Gammarid amphipods, teleosts, and ghost shrimp were the important food items of the staghorn sculpin, whereas barnacle cypris larvae, cancer crab megalops, and copepods were the main components of the shiner surfperch diet. Only large staghorn sculpins ate teleosts, whereas only the smaller ones ate isopods. This study supports literature reporting a change in sculpin diet with size. Staghorn sculpins ate larger prey if they were larger. Monophagous foraging by the shiner surfperch was found with cancer crab megalops and crab zoea. Adequate sample sizes for future studies were determined.

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INTRODUCTION

This study was a follow up of a previous study carried out in the Umpqua River Estuary, Oregon during 1981-2 (Varoujean, 1984). Staghorn sculpins (Leptocottus armatus) and shiner surfperch (Cymatogaster aggregata) collected at that time were examined in this study to determine their diet. By doing this, a reference base to assess the impact of these two fish on the biology of this estuary was established. These two fish must impact the food web significantly, since the shiner surfperch was the second most abundant fish, and the staghorn sculpin the fifth most abundant fish caught by beach seine during the ten sampling dates examined (Varoujean, 1984). In addition, the adequate sample size to assess the diet of these two fish in the future was determined. A previous study on the staghorn sculpin found that 32 fish did not portray its entire diet (Wolf, et. al., 1983). The current study was the largest that has been conducted to assess the needed sample size for these two fish.

A comparison between the current study and the previous literature on the diets of the two fish was made. This allowed a determination of common prey items of the fish throughout the Pacific Coast (studies done have ranged from Southern Alaska to Baja, California). In a study on the staghorn sculpin, Jones (1962) said: "The staghorn sculpin is probably rather unselective in its diet, and feeds mostly on what is available". The current study determined the validity of that statement. Most of the previous studies on the staghorn sculpin found a variation in diet between juveniles and adults, whereas only one shiner surfperch study found this to exist. By comparing the literature with the current study, a determination was made as to whether diet variations with size (and therefore age) exists in the fish, and if so, whether the variation is consistent among studies. Limitations on comparing previous studies with this one were present since many variables cannot be accounted for, but the general area and method of capture were considered.

Another aspect of this study was to characterize the fish as had not adequately been done previously. The expected fact that larger fish eat a larger volume of prey was addressed. Interestingly, a previous study found that larger staghorns had a larger stomach volume, but the same was not true for shiners (Boothe, 1987). This was attributed to inaccurate measuring techniques, and this study helps settle this unexpected result. The question of whether these two fish eat larger prey as they become larger was also addressed. Any prey consumed in a monophagous manner was noted.

It was further noted whether or not the two fish gradually ate more or less of a certain prey item as they grew. One study on the Lizard fish, found that it ate a smaller number of prey as it grew larger (Hayashi, 1983). The current study determined a correlation of number prey ingested versus fish length for each major prey item. This was to show any existing change in diet with age even if it was not absolute (all sizes eat some of the prey items).

Other facets of this study were to add to size data on the two fish, giving an idea of the average, maximum, and minimum sizes of the fish that occur in the Umpqua River Estuary. Seasonal variation in size and its implications as to breeding habits were also discussed. Lastly, a taxonomic list of the prey items was made to show the lowest taxonomic level to which a prey group was identified, and to allow easy cross referencing for readers new to this taxonomy.

METHODS

Fish stomachs were obtained and processed by Varoujean (1984) in the following manner: *Leptocottus armatus* and *Cymatogaster aggregata* were captured by beach seine on a sandy beach in the Umpqua River Estuary, Oregon (Reference site, figure 7). Fish were taken by two beach seine hauls on the east shore, and one on the south shore each sampling date. Sampling times varied with date, and the times of sampling were not recorded. Temperature and salinity varied widely throughout the day. A net of 50 m in length (with a square mesh size of 10 mm), was set 50 m from shore at the start of the beach seine. Five sampling dates were taken in 1981 and 1982, ranging from April 22 to September 17 and May 20 to October 28 respectively. Staghorn sculpin stomachs were preserved on only three of the six dates each year. Upon capture, the fish were placed in 10% formaldehyde to preserve their stomach contents. The fish were transferred to 40% isopropyl alcohol for laboratory procedures. Weight and length measurements were taken for each fish before the stomach was removed and placed in 50% isopropyl alcohol.

In this study, fish stomach contents of 155 shiner surfperch and 81 staghorn sculpins were analyzed. The upper intestine of the shiner surfperch was also examined, for some contents remained undigested there as described by Boothe (1967). Prey types were classified to the lowest taxonomic level their digested state would allow. Each prey type has from 1 to 6 categories for classification by total length. If a prey was partially digested, size data was taken as an estimate of its size before digestion. However, if a prey such as a fish appeared to be ingested as a partial organism, then total length was not extrapolated. If a prey was classified as an unidentifiable crustacean fragment, then its total length was set at its average of 2 mm for simplicity. Fish with empty stomachs (zero volume and number) accounted for 8.6% of all stomachs examined, and were included in all correlations. Volume estimations were made from total length as described in the appendix. Fish vertebrae were estimated as and combined with teleosts for all figures and tables (including volume correlations) except 3 and 2A respectively.

Major prey of the two fish were any taxa occupying an easily discernable volume on the graph (Figures 3 and 4). Three Pearson correlations (Phillips, 1978) were performed: Total volume of prey ingested versus standard length, average volume of a prey ingested versus standard length, and the number of a prey item eaten versus total length (Hayashi, 1983 used total length for this correlation). Average volume of a prey ingested was determined by using the total volume of each species ingested, and then dividing by the number of organisms of that species ingested. A fish that ingested four different species, would add four cases to the correlation, each with the measured standard length of that fish.

The sample size needed for representation of the entire diet of the fish was established (Figures 5 and 6). Forty one stomachs were examined at random for prey taxa, and every prey taxon not previously noted increased the cumulative prey index by one. The graph is then a broken line to indicate the total number of fish and taxa found. Percent monophagous fish in Tables 4A and 5A means the percentage of stomachs examined in which that prey taxon was the only one found.

RESULTS

Staghorn Sculpin

Size of the staghorn sculpin increased from spring to summer. In 1981, no sculpin over 119 mm s.l. was found in April, none over 109 mm s.l. in the June sample, and none under 100 mm s.l. in September (Figure 1A). Similar results were seen in 1982, with no sculpin over 119 mm s.l. in May, a diffuse distribution in July, and none under 80 mm s.l. in August. Average weight of the fish was 21.7 g, ranging from 1.0 g to 115.5 g. Average standard length was 100 mm, ranging from 37 mm to 170 mm (Table 3).

A wide variety of food items were eaten (Table 1A). The most common prey taxon was Gammaridea, and it was also the most numerous by far (Table 2A). A total list of prey, and the number, frequency, and volume in which they were consumed is in table 2A. Major prey taxa were graphed by the same variables (Figure 3). Teleostei was by far the largest food item by volume, and the ghost shrimp (*Callianassa californiensis*) also was consumed far more than other items by volume. Gammarid amphipods were the only item consumed in large numbers (Table 4A). This occurred during a heavy gammarid feeding period in

September, 1981 (Table 4B). The largest number of different prey eaten by one fish was five.

Consumption of prey taxa varied drastically with sampling date. *Hemigrapsus* sp. and *Crangon* sp. foraging was common in May, 1981. These two genera were consumed most in the spring. Almost all teleosts found were consumed during 1982, and almost all food items could not be deduced past crustacean in June, 1981. The sculpin did not exhibit monophagous behavior with any prey taxon, except unidentified crustaceans which included a variety of organisms (Table 4A).

Only sculpins 77 mm and more in standard length consumed gammarid amphipods, teleosts and ghost shrimp. Only sculpins under 120 mm s.l. consumed isopods (Table 4A). Sculpins consumed more volume of prey if they were longer ($r=0.331$, $p<.05$). The average volume of the prey they consumed was also larger if the sculpin was longer ($r=0.263$, $p<.05$) as seen in Table 3. Sculpins did not eat more or less of a prey item by number if they were longer (Table 4A). In examining 41 stomachs at random (51% of total), 15 of the 21 (71%) different prey items found in the total of 81 fish were observed (Figure 5).

Shiner Surfperch

Size distribution by date of the shiner surfperch was the opposite of the staghorn sculpin. Bigger fish were generally around in the spring and early summer, whereas smaller fish were caught in late summer and fall (Figures 2A and 2B). Average weight of the Surfperch was 16.7 g, ranging from 1.7 g to 52.5 g. Average standard length was 82 mm, ranging from 44 mm to 121 mm. (Table 3).

Surfperch consumed a variety of food items (Table 1B). A total list of prey items is in table 2B, and the major prey items are graphed in figure 4. The most common prey taxon was barnacle cypris larvae, and it was also by far the most numerous item of the diet (Table 2B). Cancer crab megalops was the largest prey taxon by volume, and then came the ghost shrimp with no other taxon near these by volume. Copepods were also a popular prey, as they were second in frequency and number. Barnacle cypris larvae and crab zoea were eaten in large numbers, as much as 500 and 120 respectively (Table 5A). Monophagous foraging on unidentified crustaceans occurred as with the sculpin. Monophagy also occurred with the crab zoea and cancer crab megalops, as 47 and 32 percent of their predators eating only them, respectively (Table 5A). The largest number of different prey eaten by one fish was six.

Most of the cancer crab megalops found were consumed in April, 1981. Most of the clam foraging occurred in late summer and fall (Tables 5B and 5C). Almost all the crab zoea consumption was in August, 1982. Copepods were eaten in the greatest amount in August and September, 1981. Seventy nine percent of the surfperch averaged 143 barnacle cypris larvae in their stomach in September, 1982. Most of the stomachs examined in June, 1981 contained only unidentified crustaceans. No fish under 72 mm s.l. consumed cancer crab megalops, and no fish over 98 mm s.l. consumed crab zoea (Table 5A).

Surfperch consumed more volume of prey if they were longer ($r=0.322$, $p<.001$). However, the average volume of prey ingested did not significantly increase with the length of the fish (Table 3). The number of a prey taxa consumed did not vary significantly with fish length for any item (Table 5A). In examining 41 stomachs at random (76% rate of total), 16 of the 22 prey items (73%) found in the total of 155 fish were seen (Figure 6).

DISCUSSION

Staghorn Sculpin

The seasonal size distribution of the sculpin in this study reflected what is stated in the literature. Tasto (1975) reports that juveniles occurring in Anaheim Bay, CA, grew throughout the summer and winter until being replaced by a new generation in the spring. A study done at Lower Cook Inlet, Alaska reported two size classes growing throughout the summer (Blackburn, et. al., 1980). The two groups started at 40 mm s.l. and 100 mm s.l. in the spring, and grew to 100 mm s.l. and 180 mm s.l. respectively by the fall. This study reflected the same growth pattern as was seen in the two studies mentioned above (Figures 1A and 1B.).

As described by Wolf et. al. (1983), an asymptote was neared in the cumulative prey index graph (Figure 5), with just over half the total sample size examined. It is then apparent that the total diet of the sculpin is recorded by this study. Since the study was done over two different summers, the chance for a change in prey availability was large. Therefore, the fact that 71% of the total prey items were found in 41 fish indicates that a small sample size should suffice for further studies of the staghorn's diet. This author feels that 60 stomachs are adequate for a one season study, and that 100 stomachs will suffice for a multi-season study.

The correlation for total volume prey consumed versus standard length confirmed the assertion by Boothe (1967), that larger staghorns eat more. The staghorn sculpin was also found to eat larger prey as it grew larger, and this could have implications of optimal foraging in the way of maximized intake per foraging event. However, too many variables not accounted for, such as prey caloric value, ease of capture, and their availability, does not allow meaningful discussion on this subject. Numerous possible biases present with these correlations must be elaborated on.

In the average prey size correlation, there could be a large variation in size among the particular prey item eaten. This would, for example, allow a large fish to have a large average prey volume while still eating small prey. Prey size did vary greatly within a given taxon (Table 4A), and so this correlation cannot rule out large fish eating some small prey. Including empty stomachs in the total volume correlation biased it to non-significance. Eating no prey volume is close to eating a very small prey volume, and so large fish with empty stomachs would indicate that large fish eat a small volume. Small fish with empty stomachs indicate that small fish eat a small volume, and would bias the result to significance. However, if a correlation does truly exist for these variables, it will be biased more to non-significance, since smaller fish would eat a smaller volume anyway. This bias affects the number prey consumed versus total length correlation mentioned below in the same way.

The last bias arises from counting teleost vertebrae as teleosts. This tends to bias both volume correlations towards significance (since larger fish ate teleosts), as the fish would have more room in its stomach to eat than it would have had it been the whole fish. However, I feel it necessary to include them as the whole fish, for normal gastric evacuation takes 27 hours (Tasto, 1975), whereas the vertebrae stay in the stomach an unspecified amount of time. These vertebrae take up room for a longer time, and may result in reducing the fishes appetite. Ideally, this bias towards insignificance is just balanced by the bias towards significance. The correlations are probably legitimate, except that large fish eating small prey cannot be ruled out by the average volume correlation.

Only staghorns over 77 mm in standard length consumed ghost shrimp, gammarids,and teleosts. However, gammarids and ghost shrimp were only consumed on dates (Table 4B) where no fish were smaller than 80 mm s.l. (Figures 1A and 1B). On the other hand, teleosts were frequently consumed during May, 1982 (Table 4B) when many small sculpins were present (Figure 1B). Therefore, only sculpins larger than 80 mm s.l. eat teleosts, and sculpins under 80 mm s.l. do not even if teleosts are available. Isopods were not consumed by fish over 120 mm s.l. (Table 4B), even though they were available to larger fish (Figures 1A and 1B).

A change in diet could also occur in a prey consumed by all sizes, but more often at one prey size. This was not the case though, as no significant correlation of number prey eaten versus total length of fish was found. A previous study has found that sculpins consume fewer insect larvae as they increase in length, but these fish came from a tide pool (Wolf, et. al., 1983). In summary, a change of diet was found to occur only with regard to teleost and isopod foraging by the sculpin.

Before the diet of this study can be compared with other studies, certain biases must be addressed. The June, 1981 examination found only unidentified crustaceans in ten stomachs. If all these fish consumed the same taxon, my results would have differed noticeably. The apparent monophagy by the sculpin on unidentified crustaceans is a misnomer, since this category contains many prey items. Tide, temperature, sex, or predators of the sculpin are not controlled. Smaller sculpins reside in more brackish water than larger sculpins (Jones, 1982), and this could result in the two groups being exposed to different prey items. One study found no seasonal variation in the sculpins diet from spring to summer (McCabe, et. al., 1983). Another study found only crab and ghost shrimp predation to vary seasonally (Boothe, 1967), and yet another found the diet to vary with seasonal prey availability (Jones, 1962). Hence, there will be a discrepancy arising from comparing results without regard to season. Time of capture has also not been controlled. One study found that sculpins feed more at night, eat more ghost shrimp at night, and less _Hemigrapsus_ sp. at night (Tasto, 1975). The microhabitat has been previously found to affect the sculpin diet, with stomach contents varying from station to station (Boothe, 1967).

In a San Francisco Bay study (done by otter trawls), prey consumption in descending order of importance was: _Crangon_, bay goby (_Lepidogebius lepidus_), crabs, and ghost shrimp (Boothe, 1967). One sculpin gut was reported to be full of sculpin eggs (many studies mention sculpin cannibalism). Gobies were said to be important only to larger fish. All fish in the study were over 100 mm in standard length, and these results show no discrepancies with this present study. Another study captured staghorns by beach and purse seine at the intertidal zone of the inland Columbia River Estuary, Oregon (McCabe, et. al., 1983). Gammarid amphipods were the main prey item found, and no evidence of a change in diet was seen. This is not surprising though, as none of their 48 samples contained teleosts or isopods.

A San Francisco Bay study was done in two phases (Jones, 1982). Eighty seven sculpins ranging from 125 mm to 237 mm in standard length were taken from the Bay during winter. Shrimp, crabs, and fish (including staghorns) were the main prey items. One hundred and one sculpins (ranging from 20 mm to 135 mm in standard length) were taken from Walker Creek over an entire year. Amphipods were the main prey item for this part, and Hemigrapsus sp. were consumed in both parts of the study. In Anaheim Bay, California, Tasto (1975), reported that juvenile sculpins ate amphipods and gobies, whereas maturing sculpins ate ghost shrimp, crabs and fish. This study involved 213 stomachs captured mainly by beach seine. Boothe (1967) had found that gobies were eaten by larger fish, and the present study found that teleosts were only eaten by larger fish. This contradiction could be due to comparison bias.

In a study around Humboldt Bay, California, smaller sculpins were reported to eat mainly amphipods, and larger sculpins to eat amphipods and bay shrimp (Porter, 1964). The report goes on to state that algae and fish become important in the diet after the fish reaches 100 mm in standard length. Isopods, annelids, caprelids, and clams were also present in the diet. This study involved 218 fish captured by traps in three different areas. The results are similar to this present study, and all species of fish noted in the present study were also found by Porter. At Lower Cook Inlet, Alaska in May, a beach seine captured eight sculpins (Blackburn, et. al., 1983). Fish larvae was the main item found in their stomachs.

A study done in Potter Marsh, Alaska reported the juvenile sculpin diet to be: amphipods, plants, insect larvae, and larval fish (Wolf, et. al., 1983). This study was composed of 60 sculpins captured from tide pools during various months. Here, the variety of the sculpin diet was found to decrease as the sculpin increased. This contradicts Porter (1964) but the studies involved different sampling techniques. The staghorn sculpin does not merely feed on what is available as suggested by Jones (1962). No sculpins consumed copepods, which are a major prey of the shiner surfperch captured at the same time. Small sculpins eat mainly Peracarida, and the large sculpins eat Eucarida and fish. An exception to this was found by Tasto (1975).

Shiner Surfperch

Odenweller (1971) gives the standard length range in his study by year: first year- 31 mm to 87 mm, second year- 68 mm to 115 mm, and third year- 81 mm to 117 mm. It is evident that only first year fish are in the Umpqua River estuary in late summer, and only second and third year fish in spring and early summer. Size distribution of the surfperch by date corresponds to their breeding habits. Large viviparous females come into the bay in the spring to give birth, and mating with the large males occurs soon afterward. The sperm is stored in the female ovary, until fertilization of the eggs take place around December. The newborn young remain in the bay during the summer, and mating takes place during this time (Bane and Robinson, 1970).

An asymptote was neared in the cumulative prey index,

(Figure 6), with only one quarter of the total stomachs examined. Therefore, as described by Wolf et. al. (1983), this study shows the entire diet of the surfperch. This index was compiled from a two year sample (two seasons per year), and 73% of the prey were found in 41 stomachs. Hence, this author feels that 100 stomachs for a multi-year sample, and 80 stomachs for a single year sample should be adequate to characterize the shiner surfperch diet in future studies.

Surfperch were found to eat more volume of prey if they were larger. This supports the suspicion by Boothe (1967), that his results to the contrary were due to sampling error. Biases in this correlation are mentioned in the staghorn sculpin discussion. The surfperch were not found to eat larger prey if they were larger. The shiner differs from the sculpin in this respect.

No diet change is evident in the surfperch diet. Cancer crab megalops were only eaten by larger fish, but they were also only eaten in the early summer of 1981 (table 5B) when fish were large (Figure 2A). Although crab zoea were only eaten by smaller fish, they were mainly consumed in August, 1982 (Table 5C), when no fish were over 100 mm s.l. (Figure 2B). There was also no relative change in diet, as no significant correlation for number species consumed versus fish size were present.

Monophagous foraging by the surfperch occurred with both crab zoea and cancer crab megalops. This could indicate the fish prefers these taxa to the extent that it will consume only these taxa when available. A large number of barnacle cypris larvae were consumed in August 1982 (Table 5C), when heavy zoea feeding occurred. This makes the monophagy on the zoea more significant, as it was not the only prey available. The same is true of the crab megalops, as large numbers of the cypris larvae were consumed on heavy megalops feeding dated: April, May, 1981 (Table 5B). Unidentified crustaceans are not consumed monophagously for reasons given previously.

Possible biases in the prey data must be mentioned before a comparison with the literature can be performed. The stomach contents of most of the 33 fish in June, 1981 could only be identified as unidentified crustaceans. This presents the same bias as mentioned for the staghorn sculpin. Nematodes have been noted as an intestinal parasite of the surfperch (Walder and Arai, 1974). Therefore, the nematodes found in the surfperch stomachs were probably parasitic, and were not considered prey.

Time, temperature, salinity and predators present at time of capture were not taken into account. Lunar effects have been controlled for in a previous study, where the shiner was found to forage only at night (Hobson and Chess, 1986). Another study found the shiner to be more abundant at night (Bayer, 1981), further bringing into question the uncontrolled lunar phase. However, Odenweller (1971), found no foraging differences between day and night capture. Seasonal variation in diet has been found by two studies (McCabe, et. al., 1983 and Odenweller, 1981), and must be regarded as a major limitation to literature comparison. The sex of shiner surfperch were not taken into account, but this probably does not create a comparison bias. Odenweller (1971) found no variation in diet with sex, and another study found only cumaceans (not found in the present study) to vary with sex independent of size (Boothe 1967). This same study also found variation in diet between capture areas, showing the comparison bias of an uncontrolled for microhabitat.

In a San Francisco Bay study, the shiner surfperch diet comprised, in descending order of importance: gammarid amphipods, cumaceans, bivalves, polychaetes, and copepods (Boothe, 1967). This study was done by otter trawls over ten months, and selected its large sample to obtain equal numbers of all size fish. The study went on to report that amphipods and bivalves occurred more frequently in larger fish, whereas copepods and ostracods were eaten in greater amounts by the smaller fish. This foraging difference was relative, with one size class eating the item more or less frequently than the other. In the present study, any relative foraging differences as described above were not large enough to make the number prey eaten versus fish length correlation significant.

One hundred seventy four shiner surfperch were captured by beach and purse seine at the intertidal zone of the inland Columbia Estuary, Oregon (McCabe, et. al., 1983). Gammarids were the main prey item in the spring, and copepods were the main prey in the summer. No foraging differences with size were noted. Another study done in Newport Bay, California reported the surfperch as omniverous, consuming in descending order: green plants, small crustaceans, annelids, eggs and algae (Bane and Robinson, 1970). The study examined 139 fish caught by various methods. This Newport Bay study also found a difference from the earlier San Francisco study in that it reported no foraging differences between adults and juveniles. This is the only study that found plants to be a major prey item.

Day and night otter trawls were employed to catch 138 shiners in Anaheim Bay, California (Odenweller, 1971). Various areas of the bay were trawled, and the habitat was mainly muddy. Zooplankton were the most common item, and benthic fauna were consumed when zooplankton were not available. No differences in foraging were found with age. In the last study, surfperch were captured by spear off an open sand beach 100 meters from shore in a cove off Santa Catalina, California (Hobson and Chess, 1986). The study caught its fish (70 mm to 109 mm s.l.) two hours before dawn over three days in July. Gammarids, tanaids, and cumaceans were found to be the major prey taxa.

In summary, the surfperch does not change its diet with size in regard to prey taxa, number of a prey taxon eaten or average prey size. Boothe, (1967) did report a relative difference in foraging with size, but no other study (including this one) found such a difference. Peracarida are major food items in all studies. Plants and cumaceans are major prey items in some studies, but were not found in this study.

Table 1A-Staghorn sculpin food items captured by beach seine on the Umpqua River Estuary, Oregon 1981-82.

Staghorn Sculpin

- Division Chlorophyta (with epiphytes)
- Division Anthophyta (plant seed)
- Pnylum Mollusca
  - Class Bivalvia (clams)
- Phylum Annelida
  - Class Polychaeta
- Plylum Arthropoda
  - Class Insecta
    - Order Diptera
      - Family Chironomidae
  - Class Crustacea
    - Unident. fragments
    - Subclass Copepoda
    - Sublcass Cirripedia
      - Cypris larvae
    - Subclass Malacostraca
      - Division Peracarida
        - Order Mysidacea
        - Order Isopoda
        - Order Amphipoda
          - Suborder Gammaridea
            - Corophium sp.
          - Suborder Hyperiidea
      - Division Eucarida
        - Order Decapoda
          - Suborder Natantia
            - Family Crangonidae
              - Crangon sp.
          - Suborder Reptantia
            - Zoea larvae
            - Section Anomura
              - Family Callianassidae
                - Callianassa Californiensis
            - Section Brachyura
              - Family Cancridae
                - Megalops larvae
              - Family Grapsidae
                - Hemigrapsus sp.
- Phylum Chaetognatha
- Plylum Chordata
  - Class Osteichthyes
    - Subclass Teleostei
      - Unident. Vertebrae
      - Unident. Fish Piece
      - Unident. Whole Fish
      - Order Atheriniformes
        - Family Atherinidae
          - Atherinops affinis
        - Order Pleuronectiformes
          - Family Pleuronectidae
            - Parophrys vetulus
        - Order Salmoniformes
          - Family Osmeridae
            - Hypomesus pretiosus

Table 1B-Shiner Surfperch food items captured by beach seine on the Umpqua River Estuary, Oregon 1981-82.

Shiner Surfperch

- Phylum Nemertea
- Phylum Nematoda
- Phylum Mollusca
    - Class Bivalvia (clams)
    - Class Gastropoda (snail larvae)
- Phylum Annelida
    - Class Oligochaeta
    - Class Polychaeta
- Phylum Arthropoda
    - Class Insecta
    - Class Crustacea
        - Unident. Fragments
        - Subclass Copepoda
        - Subclass Cirripedia
            - Cypris larvae
            - Nauplii larvae
            - Molt
        - Subclass Malacostraca
            - Division Peracarida
                - Order Tanaidacea
                - Order Mysidacea
                - Order Isopoda
                - Order Amphipoda
                    - Suborder Gammaridea
                        - *Corophium* sp.
            - Division Eucarida
                - Order Decapoda
                    - Suborder Natantia
                        - Family Crangonidae
                            - *Crangon* sp.
                    - Suborder Reptantia
                        - Zoea larvae
                        - Section Anomura
                            - Family Callianassidae
                                - *Callianassa californiensis*
                        - Section Brachyura
                            - Family Cancridae
                                - Megalops larvae
                            - Family Grapsidae
                                - *Hemigrapsus* sp.
- Phylum Chordata
    - Class Osteichthyes
        - Eggs
        - Larvae

Table 2A: Major prey items of the staghorn sculpin captured by beach seine on the Umpqua River Estuary, Oregon 1981-82.

Species	Percentage number of stomachs in which occurred	Total number eaten	Total volume eaten (ml)
Gammaridea	23.5	165	4.64
Unident. crustacea	22.2	19	0.03
Hemigrapsus sp.	21.0	41	4.56
Teleostei	18.5	50	107.9
Fish vertebrae	14.8	12	1.21
C. californiensis	12.3	14	11.82
Isopoda	12.3	21	0.27
Crangon sp.	11.1	12	0.42
Cancer crab megalops	9.9	41	1.44
Empty/totally digested	8.6	N/A	N/A
Polychaeta	6.2	6	0.13
Clam	3.7	4	0.56
Copepoda	3.7	5	0.04
Barnacle cypris larvae	3.7	4	0.03
Crab zoea larvae	2.5	12	*
Hyperiidea	1.2	1	0.01
Barnacle molt	1.2	1	*
Algae	1.2	1	*
Plant seed	1.2	2	*
Mysidacea	1.2	1	*
Insecta	1.2	1	*
Chaetognatha	1.2	1	*

Number stomachs sampled =81; * means volume is less than 0.005 ml.

Table 2B: Major prey items of the shiner surfperch captured by beach seine on the Umpqua River Estuary, Oregon 1981-82.

Species	Percentage number of stomachs in which occurred	Total number eaten	Total volume eaten (ml)
Barnacle cypris larvae	29.7	2015	0.81
Copepoda	26.5	774	0.85
Gammaridea	23.2	167	0.68
Unident crustacea	21.3	54	0.11
Cancer crab megalops	14.2	243	14.96
Empty/totally digested	13.5	N/A	N/A
Crab zoea larvae	12.3	767	0.31
Clam	11.6	91	0.11
Isopoda	7.1	15	0.06
Barnacle nauplii larvae	6.5	11	0.01
Fish eggs	4.5	257	0.13
Polychaeta	3.2	6	0.01
Hemigrapsus sp.	2.6	25	1.00
Crangon sp.	2.6	4	0.07
Mysidacea	1.9	21	0.11
Nematoda	1.9	12	0.01
Insecta	1.9	3	*
C. californiensis	1.3	4	6.57
Oligochaeta	0.6	1	0.03
Fish larvae	0.6	11	0.01
Barnacle molt	0.6	3	0.01
Tanaidacea	0.6	1	*
Nemertea	0.6	1	*
Snail larvae	0.6	1	*

Number stomachs sampled =155; * means volume less than 0.005

Table 3: Weight and length of staghorn sculpin and shiner surperch caught by beach seine on Umpqua River Estuary, Oregon 1981-82, and the relationship of fish size to diet.

Statistic	Staghorn Sculpin	Shiner Surfperch
Average weight (g)	21.7	16.7
Weight range (g)	1.0-115.5	1.7-52.5
Average standard length (mm)	100	82
Standard length range (mm)	37-170	44-121
Largest number of different prey eaten by one fish	5	6
Total volume of prey eaten vs. standard length	$r=0.331$ $n=81$ $p<.05$	$r=0.322$ $n=153$ $p<.001$
Average species prey volume eaten vs. standard length	$r=0.263$ $n=126$ $p<.05$	$r=0.109$ $n=227$ ns*

* not significant, $p>.05$

Table 4A: Predation statistics and size of the major prey of the staghorn sculpin captured by beach seine on the Umpqua River Estuary, Oregon 1981-82.

Major Prey Species	Total length range prey (mm)	Largest number eaten at once	Range standard length fish (mm)	Percent monophagous fish	Total Length fish vs. number eaten (r)*
Gammaridea	2-20	68	77-140	11	0.091
Unident. crustacean	2	3	56-161	56	0.021
Hemigrapsus sp.	2-10	7	37-140	28	0.056
Teleostei	10-70	4	83-170	26	0.294
C. californiensis	10-60	3	80-130	30	0.057
Isopoda	2-10	8	48-119	11	0.053
Crangon sp.	3-15+	2	37-140	22	0.014
Cancer crab megalops	2-10	6	48-128	0	-0.131

*not significant for all values, $p > .05$

Table 4B: Predation on major prey items by date, of the staghorn sculpin captured by beach seine on the Umpqua River Estuary, Oregon 1981-82.

	Percent frequency occurance: average number eater					
Major Prey Species	22 April 1981 n=15	17 June 1981 n=10	17 Sept. 1981 n=11	20 May 1982 n=13	27 July 1982 n=8	23 August 1982 n=24
Gammaridea	53:1	0:0	45:26	8:2	38:1	8:5
Unident. crustacean	13:1	50:1	36:1	8:1	13:2	17:1
Hemigrapsus sp.	20:5	0:0	9:1	77:2	13:1	21:2
Teleostei	0:0	0:0	9:1	23:2	63:2	71:2
C. californiensis	33:2	20:1	18:1	0:0	0:0	8:2
Isopoda	20:2	10:1	18:6	8:2	13:1	13:1
Crangon sp.	20:1	0:0	9:1	23:2	0:0	4:1
Cancer crab megalops	33:2	0:0	0:0	0:0	25:10	4:3

Table 5A: Predation statistics and size of the major prey of the shiner surfperch captured by beach seine on the Umpqua River Estuary, Oregon 1981-82.

Major Prey Species	Total length range prey (mm)	Largest number eaten at once	Range standard length fish (mm)	Percent monophagous fish	Total length fish vs. number eaten (r)*
Barnacle cypris larvae	2	500	48-110	11	-0.242
Copepoda	2-4	11	44-110	12	-0.055
Gammaridea	2-10	25	44-110	3	-0.024
Unident. crustacean	2	15	59-116	64	0.054
Cancer crab megalopse	2-6	36	72-120	32	0.356
Crab zoea	2	120	48-98	47	0.0[illegible]9
Clam	1-3	25	57-107	5	-0.209

* not significant for all values, $p > .05$

Table 5B: Predation on major prey items by date, of the shiner surfperch captured by beach seine on the Umpqua River Estuary, Oregon 1981

	Percent frequency occurrence: average number eaten				
Major Prey Species	22 April n=26	26 May n=8	17 June n=33	20 August n=16	17 September n=10
Barnacle cypris larvae	27:2	25:4	0:0	44:4	80:21
Copepoda	31:4	0:0	0:0	75:53	70:18
Gammaridea	38:6	25:13	0:0	38:3	40:11
Unident. crustacean	8:1	63:1	39:4	25:5	10:1
Cancer crab megalops	65:14	50:1	3:2	0:0	0:0
Crab zoea	8:1	0:0	0:0	6:1	0:0
Clam	8:1	0:0	0:0	25:2	10:1

Table 5C: Predation on major prey items by date, of the shiner surfperch captured by beach seine on the Umpqua River Estuary, Oregon 1982

Major Prey Species	Percent frequency occurence: average number eaten 20 May n=11	27 July n=10	23 August n=17	29 Sept. n=14	28 October n=10
Barnacle cypris larvae	0:0	20:1	29:44	79:143	20:1
Copepoda	36:1	20:4	0:0	0:0	40:2
Gammaridea	9:1	40:3	6:3	21:2	40:1
Unident. crustacean	36:1	30:1	0:0	0:0	20:1
Cancer crab megalops	0:0	0:0	6:1	0:0	0:0
Crab zoea	0:0	0:0	82:54	7:2	0:0
Clam	0:0	0:0	0:0	71:7	10:1

FIGURE 1A: SIZE DISTRIBUTION OF STAGHORN SCULPIN CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1981.

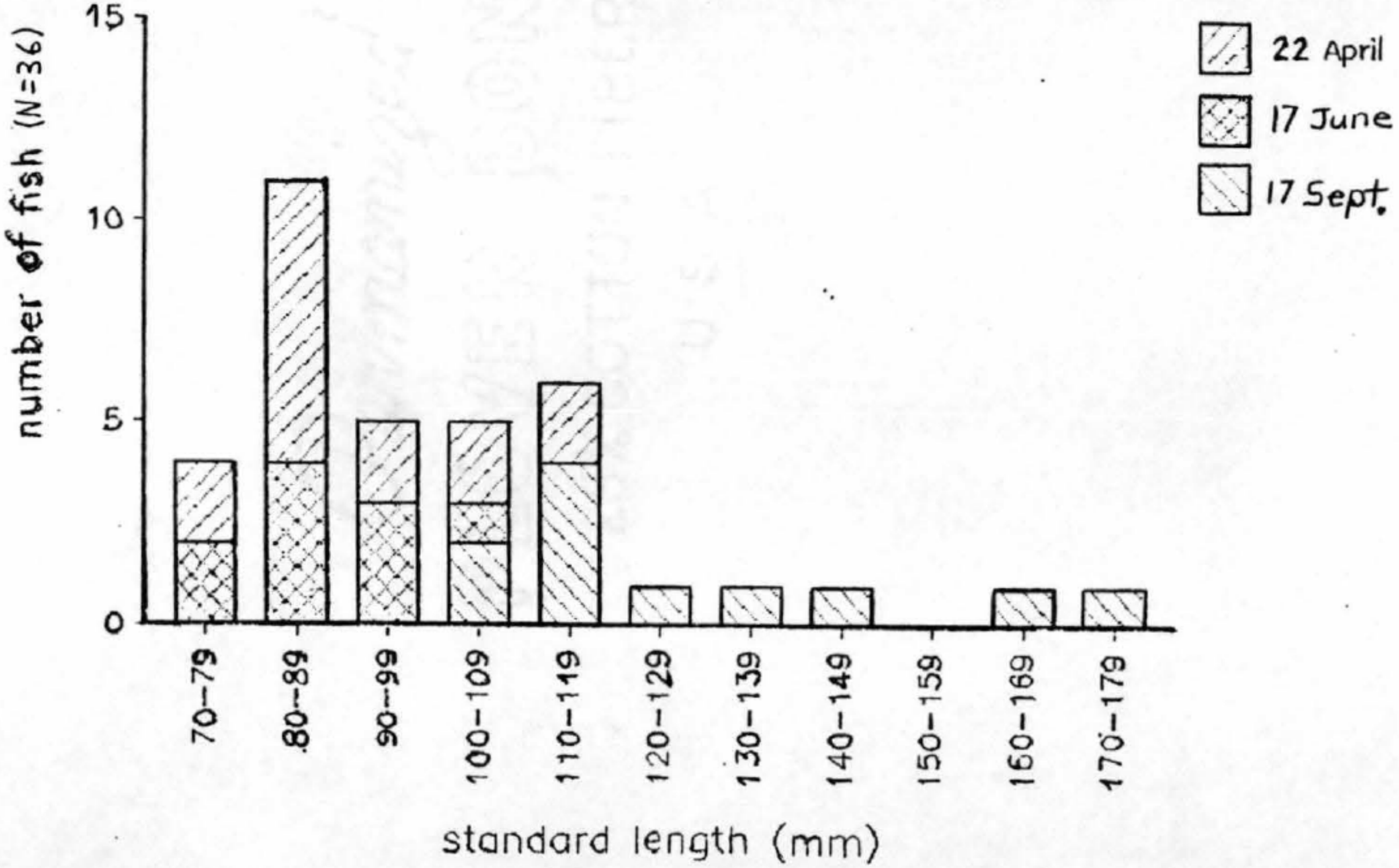

FIGURE 1B: SIZE DISTRIBUTION OF STAGHORN SCULPIN CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1982.

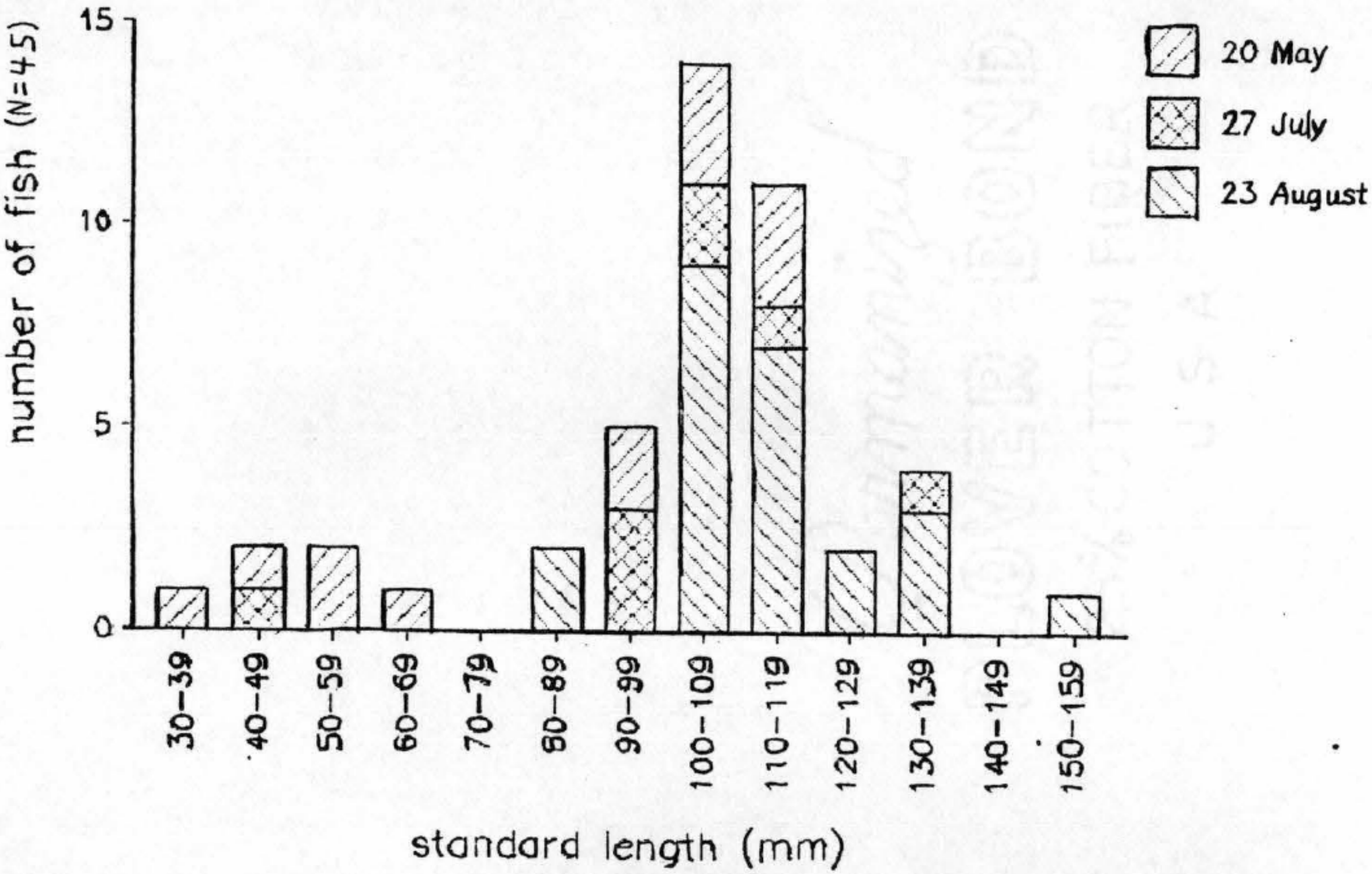

FIGURE 2A: SIZE DISTRIBUTION OF SHINER SURFPERCH CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1981.

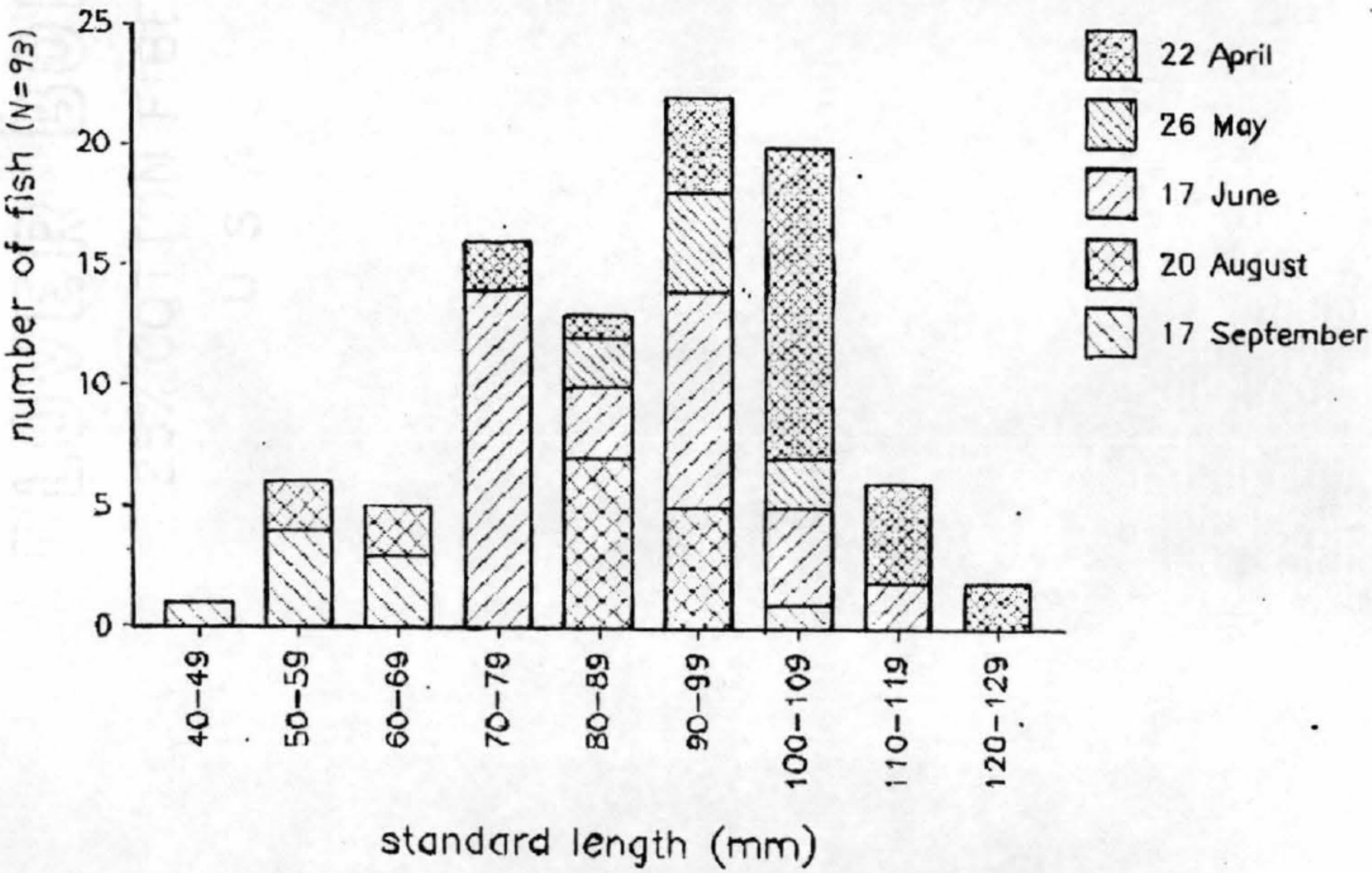

FIGURE 2B: SIZE DISTRIBUTION OF SHINER SURFPERCH CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1982.

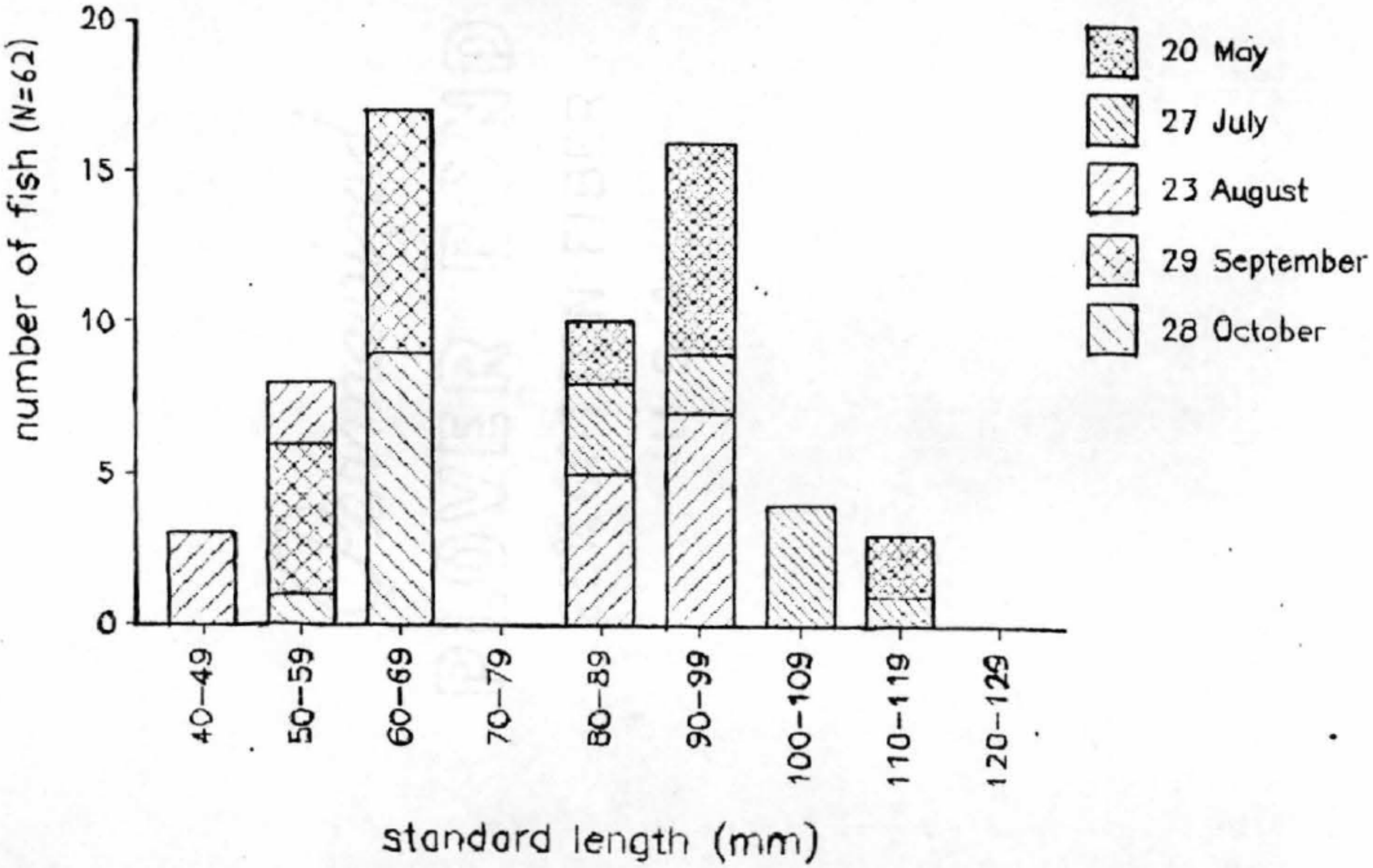

FIGURE 3: PREY ITEMS OF THE STAGHORN SCULPIN CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1981-82. PREY ITEMS IDENTIFIED TO LOWEST POSSIBLE TAXON. THE DIET IS EXPRESSED AS NUMBER OF PREY INGESTED, VOLUME EATEN, AND FREQUENCY OF OCCURRENCE.

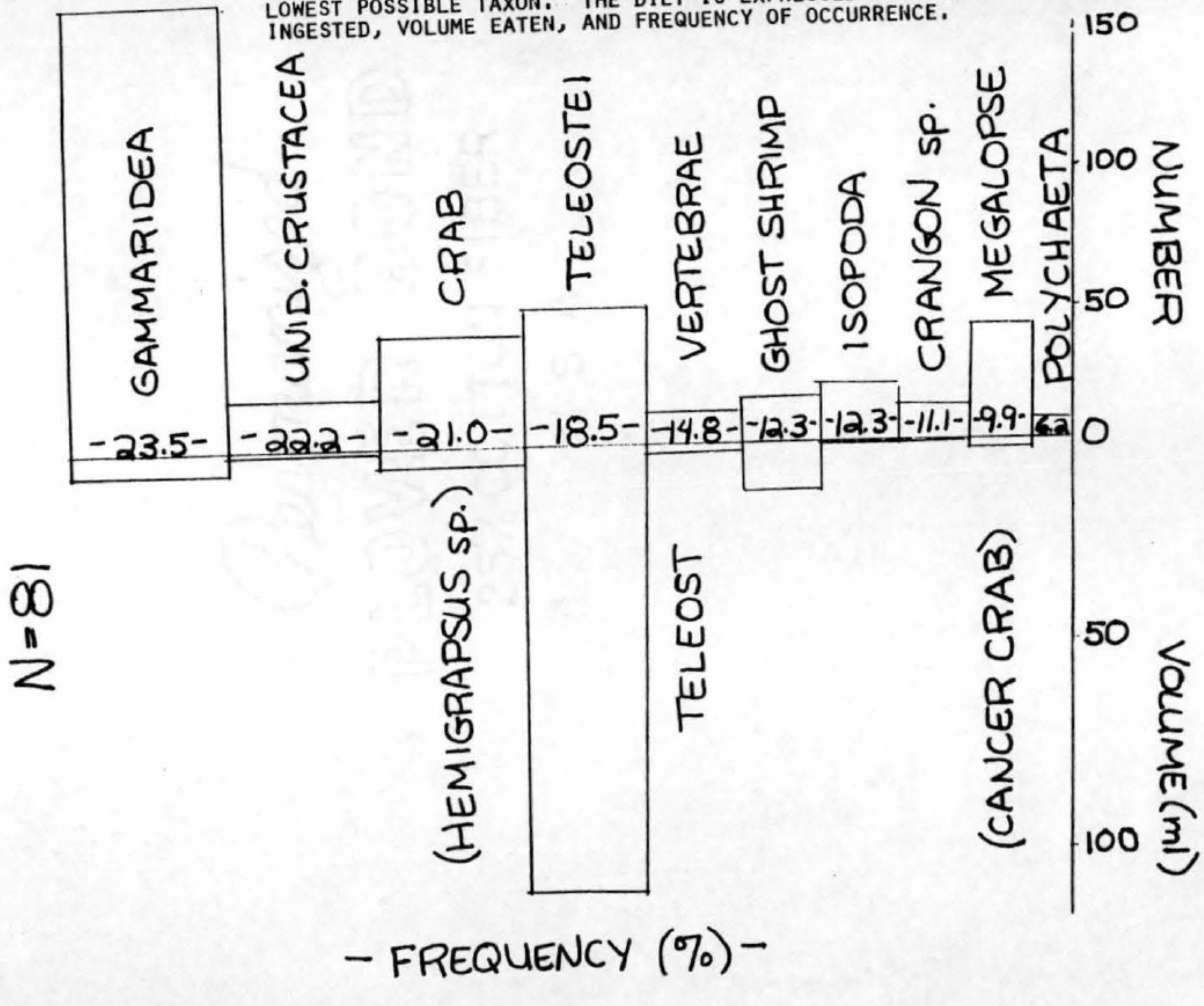

FIGURE 4: PREY ITEMS OF THE SHINER SURFPERCH CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1981-82. PREY ITEMS IDENTIFIED TO LOWEST POSSIBLE TAXON. THE DIET IS EXPRESSED AS NUMBER OF PREY INGESTED, VOLUME EATEN, AND FREQUENCY OF OCCURRENCE.

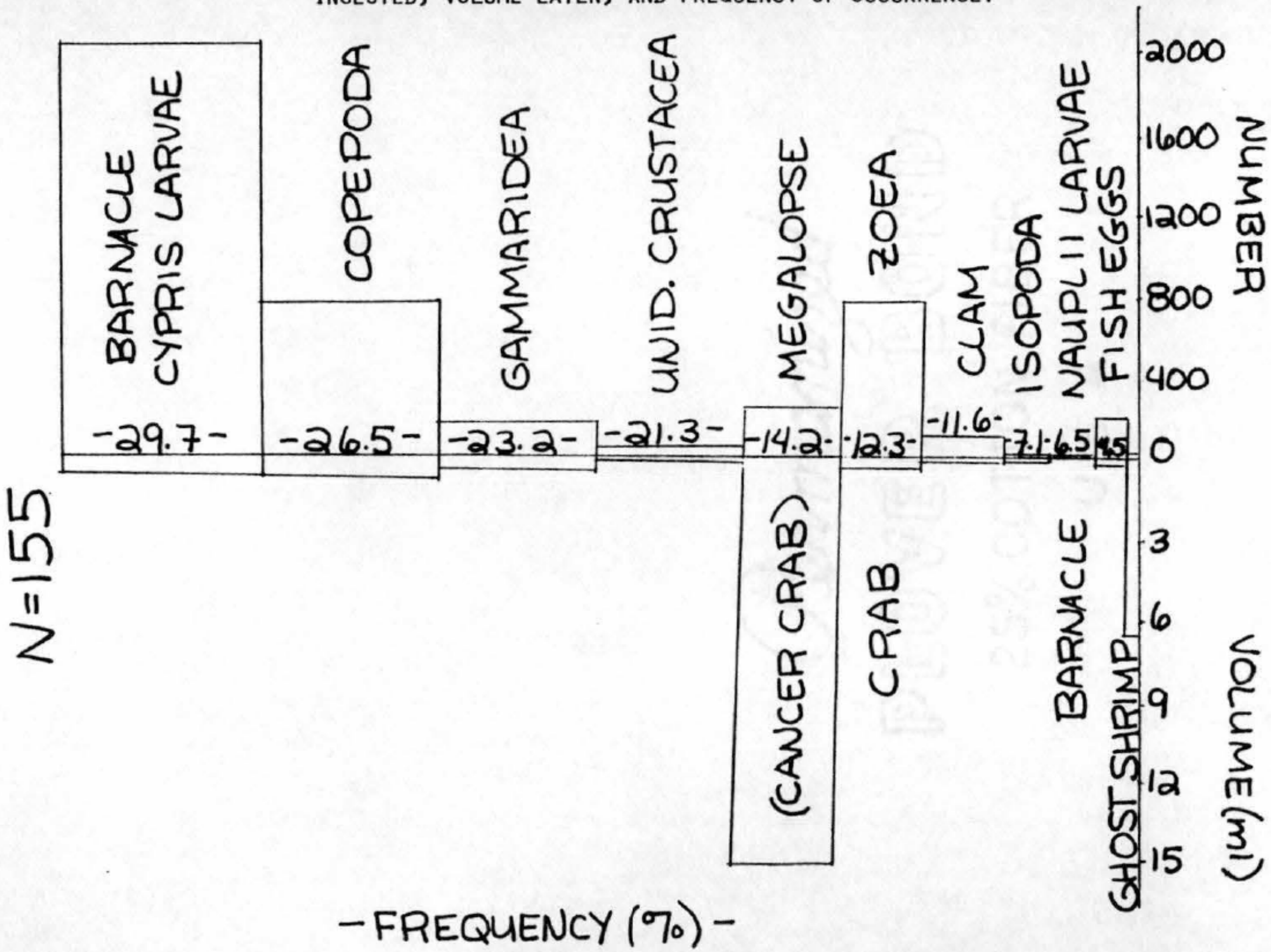

FIGURE 5: RELATIONSHIP BETWEEN SAMPLE SIZE AND CUMULATIVE PREY INDEX FOR THE STAGHORN SCULPIN CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1981-82. DOTTED LINE EXTRAPOLATED TO THE TOTAL NUMBER OF STOMACHS EXAMINED AND THE TOTAL NUMBER OF PREY TAXA FOUND.

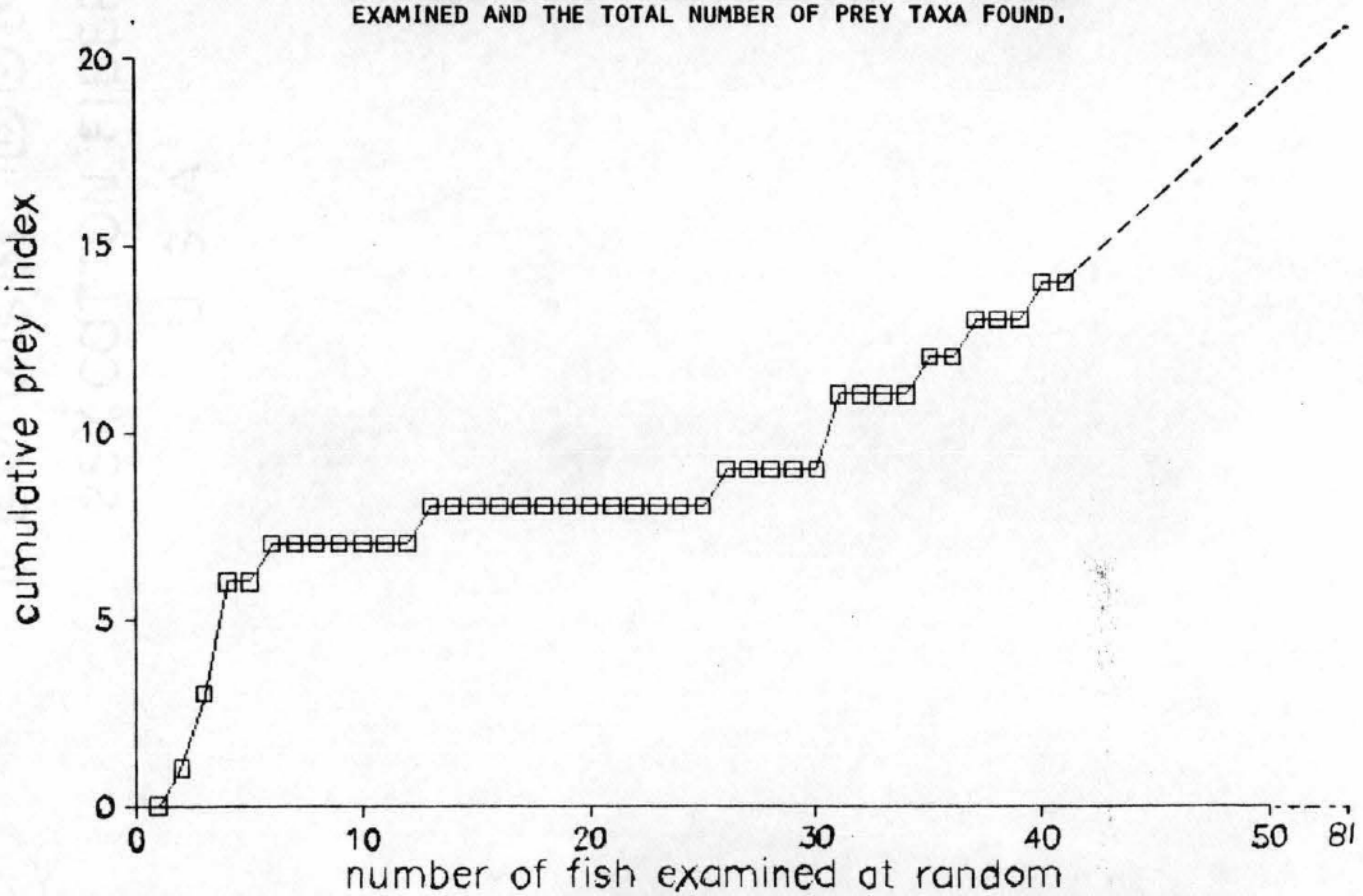

FIGURE 6: RELATIONSHIP BETWEEN SAMPLE SIZE AND CUMULATIVE PREY INDEX FOR THE SHINER SURFPERCH CAPTURED BY BEACH SEINE ON THE UMPQUA RIVER ESTUARY, OREGON, 1981-82. DOTTED LINE EXTRAPOLATED TO THE TOTAL NUMBER OF STOMACHS EXAMINED AND THE TOTAL NUMBER OF PREY TAXA FOUND.

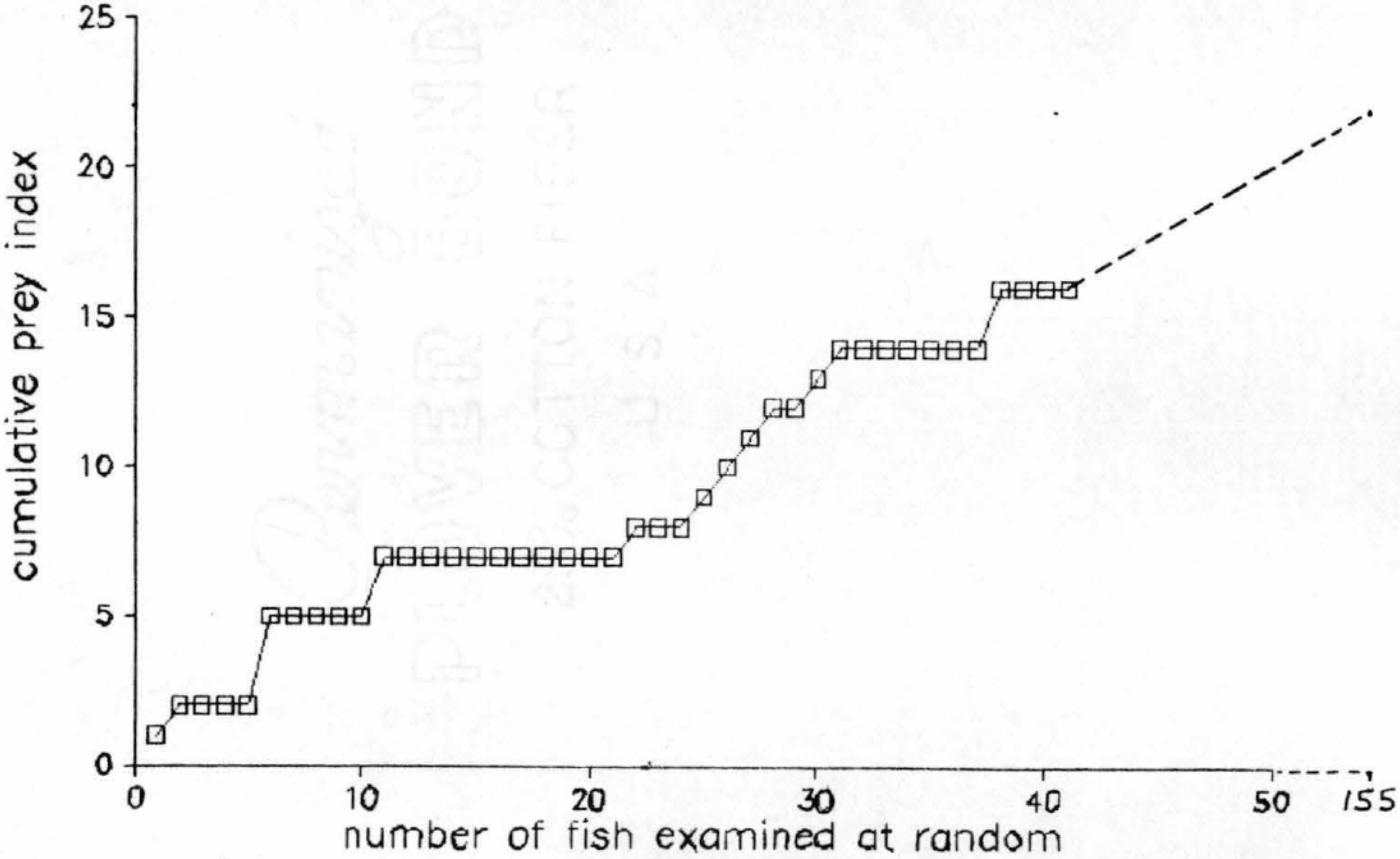

FIGURE 7: AREA OF STUDY ON THE UMPQUA RIVER ESTUARY, OREGON, 1981-82.

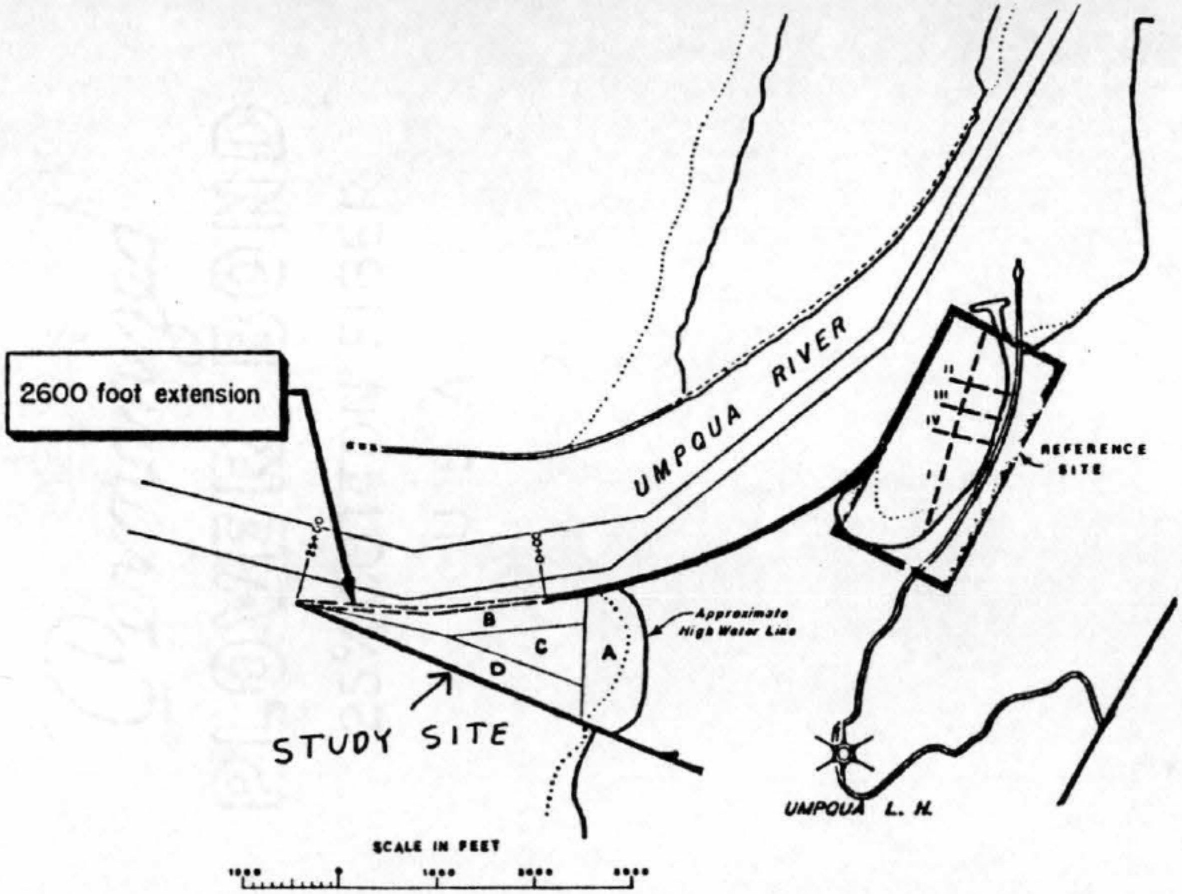

Figure 1. Study area and reference site. The 23 hectare study area was subdivided into three habitat types: A = intertidal, B and D = subtidal/jetty edge, and C = subtidal center. The sampling transects for the reference site are also shown. Otter trawls and zooplankton tows were conducted along transect I. Benthic samples were taken on the beach, 50 m and 100 m offshore along each of the transects II-IV.

Appendix

Volume estimation of prey using a single parameter. Prey taxa were considered to be a rectangle, cylinder or sphere. Volume was calculated using a single parameter.

Prey Item	Shape	Parameter Relationship	Volume Formula
Clam	cylinder	D=4L	$V=0.2D^3$
Polychaeta	cylinder	L=10D	$V=0.008L^3$
Arrow Worm	cylinder	L=10D	$V=0.008L^3$
Nemertea	cylinder	L=7D	$V=0.02L^3$
Nematoda	cylinder	L=10D	$V=0.008L^3$
Oligochaeta	cylinder	L=10D	$V=0.008L^3$
Unident. crustecea	square	L=4H	$V=0.25W^3$
Copepoda	cylinder	L=4D	$V=0.25L^3$
Barnacle cypris lar.	cylinder	L=4D	$V=0.05L^3$
Barnacle nauplii lar.	square	L=10H	$V=0.1L^3$
Barnacle molt	cylinder	D=4L	$V=0.2D^3$
Mysidacea	cylinder	L=5D	$V=0.03L^3$
Isopoda	cylinder	L=4D	$V=0.05L^3$
Tanaidacea	cylinder	L=5D	$V=0.03L^3$
Gammaridea	cylinder	L=5D	$V=0.03L^3$
Hyperiidea	cylinder	L=5D	$V=0.03L^3$
Insecta	cylinder	L=5D	$V=0.03L^3$
Crangon sp.	cylinder	L=5D	$V=0.03L^3$
Crab zoea larvae	cylinder	L=4D	$V=0.05L^3$
C. californiensis	cylinder	L=5D	$V=0.03L^3$
Crab megalops larvae	cylinder	D=4L	$V=0.2D^3$
Hemigrapsus sp.	cylinder	D=4L	$V=0.2D^3$
Osteichthyes larvae	sphere	N/A	$V=0.5D^3$
Osteichthyes eggs	sphere	N/A	$V=0.5D^3$
Fish vertebrae	cylinder	L=10D	$V=0.008L^3$
Teleostei (smelt)	cylinder	L=5D	$V=0.03L^3$
or (sole)	rectangle	L=.3W=.1H	$V=0.03L^3$
Algae	square	L=4H	$V=0.25W^3$
Plant seed	rectangle	L=2W=2H	$V=0.25L^3$
Snail larvae	cylinder	L=4D	$V=0.05L^3$

Parameters: L=length, W=width, H=height, D=diameter.

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Appendix 1A: key to appendices

Dates:
1- 22 April 1981
2- 26 May 1981
1- 17 June 1981
4- 20 August 1981
5- 17 September 1981
6- 20 May 1982
7- 27 July 1982
8- 23 August 1982
9- 29 September 1982
10- 28 October 1982

weight- in grams
standard length- measured from the first cervicle vertebrae to the caudal end of the fish in mm.
volume- in ml
species- full names of species found in tables 1A and 1B

	A	B	C	D	E
1	Appendix 2A				
2	Staghorn81				
3	date	weight	stan. length	polychaete #	volume
4	1	32	117	0	0
5	1	16.5	98	0	0
6	1	13	85	0	0
7	1	32	114	0	0
8	1	18	94	0	0
9	1	24	106	0	0
10	1	23.5	105	1	.009
11	1	17.5	87	0	0
12	1	9.5	80	0	0
13	1	12	85	0	0
14	1	9	71	0	0
15	1	12.5	86	0	0
16	1	14	83	0	0
17	1	13.5	81	0	0
18	1	9.5	77	0	0
19	3	6.5	70	0	0
20	3	9.5	86	0	0
21	3	6.5	70	0	0
22	2	13.5	86	0	0
23	3	10.5	87	0	0
24	3	17	94	0	0
25	3	13	90	0	0
26	3	11	84	0	0
27	3	19	100	0	0
28	3	15.5	92	0	0
29	5	115.5	170	0	0
30	5	74.5	161	0	0
31	5	50	140	0	0
32	5	48.5	139	0	0
33	5	34	123	0	0
34	5	25	108	2	.125
35	5	26	109	0	0
36	5	28	119	0	0
37	5	27	114	0	0
38	5	22	111	0	0
39	5	29	116	0	0

	F	G	H	I	J
1					
2					
3	crustacea #	volume	cypris lar.#	volume	isopod #
4	1	.002	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	1
9	0	0	0	0	0
10	0	0	0	0	3
11	0	0	0	0	0
12	0	0	0	0	0
13	1	.002	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	1	.002	0	0	0
18	0	0	0	0	0
19	1	.002	1	.0004	1
20	0	0	0	0	0
21	0	0	0	0	0
22	1	.002	0	0	0
23	1	.002	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	1	.002	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	1	.002	0	0	0
31	2	.004	1	.0004	0
32	0	0	0	0	0
33	1	.002	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	1	.002	0	0	3
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	8

	K	L	M	N	O
1					
2					
3	volume	gammarid #	volume	Crangon sp.#	volume
4	0	0	0	0	0
5	0	0	0	2	.2
6	0	1	.006	0	0
7	0	0	0	1	.02
8	.01	1	.006	0	0
9	0	0	0	0	0
10	.032	2	.06	1	.022
11	0	1	.03	0	0
12	Q	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	2	.036	0	0
16	0	1	.006	0	0
17	0	1	.006	0	0
18	0	1	.0002	0	0
19	.0004	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	1	.022
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	1	.006	1	.022
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	.033	1	.00024	0	0
37	0	59	.382	0	0
38	0	1	.006	0	0
39	.086	68	.441	0	0

	P	Q	R	S	T
1					
2					
3	Callianassa#	volume	megalopse #	volume	Hemigrapsus#
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	6
7	1	.81	0	0	7
8	2	.43	0	0	0
9	3	.3	1	.2	0
10	0	0	0	0	0
11	1	.03	0	0	0
12	1	.24	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	1
16	0	0	1	.043	1
17	0	0	3	.13	0
18	0	0	6	.26	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	1	.81	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	1
32	0	0	0	0	0
33	1	.24	0	0	0
34	0	0	0	0	0
35	1	6.48	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0

	U	V	W	X	Y
1					
2					
3	volume	teleost #	volume	hyperiid #	volume
4	0	0	0	0	0
5	0	0	0	0	0
6	.26	0	0	0	0
7	1.4	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	1	.006
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	.043	0	0	0	0
16	.043	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	1	6.48	0	0
30	0	0	0	0	0
31	.2	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0

	Z	AA	AB	AC
1				
2				
3	barn. molt #	volume	algae #	volume
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	1	.043	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	1	.002
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0

	A	B	C	D	E
1	Appendix 2B				
2	staghorn 82				
3	date	weight	stan. length	clam #	volume
4	6	5.5	68	0	0
5	6	1	37	0	0
6	6	22	106	0	0
7	6	19.5	102	1	.54
8	6	21	106	0	0
9	6	24	110	1	.005
10	6	28	115	0	0
11	6	23.5	112	0	0
12	6	2.5	56	0	0
13	6	16.5	98	2	.011
14	6	13.5	93	0	0
15	6	1	42	0	0
16	6	1.8	51	0	0
17	7	24.9	117	0	0
18	7	1.6	48	0	0
19	7	18.5	98	0	0
20	7	14.8	94	0	0
21	7	11.5	91	0	0
22	7	40.2	131	0	0
23	7	16.4	102	0	0
24	7	24.2	106	0	0
25	8	19.4	110	0	0
26	8	69.4	153	0	0
27	8	52	134	0	0
28	8	27.7	115	0	0
29	8	15.9	108	0	0
30	8	7.8	83	0	0
31	8	16	105	0	0
32	8	6.7	85	0	0
33	8	15	109	0	0
34	8	17.6	106	0	0
35	8	18.5	107	0	0
36	8	30.2	130	0	0
37	8	22.3	113	0	0
38	8	20.1	110	0	0
39	8	16.9	105	0	0
40	8	22.9	128	0	0
41	8	17	102	0	0
42	8	15.2	104	0	0
43	8	28	118	0	0
44	8	34.1	135	0	0
45	8	28.9	119	0	0
46	8	29.7	117	0	0
47	8	28.8	120	0	0
48	8	20.5	105	0	0

	F	G	H	I	J
1					
2					
3	polychaete #	volume	unid. crus.#	volume	copepod #
4	0	0	1	.002	0
5	1	.001	0	0	1
6	0	0	0	0	2
7	0	0	0	0	0
8	1	.001	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	1	.002	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	1
17	0	0	1	.002	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	1	.001	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	1	.002	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	1	.002	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	1	.002	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	1	.002	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0

	K	L	M	N	O
1					
2					
3	volume	cypris lar.#	volume	mysid #	volume
4	0	0	0	0	0
5	.003	0	0	0	0
6	.006	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	.032	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	1	.0002
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	2	.0004	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0

	P	Q	R	S	T
1					
2					
3	isopod #	volume	gammarid #	volume	Crangon sp.#
4	0	0	0	0	0
5	0	0	0	0	1
6	0	0	0	0	2
7	0	0	0	0	0
8	0	0	2	.013	0
9	0	0	0	0	2
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	1	.011	0	0	0
19	0	0	11	3.3	0
20	0	0	1	.3	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	1	.006	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	1	.011	0	0	0
33	0	0	0	0	1
34	0	0	0	0	0
35	1	.05	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	1	.086	0	0	0
39	0	0	0	0	0
40	1	.05	0	0	0
41	0	0	5	.001	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	5	.032	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0

	U	V	W	X	Y
1					
2					
3	volume	zoea lar. #	volume	Callianassa#	volume
4	0	0	0	0	0
5	.0008	0	0	0	0
6	.022	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	.002	0	0	0	0
10	0	0	0	0	0
11	0	1	.0004	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	.101	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	2	1.62
37	0	0	0	1	.81
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	11	.004	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0

	Z	AA	AB	AC	AD
1					
2					
3	megalopse #	volume	Hemigrapsus#	volume	vertebrae #
4	0	0	0	0	0
5	4	.006	0	0	0
6	2	.086	0	0	0
7	0	0	2	.4	0
8	0	0	1	.2	0
9	0	0	1	.043	0
10	0	0	4	.486	0
11	0	0	4	.8	0
12	0	0	0	0	0
13	0	0	0	0	1
14	0	0	1	.2	0
15	0	0	1	.002	0
16	0	0	0	0	0
17	0	0	0	0	0
18	1	.2	0	0	0
19	0	0	0	0	0
20	20	.864	0	0	1
21	0	0	0	0	1
22	0	0	0	0	0
23	0	0	1	.002	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	5	.843	0
30	0	0	0	0	1
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	1	.2	1
35	0	0	0	0	1
36	0	0	0	0	0
37	0	0	0	0	1
38	0	0	0	0	0
39	0	0	1	.2	0
40	3	.005	3	.13	0
41	0	0	0	0	1
42	0	0	0	0	1
43	0	0	0	0	0
44	0	0	0	0	1
45	0	0	0	0	1
46	0	0	0	0	0
47	0	0	0	0	1
48	0	0	0	0	0

	AE	AF	AG	AH	AI
1					
2					
3	volume	teleostei #	volume	insect #	volume
4	0	0	0	0	0
5	0	0	0	0	0
6	0	3	2.43	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	1	.81	0	0
12	0	0	0	0	0
13	.064	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	4	6.18	0	0
18	0	0	0	0	0
19	0	2	7.5	0	0
20	.216	0	0	0	0
21	.216	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	11	8.91	0	0
25	0	0	0	0	0
26	0	12	51.54	0	0
27	0	2	10.23	0	0
28	0	1	6.48	0	0
29	0	0	0	0	0
30	.008	0	0	0	0
31	0	0	0	1	.004
32	0	0	0	0	0
33	0	3	.09	0	0
34	.008	0	0	0	0
35	.064	1	.03	0	0
36	0	0	0	0	0
37	.064	1	.81	0	0
38	0	3	2.43	0	0
39	0	0	0	0	0
40	0	3	2.43	0	0
41	.064	0	0	0	0
42	.064	0	0	0	0
43	0	0	0	0	0
44	.008	0	0	0	0
45	.216	0	0	0	0
46	0	2	1.62	0	0
47	.216	0	0	0	0
48	0	0	0	0	0

	AJ	AK	AL	AM
1				
2				
3	plant seed#	volume	arrow worm#	volume
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	2	.002	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	1	.001
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0

	A	B	C	D	E
1	Appendix 3A				
2	Shiner 81				
3	date	weight	stan. length	nemertian #	volume
4	1	20	91	0	0
5	1		94	0	0
6	1	32.5	104	0	0
7	1	10.5	73	0	0
8	1	9.5	72	0	0
9	1	52.5	120	0	0
10	1	28	100	0	0
11	1	24.5	93	0	0
12	1	40.5	115	0	0
13	1	37.5	109	0	0
14	1	41.5	110	0	0
15	1	31.5	106	0	0
16	1	39	109	0	0
17	1	38	109	0	0
18	1	33	105	0	0
19	1	15	82	0	0
20	1	28	99	0	0
21	1	31	102	0	0
22	1	38	110	0	0
23	1	33.5	108	0	0
24	1	37	110	0	0
25	1	30.5	107	0	0
26	1	32	104	0	0
27	1	33.5	109	0	0
28	1	33.5	107	0	0
29	1	41.5	121	0	0
30	2	28	94	0	0
31	2	19	91	0	0
32	2	27	92	0	0
33	2	27.5	96	0	0
34	2	36	105	0	0
35	2	35.5	103	0	0
36	2	14	80	0	0
37	2	11	87	0	0
38	3	22	90	0	0
39	3			0	0
40	3	18	90	0	0
41	3	13	81	0	0
42	3	29	91	0	0
43	3	12	74	0	0
44	3	10.5	75	0	0
45	3	11.5	75	0	0
46	3	20.5	90	0	0
47	3	14	76	0	0
48	3	16	82	0	0

	F	G	H	I	J
1					
2					
3	nematode #	volume	clam #	volume	polychaete#
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	1	.008	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	1	.005	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	1	.005	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	1
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0

	K	L	M	N	O
1					
2					
3	volume	insect #	volume	unid. crus.#	volume
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	1	.002
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	1	.002
33	0	0	0	1	.002
34	0	0	0	1	.002
35	0	0	0	1	.002
36	0	0	0	1	.002
37	0	0	0	0	0
38	0	0	0	1	.002
39	.001	0	0	0	0
40	0	0	0	0	0
41	0	0	0	3	.006
42	0	0	0	2	.004
43	0	0	0	1	.002
44	0	0	0	0	0
45	0	0	0	1	.002
46	0	0	0	5	.01
47	0	0	0	0	0
48	0	0	0	1	.002

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	P	Q	R	S	T
1					
2					
3	copepod #	volume	cypris lar.#	volume	nauplii #
4	8	.026	0	0	0
5	1	.003	0	0	0
6	1	.003	0	0	0
7	0	0	0	0	0
8	3	.01	1	.0004	0
9	0	0	0	0	0
10	2	.006	0	0	0
11	1	.003	1	.0004	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	1	.0004	0
16	0	0	0	0	0
17	0	0	0	0	0
18	2	.006	0	0	0
19	0	0	1	.0004	0
20	11	.035	2	.001	0
21	0	0	2	.001	0
22	6	.019	1	.0004	0
23	0	0	0	0	0
24	3	.001	0	0	0
25	0	0	0	0	0
26	2	.006	2	.001	0
27	0	0	0	0	0
28	1	.003	0	0	0
29	0	0	0	0	0
30	0	0	1	.0004	0
31	0	0	6	.002	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0

	U	V	W	X	Y
1					
2					
3	volume	barn. molt#	volume	tanaid #	volume
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	1	.002
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0

	Z	AA	AB	AC
1				
2				
3	isopod #	volume	gammarid #	volume
4	2	.002	3	.018
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	6	.012
9	0	0	0	0
10	0	0	1	.006
11	1	.001	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	1	.011	10	.063
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	1	.0002
20	1	.011	7	.043
21	0	0	2	.012
22	0	0	11	.071
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	2	.0005
28	0	0	12	.065
29	0	0	0	0
30	1	.011	25	.162
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	1	.006
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0

	AD	AE	AF	AG
1				
2				
3	Crangon #	volume	zoea lar.#	volume
4	0	0	1	.0004
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	1	.0004
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	1	.001	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0

	AH	AI	AJ	AK
1				
2				
3	Callianassa#	volume	megalopse #	volume
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	3	.13
9	0	0	32	1.382
10	0	0	10	.432
11	0	0	0	0
12	0	0	21	.907
13	0	0	0	0
14	0	0	36	1.555
15	0	0	0	0
16	0	0	9	.389
17	0	0	23	.994
18	0	0	0	0
19	0	0	0	0
20	0	0	3	.088
21	0	0	5	.216
22	0	0	10	.432
23	0	0	24	1.037
24	0	0	6	.259
25	0	0	4	.173
26	0	0	6	.259
27	0	0	17	.734
28	0	0	27	1.167
29	3	5.76	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	1	.043
34	0	0	1	.043
35	0	0	1	.043
36	0	0	1	.043
37	0	0	0	0
38	0	0	2	.003
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0

	A	B	C	D	E
49	date	weight	stan. length	nemertian #	volume
50	3	28.5	100	0	0
51	3	23	89	0	0
52	3	25	98	0	0
53	3	30	100	0	0
54	3	10.5	72	0	0
55	3	10	75	0	0
56	3	12	76	0	0
57	3	13.5	78	0	0
58	3	32	111	0	0
59	3	27.5	96	0	0
60	3	37.5	106	0	0
61	3	19	90	0	0
62	3	12.5	77	0	0
63	3	12.5	76	0	0
64	3	21.5	92	0	0
65	3	29.5	103	0	0
66	3	42	111	0	0
67	3	10	74	0	0
68	3	13	77	0	0
69	3	10	78	0	0
70	3	11	74	0	0
71	3	21.5	90	0	0
72	4	18	93	0	0
73	4	14.5	80	0	0
74	4	17	82	0	0
75	4	16	84	0	0
76	4	7.5	65	0	0
77	4	5.5	60	0	0
78	4	16	81	0	0
79	4	14.5	82	0	0
80	4	19.5	90	0	0
81	4	15.5	81	0	0
82	4	26	95	0	0
83	4	13	87	0	0
84	4	19	92	0	0
85	4	5	56	0	0
86	4	25	94	0	0
87	4	5	55	0	0
88	5	5	59	0	0
89	5	7	67	0	0
90	5	5.5	60	0	0
91	5	5	57	0	0
92	5	4	55	0	0
93	5	4.5	57	0	0
94	5	31.5	103	1	.003
95	5	7.5	68	0	0
96	5	4	52	0	0
97	5	2.5	44	0	0

	F	G	H	I	J
49	nematode #	volume	clam #	volume	polychaete#
50	0	0	0	0	0
51	0	0	0	0	0
52	0	0	0	0	0
53	0	0	0	0	0
54	0	0	0	0	0
55	0	0	0	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	0	0
61	0	0	0	0	0
62	0	0	0	0	0
63	0	0	0	0	0
64	0	0	0	0	0
65	0	0	0	0	0
66	0	0	0	0	0
67	0	0	0	0	0
68	0	0	0	0	0
69	0	0	0	0	0
70	0	0	0	0	0
71	0	0	0	0	0
72	0	0	1	.0002	2
73	0	0	0	0	0
74	0	0	0	0	0
75	0	0	0	0	0
76	0	0	0	0	0
77	0	0	0	0	0
78	0	0	0	0	0
79	0	0	3	.001	0
80	0	0	0	0	0
81	0	0	1	.0002	0
82	0	0	1	.0002	1
83	0	0	0	0	0
84	0	0	0	0	0
85	0	0	0	0	0
86	1	.0001	0	0	0
87	10	.001	0	0	0
88	0	0	1	.005	0
89	0	0	0	0	0
90	0	0	0	0	0
91	0	0	0	0	0
92	0	0	0	0	0
93	0	0	0	0	0
94	0	0	0	0	1
95	0	0	0	0	0
96	0	0	0	0	0
97	0	0	0	0	0

	K	L	M	N	O
49	volume	insect #	volume	unid. crus.#	volume
50	0	0	0	1	.002
51	0	0	0	0	0
52	0	0	0	1	.002
53	0	0	0	1	.002
54	0	0	0	0	0
55	0	0	0	1	.002
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	1	.002
61	0	0	0	0	0
62	0	0	0	0	0
63	0	0	0	0	0
64	0	0	0	0	0
65	0	0	0	0	0
66	0	0	0	1	.002
67	0	0	0	0	0
68	0	0	0	0	0
69	0	0	0	1	.002
70	0	0	0	0	0
71	0	0	0	0	0
72	.002	0	0	1	.002
73	0	0	0	15	.03
74	0	0	0	0	0
75	0	1	.0002	1	.002
76	0	0	0	0	0
77	0	0	0	0	0
78	0	0	0	1	.002
79	0	1	.0002	0	0
80	0	0	0	0	0
81	0	0	0	0	0
82	.001	0	0	0	0
83	0	0	0	0	0
84	0	0	0	0	0
85	0	0	0	0	0
86	0	0	0	0	0
87	0	0	0	0	0
88	0	0	0	0	0
89	0	0	0	0	0
90	0	0	0	0	0
91	0	0	0	0	0
92	0	1	.002	0	0
93	0	0	0	0	0
94	.001	0	0	0	0
95	0	0	0	0	0
96	0	0	0	0	0
97	0	0	0	0	0

	P	Q	R	S	T
48	0	0	0	0	0
49	copepod #	volume	cypris lar.#	volume	nauplii #
50	0	0	0	0	0
51	0	0	0	0	0
52	0	0	0	0	0
53	0	0	0	0	0
54	0	0	0	0	0
55	0	0	0	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	0	0
61	0	0	0	0	0
62	0	0	0	0	0
63	0	0	0	0	0
64	0	0	0	0	0
65	0	0	0	0	0
66	0	0	0	0	0
67	0	0	0	0	0
68	0	0	0	0	0
69	0	0	0	0	0
70	0	0	0	0	0
71	0	0	0	0	0
72	130	.052	1	.0004	0
73	0	0	0	0	0
74	150	.06	10	.004	0
75	1	.0004	0	0	1
76	13	.005	0	0	0
77	18	.007	1	.0004	0
78	0	0	0	0	0
79	123	.05	5	.002	2
80	1	.0004	2	.001	0
81	124	.05	5	.002	1
82	5	.002	0	0	0
83	2	.001	0	0	0
84	14	.006	1	.0004	0
85	3	.001	0	0	0
86	0	0	0	0	0
87	4	.002	0	0	0
88	62	.205	104	.042	1
89	0	0	1	.0004	1
90	36	.115	50	.02	0
91	24	.077	4	.002	0
92	0	0	1	.0004	0
93	1	.0004	0	0	0
94	0	0	0	0	0
95	2	.006	1	.0004	0
96	1	.0004	9	.004	0
97	3	.001	1	.0004	1

	U	V	W	X	Y
49	volume	barn. molt #	volume	tanaid #	volume
50	0	0	0	0	0
51	0	0	0	0	0
52	0	0	0	0	0
53	0	0	0	0	0
54	0	0	0	0	0
55	0	0	0	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	0	0
61	0	0	0	0	0
62	0	0	0	0	0
63	0	0	0	0	0
64	0	0	0	0	0
65	0	0	0	0	0
66	0	0	0	0	0
67	0	0	0	0	0
68	0	0	0	0	0
69	0	0	0	0	0
70	0	0	0	0	0
71	0	0	0	0	0
72	0	3	.005	0	0
73	0	0	0	0	0
74	0	0	0	0	0
75	0001	0	0	0	0
76	0	0	0	0	0
77	0	0	0	0	0
78	0	0	0	0	0
79	0002	0	0	0	0
80	0	0	0	0	0
81	0001	0	0	0	0
82	0	0	0	0	0
83	0	0	0	0	0
84	0	0	0	0	0
85	0	0	0	0	0
86	0	0	0	0	0
87	0	0	0	0	0
88	0001	0	0	0	0
89	0001	0	0	0	0
90	0	0	0	0	0
91	0	0	0	0	0
92	0	0	0	0	0
93	0	0	0	0	0
94	0	0	0	0	0
95	0	0	0	0	0
96	0	0	0	0	0
97	0001	0	0	0	0

	Z	AA	AB	AC
49	isopod #	volume	gammarid #	volume
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	2	.022	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	1	.0002
75	0	0	1	.0002
76	0	0	9	.002
77	0	0	0	0
78	0	0	0	0
79	0	0	7	.002
80	0	0	0	0
81	0	0	1	.0002
82	0	0	0	0
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	1	.0002
88	0	0	1	.006
89	0	0	0	0
90	0	0	0	0
91	3	.001	17	.003
92	0	0	1	.0002
93	0	0	0	0
94	0	0	0	0
95	0	0	14	.114
96	0	0	0	0
97	0	0	10	.002

	AD	AE	AF	AG
49	Crangon #	volume	zoea lar.#	volume
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	1	.0004
81	0	0	0	0
82	0	0	0	0
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	0	0
88	0	0	0	0
89	0	0	0	0
90	0	0	0	0
91	0	0	0	0
92	0	0	0	0
93	0	0	0	0
94	0	0	0	0
95	0	0	0	0
96	0	0	0	0
97	0	0	0	0

	AH	AI	AJ	AK
49	Callianassa#	volume	megalopse #	volume
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	1	.81	0	0
65	0	0	0	0
66	0	0	0	0
67	0	0	0	0
68	0	0	0	0
69	0	0	0	0
70	0	0	0	0
71	0	0	0	0
72	0	0	0	0
73	0	0	0	0
74	0	0	0	0
75	0	0	0	0
76	0	0	0	0
77	0	0	0	0
78	0	0	0	0
79	0	0	0	0
80	0	0	0	0
81	0	0	0	0
82	0	0	0	0
83	0	0	0	0
84	0	0	0	0
85	0	0	0	0
86	0	0	0	0
87	0	0	0	0
88	0	0	0	0
89	0	0	0	0
90	0	0	0	0
91	0	0	0	0
92	0	0	0	0
93	0	0	0	0
94	0	0	0	0
95	0	0	0	0
96	0	0	0	0
97	0	0	0	0

	A	B	C	D	E
1	Appendix 3B	Shiner 82			
2	date	weight	stan. length	clam #	volume
3	6	24.5	98	0	0
4	6	18.5	89	0	0
5	6	18.5	89	0	0
6	6	26	95	0	0
7	6	23.5	94	0	0
8	6	18	90	0	0
9	6	38.5	114	0	0
10	6	19	91	0	0
11	6	44	116	0	0
12	6	20.5	93	0	0
13	6	23.5	92	0	0
14	7	23.5	105	0	0
15	7	27.4	107	0	0
16	7	33.5	116	0	0
17	7	22.5	101	0	0
18	7	19.8	90	0	0
19	7	12.8	83	0	0
20	7	14.8	82	0	0
21	7	26.8	100	0	0
22	7	12.3	84	0	0
23	7	20.3	94	0	0
24	8	2.3	54	0	0
25	8	2.1	53	0	0
26	8	1.8	49	0	0
27	8	16.5	93	0	0
28	8	1.9	49	0	0
29	8	1.7	48	0	0
30	8	16.4	89	0	0
31	8	21	95	0	0
32	8	14	91	0	0
33	8	10.7	82	0	0
34	8	16	91	0	0
35	8	14.8	91	0	0
36	8	10	80	0	0
37	8	16.2	98	0	0
38	8	11.4	88	0	0
39	8	11.9	81	0	0
40	8	13.1	90	0	0
41	9	2.8	57	0	0
42	9	5.9	63	4	.016
43	9	5.4	64	2	.011
44	9	5.5	61	0	0
45	9	4.7	59	25	.057
46	9	4.8	60	8	.002
47	9	4.5	58	11	.002
48	9			1	.0002
49	9	3.8	56	0	0
50	9	3.8	57	4	.001
51	9	5.8	63	0	0
52	9	6.4	64	5	.001
53	9	5.8	64	7	.0015
54	9	5.9	66	14	.003
55	10	5.5	62	0	0
56	10	7.6	67	0	0
57	10	7.2	65	0	0
58	10	6.1	64	0	0
59	10	7.4	67	0	0
60	10	7.6	68	0	0
61	10	5.9	64	0	0
62	10	6.4	63	0	0
63	10	5.6	62	1	.0002
64	10	4.6	59	0	0

	F	G	H	I	J
2	snail lar. #	volume	oligochaete#	volume	polychaete#
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	0	0
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	0	1
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	1	.0004	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
51	0	0	0	0	0
52	0	0	0	0	0
53	0	0	0	0	0
54	0	0	0	0	0
55	0	0	0	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	1	.027	0
60	0	0	0	0	0
61	0	0	0	0	0
62	0	0	0	0	0
63	0	0	0	0	0
64	0	0	0	0	0

	K	L	M	N	O
2	volume	unid. crus.#	volume	copepod #	volume
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	1	.002	1	.003
7	0	1	.002	0	0
8	0	1	.002	1	.0004
9	0	0	0	0	0
10	0	0	0	0	0
11	0	1	.002	0	0
12	0	0	0	0	0
13	0	0	0	1	.0004
14	0	0	0	0	0
15	0	0	0	4	.004
16	0	1	.002	0	0
17	0	0	0	0	0
18	0	1	.002	0	0
19	0	1	.002	0	0
20	0	0	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	0	0	0	2	.001
24	0	0	0	0	0
25	0	0	0	0	0
26	.001	0	0	0	0
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	0	0
43	0	0	0	0	0
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	0	0
51	0	0	0	0	0
52	0	0	0	0	0
53	0	0	0	0	0
54	0	0	0	0	0
55	0	0	0	0	0
56	0	1	.002	0	0
57	0	0	0	1	.003
58	0	0	0	4	.01
59	0	0	0	0	0
60	0	0	0	0	0
61	0	0	0	1	.003
62	0	0	0	1	.003
63	0	0	0	0	.0
64	0	1	.002	0	0

2	cypris lar.#	volume	nauplii #	volume	mysid #
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	1	.001	0
9	0	0	0	0	12
10	0	0	0	0	1
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	8
14	0	0	0	0	0
15	1	.0004	0	0	0
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	1	.0004	0	0	0
21	0	0	0	0	0
22	0	0	0	0	0
23	2	.0004	0	0	0
24	2	.0004	0	0	0
25	65	.26	0	0	0
26	6	.002	0	0	0
27	0	0	0	0	0
28	72	.014	0	0	0
29	77	.015	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	252	.101	1	.001	0
43	0	0	0	0	0
44	60	.024	0	0	0
45	0	0	0	0	0
46	1	.0004	0	0	0
47	500	.2	0	0	0
48	16	.006	0	0	0
49	350	.14	0	0	0
50	300	.12	0	0	0
51	6	.002	0	0	0
52	35	.014	0	0	0
53	12	.005	0	0	0
54	41	.016	0	0	0
55	1	.0004	0	0	0
56	0	0	0	0	0
57	0	0	0	0	0
58	0	0	0	0	0
59	0	0	0	0	0
60	0	0	0	0	0
61	1	.0004	0	0	0
62	0	0	1	.001	0
63	0	0	0	0	0
64	0	0	0	0	0

	U	V	W	X	Y
2	volume	isopod #	volume	gammarid #	volume
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	1	.0002
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	.072	0	0	0	0
10	.0002	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	.033	0	0	0	0
14	0	0	0	1	.0002
15	0	1	.0004	1	.006
16	0	0	0	0	0
17	0	0	0	0	0
18	0	0	0	0	0
19	0	0	0	0	0
20	0	0	0	0	0
21	0	1	.0004	5	.026
22	0	0	0	0	0
23	0	0	0	2	.006
24	0	0	0	0	0
25	0	0	0	0	0
26	0	0	0	3	.001
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0
33	0	0	0	0	0
34	0	0	0	0	0
35	0	0	0	0	0
36	0	0	0	0	0
37	0	0	0	0	0
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
41	0	0	0	0	0
42	0	0	0	2	.012
43	0	1	.0004	2	.006
44	0	0	0	0	0
45	0	0	0	0	0
46	0	0	0	0	0
47	0	0	0	0	0
48	0	0	0	0	0
49	0	0	0	0	0
50	0	0	0	2	.006
51	0	0	0	0	0
52	0	0	0	0	0
53	0	0	0	0	0
54	0	0	0	0	0
55	0	0	0	1	.006
56	0	0	0	0	0
57	0	0	0	1	.006
58	0	0	0	0	0
59	0	0	0	0	0
60	0	1	.0004	1	.006
61	0	0	0	0	0
62	0	0	0	1	.0002
63	0	0	0	0	0
64	0	0	0	0	0

	Z	AA	AB	AC
2	Crangon #	volume	zoea lar.#	volume
3	1	.022	0	0
4	0	0	0	0
5	1	.022	0	0
6	0	0	0	0
7	1	.022	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	5	.002
25	0	0	0	0
26	0	0	0	0
27	0	0	34	.014
28	0	0	1	.0004
29	0	0	2	.001
30	0	0	3	.001
31	0	0	2	.001
32	0	0	56	.022
33	0	0	112	.045
34	0	0	53	.021
35	0	0	94	.038
36	0	0	66	.026
37	0	0	120	.048
38	0	0	78	.031
39	0	0	65	.026
40	0	0	62	.025
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	11	.004
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0

	AD	AE	AF	AG
2	megalopse #	volume	Hemigrapsus #	volume
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	1	.043
9	0	0	0	0
10	0	0	0	0
11	0	0	11	.475
12	0	0	11	.475
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	2	.003
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	1	.002	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0

	AH	AI	AJ	AK
2	fish eggs #	volume	fish larvae#	volume
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	16	.006
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	7	.004	0	0
25	0	0	0	0
26	1	.0005	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0
30	32	.016	0	0
31	112	.056	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	90	.045	0	0
42	0	0	0	0
43	0	0	0	0
44	3	.002	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	12	.006	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0
60	0	0	0	0
61	0	0	0	0
62	0	0	0	0
63	0	0	0	0
64	0	0	0	0