

4-30-1992

Port Everglades Macroinvertebrate Monitoring: Monitoring of Benthic Macroinvertebrate Assemblages at the Southport Turning Basin and Adjacent Areas of John U. Lloyd State Recreation Area: January 1992

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Charles G. Messing and Richard E. Dodge. 1992. Port Everglades Macroinvertebrate Monitoring: Monitoring of Benthic Macroinvertebrate Assemblages at the Southport Turning Basin and Adjacent Areas of John U. Lloyd State Recreation Area: January 1992 : 1 -31. https://nsuworks.nova.edu/occ_facreports/22.

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PORT EVERGLADES MACROINVERTEBRATE MONITORING

MONITORING OF BENTHIC MACROINVERTEBRATE ASSEMBLAGES AT THE SOUTHPORT TURNING BASIN AND ADJACENT AREAS OF JOHN U. LLOYD STATE RECREATION AREA: JANUARY 1992

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Submitted: 30 April 1992

A. INTRODUCTION

This report documents the January 1992 monitoring of benthic macroinvertebrate assemblages in the Port Everglades Southport turning basin vicinity and adjacent areas of John U. Lloyd State Recreation Area. This is the second monitoring effort of the series carried out by Nova University Oceanographic Center. Sampling was carried out during the first two weeks of January 1992. A history of the monitoring project since its inception in 1988 was given in the previous report (submitted December 1991).

B. METHODOLOGY

Figure 1 illustrates locations of stations occupied for the January 1992 sampling period and the kind of sample (Ponar grab, crab census, or hand collection) taken at each.

Shannon-Weaver Diversity Indices are calculated for each station and, at Ponar grab stations, for each replicate as well using the following equation:

$$H' = -\sum_{i=1} p_i \ln p_i$$

where p_i is the relative abundance of species i . H' increases with increasing number of species S . For any given S , H' reaches a maximum value (H'_{\max}) when all values of p are equal ($p_1=p_2=p_3=\dots$), and H' equals $\ln S$. Because H' is primarily affected by species number rather than by abundances of common or rare species, or by species of moderate abundance, evenness (J') has also been calculated for each station and replicate using the equation:

$$J' = H'/H'_{\max} = H'/\ln S$$

As a ratio between the diversity index (H') for a given sample and the maximum possible diversity index (H'_{\max}) for the number of species and specimens in that sample, evenness (J') gives an indication of how close the data come to maximum possible diversity.

B.1. GRAB SAMPLES

Benthic grab samples are taken according to contract specifications with a 225 cm² grab

sampler¹ at stations 1, 8, 8a, 9, 10a, 11, 13a, 14, 17, 18 and 19a, with three replicate samples at each station. All samples are fixed in 5% seawater buffered formalin with rose bengal stain and sieved through a 0.5 mm mesh screen. Organisms and sediment retained on the screen are transferred to 70% ethanol and sorted to most specific distinguishable taxa. Taxa are either identified or sent to recognized experts for identification (Table 7). Nematodes and harpacticoid copepods have not been enumerated or included in diversity calculations. These organisms are normally treated as meiofauna, not macrofauna. The relatively few large specimens retained by a 0.5 mm mesh screen do not accurately reflect their true abundances. Similarly, a small number of planktonic organisms (e.g., calanoid copepods) accidentally collected by the grab sampler have likewise not been included in counts and diversity calculations.

Modifications in sampling and handling protocols instituted during the August 1991 survey to improve sampling accuracy in conformity with contract specifications are described in the previous report (submitted December 1991) and have been maintained.

Depths recorded for Ponar stations below may differ from those recorded for the August 1991 survey because of tidal variations and because some August station depths were recorded in feet in field notes but written as meters in the report.

B.2. CRAB COLLECTIONS

Three 1.0-m² replicate quadrats are randomly placed within about 2.0m of each other at stations 1a, 2, 3, 4, 5, 6, 7, 10, 12, 13, 15 and 16. Within each quadrat, all crab burrows are counted and 10% excavated, and the inhabitants counted and identified in the field or collected and identified in the laboratory, according to contract specifications.

Modifications in sampling and handling protocols instituted during the August 1991 survey to improve sampling accuracy in conformity with contract specifications are described in the previous report (submitted December 1991) and have been maintained.

1. Contract specifications call for a 225 cm³ grab sampler, but this is clearly an error. Such a grab sampler, about 6 cm on a side, was not used by the previous contractor and is not, to our knowledge, manufactured.

B.3 HAND COLLECTIONS

Hand collections are taken at stations 9, 13, and 17, with three replicates at each station. Each replicate sample covers an area of 0.1m². Justification for this sampling area is discussed in the survey report for August 1991. Organisms identifiable in the field are counted and released. Taxa unidentifiable in the field are collected by hand, with forceps, or by agitating algae-covered rocks in a bag of seawater. Collected specimens are placed in plastic bags with seawater, fixed in 10% buffered seawater formalin in the laboratory, and finally stored in 70% ethanol.

Modifications in sampling and handling protocols instituted during the August 1991 survey to improve sampling accuracy in conformity with contract specifications are described in the previous report (submitted December 1991) and have been maintained.

Some algae-covered rocks were examined and their associated fauna sorted in the laboratory, but these are not included in diversity index calculations (Table 5) because accurate quantification requires substantial modification of the environment (i.e., collection of all rocks in a transect). Although numbers of organisms sorted from one or more rocks in the laboratory are given in the text as an indication of their relative abundances, the figures cannot be extrapolated to the entire quadrat because population variations relative to rock size, algal density and other factors are unknown.

Barnacles also present a difficult quantification/identification problem. As with the fauna associated with algae-covered rocks, where relatively large numbers occur, all specimens cannot be collected without significantly modifying the local habitat. As a result, all recognizably different taxa are distinguished and enumerated in the field and a representative sample of each is collected for identification. As in the previous survey, microscopic analyses by an expert in barnacle taxonomy reveals that one "field-distinguished" form represents two species (*Balanus amphitrite* and *B. reticulatus*), whereas two other "field-distinguished" forms represent juvenile and adult members of a single species (*Chthamalus fragilis*). The numbers recorded for each species (Table 5) are extrapolated from the collected and accurately identified sample to provide a diversity estimate.

C. RESULTS

C.1. GRAB SAMPLES

Table 1 lists raw data, Shannon-Weaver Diversity Indices (H') and evenness (J') for all samples by station and by replicate. Table 2 summarizes numbers of specimens by major taxonomic group; Table 3 summarizes relative abundances of major taxonomic groups (percent occurrence).

A total of 3,343 specimens were sorted and identified from the 33 grab samples (11 stations with three replicates each), somewhat less than in August 1991 (3981). The distribution of organism totals by station differs substantially from the last survey. As examples, station 17 has declined from 1822 specimens in August (the highest of any station) to 409. Station 10a now records the most specimens: 1154, an almost three-fold increase from August and twice as many specimens as any other station. Station 1 has declined ten-fold and stations 8a and 11 three-fold while stations 9, 14 and 19a have about doubled in numbers of specimens.

As in August, polychaete worms dominate the overall fauna (47.9%) followed by increased proportions of peracarid (30.0%) and ostracod crustaceans (10.9%). Molluscs (2.9%) and sipunculans (1.4%) have declined in importance. The distribution of dominance has changed considerably. Thus, polychaetes account for more than 75% of the fauna at stations 11, 13a and 14 in August 1991 but at 1, 8 and 8a in January 1992. Individual stations vary considerably from these values, usually due to the presence of a particular species found in large numbers at one or a few stations.

Several taxa that were important in August 1991 have either decreased substantially in numbers (polychaetes *Prionospio heterobranchiata*, *Mediomastus* sp. and *Pseudopolydora* sp., gastropod *Caecum pulchellum*, sipunculan *Aspidosiphon albus*) or disappeared (gastropod *Caecum imbricatum*, ostracod *Rutiderma darbyi*). Others occur in substantial numbers for the first time (polychaetes *Leitoscoloplos foliosus*, *Laeonereis culveri*, amphipod *Grandidierella bonnieroides*).

One taxon requires a special comment. An unidentified podocopan ostracod was particu-

larly abundant at station 10a and occurred in small numbers at 9, 17, 18 and 19a in the August 1991 survey. In January 1992, it was abundant at stations 9, 10a and 14 and occurred in smaller numbers at 18 and 19a. In August, however, all specimens counted were clearly alive when collected. The figures given in Table 1 represent our best estimate of the specimens alive when collected in January; far greater numbers of very recently dead specimens were collected. Counts would certainly have been much greater had collections taken place a week or two earlier (in December 1991).

All stations in the Intracoastal Waterway (ICWW) were taken between 3 and 5 m from the water's edge. Following is a brief description of results for each station.

Station 1: West side of Intracoastal Waterway (ICWW) at NE corner of Southport Turning Notch. Depth: approx. 3m. Bottom: fine muddy sand with finely divided mangrove detritus. Faunal totals: 43 specimens, 10 species. Shannon-Weaver Diversity Index (H'): 1.365. Evenness (J'): 0.593.

Polychaetes dominate the station (86.1%) to a far greater degree than in August. Oligochaetes (7.0%) are still the second most abundant group. The most abundant species, the polychaete, *Aricidea taylori*, accounts for 63% of specimens collected. It was present in relatively small numbers in August. The dominant taxa in August either occur in much smaller numbers (*Mediomastus* sp.) or have disappeared (*Prionospio heterobranchiata*, the oligochaetes *Tectidrilus verrucosus*, *Tubificoides motei*, and an unidentified tubificid, and the gastropod mollusc *Caecum pulchellum*.) This station exhibits a sharp decrease in species abundance, richness and diversity relative to August 1991. Species composition has also changed substantially.

Station 8: West side of ICWW approximately 30 m north of station 1. Depth: approximately 3m. Bottom: fine muddy sand with finely divided mangrove detritus and scattered hand-sized rocks. Scattered *Halophila* seagrass. Faunal totals: 160 specimens, 28 species. H' : 2.057. J' : 0.617.

Polychaetes again exhibit greater dominance here than in August (80.6%), and are again followed in importance by oligochaetes (6.9%). Peracarid crustaceans (4.4%) are more abundant than in August while molluscs (1.3%) and nemertines (3.8%) have declined. *Aricidea taylori* is

still the most abundant taxon and accounts for a much greater proportion of organisms than in August (55%). *Mediomastus* sp. is still present but in smaller numbers. Although species richness has increased from 21 to 28, diversity has declined, primarily due to the large numbers of *A. taylori*. This species only occurs in numbers at stations 1 and 8.

Station 8a: West side of ICWW approximately 50 m north of station 8. Depth and bottom: similar to station 8 with *Halophila* and a scattered fine algal turf. Faunal totals: 53 specimens, 23 species. H' : 2.800. J' : 0.893.

Polychaetes exhibit increased dominance relative to August (81.1%). Oligochaetes (1.9%) and peracarid crustaceans (3.8%) have declined and molluscs have disappeared. The most abundant organisms are the polychaetes *Mediomastus* sp. and *Glycera abbranchiata*, both of which were present in August. Other August dominants have declined (*Aricidea taylori*) or disappeared (*Prionospio heterobranchiata*). Although species richness and diversity maintain levels reported in August, organism abundance has diminished three-fold.

Station 9: East side of ICWW at the SW corner of a mangrove island north of the northern entrance to Whiskey Creek. Depth: approximately 1 m. Bottom: Fine muddy sand with filamentous algal turf and *Arenicola* (lugworm) burrows. Faunal totals: 503 specimens, 36 species. H' : 2.364. J' : 0.660.

Polychaetes still dominate but are reduced in importance relative to August 1991 (40.2%). Ostracod and peracarid crustaceans have increased sharply and molluscs moderately in both absolute and relative numbers (31.4, 20.1 and 6.6%, respectively). Oligochaetes decline substantially (1.4%). The most abundant taxa are the polychaetes *Aricidea philbinae*, *Glycera abbranchiata* and *Leitoscoloplos fragilis*, the gastropod *Haminoea succinea*, an unidentified podocopan ostracod, the cumacean *Oxyurostylis* sp. A and the amphipod *Grandidierella bonnieroides*. Several taxa have declined sharply since August: the polychaetes *Prionospio heterobranchiata*, *Pseudopolydora* sp., and *Capitella capitata*, and the amphipod *Cerapus* sp. Species diversity has declined somewhat while species richness has increased slightly and organism abundance has more than doubled since August 1991.

Station 10a: Middle of shallow creek behind Environmental Education Bldg., John U. Lloyd State Recreation Area, east side of ICWW. Depth: approximately 0.1m (exposed at low tide). Bottom: Sandy mud. Faunal totals: 1154 specimens, 46 species. H' : 2.555. J' : 0.667.

Polychaetes and peracarid crustaceans are more important than in August (65.9% and 22.3%) while ostracods have decreased sharply (6.9%). Dominant organisms include the polychaetes *Aricidea philbiniae*, *Leitoscoloplos foliosus*, *Capitella capitata* and *Laeonereis culveri*, an unidentified polychaetan ostracod, the tanaid *Leptochelia rapax* and the amphipods *Cerapus* n. sp. and *Grandidierella bonnieroides*. Organism abundance has almost tripled; species richness has more than doubled; diversity has almost doubled relative to August.

Station 11: At north corner of the northern entrance to Whiskey Creek. Depth: approximately 5 m. Bottom: Pockets of fine muddy sand with finely divided mangrove detritus on steep slope among large boulders (riprap). Faunal totals: 61 specimens, 25 species. H' : 2.614. J' : 0.812.

Polychaetes dominate, but to a lesser degree than in August (68.9%). Oligochaetes (14.8%) are more important than in the last survey. Molluscs and nemertines have both declined. The most abundant taxa are the polychaetes *Aricidea catherinae*, *Prionospio cristata* and *Mediomastus* sp. Organism abundance has dropped almost four-fold but species richness and diversity remain at about August levels.

Station 13a: East side of ICWW opposite the Florida Power & Light discharge canal. Depth: approximately 1.5 m. Bottom: Fine muddy sand with algal turf. Faunal totals: 234 specimens, 47 species. H' : 2.823. J' : 0.733.

Polychaetes contribute much less to the fauna than in August (43.2 down from 83.9%). Peracarid crustaceans are much more important (41.5 up from 5.4% in August). The most abundant taxa are the polychaete *Aricidea philbiniae* and the amphipods *Cerapus* n. sp. and *Grandidierella bonnieroides*. Relative to August 1991, species richness has doubled, diversity has increased sharply and organism abundance is up by about 25%.

Station 14: East side of ICWW opposite northern margin of Southport Turning Notch. Depth: approximately 1.5 m. Bottom: Fine muddy sand with *Halophila*, algal turf and numerous

rocks. Faunal totals: 337 specimens, 45 species. H' : 2.831. J' : 0.744.

Polychaetes are still the most abundant group by percent occurrence but are less than half as important as in August (37.7 down from 77.2%). Ostracod and peracarid crustaceans make up much greater proportions of the fauna than in August (13.4 up from 0% and 36.2 up from 6.7%, respectively). Molluscs have declined sharply. The most abundant taxa are the polychaete *Aricidea philbinae*, an unidentified podocopan ostracod, and the amphipods *Cerapus* n. sp. and *Grandidierella bonnieroides*. Organism abundance and species richness have more than doubled; diversity has increased substantially.

Station 17: Whiskey Creek on a line directly east of station 14. Depth: 0.2 m. Bottom: Coarse shelly sand (incorrectly reported for August 1991 as fine muddy sand) with large shallow depressions and scattered clumps of filamentous algae. Faunal totals: 409 specimens, 12 species. H' : 1.139. J' : 0.458.

This station continues to exhibit a fauna that differs strongly from all other stations. Peracarid crustaceans dominate overwhelmingly (72.6%). Ostracods have increased since August but polychaetes (5.6%), molluscs (0%) and sipunculans (8.3%) have all declined substantially. The tanaid *Kalliapseudes* sp. is by far the most abundant organism (71% of all specimens) followed by much smaller numbers of the polychaetes *Ehlersia cornuta* and *Nematoneris hebes*, the sipunculan *Aspidosiphon albus* and the ostracod *Harbansus paucichelatus*. Organism abundance, species diversity and richness have all dropped sharply since August.

Station 18: East side of ICWW opposite Southport Everglades container dock. Depth: approximately 1 m. Bottom: Fine muddy sand with finely divided mangrove detritus, some *Halophila* and scattered fine algal turf. Faunal totals: 277 specimens, 51 species. H' : 3.282. J' : 0.835.

Polychaetes dominate (43.0%), followed by peracarid crustaceans (31.1%) and oligochaetes (12.3%). Molluscs have declined dramatically (4.3%). The most abundant taxa are the polychaete *Aricidea philbinae* and the amphipod *Grandidierella bonnieroides*. Organism abundance and species richness have doubled; diversity has increased sharply.

Station 19a: Whiskey Creek on a line due east of station 18. Depth: 0.2 m. Bottom: Fine muddy sand with algae. Faunal totals: 112 specimens, 21 species. H': 2.408. J': 0.791.

Peracarid and ostracod crustaceans dominate (28.6 and 25.9%, respectively) followed by polychaetes (16.1%). Oligochaetes and sipunculans have declined substantially while molluscs and nemerteans have increased. The most abundant taxa are the amphipod *Grandidierella bonnieroides* and an unidentified podocopan ostracod. Organism abundance and species richness have doubled and diversity has increased sharply.

C.2. CRAB CENSUSES

Table 4 lists all crab census data including numbers of burrows, species and specimens, diversity indices and evenness values. Of ground-dwelling crabs, very small juvenile fiddler crabs (genus *Uca*, not identifiable to species) are now most abundant. The grapsid *Sesarma curacaoense* is still the most abundant of taxa identifiable to species and occurs at six of seven stations on the west side of the ICWW. Small numbers of tree crabs, *Aratus pisoni* are next most abundant. They were not found on the ground during the August 1991 survey. Identifiable fiddler crabs occur in smaller numbers than in August: *Uca thayeri* at three stations on the west side of the ICWW, and *U. pugilator* (station 13) and *U. rapax* (13 & 15) on the east side. The xanthid *Eurytium limosum* occurs only at station 7. Smaller numbers of crabs relative to August most likely represent a seasonal variation. The large proportion of juveniles anticipate increased populations in the August 1992 survey. The replacement of *U. pugnax* by *U. rapax* at stations 13 & 15 may result from taxonomic problems rather than actual replacement. Several members of the genus *Uca* are difficult to distinguish.

Tree crabs (*Aratus pisoni*) again occur at all stations north of the Turning Notch (west of the ICWW), but in smaller numbers than in August--again, likely a seasonal variation. East of the ICWW, *A. pisoni* was recorded inside the designated sampling area at stations 10 and 16. All crab census results are summarized below.

Station 1a: Edge of red mangrove fringe adjacent to riprap at northeast corner of Southport Turning Notch. Crab census data: *Sesarma curacaoense* (4), *U. thayeri* (1), *Uca* sp. (juve-

niles) (6); *Aratus pisoni* (9 specimens in 1 tree/m²). Number of burrows by replicate: 145, 66, 137. Shannon-Weaver Diversity Index (H'): 0.916. Evenness (J'): 0.834.

Station 2: In dense red mangrove fringe 10 m north of Turning Notch and 10 m west of ICWW. Crab census data: *S. curacaoense* (2), *U. thayeri* (1), *Uca* sp. (juveniles)(5); *A. pisoni* (7 in 1 tree/m²). Number of burrows by replicate: 189, 87, 142. H' : 1.220. J' : 0.880.

Station 3: In dense red mangrove fringe 3 m east of natural drainage canal, 10 m north of Turning Notch. Crab census data: *S. curacaoense* (1), *Uca* sp. (juveniles)(3); *A. pisoni* (5 in 2 trees/m²). Number of burrows by replicate: 236, 192, 120. H' : 0.562. J' : 0.811.

Station 4: In dense red mangrove fringe 10 m north of Turning Notch and approximately 40 m west of drainage canal. Crab census data: *S. curacaoense* (5), *Uca* sp. (juveniles)(3); *A. pisoni* (4 in 2 trees/m²). Number of burrows by replicate: 137, 101, 107. H' : 0.662. J' : 0.954.

Station 5: In dense red mangrove fringe 30 m north of station 4. Crab census data: *S. curacaoense* (4); *A. pisoni* (1 on ground)(7 on 2 trees/m²). Number of burrows by replicate: 171, 110, 103. H' : 0.500. J' : 0.722.

Station 6: In dense red mangrove fringe 3 m east of natural drainage canal and 10 m north of station 3. Crab census data: *A. pisoni* (1 on ground)(7 in 2 trees/m²). Number of burrows by replicate: 123, 163, 139. H' : 0 (only one species). J' : 0.

Station 7: In dense red mangrove fringe 30 m north of station 2. Crab census data: *S. curacaoense* (1), *U. thayeri* (1), *Eurytium limosum* (2), *Uca* sp. (juvenile) (4); *A. pisoni* (1 on ground)(5 in 5 trees/m²). Number of burrows by replicate: 181, 173, 187. H' : 1.427. J' : 0.887.

Station 10: In open area among scattered large red mangroves east of the center of small island on east side of ICWW north of northern entrance to Whiskey Creek. Crab census data: *Uca* sp. (juvenile)(3). Number of burrows by replicate: 22, 26, 12. H' : 0. J' : 0.

Station 12: On high ground among Australian pine trees at a point intersected by lines running due east from station 11 (north side of northern entrance to Whiskey Creek) and due north of station 13. Crab census data: no crabs, no burrows.

Station 13: On sand among shrubby white mangroves north side of Whiskey Creek

approximately 20 m west of North Ocean Drive bridge. Crab census data: *Uca pugilator* (2), *U. rapax* (2). No tree crabs. Number of burrows by replicate: 41, 23, 25. H' : 0.693. J' : 1.000.

Station 15: Among dense red mangrove fringe 35 m west of North Ocean Drive on line running east of north side of Turning Notch. Crab census data: *Uca rapax* (2). No tree crabs. Number of burrows by replicate: 5, 10, 10. H' : 0. J' : 0.

Station 16: Among red mangroves 110 m east of North Ocean Drive on line running due east of north side of Turning Notch. Crab census data: *Uca* sp. (juvenile)(1); *A. pisoni* (1 on 5 trees/m²). H' : 0. J' : 0.

C.3. HAND SAMPLES

A total of 614 specimens representing 15 taxa were collected at the three hand collection stations. Table 5 lists all raw data, diversity indices and evenness values by station and by replicate. The three most abundant taxa at all three stations taken together are the same as in August 1991: the gastropod *Batillaria minima*, the barnacle *Chthamalus fragilis* and the springtail insect *Anurida maritima*. Results are summarized below.

Station 9: Intertidal rubble in a red mangrove fringe protected from heavy wave action by adjacent rip-rap on the southwestern corner of a small island along the east side of the ICWW just north of the northern entrance to Whiskey Creek. Filamentous green and red algal mats cover portions of the shoreline. H' : 1.528. J' : 0.664.

The barnacle *Chthamalus fragilis* and the gastropod *Batillaria minima* are the most abundant organisms. Numbers of different barnacle species have been extrapolated from identified subsamples. Barnacle cover varies widely due to variations in rock size and algal cover among replicates.

Organisms sorted from filamentous algal turf on a single rock in replicate 1 include: the amphipod *Hyale grandicornis* (25)(probably the same species as that referred to as an unidentified talitrid in the August 1991 report), an unidentified isopod (24), the gastropod *Caecum pulchellum* (18), juvenile xanthid crabs (2), unidentified polychaetes (2) and a juvenile *Aratus pisoni* (1).

Organisms sorted from similar algal turf on a larger rock in replicate 2 include: *H. gran-*

dicornis (47), *C. pulchellum* (31), the hermit crab *Clibanarius tricolor* (3), unidentified polychaetes (2), the tanaid *Leptochelia rapax* (2), and one each of a eunicid polychaete, an unidentified isopod, the crabs ?*Panopeus* sp. and *Aratus pisoni* (juvenile).

Adjacent boulders (riprap) exposed to greater wave surge support dense barnacle populations, chiefly *Chthamalus fragilis* with some *Balanus* spp. and scattered volcano barnacles, *Tetraclita squamosa* with a few pulmonate limpets (*Siphonaria pectinata*); scattered and clustered flat oysters (*Isognomon alatus*), scattered vermetids (*Petalochonchus ?varians*), oysters (?*Crassostrea virginica*) and mussels (?*Brachidontes exustus*) occur lower in the intertidal zone. Smaller rocks sheltered from direct surge among the riprap support numerous hermit crabs, *Clibanarius antillensis*, in *Batillaria* shells.

Station 13: Intertidal muddy sand with numerous small rocks and pebbles on the north side of Whiskey Creek, about 15m west of the North Ocean Drive bridge; replicates taken between fringe of shrubby white mangroves and row of four mangrove seedlings closest to water's edge. H': 0.853. J': 0.438.

The gastropod *Batillaria minima* and the springtail insect *Anurida maritima* are the most abundant organisms. Greater numbers of barnacles occur on rocks outside the randomly selected quadrats. One rock from replicate 3 examined in the laboratory produced *Hyale grandicornis* (14), *Leptochelia rapax* (4), five unidentified polychaetes and four *Balanus* sp.

Adjacent inter- and subtidal rocks support a more diverse fauna including polyclad flatworms, gastropods (*Nassarius vibex*), hermit crabs (*Clibanarius* sp. and *C. vittatus*), polychaetes, amphipods, isopods and oysters.

Station 17: Intertidal coarse shelly sand among partly algae-covered red mangrove roots and white mangrove pneumatophores with partly buried rocks, west side of Whiskey Creek, on a line running due east of the north side of the Turning Notch and about 500 m north of the footbridge. Meter transects were taken along the mangrove roots closest to the water's edge. H': 1.241. J': 0.692.

The *Balanus amphitrite* are attached to both mangrove roots and flat oysters which, in

turn, attach to the mangrove roots. The snail *Batillaria minima* is present but in smaller numbers than at the other two stations.

D. DISCUSSION

D.1. GRAB COLLECTIONS

Several important differences appear in the January 1992 that distinguish stations on the west and east sides of the ICWW from each other. The west side stations (1, 8, 8a) are dominated to a much greater degree by polychaetes than are the east side stations (9, 11, 13a, 14, 18) (81-86% versus 38-69%). With the exception of the deeper water station 11, the east side stations support larger populations of peracarid crustaceans than the west side (20-41% versus 0-4%). Several individual taxa reflect these differences: *Aricidea taylori* occurs chiefly at stations 1 and 8 while *A. philbinae* occurs primarily at 9, 13a, 14 and 18. Among peracarid crustaceans, the cumacean *Oxyurostylis* sp. A and the amphipod *Cerapus* n. sp. occur at 9, 13a, 14, and 18. Similarly, west side stations exhibit lower species richness values and abundance levels than east side stations, again with the exception of deeper water station 11. Stations 1, 8 and 8a (west side) support 10-28 species and 43-160 individuals while east side stations support 36-51 species and 234-503 individuals. Station 11 supports only 25 species and 61 individuals. It also differs in that two important taxa are found in greater numbers here than at any other station (*Aricidea catherinae* and *Prionospio cristata*). Nevertheless, several taxa occur in at least small numbers at many or most stations: the amphipod *Grandidierella bonnieroides* (10 stations), the polychaetes *Prionospio cristata* (7), *Mediomastus* sp. (7), and *Glycera abbranchiata* (8), and an unidentified tubificid oligochaete (9).

Stations outside the ICWW support substantially different faunas than in the ICWW, but diversities and richness values are not as uniformly low as in August. Station 10a, in shallower water than the ICWW stations, is not as distinct as in August. Several taxa abundant here are also found in numbers in the ICWW (*A. philbinae*, *Oxyurostylis* sp. A, *Cerapus* n. sp. and *Grandidierella bonnieroides*). It still, however, maintains a fauna recognizably different than that at other stations (e.g., *Leitoscoloplos foliosus*, *Capitella capitata*, *Streptosyllis pettiboneia*, *Laeonereis*

culveri, *Leptochelia rapax*). This station supports the largest number of organisms recorded in the January 1992 survey. Richness and diversity values are now at the upper end of the range of values for ICWW stations.

The two stations in Whiskey Creek differ substantially from each other. Peracarid crustaceans dominate station 17 to a far greater degree than in August. The tanaidacean *Kalliapseudes* sp. accounts for the vast majority of organisms and generates, as a result, this station's low diversity. Both species richness and organism abundance have declined sharply here since August.

Station 19a, also in Whiskey Creek, is not as distinct as in August. Numbers of organisms, diversity and richness have all increased and the most abundant taxa are also found at other stations.

A substantial portion of the variation between this survey and the previous one is likely seasonal. It is possible, however, that substantial within-station population patchiness exists that cannot be identified with only three replicate samples per station. The next report due will complete a full year of surveys with detailed identifications and will permit a fuller comparative account of Ponar grab data.

D.2. CRAB CENSUSES

Crab census stations on the west side of the ICWW north of the Turning Notch continue to be dominated by the grapsid *Sesarma curacaoense* accompanied by smaller numbers of the oecypodid *Uca thayeri*, the xanthid *Eurytium limosum* and, for the first time, ground-collected tree crabs, *Aratus pisoni*. *Uca speciosa*, reported on this side of the ICWW for the first time in August 1991 is not present in January 1992. Crabs occur at all stations but in smaller numbers than in August. Crabs occurred at only two stations and in fewer numbers in January 1991, but at six stations and somewhat greater numbers in January 1990. The tree crab, *Aratus pisoni* occurs at all stations but in smaller numbers than in August 1991.

The January 1992 sampling at station 10 (on a small mangrove island north of Whiskey Creek) records only three juvenile *Uca* sp., the same number and diversity of crabs as in August 1991, but a decline in both species richness and diversity from earlier sampling efforts. It is not

certain, however, if the January 1992/August 1991 station location is precisely the same as previously. Station 12 again records no crabs. As mentioned in the last report, it is not clear that the spot identified as station 12 in August 1991 is the same as that used previously. Earlier sampling efforts recorded both *Uca rapax* and *U. pugilator* and the grapsid *Sesarma ricordi* here. Directions provided to us by the previous contractor place this station on high ground where no crabs were observed.

Station 13 continues to maintain a population of *Uca pugilator*, now accompanied by *U. rapax* as reported in earlier sampling efforts. *Uca pugnax* and *U. thayeri*, reported here in August 1991, are now absent. Again, caution must be exercised here because members of the *pugilator-pugnax-rapax* complex in the genus *Uca* are distinguishable only with difficulty, if at all, and several crustacean taxonomists have advised us that these crabs are in need of taxonomic revision.

Station 15 includes only *U. rapax*, suggesting that the crab community may still be changing. The August 1991 sampling reported *Uca pugnax* and *U. thayeri* whereas previous reports chiefly included *Sesarma curacaoense*, *U. thayeri* and *Eurytium limosum*. This station lies in the narrow strip of red mangroves between the ICWW and North Ocean Drive. Because of its small area (especially in comparison with the extensive continuous forest west of the ICWW), resident crab populations are more likely to have been affected by the surrounding mitigation dredging and riprap emplacement.

Only a single juvenile *Uca* sp. occurs at station 16, maintaining the apparent decline in crab populations from January 1991 when six individuals belonging to three species were collected. This may represent natural variation, however, because no crabs were reported in January 1990 here. This station is located well within the red mangrove forest between North Ocean Drive and Whiskey Creek. Earlier records include at various times *U. thayeri*, *U. rapax*, *U. speciosa*, *S. curacaoense*, *E. limosum* and unidentified *Uca*. Again, station location may not be precisely the same as previously. Alternatively, drainage patterns within the forest may have been modified by the dredging of canals associated with mitigation east of North Ocean Drive.

D.3. HAND COLLECTIONS

Station 9 continues to maintain a typical intertidal fauna. The January 1992 record includes most of the species recorded in August 1991 and January 1989. The common intertidal gastropod, *Batillaria minima*, has also been recorded at station 13 since August 1990. Station 17 continues to record small numbers of few species. The pattern of diversity indices among the three hand stations is the same as in August 1991: Station 9 highest, 13 lowest and 17 intermediate, despite its low richness and numbers. Indices have increased slightly at 9 and 13 and decreased slightly at 17. Numbers of organisms have increased relative to August 1991 overall. Species richness has increased from 4 to 7 taxa at station 13, perhaps because the August 1991 sampling followed a rain.

Figure 1. MACROINVERTEBRATE
MONITORING STATIONS

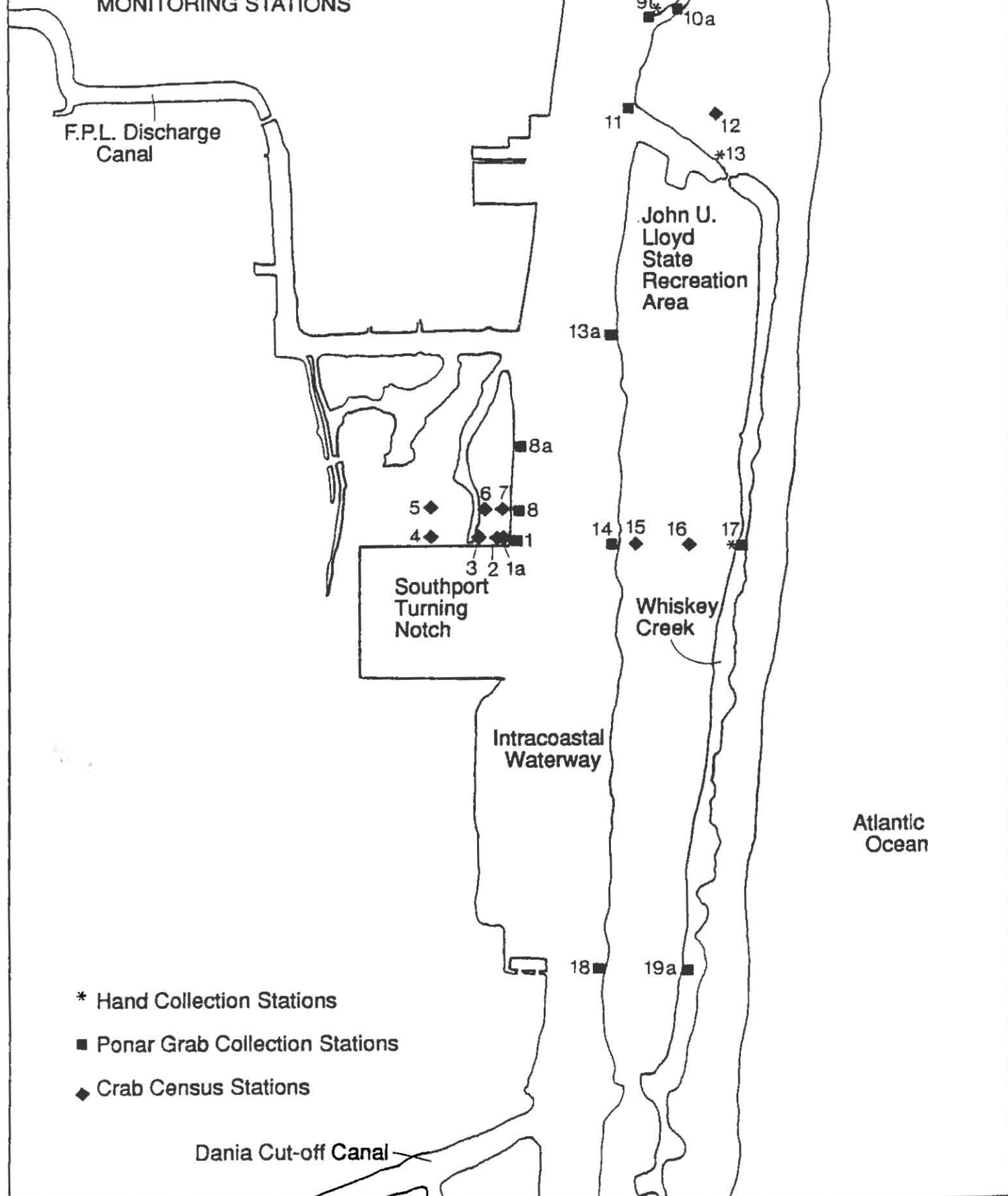


TABLE 1. Ponar Grab Collection Stations: raw data, diversity (H') and evenness (J').

[illegible]

TABLE 1. Ponar Grab Collection Stations: raw data, diversity (H') and evenness (J').

STATION	1			8			8a			9			10a			11			13a			14			17			18			19a			
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3				
TAXON																																		
Family HAMINOEIDAE																																		
Haminoea ?antillarum												1																	1		2			
Haminoea succinea										9	8	10			1																28			
Class BIVALVIA																																		
Order ARCOIDA																																		
Family ARCIDAE																																		
Arcopsis adamsi																1															1			
Order PTEROIDA																																		
Family LUCINIDAE																																		
Linga sp.?													1																		1			
Family TELLINIDAE																																		
Macoma constricta										2	1		8	3	7			1		1		3				3					29			
Family VENERIDAE																																		
Anomalocardia auberiana															1																1			
Chione cancellata			1																												1			
Order MYOIDA																																		
Family LYONSIIDAE																																		
Lyonsia hyalina															1																1			
Phylum ANNELIDA																																		
Class POLYCHAETA																																		
Order ORBINIIDA																																		
Family ORBINIIDAE																																		
Leitoscoloplos foliosus													1	19	19																39			
Leitoscoloplos fragilis										10	1	5	1																		17			
Leitoscoloplos sp.											15																				15			
Family PARAONIDAE																																		
Aricidea catherinae																1	3	9		5											18			
Aricidea philibinae					2				1	31	21	20	73	83	97				2	13	11	14	18	20			9	4	6	1	2	428		
Aricidea taylori	9	10	8	18	52	20	1		1										1	1						2	2	3			128			
Aricidea sp.																			1												1			
Order SPIONIDA																																		
Family SPIONIDAE																																		
Polydora socialis																				1											1			
Polydora sp. A																			2												2			

[illegible]

TABLE 1. Ponar Grab Collection Stations: raw data, diversity (H') and evenness (J').

STATION	1			8			8a			9			10a			11			13a			14			17			18			19a			
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3				
TAXON																																		
Lumbrineris verrilli										1	1					1					1	2	6				4	11	6			33		
Lumbrineris sp. B				1																											1			
Lumbrineris sp.																		2													2			
Family DORVILLEIDAE																																		
Ophryotrocha sp. A												2														1					3			
Ophryotrocha sp.												11																			11			
Order TEREbellIDA																																		
Family TRICHOBRANCHIDAE																																		
Terebellides stroemi				2	2	1	1												1	2		1									10			
Terebellides sp.																		1													1			
Order SABELLIDA																																		
Family SABELLIDAE																																		
Branchiomma nigromaculata																		1	1			1									3			
Fabriciella sp. A												2									1					8	1				12			
Class OLIGOCHAETA																																		
Family TUBIFICIDAE																																		
Limnodriloides baculatus																						1			2						3			
Limnodriloides barnardi												1						2									1	3			7			
Limnodriloides rubicundis		3										1	5									2									11			
Limnodriloides sp.												1																			1			
Unidentified limnodriloidine					3																							1			4			
Smithsondrilus marinus															3			6		3	5	1				2	7				27			
Smithsondrilus sp.															1																1			
Tectidrilus sp.					1										1													1			3			
Thalassodrilides gurwitschi										1	1		8	2		1				3		2				6				1	25			
Tubificoides bermudae																		1													1			
Tubificoides motel				1	1		1						1														3	1			8			
Tubificoides sp. HS															1																1			
Unidentified tubificid				1		4				1	1		1		1	2			3	4	2	3	1	3		6	2		8	3	1	1	48	
Phylum SIPUNCULA																																		
Class PHASCOLOSOMATIDEA																																		
Order ASPIDOSIPHONIFORMES																																		
Family ASPIDOSIPHONIDAE																																		
Aspidosiphon albus																								11	17	6			1			35		

TABLE 1. Ponar Grab Collection Stations: raw data, diversity (H') and evenness (J').

[illegible]

TABLE 1. Ponar Grab Collection Stations: raw data, diversity (H') and evenness (J').

STATION	1			8			8a			9			10a			11			13a			14			17			18			19a			
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3				
TAXON																																		
Leptochelia rapax										4		2	7	30	15				1	1			3	4				3	1			71		
Unidentified tanaidacean																											1		1		2			
Order ISOPODA																																		
Family HYSSURIDAE																																		
Xenanthura brevitelson																											11		1		12			
Family CIROLANIDAE																																		
Eurydice sp.																					1		1								2			
Family IDOTEIDAE																																		
Erichsonella attenuata													1																		1			
Order AMPHIPODA																																		
Family AMPHILOCHIDAE																																		
Unidentified amphiloichid																													1		1			
Family BATEIDAE																																		
Batea catharinensis												2																			2			
Family COROPIIIDAE																																		
Cerapus n. sp.											1		32	31	41				42	3	24	5	23	34			1	2		2	241			
Grandiferella bonnieroides					4	2			2	17	13	6	5	52	22		1		16	5	8	23	13	1	4		14	22	14	18	5	267		
Family LILLJEBORGIDAE																																		
Unident. lilljeborgid (frag)														1																	1			
Family MEGALUROPIDAE																																		
Gibberosus myersi												1																			1			
Order DECAPODA																																		
Infraorder CARIDEA																																		
Family ALPHEIDAE																																		
Alpheus floridanus			1			2			1						1			1	1												7			
Alpheus nuttingi														1																	1			
Alpheus sp.																		2													2			
Family PALAEMONIDAE																																		
Brachycarpus biunguiculatus							1																								1			
Periclimenes sp.																						1									1			
Family PASIPHAEIDAE																																		
Leptochela serratorbita																				1											1			
Infraorder ANOMURA																																		

TABLE 1. Ponar Grab Collection Stations: raw data, diversity (H') and evenness (J').

STATION		1			8			8a			9			10a			11			13a			14			17			18			19a		
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
TAXON																																		
Family DIOGENIDAE																																		
Clibanarius cubensis																			1															1
Family PAGURIDAE																																		
Pagurus simpsoni																1						2						2						5
Pagurus sp.																		1					1											2
Infraorder BRACHYURA																																		
Family GONEPLACIDAE																																		
Unidentified goneplacid				1																														1
Family XANTHIDAE																																		
Dyspanopeus sayi																			1			1												2
Phylum ECHINODERMATA																																		
Class OPHIUROIDEA																																		
Unidentified ophiuroid					1		1		1						1	1		2					1											8
UNKNOWN															1																			1
TOTAL	12	16	15	35	90	35	26	8	24	220	136	144	230	519	405	30	13	18	71	66	77	71	119	147	162	147	100	111	98	68	49	16	47	3342
Total # species (by replicate)	4	3	7	13	20	8	15	7	14	23	20	22	19	29	31	16	7	8	14	28	26	25	26	26	7	10	9	30	28	27	12	6	10	139
H' (by replicate)	0.837	0.921	1.507	1.841	1.870	1.447	2.266	1.906	2.417	2.212	2.177	2.223	2.091	2.473	2.541	2.433	1.692	1.638	1.569	2.848	2.582	2.839	2.588	2.360	0.936	1.333	0.983	3.031	2.794	2.896	1.948	1.488	1.786	
J' (by replicate)	0.604	0.839	0.774	0.718	0.624	0.696	0.837	0.980	0.916	0.705	0.727	0.719	0.710	0.735	0.740	0.877	0.870	0.788	0.594	0.855	0.793	0.882	0.794	0.724	0.481	0.579	0.447	0.891	0.838	0.879	0.784	5.000	0.776	
Total # species (by station)		10			28			23			36			46			25			47			45			12			51			21		
H' (by station)		1.365			2.057			2.800			2.364			2.555			2.614			2.823			2.831			1.139			3.282			2.406		
J' (by station)		0.593			0.617			0.893			0.660			0.667			0.812			0.733			0.744			0.458			0.835			0.791		

TABLE 2. Summary of Major Taxonomic Groups in Grab Collections.

STATION	1	8	8a	9	10a	11	13a	14	17	18	19a	TOT
NEMERTINA	0	6	3	1	3	3	3	5	8	10	11	53
MOLLUSCA	1	2	0	33	22	1	6	9	0	12	10	96
POLYCHAETA	37	129	43	202	760	42	101	127	23	119	18	1601
OLIGOCHAETA	3	11	1	7	21	9	21	21	8	34	7	143
SIPUNCULA	0	1	0	1	6	0	0	0	34	0	5	47
OSTRACODA	0	0	0	158	79	0	0	45	39	14	29	364
PERACARIDA	0	7	2	101	257	1	97	122	297	86	32	1002
OTHER	2	4	4	0	6	5	6	8	0	2	0	37
TOTALS	43	160	53	503	1154	61	234	337	409	277	112	3343

Table 4. Crab census data. Numbers in parentheses indicate numbers of trees inside 1.0 square meter sampling area.

STATION	1a			2			3			4			5			6			7			10			12			13			15			16			TOT
REPLICATE	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3				
CRAB BURROWS	145	66	137	189	87	142	236	192	120	137	101	107	171	110	103	123	163	139	181	173	187	22	26	12	0	0	0	41	23	25	5	10	10	68	32	77	
CRAB CENSUS																																					
Family GRAPSIDAE																																					
Aratus pisonii (juv)				1		1								1		1		1																5			
Sesarma curacaoense		3	1			2	1			2	1	2		1	3			1																	17		
Family XANTHIDAE																																					
Eurytium limosum																			1	1															2		
Family OCYPODIDAE																																					
Uca pugilator																												2								2	
Uca ?rapax																											2			2					4		
Uca thayeri		1			1													1																	3		
Uca sp. (juv.)	4		2	1	1	3	1		2	3									2	2	1	1	1											1	25		
Total # specimens	4	4	3	2	2	6	2	0	2	5	1	2	0	2	3	0	1	0	3	3	3	1	1	1	0	0	0	2	2	0	2	0	0	0	0	1	58
Total # species (by station)		3			4			2			2			2		1			5			1			0			2			1			1			
H' (by station)		0.916			1.220			0.562			0.662			0.500		0			1.427			0			0			0.693			0			0			
J' (by station)		0.834			0.880			0.811			0.954			0.722		0			0.887			0			0			1.000			0			0			
TREE CRAB CENSUS																																					
Family GRAPSIDAE																																					
Aratus pisonii*	9(1)			7(1)			5(2)			4(2)			7(2)			7(2)		5(5)				0(1)			0(0)			0(0)			0			1(5)			

TABLE 5. Hand collection stations: raw data, diversity (H') and evenness (J').

STATION	9			13			17			TOT
REPLICATE	1	2	3	1	2	3	1	2	3	
TAXON										
Phylum MOLLUSCA										
Class GASTROPODA										
Family POTAMIDIDAE										
Batillaria minima	31	47	11	61	62	32	2	11		257
Family VERMETIDAE										
?Petalocochus varians	1	9								10
Class BIVALVIA										
Family ISOGNOMONIDAE										
Isognomon alatus								8		8
Family OSTREIDAE										
?Crassostrea virginica								1		1
Family MYTILIDAE										
Brachidontes exustus				1	1					2
Phylum ARTHROPODA										
Subphylum CRUSTACEA										
Class CIRRIPIEDIA										
Family BALANIDAE										
Balanus amphitrite		12	3			4		24		43
Balanus reticulatus		3								3
Family CHTHAMALIDAE										
Chthamalus fragilis		149	14							163
Class MALACOSTRACA										
Order AMPHIPODA										
Family HYALIDAE										
Hyalae grandicornis	1	12	18	2		1				34
Order DECAPODA										
Family DIOGENIDAE										
Clibanarius tricolor		4								4
Clibanarius sp. ?				7						7
Family GRAPSIDAE										
Aratus pisonii (juv)	1	1								2
Family XANTHIDAE										
unident. juv. xanthid	2	1				1			1	5
Subphylum UNIRAMIA										
Class INSECTA										
Order COLLEMBOLA										
Family ANURIDIDAE										
Anurida maritima	16	9	5	23	9	6				68
Phylum PORIFERA										
unident. juv. sponge									1	1
Total # of specimens	52	247	51	94	72	44	2	44	2	608
Total # species (by replicate)	6	10	5	5	3	5	1	4	2	15
H' (by replicate)	1.024	1.321	1.448	0.949	0.448	0.893	0	1.073	0.693	
J' (by replicate)	0.572	0.574	0.899	0.589	0.408	0.555	0	0.774	1	
Total # species (by station)		10			7			6		
H' (by station)		1.528			0.853			1.241		
J' (by station)		0.664			0.438			0.692		

TABLE 7. List of outside taxonomic experts consulted and their area(s) of expertise.

Dr. Jon F. Norenburg, Smithsonian Institution (Nemertina)
Dr. Donald R. Moore, University of Miami (Mollusca)
Dr. Michael Milligan, Mote Marine Laboratory (Polychaeta and Oligochaeta)
Dr. Julie Piraino, Harbor Branch Oceanographic Institute (Sipuncula)
Dr. Louis Kornicker, Smithsonian Institution (Ostracoda)
Dr. James D. Thomas, Newfound Harbor Marine Institute (Amphipoda)
Dr. Raphael LeMaitre, Smithsonian Institution (Decapoda)
Dr. Julio Garcia-Gomez, Miami-Dade Community College (Decapoda)
Dr. Patsy A. McLaughlin, Sedro Woolley, WA (Cirripedia)
Dr. David L. Pawson, Smithsonian Institution (Echinodermata)