CAMINADA HEADLAND BEACH BENTHIC ORGANISM SURVEY: YEAR 5

by

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c/o

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Figure 1. Map showing locations of benthic stations at Caminada Headland Beach, Fourchon, Louisiana in Years 2 - 5.

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Background

Beginning in 2013, the Barataria-Terrebonne Estuary Foundation (BTEF) instigated a series of monitoring surveys of benthic macroinvertebrate communities from open beach intertidal and wrack line habitats and bay side saltmarsh mudflats with the purpose of assessing the food resources available for wintering piping plovers (*Charadrius melodus*) along the Caminada Headland Beach (Fourchon, Louisiana). With the exception of 2017, these surveys were conducted annually in April. The following is a brief history of the previous four sampling efforts and an overview of the current study.

A pre-construction survey of the gulf shoreline benthic community from wet sand (intertidal) and wrack line habitats at four stations along the Caminada Headland Beach was conducted April 1-2, 2013, as part of a beach and dune restoration project which required monitoring of wintering piping plovers in that area (McLelland 2013). The 2013 survey showed that the intertidal macrobenthic population was dominated by the polychaete annelid, *Scolelepis squamata* and the amphipod crustacean, *Lepidactylus triarticulatus*. Although the latter was more numerous, the two populations were nearly equal in total biomass. The beach wrack-line invertebrate community at three of the four stations was dominated by large numbers and a rich variety of small insects, but was lower in total biomass than the corresponding intertidal zone fauna.

Year 2 of the survey was conducted April 16-17, 2014, and focused on three aspects: (1) revisiting the same four gulf-side stations to assess changes in the macroinvertebrate population structure resulting from beach renourishment and dune construction (post-construction); (2) survey an additional six gulf-side sites along the Caminada Headland Beach extending eastward from those surveyed in 2013 in order to provide a baseline for further restoration to commence as part of Phase II; and (3) survey the benthic community at three bayside sites within the Caminada Headland Beach and Dune Restoration project footprint, areas known to provide forage for transient shorebirds. To allow comparison between sampling events, all year 2 samples were collected in the same manner as those of year 1 (McLelland 2014).

Years 3 and 4 of the survey, conducted March 30-April 1, 2015 and April 4-5, 2016, respectively, were essentially repeats of the Year 2 survey with the purpose of continuing observations on the macroinvertebrate assemblages and assessing the impact on the benthic community from further beach renourishment progressing eastward along the headland beach. The same stations from Year 2 were surveyed using the same procedures (McLelland 2015, 2016). In addition, following the 2016 survey, intertidal biomass values from 2013 (pre-construction) were compared with levels from beach stations in following years using a 70% target value based on an average value from four 2013 pre-construction stations. Results showed that the number of stations with total biomass values exceeding a 70% target value, steadily increased from seven in 2014, to eight in 2015 and nine in 2016. By 2016, all west-end beach stations that had undergone construction during the previous two years had re-established biomass levels well above the 70% target value.

The current study, conducted April 2-3, 2018 again repeated the surveys from years 2-4 at the same stations using the same methodology, with the purpose of further monitoring the availability of food resources for shorebirds. The locations of the 10 beach stations and 3 bayside stations sampled in year 5 and in previous years of the survey appear on the map in Figure 1.

Field Procedures.

Intertidal samples were collected at each station near mid-swash zone - that area halfway between the point at which waves break on the beach face and the upper extent of the moving water. A hand-held stainless steel box core, described by Saloman and Naughton (1977), was used for intertidal sampling (Fig. 2). The coring device, six inches (12.5cm) on a side and penetrating to a depth of 18-20cm, was used to collect three replicate quantitative samples at approximately 1 meter apart and representing 0.0156m^2 of substrate. Box Core samples were treated with a weak formalin solution to anesthetize motile organisms, then repeatedly elutriated through a 0.5mm mesh sieve. The elutriation technique served to float off soft-bodied infauna (e.g. polychaetes, amphipods) from the samples. The remaining sediment was screened through a 1.0mm sieve to remove possible heavier bodied organisms (e.g., mollusks). Samples were preserved in the field with rose bengal-stained 5% formalin, labeled and returned to the laboratory for analysis. Rose bengal, a protein stain, facilitates the detection of benthic organisms among the sediment and detritus in the samples during the laboratory sorting process.

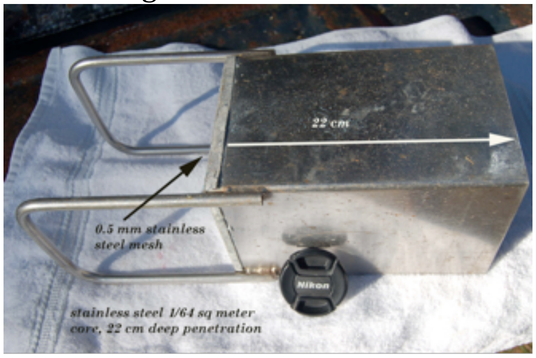

Figure 2. Box Core used in intertidal sampling. Photo by J.M. Foster.

The wrack line community was sampled following National Water Quality Assessment (NAWQA) Program protocols (Moulton et al, 2002) for the collection of richest-targeted habitat (RTH) samples corresponding to approximately 0.25 square meters of wrack substrate (fine organics, shells, woody debris, drift vegetation, etc.) per sample. Three replicate samples were collected by scooping out about 5 cm of sediment inside a 0.25 square meter quadrant that was placed at about two meter intervals within a 10 meter section of the wrack line (Fig. 3). Large debris particles were removed from the samples by sifting through a coarse screen (4.0 mm) that was dipped in a water bucket to dislodge clinging organisms (spiders, insects, etc.). Samples were then processed and preserved in a similar manner to the box cores using elutriation and screening through a 1.0mm sieve.

One qualitative multi-habitat (QMH) wrack-line sample per station was collected to account for large and rare specimens (i.e. crabs, snails, etc.) occurring among the flotsam and jetsam within the same homogenous wrack-line section used for the collection of RTH sample.

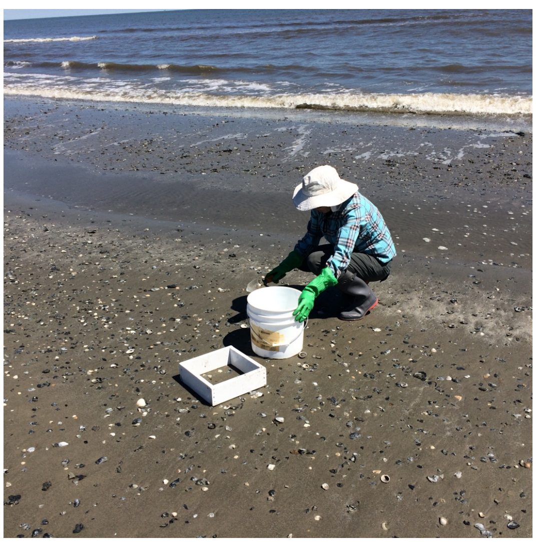

Figure 3. 0.25 m quadrant used for sampling beach wrack fauna. Photo by J. McLelland.

The purpose of this sample was to provide an indication of RTH sampling efficiency. QMH sampling, based on NAWQA protocols, was conducted by pushing a wide-mouth kicknet along the 10-meter wrack-line section with the ensuing sediment and debris (e.g., *Sargassum* weed) being washed by agitation in a sampling bucket. Organisms resulting from this action were placed in a jar, labeled and preserved.

Additional physical data included GPS coordinates, salinity, water and air temperatures, wind speed and direction, and sea state (Table 1). The three bayside stations were sampled similarly to the beach station wrack-line habitats (Fig. 4) except that no QMH sample was collected (see Table 2 for station data).

Figure 4. Sieving benthic samples at a bayside mudflat station.

Table 1. Caminada Headland Beach Gulf Side Benthic Field Data – April, 2018

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10
Date sampled	4/2/18	4/2/18	4/3/18	4/3/18	4/2/18	4/3/18	4/3/18	4/3/18	4/2/18	4/2/18
Time on Site	1010 - 1115	1225 - 1325	1330 - 1415	1145 - 1230	1330 - 1425	1240 - 1325	1050 - 1130	0955 - 1035	1610 - 1700	1515 - 1605
Latitude	N 29.09099	N 29.11033	N 29.12455	N 29.13895	N 29.11762	N 29.13168	N 29.15335	N 29.16837	N 29.18138	N 29.18768
Longitude	W -90.21357	W -90.17789	W -90.15539	W -90.13176	W -90.16664	W -90.14372	W -90.10947	W -90.08601	W -90.06322	W -90.05105
Station ID no.	ID 334	ID 417	ID 406	ID 421	ID 411	ID 401	ID 526	ID 426	ID 493	ID 490
Intertidal length	4.9m	1.8m	4.8m	3.0m	4.7m	4.7m	5.9m	4.5m	1.0m	1.8m
Wrack to water	10m	3.0m	8.0m	4.0m	3.0m	2.0m	2.0m	1.0m	2.0m	8.7m
<u>Sample types:</u>										
box cores	3	3	3	3	3	3	3	3	3	3
wrack semi-quant	3	3	3	3	3	3	3	3	3	3
wrack qualitative	1	1	1	1	1	1	1	1	1	1
<u>Physical data:</u>										
salinity ppt	12		17	16	11	17	15	14	13	13
air temp °C	22.7	25.1	25.2	24.4	25.6	26.1	24.5	23.3	25.6	24.6
water temp °C	22.9	23.7	24.3	24.1	24.6	24.3	23.1	23.3	24.8	25.2
wind speed mph	5	10	10	5	5-10	5	10	10	5	5
wind direction	S	S	S	S	S	S	S	S	SE	SE
% cloud cover	5	15	20	20	10	50	40	20	5	10
sea state ft	3	3	3	3	3	3	3	2-3	2	2

Table 2. **Caminada Headland Beach Bayside Benthic Field Data – for April 2018**

	BS 1	BS 2	BS 3
Date sampled	4/3/18	4/3/18	4/2/18
Time on Site	1030 - 1040	0840 - 0910	1145 - 1215
Latitude	N 29.16995	N 29.18449	N 29.11870
Longitude	W -90.08737	W -90.06407	W -90.16815
Station ID no.		ID 493	ID 711
Intertidal length	-	-	-
Wrack to water	-	-	-
Sample types:			
box cores	-	-	-
wrack semi-quant	3	3	3
wrack qualitative	-	-	-
Physical data:			
salinity ppt	16	13	20
air temp °C	24.1	24.2	26.4
water temp °C	23.8	22.7	25.4
wind speed mph	5	10	5
wind direction	S	SE	S
% cloud cover	10	20	20
sea state ft	-	-	-

Laboratory Procedures.

Sorting was conducted under a stereoscopic dissecting microscope to remove all macrobenthic organisms and recognizable fragments. Specimens were counted and identified to the lowest possible taxonomic category with representative reference material being retained and transferred to 70% ethanol for storage. The remaining material was separated into major groups of prey items (e.g, annelids, crustaceans, molluscs), preserved in ethanol and set aside for biomass measurement. A numerical database was constructed using Microsoft Access and data was further condensed and organized in spreadsheet format using Microsoft Excel. Numbers counted were converted to numbers per square meter using 64.103 per individual for box core data and 16 per individual for the 0.25 meter quadrant. Metrics of species diversity (H'), equitability (J') and dominance were calculated using formulae incorporated in the Excel spreadsheet.

Species diversity is the number of different species in a particular area (species richness) weighted by some measure of abundance such as number of individuals or biomass. The Shannon-Weiner Diversity Index (H') is the most popular mathematical expression of species richness and evenness in use in ecological investigation, including benthic monitoring studies. According to Pielou (1966), who studied the use of H' in detail, the index is appropriate to use when random samples are drawn from a large community in which the total numbers of species is known. H' is calculated as $-\sum \rho i \log n(\rho i)$, where ρi is the proportion of the total number of specimens *i* expressed as a proportion of the total number of species for all species in the ecosystem. The product of ρilogn (ρi) for each species in the ecosystem is summed and multiplied by −1 to give H'.

The species equitability index (J'), also known as Evenness, is another measure of how well the abundance of individuals is spread among the number of species. It is calculated as H'/H_{max}, where H_{max} is the maximum possible value of H', and equals the log of S, which is the number of species (species richness). The index of dominance, a measure of how a population is dominated by one or a few species, is calculated simply as 1-J'.

Total benthic biomass (by weight) of piping plover prey species was measured following methods described by Versar, Inc. (2002). Samples composed of prey specimen groups (see above), pooled from all replicates, were air dried to a constant weight at 60ºC in a drying oven and then baked for 4 hours at 500ºC in a muffle furnace to determine the ash-free dry weight. Samples were weighed before and after baking using an analytical balance accurate to 0.0001 g. Bivalves and barnacles in the samples were crushed prior to drying to eliminate fluid trapped in the shells.

Figure 5. Typical Gulf-side beach face.

Results.

General field observations. As in previous years, the typical beach face at most of the Gulf-side stations was flat with little contour (Fig. 5). The substrate consisted of very fine, firmly packed sediment overlaying sparse amounts of shell hash composed of fine flakes at some stations and coarse rubble at others. The sediment was light brown in color due likely to large amounts of fine silt originating from nearby rivers and bays. The wrack line, indicated by the most recent high-tide mark, was almost non-discernable at some stations but at others (stations 3 – 7 and 10) there was a considerable amount of washed up marsh grass detritus present (Fig. 6).

Figure 6. Wrack-line at eastern stations.

The three bayside stations, open to the bay on the north side, appeared unchanged from previous surveys. They were similar in that they were typical exposed mud/sand-flat areas with standing water replenished by tidal inundation, and with varying amounts of fringing vegetation (Figs. 4 and 7). The sediment was composed of mud and fine-grained sand topped by a thin algal mat. Quadrant sampling at stations BS1 and BS3 was conducted at the waterline in sediment either exposed or with about a centimeter of water coverage. Because of deeper water during high tide (about 30 cm), a box core was used to take samples at station BS2.

Figure 7. Typical bayside station behind Caminada Headland Beach.

Benthic fauna.

During the Year 5 sampling period, a total of 6,368 organisms were examined from Caminada Headland Beach samples (5,284 from the 10 Gulf-side stations and 1,084 from the three bayside stations) representing 95 nominal taxa from four phyla. These totals include specimens examined from the qualitative wrack-line (QMH) samples collected at the beach stations (see Appendix I). Numerical, biomass and diversity data for quantitative samples are presented in Tables 3 and 4 for the intertidal and wrack line communities respectively and in Table 5 for the bayside benthic community. A complete phylogenetic listing of organisms encountered appears in Appendix II.

Gulf-side Stations

Among the ten Gulf-facing stations, station 10 had the largest number of intertidal individuals collected with over 18,000 organisms/m^2, largely due to high numbers of the spionid polychaete, *Scolelepis squamata*, the haustoriid amphipod, *Lepidactylus triarticulatus,* and the bivalve *Donax texasianus* (Figs. 8 and 10). Crustaceans and annelids were the numerically dominant intertidal organisms at all beach stations with peaks occurring at stations 10 and 8. The highest density of total organisms in the beach wrack-line community occurred at Station 9 (13,712/m^2) with substantial numbers (6,720/m^2) also at station 1 (Fig. 9). High numbers of *Lepidactylus*, embedded in the upper few cm of sediment in the wrack line, accounted for the densities of over 1000/ m^2 at all but one of the beach stations (Fig. 11) but were highest at the aforementioned stations 9 and 1.

Intertidal species diversity (H') values, ranging between 0.491 and 0.182, were higher than corresponding wrack-line values at all stations except stations 2,4 and 6, the latter of which registered a value of 0.597. Dominance values (1-J') in the wrack-line zone were higher than corresponding intertidal values at all stations except for stations 2 and 6. Large numbers of embedded amphipods in the wrack community and higher numbers of crustaceans and bivalves in the intertidal core samples undoubtedly influenced these trends (see Figs. 12 and 13, Table 3 data).

In terms of macrofaunal biomass, there was considerably more g /m^2 of available nutrition in the intertidal zone than in the wrack community (see the scales of Figs. 14 and 15). An exceptionally large peak of intertidal biomass at station 7 of nearly 50 g/m2 (Figs. 14 and 16) was influenced by the presence of high numbers of amphipods and a couple of large mole crabs (*Emerita talpoida*). In the wrack community, there were only three stations (3,7 and 9) with total biomass values greater than 1.5 g/m2 and these had relatively high numbers of amphipods embedded in the moist sand beneath the wrack line (Figs. 15 and 17). In comparing the biomass totals of all stations (Figs. 18 and 19), crustaceans (58%) and annelids (36%) dominated the intertidal zone, with a scant representation by molluscs and other taxa (about 6%), while crustaceans (97%) provided the overwhelming bulk of biomass in the wrack community.

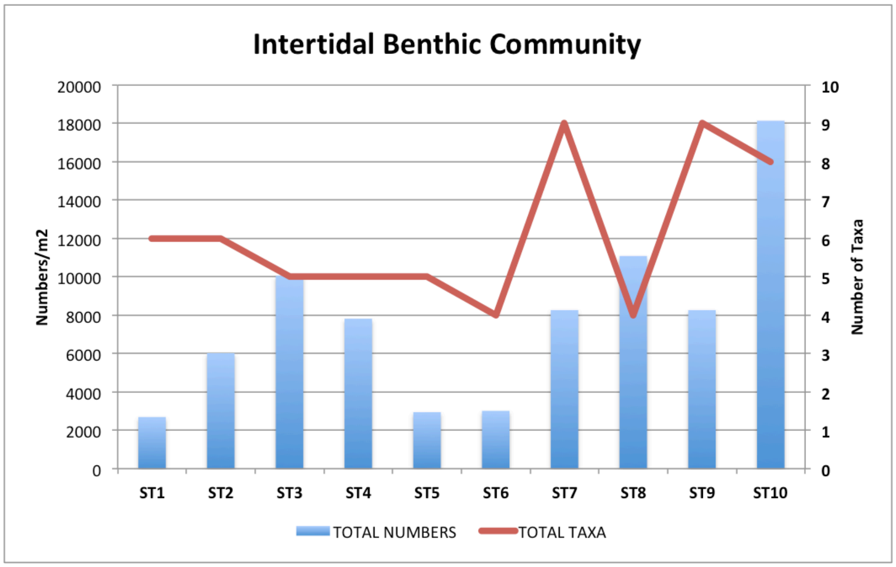

Figure 8. Intertidal total density vs. richness.

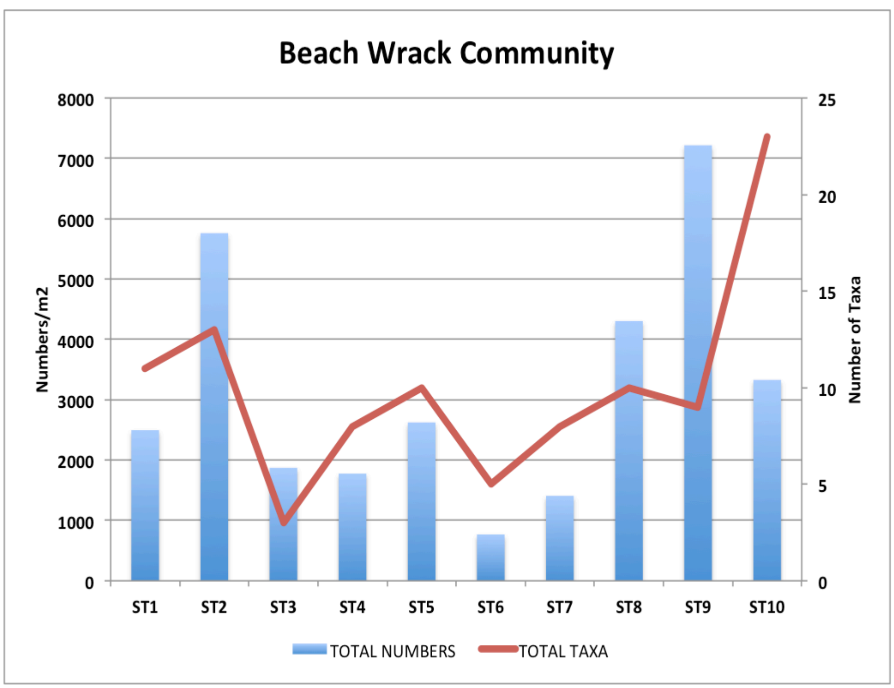

Figure 9. Wrack-line total density vs. richness

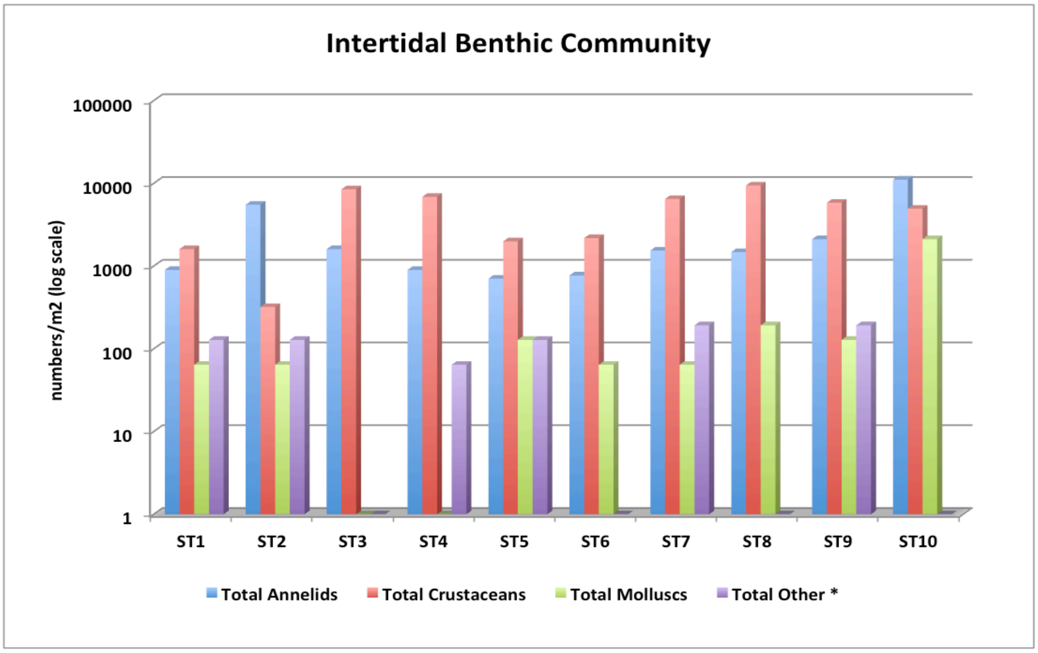

Figure 10. Gulf-side intertidal macrobenthic components.

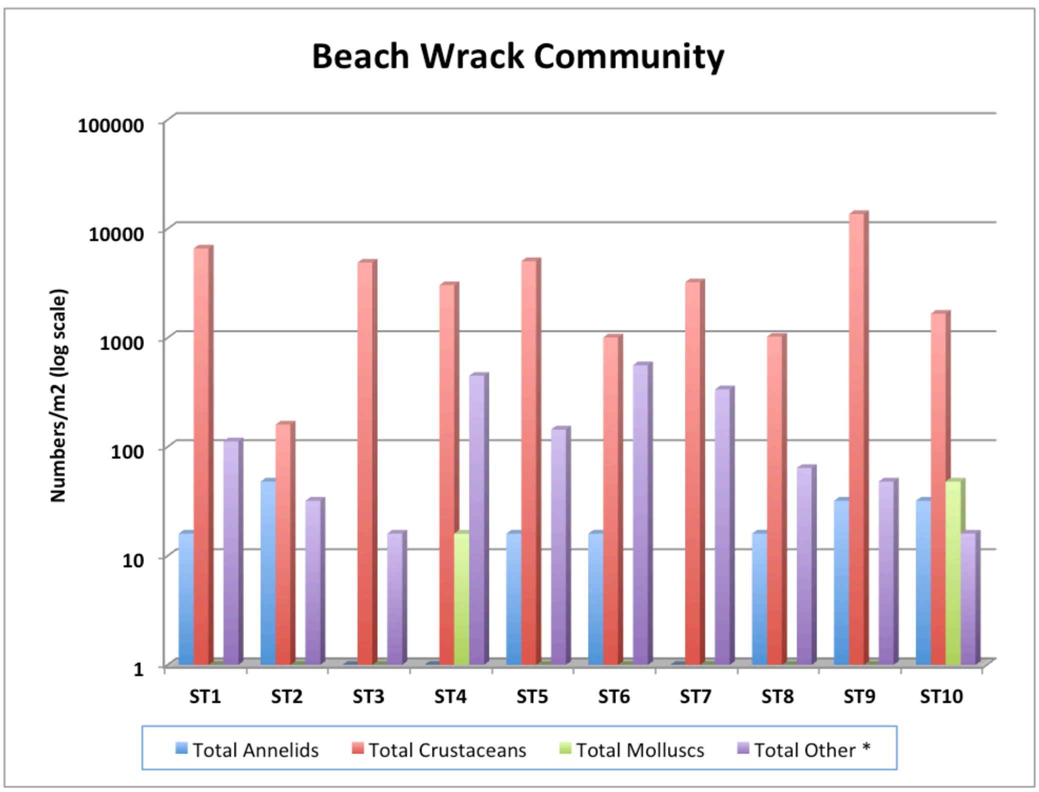

Figure 11. Gulf-side wrack community macrobenthic components.

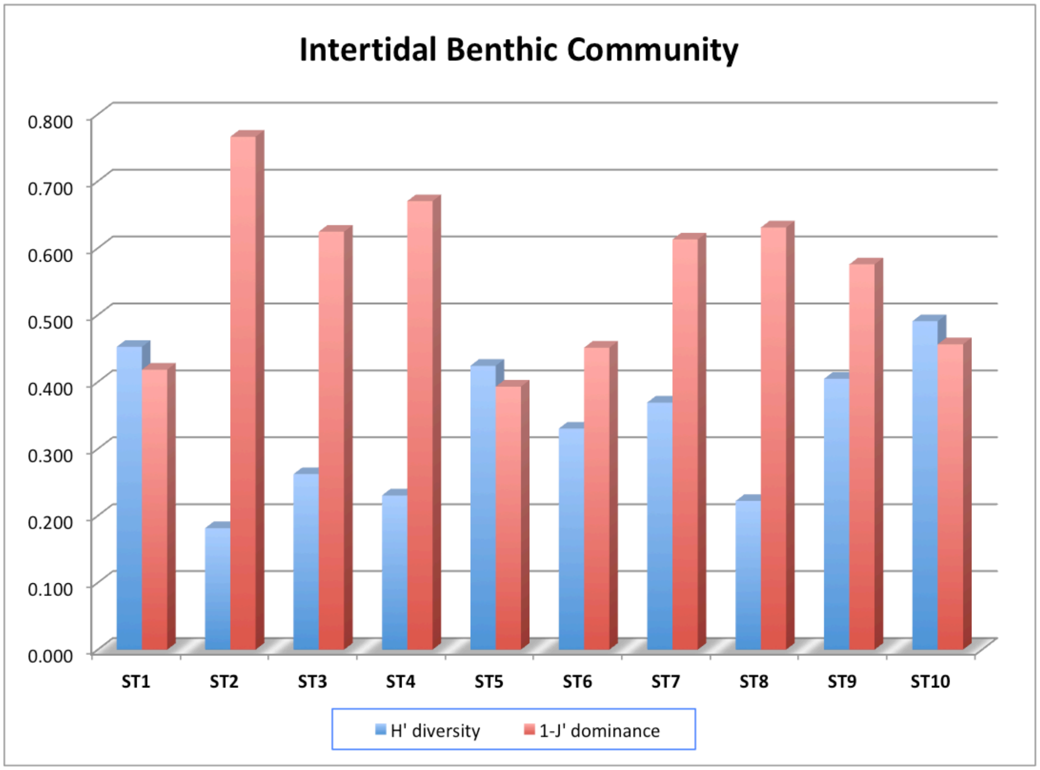

Figure 12. Gulf-side intertidal diversity indices.

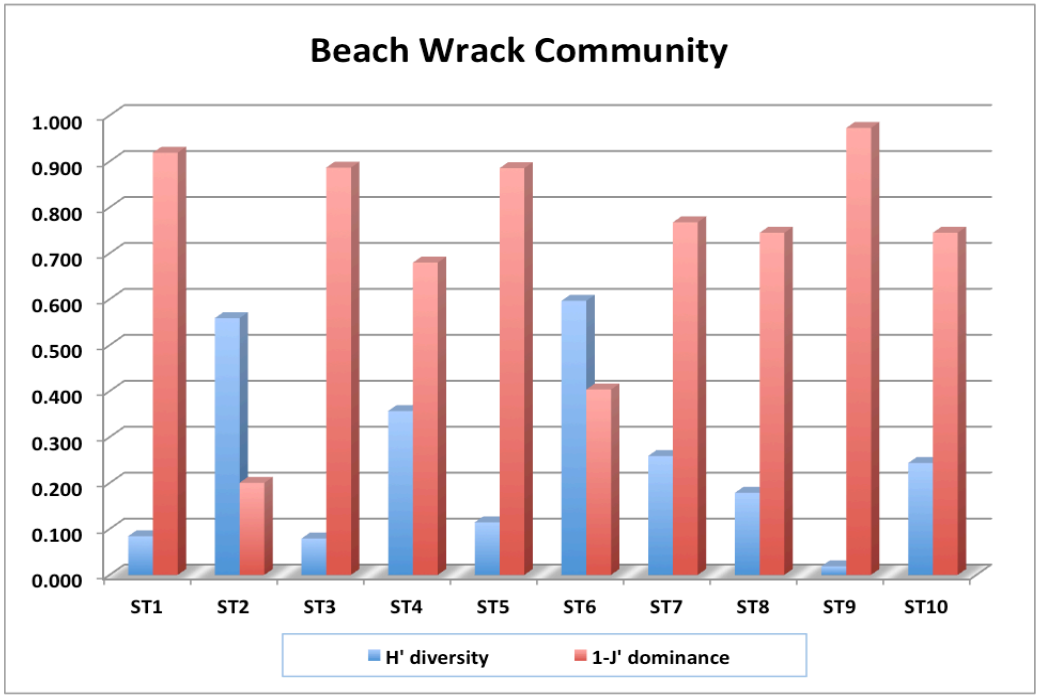

Figure 13. Gulf-side wrack-line diversity indices.

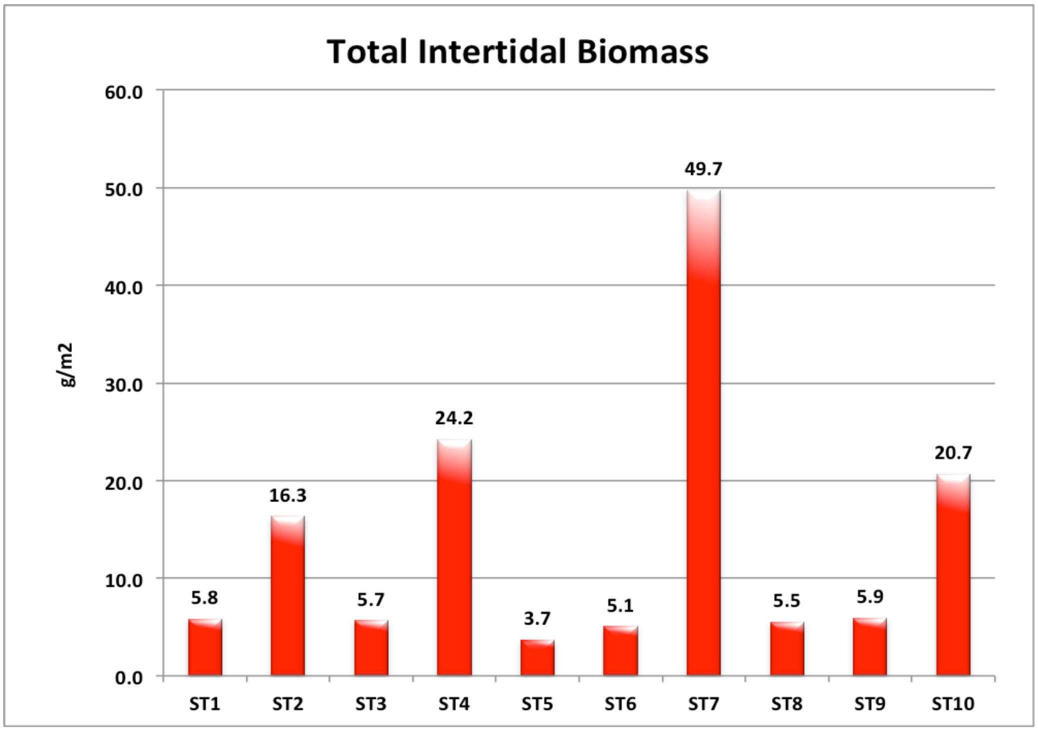

Figure 14. Gulf-side stations total intertidal biomass.

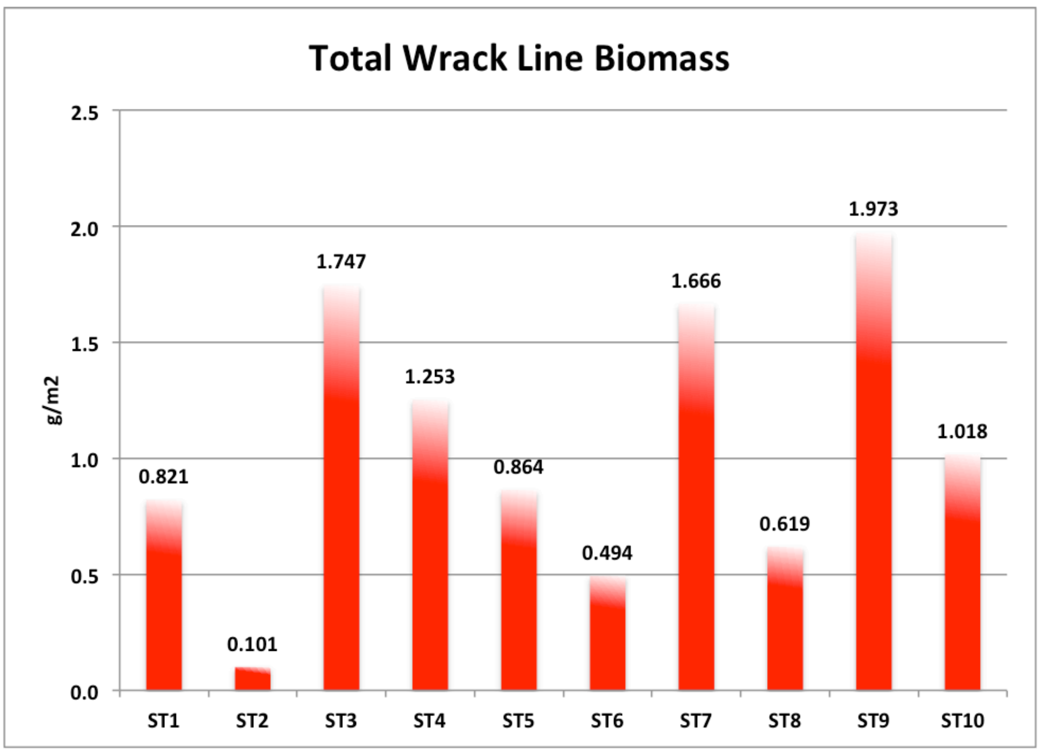

Figure 15. Gulf-side stations total wrack-line biomass.

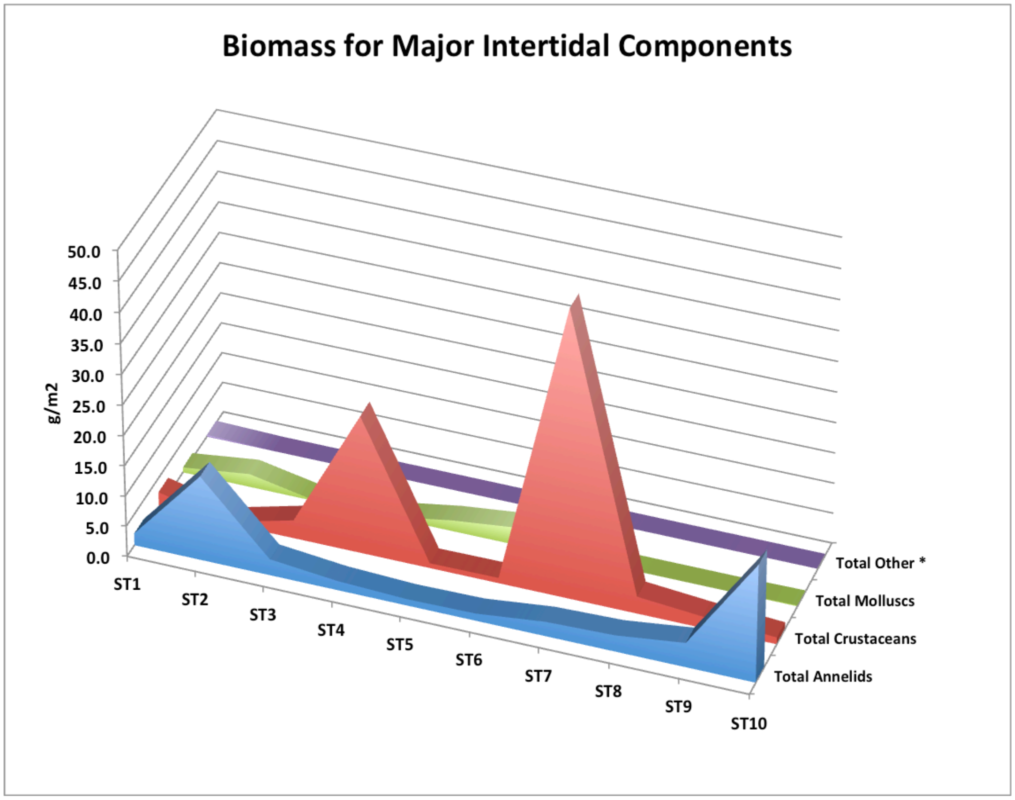

Figure 16. Gulf-side stations intertidal biomass components.

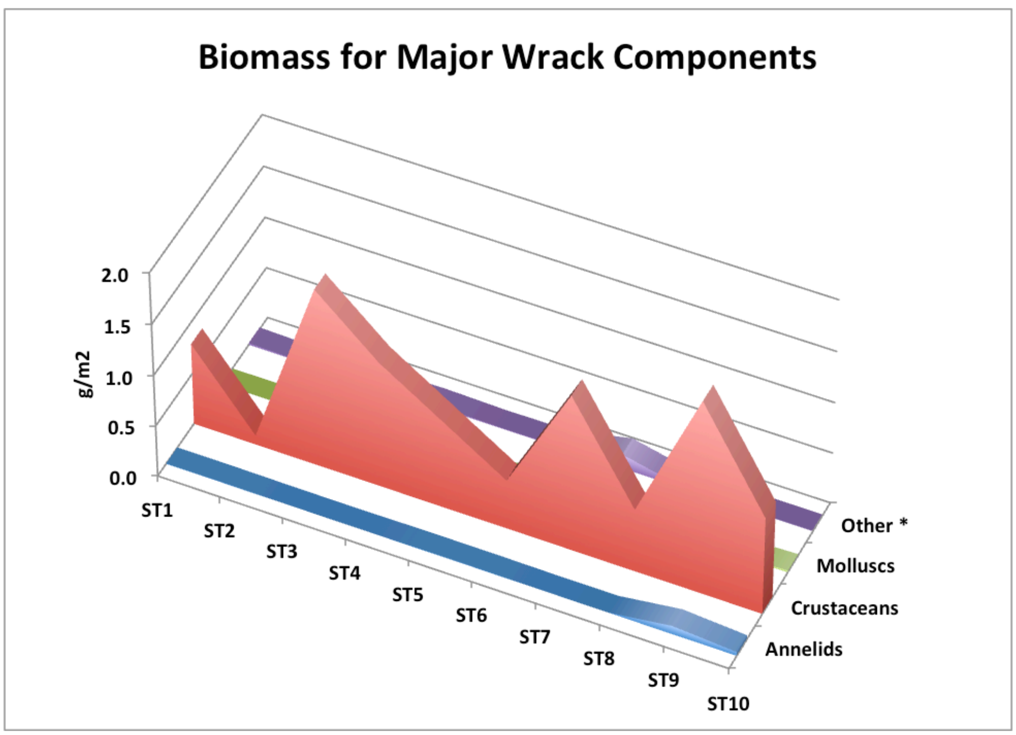

Figure 17. Gulf-side stations wrack-line biomass components.

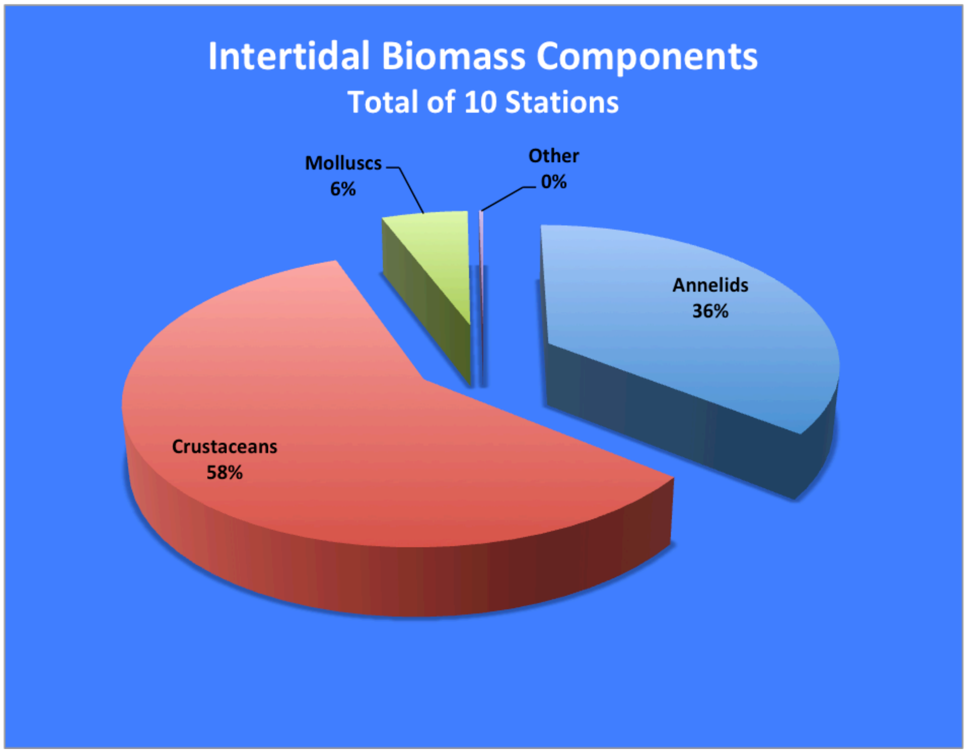

Figure 18. Gulf-side stations combined intertidal biomass components.

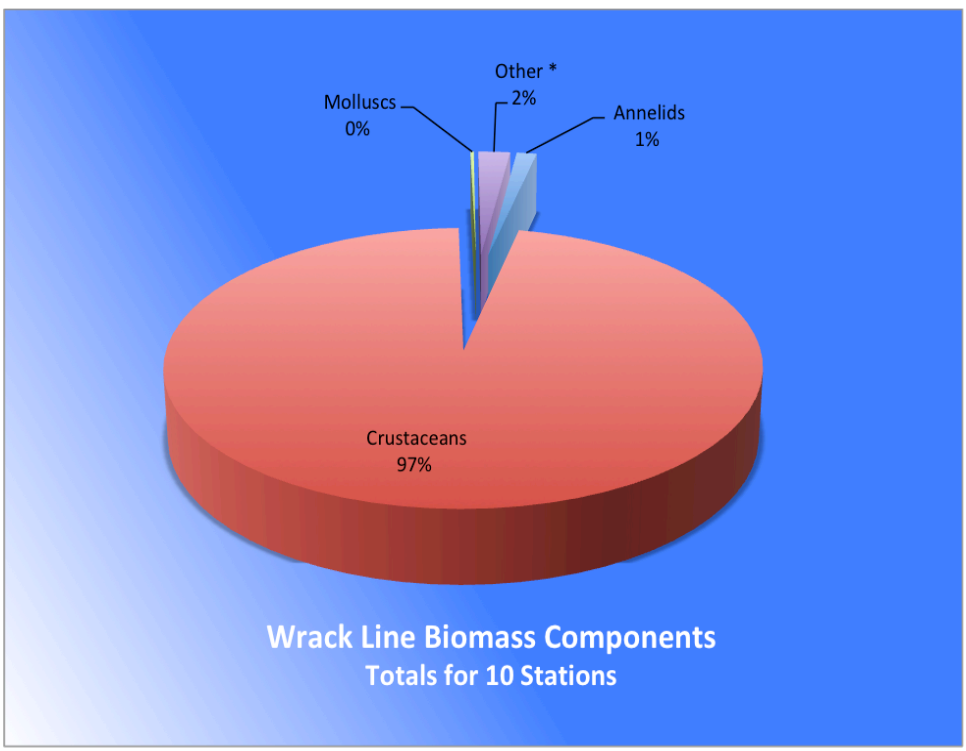

Figure 19. Gulf-side stations combined wrack-line biomass components.

Bayside Stations

Of the three bayside sites, station BS2 had a higher density (16,474 organisms/m2), species richness (18) and total biomass (30.4 g/m2) than BS1 and BS3 (Figs. 20 and 23). These values were due largely to the abundance and diversity of polychaetous annelids (13 species) present at BS2 (Figs 22 and 24); annelids were scarce at the other two stations. Stations BS1 and BS3 were similar in the prominent presence of insect larvae, particularly pupae cases, embedded in the algal mat overlying the bottom (see Fig. 22). In terms of total biomass, polychaete annelids dominated the bayside fauna (72%) again due to large numbers present at station BS2 (Fig. 25). The most abundant polychaetes recorded were the capitellids, *Mediomastus ambiseta* and *Heteromastus filiformis* with numbers of 7244 and 4872/m^2 respectively at BS2. The fauna at the bayside stations was typical of that found in low energy, mesohaline embayments of northern Gulf of Mexico estuaries characterized by low oxygenated, detritus-rich silt bottoms (Heard 1982).

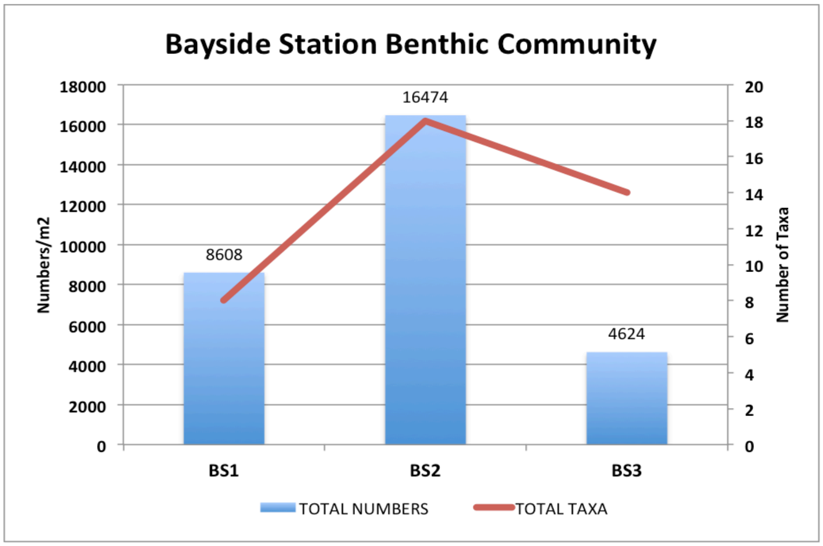

Figure 20. Bayside stations. Total macrobenthic density vs. richness.

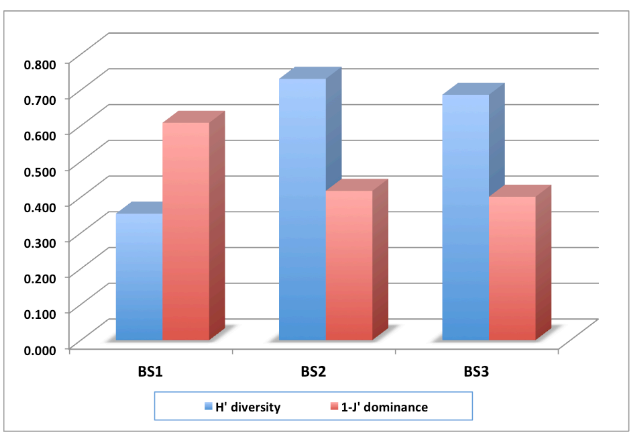

Figure 21. Bayside stations. Diversity indices.

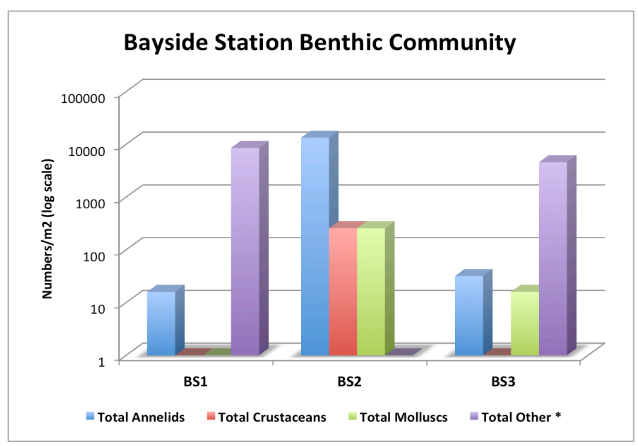

Figure 22. Bayside stations. Macrobenthic components.

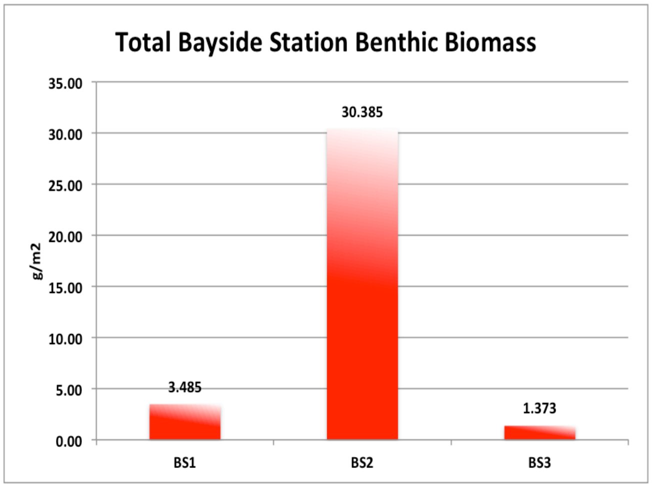

Figure 23. Baside stations. Macrobenthic biomass.

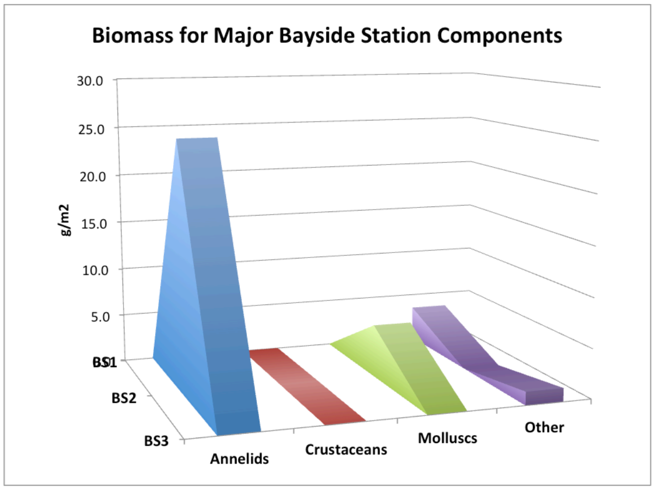

Figure 24. Bayside stations. Macrobenthic biomass components.

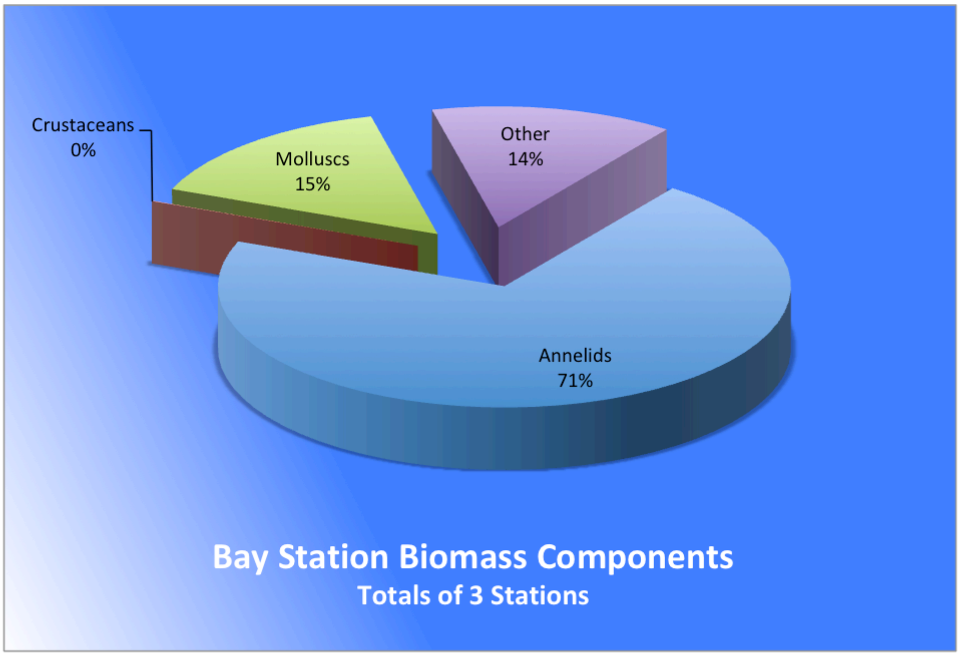

Figure 25. Bayside stations. Combined macrobenthic biomass components.

Beach Stations 1-4: Five-year comparisons.

The faunal and physical data collected during the present study at stations 1 through 4 provide a comparison data to four years of benthic investigations from 2013 to 2016 since only these stations were sampled in 2013. However the full compliment of 10 Gulf-side and three bayside stations are available for comparison between 2014 and 2016 and will be dealt with later.

Intertidal zone. The mean H' value of stations 1-4 in 2018 fell below levels recorded in 2016 and 2015 but was higher than the 2014 value (Fig. 26). Conversely, the total density during 2018 was higher than that recorded during 2016 (Fig. 27) at all four stations but was substantially less than those recorded at stations 1 and 4 during 2015 and stations 1 and 2 during 2013, the first year of surveys. During the five years, the total biomass for 2018 was higher at only station 2 (Fig. 28) despite the fact that component percentages for 2018 were similar to those of 2013, and 2016 in terms of crustacean biomass. The mollusc biomass, so predominant in 2014-2016 was reduced to 6% in 2018. The annelid biomass component increased in 2018 to near 2013 levels after becoming steadily reduced in the following years of surveys. These component comparisons are presented in pie chart figures 28-32.

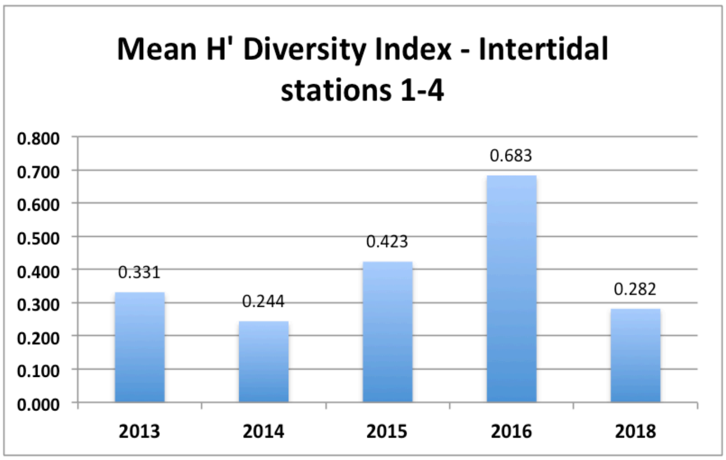

Figure 26. Intertidal mean diversiy for 5 years.

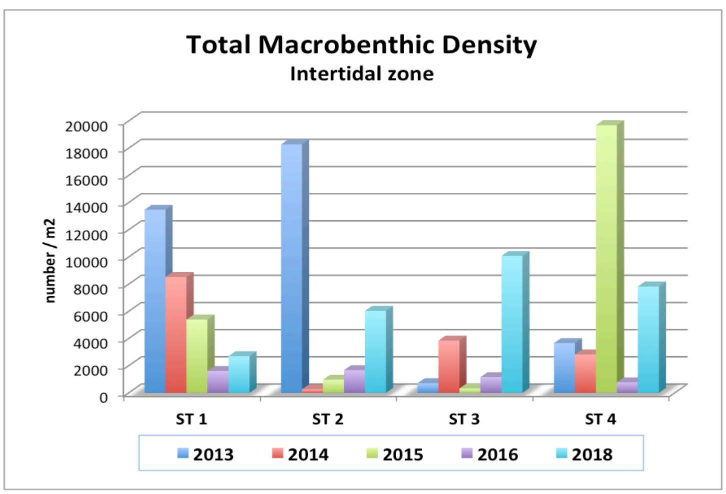

Figure 27. Total macroinvertebrate density - 5 years.

Wrack-line community. In 2018 total density in the wrack-line community showed an increase over the 2016 values at stations 1,3 and 4 but a large decrease at station 2 (Fig. 33). The total density at station 1 (6,720/m2) was the highest value recorded at the four stations during the five years of surveys. Station 3 was the only one among the four stations that showed in increase in biomass over the previous four years of the survey (Fig. 34), reflecting a substantial number of amphipods present. Mean H' diversity values over the four stations continued to decline since 2015 reaching a new low of 0.270 (Fig. 35). The total biomass components in the wrack-line community changed little if any in 2018 compared to previous years with a near total dominance of embedded crustaceans in the damp sand beneath the wrack line (See pie charts in Figs. 36-40). In fact, the biomass component structure was nearly identical to that of 2014 with crustaceans representing 98% of the biomass.

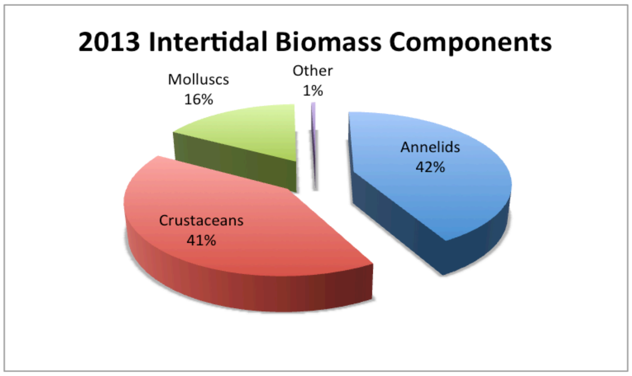

Figure 28. Combined components for four stations – 2013.

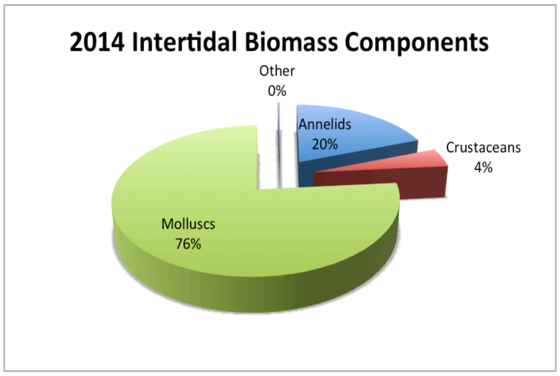

Figure 29. Combined components for four stations - 2014.

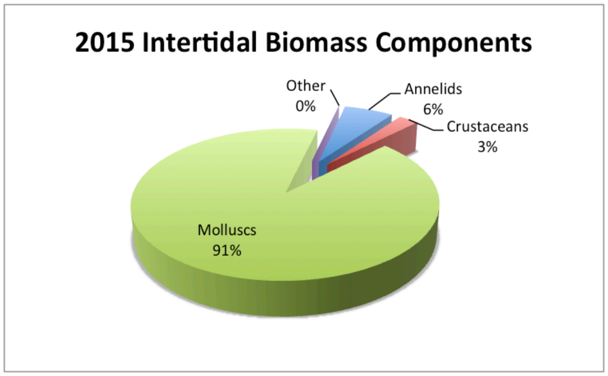

Figure 30. Combined components for four stations - 2015.

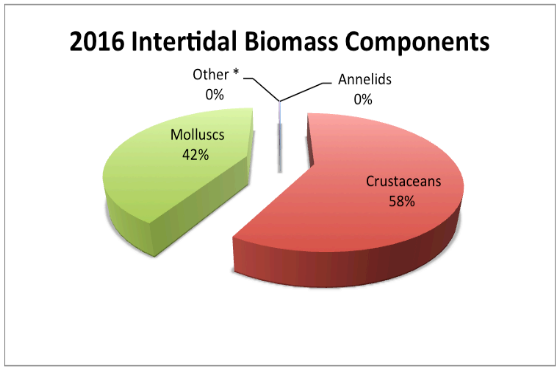

Figure 31 . Combined components for four stations - 2016.

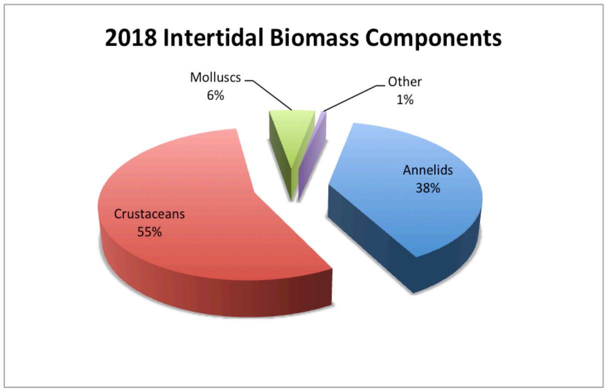

Figure 32. Combined components for four stations - 2018.

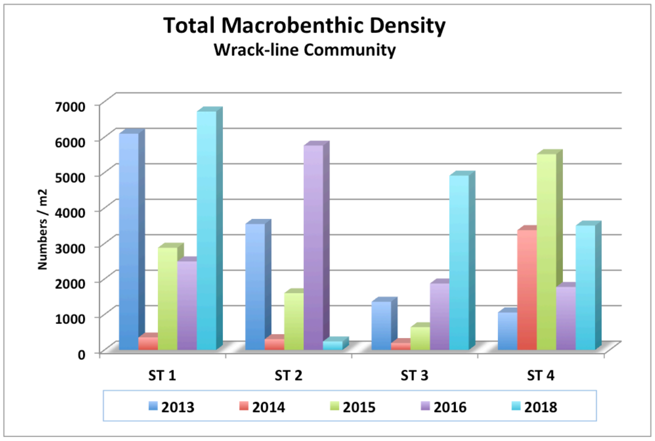

Figure 43. Total wrack-line macroinvertebrate density - 5 years.

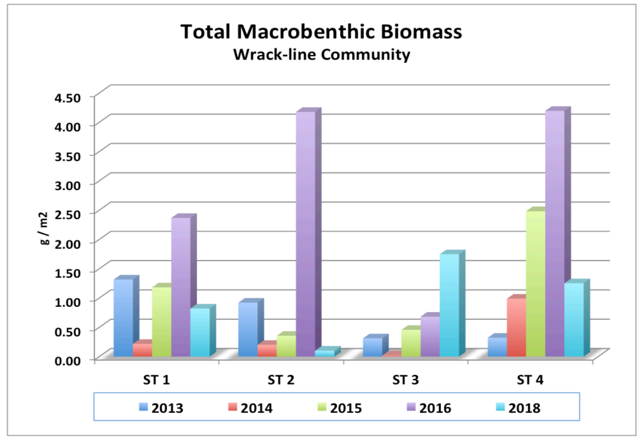

Figure 34. Total wrack-line macroinvertebrate biomass - 5 years.

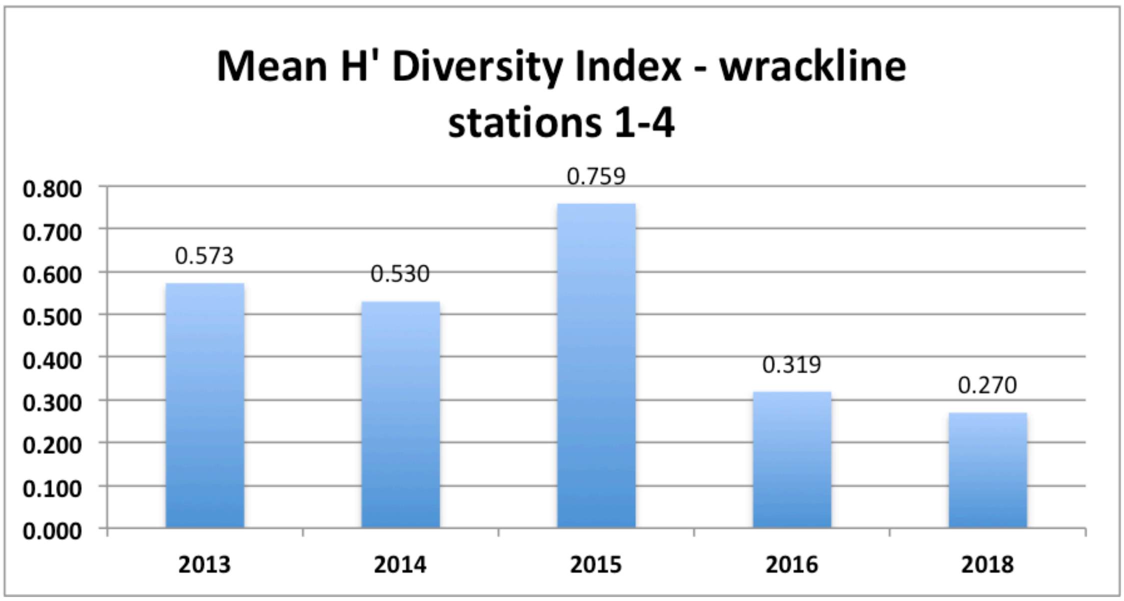

Figure 35 . Wrack-line mean H' diversity - 5 years.

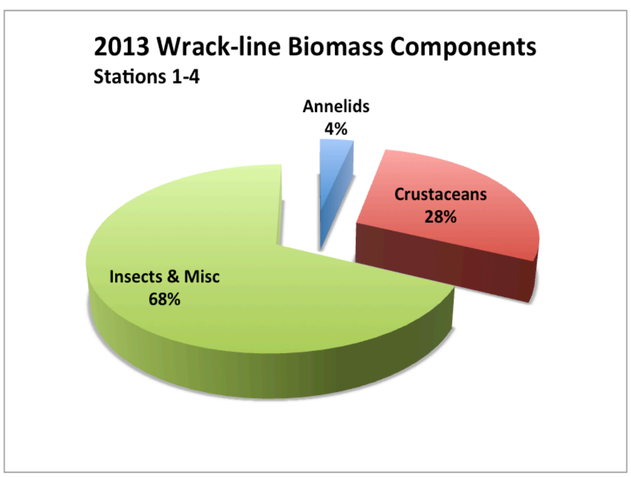

Figure 36. Combined components for four stations - 2013.

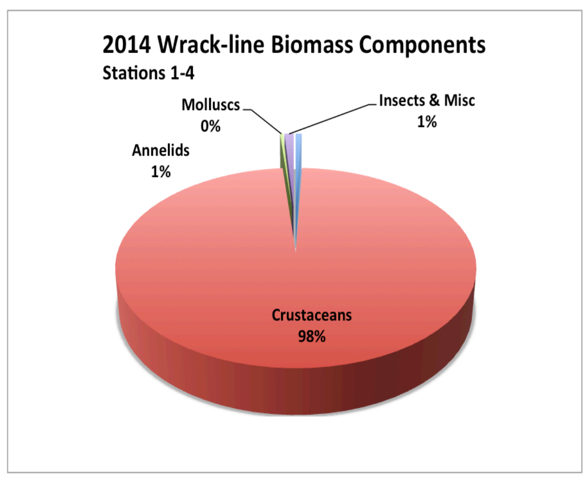

Figure 37. Combined components for four stations - 2014.

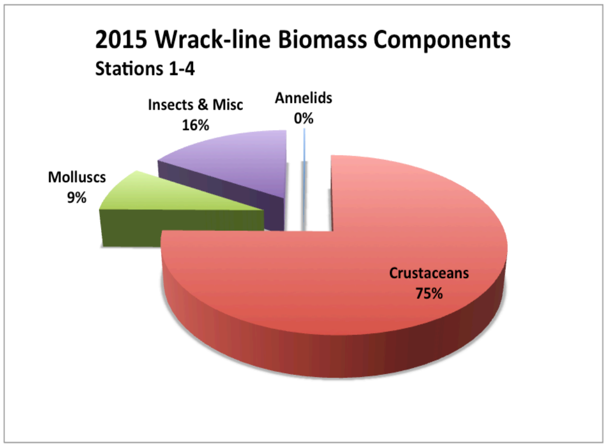

Figure 38. Combined components for four stations - 2015.

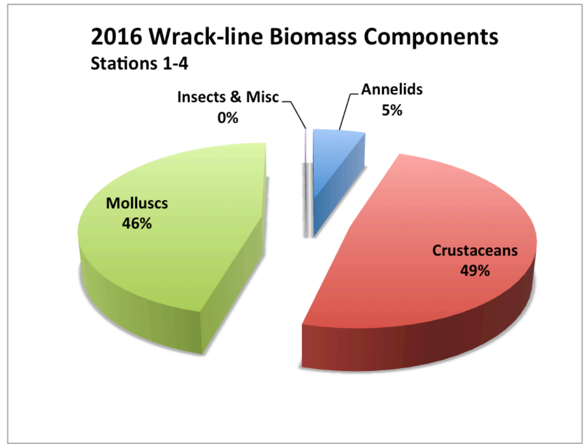

Figure 39. Combined components for four stations - 2016.

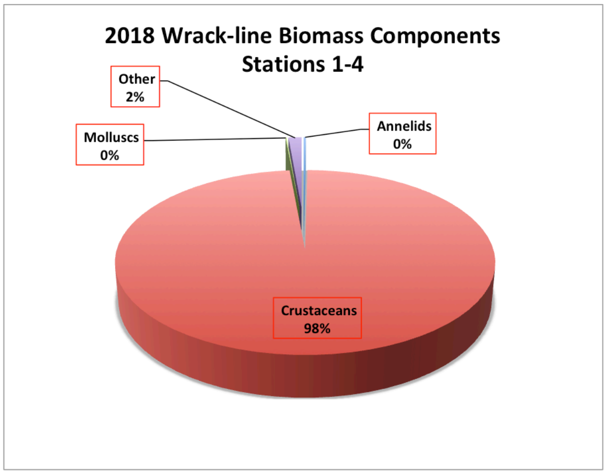

Figure 40. Combined components for four stations - 2018

Beach Stations 1-10: Four-year Comparisons.

Intertidal zone. In comparing mean intertidal values over all ten stations, the macroinvertebrate community in 2018 showed an increase in density and biomass from the 2016 values but with a corresponding decrease in H' diversity to a level similar to 2015 (Figs. 41-43). In 2018, crustaceans were the dominant organisms in terms of density and biomass, owing to large numbers of the haustoriid amphipod, *Lepidactylus triarticulatus* and the mole crab, *Emerita talpoida* that was present at three stations. Mole crabs, though few in number, occurred as large sub-adults, thus impacting the overall biomass. The polychaete annelid, *Scolelepis squamata* was another major component of the intertidal biomass during 2018, comprising 35% of the total biomass, a value that dramatically increased since 2016. *Scolelepis*, like *Lepidactylus*, was present at every station. The molluscan component (8 per cent), primarily the coquina clam, *Donax texasianus*, was much reduced from levels seen in 2016. This clam, present in substantial numbers in 2015 and accounting for the peak in biomass depicted in Figure 42, was present at eight stations in 2018 in smaller numbers and occurred as juveniles or sub-adults, reducing its importance to the total biomass. Comparative intertidal biomass components among surveys are depicted in Figures 44-47.

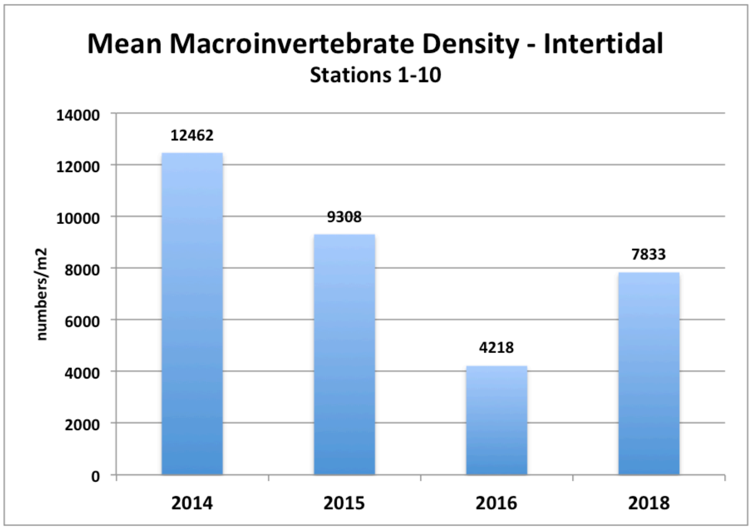

Figure 41. Mean intertidal density over 10 stations - 4 years.

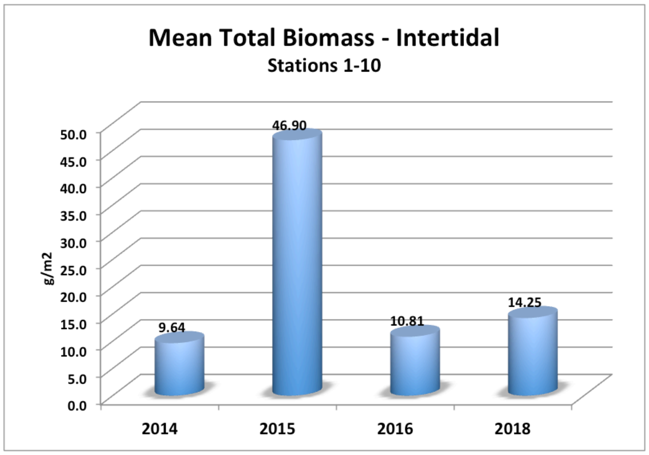

Figure 42. Mean intertidal biomass over 10 stations - 4 years.

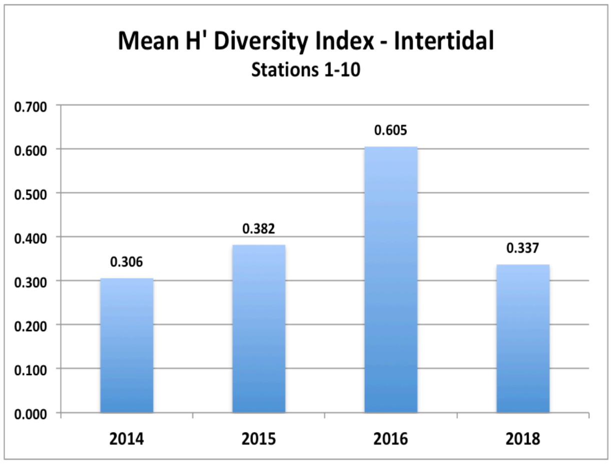

Figure 43. Mean intertidal diversity over 10 stations. 4 years.

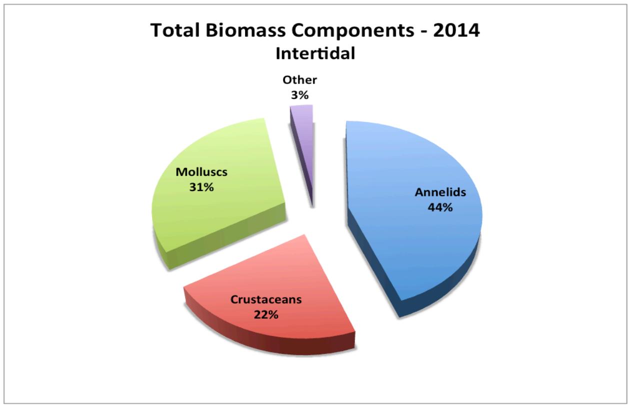

Figure 44. Combined intertidal components for 10 stations - 2014

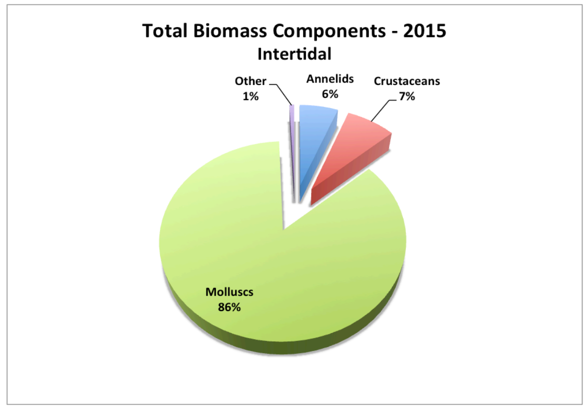

Figure 45 . Combined intertidal components for 10 stations - 2015

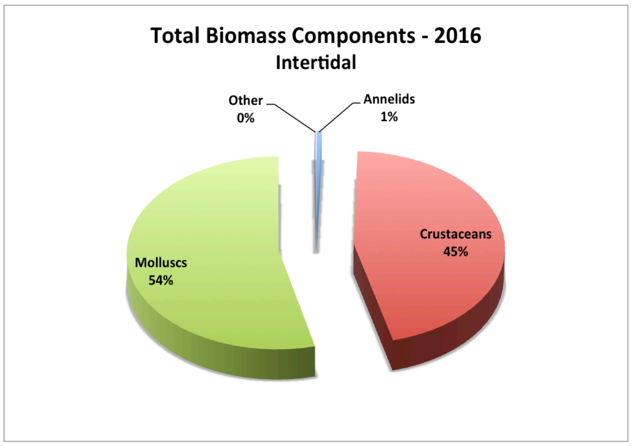

Figure 46. Combined intertidal components for 10 stations - 2016

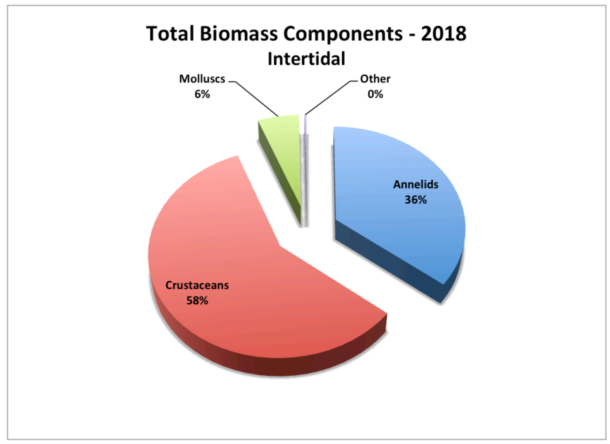

Figure 47. Combined intertidal components for 10 stations - 2018.

Wrack-line community. Since 2016, the 2018 wrack-line macroinvertebrate community, averaged over the 10 beach stations, decreased in mean diversity and biomass but did show a slight increase in total density (Figs. 48-50). The scarcity of washed-up plant debris seen in earlier years of surveys do doubt influenced a decrease in diversity and biomass due to the reduced numbers of insects and attached organisms normally associated with the complex and cryptic structure provided by such debris as *Sargassum* and rotting marsh vegetation. Crustaceans, mostly haustoriid amphipods, embedded in the damp sand beneath the wrack line once again proved substantial in density and biomass and accounted for the largest percentage of the total wrack community biomass in all four years of the study (Figs. 51-54).

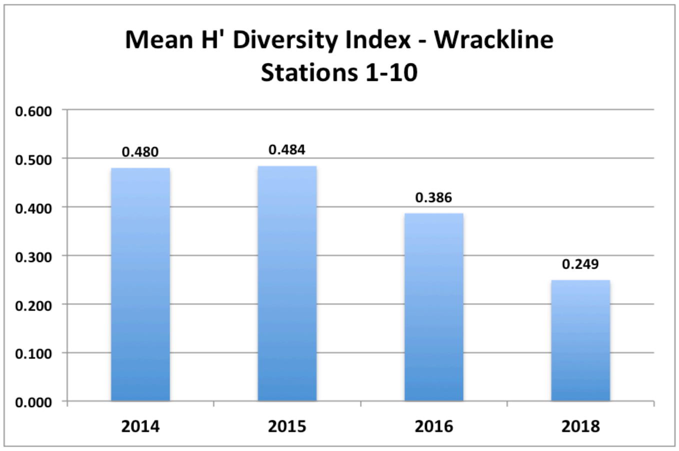

Figure 48. Mean wrackline diversity over 10 stations - 4 years.

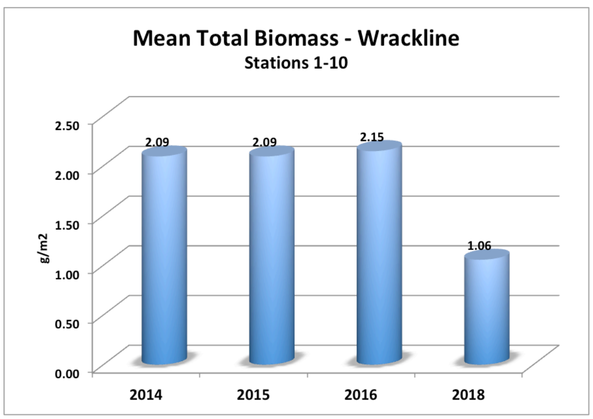

Figure 49. Mean wrackline biomass over 10 stations - 4 years.

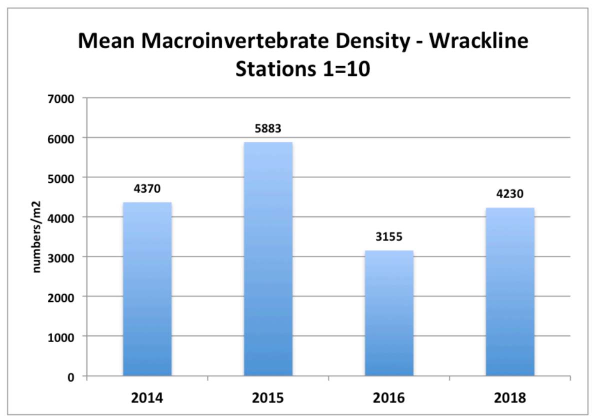

Figure 50. Mean wrackline density over 10 stationa - 4 years.

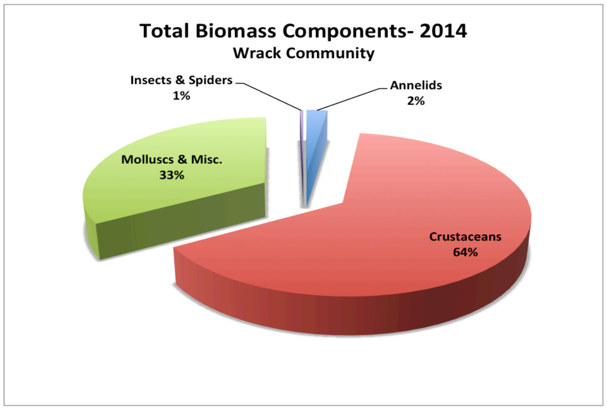

Figure 51. Combined wrackline components over 10 stations - 2014.

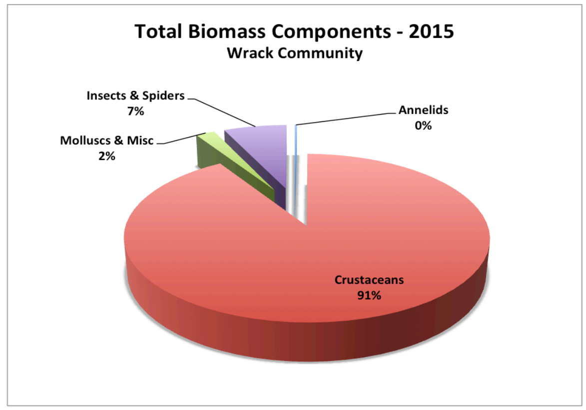

Figure 52. Combined wrackline components over 10 stations - 2015.

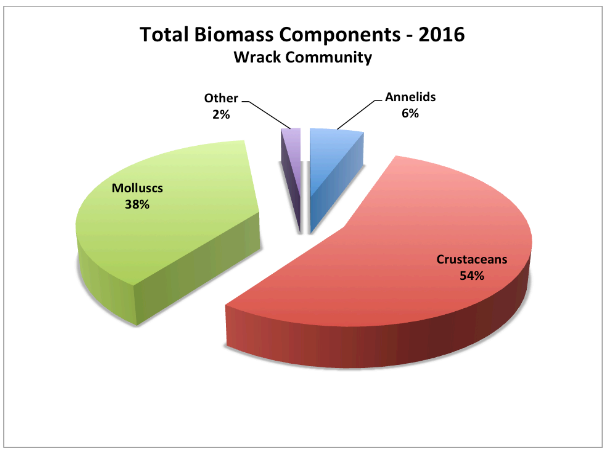

Figure 53. Combined wrackline components over 10 stations - 2016.

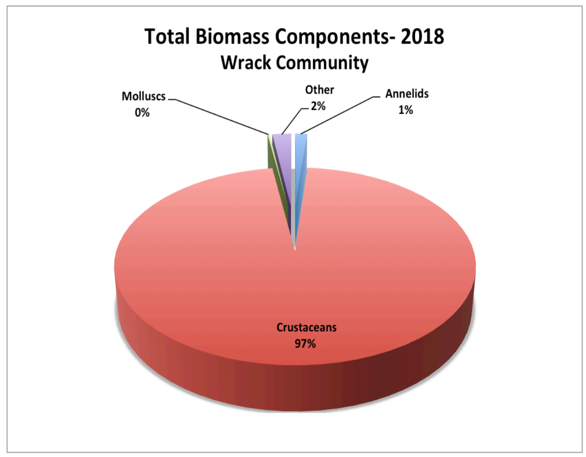

Figure 54. Combined wrackline components over 10 stations - 2018.

Bayside Stations: Four-year comparisons.

Mean values for density, diversity and biomass all showed increases in 2018 from the previous survey in 2016. H' diversity (Fig. 55) was only slightly elevated over 2016 values but density (Fig. 56) and biomass (Fig. 57) showed record increases for all surveys. In comparing the combined bayside biomass components over the four years, annelids once again prevailed with 71% in 2018, returning to the same percentage as in 2015 after decreasing from the 91% level in 2016. Meanwhile, molluscs and insects took on more importance in 2018 with 15% and 14% respectively. The presence of large bodied clams *Tagelus plebius* and *Ensis minor* at BS2 enhanced the mollusc biomass for 2018, while substantial numbers of embedded dipteran larvae and pupae bolstered the insect biomass (Figs. 58-61).

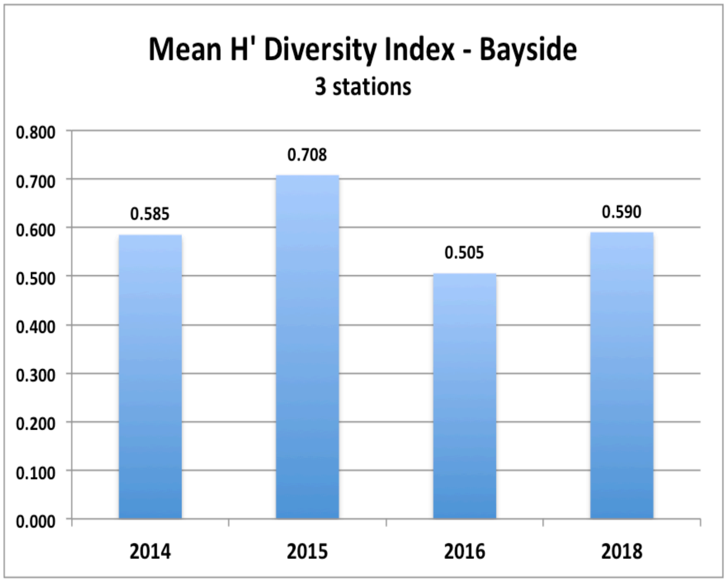

Figure 55. Mean bayside H' diversity over three stations - 4 years.

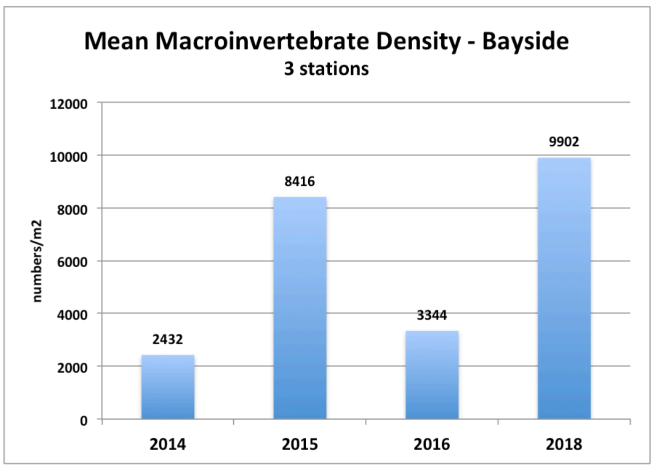

Figure 56. Mean bayside density over three stations - 4 years.

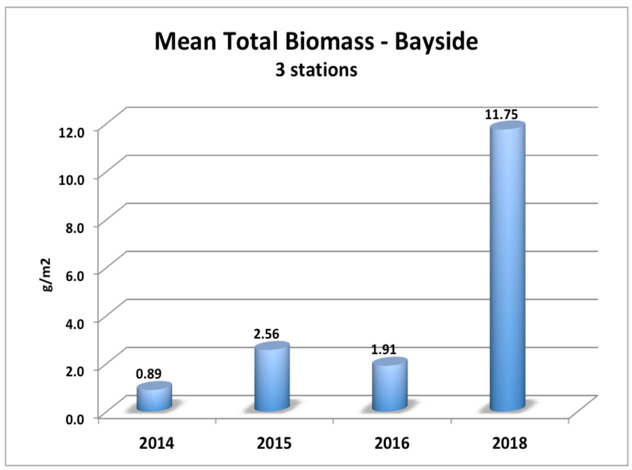

Figure 57. Mean bayside biomass over three stations - 4 years.

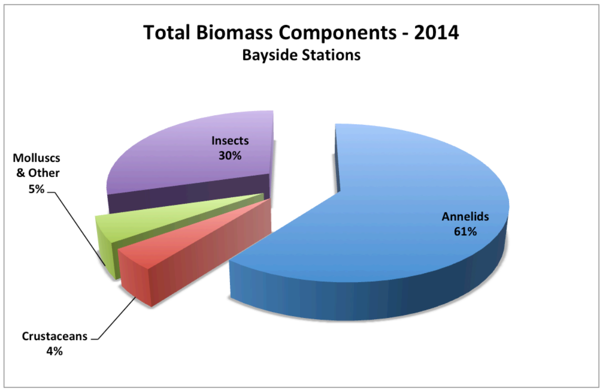

Figure 58. Combined bayside biomass components - 2014.

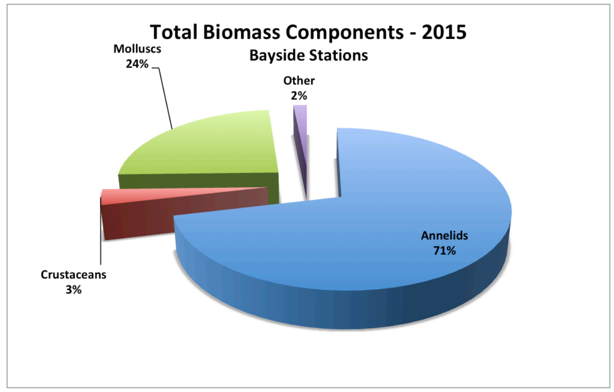

Figure 59. Combined bayside biomass components - 2015.

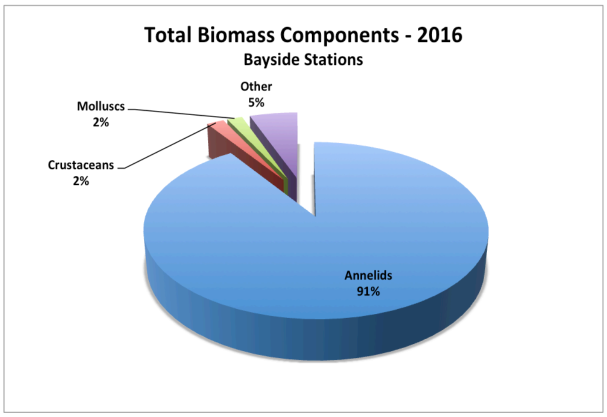

Figure 60. Combined bayside biomass components - 2016.

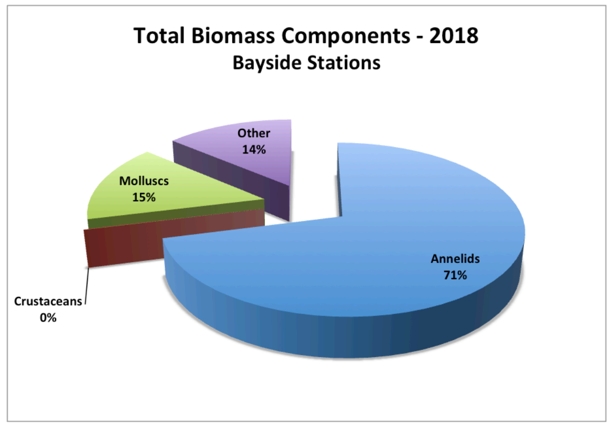

Figure 61. Combined bayside biomass components - 2018.

Summary and Conclusions

The key components in the Macrobenthic community from the previous four spring surveys were again present along the Caminada Headland Beach in 2018. The polychaete, *Scolelepis squamata*, the amphipod, *Lepidactylus triarticulatus* and the bivalve mollusc, *Donax texasianus* accounted for most of the Macrobenthic density and biomass in both, the intertidal zone and wrack community at the ten beach stations. These intertidal species are commonly occurring inhabitants of intertidal and near-shore benthic habitats from the barrier island and mainland beaches from the Florida panhandle area to Texas (Rakocinski et al. 1991, 1993; McLelland and Heard 1991; Mikkelsen and Bieler 2008; Tunnel et al. 2010). The Caminada beach wrack community, because of a smaller amount of deposited debris and its associated fauna in 2018, was notably different from previous years by its decreased mean biomass and diversity. Mean density in the wrack-line community, however showed an increase over that of 2016 because of the large numbers of embedded amphipods found at most stations.

The three bayside stations on the backside of Caminada Headland Beach had typical faunal components seen in the previous two years and the 2018 mean biometrics showed increases in all three categories – density, diversity and biomass. The polychaete biomass, especially at BS2 was again as in 2016, the most notable component of the bayside benthic community, typified by the usual brackish water species, *Streblospio gynobranchiata,* the nereids, *Laenonereis culveri* and *Alitta succinea*, and three species of Capitellidae. Also numerically important was large numbers of insect pupae and Diptera larvae embedded in the benthic algal mats of BS1 and BS3. These mesohaline organisms are common along bays and estuaries of the northern Gulf of Mexico (Heard 1982; LaSalle and Bishop 1987).

The findings of Year 5 of the Caminada Headland Beach benthic survey are summarized thus:

1. 95 nominal taxa from four different phyla were represented from the total of 6,368 organism examined during the survey. The intertidal organism *Scolelepis squamata, Lepidactylus triarticulatus* and *Donax texasianus* accounted for most of the numeric density and biomass (g/m2) at the 10 beach stations while embedded insect larvae and 12 species of polychaetes, led by the capitellids *Heteromastus filiformis* and *Mediomastus ambiseta*, and the spionid, *Streblospio gynobranchiata*, were important food resources at the three calm-water bayside stations.

2. Among the ten Gulf-facing stations, station 10 had the largest number of intertidal individuals collected with over 18,000 organisms/m^2, largely due to high numbers of the spionid polychaete, *Scolelepis squamata*, the haustoriid amphipod, *Lepidactylus triarticulatus,* and the bivalve *Donax texasianus*. Crustaceans and annelids were the numerically dominant intertidal organisms at all beach stations with peaks occurring at stations 10 and 8. The highest density of total organisms in the beach wrack-line community occurred at Station 9 (13,712/m^2) with substantial numbers (6,720/m^2) also at station 1. High numbers of *Lepidactylus*, embedded in the upper few cm of sediment in the wrack line, accounted for the densities of over 1000/ m^2 at all but one of the beach stations but were highest at the aforementioned stations 9 and 1.

3. Intertidal species diversity (H') values, ranging between 0.491 and 0.182, were higher than corresponding wrack-line values at all stations except stations 2,4 and 6, the latter of which registered a value of 0.597. Dominance values (1-J') in the wrack-line zone were higher than corresponding intertidal values at all stations except for stations 2 and 6. Large numbers of embedded amphipods in the wrack community and higher numbers of crustaceans and bivalves in the intertidal core samples undoubtedly influenced these trends.

4. In terms of macrofaunal biomass, there was considerably more g /m^2 of available nutrition in the intertidal zone than in the wrack community. An exceptionally large peak of intertidal biomass at station 7 of nearly 50 g/m2 was influenced by the presence of high numbers of amphipods and a couple of large mole crabs (*Emerita talpoida*). In the wrack community, there were only three stations (3,7 and 9) with total biomass values greater than 1.5 g/m2 and these had relatively high numbers of amphipods embedded in the moist sand beneath the wrack line. In comparing the biomass totals of all stations, crustaceans (58%) and annelids (36%) dominated the intertidal zone, with a scant representation by molluscs and other taxa (about 6%), while crustaceans (97%) provided the overwhelming bulk of biomass in the wrack community.

5. Of the three bayside sites, station BS2 had a higher density (16,474 organisms/m2), species richness (18) and total biomass (30.4 g/m2) than BS1 and BS3.

These values were due largely to the abundance and diversity of polychaetous annelids (13 species) present at BS2 (Figs 22 and 24); annelids were scarce at the other two stations. Stations BS1 and BS3 were similar in the prominent presence of insect larvae, particularly pupae cases, embedded in the algal mat overlying the bottom. In terms of total biomass, polychaete annelids dominated the bayside fauna (72%) again due to large numbers present at station. The most abundant polychaetes recorded were the capitellids, *Mediomastus ambiseta* and *Heteromastus filiformis* with numbers of 7244 and 4872/m^2 respectively at BS2.

6. Data from Gulf-side stations 1-4 collected from 2013 to 2018 were compared. The mean H' value of stations 1-4 in 2018 fell below levels recorded in 2016 and 2015 but was higher than the 2014 value. Conversely, the total density during 2018 was higher than that recorded during 2016 at all four stations but was substantially less than those recorded at stations 1 and 4 during 2015 and stations 1 and 2 during 2013, the first year of surveys. During the five years, the total biomass for 2018 was higher at only station 2 despite the fact that component percentages for 2018 were similar to those of 2013, and 2016 in terms of crustacean biomass. The mollusc biomass, so predominant in 2014-2016 was reduced to 6% in 2018. The annelid biomass component increased in 2018 to near 2013 levels after becoming steadily reduced in the following years of surveys. In 2018 total density in the wrack-line community showed an increase over the 2016 values at stations 1,3 and 4 but a large decrease at station 2. The total density at station 1 (6,720/m2) was the highest value recorded at the four stations during the five years of surveys. Station 3 was the only one among the four stations that showed in increase in biomass over the previous four years of the survey, reflecting a substantial number of amphipods present. Mean H' diversity values over the four stations continued to decline since 2015 reaching a new low of 0.270. The total biomass components in the wrack-line community changed little if any in 2018 compared to previous years with a near total dominance of embedded crustaceans in the damp sand beneath the wrack line. In fact, the biomass component structure was nearly identical to that of 2014 with crustaceans representing 98% of the biomass.

7. Four years of data from 10 Gulf-side and 3 bayside stations were compared. In comparing mean intertidal values over all ten stations, the macroinvertebrate community in 2018 showed an increase in density and biomass from the 2016 values but with a corresponding decrease in H' diversity to a level similar to 2015. In 2018, crustaceans were the dominant organisms in terms of density and biomass, owing to large numbers of the haustoriid amphipod, *Lepidactylus triarticulatus* and the mole crab, *Emerita talpoida* that was present at three stations. Mole crabs, though few in number, occurred as large sub-adults, thus impacting the overall biomass. The polychaete annelid, *Scolelepis squamata* was another major component of the intertidal biomass during 2018, comprising 35% of the total biomass, a value that dramatically increased since 2016. *Scolelepis*, like *Lepidactylus*, was present at every station. The molluscan component (8 percent), primarily the coquina clam, *Donax texasianus*, was much reduced from levels seen in 2016. This clam, present in substantial numbers in 2015, was present at eight stations in 2018 in smaller numbers and occurred as juveniles or subs adults, reducing its importance to the total biomass. Since 2016, the 2018 wracks line macroinvertebrate community, averaged over the 10 beach stations, decreased in mean diversity and biomass but did show a slight increase in total density. The scarcity of washed-up plant debris seen in earlier years of

surveys do doubt influenced a decrease in diversity and biomass due to the reduced numbers of insects and attached organisms normally associated with the complex and cryptic structure provided by such debris as *Sargassum* and rotting marsh vegetation. Crustaceans, mostly haustoriid amphipods, embedded in the damp sand beneath the wrack line once again proved substantial in density and biomass and accounted for the largest percentage of the total wrack community biomass in all four years of the study. Mean values for density, diversity and biomass all showed increases in 2018 from the previous survey in 2016. H' diversity was only slightly elevated over 2016 values but density and biomass showed record increases for all surveys. In comparing the combined bayside biomass components over the four years, annelids once again prevailed with 71% in 2018, returning to the same percentage as in 2015 after decreasing from the 91% level in 2016. Meanwhile, molluscs and insects took on more importance in 2018 with 15% and 14% respectively. The presence of large bodied clams *Tagelus plebius* and *Ensis minor* at BS2 enhanced the mollusc biomass for 2018, while substantial numbers of embedded dipteran larvae and pupae bolstered the insect biomass.

Table 3. Summary of Intertidal Box Core Data – condensed by station.
Values in numbers/ m^2

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
ANNELIDA										
Polychaeta										
Order Spionida										
Family Spionidae										
Scolelepis squamata	897	5513	1603	897	705	769	1538	1474	2115	11090
ARTHROPODA										
Entognatha										
Oder Poduromorpha										
Unid. Collembola		64		64						
Family Hypogastruridae										
Unid. Hypogastruridae							128			
Insecta										
Unid. Insecta									64	
Order Coleoptera										
Family Staphylinidae										
Unid. Staphylinidae		64							64	
Order Diptera										
Unid. Diptera	64				128				64	
Family Cecidomyiidae										
Unid. Cecidomyiidae							64			
Family Chironomidae										
Unid. Chironomidae	64									
Malacostraca										
Order Amphipoda										
Family Corophiidae										
Apocorophium louisianum										513
Unid. Corophiidae			192		64					64
Family Haustoriidae										
Lepidactylus triarticulatus	1538	128	8141	6667	1923	2115	6154	9359	5577	4359
Family Liljeborgiidae										
Idunella barnardi			64	64			64	64		
Family Talitridae										
Platorchestia sp.									64	
Order Decapoda										
Family Hippidae										
Emerita talpoida	64			128			128			

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Family Penaeidae										
Penaeidae zoea		192								
Order Isopoda										
Family Sphaeromatidae										
Ancinus depressus			64				64		128	
Order Mysida										
Family Mysidae										
Chlamydopleon dissimile						64	64			
Maxillopoda										
Order Calanoida										
Unid. Calanoid copepod									64	
MOLLUSCA										
Bivalvia										
Unid. Bivalvia										128
Order Cardiida										
Family Donacidae										
Donax texasianus	64	64			128	64	64	192	128	897
Gastropoda										
Unid. Gastropoda										1026
Order Heterostropha										
Family Pyramidellidae										
Eulimastoma weberi										64
TOTAL NUMBERS	2692	6026	10064	7821	2949	3013	8269	11090	8269	18141
TOTAL TAXA	6	6	5	5	5	4	9	4	9	8
diversity indices										
Hmax'	0.778	0.778	0.699	0.699	0.699	0.602	0.954	0.602	0.954	0.903
H' diversity	0.453	0.182	0.262	0.230	0.424	0.330	0.369	0.222	0.405	0.491
J' evenness (equitability)	0.582	0.233	0.375	0.330	0.607	0.549	0.387	0.369	0.424	0.544
1-J' dominance	0.418	0.767	0.625	0.670	0.393	0.451	0.613	0.631	0.576	0.456

numbers/m2

	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Total Annelids	897	5513	1603	897	705	769	1538	1474	2115	11090
Total Crustaceans	1603	321	8462	6859	1987	2180	6474	9423	5833	4936
Total Molluscs	64	64	0	0	128	64	64	192	128	2115
Total Other *	128	128	0	64	128	0	192	0	192	0

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
					AFD biomass - g					
Total Annelids	0.0102	0.0724	0.0139	0.0079	0.0055	0.0062	0.0124	0.014	0.0208	0.1008
Total Crustaceans	0.0143	0.0012	0.0155	0.1179	0.0042	0.0046	0.2459	0.0146	0.0096	0.0059
Total Molluscs	0.0043	0.0112	0	0	0.0093	0.0155	0.0001	0.0001	0.0001	0.0008
Total Other *	0.0015	0.0001	0	0.0001	0.0001	0	0.0001	0	0.0001	0
					AFD biomass - g/m2					
Total Annelids	1.96	13.92	2.67	1.52	1.06	1.19	2.38	2.69	4.00	19.38
Total Crustaceans	2.75	0.23	2.98	22.67	0.81	0.88	47.29	2.81	1.85	1.13
Total Molluscs	0.83	2.15	0.00	0.00	1.79	2.98	0.02	0.02	0.02	0.15
Total Other *	0.29	0.02	0.00	0.02	0.02	0.00	0.02	0.00	0.02	0.00

* includes insects, spiders, and misc. taxa

Table 4. Summary of Wrack-line Quantitative Data – condensed by station.
Values in numbers/m^2

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
ANNELIDA										
Unid. Annelida										16
Clitellata										
Order Haplotaxida										
Family Enchytraeidae										
Unid. Enchytraeidae								16		
Polychaeta										
Order Spionida										
Family Spionidae										
Scolelepis squamata	16	48			16	16			32	16
ARTHROPODA										
Arachnida										
Order Araneae										
Unid. Araneae	16									
Family Araneidae										
Unid. Araneidae							16			
Family Lycosidae										
Unid. Lycosidae				16						
Chelicerata										
Order Trombidiformes										
Unid. Hydrachnidia							16			
Entognatha										
Order Poduromorpha										
Unid. Collembola	16	16								
Family Hypogastruridae										
Unid. Hypogastruridae				336	64	480	112	32		16
Insecta										
Order Coleoptera										
Unid. Coleoptera				16	16		16			
Family Carabidae										
Bembidion sp.				16						
Family Curculionidae										
Unid. Curculionidae							16			
Family Dytiscidae										
Unid. Dytiscidae	16				16					

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Family Haliplidae										
Unid. Haliplidae							16			
Family Staphylinidae										
Unid. Staphylinidae	32				16		48		16	
Order Diptera										
Unid. Diptera		16					16	32		
Family Chironomidae										
Unid. Chironominae					16					
Family Sciomyzidae										
Unid. Sciomyzidae	16									
Family Stratiomyidae										
Odontomyia sp.	16			32		80	64			
Order Hemiptera										
Unid. Hemiptera				16			16			
Family Cercopidae										
Unid. Cercopidae									16	
Family Cicadellidae										
Unid. Cicadellidae				16						
Family Corixidae										
Unid. Corixidae			16							
Order Hymenoptera										
Family Formicidae										
Solenopsis invicta					16					
Unid. Formicidae									16	
Malacostraca										
Order Amphipoda										
Family Corophiidae										
Apocorophium louisianum						16				
Unid. Corophiidae	16	32	64			16				16
Family Gammaridae										
Gammarus mucronatus						16				
Family Haustoriidae										
Lepidactylus triarticulatus	6528	128	4752	2832	4976	768	3168	1008	13632	1568
Family Liljeborgiidae										
Idunella barnardi				16						
Family Oedicerotidae										
Ameroculodes miltoni					16					
Family Talitridae										
Platorchestia sp.	16		64	96	48	16		16		32

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Order Isopoda										
Family Munnidae										
Uromunna reynoldsi							16			
Maxillopoda										
Order Calanoida										
Unid. Calanoid copepod	32		16	80		160	48			48
Order Lepadiformes										
Family Lepadidae										
Lepas pectinata				16						
Order Sessilia										
Family Balanidae										
Amphibalanus sp.						16				
MOLLUSCA										
Bivalvia										
Unid. Bivalvia										16
Order Veneroida										
Family Mactridae										
Mulinia lateralis										32
Gastropoda										
Family Litiopidae										
Litiopa melanostoma				16						
TOTAL NUMBERS	6720	240	4912	3504	5200	1584	3568	1104	13712	1760
TOTAL TAXA	11	5	5	13	10	10	13	5	5	9
diversity indices										
Hmax'	1.041	0.699	0.699	1.114	1.000	1.000	1.114	0.699	0.699	0.954
H' diversity	0.084	0.559	0.079	0.357	0.115	0.597	0.259	0.179	0.019	0.243
J' evenness (equitability)	0.081	0.800	0.113	0.320	0.115	0.597	0.232	0.255	0.027	0.255
1-J' dominance	0.919	0.200	0.887	0.680	0.885	0.403	0.768	0.745	0.973	0.745

					numbers/m2					
Total Annelids	16	48	0	0	16	16	0	16	32	32
Total Crustaceans	6592	160	4896	3040	5040	1008	3232	1024	13632	1664
Total Molluscs	0	0	0	16	0	0	0	0	0	48
Total Other *	112	32	16	448	144	560	336	64	48	16

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
	AFD biomass - g									
Total Annelids	0.0001	0.0001	0	0	0.0001	0.0001	0	0	0.0017	0.0008
Total Crustaceans	0.0166	0.0019	0.0362	0.0256	0.0178	0.01	0.0318	0.0128	0.0393	0.0199
Total Molluscs	0	0	0	0.0001	0	0	0	0	0	0.0004
Total Other *	0.0004	0.0001	0.0002	0.0004	0.0001	0.0002	0.0029	0.0001	0.0001	0.0001
	AFD biomass - g/m2									
Total Annelids	0.005	0.005	0.000	0.000	0.005	0.005	0.000	0.000	0.082	0.038
Total Crustaceans	0.797	0.091	1.738	1.229	0.854	0.480	1.526	0.614	1.886	0.955
Total Molluscs	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.019
Total Other *	0.019	0.005	0.010	0.019	0.005	0.010	0.139	0.005	0.005	0.005

* includes insects, spiders, and misc. taxa

Table 5. Summary of Bayside Quantitative Data – condensed by station.
Values in numbers/m^2

TAXA	BS1	BS2	BS3
ANNELIDA			
Polychaeta			
Family Arenicolidae			
Arenicola cristata		449	
Family Capitellidae			
Capitella capitata complex		769	16
Heteromastus filiformis		4872	
Mediomastus ambiseta	16	7244	16
Family Orbiniidae			
Leitoscoloplos sp.		64	
Order Phyllodocida			
Family Nereididae			
Alitta succinea		577	
Laeonereis culveri		192	
Family Phyllodocidae			
Eteone heteropoda		321	
Order Sabellida			
Family Sabellidae			
Dialychone perkinsi		128	
Order Spionida			
Family Spionidae			
Streblospio gynobranchiata		1090	
Order Terebellida			
Family Ampharetidae			
Hobsonia florida		64	
Melinna maculata		64	
Family Cirratulidae			
Aphelochaeta sp.		128	
ARTHROPODA			
Arachnida			
Order Araneae			
Unid. Araneae	16		48
Chelicerata			
Order Trombidiformes			
Unid. Hydrachnidia			224

TAXA	BS1	BS2	BS3
Entognatha			
Order Poduromorpha			
Family Hypogastruridae			
Unid. Hypogastruridae			144
Unid. Collembola			32
Insecta			
Unid. Insect pupa	3568		1040
Order Coleoptera			
Unid. Coleoptera			16
Family Staphylinidae			
Unid. Staphylinidae	48		1824
Order Diptera			
Unid. Diptera larva	4832		1120
Family Cecidomyiidae			
Unid. Cecidomyiidae	16		
Family Chironomidae			
Unid. Chironomidae			16
Family Dolichopidae			
Unid. Dolichopidae	96		
Order Hemiptera			
Unid. Hemiptera	16		
Order Hymenoptera			
Family Formicidae			
Unid. Formicidae			16
Order Trichoptera			
Unid. Trichoptera			96
Malacostraca			
Order Decapoda			
Caridea zoea		64	
Maxillopoda			
Order Cyclopoida			
Unid. Cyclopoid copepod		192	
MOLLUSCA			
Bivalvia			
Unid. Bivalvia		64	
Order Veneroida			
Family Solecurtidae			
Tagelus plebeius		128	

TAXA	BS1	BS2	BS3
Family Solenidae			
Ensis minor		64	
Gastropoda			
Order Littorinimorpha			
Family Hydrobiidae			
Unid. Hydrobiidae			16
TOTAL NUMBERS	8608	16474	4624
TOTAL TAXA	8	18	14
diversity indices			
Hmax'	0.903	1.255	1.146
H' diversity	0.354	0.731	0.686
J' evenness (equitability)	0.392	0.582	0.599
1-J' dominance	0.608	0.418	0.401
	numbers/m2		
Total Annelids	16	13398	32
Total Crustaceans	0	256	0
Total Molluscs	0	256	16
Total Other *	8592	0	4576
	AFD biomass - g		
Total Annelids	0.0001	0.1301	0.0001
Total Crustaceans	0	0.0001	0
Total Molluscs	0	0.0278	0.0001
Total Other *	0.0725	0	0.0284
	AFD biomass - g/m2		
Total Annelids	0.005	25.019	0.005
Total Crustaceans	0.000	0.019	0.000
Total Molluscs	0.000	5.346	0.005
Total Other *	3.480	0.000	1.363

* includes insects, spiders, and misc. taxa

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Appendices.

Appendix I. Qualitative beach wrack-line data (QMH). Numbers represent specimens observed in samples.

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
ANNELIDA										
Clitellata										
Order Haplotaxida										
Family Enchytraeidae										
Unid. Enchytraeidae		3			4			1		
Family Naididae										
Unid. Naididae		1								
Polychaeta										
Order Phyllodocida										
Family Nereididae										
Unid. Nereididae				1	1					7
Order Sabellida										
Family Sabellidae										
Unid. Sabellidae					7					
Order Spionida										
Family Spionidae										
Dipolydora socialis					3					
Scolelepis squamata		1				1				
Polydora cornuta					1					
ARTHROPODA										
Arachnida										
Order Araneae										
Family Linyphiidae										
Unid. Linyphiidae	1			1	3					
Unid. Erigoninae	1									
Family Lycosidae										
Unid. Lycosidae	1									
Chelicerata										
Order Trombidiformes										
Unid. Hydrachnidia	1		1		1		1	1		
Entognatha										
Order Poduromorpha										
Family Hypogastruridae										
Unid. Hypogastruridae			2	22	1	20	14			

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Insecta										
Unid. Insecta				1						
Order Coleoptera										
Unid. Coleoptera	5									
Family Carabidae										
Bembidion sp.				1						
Family Coccinellidae										
Naemia seriata	3			1			1			
Family Curculionidae										
Unid. Curculionidae	1			1						
Family Dytiscidae										
Unid. Dytiscidae	4			2		1				
Family Staphylinidae										
Unid. Staphylinidae	3		1	7		4	2		2	
Order Diptera										
Unid. Diptera	2		1	2	1	4		3		1
Unid. Diptera larva							1			
Family Chironomidae										
Unid. Chironominae	3		1	5	5	2	4	2		
Family Phoridae										
Unid. Phoridae										1
Family Sciaridae										
Unid. Sciaridae		1		1						
Family Sciomyzidae										
Unid. Sciomyzidae			1							
Family Stratiomyidae										
Odontomyia sp.	3	1	2	8	3	13	1			
Order Hemiptera										
Unid. Hemiptera							2			
Family Aphididae										
Unid. Aphididae							2		2	
Family Cercopidae										
Unid. Cercopidae	3									
Family Cicadellidae										
Unid. Cicadellidae				1						
Family Corixidae										
Unid. Corixidae				2			1			
Family Miridae										
Unid. Miridae	1									

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Malacostraca										
Order Amphipoda										
Family Aoridae										
Grandidierella bonnieroides						2				
Family Ampithoidae										
Ampithoe valida	1									
Family Corophiidae										
Unid. Corophiidae	2			9			2			
Apocorophium louisianum		126			333	4				21
Family Gammaridae										
Gammarus mucronatus	3	1		7	2	1	1			
Family Haustoriidae										
Lepidactylus triarticulatus	105	3	58	48	28	10	43	10	57	6
Family Isaeidae										
Microprotopus raneyi							4	3	1	
Family Liljeborgiidae										
Idunella barnardi			3	6	1	1				
Family Maeridae										
Elasmopus pectenicrus						1				
Family Melitidae										
Melita sp.					1					
Family Photidae										
Gammaropsis togoensis		1								
Family Talitridae										
Platorchestia sp.	9	12	43	57	33	18	13	4		8
Order Decapoda										
Brachyura megalops				1						
Family Penaeidae										
Penaeidae zoea	1									
Family Portunidae										
Portunidae megalops				1						
Order Isopoda										
Family Sphaeromatidae										
Cassidinidea ovalis					3					
Order Tanaidacea										
Family Paratanaidae										
Hargeria rapax					3					
Maxillopoda										
Order Calanoida										
Unid. Calanoid copepod	4		2	5	7	8	9	3	1	

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
MOLLUSCA										
Bivalvia										
Order Arcoida										
Family Arcidae										
Anadara transversa										2
Order Cardiida										
Family Donacidae										
Donax texasianus		1								
Order Veneroida										
Family Mactridae										
Mulinia lateralis									1	5
Family Veneridae										
Petricolaria pholadiformis									3	26
MISC TAXA										
Platyhelminthes										
Unid. Platyhelminthes					1					

Appendix II. Phylogenetic listing of taxa.

Phylum	Class	Subclass	Order	Suborder	Family	Taxon	Authority
Annelida	Clitellata	Oligochaeta	Haplotaxida	Tubificina	Enchytraeidae	Unid. Enchytraeidae	
					Naididae	Unid. Naididae	
	Polychaeta	Errantia	Phyllodocida	Nereidiformia	Nereididae	Alitta succinea	(Leukart, 1847)
						Laeonereis culveri	(Webster, 1880)
						Unid. Nereididae	
				Phyllodociformia	Phyllodocidae	Eteone heteropoda	Hartman, 1951
		Sedentaria	Sabellida		Sabellidae	Dialychone perkinsi	(Tovar-Hernandez, 2005)
						Unid. Sabellidae	
			Spionida	Spioniformia	Spionidae	Dipolydora socialis	(Schmarda, 1861)
						Polydora cornuta	Bosc, 1802
						Scolelepis squamata	(Muller, 1806)
						Streblospio gynobranchiata	Rice & Levin, 1998
			Terebellida	Cirratuliformia	Cirratulidae	Aphelochaeta sp.	
				Terebellomorpha	Ampharetidae	Hobsonia florida	Hartman, 1951
						Melinna maculata	Webster, 1879
				Scolecida	Arenicolidae	Arenicola cristata	Stimpson, 1856
					Capitellidae	Capitella capitata complex	(Fabricius, 1780)
						Heteromastus filiformis	(Claparede, 1864)
						Mediomastus ambiseta	(Hartman, 1947)
					Orbiniidae	Leitoscoloplos sp.	
						Unid. Annelida	
Arthropoda	Arachnida		Araneae		Araneidae	Unid. Araneidae	
					Linyphiidae	Unid. Erigoninae	
						Unid. Linyphiidae	
					Lycosidae	Unid. Lycosidae	
						Unid. Araneae	
	Chelicerata	Acari	Trombidiformes			Unid. Hydrachnidia	
	Entognatha	Collembola	Poduromorpha		Hypogastruridae	Unid. Hypogastruridae	
						Unid. Collembola	
	Insecta					Unid. Insect pupa	
						Unid. Insecta	
		Pterygota	Coleoptera	Adephaga	Carabidae	Bembidion sp.	
					Haliplidae	Unid. Haliplidae	
				Polyphaga	Coccinellidae	Naemia seriata	(Melsheimer, 1847)
					Curculionidae	Unid. Curculionidae	
					Staphylinidae	Unid. Staphylinidae	
					Dytiscidae	Unid. Dytiscidae	
						Unid. Coleoptera	
			Diptera	Brachycera	Sciomyzidae	Unid. Sciomyzidae	

Phylum	Class	Subclass	Order	Suborder	Family	Taxon	Authority
					Stratiomyidae	Odontomyia sp.	
				Nematocera	Cecidomyiidae	Unid. Cecidomyiidae	
					Chironomidae	Unid. Chironomidae	
						Unid. Chironominae	
					Dolichopidae	Unid. Dolichopidae	
					Phoridae	Unid. Phoridae	
					Sciaridae	Unid. Sciaridae	
						Unid. Diptera	
						Unid. Diptera larva	
			Hemiptera	Auchenorrhyncha	Cercopidae	Unid. Cercopidae	
				Heteroptera	Corixidae	Unid. Corixidae	
					Miridae	Unid. Miridae	
				Sternorrhyncha	Aphididae	Unid. Aphididae	
					Cicadellidae	Unid. Cicadellidae	
						Unid. Hemiptera	
			Hymenoptera		Formicidae	Solenopsis invicta	Buren, 1972
						Unid. Formicidae	
			Trichoptera			Unid. Trichoptera	
	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Ampithoidae	Ampithoe valida	Smith, 1873
					Aoridae	Grandidierella bonnieroides	Stephensen, 1948
					Corophiidae	Apocorophium louisianum	Shoemaker, 1934
						Unid. Corophiidae	
					Gammaridae	Gammarus mucronatus	Say, 1818
					Haustoriidae	Lepidactylus triarticulatus	Robertson & Shelton, 1980
					Isaeidae	Microprotopus raneyi	Wigley, 1966
					Liljeborgiidae	Idunella barnardi	(Wigley, 1966)
					Melitidae	Melita sp.	
					Oedicerotidae	Ameroculodes miltoni	Foster & Heard, 2002
					Talitridae	Platorchestia sp.	
				Senticaudata	Maeridae	Elasmopus pectenicrus	(Spence Bate, 1862)
					Photidae	Gammaropsis togoensis	(Schellenberg, 1925)
			Decapoda	Dendrobranchiata	Penaeidae	Penaeidae zoea	
				Pleocyemata	Hippidae	Emerita talpoida	(Say, 1817)
					Portunidae	Portunidae megalops	
						Caridea zoea	
						Brachyura megalops	
			Isopoda	Asellota	Munnidae	Uromunna reynoldsi	Frankenberg & Menzies, 1966
				Sphaeromatidea	Sphaeromatidae	Ancinus depressus	(Say, 1818)
						Cassidinidea ovalis	(Say, 1818)
			Mysida		Mysidae	Chlamydopleon dissimile	(Coifmann, 1937)

Phylum	Class	Subclass	Order	Suborder	Family	Taxon	Authority
			Tanaidacea	Tanaidomorpha	Paratanaidae	Hargeria rapax	(Harger, 1879)
	Maxillopoda	Copepoda	Calanoida			Unid. Calanoid copepod	
			Cyclopoida			Unid. Cyclopoid copepod	
		Thecostraca	Lepadiformes	Lepadomorpha	Lepadidae	Lepas pectinata	Spengler, 1793
			Sessilia	Balanomorpha	Balanidae	Amphibalanus sp.	
Mollusca	Bivalvia	Heterodonta	Cardiida		Donacidae	Donax texasianus	Philippi, 1847
			Veneroida		Mactridae	Mulinia lateralis	(Say, 1822)
					Solecurtidae	Tagelus plebeius	(Lightfoot, 1786)
					Solenidae	Ensis minor	Dall, 1900
					Veneridae	Petricolaria pholadiformis	(Lamarck, 1818)
		Pteriomorphia	Arcoida		Arcidae	Anadara transversa	(Say, 1822)
						Unid. Bivalvia	
	Gastropoda	Caenogastropoda	Littorinimorpha		Hydrobiidae	Unid. Hydrobiidae	
					Litiopidae	Litiopa melanostoma	Rang, 1829
			Heterostropha		Pyramidellidae	Eulimastoma weberi	(Morrison, 1965)
						Unid. Gastropoda	
Platyhelminthes						Unid. Platyhelminthes	