CAMINADA HEADLAND BEACH BENTHIC ORGANISM SURVEY: YEAR 6

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 - 6.

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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 five 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.

Surveys in years 5 (McLelland 2018) and 6 (the current study) were conducted in April 2-3 and April 1-2 respectively. These efforts were a repeat of surveys from previous years using the same methodology at the same stations, 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 6 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, and 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. The wrack-line macroinvertebrate community was investigated using a square quadrant, 0.25 m on a side, to take three replicate (0.25 m^2) samples at each beach station (Fig. 3). Collections were made along a 10-meter section of beach immediately adjacent to the highest upper wave swash following NAWQA protocols (Moulton et al., 2002) for the collection of richest-targeted habitats (RTH). The RTH samples were field processed in the same manner as the box core samples.

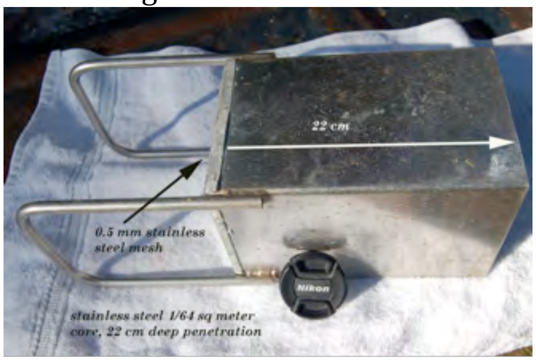

Figure 2. Box Core used in intertidal sampling. Photo by J.M. Foster.

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. 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 being washed by agitation in a sampling bucket. Organisms resulting from this action were placed in a jar, labeled and preserved.


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

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, 2019

	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10
Date sampled	4/1/19	4/1/19	4/1/19	4/1/19	4/1/19	4/1/19	4/1/19	4/2/19	4/2/19	4/2/19
Time on Site	0905 - 1010	1110 - 1200	1305 - 1350	1540 - 1730	1205 - 1255	1400 - 1440	1640 - 1725	1130 - 1225	1030 - 1125	0900 - 1010
Latitude	N 29.09071	N 29.11027	N 29.12441	N 29.13878	N 29.11753	N 29.13152	N 29.15329	N 29.16816	N 29.18126	N 29.18720
Longitude	W -90.21363	W -90.17777	W -90.15524	W -90.13164	W -90.16651	W -90.14355	W -90.10933	W -90.08594	W -90.06307	W -90.05094
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	4.0m	0.5m	4.0m	1.5m	2.0m	2.5m	4.0m	2.0m	2.0m	1.0M
Wrack to water	10m	4.0m	5.0m	5.0m	5.0m	5.0m	5.0m	1.0m	1.5m	1.0M
Sample types:										
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
Physical data:										
salinity ppt	17	17	16	12	16	16	11	15	14	11
air temp °C	15	15.5	15.3	15.1	16.8	16.5	15.8	15	14.5	13.6
water temp °C	15.4	17.4	17.7	19	17.7	18.5	18.4	17.8	16.7	14.9
wind speed mph	15	15	15	15-20	15	10	15	10	10	15
wind direction	NE	NE	NE	NE	NE	NE	NE	NE	N	N
% cloud cover	15	80	20	10	30	20	30	30	20	5
sea state ft	2-3	2-3	2-3	2	2-3	2	2	1-2	1-2	1-2

Table 2. Caminada Headland Beach Bayside Benthic Field Data – for April 2019

	BS 1	BS 2	BS 3
Date sampled	4/2/19	4/2/19	4/1/19
Time on Site	1240 - 1310	1330 - 1345	1035 – 1100
Latitude	N 29.17066	N 29.18461	N 29.11888
Longitude	W -90.08723	W -90.06370	W -90.16814
Station ID no.		ID 493	ID 711
Intertidal length	-	-	-
Wrack to water	-	-	-
Sample types:			
box cores	-	3	-
wrack semi-quant	3	-	3
wrack qualitative	-	-	-
Physical data:			
salinity ppt	11	12	18
air temp °C	15.4	16.3	16
water temp °C	21.1	19.2	17.6
wind speed mph	5	5	15
wind direction	N	N	NE
% cloud cover	20	10	60
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 (annelids, crustaceans, molluscs, insects), 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 RTH samples. 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 facilitate the evaporation of fluid trapped in the shells.

Figure 5. Typical Gulf-side beach face.

Results.

<u>General field observations</u>. 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 most stations but at some of those at the eastern end, there was a considerable amount of fine 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 6 sampling period, a total of 21,313 organisms were examined from Caminada Headland Beach samples (21,178 from the 10 Gulf-side stations and 1,135 from the three bayside stations) representing 75 nominal taxa from five 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 1 had the largest number of intertidal individuals collected with over 120,000 organisms/m^2, largely due to high numbers of the haustoriid amphipod, *Lepidactylus triarticulatus* (Figs. 8 and 10). *Lepidactylus* was the numerically dominant intertidal organism at all beach stations with numbers of over 12,000/m^2 occurring at all stations except 10 (11,731/m^2). The highest density of total organisms in the beach wrack-line community occurred at Station 10 (65,936/m^2) with substantial numbers (33,200/m^2) also at station 9 (Fig. 9). High numbers of *Lepidactylus*, embedded in the upper few cm of sediment in the wrack line, accounted for the densities of over 10,000/m^2 at the four eastern-most beach stations (Fig. 11).

Species diversity (H') values were low at all stations due to exceptionally high values of dominance (1-J') influenced by large numbers of embedded amphipods in nearly every sample. Intertidal species diversity values ranged between 0.016 and 0.181, but were slightly higher at the eastern-most stations. Diversity values were likewise low in the wrack community due to even higher numbers of amphipods; most H' values ranged between .006 and 0.101 except for station 2 which had a peak of 0.291. Not surprisingly, stations with the lowest number of taxa had the highest dominance values (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). Exceptionally large peaks of intertidal biomass of nearly 45 g/m2 (Figs. 14 and 16) occurred at stations 1 and 8, influenced by higher numbers of amphipods at station 1 and coquina clams (*Donax texasianus*) at station 8. In the wrack community, there appeared to be a steady eastward increase in biomass with peaks of 13.9 and 14.1 being reached at stations 8 and 10 respectively (Fig. 15). As with diversity, the largest influence on these density and biomass values are the 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 (72%) and molluscs (23%) dominated the intertidal zone, with a scant representation by annelids and other taxa (about 5%), while crustaceans (97%) provided the overwhelming bulk of biomass in the wrack community.

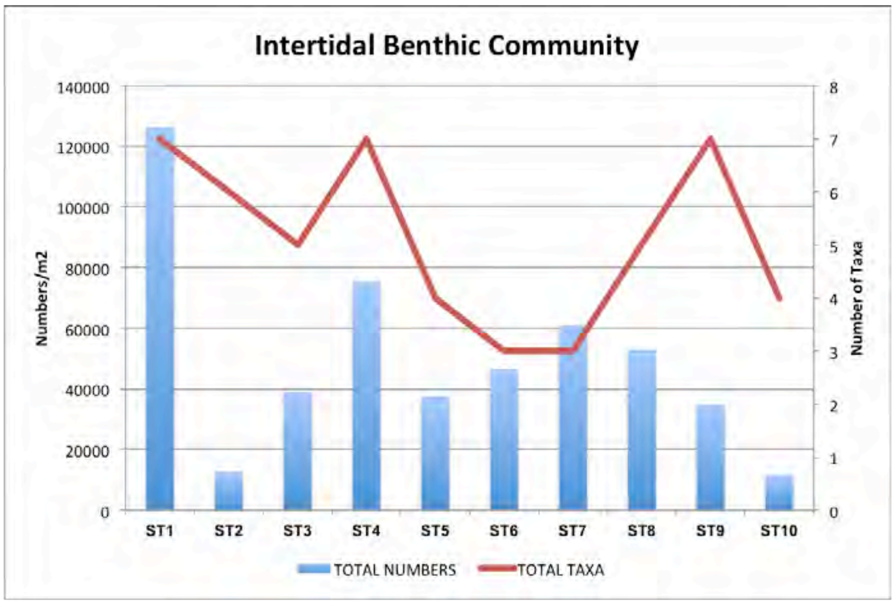

Figure 8. Intertidal total density vs. richness.

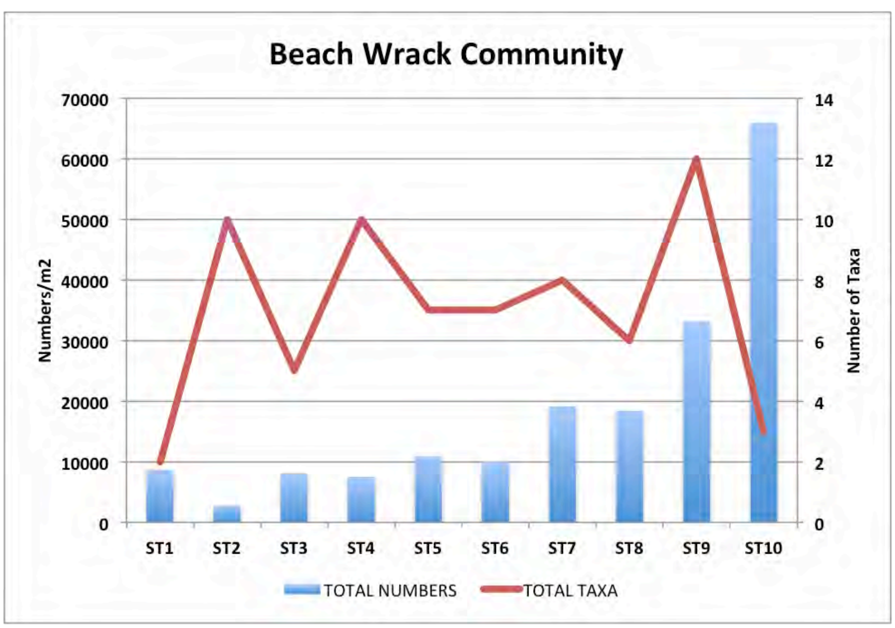

Figure 9. Wrack-line total density vs. richness.

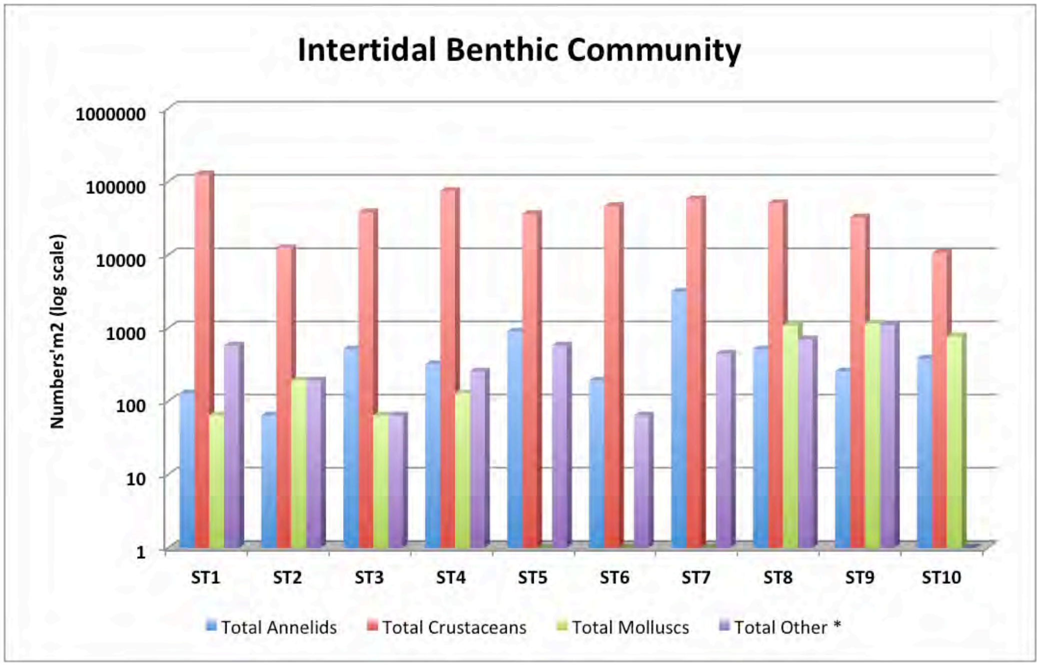

Figure 10. Gulf-side intertidal macrobenthic components.

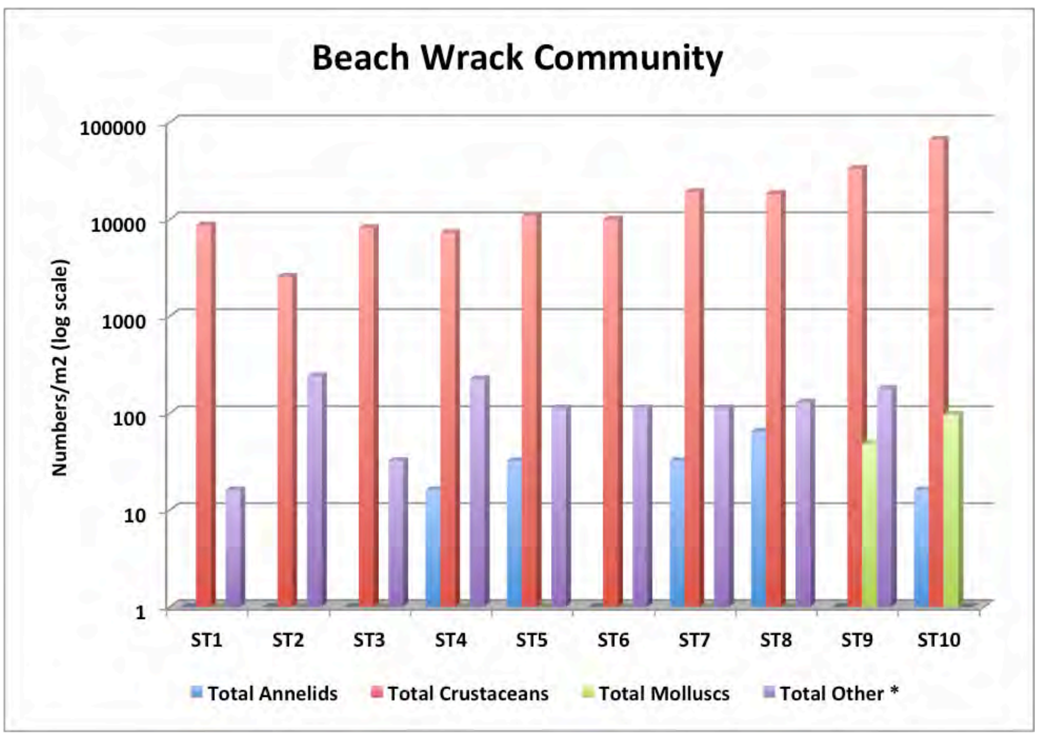

Figure 11. Gulf-side wrack community macrobenthic components.

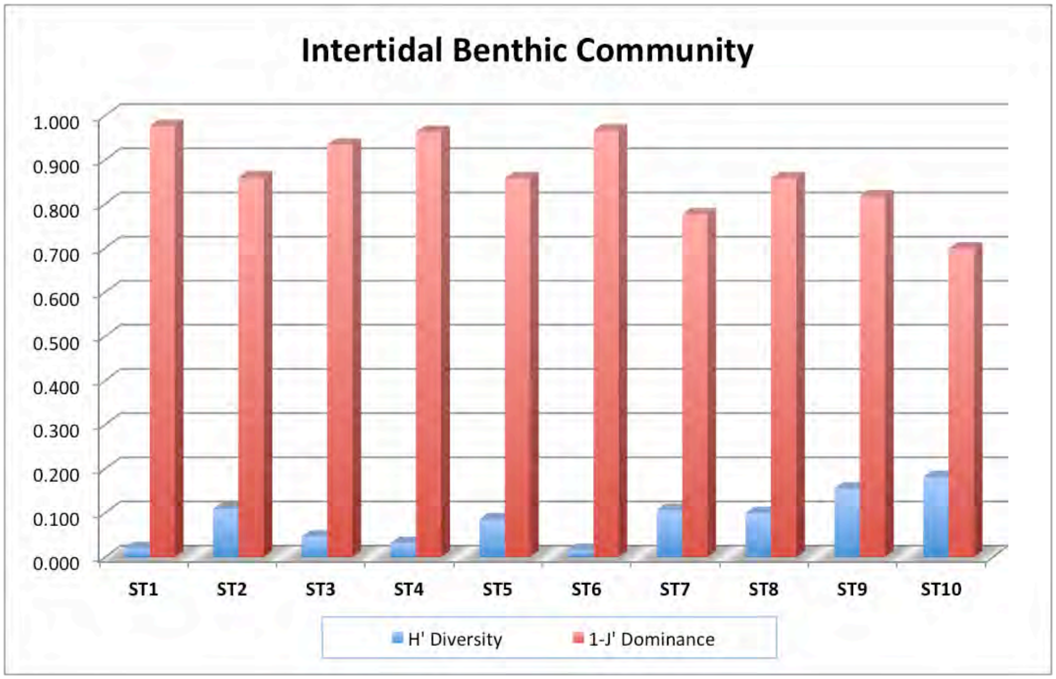

Figure 12. Gulf-side intertidal diversity indices.

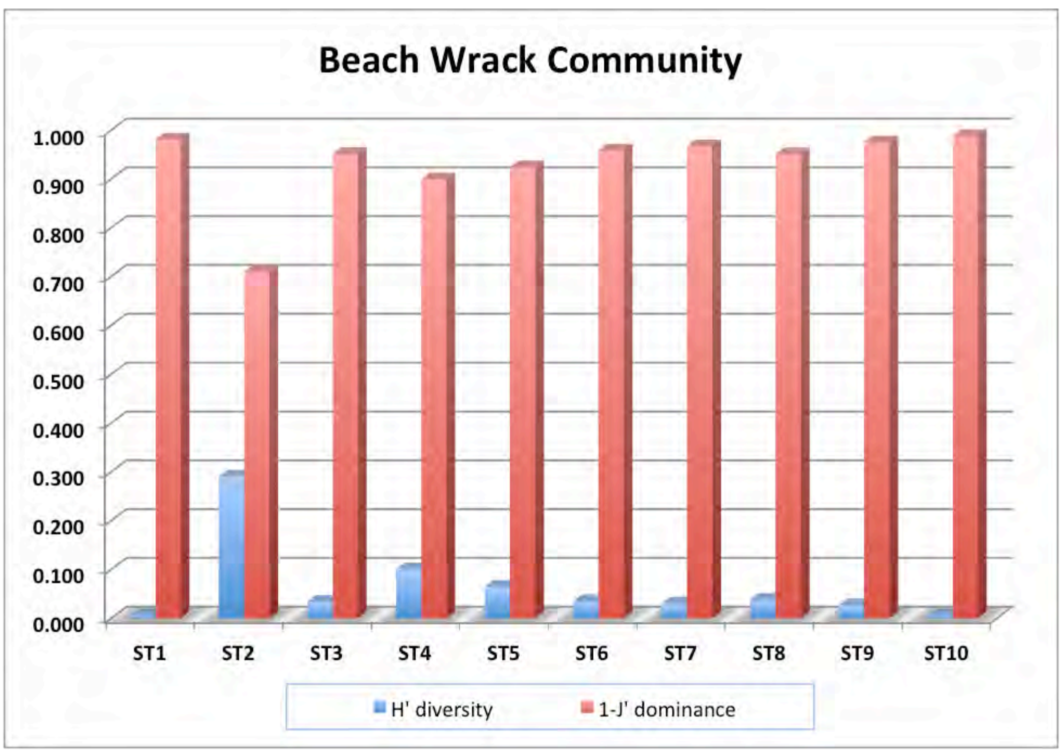

Figure 13. Gulf-side wrack-line diversity indices.

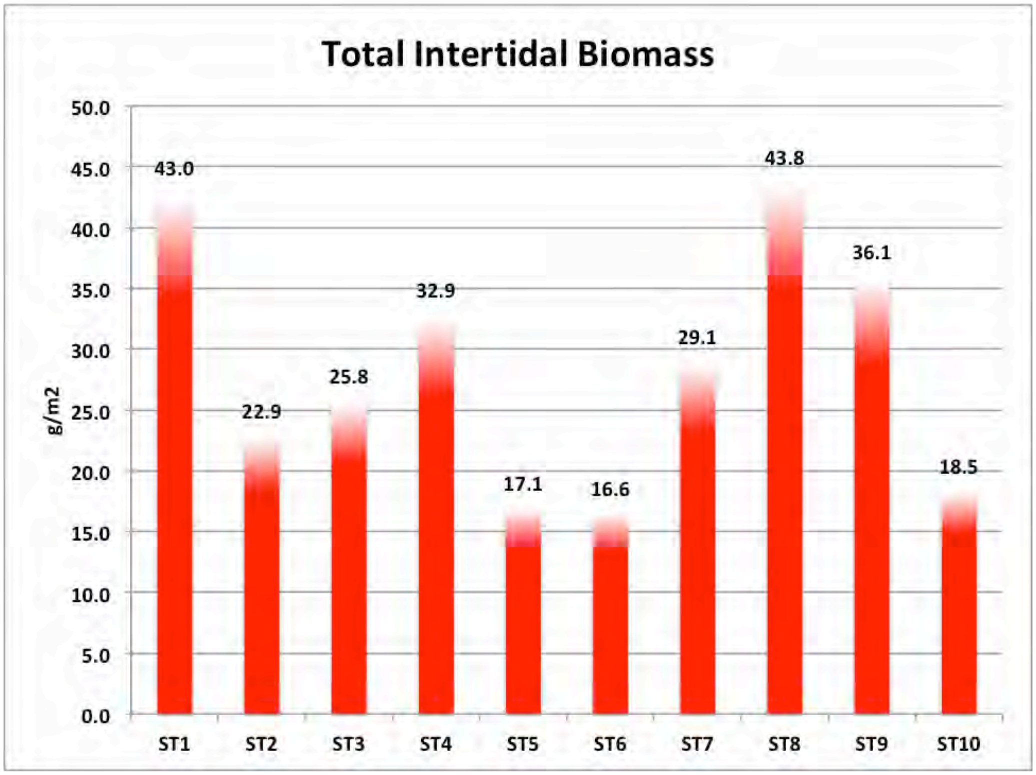

Figure 14. Gulf-side stations total intertidal biomass.

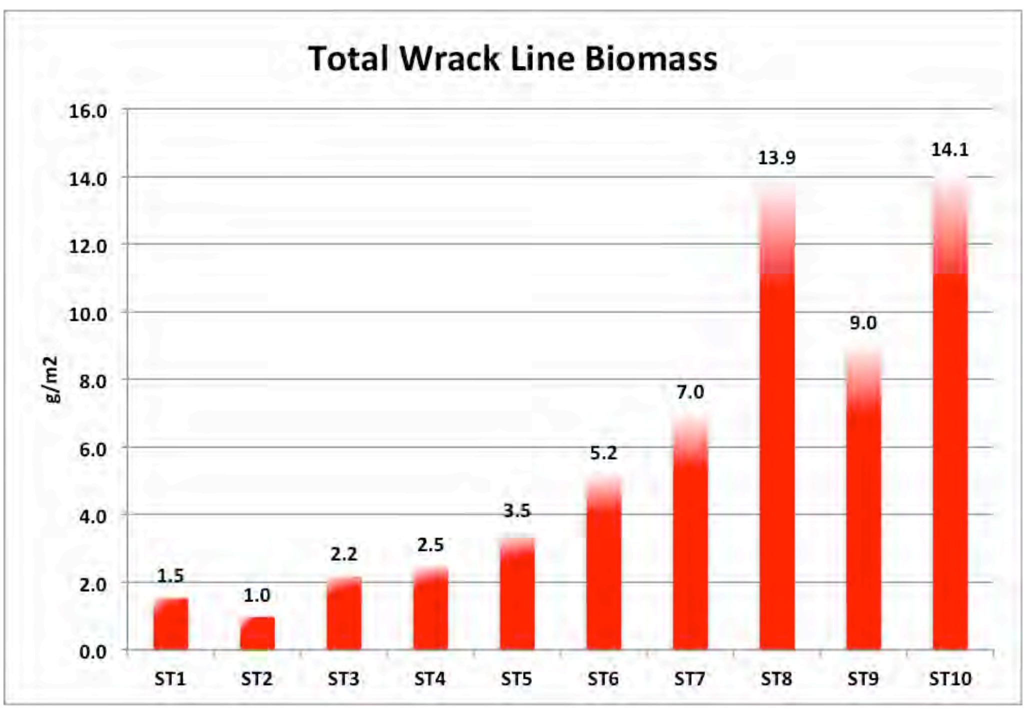

Figure 15. Gulf -side stations total wrack-line biomass.

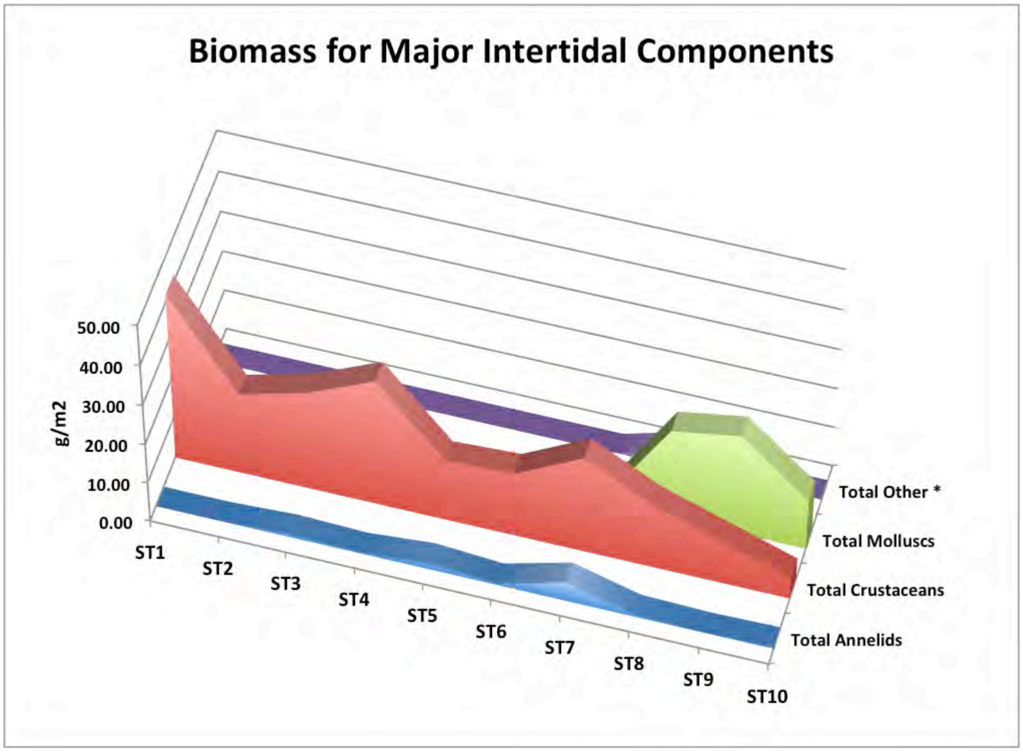

Figure 16. Gulf-side stations intertidal biomass components.

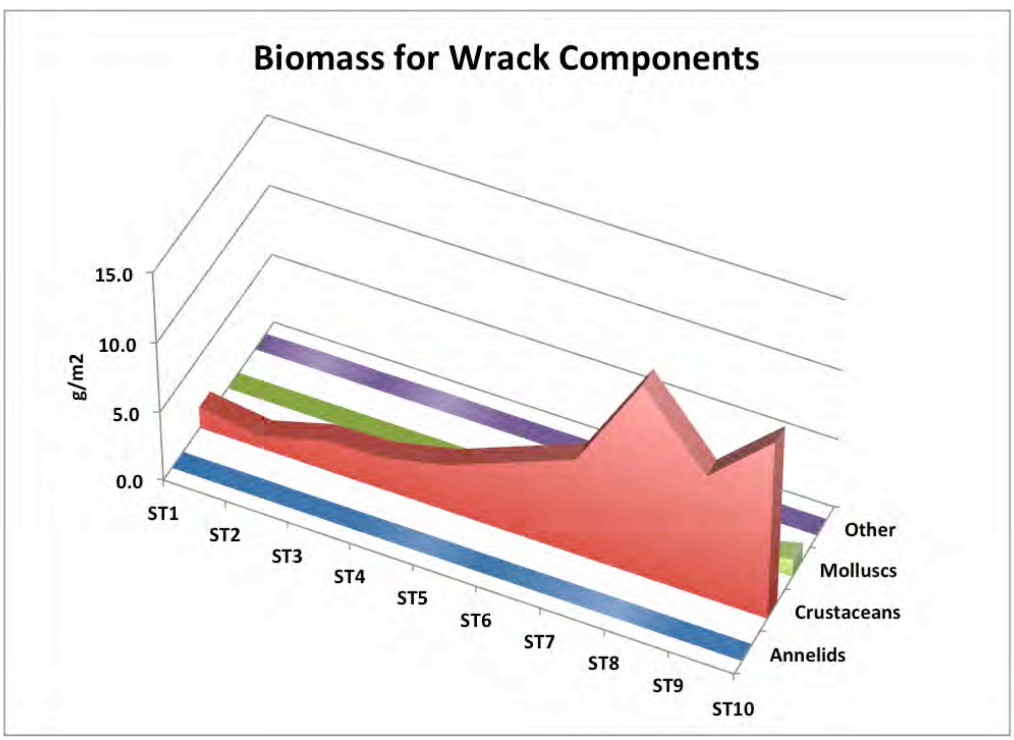

Figure 17. Gulf-side stations wrack-line biomass components.

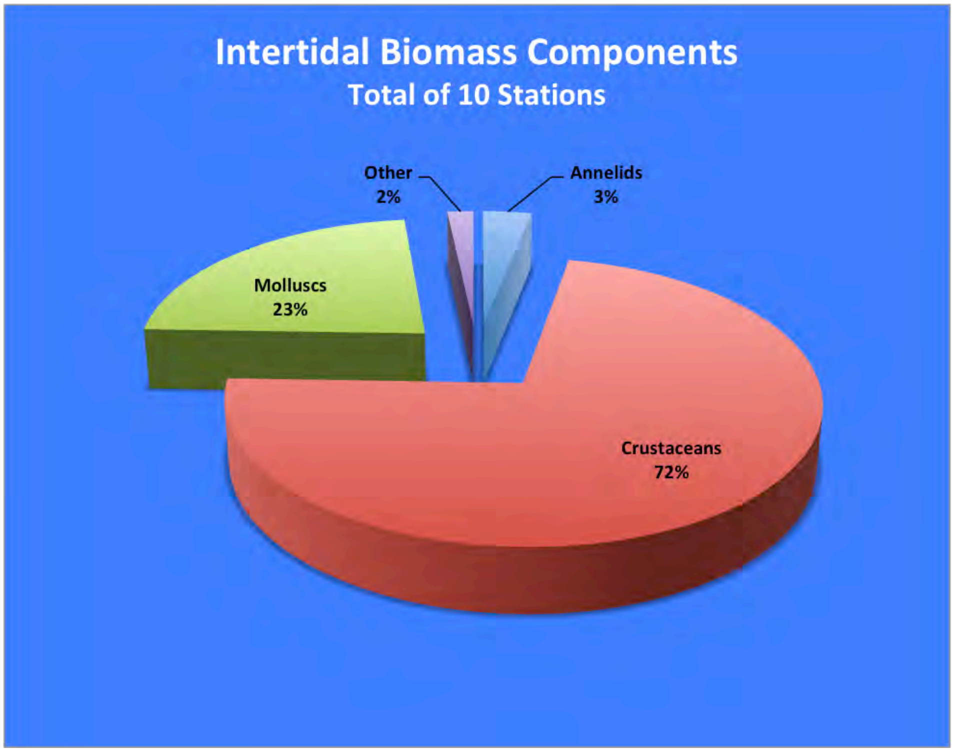

Figure 18. Gulf-side stations combined intertidal biomass components.

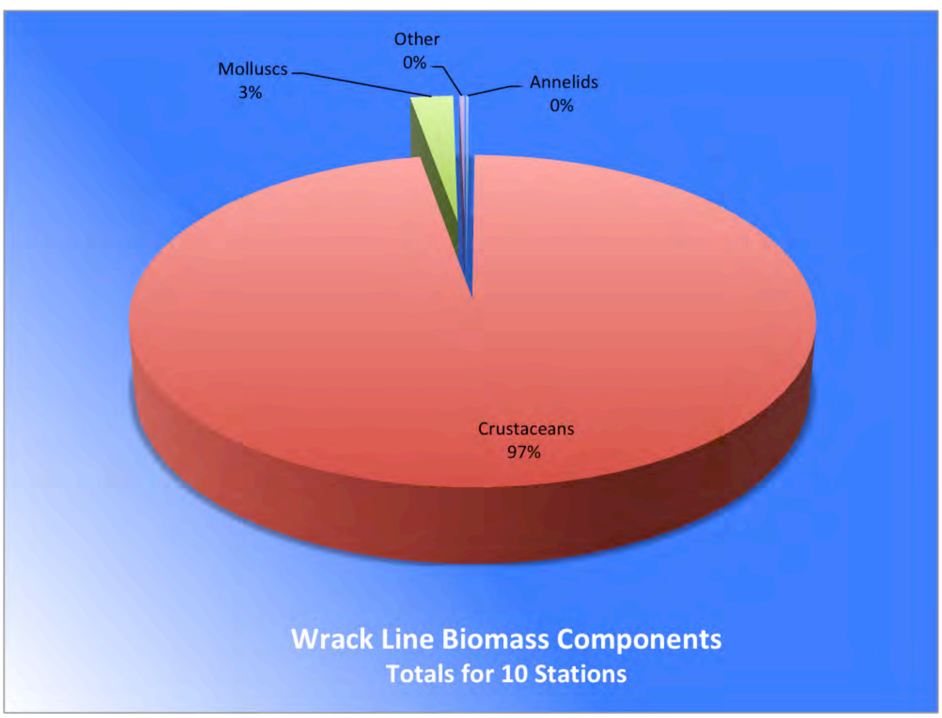

Figure 19. Gulf-side stations combined wrack-line biomass components.

Bayside Stations

Of the three bayside sites, station BS2 had a higher density (12,372 organisms/m2), species richness (19) and total biomass (24 g/m2) than BS1 and BS3 (Figs. 20 and 23). These values were due largely to the abundance and diversity of polychaetous annelids and crustaceans present at BS2 (Figs 22 and 24); crustaceans were much less abundant at the other two stations. In terms of total biomass, polychaete annelids dominated the bayside fauna (59%) 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 3141 and 1923/m^2 respectively at BS2. The total molluscan biomass (38%) was skewed by the presence of a single large razor clam (*Ensis megistus coseli*) present at BS2 (Figs. 24 and 25), the only mollusc collected at the bayside stations. 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).

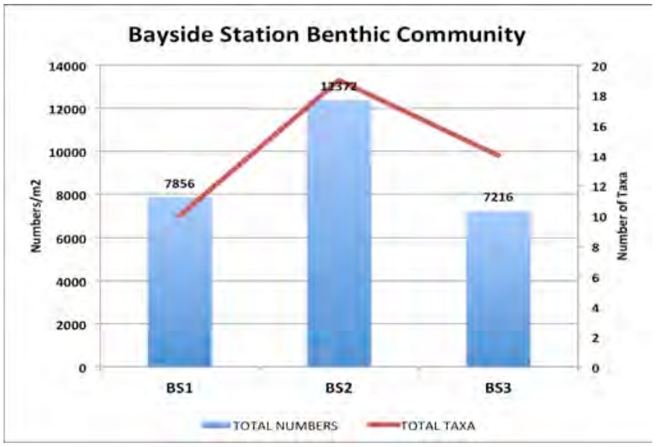

Figure 20. Total macrobenthic density vs. richness.

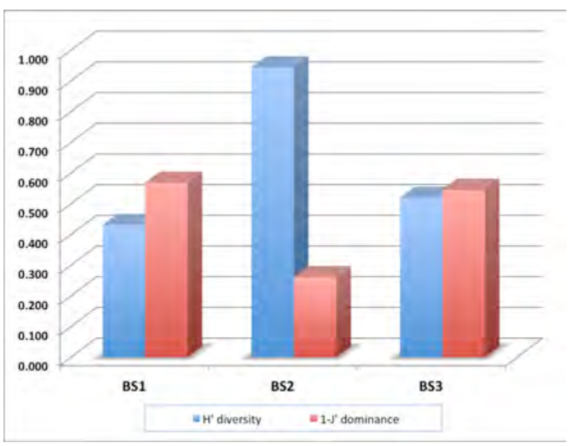

Figure 21. Bayside stations. Diversity indices.

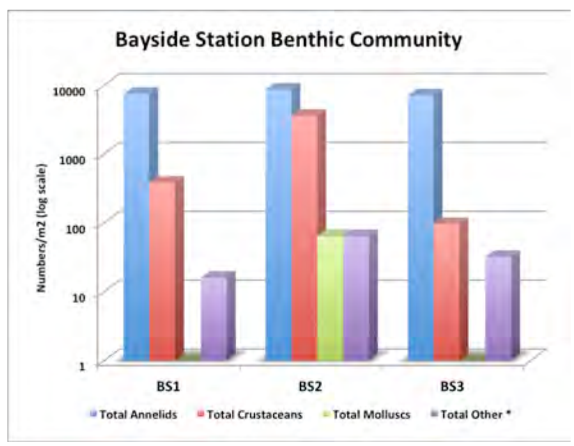

Figure 22. Macrobenthic components.

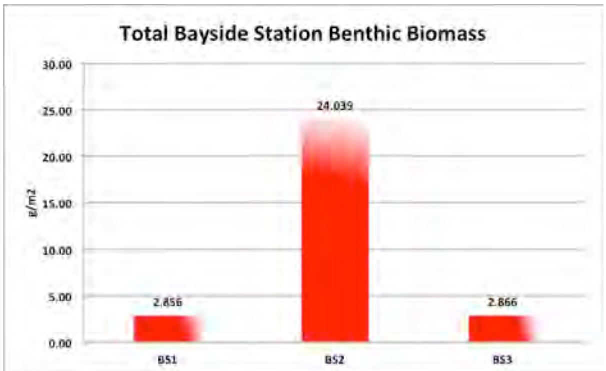

Figure 23. Total macrobenthic biomass.

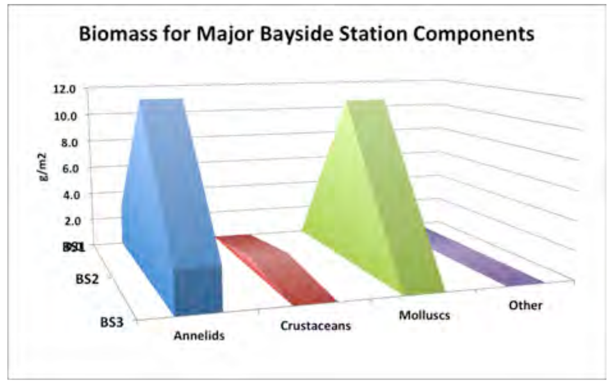

Figure 24. Macrobenthic biomass components..

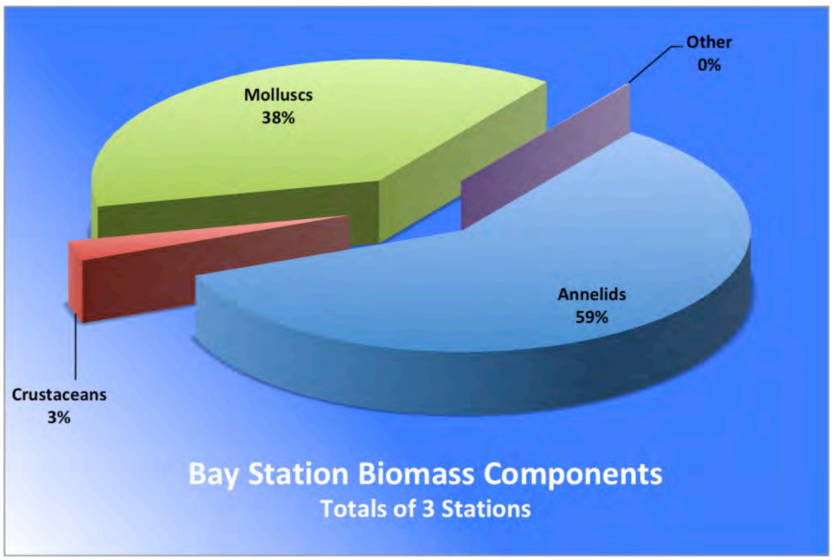

Figure 25. Combined macrobenthic biomass components.

Beach Stations 1-4: Six-year comparisons.

The faunal and physical data collected during the present study at stations 1 through 4 provide a comparison data to five years of benthic investigations from 2013 to 2018 since only these stations were sampled in 2013 (no collections were made in 2017). However the full compliment of 10 Gulf-side and three bayside stations are available for comparison between 2014 and 2018 and will be dealt with later.

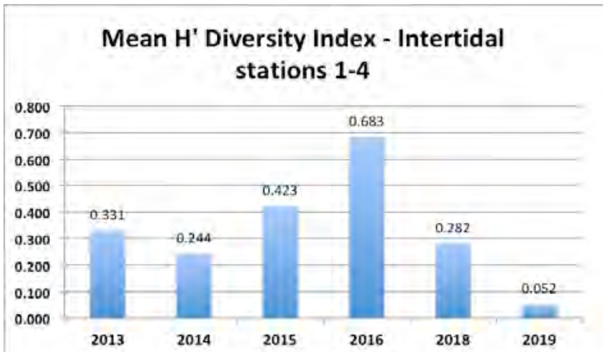

Figure 26. Intertidal mean density for 6 years.

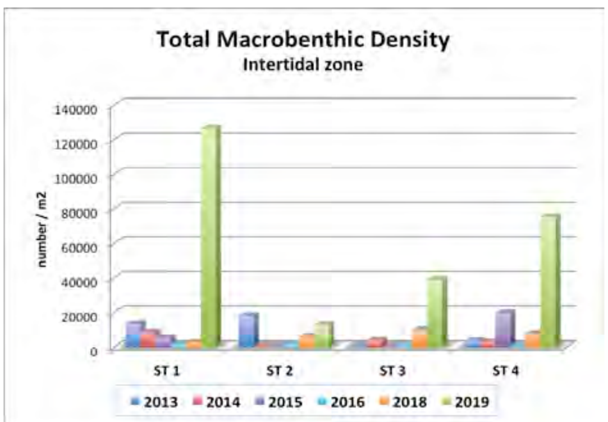

Figure 27. Total macroinvertebrate density for 6 years.

Intertidal zone. The mean H' value of stations 1-4 in 2019 fell substantially below levels recorded in all previous years (Fig. 26). Conversely, the total density during 2019 was much higher than that recorded in all previous years except 2013 which had higher values at station 2. Extreme numbers at station 1 in 2019 hindered the ability to visually compare stations/years (Fig. 27). During the six years, the total biomass for 2019 was higher at all stations (Fig. 28) reflecting a dominance in crustacean percentage for that year. The mollusc biomass, so predominant in 2014-2016 was reduced to 6% in 2018 and 4% in 2019. The annelid biomass component, showing substantial percentages in 2013 and 2018, was practically non-existent in 2019. These component percentages are arranged for comparison by year in pie chart figures 29-34.

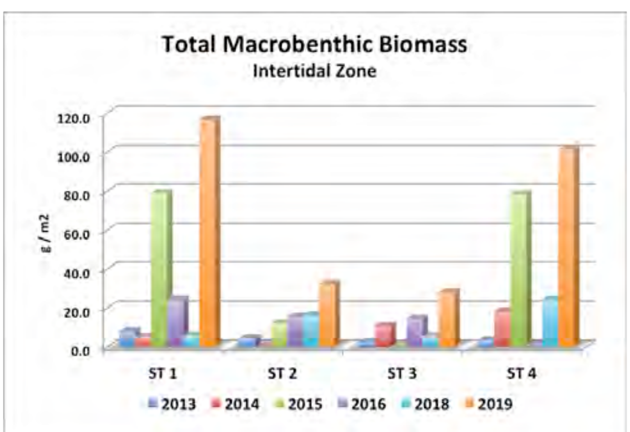

Figure 28. Total macroinvertebrate biomass for six years.

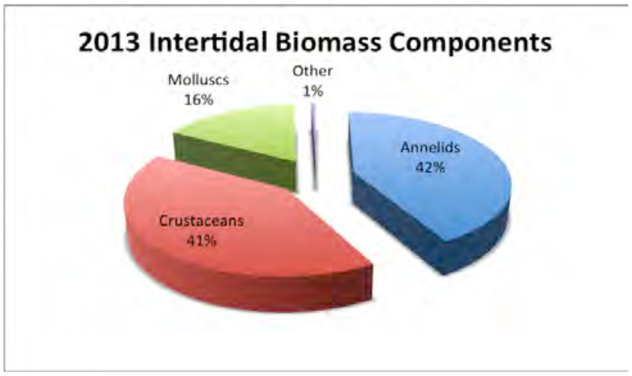

Figure 29. Combined components for four stations – 2013.

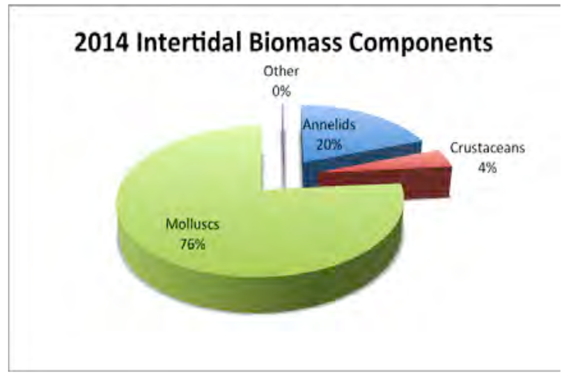

Figure 30. Combined components for four stations - 2014.

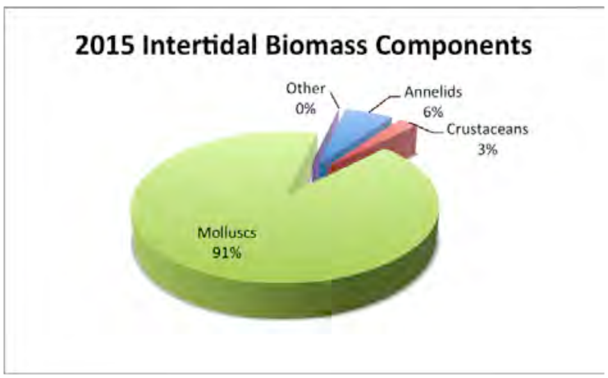

Figure 31. Combined components for four stations - 2015.

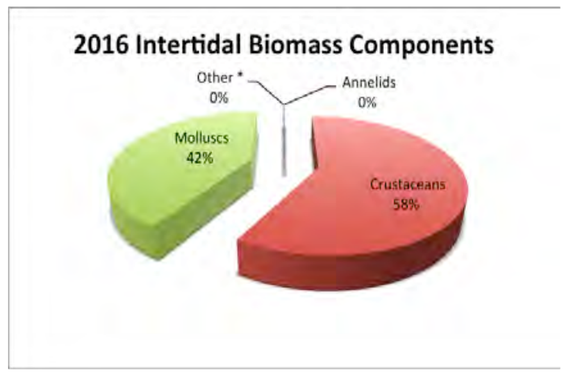

Figure 32 . Combined components for four stations - 2016.

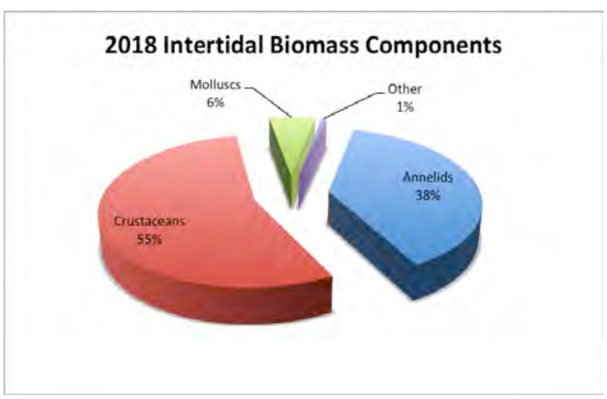

Figure 33. Combined components for four stations - 2018.

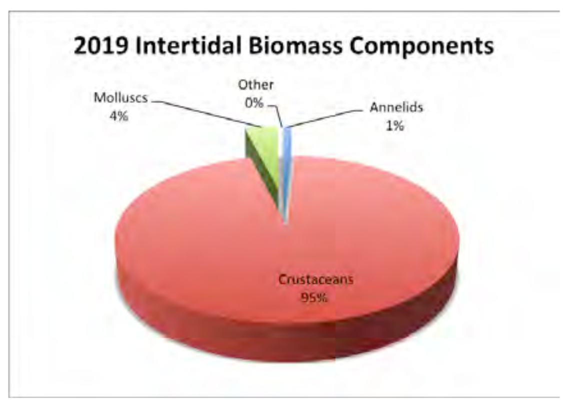

Figure 34. Combined components for four stations - 2019.

Wrack-line community. In 2019 total density in the wrack-line community showed a large increase over the 2018 values at all stations but was less than values displayed at station 2 during 2013 and 2016 (Fig. 35). The total density at station 1 (8,656/m2) was the highest value recorded at the four stations during the six years of surveys. In terms of total biomass, 2019 values were higher than previous years for all stations except station 3, which were slightly less than 2018. Total biomass values were higher than those of 2018 at all four stations but fell below those of 2016 recorded at stations 1, 2 and 4 (Fig. 36). Mean H' diversity values over the four stations continued to decline since 2015 reaching a new low of 0.108 (Fig. 37). The total biomass components in the wrack-line community changed little if any in 2019 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. 38 - 43). In fact, the biomass component structure was nearly identical to those of 2014 and 2018 with crustaceans representing 98% of the biomass.

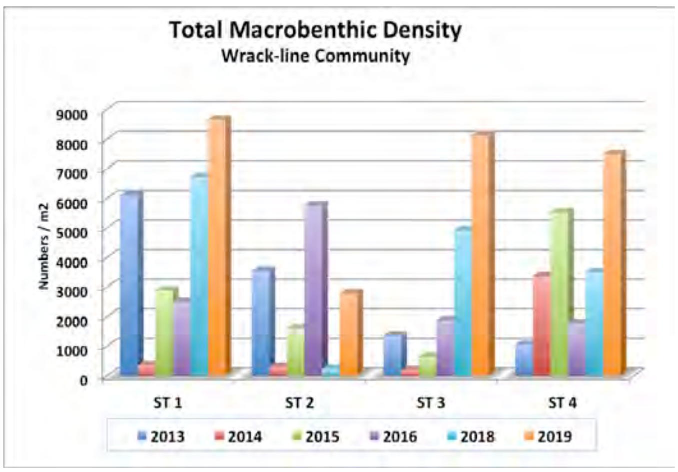

Figure 35. Total wrack-line macroinvertebrate density - 6 years.

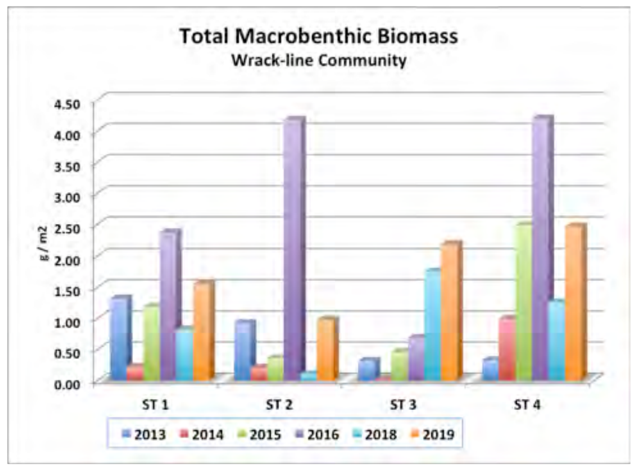

Figure 36. Total wrack-line macroinvertebrate biomass - 6 years.

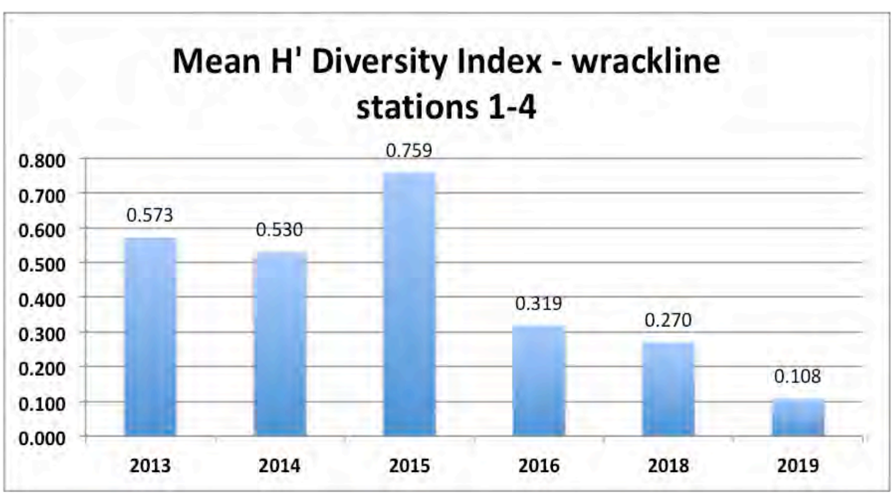

Figure 37. Wrack-line mean H' diversity - 6 years.

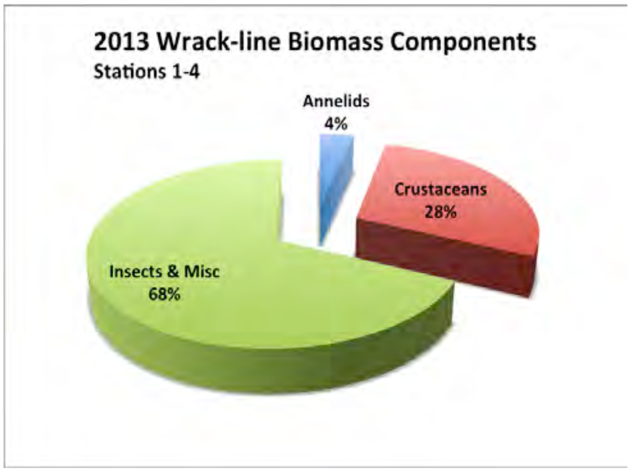

Figure 38. Combined components for four stations - 2013.

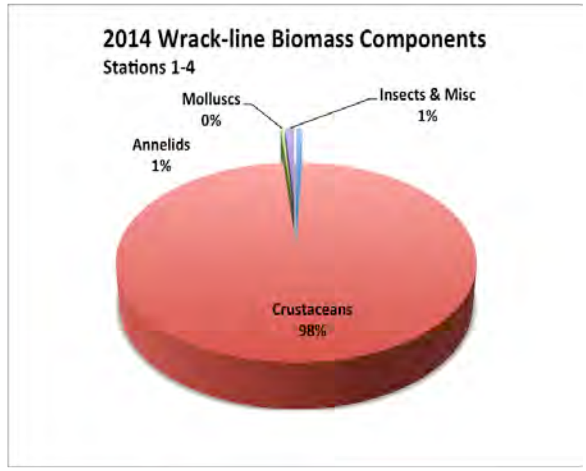

Figure 39. Combined components for four stations - 2014.

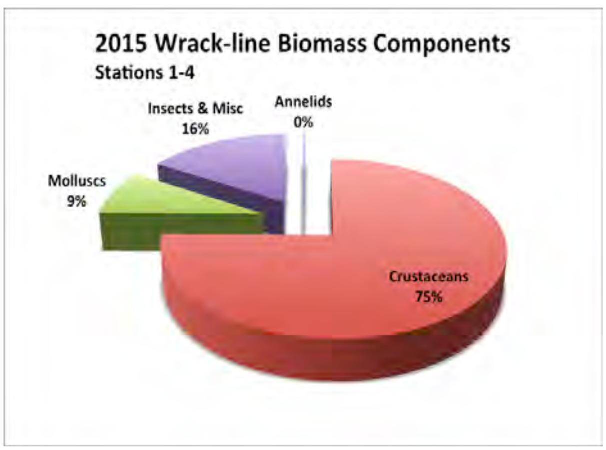

Figure 40. Combined components for four stations - 2015.

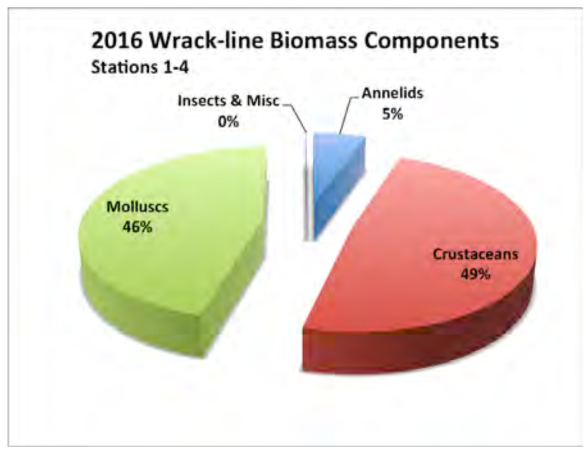

Figure 41. Combined components for four stations - 2016.

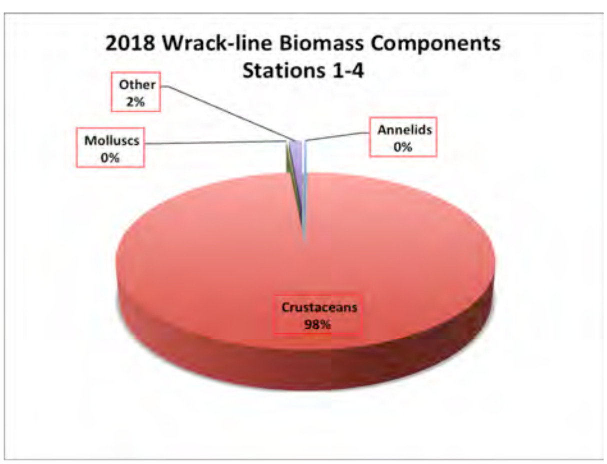

Figure 42. Combined components for four stations - 2018.

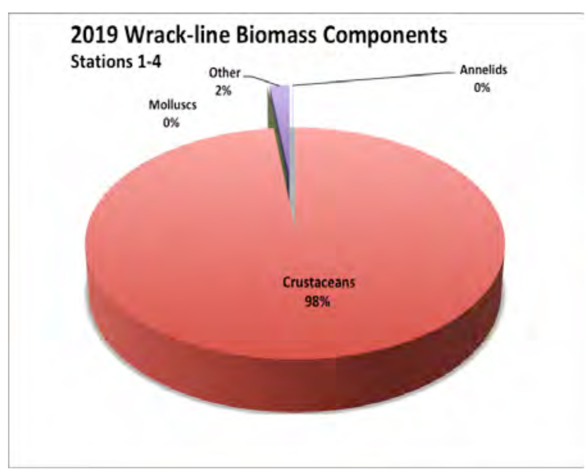

Figure 43. Combined components for four stations - 2019.

Beach Stations 1-10: Five-year Comparisons.

Intertidal zone. In comparing mean intertidal values over all ten stations, the macroinvertebrate community in 2019 showed an increase in density and biomass from the 2018 values but with a corresponding decrease in H' diversity to the lowest level in the five-year survey (Figs. 44-46). In 2019, crustaceans were the dominant organisms in terms of density and biomass, owing to large numbers of the haustoriid amphipod, *Lepidactylus triarticulatus* that were present at all stations with a peak of 125,514/m^2 at station 1. Mole crabs, though few in number, occurred as sub-adults at four stations, thus impacting the overall biomass. The polychaete annelid, *Scolelepis squamata*, although present at every station in 2019, had less an impact on the overall biomass as in past years, comprising just 3% of the total biomass. The molluscan component (23 %), primarily the coquina clam, *Donax texasianus*, showed an increase over 2018 levels but was much reduced from levels seen in the first three years of surveys. This clam, present in substantial numbers in 2015 (86%), was present at seven stations in 2019 and occurred mostly as smaller numbers of juveniles or sub-adults, thus reducing its importance to the total biomass. Comparative intertidal biomass components among surveys are depicted in Figures 44-51.

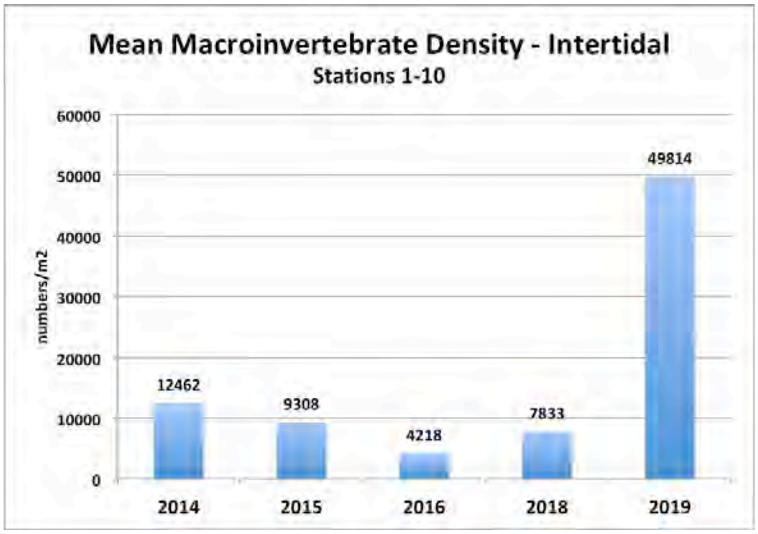

Figure 44. Mean interidal density over 10 stations - 5 years.

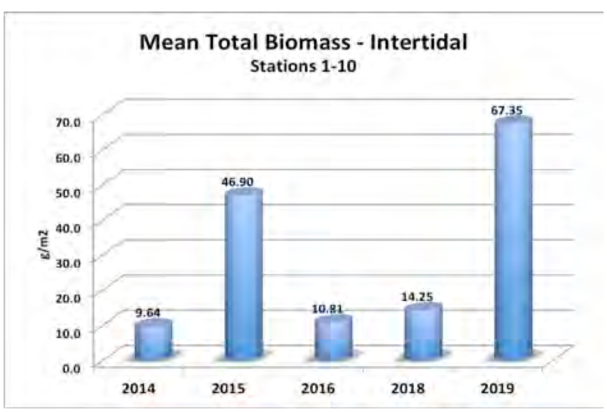

Figure 45. Mean intertidal biomass over 10 stations - 5 years.

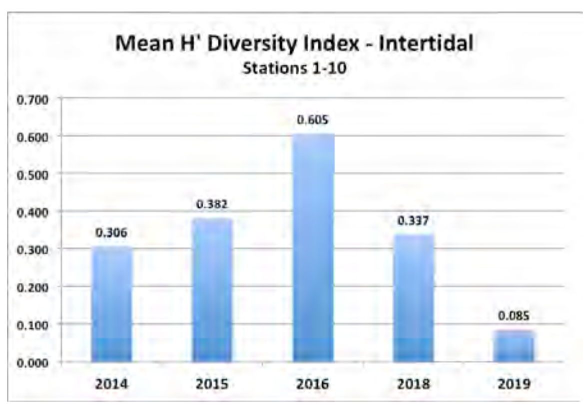

Figure 46. Mean intertidal diversity over 10 stations - 5 years.

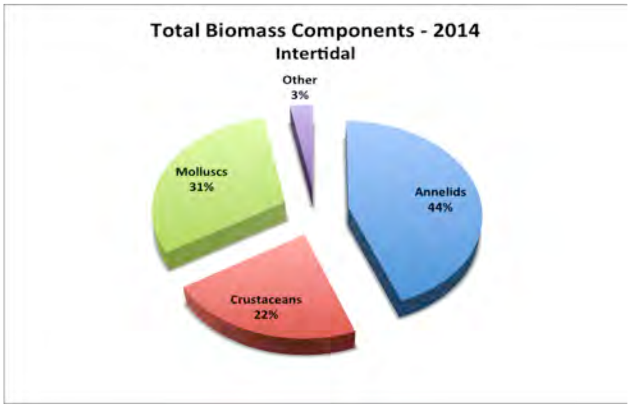

Figure 47. Combined intertidal components for 10 stations - 2014

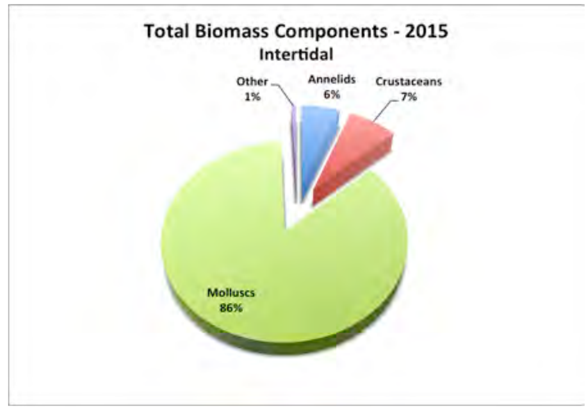

Figure 48 . Combined intertidal components for 10 stations - 2015

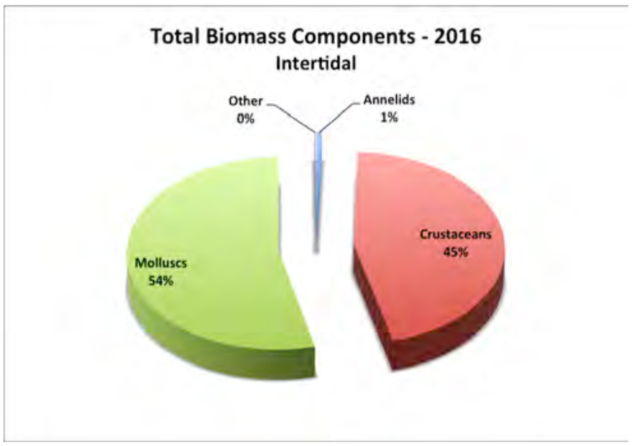

Figure 49. Combined intertidal components for 10 stations - 2016

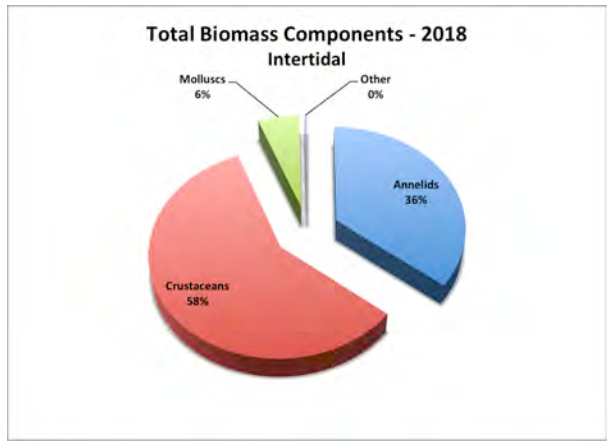

Figure 50. Combined intertidal components for 10 stations - 2018.

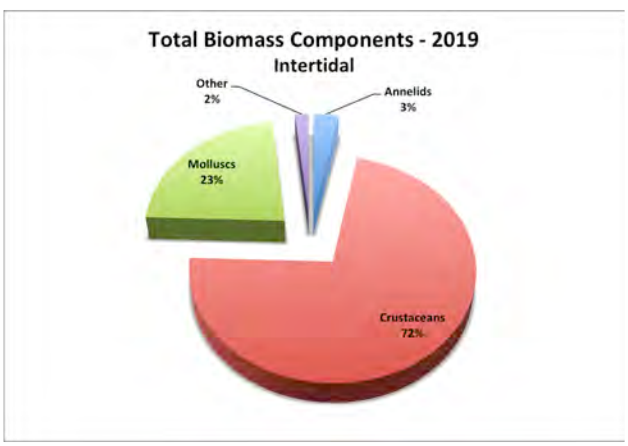

Figure 51. Combined intertidal components for 10 stations - 2019.

Wrack-line community. In 2019, although the wrack-line macroinvertebrate community, averaged over the 10 beach stations, continued a decline in diversity reaching a low of 0.063, it showed large increases in density and biomass (Figs. 52-54). The scarcity of washed-up plant debris seen in earlier years of surveys again influenced a decrease in diversity, as it did in 2018, 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. Large numbers of crustaceans embedded in the damp sand beneath the wrack line were mostly juvenile haustoriid amphipods (*Lepidactylus triarticulatus*); these once again proved substantial in density and biomass and accounted for the largest percentage of the total wrack community biomass in all five years of the study (Figs. 55-59).

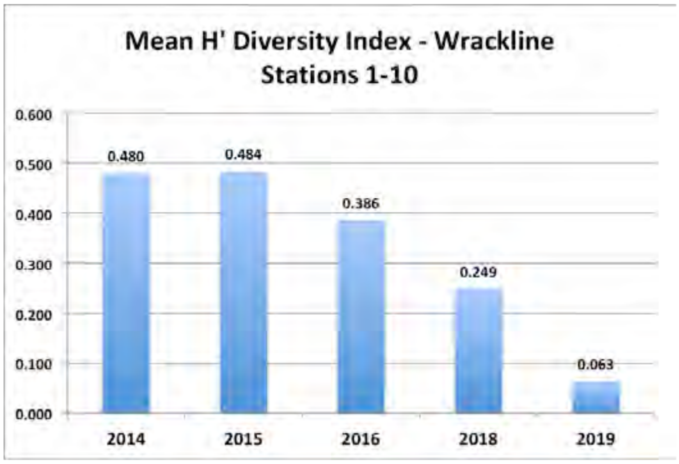

Figure 52. Mean wrack-line diversity over 10 stations - 5 years.

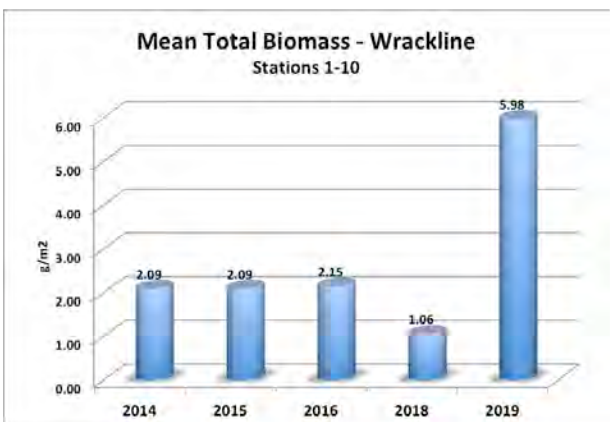

Figure 33. Mean wrack-line biomass over 10 stations - 5 years.

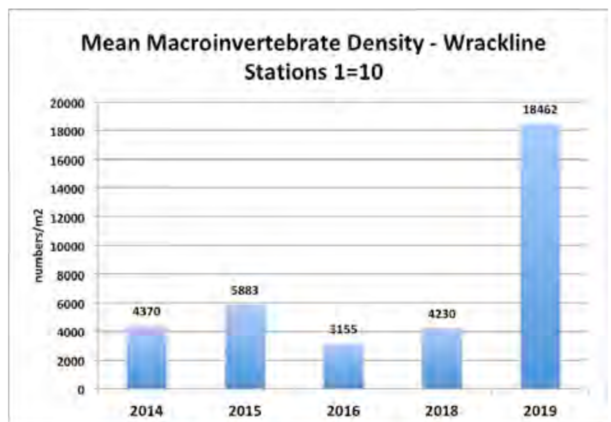

Figure 54. Mean wrack-line density over 10 stations - 5 years.

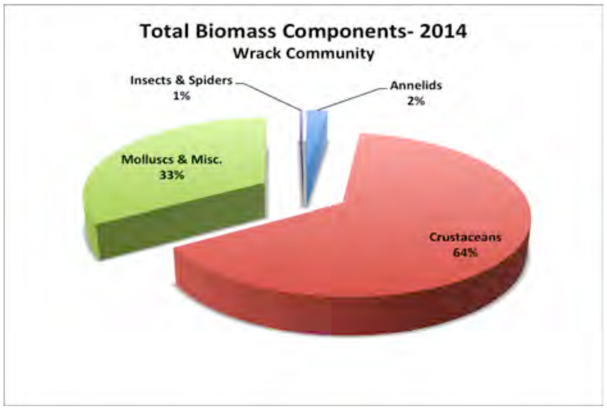

Figure 55. Combined wrack-line components over 10 stations - 2014.

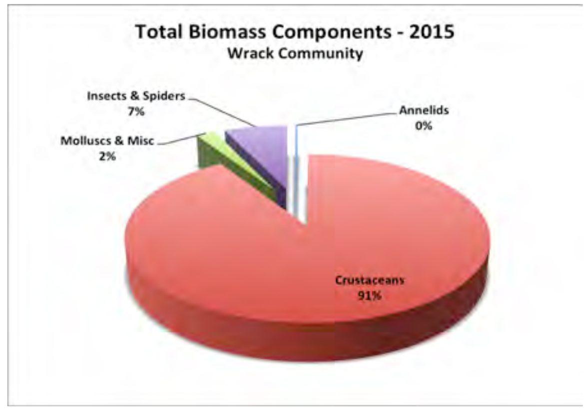

Figure 56. Combined wrack-line components over 10 stations - 2015.

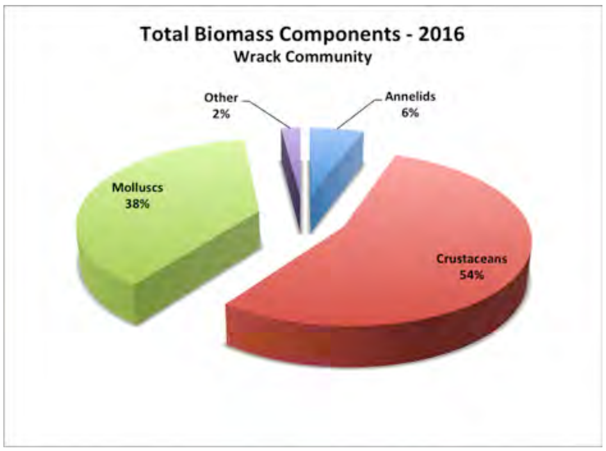

Figure 57. Combined wrack-line components over 10 stations - 2016.

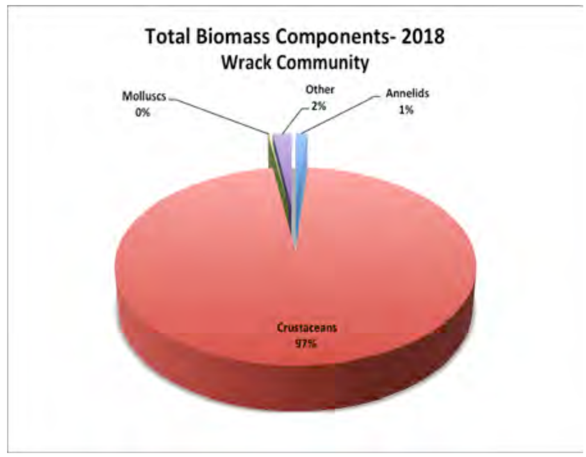

Figure 58. Combined wrack-line components over 10 stations - 2018.

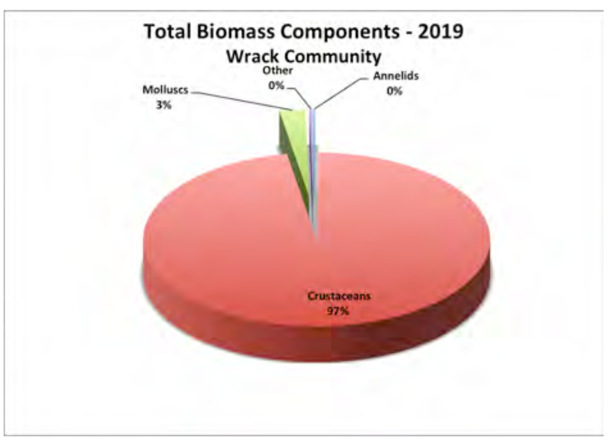

Figure 59. Combined wrack-line components over 10 stations - 2019.

Bayside Stations: Five-year comparisons.

Mean values for density (Fig. 61) and biomass (Fig. 62) in 2019 showed slight decreases from 2018 but H' diversity (Fig. 60) was slightly elevated from the previous two surveys due to a large variety of polychaete annelids. In comparing the combined bayside biomass components over the five years, annelids once again prevailed with 59 % in 2019, similar to that seen in 2014. Molluscan biomass increased substantially from 13 % in 2018 to 38% of the total biomass in 2019 but this value was deceptively large because of the presence of a single specimen of the large-bodied razor clam, *Ensis megistus coseli* (formerly known as *Ensis minor*) at station BS2 (Figs. 63-67).

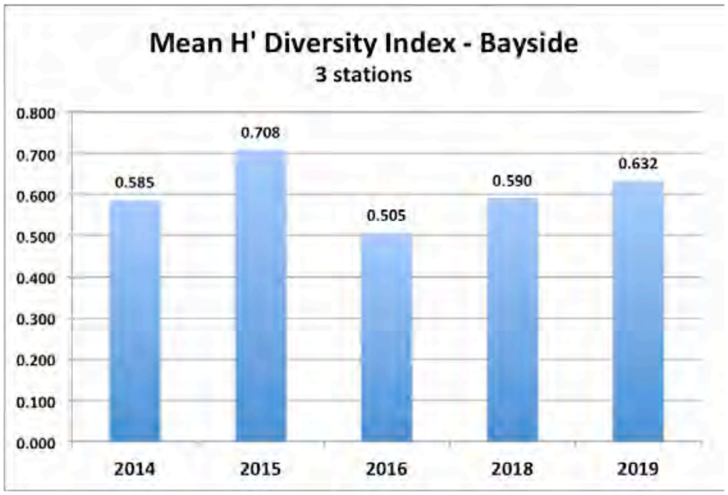

Figure 60. Mean bayside H' diversity over three stations - 5 years.

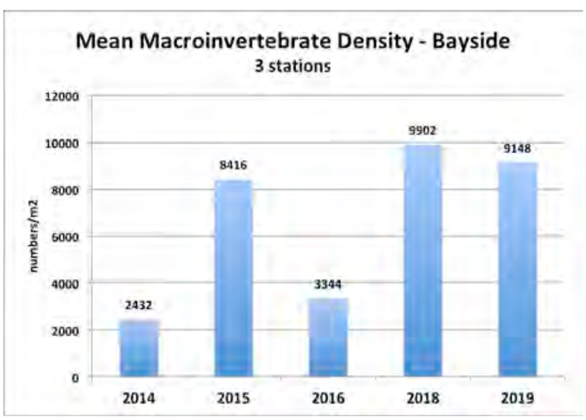

Figure 61. Mean bayside density over three stations - 5 years.

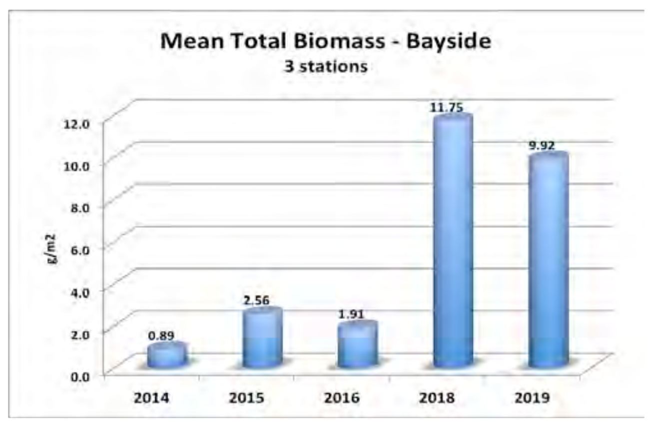

Figure 62. Mean bayside biomass over three stations - 5 years.

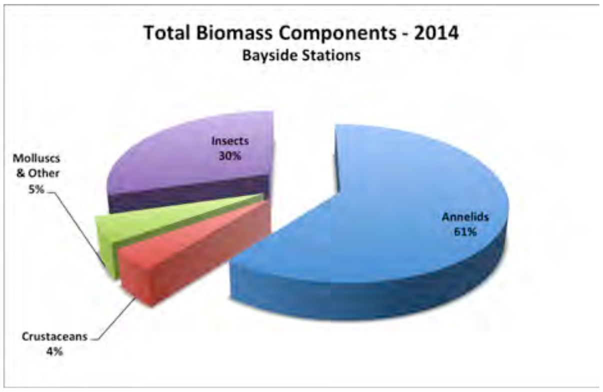

Figure 63. Combined bayside biomass components - 2014.

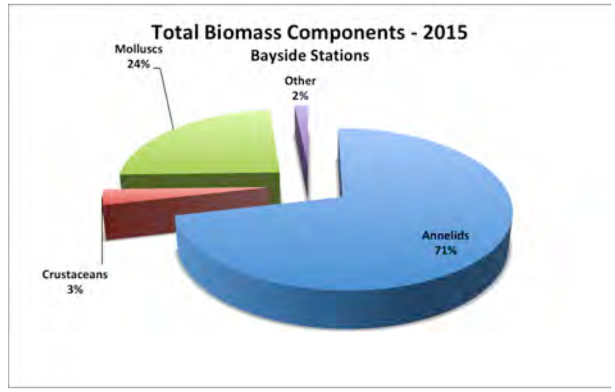

Figure 64. Combined bayside biomass components - 2015.

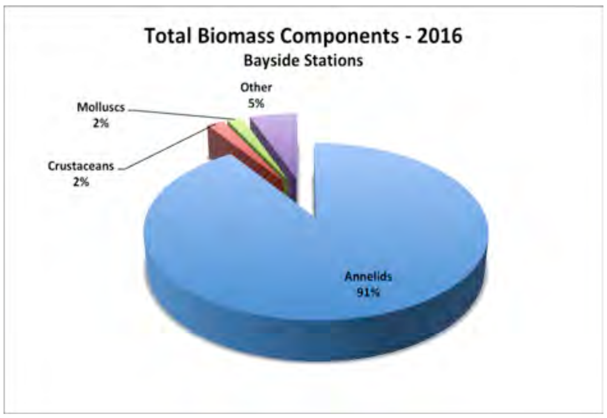

Figure 65. Combined bayside biomass components - 2016.

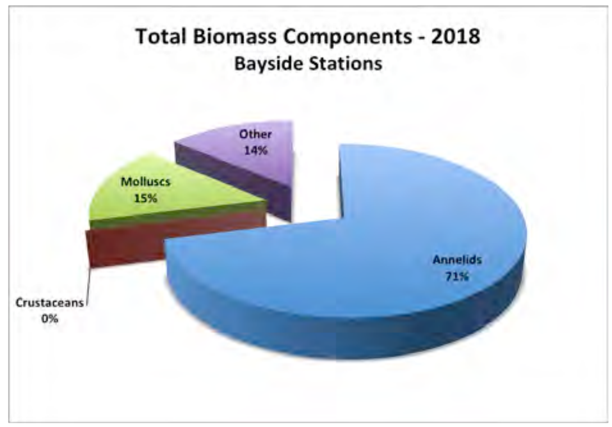

Figure 66. Combined bayside biomass components - 2018.

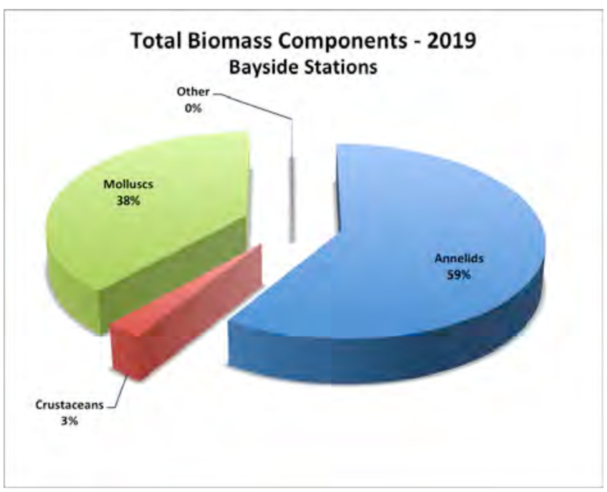

Figure 67. Combined bayside biomass components - 2019.

Summary and Conclusions

The key components in the Macrobenthic community from the previous five spring surveys were again present along the Caminada Headland Beach in 2019. 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). As in 2018, the Caminada beach wrack community, because of a smaller amount of deposited debris and its associated fauna in 2019, was notably different from previous years by its decreased mean diversity. Mean density and biomass in the wrack-line community, however showed an increase over that of 2018 because of the large numbers of embedded amphipods found at most stations. Likewise, although the intertidal diversity at the beach stations was extremely low, averaging 0.085 over 10 stations, density and biomass of prey fauna reached record levels owing to the large numbers of infaunal amphipods.

The three bayside stations on the backside of Caminada Headland Beach had typical faunal components seen in the previous two years and the 2019 mean biometrics showed levels of density, diversity and biomass similar to 2018. 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, the spionid polychaetes, *Polydora cornuta*, *Streblospio gynobranchiata,* the nereids, *Laenonereis culveri* and *Alitta succinea*, and three species of Capitellidae. The embedded insect larvae prevalent in 2018 were noticeably absent in 2019. The mesohaline organisms found in the bayside samples are common fauna along bays and estuaries of the northern Gulf of Mexico (Heard 1982; LaSalle and Bishop 1987).

The findings of Year 6 of the Caminada Headland Beach benthic survey are summarized thus:

1. 75 nominal taxa from five different phyla were represented from the total of 21,313 organisms 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 12 species of polychaetes, led by the capitellids, *Capitella capitata*, *Heteromastus filiformis* and *Mediomastus ambiseta*, the spionid, *Streblospio gynobranchiata*, and the nereid, *Laeonereis culveri* were important food resources at the three calm-water bayside stations.

2. Among the ten Gulf-facing stations, station 1 had the largest number of intertidal individuals collected with over 120,000 organisms/m^2, largely due to high numbers of the haustoriid amphipod, *Lepidactylus triarticulatus*. Crustaceans, primarily *Lepidactylus*, were the numerically dominant intertidal organisms at all beach stations with numbers of over 12,000/m^2 occurring at all stations except 10 (11,731/m^2). The highest density of total organisms in the beach wrack-line community occurred at Station 10 (65,936/m^2) with substantial numbers (33,200/m^2) also at station 9. High numbers of *Lepidactylus*,

embedded in the upper few cm of sediment in the wrack line, accounted for the densities of over 10,000/m^2 at the four eastern-most beach stations.

3. Intertidal species diversity (H') values were low at all stations due to exceptionally high values of dominance (1-J') influenced by large numbers of embedded amphipods in nearly every sample. These values ranged between 0.016 and 0.181, but were slightly higher at the eastern-most stations. Diversity values were likewise low in the wrack community due to even higher numbers of amphipods; most H' values ranged between .006 and 0.101 except for station 2 which had a peak of 0.291. Stations with the lowest number of taxa had the highest dominance values.

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. Exceptionally large peaks of intertidal biomass of nearly 45 g/m2 occurred at stations 1 and 8, influenced by higher numbers of amphipods at station 1 and coquina clams (*Donax texasianus*) at station 8. In the wrack community, there appeared to be a steady eastward increase in biomass with peaks of 13.9 and 14.1 being reached at stations 8 and 10 respectively. In comparing the biomass totals of all stations, crustaceans (72%) and molluscs (23%) dominated the intertidal zone, with a scant representation by annelids and other taxa (about 5%), 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 (12,372 organisms/m2), species richness (19) and total biomass (24 g/m2) than BS1 and BS3. These values were due largely to the abundance and diversity of polychaetous annelids and crustaceans present at BS2; crustaceans were much less abundant at the other two stations. In terms of total biomass, polychaete annelids dominated the bayside fauna (59%) again due to large numbers present at station BS2. The most abundant polychaetes recorded were the capitellids, *Mediomastus ambiseta* and *Heteromastus filiformis* with numbers of 3141 and 1923/m^2 respectively at BS2. The total molluscan biomass (38%) was skewed by the presence of a single large razor clam (*Ensis megistus coseli*) present at BS2, the only mollusc collected at the bayside stations.

6. Data from Gulf-side stations 1-4 collected from 2013 to 2019 were compared. The mean H' value of stations 1-4 in 2019 fell substantially below levels recorded in all previous years. Conversely, the total density during 2019 was much higher than that recorded in all previous years except 2013 which had higher values at station 2. During the six years, the total biomass for 2019 was higher at all stations reflecting a dominance in crustacean percentage. The mollusc biomass, so predominant in 2014-2016 was reduced to 6% in 2018 and 4% in 2019. The annelid biomass component, showing substantial percentages in 2013 and 2018, was practically non-existent in 2019. In 2019 total density in the wrack-line community showed a large increase over the 2018 values at all stations but was less than values displayed at station 2 during 2013 and 1016. The total density at station 1 (8,656/m2) was the highest value recorded at the four stations during the six years of surveys. In terms of total biomass, 2019 values were higher than previous years for all stations except station 3, which were slightly less than 2018. Total biomass values were higher than those of 2018 at all four stations but fell below those of 2016 recorded at stations 1, 2 and 4. Mean H' diversity values over the four stations continued to decline since 2015 reaching a new low of 0.108. The total biomass components in the wrack-line community changed little if any in 2019 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 those of 2014 and 2018 with crustaceans representing 98% of the biomass.

7. Five 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 2019 showed an increase in density and biomass from the 2018 values but with a corresponding decrease in H' diversity to the lowest level in the five-year survey. In 2019, crustaceans were the dominant organisms in terms of density and biomass, owing to large numbers of the haustoriid amphipod, *Lepidactylus triarticulatus* that were present at all stations with a peak of 125,514/m^2 at station 1. Mole crabs, though few in number, occurred as sub-adults at four stations, thus impacting the overall biomass. The polychaete annelid, *Scolelepis squamata*, although present at every station in 2019, had less an impact on the overall biomass as in past years, comprising just 3% of the total biomass. The molluscan component (23 %), primarily the coquina clam, *Donax texasianus*, showed an increase over 2018 levels but was much reduced from levels seen in the first three years of surveys. This clam, present in substantial numbers in 2015 (86%), was present at seven stations in 2019 and occurred mostly as smaller numbers of juveniles or sub-adults, thus reducing its importance to the total biomass. In 2019, although the wrack-line macroinvertebrate community, averaged over the 10 beach stations, continued a decline in diversity reaching a low of 0.063, it showed large increases in density and biomass. The scarcity of washed-up plant debris seen in earlier years of surveys again influenced a decrease in diversity, as it did in 2018, 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. Large numbers of crustaceans embedded in the damp sand beneath the wrack line were mostly juvenile haustoriid amphipods (*Lepidactylus triarticulatus*); these once again proved substantial in density and biomass and accounted for the largest percentage of the total wrack community biomass in all five years of the study. At the bayside stations, mean values for density and biomass in 2019 showed slight decreases from 2018 but H' diversity was slightly elevated from the previous two surveys due to a large variety of polychaete annelids. In comparing the combined bayside biomass components over the five years, annelids once again prevailed with 59 % in 2019, similar to that seen in 2014. Molluscan biomass increased substantially from 13 % in 2018 to 38% of the total biomass in 2019 but this value was deceptively large because of the presence of a single specimen of the large-bodied razor clam, *Ensis megistus coseli* (formerly known as *Ensis minor*) at station BS2.

Table 3. Summary of Intertidal Box Core Data – condensed by station.
Values in numbers/ m²

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
ANNELIDA										
Polychaeta										
Order Spionida										
Family Spionidae										
Scolelepis squamata	128	64	513	321	897	192	3141	513	256	385
ARTHROPODA										
Arachnida										
Order Araneae										
Unid. Araneae									64	
Entognatha										
Order Poduromorpha										
Family Hypogastruridae										
Unid. Hypogastruridae				64	513		449	641	897	
Insecta										
Unid. Insecta									128	
Order Coleoptera										
Family Staphylinidae										
Unid. Staphylinidae			64	64						
Order Diptera										
Unid. Diptera	385			128						
Family Mycetophilidae										
Unid. Mycetophilidae	64									
Family Phoridae										
Unid. Phoridae		64								
Family Sciaridae										
Unid. Sciaridae	64	128			64	64				
Order Hymenoptera										
Family Formicidae										
Unid. Formicidae	64									
Malacostraca										
Order Amphipoda										
Family Haustoriidae										
Lepidactylus triarticulatus	125514	12308	38269	74616	36090	46218	57436	50577	32372	10513
Order Decapoda										
Family Hippidae										

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Emerita benedicti			64							
Emerita talpoida		128		64					64	
Family Pinnotheridae										
Austinixa behreae										64
MOLLUSCA										
Bivalvia										
Order Cardiida										
Family Donacidae										
Donax texasianus	64	192	64	128				1090	1154	769
NEMERTEA										
Anopla										
Family Lineidae										
Cerebratulus lacteus								64		
TOTAL NUMBERS	126283	12885	38975	75385	37564	46475	61026	52885	34936	11731
TOTAL TAXA	7	6	5	7	4	3	3	5	7	4
diversity indices										
Hmax'	0.845	0.778	0.699	0.845	0.602	0.477	0.477	0.699	0.845	0.602
H' diversity	0.020	0.109	0.046	0.032	0.086	0.016	0.107	0.100	0.155	0.181
J' evenness (equitability)	0.024	0.140	0.066	0.038	0.142	0.034	0.224	0.142	0.184	0.301
1-J' dominance	0.976	0.860	0.934	0.962	0.858	0.966	0.776	0.858	0.816	0.699

numbers/m2

Total Annelids	128	64	513	321	897	192	3141	513	256	385
Total Crustaceans	125514	12436	38334	74680	36090	46218	57436	50577	32436	10577
Total Molluscs	64	192	64	128	0	0	0	1090	1154	769
Total Other *	577	192	64	256	577	64	449	705	1090	0

AFD biomass - g

Total Annelids	0.0001	0.0001	0.0042	0.0013	0.0084	0.0022	0.0252	0.0027	0.0004	0.0021
Total Crustaceans	0.2168	0.1066	0.1291	0.165	0.0803	0.0841	0.126	0.0841	0.0559	0.0281
Total Molluscs	0.0066	0.0125	0.001	0.0046	0	0	0	0.1169	0.1312	0.0659
Total Other *	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0242	0.0001	0

AFD biomass - g/m2

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Total Annelids	0.02	0.02	0.81	0.25	1.62	0.42	4.85	0.52	0.08	0.40
Total Crustaceans	41.69	20.50	24.83	31.73	15.44	16.17	24.23	16.17	10.75	5.40
Total Molluscs	1.27	2.40	0.19	0.88	0.00	0.00	0.00	22.48	25.23	12.67
Total Other *	0.02	0.02	0.02	0.02	0.02	0.02	0.02	4.65	0.02	0.00

* includes insects, spiders, and misc. taxa

Table 4. Summary of Wrack-line Quantitative Data – condensed by station.
Values in numbers/m²

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
ANNELIDA										
Clitellata										
Order Haplotaxida										
Family Enchytraeidae										
Unid. Enchytraeidae				16						
Polychaeta										
Order Spionida										
Family Spionidae										
Scolelepis squamata					32		32	64		16
ARTHROPODA										
Arachnida										
Order Araneae										
Unid. Araneae				16						
Chelicerata										
Order Trombidiformes										
Unid. Hydrachnidia						16				
Entognatha										
Order Poduromorpha										
Unid. Collembola				16					16	
Family Hypogastruridae										
Unid. Hypogastruridae		32		128	16	16	48	32	80	
Insecta										
Unid. Insecta									16	
Order Coleoptera										
Family Carabidae										
Bembidion sp.				16						
Family Curculionidae										
Unid. Curculionidae							16			
Family Nitidulidae										
Unid. Nitidulidae									16	
Family Staphylinidae										
Unid. Staphylinidae		48		16	64	16	16			

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Order Diptera										
Unid. Diptera		128	16			32				
Family Chironomidae										
Unid. Chironomidae								96	16	
Family Sciaridae										
Unid. Sciaridae		16	16			16	16		16	
Family Tipulidae										
Unid. Tipulidae							16			
Order Hemiptera										
Unid. Hemiptera				16						
Order Hymenoptera										
Family Formicidae										
Unid. Formicidae		16				16			16	
Malacostraca										
Order Amphipoda										
Family Gammaridae										
Gammarus lecroyae									16	
Family Haustoriidae										
Lepidactylus triarticulatus	8640	2400	8032	7200	10640	9872	18976	18160	32944	65824
Family Liljeborgiidae										
Idunella barnardi									16	
Family Talitridae										
Platorchestia sp.		64	16		96		32	32		
Order Cumacea										
Family Diastylidae										
Oxyurostylis sp.		16								
Order Isopoda										
Family Idoteidae										
Edotia triloba								16		
Maxillopoda										
Order Calanoida										
Unid. Calanoid copepod		32	48	48						
Order Lepadiformes										
Family Lepadidae										
Lepas pectinata		32								
Order Sessilia										

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
Family Balanidae										
Amphibalanus sp.					16					
CHORDATA										
Actinopterygii										
Demersal fish eggs	16			16	32					
MOLLUSCA										
Bivalvia										
Unid. Bivalvia									32	
Order Cardiida										
Family Donacidae										
Donax texasianus									16	96
TOTAL NUMBERS	8656	2784	8128	7488	10896	9984	19152	18400	33200	65936
TOTAL TAXA	2	10	5	10	7	7	8	6	12	3

diversity indices										
Hmax'	0.301	1.000	0.699	1.000	0.845	0.845	0.903	0.778	1.079	0.477
H' diversity	0.006	0.291	0.034	0.101	0.064	0.035	0.030	0.038	0.027	0.006
J' evenness (equitability)	0.019	0.291	0.049	0.101	0.076	0.042	0.033	0.049	0.025	0.012
1-J' dominance	0.981	0.709	0.951	0.899	0.924	0.958	0.967	0.951	0.975	0.988

					numbers/m2					
Total Annelids	0	0	0	16	32	0	32	64	0	16
Total Crustaceans	8640	2544	8096	7248	10752	9872	19008	18208	32976	65824
Total Molluscs	0	0	0	0	0	0	0	0	48	96
Total Other *	16	240	32	224	112	112	112	128	176	0

					AFD biomass - g					
Total Annelids	0	0	0	0.0001	0.0006	0	0.0004	0.0009	0	0.0001
Total Crustaceans	0.032	0.0191	0.0453	0.0499	0.0713	0.1079	0.1445	0.2878	0.1846	0.2671
Total Molluscs	0	0	0	0	0	0	0	0	0.0033	0.0271
Total Other *	0.0001	0.0012	0.0001	0.0013	0.0001	0.0001	0.0001	0.0007	0.0001	0

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
					AFD biomass - g/m2					
Total Annelids	0	0	0	0.0048	0.0288	0	0.0192	0.0432	0	0.0048
Total Crustaceans	1.536	0.9168	2.1744	2.3952	3.4224	5.1792	6.936	13.8144	8.8608	12.8208
Total Molluscs	0	0	0	0	0	0	0	0	0.1584	1.3008
Total Other *	0.0048	0.0576	0.0048	0.0624	0.0048	0.0048	0.0048	0.0336	0.0048	0

* 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			
Order Phyllodocida			
Family Nereididae			
Alitta succinea		577	32
Laeonereis culveri	2464	192	48
Unid. Nereididae			16
Family Phyllodocidae			
Eteone heteropoda	80	1282	672
Family Pilargidae			
Hermundura tricuspis		64	
Order Sabellida			
Family Sabellidae			
Dialychone perkinsi			64
Order Spionida			
Family Spionidae			
Polydora cornuta	48	192	32
Streblospio gynobranchiata	64	1154	1040
Family Capitellidae			
Capitella capitata	4752	64	4720
Heteromastus filiformis		1923	32
Mediomastus ambiseta	48	3141	432
Order Terebellida			
Family Cirratulidae			
Aphelochaeta sp.		64	
ARTHROPODA			
Entognatha			
Order Poduromorpha			
Family Hypogastruridae			
Unid. Hypogastruridae		64	
Insecta			
Unid. Insecta			16
Unid. Insect pupa			16
Order Diptera			
Family Chironomidae			
Unid. Chironomidae	16		
Hexanauplia			

TAXA	BS1	BS2	BS3
Order Cyclopoida			
Unid. Cyclopoid copepod		128	
Malacostraca			
Order Amphipoda			
Family Corophiidae			
Apocorophium louisianum		2436	16
Family Gammaridae			
Gammarus sp.		64	
Family Haustoriidae			
Lepidactylus triarticulatus		256	80
Family Isaeidae			
Microprotopus raneyi		64	
Order Decapoda			
Unid. Brachyura zoea	16		
Order Tanaidacea			
Family Paratanaidae			
Hargeria rapax		64	
Maxillopoda			
Order Harpacticoida			
Unid. Harpacticoida	16		
Order Sessilia			
Family Balanidae			
Amphibalanus sp.		577	
Ostracoda			
Unid. Ostracoda	352		
MOLLUSCA			
Bivalvia			
Order Adapedonta			
Family Pharidae			
Ensis megistus coseli		64	
TOTAL NUMBERS	7856	12372	7216
TOTAL TAXA	10	19	14

TAXA	BS1	BS2	BS3
diversity indices			
Hmax'	1.000	1.279	1.146
H' diversity	0.431	0.944	0.520
J' evenness (equitability)	0.431	0.739	0.454
1-J' dominance	0.569	0.261	0.546
		numbers/m2	
Total Annelids	7456	8654	7088
Total Crustaceans	384	3590	96
Total Molluscs	0	64	0
Total Other *	16	64	32
		AFD biomass - g	
Total Annelids	0.059	0.0616	0.0595
Total Crustaceans	0.0004	0.004	0.0001
Total Molluscs	0	0.0593	0
Total Other *	0.0001	0.0001	0.0001
		AFD biomass - g/m2	
Total Annelids	2.832	11.846	2.856
Total Crustaceans	0.019	0.769	0.005
Total Molluscs	0.000	11.404	0.000
Total Other *	0.005	0.019	0.005

* 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			
Insecta										

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
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									
Malacostraca										
Order Amphipoda										

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
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	
MOLLUSCA										
Bivalvia										
Order Arcoida										

TAXA	ST1	ST2	ST3	ST4	ST5	ST6	ST7	ST8	ST9	ST10
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	