

BENTHIC SAMPLING REPORT

FOR

KONA BLUE WATER FARMS

SAMPLES TAKEN AT THE OFFSHORE FARM SITE ON:
MARCH 31, 2009

BY

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DEEP BLUE RESEARCH LLC

This report details the first benthic sampling period of 2009 on the KBWF offshore fish farm site in Kona off Unualoha Point on the Big Island. The samples were taken with a ponar grab sampler lowered to the bottom from the stern of a boat and retrieved with an electric winch. Upon retrieval the sampler was opened and the sample placed in a bucket along with the water that came up with the sample.

Each sample is evaluated immediately after retrieval for:

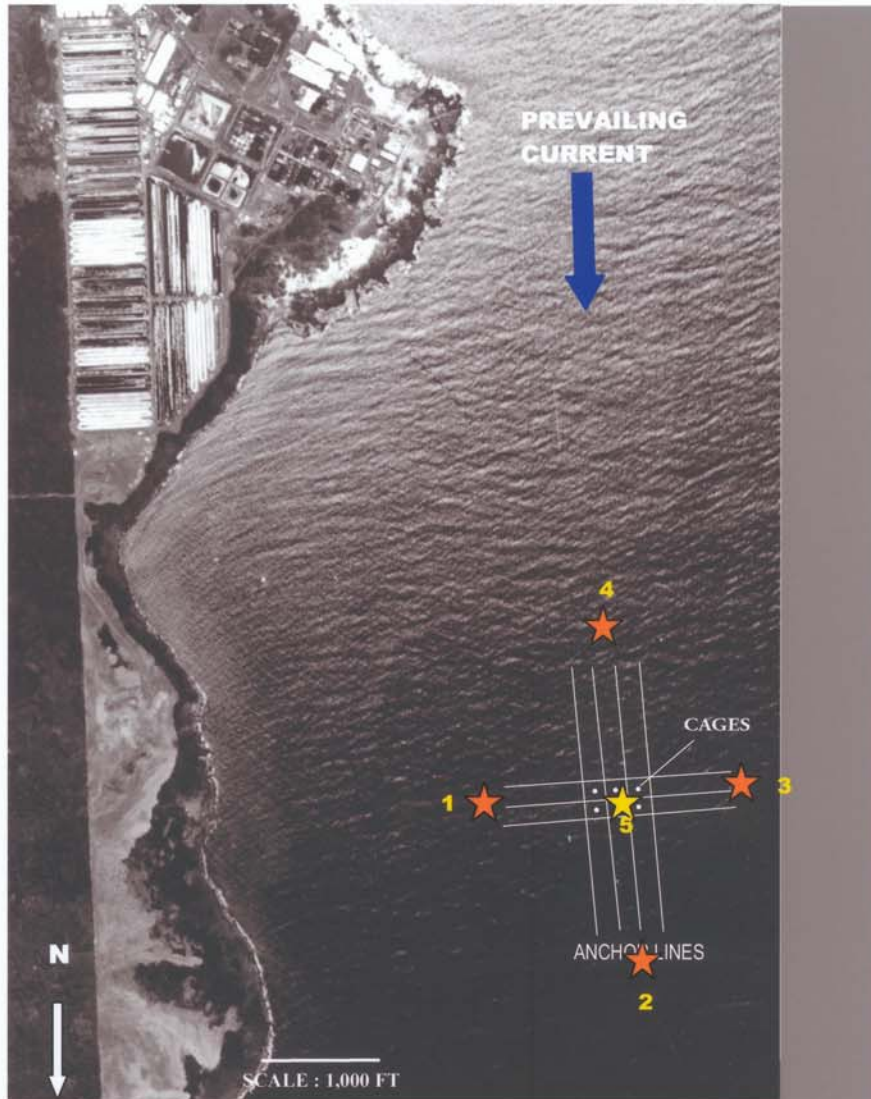
- General appearance
- Macro fauna
- Macro algae
- ORP readings
- Odor (presence of H₂S)

Sub-samples of each sample are taken to the SG Aquatics Laboratories in Kamuela for Total Organic Carbon analysis. Other sub-samples are then washed with fresh water to remove salt and sun-dried. Once dried, the samples are sieved for sand characterization.

Further sub-samples of each sample are examined by microscope, and all micro-mollusks are collected and sent to the Bishop Museum for identification and analysis.

Additional detailed descriptions of the sampling and analysis methodology are described in the first quarterly report.

AERIAL PHOTOGRAPH OF KEAHOLE POINT AREA, AND KONA BLUE FARM SITE,
INDICATES THE BENTHIC SAMPLING SITES.



Stars indicate sampling sites. Samples are taken with a Ponar grab sampler deployed from a boat. Benthic sampling is done quarterly.

GENERAL SAMPLE DESCRIPTION

Benthic sampling notes for 3/31/2009

North Anchor

Light Gray
No Algae
No Smell
No Macro Invertebrates
ORP 137

South Anchor

Dark Gray
No Algae
No Smell
No Macro Invertebrates
ORP 123

West Anchor

Clean
No Algae
No Smell
No Macro Invertebrates
ORP 145

East Anchor

Dark Gray
No Smell
Some Algae (<5 g)
No Macro Invertebrates
ORP 130

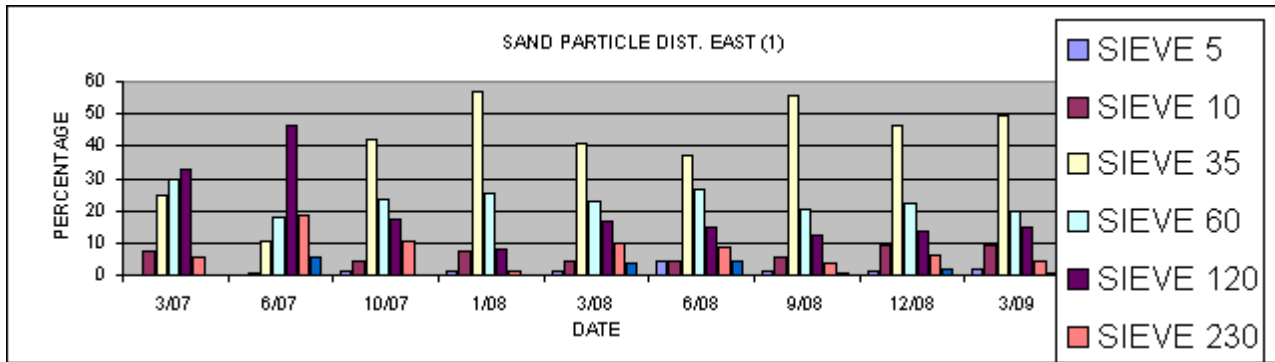
Under Cages

Dark Gray
No Smell
No algae
No Macro Invertebrates
ORP 125

SAND PARTICLE
DISTRIBUTION

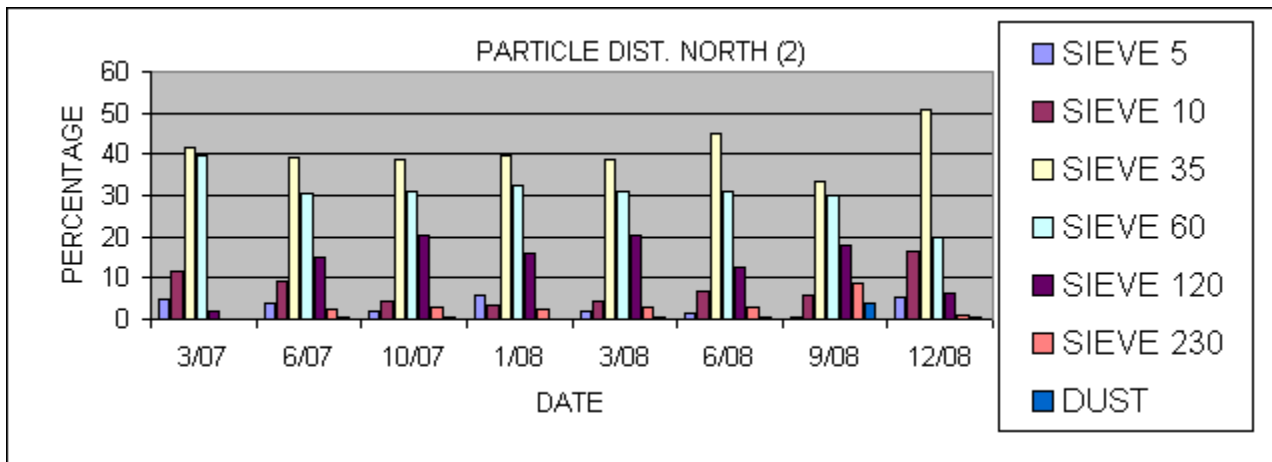
EASTERN ANCHOR SITE (1)

	3/07	6/07	10/07	1/08	3/08	6/08	9/08	12/08	3/09
5	0.3	0.2	1.5	1.3	1.4	4.1	1.4	1.3	1.8
10	7.2	0.9	4.6	7.4	4.5	4.2	5.8	9.2	9.5
35	24.6	10.7	42.2	56.9	40.7	37.3	55.4	46.1	49.3
60	29.5	18	23.5	25.4	22.7	26.7	20.3	22.4	19.5
120	32.9	46.3	17.6	8.1	17	14.6	12.6	13.4	14.7
230	5.4	18.6	10.5	1	10.2	8.7	3.6	6	4.3
dust	0	5.3	0	0	3.6	4.5	0.8	1.6	0.8



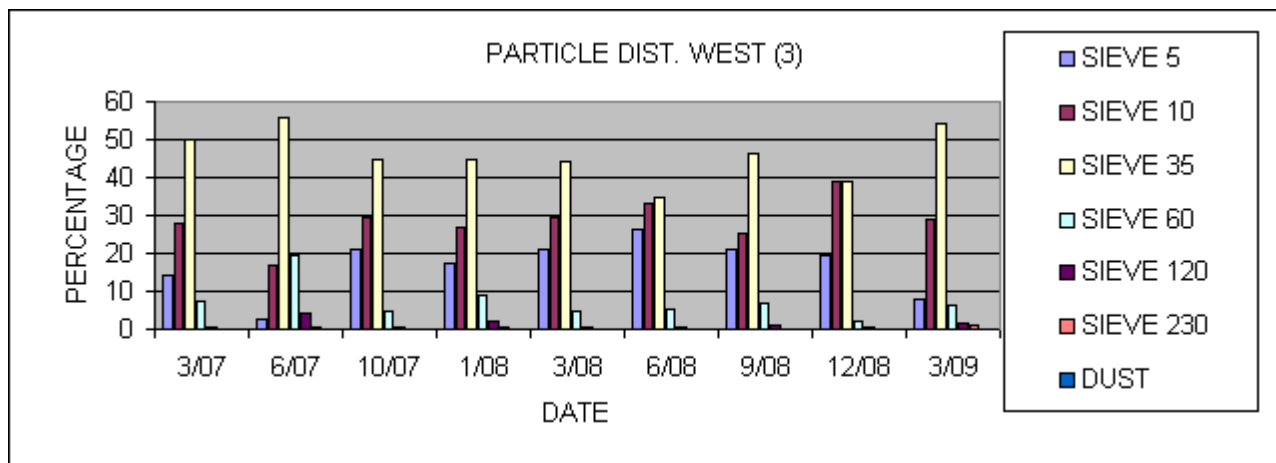
NORTHERN ANCHOR SITE (2)

	3/07	6/07	10/07	1/08	3/08	6/08	9/08	12/08	3/09
5	5	3.7	1.9	5.8	1.9	1.5	0.5	5.4	1.2
10	11.4	9.1	4.4	3.5	4.4	6.6	5.8	16.3	7.2
35	41.8	39	38.8	39.8	38.8	44.9	33.5	51	47
60	39.8	30.6	31.1	32.4	31.1	31.0	29.8	19.6	28.6
120	1.9	15.1	20.3	16.1	20.3	12.5	17.7	6.5	12.3
230	0	2.3	3	2.3	3	2.8	8.6	0.9	3
dust	0	0.3	0.5	0.1	0.5	0.6	4.1	0.3	0.7



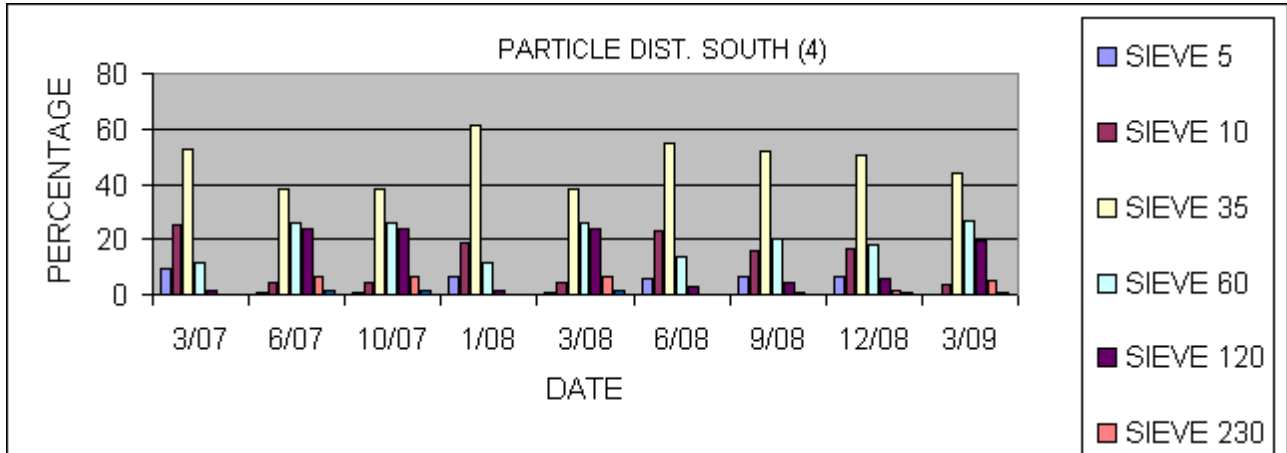
WESTERN ANCHOR SITE (3)

	3/07	6/07	10/07	1/08	3/08	6/08	9/08	12/08	3/09
5	14.3	2.7	21	17.3	20.9	26.3	20.9	19.4	7.7
10	28.1	17.1	29.7	26.7	29.5	33.3	25.2	38.9	28.9
35	49.8	56	44.6	44.6	44.4	34.6	46.1	39	54.4
60	7.2	19.6	4.5	8.8	4.5	5.1	6.6	2.3	6.2
120	0.7	4.3	0.7	2.1	0.7	0.7	1.2	0.3	1.5
230	0	0.3	0.1	0.5	0.1	0.1	0.1	0.1	1.3
dust	0	0	0	0	0	0.0	0	0	0



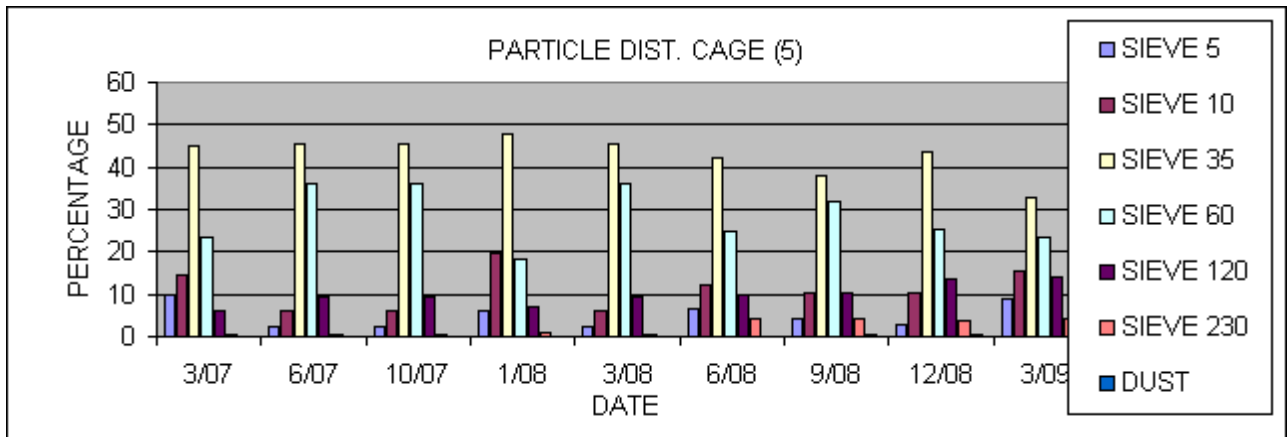
SOUTHERN ANCHOR SITE
(4)

	3/07	6/07	10/07	1/08	3/08	6/08	9/08	12/08	3/09
5	9.2	0.5	0.5	6.6	0.5	5.6	6.3	6.8	0.3
10	25.2	4.2	4.2	18.7	4.2	23	15.7	16.9	3.6
35	52.7	38.1	38.1	61.3	38.1	54.9	52	50.4	43.7
60	11.6	26	26	11.4	26	13.4	20.3	17.9	26.6
120	1.2	23.5	23.5	1.6	23.5	3	4.6	6.1	19.8
230	0.1	6.3	6.3	0.1	6.3	0.2	0.9	1.3	5.1
dust	0	1.4	1.4	0.3	1.4	0	0.2	0.5	0.9



CAGE SITE (5)

	3/07	6/07	10/07	1/08	3/08	6/08	9/08	12/08	3/09
5	10	2.3	2.3	6.2	2.3	6.4	4.3	2.7	8.7
10	14.7	6.2	6.2	19.6	6.2	12.3	10.5	10.5	15.6
35	45.1	45.4	45.4	47.8	45.4	42.3	38.1	43.7	33
60	23.5	36.1	36.1	18.3	36.1	24.8	32.1	25.3	23.5
120	6.2	9.2	9.2	7	9.2	10	10.4	13.4	14
230	0.5	0.7	0.7	0.9	0.7	4.1	4	3.8	4.1
dust	0	0.1	0.05	0.2	0.1	0.1	0.5	0.6	1



The general make up of the substrate samples is similar to previous samples. The substrate is generally sandy. The samples further from shore are coarser in nature with less silt. The site is completely sandy with no hard substrate or coral in the area. Consequently there is little macro fauna or flora in this area. While the general particle distribution relationship stays the same over time, there is more variability than would be expected. The site is known for very high current speeds, sometimes over 2 knots and can run either to the north or to the south. Changes in the current speed and direction appear to be moving the sand around and changing the relative particle distribution somewhat from time to time. This current likely stirs up, suspends, and sweeps away detritus under the farm.

CHEMICAL ANALYSIS

Chemical analysis of the sediment samples includes measuring the Total Organic Carbon levels of the substrate and testing for the Oxidation / Reduction Potential with a meter immediately after retrieval in the boat.

Sg Aquatics

SG AQUATICS

PMB #254, 65-1158 MAMALAHOA HWY.
KAMUELA, HI 96743
808-885-3597 OFFICE/FAX

06/09/09


CLIENT: Dale Sarver

Sample type: Sediment

Date sampled: 03/09/09 - D 1183

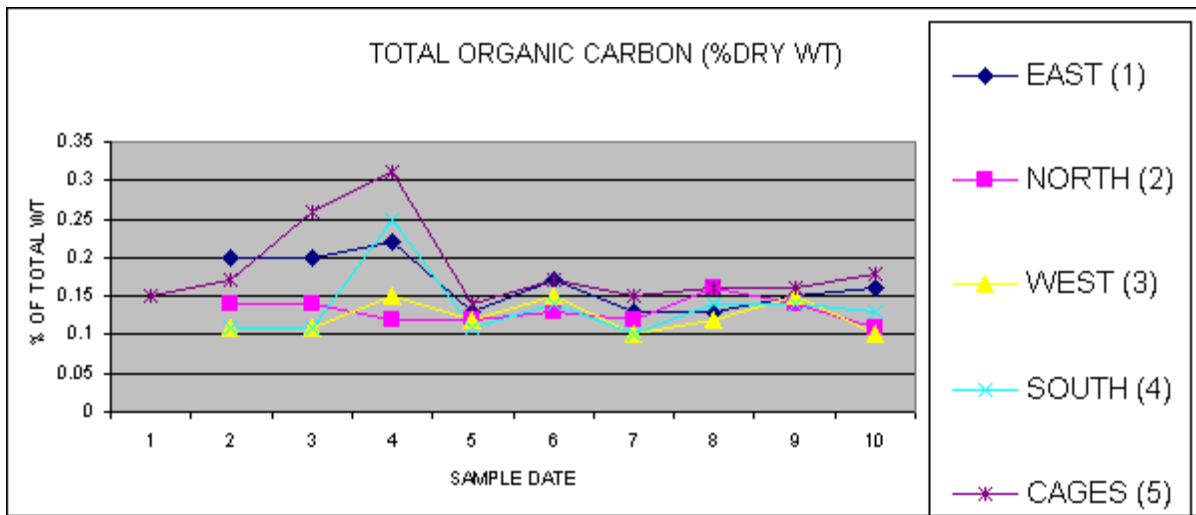
Analyte: Sample:	TOC (%)	DLR
South Anchor	0.13	0.01
North Anchor	0.11	0.01
West Anchor	0.10	0.01
East Anchor	0.16	0.01
Cage	0.18	0.01

Please call with any questions.


Steve Grasso, Director

TOC HISTORY KBWF SITE

	11/17/06	3/8/07	6/18/07	10/27/07	1/31/08	3/31/08	6/19/08	9/25/08	12/31/08	3/31/09
EAST (1)		0.2	0.2	0.22	0.13	0.17	0.13	0.13	0.15	0.16
NORTH (2)		0.14	0.14	0.12	0.12	0.13	0.12	0.16	0.14	0.11
WEST (3)		0.11	0.11	0.15	0.12	0.15	0.1	0.12	0.15	0.1
SOUTH (4)		0.11	0.11	0.25	0.11	0.14	0.1	0.14	0.14	0.13
CAGES (5)	0.15	0.17	0.26	0.31	0.14	0.17	0.15	0.16	0.16	0.18



During the last year the TOC levels in the substrates around the farm have stabilized considerably at relatively low levels. There is much less variability between the sampling sites. As suggested previously, the improvement is most likely due to improvements in feeding technology. The methods for feeding the fish have changed as the farm grew. The process has become more mechanized with the introduction of a feeding barge permanently moored on the site. Feed is now distributed through a much improved computerized pumping system and feeding is monitored by multiple underwater video cameras. This allows for better monitoring of fish feeding behavior and feed falling through the water. Feed introduction can be stopped as soon as vigorous feeding behavior slows down. This feeding strategy improves digestive efficiency and eliminates pellets falling through the cage and settling on the bottom. It appears that the stabilization of the TOC readings is a result of better feeding control.

In addition, the farm is reducing the number of cages and fish on the farm. This results in less feed and consequently less organic material settling on the bottom. The lower TOC levels are no doubt also associated with less fish biomass and feed on the farm.

TOC measurements over time can reflect the influence of organics coming from the farm. TOC readings are regularly monitored around the sewer outfall on Oahu, and range between 0.17 and 0.42 as a % of dry wt. The readings from the farm range between 0.15 to 0.31, and are within the range seen at the outfall. These levels measured around the outfall are not considered problematic. As stated in the Benthic

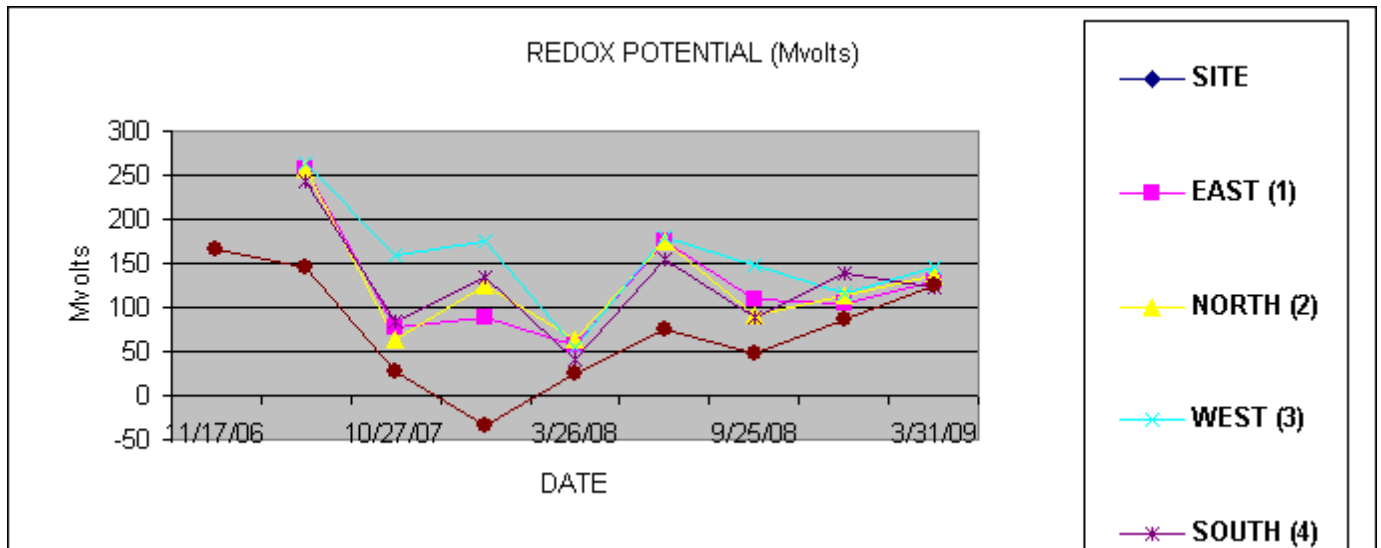
Sampling Adjacent to the Waianai Ocean Outfall, Oahu, Hawaii, May 2006 by the Water Resources Research Center : “Based on available data using tests recommended by EPA for sediment analysis, there is no evidence that secondary treated sewage effluent from the Waianae Ocean Outfall is affecting the benthic fauna community in the vicinity of the discharge.

OXYDATION / REDUCTION READINGS

METER ORP READINGS OF THE SUBSTRATE SAMPLES ARE TAKEN IMMEDIATELY AFTER SAMPLE IS BROUGHT ON BOARD.

OXYDATION/REDUCTION POTENTIAL (Mvolts)

	11/17/06	6/18/07	10/27/07	1/31/08	3/26/08	6/19/08	9/25/08	12/31/08	3/31/09
SITE									
EAST (1)		256	78	88	56	176	110	104	130
NORTH (2)		256	64	125	64	175	90	114	137
WEST (3)		264	158	174	54	179	147	115	145
SOUTH (4)		244	84	134	41	155	88	138	123
CAGES (5)	167	146	28	-34	25	75	47	86	125



OXYDATION / REDUCTION POTENTIAL

ORP is an indirect means of evaluating the level of biological activity in the substrate as well as how efficiently the substrate is chemically communicating with the water above. Low readings suggest there is a high amount of biological activity (primarily bacterial) and that there is insufficient exchange to

maintain aerobic conditions. Readings below zero indicate anaerobic conditions. High levels of biological activity remove oxygen faster than it can be replaced and the system becomes anaerobic. Anaerobic conditions determine the types of organisms that can inhabit the substrate and there is a shift in the make-up and abundance of the fauna and flora. Introduction of excessive organic material (fish feces, uneaten feed, or large amounts of fouling material from the cages) can result in anaerobic conditions.

Standard sampling methods suggest ORP readings should be taken as soon as possible after the samples are retrieved, and these readings are taken within minutes. Overall, the data available suggest declining ORP readings in the area up to the first quarter of 2008. Decreased readings under the cages and to the North and South are understandable as organic material from the farm could be affecting those areas. Any decreased readings however for the West Anchor site is puzzling as there is never current running from the cages directly out to sea. There may be inherent variability in the substrate and sediments based on current direction and speed, and possibly natural seasonality.

The status of the substrate under and around the cages has certainly varied over the past years, and has trended toward lower readings until recently. For the first time in January the REDOX reading directly under the cages went below zero, indicating anoxic conditions. This result agrees with the visual observations and odor of that sample. However, by March, all the readings were positive again, which corresponded to other readings and reduction of H₂S odors. The REDOX readings in June and again in September and December were all much higher than in the previous few months, even though the standing stock of fish and feeding had increased. The REDOX data is showing the same tendency as the TOC data, visual, and H₂S smell suggesting a reduced influx of organic material to the bottom. Again, these results are most likely due to vastly improved feeding techniques reducing organic matter falling to the bottom.

The lower TOC readings are no doubt also due in part to the reduction of fish biomass and feeding on the farm.

It is possible that the fauna and flora of the area could be adapting to increases in organic input and more successfully cycling the material through the ecosystem while maintaining aerobic conditions. However, the data from the micromollusk monitoring does not indicate this to be the case. The relative abundance and distribution of the snails has remained relatively constant.

MICROMOLLUSK DISTRIBUTION REPORT
FOR
KONA BLUE WATER FARMS
(Regina Kawamoto, Bishop Museum & Dale Sarver)

Collected March 2009

Methods:

The sand samples were taken with a Ponar grab sampler lowered and retrieved using an electric winch mounted on the stern of the research boat Hanamana. The grabs were about 1 liter in volume. The samples were rinsed in fresh water and sun dried. Micromollusks (mollusk shells less than 10mm in greatest diameter) were collected by Dr. Dale Sarver from sand-accumulations at five stations: Sta. 1, 2, 3, 4, and 5.

Only fresh shells were removed from aliquots of 15 ml by using a dissecting microscope. Because these shells were not separated into living and dead fractions, they represent time-average samples. The shells were identified to the lowest taxonomic level possible using Kay, 1979 as the primary taxonomic, habit and habitat references, along with Beesley, Ross & Wells, 1998 for additional habitat and trophic information.

Micromollusks:

The March 2009, micromollusk samples from the Kona Blue Water Farm LLC off-shore aquaculture sites were representative of various habitats and trophic structures (Kay, 1979; Beesley et al., 1998). A total of 1,131 micromollusks belonging to 79 mollusk taxa were sorted and counted. [Appendix 1; Fig. M1- M5].

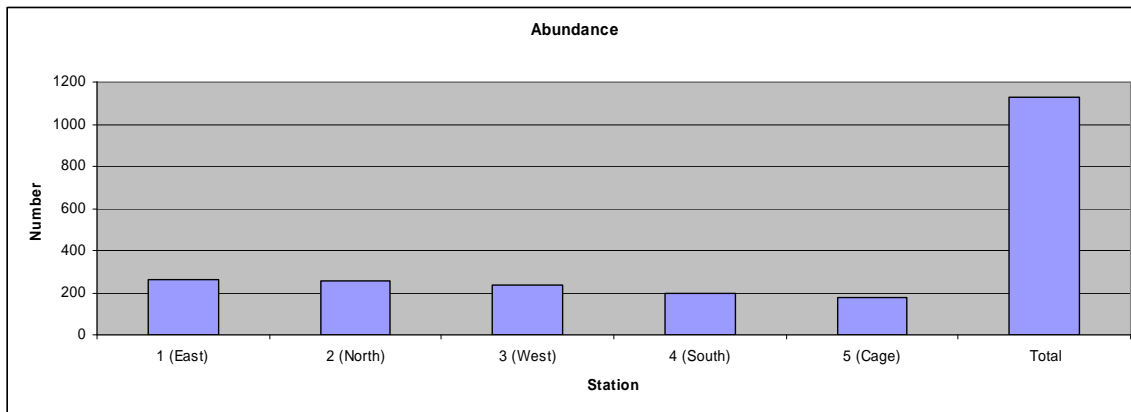


Fig. M1: Mollusk abundances for March 2009.

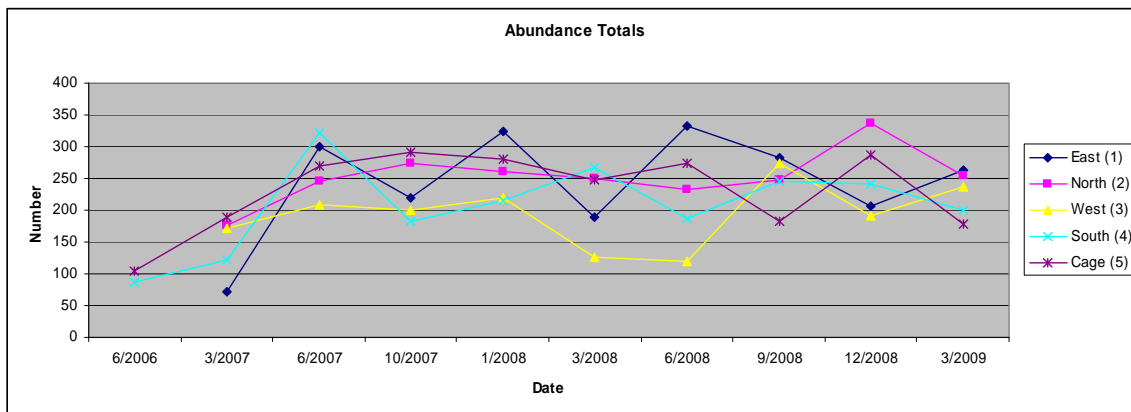


Fig. M2: Mollusk abundance for March 2009, compared with abundances from previous samplings: *June 2006 (only 2 sample sites); March, June and October 2007; and January, March, June, September and December 2008.

The abundances for all dates and stations fluctuated between a low of 71 (Sta. 1, March 2007) and a high of 337 (Sta. 2, December 2008) [Fig. M2].

When abundance totals were compared for each sampling date (i.e. *June 2006, only 2 sample sites; March, June and October 2007; January, March, June, September and December 2008; and March 2009) the numbers ranged between 193 (June 2006) and 1346 (June 2007) [Fig. M3].

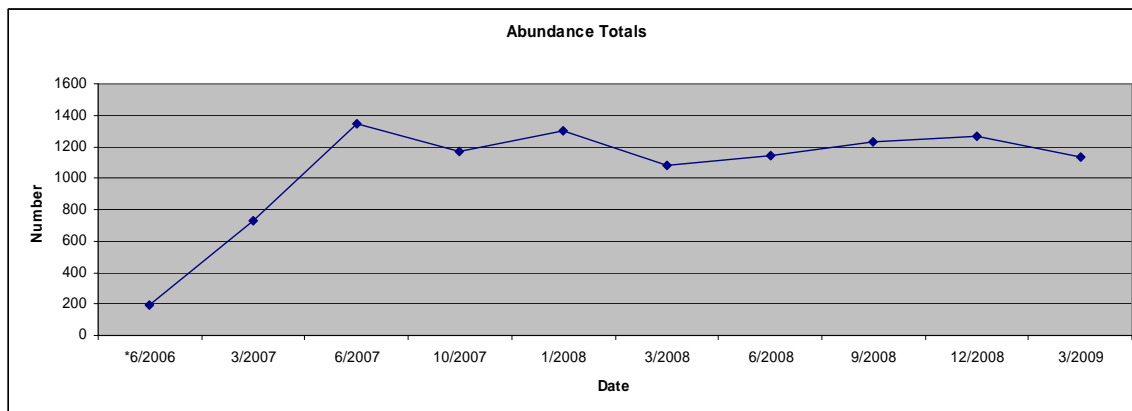


Fig. M3: Abundance totals for: *June 2006 (only 2 sample sites); March, June and October 2007; January, March, June, September and December 2008; and March 2009.

There were a total of 79 mollusk taxa for March 2009. There were 33 for Sta. 1 (East); 35 for Sta. 2 (North); 38 each for Sta. 3 (West), 44 Sta. 4 (South); and 31 for Sta. 5 (Cage) [Fig. M4].

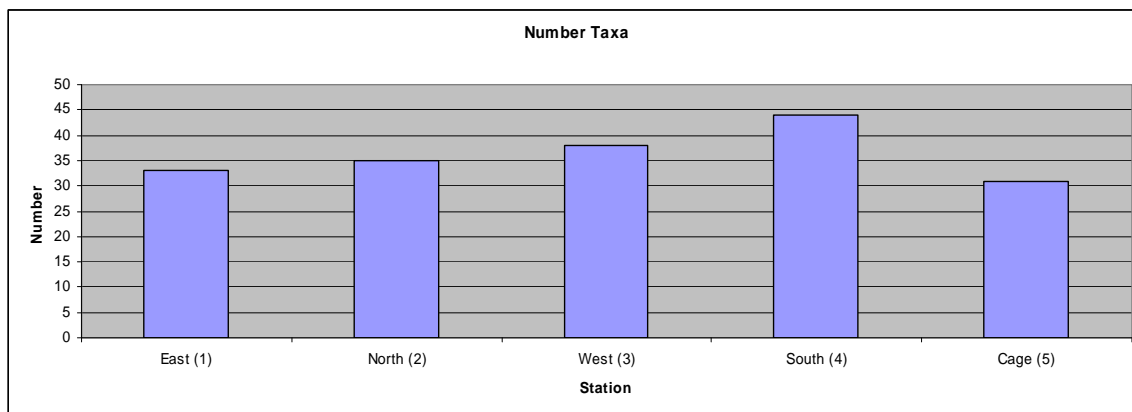


Fig. M4: Number of mollusk taxa for March 2009.

The number of taxa for all stations and sampling dates ranged between 19 (Sta. 1, March 2007) and 49 (Sta. 4, June 2007) [Fig. M5].

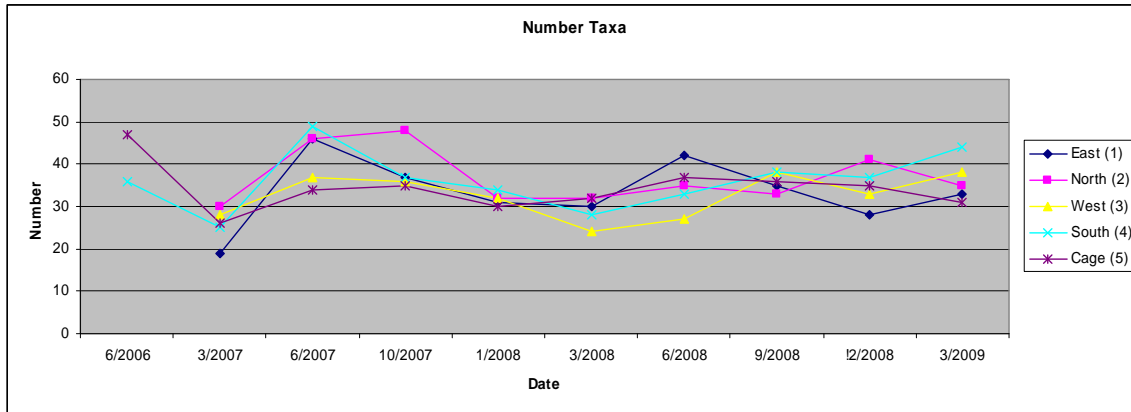


Fig. M5: Number of taxa for each station for March 2009, compared with previous taxa numbers [i.e. June 2006; March, June and October 2007; January, March, June, September and December 2008].

For March 2009, gastropods comprised 98.2% of the micromollusk abundance for all stations combined (i.e. Stations 1-5). They were followed by bivalves (1.8%). There were no Scaphopoda or Polyplacophora present at this sampling. At Sta. 1 (East), gastropods (98.5%) were followed by bivalves (1.5%); Sta. 2 (North), gastropods made up 99.2% and bivalves 0.8%; Sta. 3 (West), gastropods were 98.7% of the sample with bivalves at 1.3%; Sta. 4 (South), 97.0% for gastropods and 3.0% for bivalves; and Sta. 5 (Cage), gastropods made up 97.2%, and bivalves 2.8% [Fig. M6]. The high proportion of gastropods: low bivalve proportion is said to be due to lack of expanses of nutrient-rich, silty sand ocean substrata (Kay, 1967).

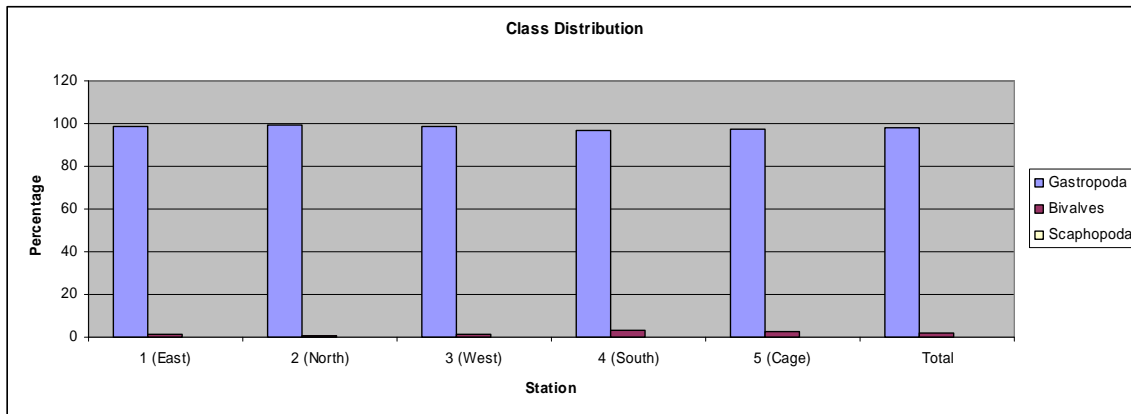


Fig. M6: Class distribution percentages for March 2009.

When comparing March 2009 class distributions with previous samples taken [i.e. March, June, and October 2007; and January, March, June, September, and December 2008], for Stas. 1, 2, 3, 4, and 5 at the Kona Blue Water Farms aquaculture, March 2009 fit into the trend (i.e. gastropods made up major portions of the molluscan assemblages, and bivalves minor portions) [Fig. M7- M11].

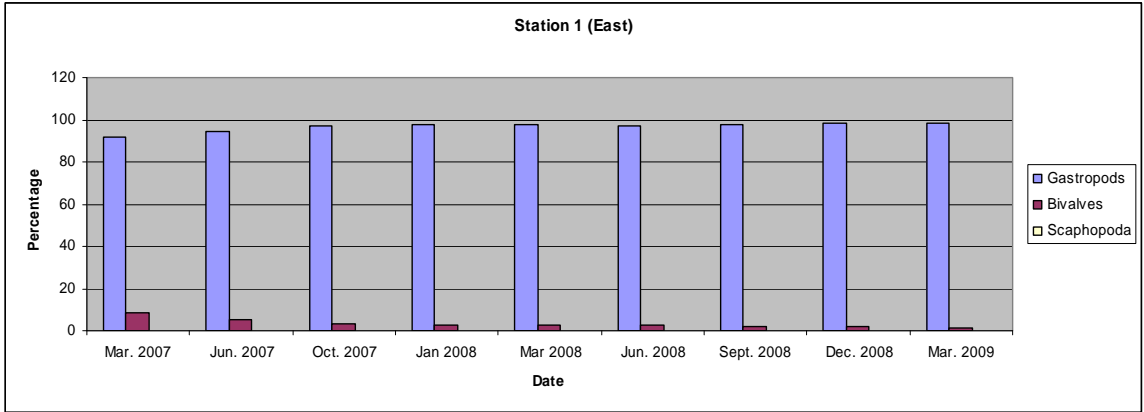


Fig. M7: Class distribution percentages for Sta 1 (East).

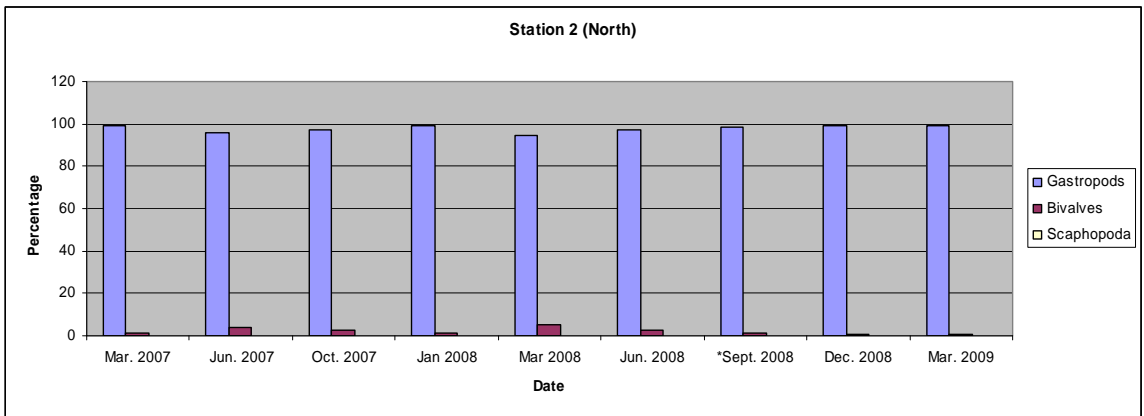


Fig. M8: Class distribution percentages for Sta. 2 (North).

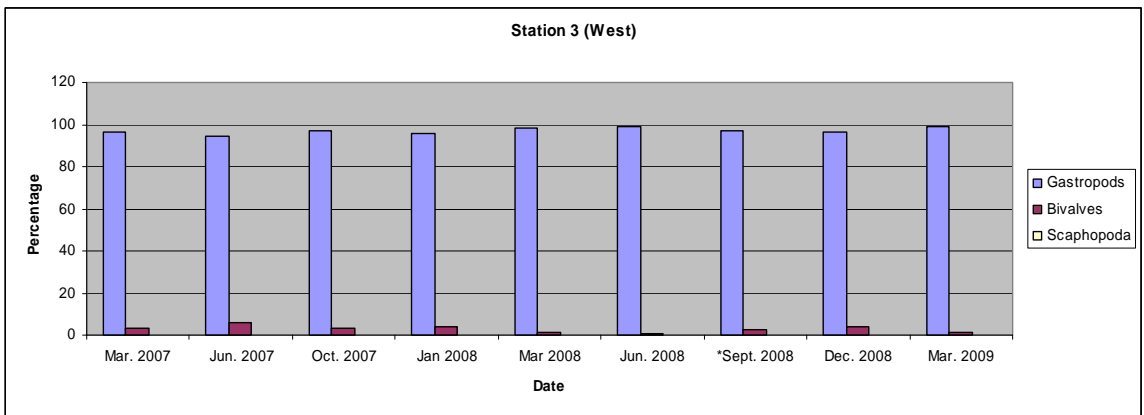


Fig. M9: Class distribution percentages for Sta. 3 (West).

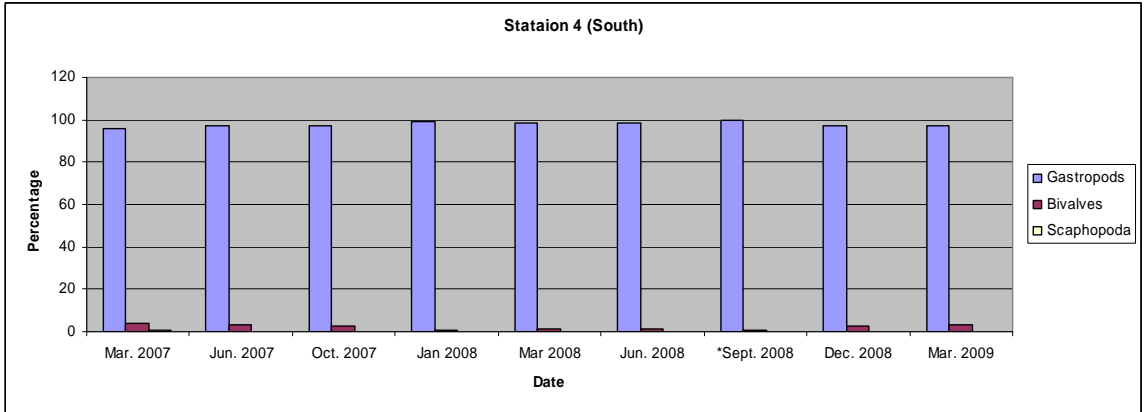


Fig. M10: Class distribution percentages for Sta. 4 (South).

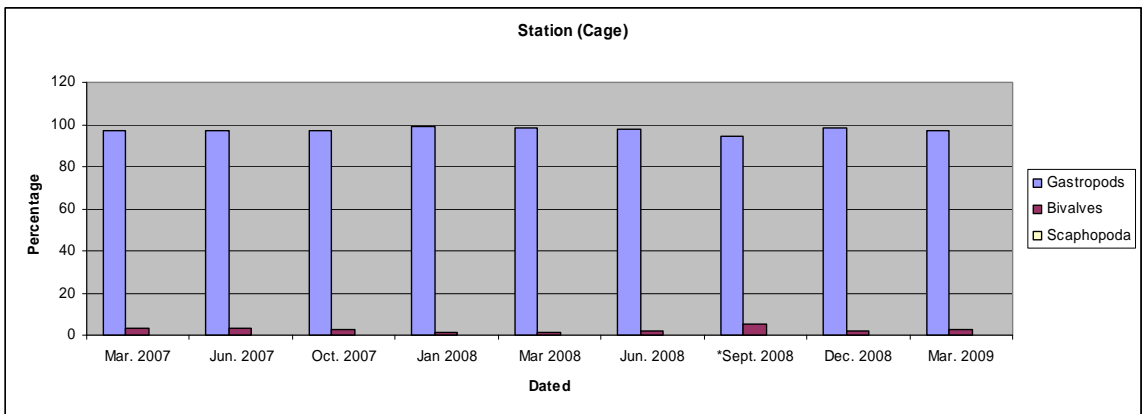


Fig. M11: Class distribution percentages for Sta. 5 (Cage).

For all taxa present at the study sites for March 2009, epifaunal species (i.e. species associated with rocks, gravel, or other hard substrata) made up 87.6% of the total. They were followed by infaunal species (i.e. species that burrow or live in bottom deposits of the ocean) (7.9%), parasites (3.6%), and undetermined (0.9%) [Fig. M12].

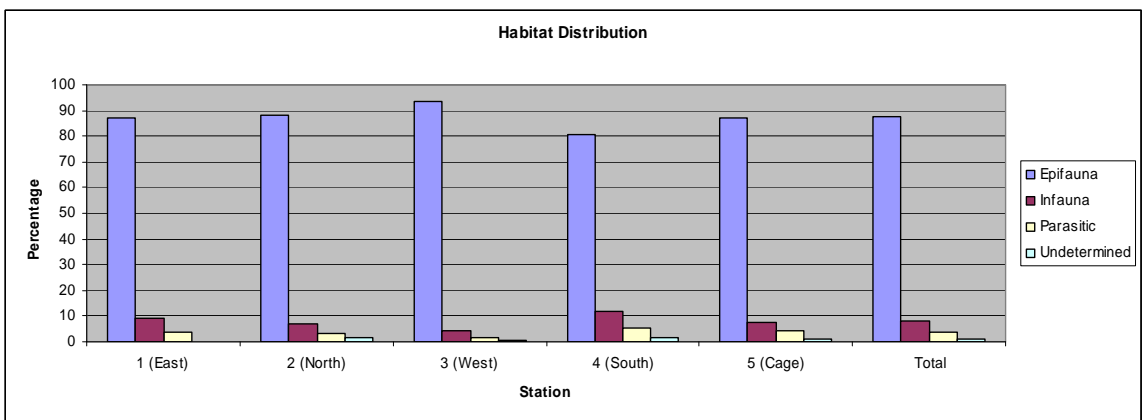


Fig. M12: Habitat distribution for March 2009.

Habitat percentages for March 2009 were similar to previous samples: [i.e. March, June and October 2007; and January, March, June, September, and December 2008] for Stas. 1 to 5 at the Kona Blue Water Farms aquaculture [Figs. M13-M17].

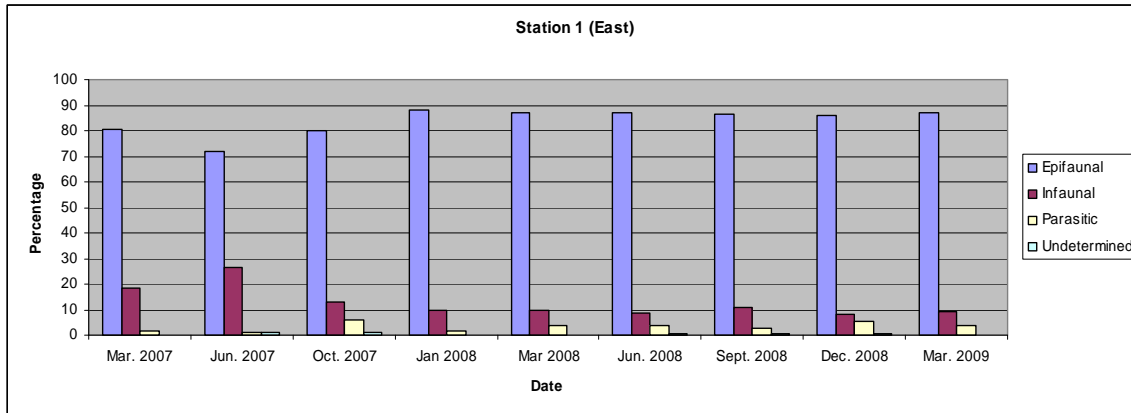


Fig. M13: Habitat distribution for all samplings at Sta. 1 (East).

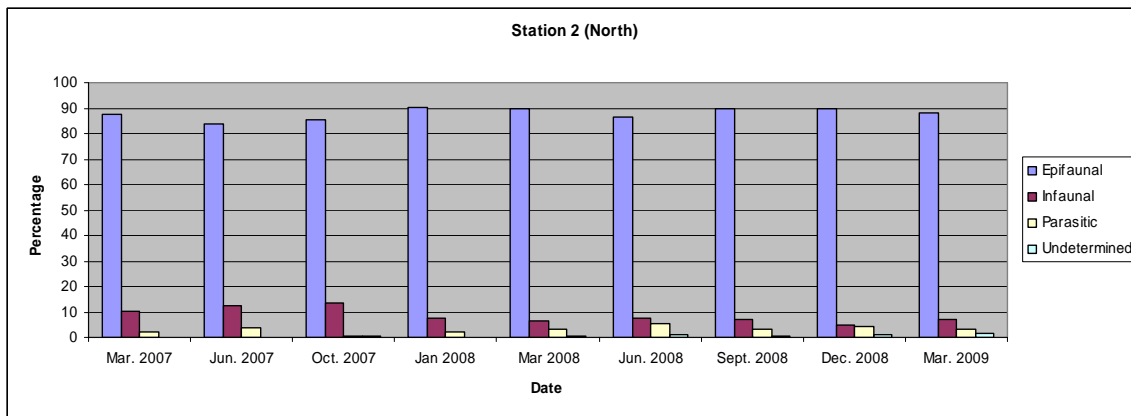


Fig. M14: Habitat distribution for all at Sta. 2 (North).

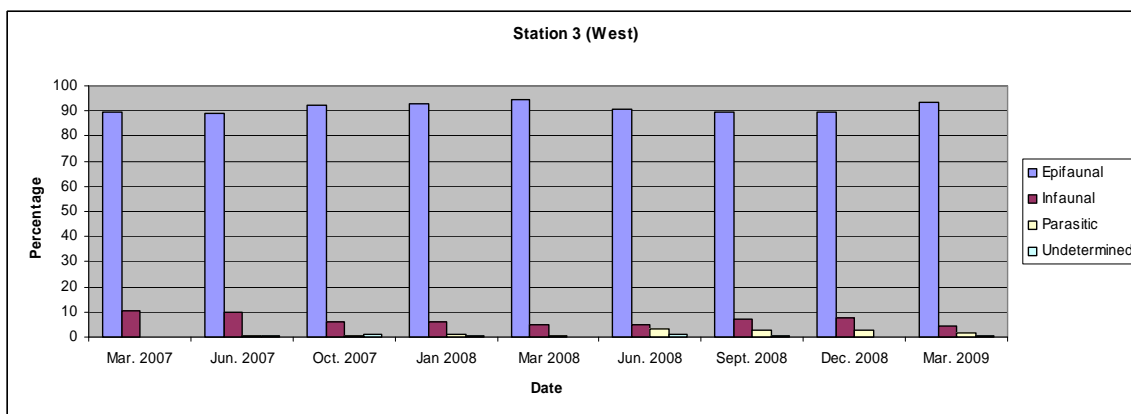


Fig. M15: Habitat distribution for all samplings at Sta. 3 (West).

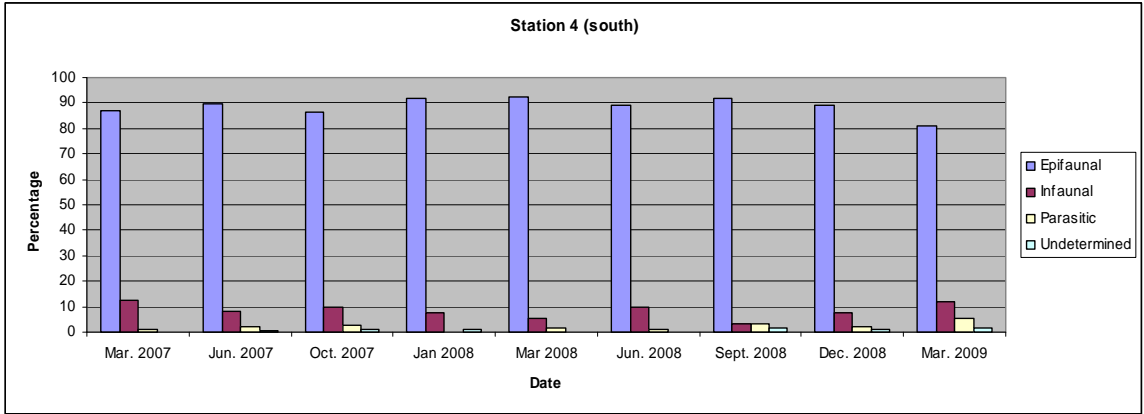


Fig. M16: Habitat distribution for all samplings at Sta. 4 (South).

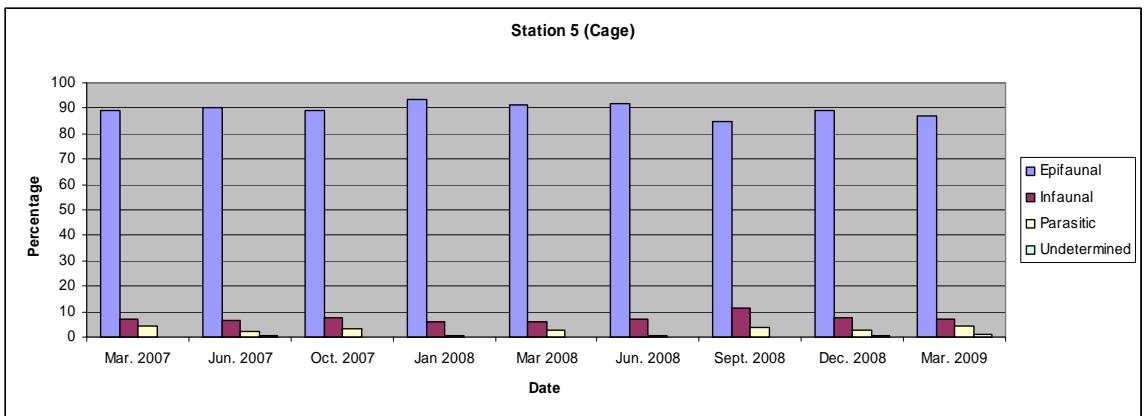


Fig. M17: Habitat distribution for all samplings at Sta. 5 (Cage).

Trophic distributions for March 2009 showed detritivores (which also includes the foragers and omnivores) made up 79.8% of the total (i.e. all taxa). They were followed by herbivores (8.8%), carnivores (5.0%), parasites (3.9%), filter feeders (1.9%), and undetermined (0.7%) [Fig. M18].

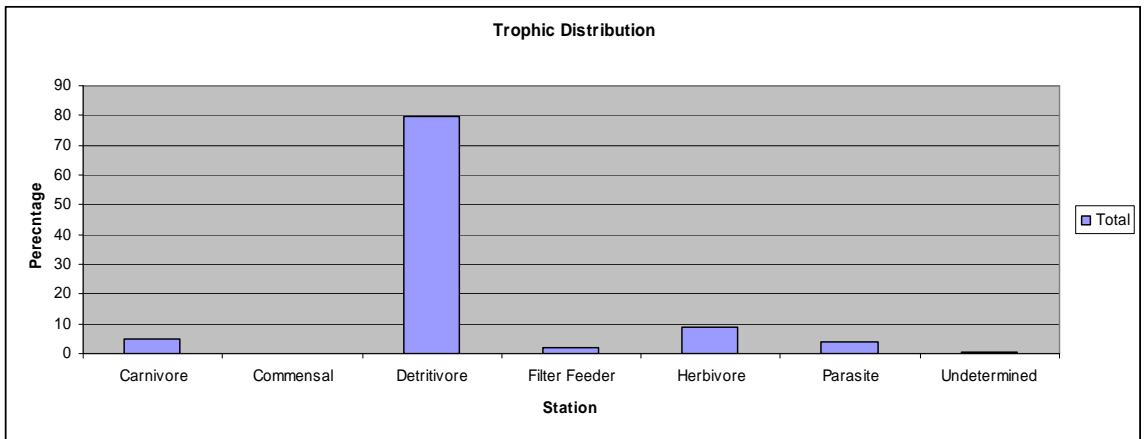


Fig. M18: Trophic Distribution of all Stations combined for March 2009.

When compared with previous samplings [i.e. March, June and October 2007, and January, March, June and September, and December 2008, excluding June 2006], March 2009 showed similar trends as before: detritivores made up between 73.4% (June and October 2007) and 80% (June 2008) of the totals. They were followed by: herbivores between 8.8% (March 2009) and 14.0% (October 2007); carnivores between 3.4% (December 2008) and 7.0% (March 2007); filter feeders between 1.5% (January 2008) and 4.4% (June 2007); parasites between 2.2% (March 2007) and 4.0% (December 2008); undetermined between 0% (March 2007) and 0.7% (October 2007); and commensals between 0.0% (March and October 2007, September and December 2008, and March 2009) and 0.3% (June 2007) [Figs.M19-M25].

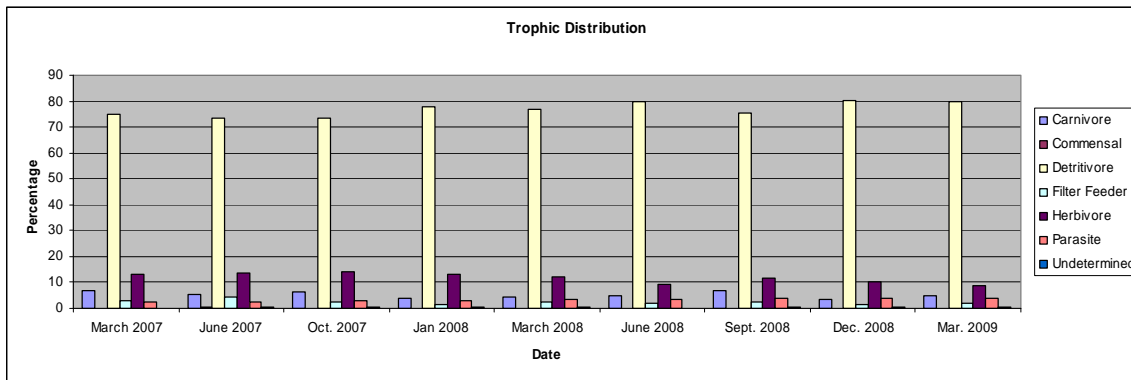


Fig. M19: Overall trophic type percentages for all stations combined for March, June, and October 2007; January, March, June, September, and December 2008; and March 2009; excluding June 2006.

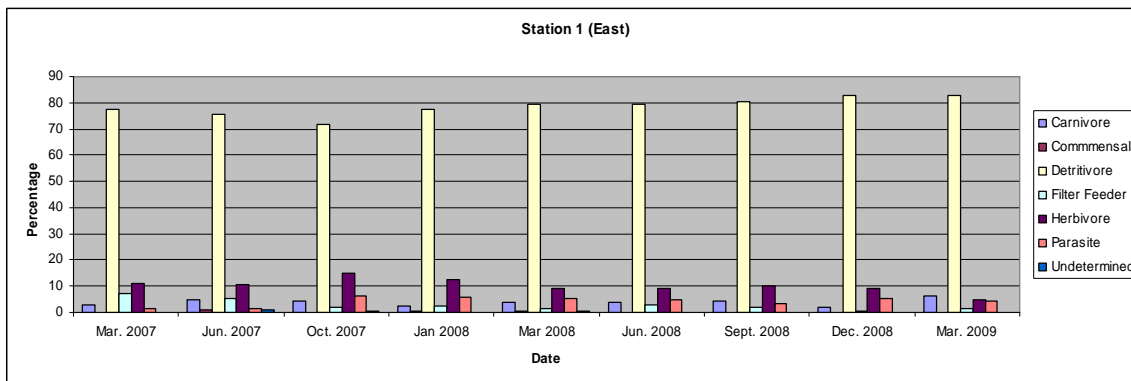


Fig. M20: Trophic distribution at Sta. 1 (East) for all samplings; excluding June 2006.

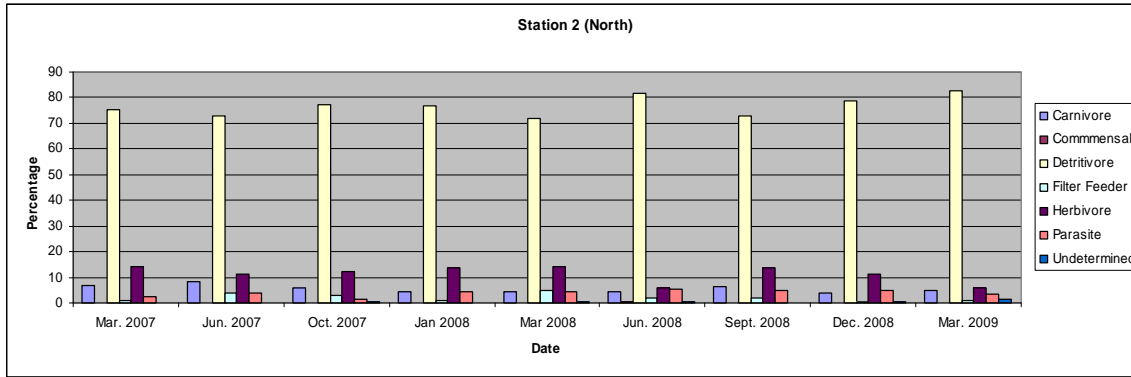


Fig. M21: Trophic distribution at Sta. 2 (North) for all samplings; excluding June 2006.

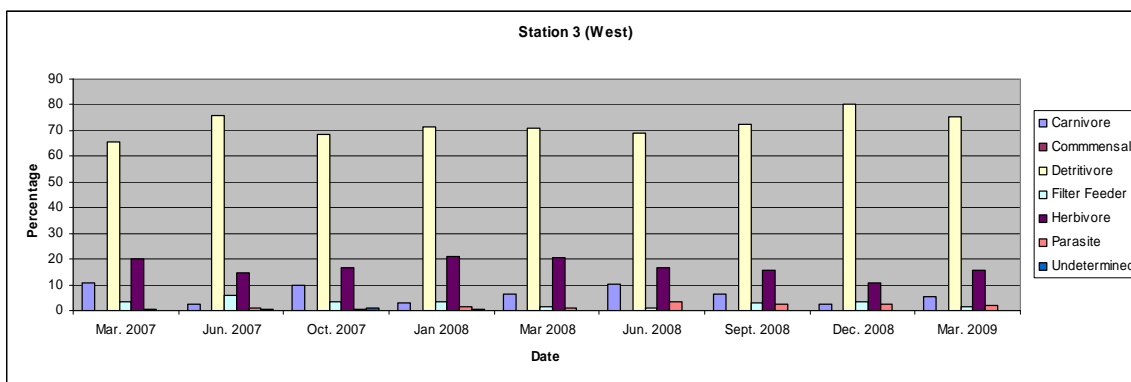


Fig. M22: Trophic distribution at Sta. 3 (West) for all sampling; excluding June 2006.

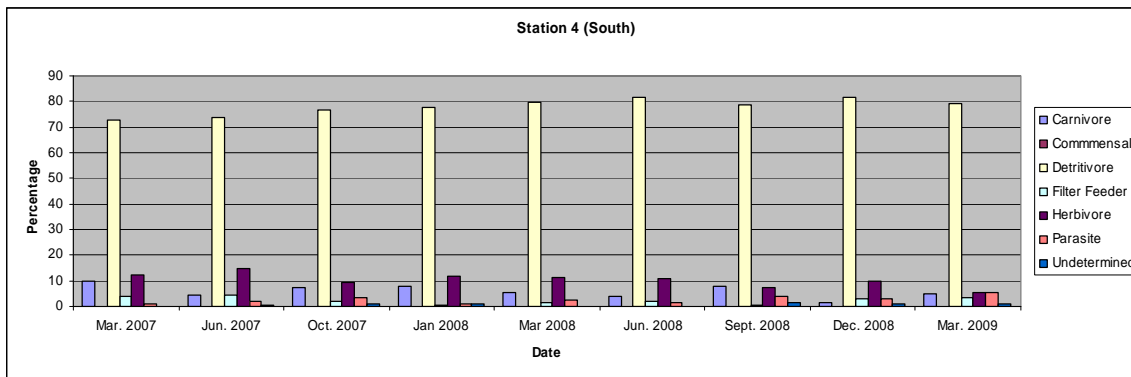


Fig. M23: Trophic distribution at Sta. 4 (South) for all samplings; excluding June 2006.

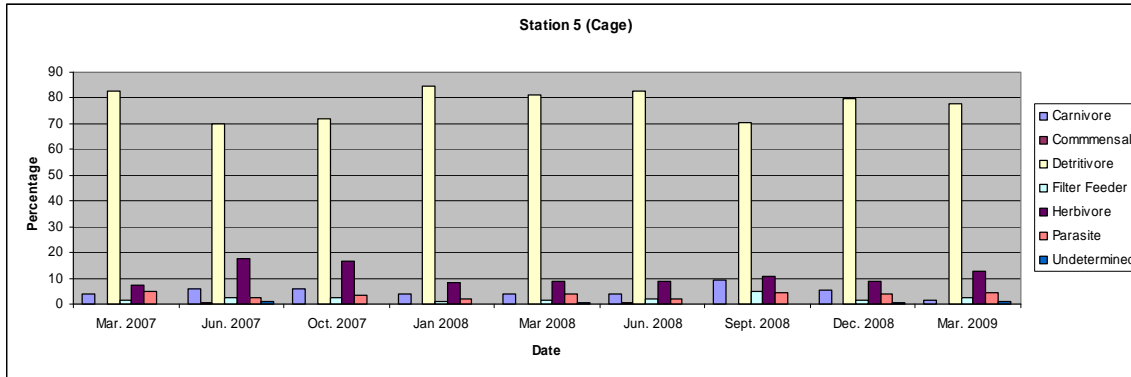


Fig. M24: Trophic distribution at Sta. 5 (Cage) for all samplings; excluding June 2006.

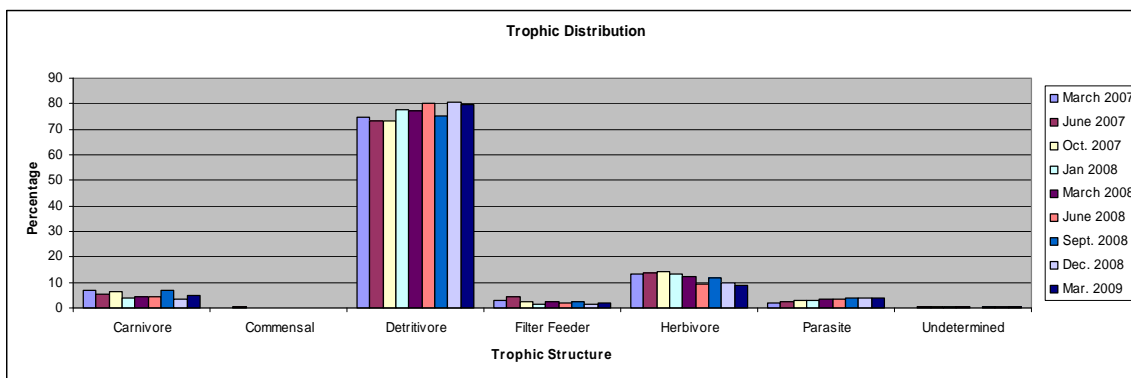


Fig. M25: Overall trophic type distribution for the differing sampling dates [i.e. March, June, and October 2007; January, March, June, September, and December 2008; and March 2009, excluding June 2006].

For the epifauna, which made up a major portion of the micromollusk population for March 2009, 85.6% were detritivores followed by herbivores (9.6%), carnivores (3.9%), filter feeders (0.6%) and parasites (0.3%). No commensals were present. At Sta. 1 (East), detritivores (88.7%) were followed by herbivores (5.7%), carnivores (4.3%), filter feeders (0.9%) and parasites (0.4%). Sta. 2 (North) showed that detritivores (87.5%) were followed by herbivores (6.7%), carnivores (4.9%), with filter feeders and parasites both at 0.4%. At Sta. 3 (West), detritivores (78.3%) were followed by herbivores (16.3%), carnivores (4.5%), and filter feeders and parasites both at 0.5%. Sta. 4 (South) showed detritivores (90.1%) were followed by herbivores (5.0%), carnivores (3.7%), and filter feeders (1.2%). No commensals or parasites were present at Station 4. At Sta. 5 (Cage), detritivores (83.9%), followed by herbivores (14.8%), and carnivores (1.3%). No commensals, filter feeders or parasites were present at Sta. 5. [Fig. M26].

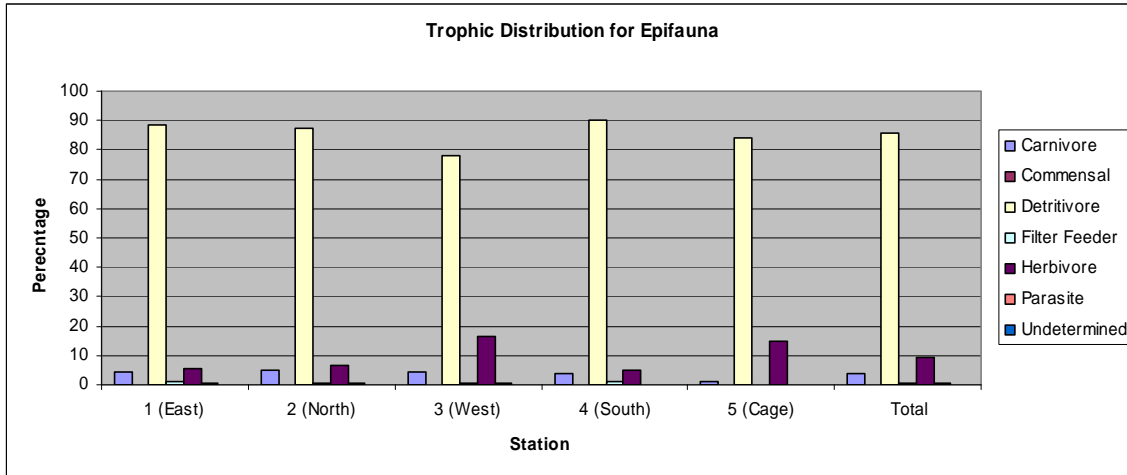


Fig. M26: Trophic distribution for epifauna, March 2009.

For infaunal species (comprising only 7.9% of the total number of specimens counted for March 2009), detritivores (61.8%) made up a major portion of this habitat. They were followed by carnivores and filter feeders both at 16.9 and herbivores at 4.5%. No commensals were present. At Sta. 1 (East), detritivores (62.5%) were followed carnivores (29.2%), and filter feeders (8.3%). No commensals or herbivores were recorded for station 1. Sta. 2 (North) showed detritivores at 77.8%; carnivores and filter feeders both at 11.1%. No herbivores were present at Sta. 2. At Sta. 3 (West), detritivores made up 33.3% of this habitat. They were followed by carnivores (20.0%), filter feeders (20.0%), and herbivores (10.0%). Sta. 4 (South) had detritivores at 54.2%, filter feeders at 20.8%, carnivores at 12.5% and herbivores at 12.5%. Finally at Sta. 5 (Cage), detritivores (61.5%) were followed by filter feeders (30.8%), and carnivores (7.7%). No commensals or herbivores were present at this station. [Fig. M27].

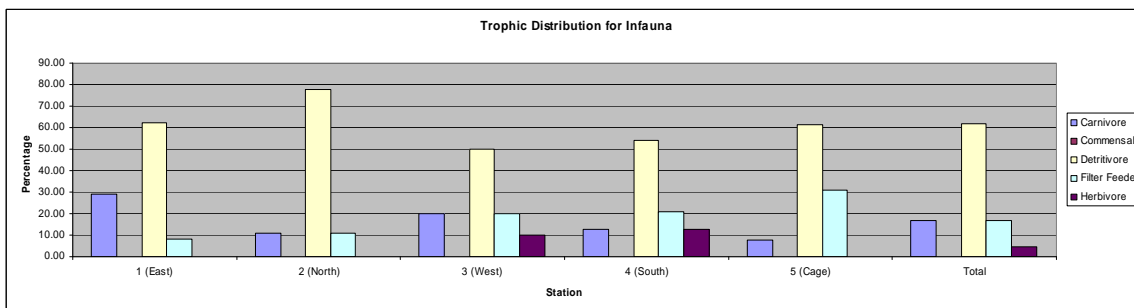


Fig. 27: Trophic distribution for infaunal populations, March 2009.

Detritivores are important in re-directing dead organic matter back into the food web. This dead organic matter would otherwise accumulate and decompose at the ocean bottom, creating high levels of hydrogen sulfide (Castro & Huber, 2007) and anoxic conditions.

For this biomonitoring sample (i.e. March 2009), the detritivore family Dialidae, made up 51.6% of the total abundance while detritivores in the family Rissoidae made up 18.9% of the total. The indicator species *Finella pupoides*, characteristic of anaerobic conditions [i.e. absence of air or free oxygen] were present at Sta.2 (1.6%) and Sta. 4 (1.5%). *F. pupoides* for all stations combined was 0.6%. Members of the bivalve family Lucinidae, usually occurring in low nutrient and often high sulphide content environments (Reid & Slack-Smith, 1998) was present only at Sta.4 (1.0%), and absent at all other

stations. Lucinids, for all stations combined, was 0.2%. The sponge feeding triphorids (2.4% of the total abundance), were present all stations [Figs. M28].

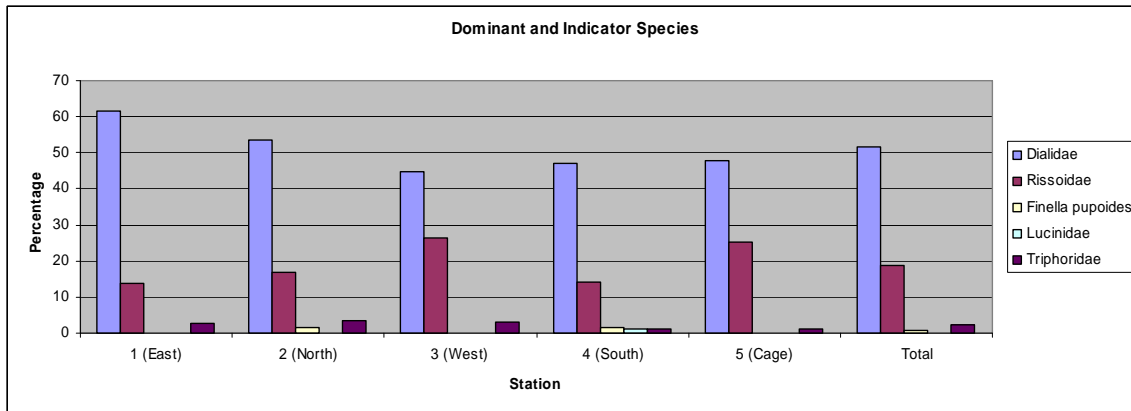


Fig. M28: Distribution of dominant and indicator species at each station for March 2009.

For March 2009, the classic model of pollution or deleterious effects of a point source of excess organic material, predicts a decline in species richness at the impact site and/or an increase in abundance of a few pollution tolerant organisms. The number of taxa for all five stations ranged between 31 at Sta. 5 (Cage) and 44 at Sta. 4 (South). The previous year the number of taxa ranged between 28 at Sta. 1 (East) and 41 at Sta. 2 (North). *Finella pupoides*, characteristic of high anaerobic conditions, was present at Sta. 2 and Sta. 4 both at 1.5%. Members of the family Lucinidae, usually occurring in environments low in nutrients and often high in sulphide contents (Reid & Slack-Smith, 1998), was present only at Sta. 4 (South) at 1.0%. Lucinids, for all stations combined, was 0.2%.

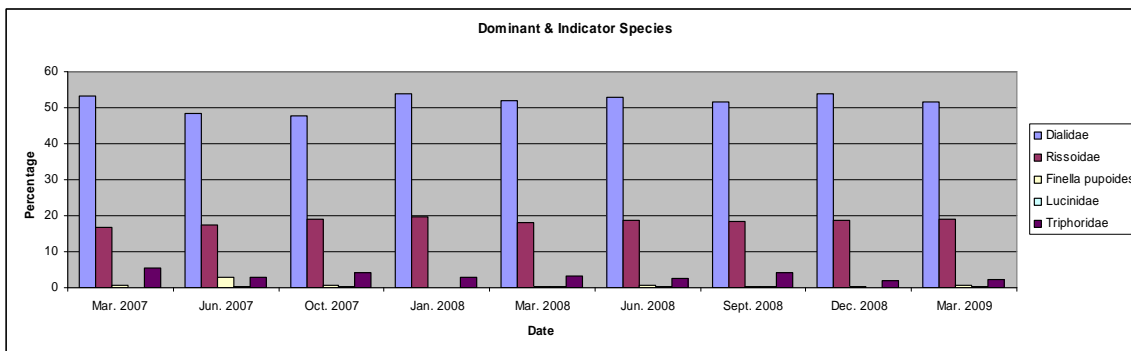


Fig. M29: Distribution of dominant and indicator species for all dates sampled except for June 2006.

For all sampling dates (i.e. March, June, and October 2007; January, March, June, September, and December 2008; and March 2009; excluding June 2006), *F. pupoides* was present at low percentages from 0.1% (January 2008 totals) to 2.7% (June 2007 totals). Lucinid bivalves ranged between 0.0% (March 2007 totals) and 0.5% (March 2008 totals).

The Deep Blue Research, LLC Off-shore aquaculture biomonitoring survey for March 2009, showed high proportions of gastropod: low bivalve proportions indicative of a lack of expanses of nutrient-rich, silty sand ocean substrata (Kay, 1967); an absence or low number of *Finella pupoides*, indicative of anaerobic

conditions; and the absence or low abundances of lucinid bivalves indicative of anoxic conditions (i.e. low nutrient, high sulfide environments). At this time, the biomonitoring survey shows none to very low impact on the benthic fauna at the Off-shore aquaculture stations, Kona, Hawaii. Based on the results of the benthic monitoring over the last two years showing “little or very low impact” the sampling requirement has been reduced to yearly. Benthic sampling is scheduled for every year to gauge any long-term effects of the fish cages on the benthic fauna below.

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APPENDIX 3

Micromollus species, numbers, habit and trophic levels at Stations 1, 2, 3, 4, and 5, March 2009

Family	Taxon	Habit	Trophic	Station					Total
				1 (East)	2 (North)	3 (West)	4 (South)	5 (Cage)	
BIVALVIA									
Condylocardiidae	<i>Carditella hawaiiensis</i>	Infaunal	Filter feeder				2	2	4
Pectinidae	<i>Chlamys</i> spp.	Epifaunal	Filter feeder						
Philobryidae	<i>Cosa waikikia</i>	Epifaunal	Filter feeder			1			1
Lucinidae	<i>Ctena bella</i>	Infaunal	Filter feeder						
Lucinidae	<i>Ctena transversa</i>	Infaunal	Filter feeder						
Cuspidariidae	<i>Cuspidaria</i> spp.	Infaunal	Carnivore						
Dimyidae	<i>Dimya molokaia</i>	Epifaunal	Filter feeder						
Lucinidae	<i>Epicodakia</i> spp.	Infaunal	Commensal						
Semelidae	<i>Ervilia bisculpta</i>	Infaunal	Filter feeder	1					1
Cardiidae	<i>Fragum mundum</i>	Infaunal	Filter feeder						
Psammobiidae	<i>Grammatomya kanaka</i>	Infaunal	Detritivore						

Pectinidae	<i>Haumea juddi</i>	Epifaunal	Filter feeder						
Lucinidae	Lucinidae spp.	Infaunal	Filter feeder			2			2
Tellinidae	<i>Macoma obliquilineata</i>	Infaunal	Detritivore						
Malleidae	<i>Malleus</i> spp.	Epifaunal	Filter feeder	1					1
Mytilidae	Mytilidae spp.	Infaunal	Filter feeder						
Ostreidae	Ostreidae spp.	Epifaunal	Filter feeder	1					1
Pinnidae	<i>Pinna</i> spp. [a]	Infaunal	Filter feeder						
Pteriidae	Pteriidae spp.	Epifaunal	Filter feeder			1			1
Mesodesmatidae	<i>Rochefortina sandwichensis</i>	Infaunal	Filter feeder	1		2		1	4
Semelidae	<i>Semelangulus crebrimaculatus</i>	Infaunal	Detritivore						
Mytilidae	<i>Septifer bryanae</i>	Infaunal	Filter feeder		2		1	1	4
Tellinidae	<i>Tellina crucigera</i>	Infaunal	Detritivore						
Tellinidae	<i>Tellina oahuana</i>	Infaunal	Detritivore						
Tellinidae	<i>Tellina perna</i>	Infaunal	Detritivore						
Tellinidae	<i>Tellina robusta</i>	Infaunal	Detritivore						
Tellinidae	Tellinidae spp.	Infaunal	Detritivore						
Bivalvia	Bivalvia spp.	UNDETER	UNDETER					1	1
GASTROPODA									
Aclididae	<i>Acclis</i> sp. A	UNDETER	UNDETER					1	1
Scaphandridae	<i>Acteocina hawaiiensis</i>	Infaunal	Carnivore						
Scaphandridae	<i>Acteocina sandwicensis</i>	Infaunal	Carnivore	3					3
Scaphandridae	<i>Acteocina</i> spp.	Infaunal	Carnivore						
Trochidae	<i>Alcyna ocellata</i>	Epifaunal	Detritivore			5	2	1	8
Rissoidae	<i>Alvania isolata</i>	Epifaunal	Detritivore						
Turridae	<i>Anacithara perfecta</i>	UNDETER	Carnivores			1			1
Architectonicidae	Architectonicidae spp.	Parasitic	Parasitic	1					1
Atyididae	<i>Atys debilis</i>	Infaunal	Herbivore				1		1
Atyididae	<i>Atys semistriata</i>	Infaunal	Herbivore			1	2		3
Atyididae	<i>Atys</i> spp.	Infaunal	Herbivore						
Eulimidae	<i>Balcis</i> spp.	Parasitic	Parasitic	3	4	3	4	5	19
Cerithiidae	<i>Bittium impendens</i>	Epifaunal	Detritivore	1		2	4	1	8
Buccinidae	Buccinidae spp.	UNDETER	UNDETER						
Bullidae	<i>Bulla vernicosa</i>	Infaunal	Herbivore						
Caecidae	<i>Caecum arcuatum</i>	Infaunal	Detritivore						
Caecidae	<i>Caecum glabrifomis</i>	Infaunal	Detritivore						
Turridae	<i>Carinapex minutissima</i>	Epifaunal	Carnivore		1				1
Turridae	<i>Carinapex papillosa</i>	Epifaunal	Carnivore						
Turridae	<i>Carinapex</i> spp.	Epifaunal	Carnivore	2					2
Cephalaspidea	Cephalaspidea spp.	Infaunal	Carnivore					1	1
Dialidae	<i>Cerithidium diplax</i>	Infaunal	Detritivore	13	9	4	7	7	40

Dialidae	<i>Cerithidium perparvulum</i>	Epifaunal	Detritivore	50	46	46	29	31	202
Cerithiopsidae	Cerithiopsidae spp.	Epifaunal	Carnivore			1	2		3
Cerithiidae	<i>Cerithium columna</i>	Epifaunal	Detritivore			3	3		6
Cerithiidae	<i>Cerithium interstriatum</i>	Epifaunal	Detritivore	4	5	4	6	5	24
Cerithiidae	<i>Cerithium matukense</i>	Epifaunal	Detritivore						
	<i>Cerithium</i> sp. cf.								
Cerithiidae	<i>nesioticum</i>	Infaunal	Detritivore		1		2		3
Cerithiidae	<i>Cerithium rostratum</i>	Epifaunal	Detritivore			6			6
Cerithiidae	<i>Cerithium zebrum</i>	Epifaunal	Detritivore						
Cerithiidae	<i>Cerithium</i> spp.	Epifaunal	Detritivore	1		4		2	7
Turridae	<i>Ceritoturris bittium</i>	Epifaunal	Carnivore						
Vitrinellidae	<i>Circulus</i> spp.	Epifaunal	Herbivore						
Turridae	<i>Clavus</i> spp.	Epifaunal	Carnivore						
Turbinidae	<i>Collonista candida</i>	Epifaunal	Forager			1		1	2
Columbellidae	Columbellidae spp.	Epifaunal	Omnivore						
Costellariidae	Costellariidae spp.	Infauna	Carnivore						
Skeneidae	<i>Cyclostremiscus emeryi</i>	Epifaunal	Detritivore Filter		1				1
Vermetidae	<i>Dendropoma</i> spp.	Epifaunal	feeder				1		1
Dialidae	<i>Diala scopulorum</i>	Epifaunal	Detritivore	60	40	11	43	38	192
Dialidae	<i>Diala semistriata</i>	Epifaunal	Detritivore	38	41	44	14	8	145
Aytidae	<i>Diniatys dentifer</i>	Infaunal	Herbivore						
Eatoniellidae	<i>Eatoniella janetaylorae</i>	Epifaunal	Herbivore						
Eatoniellidae	<i>Eatoniella</i> spp.	Epifaunal	Herbivore						
Vitrinellidae	<i>Elacorbis callusa</i>	Epifaunal	Detritivore						
Epitoniidae	<i>Epitonium thorssoni</i>	Infaunal	Carnivore		1	2			3
Epitoniidae	<i>Epitonium</i> spp.	Infaunal	Carnivore	2					2
Turridae	<i>Etrema acricula</i>	Infaunal	Carnivore				1		1
Trochidae	<i>Euchelus gemmatus</i>	Epifaunal	Herbivore						
Trochidae	<i>Euchelus</i> spp.	Epifaunal	Herbivore	1	1			2	4
Turridae	<i>Eucithara pusilla</i>	Infaunal	Carnivore						
Turridae	<i>Eucyclotoma albomacula</i>	UNDETER	Carnivore						
Obtortionidae	<i>Finella pupoides</i>	Infaunal	Detritivore		4		3		7
Trochidae	<i>Gibbula marmorea</i>	Epifaunal	UNDETER						
Marginellidae	<i>Granula sandwicensis</i>	Epifaunal	Forager	3					3
Marginellidae	<i>Granulina vitrea</i>	Epifaunal	Carnivore	1	1	1	1		4
Atyidae	<i>Haminoea</i> sp. cf. <i>curta</i>	Infaunal	Herbivore						
Atyidae	<i>Haminoea</i> sp. cf. <i>cymbalum</i>	Infaunal	Herbivore						
Atyidae	<i>Haminoea</i> spp.	Infaunal	Herbivore						
Architectonicidae	<i>Heliacus implexus</i>	Epifaunal	Carnivore						
Pyramidellidae	<i>Herviera gliiriella</i>	Parasitic	Parasitic		1		2	1	4
Pyramidellidae	<i>Hinemoa indica</i>	Parasitic	Parasitic Filter				1		1
Hipponicidae	<i>Hipponix pilosus</i>	Epifaunal	feeder						
Cerithiidae	<i>Ittibittium parcum</i>	Epifaunal	Detritivore						
Juliidae	<i>Julia exquisita</i>	Epifaunal	Herbivore						
Turridae	<i>Kermia aniani</i>	Epifaunal	Carnivore						
Turridae	<i>Kermia</i> spp.	Epifaunal	Carnivore						
Pyramidellidae	<i>Kolonella</i> spp.	UNDETER	Parasitic						

Turbinidae	<i>Leptothyra rubricincta</i>	Epifaunal	Detritivore	2		2	4	1	9
Turbinidae	<i>Leptothyra verruca</i>	Epifaunal	Detritivore		5		1		6
Turbinidae	<i>Leptothyra</i> spp.	Epifaunal	Detritivore						
Liotiidae	Liotiidae spp.	UNDETER	UNDETER		2				2
Skeneidae	<i>Lophocochlias minutissimus</i>	Epifaunal	Detritus	8	12	1	4	6	31
Marginellidae	Marginellidae spp.	Epifaunal	Carnivore						
Rissoidae	<i>Merelina hewa</i>	Epifaunal	Detritivore			1			1
Rissoidae	<i>Merelina</i> spp.	Epifaunal	Detritivore				1		1
Turridae	<i>Microdaphne trichodes</i>	Epifaunal	Carnivore						
Pyramidellidae	<i>Miralda paulbartschi</i>	Epifaunal	Detritivore						
Turridae	<i>Mitrolumna</i> spp.	UNDETER	Carnivore						
Thaididae	<i>Morula</i> spp.	Epifaunal	Carnivore						
Naticidae	Naticidae spp.	Infaunal	Carnivore				1		1
Pyramidellidae	<i>Odostomia</i> spp.	Parasitic	Parasitic						
Omalogyridae	<i>Omalogyra</i> sp. A	Epifaunal	Herbivore						
Orbitestellidae	<i>Orbitestella regina</i>	Epifaunal	Detritivore			1			1
Rissoidae	<i>Parashiela beetsi</i>	Epifaunal	Detritivore	16	14	14	17	19	80
Cerithiidae	<i>Plesiotrochus luteus</i>	Epifaunal	Detritivore						
Rissoidae	<i>Powellisetia fallax</i>	Epifaunal	Detritivore		3		1	1	5
Architectonicidae	<i>Pseudomalaxis</i> spp.	UNDETER	Carnivore				1		1
Actaeonidae	<i>Pupa pudica</i>	Infaunal	Carnivores						
Actaeonidae	<i>Pupa</i> spp.	Infaunal	Carnivores				1		1
Rissoidae	<i>Pusillina marmorata</i>	Epifaunal	Herbivore	11	11	26	4	16	68
Pyramidellidae	Pyramidellidae spp.	Parasitic	Parasitic						
Pyramidellidae	<i>Pyrgulina oodes</i>	Parasitic	Parasitic	5	1		4	2	12
Pyramidellidae	<i>Pyrgulina</i> spp.	Parasitic	Parasitic						
Rissoellidae	<i>Rissoella confusa</i>	Epifaunal	Parasitic						
Rissoellidae	<i>Rissoella longispira</i>	Epifaunal	Parasitic						
Rissoellidae	<i>Rissoella</i> spp.	Epifaunal	Parasitic	1	1	1			3
Rissoidae	Rissoidae spp.	Epifaunal	Detritivore				6	1	8
Rissoidae	<i>Rissoina ambigua</i>	Epifaunal	Detritivore						
Rissoidae	<i>Rissoina cerithiiformis</i>	Epifaunal	Detritivore				2		2
Rissoidae	<i>Rissoina pulchella</i>	Epifaunal	Detritivore	3	5	11	1	6	26
Cingulopsidae	<i>Rufodardanula conica</i>	UNDETER	UNDETER						
Cingulopsidae	<i>Rufodardanula ponderi</i>	UNDETER	UNDETER		2		2		4
Cingulopsidae	<i>Rufodardanula</i> spp	UNDETER	UNDETER						
Rissoidae	<i>Sansonia kenneyi</i>	Epifaunal	feeder			1			1
Scaliolidae	<i>Scaliola</i> spp.	Epifaunal	Detritivore	12	14	3	11	7	47
Rissoidae	<i>Schwartziella ephamilla</i>	Epifaunal	Detritivore	6	7	2	3	2	20
Scissurellidae	<i>Scissurella pseudoequatoria</i>	Epifaunal	Detritivore						
Columbellidae	<i>Seminella peasei</i>	Epifaunal	Detritivore		1				1
Columbellidae	<i>Seminella smithi</i>	Epifaunal	Detritivore						
Columbellidae	<i>Seminella</i> spp.	Epifaunal	Detritivore				4		4
Vermetidae	<i>Serpulorbis</i> spp.	Epifaunal	feeder						
Scissurellidae	<i>Sinezona insignis</i>	Epifaunal	Herbivore						
Siphonariidae	<i>Siphonaria normalis</i>	Epifaunal	Herbivore						
Rissoidae	<i>Stosicia hiloense</i>	Epifaunal	Detritivore		2				2

Caecidae	<i>Strebloceras subannulatum</i>	Infaunal	Herbivore						
Strombidae	<i>Strombus</i> spp.	Epifaunal	Herbivore						
Dialidae	<i>Styliferina goniochila</i>	Infaunal	Detritivore	2		1	1	1	5
Mitridae	<i>Subcancilla flammea</i>	Infauna	Carnivores						
Stomatellidae	<i>Synaptocochlea concinna</i>	Epifaunal	Herbivore						
Phasianellidae	<i>Tricolia variabilis</i>	Epifaunal	Herbivore	1	3	9	3	5	21
Terebridae	Terebridae spp.	Infaunal	Carnivores	1	1				2
Triphoridae	Triphoridae spp.	Epifaunal	Carnivore	7	9	7	2	2	27
Trochidae	<i>Trochus intextus</i>	Epifaunal	Herbivore						
Turbinidae	<i>Turbo sandwicensis</i>	Epifaunal	Herbivore			1			1
Pyramidellidae	<i>Turbonilla thaanumi</i>	Parasitic	Parasitic	2		1			3
Pyramidellidae	<i>Turbonilla cornelliana</i>	Parasitic	Parasitic						
Pyramidellidae	<i>Turbonilla</i> spp.	Parasitic	Parasitic		1				1
Turridae	Turridae spp.	Infaunal	Carnivores	1					1
Turridae	<i>Veprecula brunonia</i>	Infaunal	Carnivores						
Costellariidae	<i>Vexillum</i> spp.	Epifaunal	Carnivore						
Marginellidae	<i>Volvarina</i> sp. cf. <i>nevilli</i>	Epifaunal	Carnivore			1	1		2
Siphonariidae	<i>Williamia radiata</i>	Epifaunal	Herbivore						
Columbellidae	<i>Zafra</i> spp.	Epifaunal	Detritivore						
Rissoinidae	<i>Zebina</i> spp.	Epifaunal	Herbivore				1		1
Gastropoda	Gastropoda spp. [Non Marine]	UNDETER	UNDETER						
Gastropoda	Gastropoda spp.	UNDETER	UNDETER						
POLYPLACOPHORA									
Polyplacophora	Polyplacophora spp.	Epifaunal	Herbivore						
SCAPHOPODA									
Scaphopoda	Scaphopoda spp.	Infaunal	Carnivore						
Total No. of Individuals				264	254	236	199	178	1131
Total No. of Ind./cm ³				17.6	16.9	15.7	13.1	11.7	15.0
Total No. of Taxa				33	35	38	44	31	79

a. Pinna are indicated by a "+" for larval shells and by "frag" for shell fragments.