ANNUAL PROGRESS REPORT
FOR
TEXAS CLIPPER REEF BIOLOGICAL MONITORING AND EVALUATION PROGRAM - YEAR 2

November 1, 2008 - October 31, 2009

Contract No. 183089

Project Managers:

David Hicks and Carlos Cintra-Buenrostro
University of Texas-Brownsville
80 Fort Brown
Brownsville, Texas 78520

1. Project Objectives:

The goal of the Texas Clipper Reef biological monitoring and evaluation program is to provide the TPWD supplementary data for evaluating the project in terms of its capacity for increasing area recreational fishing, diving, and tourism thereby allowing for adaptive management and enhancement actions. The specific objectives of the biological monitoring program are: (1) to document development and transformations in community composition of Texas Clipper Reef biofouling and fish assemblages; (2) to delineate biological zones as they develop; (3) to stimulate ancillary research projects; and (4) to evaluate and synthesize monitoring data in order to assess change and provide recommendations to managers.

The monitoring program utilizes four survey approaches to achieve the objectives: (1) water quality measurement systems for water column habitats (i.e., structural monitoring); (2) biofouling community surveys (diversity and biomass); (3) nekton community surveys (roving diver surveys) and (4) general site assessments (video transects). Survey data is repeated quarterly.

2. Status of Tasks:

2.1. Sampling Effort:

Twelve sampling trips to the reef site were conducted from November 1, 2008 to October 31, 2009 (Table 1). Seventeen sampling trips were cancelled due to inclement weather particularly between January and April 2009. An additional sampling event (May 2009) had to be cancelled on site due to a strong current.

2.2. Scientific Diving Program and Diver Training:

Four additional UTB/TSC students received open water training in year two. These students are currently participating in our research diving activities. In addition, two students earned advanced certifications and three earned Nitrox certifications.

2.3. Fish Assemblage Monitoring:

2.3.1. Fish Surveys:

Fish surveys were conducted during April, May, June, July, and September 2009 (Table 1) using the Roving Diving Technique (RDT; Schmitt & Sullivan 1996). Community composition and abundances of organisms were analyzed using the multivariate analyses of the PRIMER v6 software package (Clarke and Gorley, 2006). For these analyses, each sampling interval (reef age in months) was used as the sampling unit (averaged across observers) to look for patterns among reef fish assemblages. All data were square root transformed in order to have the effect of down-weighting the contributions of highly abundant species and thereby allowing mid-range species to also influence community similarity calculations. Cluster analyses, including the similarity profile tests (SIMPROF), were performed to identify natural groupings (statistically significant) among samples which were deemed *a priori* unstructured, across sampling intervals. Non-metric multidimensional scaling (MDS) plots based upon Bray-Curtis similarity measures (group averaged) were used as an additional analysis tool for identifying natural groupings in fish assemblages data. Shannon's diversity (H'[log 10]) and species richness were also computed for each sampling interval using the DIVERSE routine.

A total of 59 fish species (taxa, based on lower taxonomic level possible particularly for gobies or snapper) have been identified at the reef site including 25 additional species documented during year two (Table 2, Fig. 1). Commonly encountered species (abundance category 4, > 100 individuals) in year two include the Atlantic Spadefish (*Chaetodipterus faber*), Blue Runner (*Caranx crysos*), Cocoa Damsel (*Pomacentrus variabilis*), Dusky Damsel (*Pomacentrus fuscus*), Gray Triggerfish (*Balistes capriscus*), Lookdown (*Selene vomer*), Mackerel Scad (*Decapterus macarellus*), Seaweed Blenny (*Parablennius marmoreus*), members of the Snapper Family (*Lutjanus* spp.), Tomtate (*Haemulon aurolineatum*), and Yellow Jack (*Caranx bartholomaei*).

Species diversity and richness generally increased over the study period with the highest values recorded during June 2009 corresponding to a reef age of 19 months (Fig. 2). The CLUSTER hierarchical similarity analysis of fish community composition and abundances across sampling intervals was indicative of a community undergoing succession wherein samples are becoming increasingly similar in their assemblage patterns over time (Fig. 3). The MDS ordination plot based on fish species abundance also reinforces this same successional sequence pattern (Fig. 4). Considered together, six taxa (Snapper spp., Seaweed Blenny, Tomtate, Atlantic Spadefish, Gray Triggerfish and Reef Butterfly Fish) accounted for ~ 60% of observed similarity among interval samples.

2.4. Biofouling Community Monitoring:

2.4.1. Phototransects:

Phototransects were utilized to estimate large scale changes in diversity of the biofouling community (i.e. large sessile invertebrates and algae) in each sampling interval. Three permanent transects were established on the upper starboard topsides (T2STS, T3STS, T4STS, Fig. 5) each consisting of 8 - 14, 0.25 m^{-2} sampling areas. In addition, three photostations (short transects consisting of 2 - 4, 0.25 m^{-2} sampling areas), were established along the bow and stern starboard topsides (T1STS & T5STS) and at the outermost edge of the starboard navigation deck wing (T6SNW, Fig. 5). Transects were sampled using two rectangular photo-framers (quadrapods, 60.3 x 41.5 cm = 0.25 m^{-2}).

In the laboratory, each photoquadrat image was overlain with an electronic grid consisting of 100 intersecting points. The biota or substrate at each point was categorized and represented as a percentage of the total 100 points. Expressing coverage as a percentage is essential here as the number of quadrats sampled often varied among transects and sampling periods. Without this standardization, subsequent community similarity analyses would reflect both community composition and differences in total abundances. The percent coverage data were square-root transformed to down-weight the more abundant categories so that less common species can exert some influence on the calculations of community similarity.

The CLUSTER hierarchical similarity analysis of the biofouling community across sampling intervals was indicative of a community undergoing succession wherein samples are becoming increasingly similar in their assemblage patterns over time (Fig. 6). The categories 'algae,' 'barnacle shell (dead),' and 'bare' accounted for 69, 13, and 13% of the similarity among interval samples, respectively (95% cumulatively). The MDS ordination plot based on biofouling community composition also reinforces this same successional sequence pattern within the biofouling community (Fig. 7).

2.4.2. Hull Biofouling:

The hull biofouling community was further examined by combining photographic and traditional benthic sampling using an airlift sampler that incorporated a photo framer with a detachable 25 x 25 cm magnetic quadrat for quantifying hull-fouling organisms / biomass. Prior to scraping the hull, a photograph of the 25 x 25 cm area was taken in order to relate these samples to the larger (0.25 m^{-2}) photoquadrats. The area within the quadrate was scraped using a 75 mm wide putty and the sample sucked into a 500 µm mesh bag using the airlift sampler.

In the laboratory, samples were washed into finger bowls and sorted using a dissecting microscope. The initial sample sort was used to systematically search and completely remove, from the sample, debris and all fauna of interest that were alive at the time of collection. Fauna of interest are operationally defined here as those metazoan organisms retained by a 0.5 mm (500 µm) mesh sieve. Sample debris included bottom paint, detritus and the remnants (death assemblage) of the hard parts of various organisms (for example, the fragmented and incomplete shells of bivalve mollusks or the exoskeletons of crustaceans). Fauna picked from samples were placed into separate labeled vials and preserved in a 45% isopropyl solution until the sample underwent species identification. The remaining residual (debris) was placed into another separately labeled vial and preserved in a 45% isopropyl solution. All samples were carefully tracked by sample identification labels using a sample log written in ink.

The abundance data were standardized as the number of quadrats sampled often varied among sampling periods. The standardized abundance data were square-root transformed to down-weight the more abundant categories so that less common species can exert some influence on the calculations of community similarity.

With the exception of the initial sample (February 2008), the CLUSTER hierarchical similarity analysis indicated a relatively unstructured community wherein samples generally ranged from ~ 40 to 60% similarity without a distinctive pattern (Fig. 8). Five taxa, including two species of bivalves (*Barbatia candida* and *Petricola typica*), acorn barnacles (*Balanus trigonus*), amphipods, and fan worms (*Hydroides protulicola*) accounted for > 70% of the similarity among interval samples. The MDS ordination plot of these same data indicates an initial successional sequence over the first three sampling intervals becoming relatively unstructured thereafter (Fig. 9). The third sample was taken in August 2008 following the July 23, 2008 landfall of hurricane Dolly and the fourth sample was taken in October 2008 following the September 13, 2008 landfall of hurricane Ike. Both of these storms caused substantial scouring of the ship's painted topsides resulting in removal of large patches of paint and associated fouling communities. While distinctive patterns did not emerge from scrapings of the fouling community, the cumulative number of species collected in each sampling interval has continued to increase (Fig. 10).

2.5. Video Transects:

Approximately 3.5 hours of video were recorded over the second year survey effort; mostly associated with fish surveys (Table 1).

2.6. Linking to Environmental Variables:

Two data sondes were purchased during year two to measure water quality parameters (water depth, m; temperature, ºC; pH; conductivity, µS/cm; salinity, ‰; total dissolved solids, TDS in g/l; and dissolved oxygen. The first unit was deployed at the reef site in June, 2009 (Table 1), and programmed to record measurements every hour. Units were attached to the king post just foreword of the promenade at ~ 25 m water depth. Each is capable of recording for a period of 3 - 4 weeks following each deployment. However, one of the data sondes malfunctioned on two separate occasions and has been returned to the manufacture for repairs. Thus, the records from this unit are pending repair. Data obtained from the functioning data sonde deployed on two occasions are given in Table 3.

2.7. Ancillary Tasks:

The field portion of a graduate student project related to the current sampling of the Texas Clipper Reef (intermediate disturbance hypothesis experiment) was completed in year two. A second graduated student project (effects of surface contours on biofouling recruitment) was abandon after many failed site visit attempts due to persistent inclement weather between January and April 2009. Ancillary projects are intended to be applied and aimed at providing information to managers of artificial reefs that may lead to future enhancement actions for increasing productivity at reef sites.

2.7.1. Testing the Intermediate Disturbance Hypothesis:

To test the intermediate disturbance hypothesis, physical disturbances consisting of biomass removal treatments of 22% (low disturbance level), 38.5% (intermediate disturbance level), and 55% (high disturbance level) were applied to experimental plates (25 x 25 cm). A fourth, undisturbed treatment served as a control. Forty-eight collecting plates were deployed across six plate racks (Fig. 11) over three dives (Oct 19, Oct 25, and Dec 7, 2008). Within each rack, experimental plates were randomly assigned to one of each of the three disturbance treatments and undisturbed control treatment. All four treatments were replicated once within each experimental block (rack). Thus, the design included a total of 12 replicates of each treatment across the six racks, which is experimentally referred to as a complete randomized block design with within-block replication.

Disturbances were conducted during April, June, and July 2009. All 48 plates were retrieved from the reef site in August 2009 and transported to the laboratory in 500μm mesh bags where they were washed into finger bowls and sorted using a dissecting microscope. Sorting and identification of collected specimens is nearing completion.

The Analysis of Similarity (ANOSIM) routine in PRIMER will be used to test the null hypothesis of no difference in community composition among treatments.

3. Plans for the Next Year (by Task):

3.1. Fish Assemblage Monitoring:

We plan to conduct three-to-six roving diver fish surveys in each quarter in the upcoming year and present the findings at the March 2010 Texas Academy of Sciences meeting.

3.2. Biofouling Community Monitoring:

We plan to sample all six photo stations/transects in each quarter in the upcoming year. In addition, we anticipate collecting two scrapes for species composition and biomass determinations from each of the three permanent phototransects (T2STS, T3STS, and T4STS) in each quarter.

3.3. Video Transects:

We plan to continue with video documentation. At least one video transect per sampling quarter.

3.4. Linking to Environmental Variables:

We plan to deploy the water quality sampling equipment (data sondes) during each quarter and will record physiochemical parameters on the reef between quarters. In each quarter thereafter, the deployed data sonde will be retrieved and replaced with a cleaned sonde.

3.5. Ancillary Tasks:

We plan to complete the ancillary thesis project 'testing the intermediate disturbance hypothesis' and present the findings at the March 2010 Texas Academy of Sciences meeting.

References

Clarke KR, Gorley RN. 2006. PRIMER v6: user manual / tutorial. PRIMER-E Ltd, Plymouth, UK.

Schmitt RF, Sullivan KM. 1996. Analysis of a volunteer method for collecting fish presence and abundance data in the Florida Keys. Bulletin of Marine Science 59 (2): 404-416.

Acknowledgements

Researchers from the University of Texas Marine Science Institute (John Williams and Rick Kline) have continued to assist us in training UTB/TSC students in fish census and identification techniques.

Table 1. Summary of tasks completed November 1, 2008 to October 31, 2009. Ancillary tasks include projects and activities not directly and include student thesis projects and assisting with the TPWD Clipper documentary.

Date	Tasks					
	Photo-transects	Fish Surveys	Hull Biofouling	Video	Environmental	Ancillary
12/6/08	X		X			X
4/21/09		X			X	X
5/17/09	X	X	X	X		
6/17/09						X
6/20/09	X		X		X	
6/24/09		X		X	X	
7/11/09						X
7/17/09		X		X	X	X
8/17/09						X
8/18/09					X	X
9/27/09		X	X	X	X	
9/28/09	X	X	X		X	

Table 2. List of fishes documented during the first 22 months post-reefing of the Texas Clipper (February 2008 - October 2009). Note: Snappers were clumped into one category because of difficulties to differentiate among juveniles of the three species found. Taxa from 34 onwards are new additions to the reef in year two (not reported for year one). A drop of one taxa from the previous year based on the clumping of the Lutjanidae (snappers) in year two.

Taxa (#)	Common Name	Scientific Name
1	Snapper (includes red, gray & lane)	*Lutjanus* spp.
2	Tomtate	*Haemulon aurolineatum*
3	Atlantic Spadefish	*Chaetodipterus faber*
4	Seaweed Blenny	*Parablennius marmoreus*
5	Red-Lip Blenny	*Ophioblennius atlanticus*
6	Yellowtail Hamlet	*Hypoplectrus chlorurus*
7	Sergeant Major	*Abudefduf saxatilis*
8	Gray Triggerfish	*Balistes capriscus*
9	Gag	*Mycteroperca microlepis*
10	Spot-Fin Pinfish	*Diplodus holbrooki*
11	Pinfish	*Lagodon rhomboides*
12	Spot-Fin Butterflyfish	*Chaetodon ocellatus*
13	Bar Jack	*Caranx ruber*
14	Sheeps-Head	*Archosargus probatocephalus*
15	Reef Butterfly	*Chaetodon sedentarius*
16	Yellow Jack	*Caranx bartholomaei*
17	Almaco Jack	*Seriola rivoliana*
18	Blue Runner	*Caranx crysos*
19	Amber Jack	*Seriola cf. dumerili*
20	Cocoa Damselfish	*Pomacentrus variabilis*
21	Barracuda	*Sphyraena barracuda*
22	Rockhind	*Epinephelus adscensionis*
23	Scamp	*Mycteroperca phenax*
24	Ling	*Rachycentron canadum*
25	Belted Sandfish	*Serranus subligarius*
26	Plane-Head File	*Monacanthus hispidus*
27	Lookdown	*Selene vomer*
28	Purple Reef Fish	*Chromis scotti*
29	Sharp-Nose Puffer	*Canthigaster rostrata*
30	Queen Angel	*Holacanthus ciliaris*
31	Scombridae	*Scomberomorus* sp.
32	Vermillion Snapper	*Rhomboplites aurorubens*
33	Dusky Damselfish	*Pomacentrus fuscus*
34	Beaugregory	*Stegastes leucostictus*
35	Bicolor Damselfish	*Stegastes partitus*
36	Black Grouper	*Mycteroperca bonaci*
37	Blue Angelfish	*Holacanthus bermudensis*
38	Blue Chromis	*Chromis cyanea*

Table 2. Continued.

Taxa (#)	Common Name	Scientific Name
39	Blue Hamlet	*Hypoplectrus gemma*
40	Brown Chromis	*Chromis multilineata*
41	Cleaning Goby	*Elacatinus genie*
42	Cobia	*Rachycentron canadum*
43	Creole Fish	*Paranthias furcifer*
44	Cubbyu	*Pareques umbrosus*
45	French Angelfish	*Pomacanthus paru*
46	Gold-Face Toby	*Canthigaster jamestyleri*
47	Gray Angelfish	*Pomacanthus arcuatus*
48	Hogfish	*Lachnolaimus maximus*
49	Horse-Eye Jack	*Caranx latus*
50	Long-Fin Damselfish	*Stegastes diencaeus*
51	Mackerel Scad	*Decapterus macarellus*
52	Round Scad	*Decapterus punctatus*
53	Shark-Nose Goby	*Elacatinus evelynae*
54	Spanish Hogfish	*Bodianus rufus*
55	Spot-Fin Hogfish	*Bodianus pulchellus*
56	Squirrel Fish	*Holocentrus adscensionis*
57	Yellow-Head Wrasse	*Halichoeres garnoti*
58	White-Spotted Soapfish	*Rypticus maculatus*
59	Goby (General)	

Table 3. Environmental Variables Recorded at - 25 m depth in the TX Clipper Artificial Reef. First deployment = June-July, 2009; Second deployment = August-September, 2009. Values are mean ± standard error, n = number of hours recording variables.

	First Deployment	**Second Deployment**
	n = 418	n = 960
Temperature (ºC)	23.34 ± 0.03	26.63 ± 0.06
pH	8.56 ± 0.001	8.01 ± 0.002
Salinity (‰)	37.46 ± 0.06	35.08 ± 0.09
TDS (g/l)	36.00 ± 0.05	33.95 ± 0.08

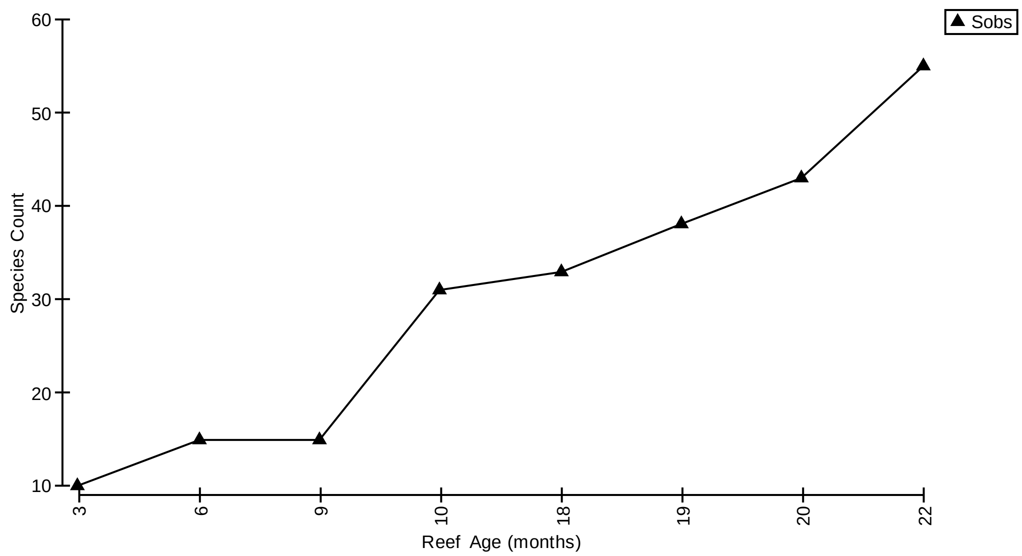

Fig. 1. Cumulative number of different fish species observed (Sobs) by reef age (month) on the Texas Clipper Reef (February 2008 - October 2009).

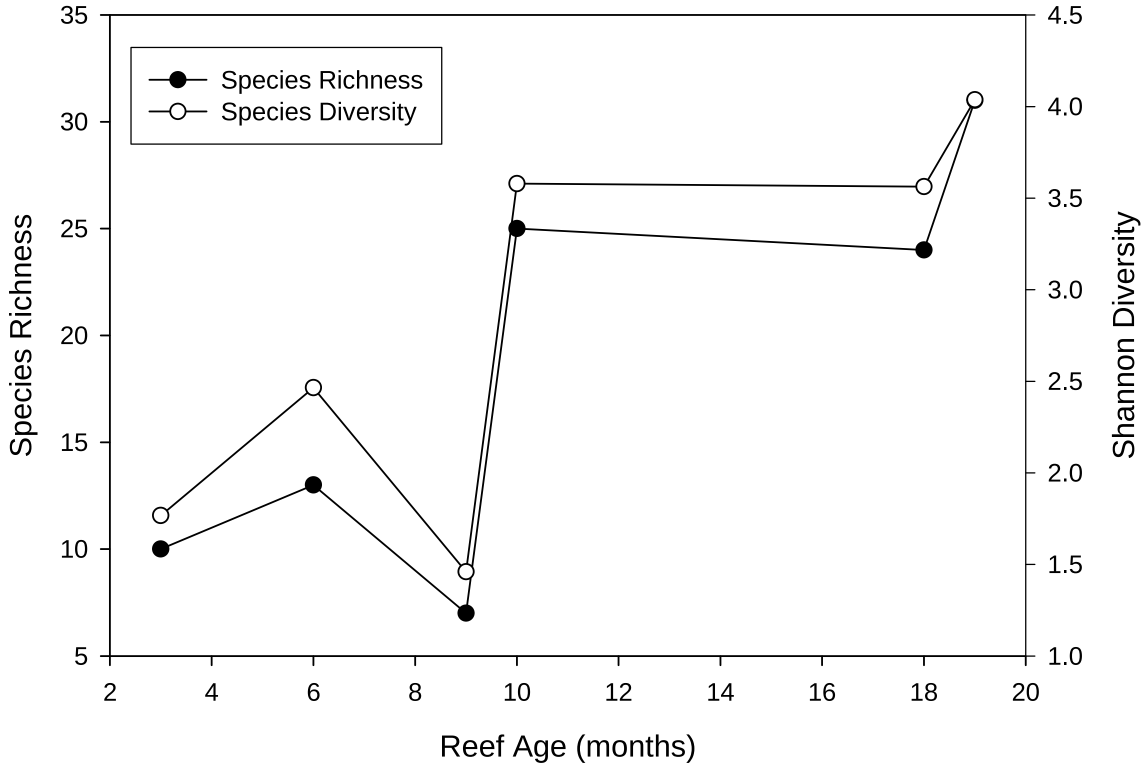

Fig. 2. Number of species observed (species richness) and Shannon diversity by reef age (months) on the Texas Clipper Reef (February 2008 - June 2009).

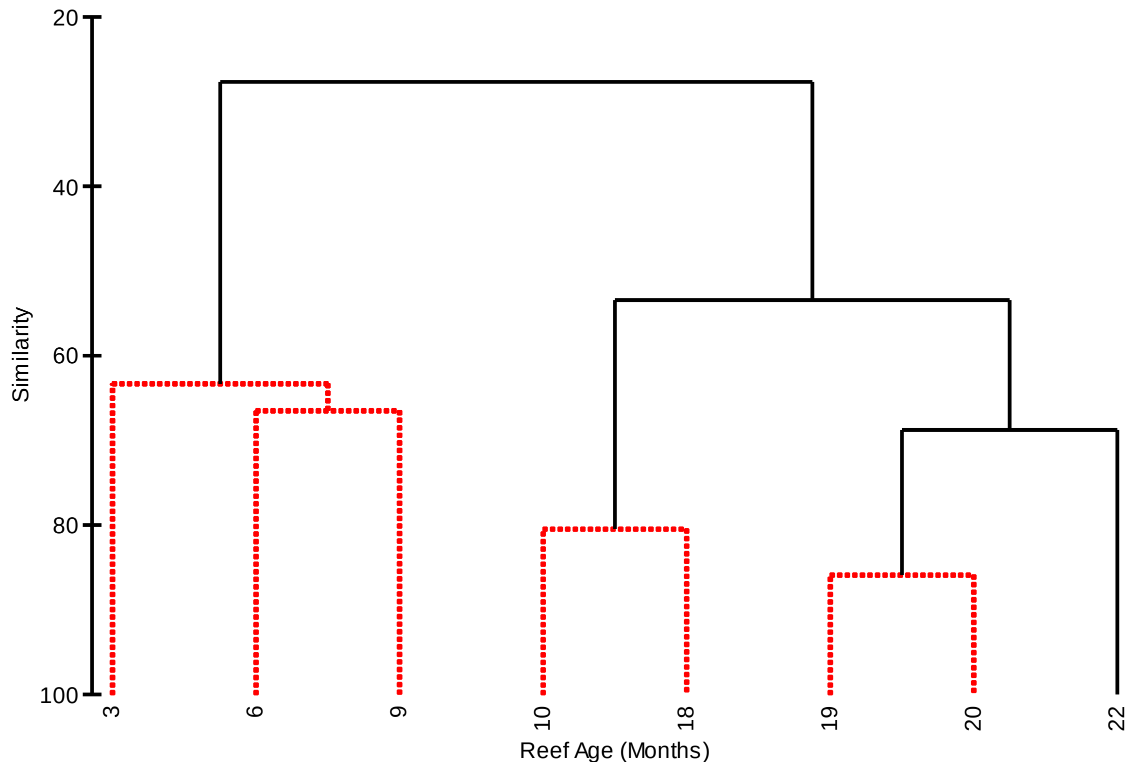

Fig. 3. Percentage similarity including SIMPROF test of fish assemblages across reef age in months at the Texas Clipper Reef. Solid branched lines represent genuine groupings found by SIMPROF tests ($\pi = 12.28$, $P = 0.001$ at 27.7%; $\pi = 7.41$, $P = 0.001$ at 53.4%; and $\pi = 5.31$, $P = 0.1$ at 68.8%). All other branches (dotted lines) indicate non-significant groupings ($P > 0.05$).

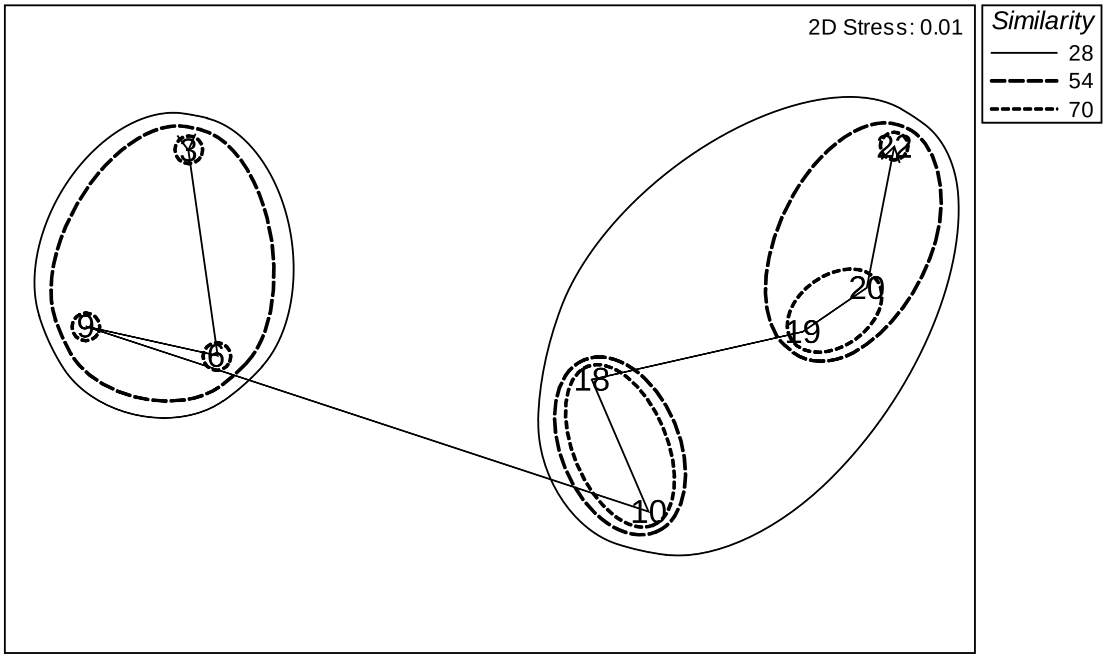

Fig. 4. Non-metric multidimensional scaling (MDS) ordination plot based on fish species composition by reef age in months (3 - 22 mo.). Dashed contours indicate the genuine groupings of varying similarity (28, 54, & 70%) from the cluster analysis. A vector (overlay trajectory) joining the samples in chronological order is given to highlight the clear pattern of community succession in time.

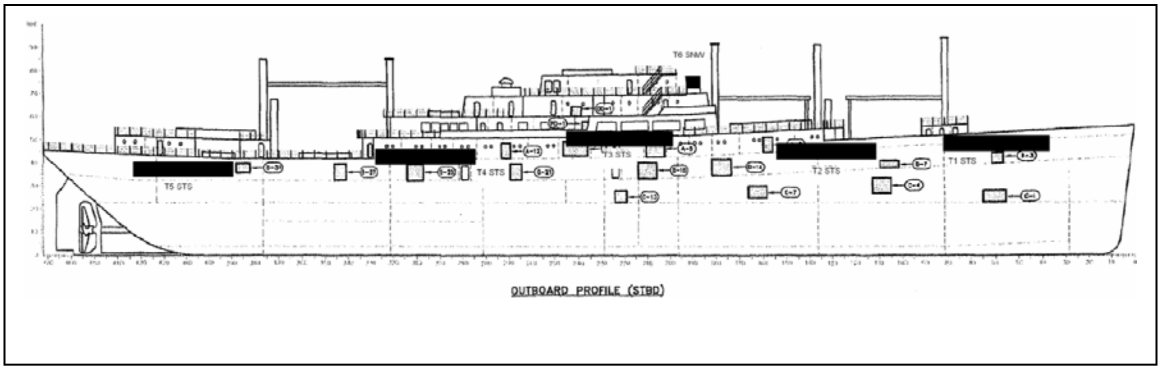

Fig. 5. Starboard view of the USTS Texas Clipper showing the approximate locations of the five permanent phototransects. The stations from bow to stern are T1STS, T2STS, T3STS, T4STS, and T5STS. Also shown is the photostation on the navigation deck (T6SNW).

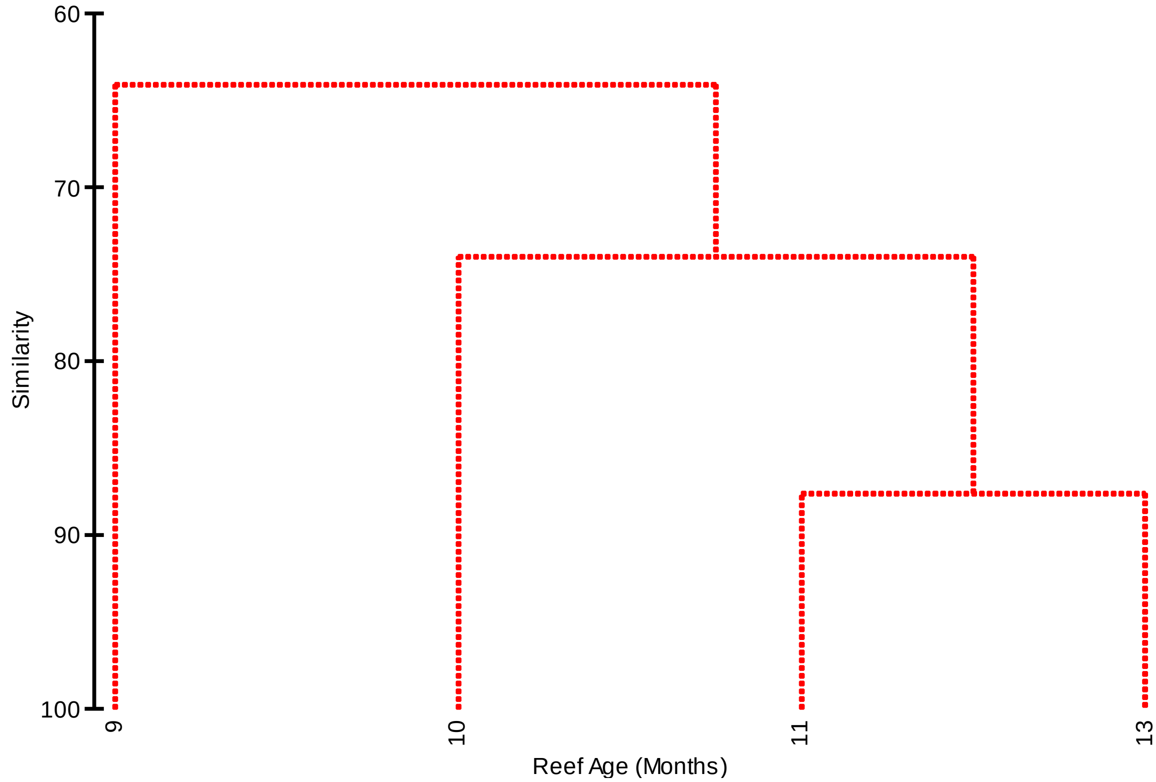

Fig. 6. Percentage similarity including SIMPROF test of macrofouling assemblages (phototransects) across reef age in months (9 - 13 mo.) at the Texas Clipper Reef. Dashed branched lines indicate non-significant groupings (P > 0.05) by SIMPROF tests.

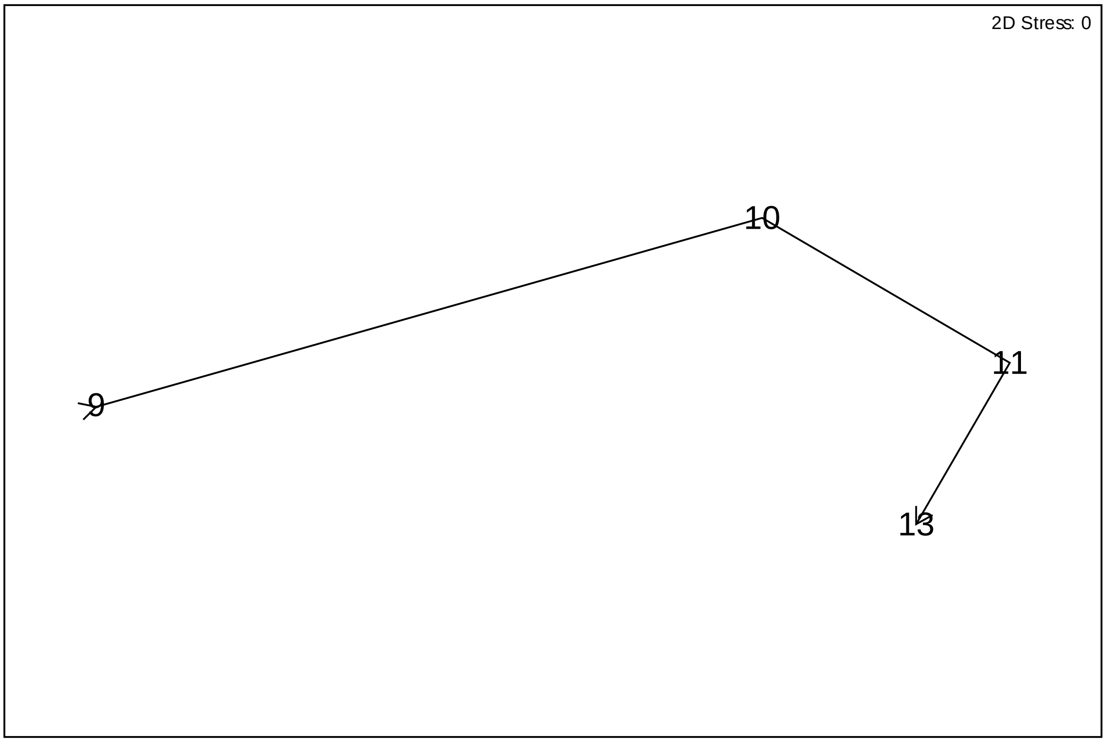

Fig. 7. Non-metric multidimensional scaling (MDS) ordination plot based on macrofouling community composition (phototransects) by reef age in months (9 - 13 mo.). A vector (overlay trajectory) joining the samples chronologically is given to highlight the clear pattern of community succession in time.

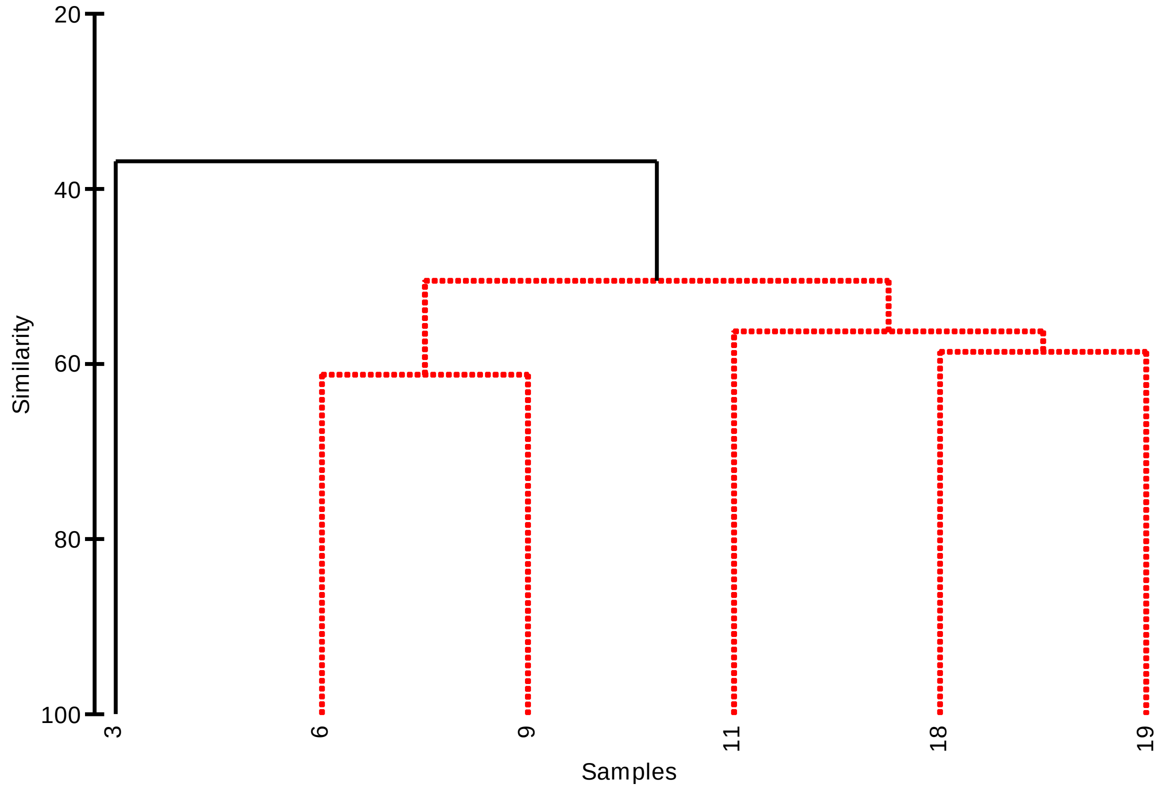

Fig. 8. Percentage similarity including SIMPROF test of fouling assemblages across reef age in months (February 2008 - June 2009) at the Texas Clipper Reef. Solid branched lines represent genuine groupings found by SIMPROF tests ($\pi = 3.95$, $P = 0.002$ at 36.9%). All other branches (dotted lines) indicate non-significant groupings ($P > 0.05$).

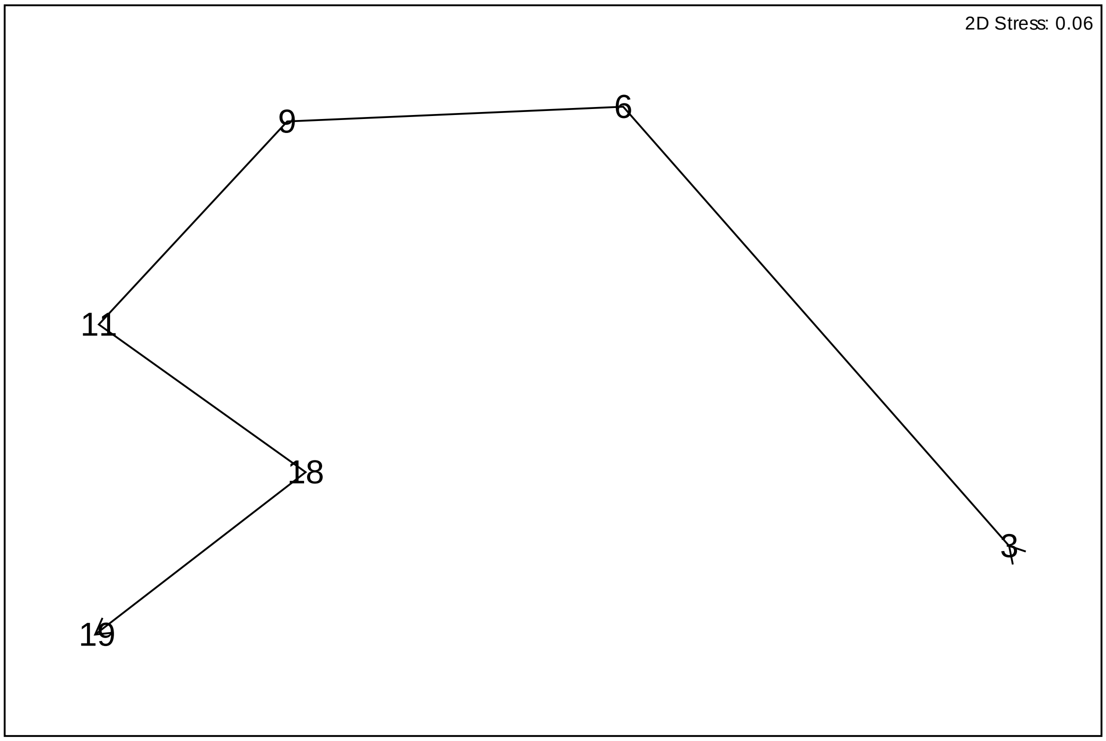

Fig. 9. Non-metric multidimensional scaling (MDS) ordination plot based on fouling community composition by reef age in months (3 - 19 mo; February 2008 - June 2009). A vector (overlay trajectory) is provided joining the samples in chronological order.

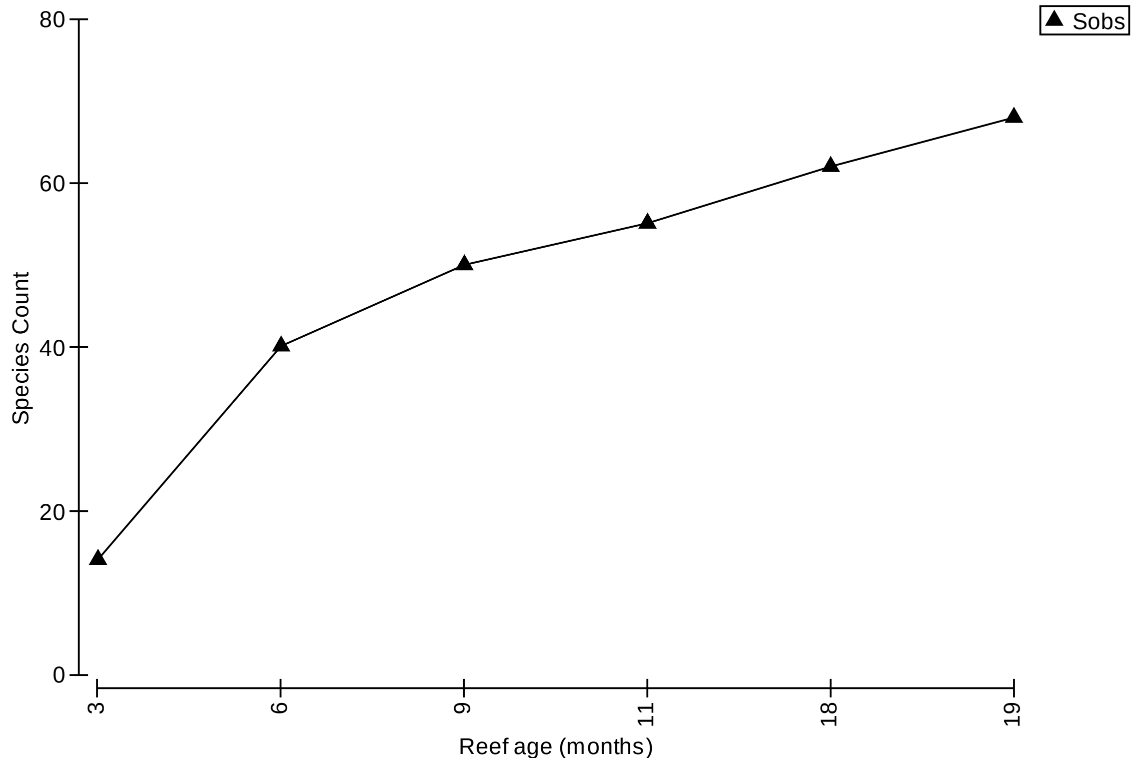

Fig. 10. Cumulative number of different benthic invertebrate species observed (Sobs) as part of the biofouling community by reef age (month) on the Texas Clipper Reef (February 2008 - June 2009).

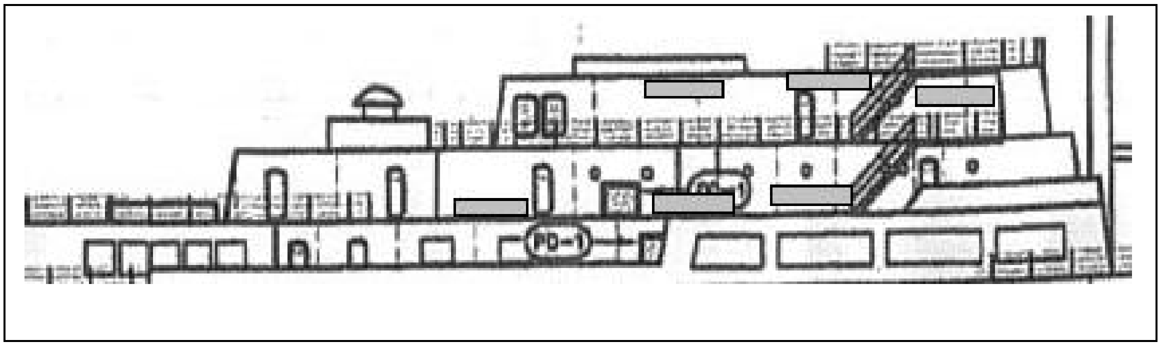

Fig. 11. Starboard view of the Promenade, Officer's, and Navigation decks showing the approximate locations of six collecting plate racks. Each rack holds eight 25 x 25 cm steel plates.