POPULATION EVALUATION OF QUEEN CONCH *(Strombus gigas)*

ALACRANES REEF NATIONAL PARK YUCATAN, MEXICO

Final report

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Introduction

The queen conch *Strombus gigas* (Linnaeus, 1758) is a marine species with high commercial value. It is widely distributed throughout the Caribbean, from Florida (USA) to the north coast of Brazil. It inhabits rocky seabed - vegetated sandy, clean waters, from shallow to depths greater than 40 m. It is a herbivorous browsing species (Warmke and Abbott, 1961), which feeds on epiphytic algae attached to rocks and seagrass (Randall, 1964), as well as blue-green algae covering the sand grains (Jory, 1989). Two types of movement or short scale migration have been recognized, one a process associated with reproduction (Randall, 1964) and the other ontogenetic (Hesse, 1979; Stoner *et al.,* 1988; Stoner, 1989).

The queen conch has been fished and used as subsistence food for a long time in almost every country in the Caribbean, however, the expansion of the commercial fishery began in the last decades due to increased international demand for its meat. The conch resource began to be exploited commercially off the coast of the Yucatan Peninsula from the fifties, and was fished on both coasts of Yucatan and Quintana Roo. However, since 1975, due to overfishing, conch populations have been severely affected and for this reason, the queen conch has been included since 1992 in Appendix II of the Convention on International Trade in Species Endangered Flora and Fauna (CITES) (Stoner and Sandt, 1992, Stoner *et al.* 1996) and in the Red List of Threatened Animals of the International Union for Conservation of Nature and Natural Resources -IUCN 1994 - as a "commercially threatened" species (Gómez-Campos *et al*2010.); totally disappearing in some areas of the Peninsula (Jesus-Navarrete *et al.,* 1992). In Yucatan conch resource has been under a regime of strict management, with fishing banned since 1998 (Official Journal of the Federation, 1988). Although some work done on the conch and fish at Alacranes reef (Rios-Lara *et al.* 2000, Perez

and Aldana, 2003, Aguilar et al. 2007), and on the Yucatan coast (Pérez *et al.* 2000), shows that Conch densities are very low. Perez and Aldana (2003) found a density ranging from 0.003 to 0.035 while ind.m $^{-2}$ Perez et al, (2000) reported density (0.00096 ind .m $^{-2)}$ on the coast.

Lately there have been no studies to determine the status of the conch resource and whether you can open your catch with sustainability criteria.

Consequently, the aim of this work will know the status of the population of *Strombus gigas;* in Arrecife Alacranes reef lagoon of National Marine Park.

Specific objectives

§ Evaluate the density of organisms, whereas juveniles and adults.

§ Determine the size structure of conch *Strombus gigas.*

§ Generate a diagnosis of the state of the population of pink conch crossing information with that obtained in other studies.

2.0 Material and Methods

2.1 Study area: The Arrecife Alacranes is located 135 km north of Puerto Progreso, between 22 ° 21'45 '' and 22 ° 34 'and 89 ° 36'47 55''N' 'and 89 ° 47 '53''W, and measures 26.51 km long by 14.84 km at its widest portion, with an approximate area of 293 km2 (Bello-Pineda 1998) (Fig. 1). Its protected status is National Marine Park since 1994, and currently fishers capture flake, shark, lobster and illegally *S. gigas.* The existence of corals reports: *Montastrea annularis, Acropora palmata, Porites porites, P. astreoides, Diploria* spp., *Manicina areolata,* large tracts of *Thalassia testudinum,* 148 fish species (Hildebrand *et al.* 1964), several commercially important such as grouper *(Epinephelus morio).*

The collection of information was carried out in three periods: September 2013, March 2014 and July 2014, for which he had the support of the authorities of the CONANP.

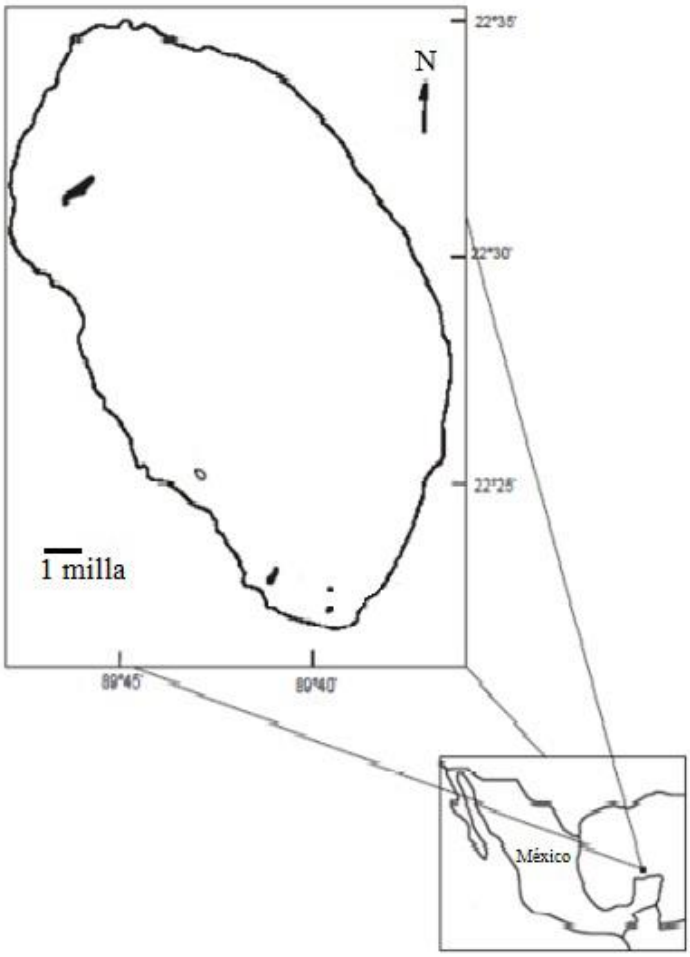

Fig. 1. Location of the study area.

2.2 Evaluation density of organisms, considering the youth and adults.

To determine the density of conch, twenty sampling stations considering the depth and stratum were located. By using a map of the National Park, overcame a satellite image of Google Earth, to check the depth of the area. 20 points were randomly selected with depths ranging from 0-20 meters in four classes: 0-5, 5.1 to 10, 10.1-15 and from 15.1 to 20 m (Table 1).

Table 1. Distribution of sampling sites, coordinates and depth in each area.

ID	X_UTM	Y_UTM	Depth (m)	Area
Ala_1	219260.63	2495856.94	-2	North
Ala_2	221896.02	2493392.70	-2	North
Ala_3	224032.24	2495630.71	-8	North
Ala_4	213657.59	2493489.08	-7	North

Ala_5	227555.92	2492760.98	-13	North
Ala_6	222247.41	2497275.96	-18	North
Ala_7	218700.70	2498897.43	-17	North
Ala_8	223153.62	2489945.05	-2	Center
Ala_9	220586.86	2485494.76	-1	Center
Ala_10	214477.32	2490853.13	-7	Center
Ala_11	227987.77	2490326.75	-9	Center
Ala_12	215781.33	2487357.16	-12	Center
Ala_13	230444.48	2484059.78	-13	Center
Ala_14	230738.02	2487529.93	-18	Center
Ala_15	224160.61	2482733.16	-2	South
Ala_16	227711.98	2479946.83	-6	South
Ala_17	228216.01	2476958.89	-10	South
Ala_18	220696.61	2481213.51	-11	South
Ala_19	228605.37	2478318.03	-16	South
Ala_20	230048.90	2480912.33	-19	South

At each site three transects were established of 100 m length and 2 wide, with the first transect drawn randomly. The next transect was placed at the end, and the end of it was placed the third perpendicular transect, in a "Z" shape. After making each transect, all organisms found within 2 m wide were sampled, taken the boat where siphonal length was measured with a vernier to the nearest mm, weighed with an electronic scale 0, 05 g precision. Conch were identified as juveniles and adults following the criterion lip width (5 mm) of Stoner *et al.* (2012).

2.3 Determination of the size structure of conch *Strombus gigas.*

With the information on frequency of sizes, a histogram was made of organisms collected in each sampling period. All data gathered was ultimately combined to determine the general structure of the population.

3.0 Results

3.1 Density of organisms

In September 2013, 152 conch were collected in total, which means a very low number of agencies around the National Park. In various sampling stations, the presence of

organisms was nil, and densities ranged from 0 to 0.06 conch.m $^{-2,}$ as shown in Figure 2. Only three sites (A16, A14 and A7) showed a higher density conch.m 0.04 $^{-2}$ in the remaining sites density was lower than 0.04 $^{-2}$ conch.m, (Fig.2).

When the density of conch per hectare expressed apparently agencies densities are higher, but remember that the distribution of conch is not uniform, so that extrapolation could be misleading. Figure 3 shows the density of conch in the National Park expressed in hectares. The sites marked in red, with 50 conch per hectare or less and could present problems of reproductive meetings in the future.

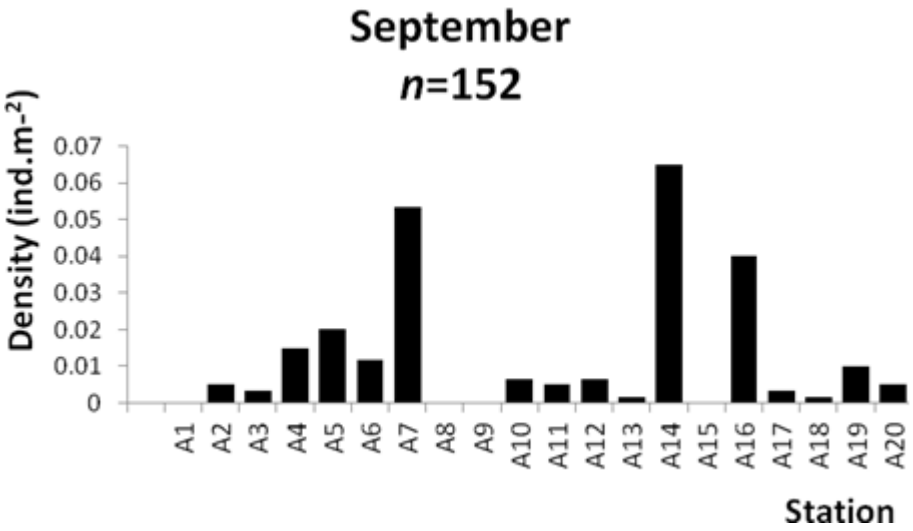

Fig.2.Density of conch (ind.m $^{-2)}$ at the sampling sites

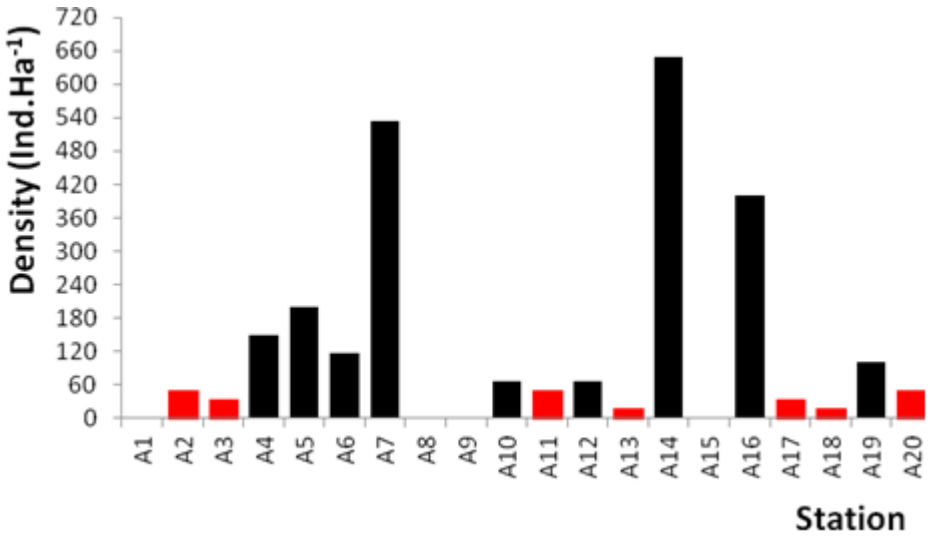

Fig 3. Density of conch per hectare in the sampling sites.; September.

Considering the abundance of conch separated into two categories: "adult" and "juvenile" and taking into account the criterion of greater than 5 mm lip, found that 102 of organisms collected were juveniles, while there were only 50 adult conch. The abundance site shown in Figure 4.

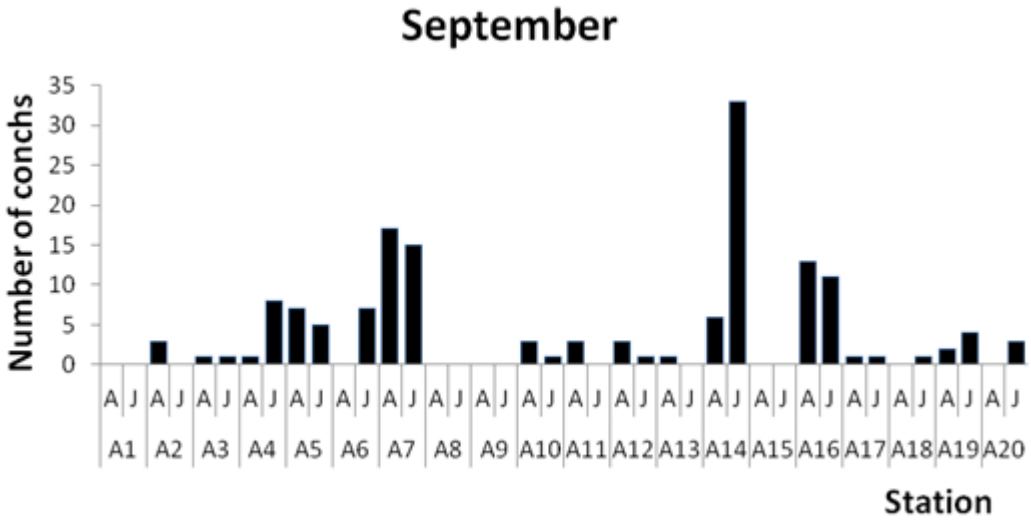

Fig. 4. Abundance of conch in the sampling sites, A = adults J = Youth.

In March 2014 141 conch distributed in the sampling area were found, and the densities ranged from 0 to 0.06 conch.m- ^{2,} as shown in Figure 5. Only two sites showed a higher density of 0.04 conch.m $^{-2,}$ the A17 (0056 conch.m- $^{2),}$ and A18 stations, in other sites density was lower than 0.04 $^{-2}$ conch.m, (Fig.5).

Figure 6 shows the density of conch per hectare can be seen that the stations A2, A3, A9, and A13 have a less than 50 conch.ha $^{-1}$ density value that has been designated as the threshold for them to be the meetings reproductive success. This is consistent with what was observed in the first sampling in the National Park.

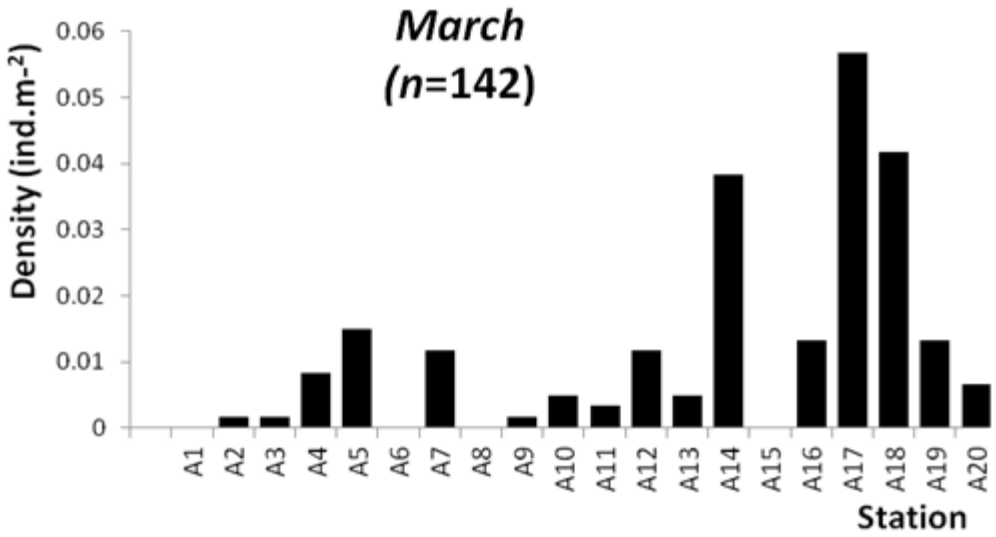

Fig.5. Conch density (ind.m $^{-2)}$ at sampling sites in March.

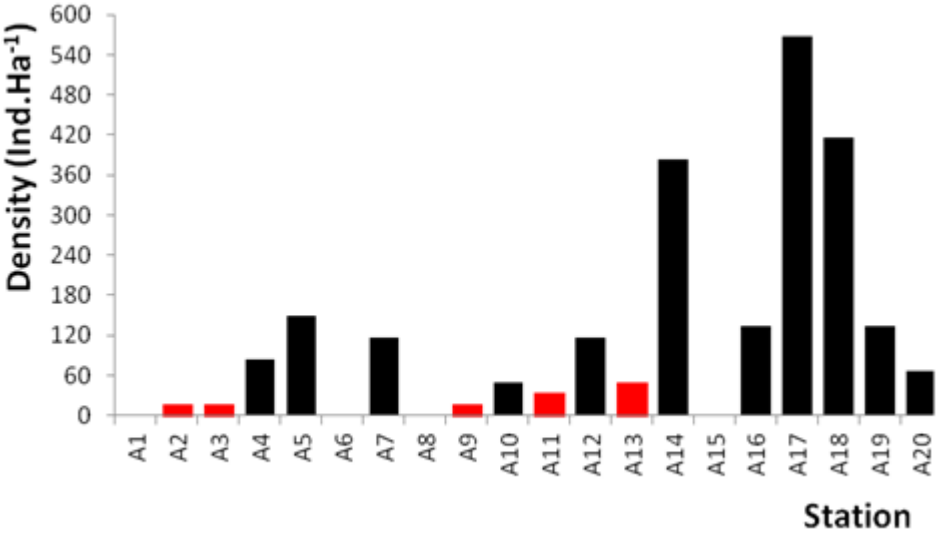

Fig. 6 conch per hectare density (ind. Ha $^{-1)}$ in March.

Considering the abundance separated by "adult" conch and "juvenile" and taking into account the criterion of greater than 5 mm lip, found that 85 of the organisms collected were juveniles, while there were only 56 adult conch. The abundance is shown in Figure 7.

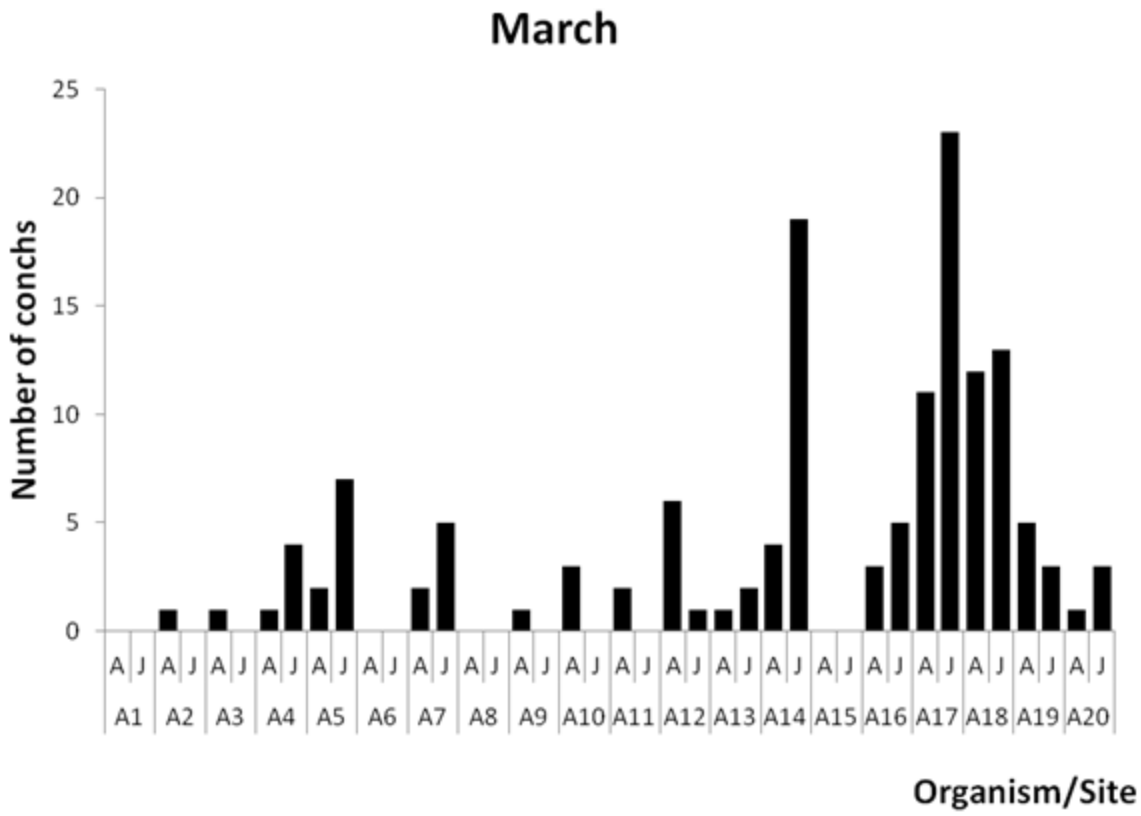

Fig. 7. Abundance of juvenile and adult conch in March.

In July, the behavior of plenty followed the same pattern as in the first and second sampling, only 159 conch distributed throughout the park were found. The densities ranged from 0 (A1 Station) conch.m- ^{2} 0.06 (A5 station), other stations were 0.03 conch.m- near ^{2} (Stations A7, A14, A16, and A17) values in the remaining stations the density was lower than 0.02 $^{-2}$conch.m, (Fig.8).

9 shows conch density per hectare is observed that except for the A4, A14 stations, and A16 all other conch are less than 50 per hectare.

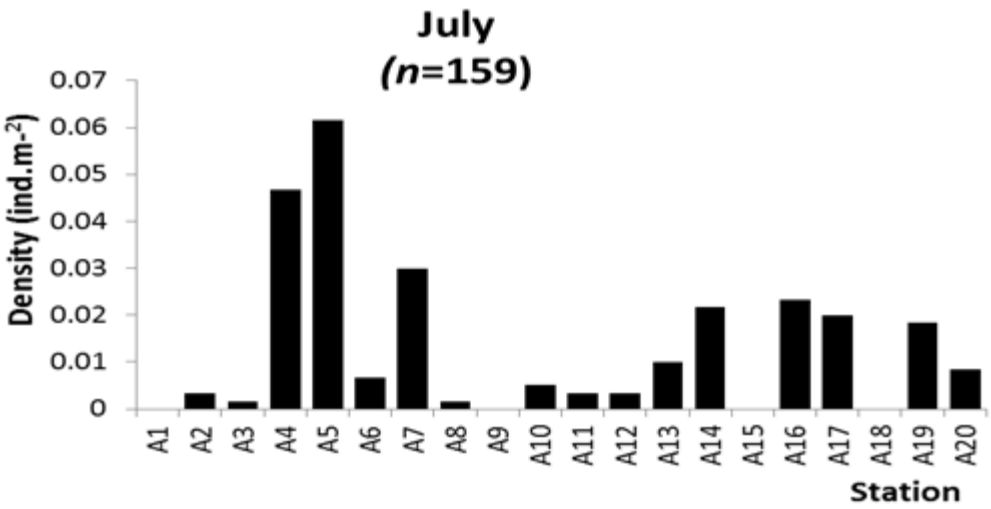

Fig.8. Conch density sampling sites in July 2014.

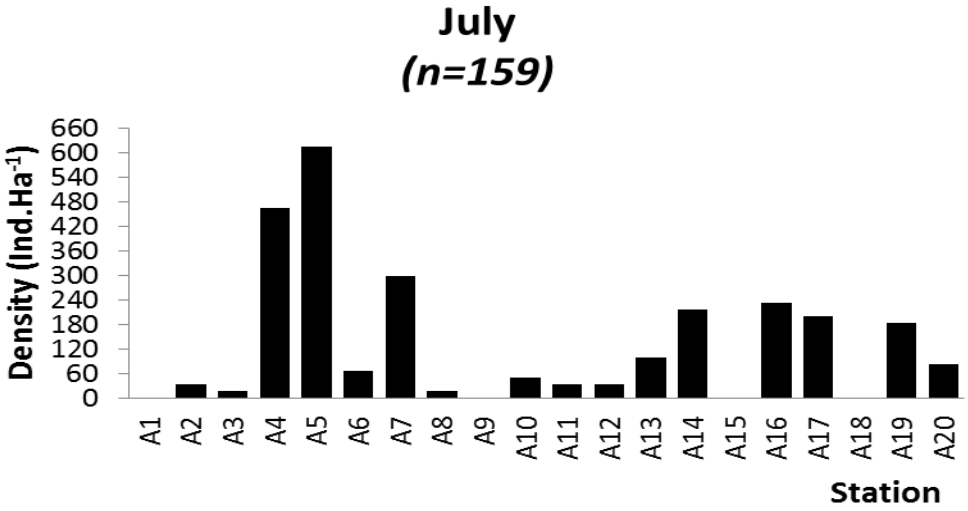

Fig. 9. Density of conch per hectare in the sampling sites

Considering the abundance separated by "adults" conch and "youth" in this sample were found to A4, A16 and A17 stations have a higher density of organisms to 100 conch per hectare. Adults abundance site shown in Figure 10.

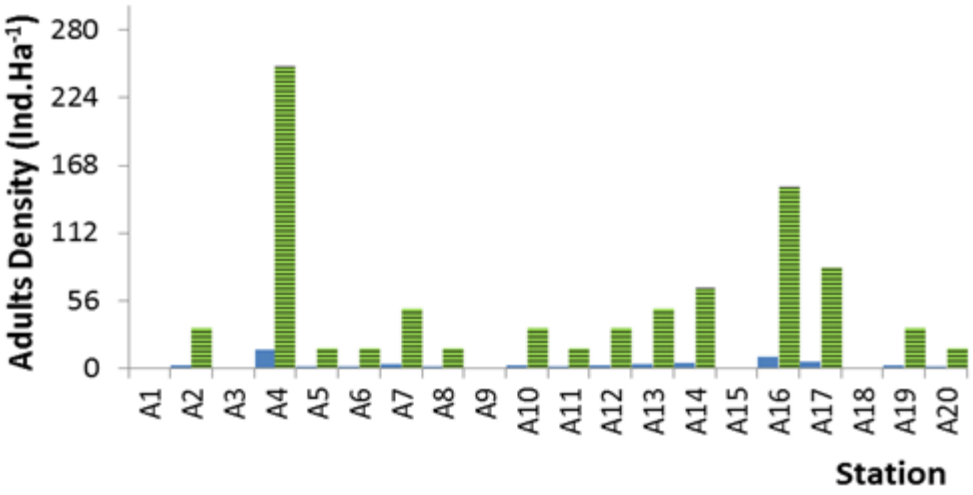

Fig. 10. Abundance of adult conch in sampling sites in July.

3.2 Size distribution

In September sizes of conch ranged from 40-275 mm shell length. The proportion of conch larger than 200 mm in Mexico corresponds to the minimum catch size (SAGARPA, 2000), was also low (33%) as shown in Figure 11. In the figure one can see three peaks of abundance, a very small in size 40 mm, the second peak and the largest of the three, in size of 100 mm and one more in the size of 220 mm, this could be natural variations in the life cycle of conch.

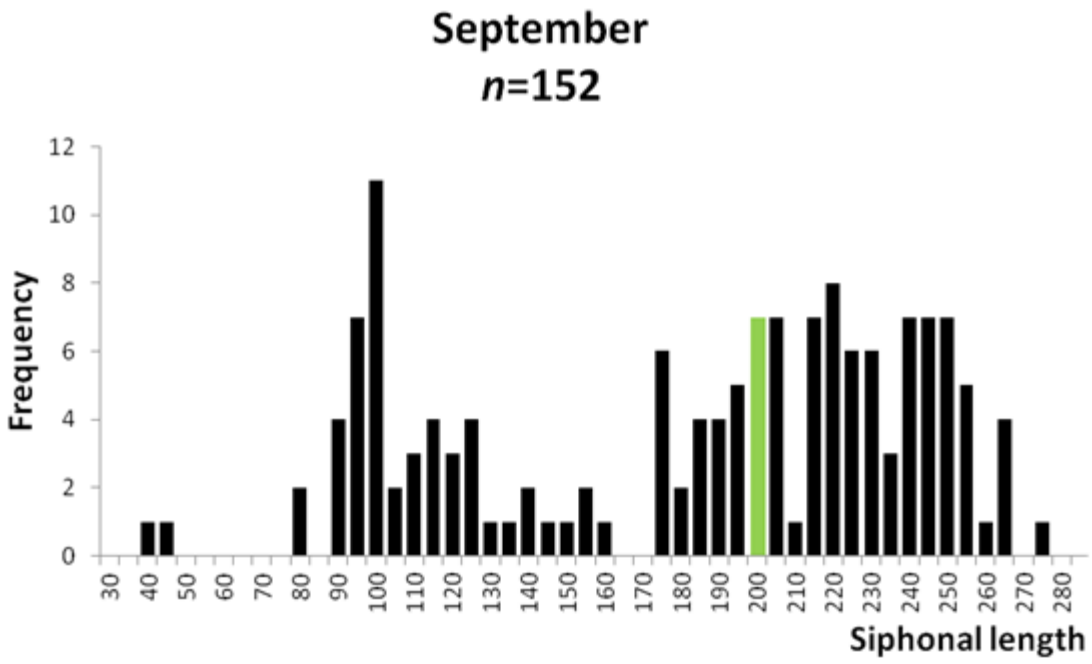

Fig. 11. Frequency distribution of S. gigas shell carvings. Green bar corresponds to legal catch size in Mexico.

In March, the sizes of conch ranged from 115-295 mm shell length, as already mentioned abundance was low as in the first month of sampling. The proportion of juveniles and, based on the presence and adults lip width was: 85 young conch are considered and only 56 are adult organisms throughout the protected area, this is shown in Figure 5. In Figure 12 they can be see two peaks of abundance, one very small in size 115 mm, the second peak and the larger of the two, at the height of 225 mm. The maximum size of the conch corresponded to 295 mm, but with a low frequency.

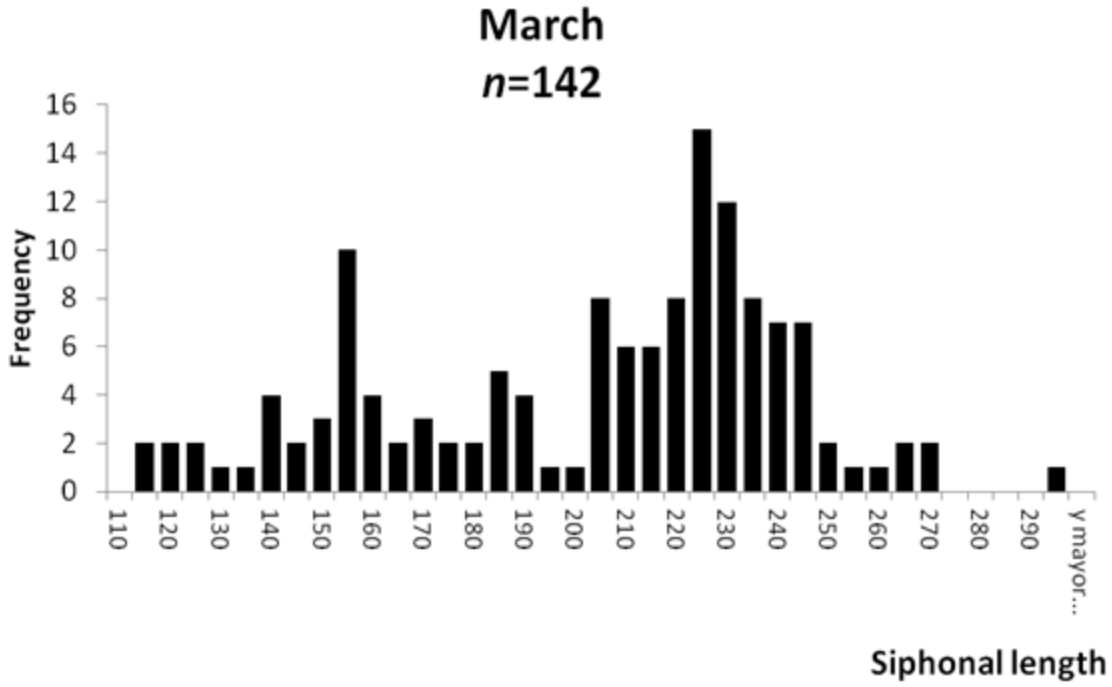

Fig. 12. Frequency distribution of conch size *S. gigas.*

In July, the size distribution was bimodal, with mean values of 175 mm and 230 mm shell length, respectively (Fig. 13). It could be considered that there is a high portion of organisms distributed between 175 and 300 mm which was the largest recorded size, the fact is that very few organisms in the sample (159 conch). This time the smaller size corresponded to 75 mm of siphonal length.

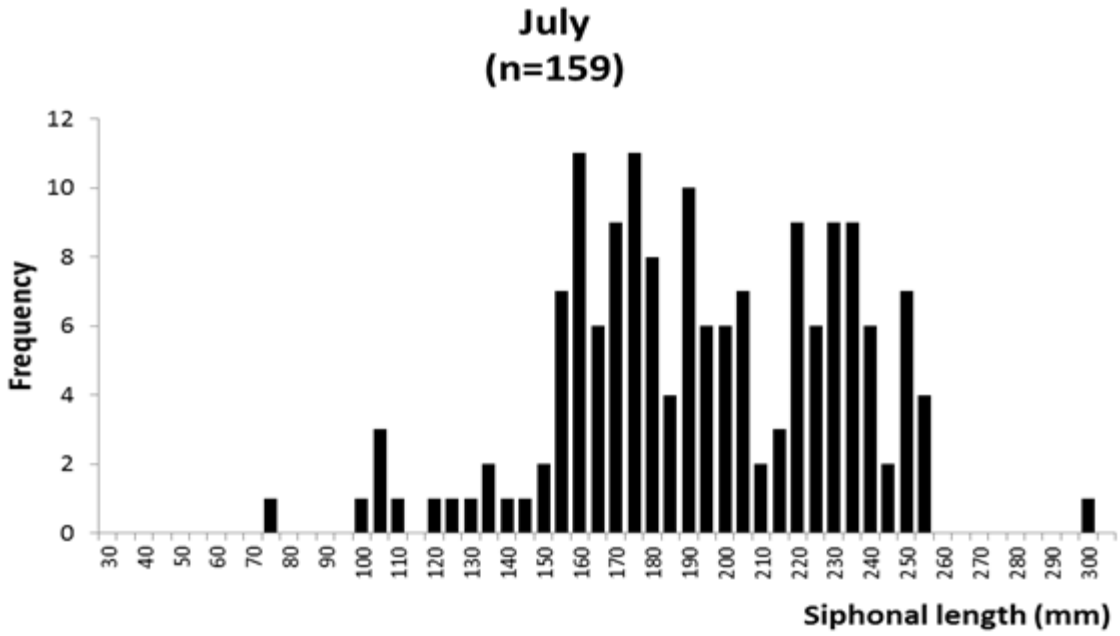

Fig. 13. Frequency distribution of conch size *S. gigas* July.

3.3 Physicochemical parameters

At each site the environmental parameters of the water column were measured. The results are consistent with other work in this area. Temperature was normal with values above 29 degrees Celsius, as was the salinity with values above 36 UPS and very little variation. The values of other parameters are shown in Figure 14.

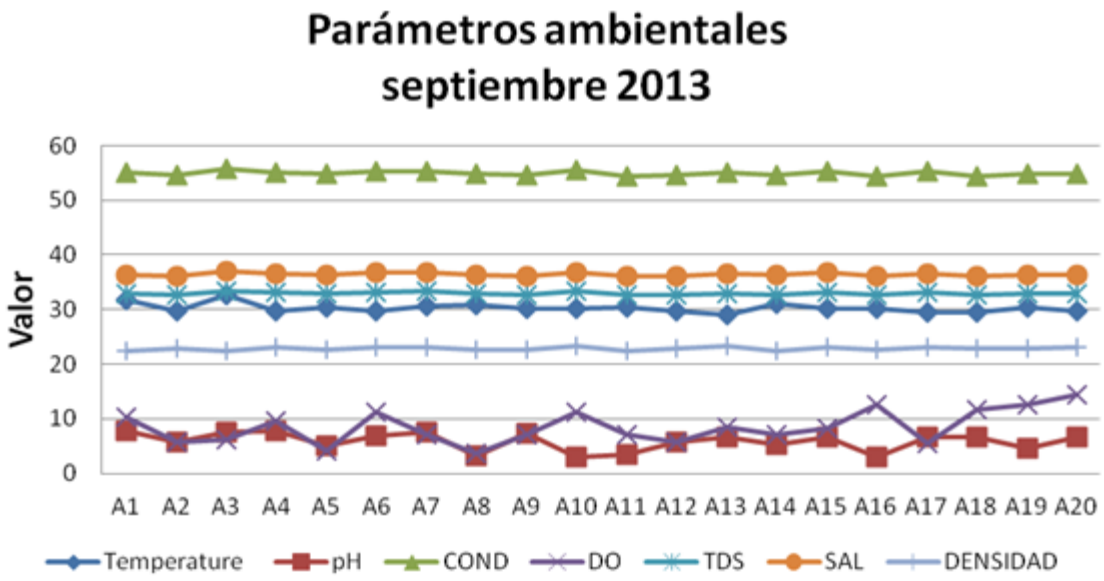

Fig. 14 environmental parameters in the study area, September.

No drastic changes in the parameters are within normal values in the region, with temperatures between 28-30 ° C and salinities of 36-37 UPS are observed. It is noteworthy low pH (2.9-5) at some stations such as A10 and A16.

In March, the behavior of the parameters was similar, with normal seawater for the region values, and very similar to those obtained in September. The conductivity was between 50 and 55 µmohos, the temperature between 28 and 30 ° C and salinity UPS between 34 and 35, as shown in Figure 15.

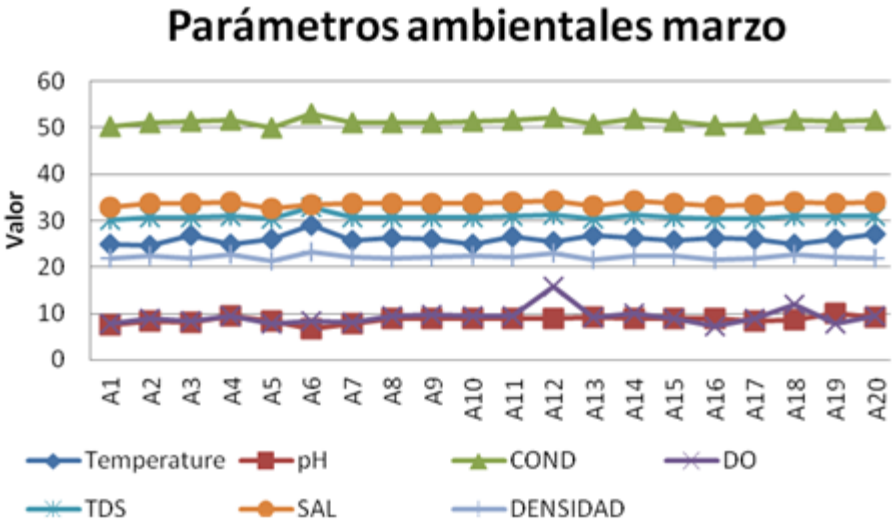

Fig. 15. Environmental parameters in the study area, March.

In July, the behavior was similar with temperature varying between 28 and 31 ° C, salinity between 32 and 33 UPS and conductivities between 49.9 and 50.4, which are considered completely normal in a marine environment such as Arrecife Alacranes. These and other data are shown in Figure 16.

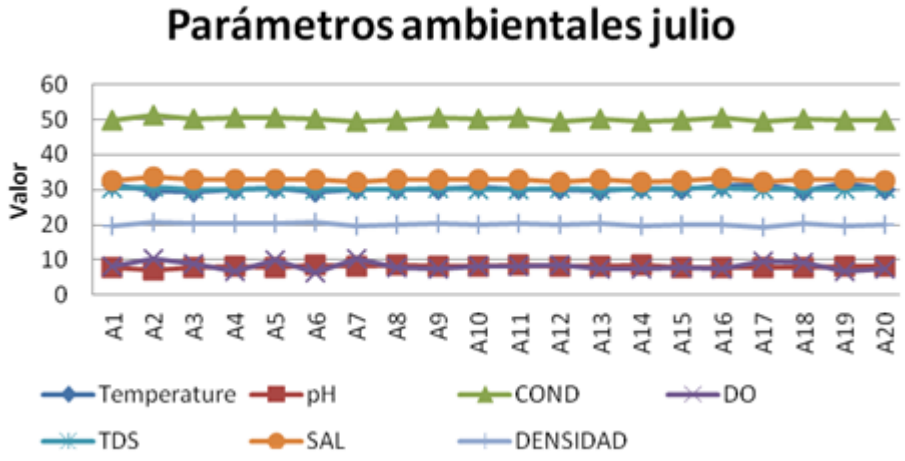

Fig. 16. Environmental parameters in the study area, July.

The results of Pearson correlations and density of conch, were not significant ($p > 0.05$) in any of the months of sampling.

4.0 Discussion and conclusions

When a natural resource is exploited without sustainability criteria, changes occur in the structure of the population (Harmelin *et al.,* 1995). Within these changes, the most conspicuous are a low density of organisms, and a decrease in sizes that comprise the population (Pauly & Palomares, 2005), and this appears to be happening at Alacranes reef.

Table 2 shows changes in the density of the conch *S. gigas,* in the Mexican Caribbean.

Table 2. Changes in density (ind.m $^{-2)}$ spiral *S. gigas* in the Mexican Caribbean.

Author / Year	1984	1988	1990	1998	2003	2012	2014
De la Torre	Three						
Quijano		0.03					
Chavez			One				
Basurto				0.08			
Peel and Aldana,						0.17	
River-Lara				0.00047			
Perez and Aldana					0.018		
This study							0.013

Data from De la Torre, and Quijano, are the oldest and correspond to density values in southern Quintana Roo in the eighties, Chavez and Basurto collected information on Banco Chinchorro and how we see indicates a decrease in density few years. Peel *et al.* (2008) found that the inlet of Xel-Ha, a protected area for tourist use, there is a density of 0.16 conch.m $^{-2,}$ with the presence of all sizes.

In the Alacranes reef, the oldest date density assessment was conducted by Rios-Lara et al (2000) and found that the density of conch was 0.00047 conch.m $^{-2.}$ On the other hand, Perez and Aldana (2003) reported an average density of 0.018 $^{-2}$ conch.m three collection sites, but with a variation of 0004-0035 conch.m $^{-2.}$ In our study, we found a very similar average density (0.013 conch.m $^{-2),}$ which compared with the year of the ban (1998) could mean an improvement, but in fisheries and resource management terms, means a density very low to support the fishery.

This situation of low density of organisms is shared by other sites in the Caribbean, Wood and Olsen (1981) reported a density of 0.0009 conch.m $^{-2}$ in the Virgin Islands, while Berg *et al.,*(1992) in Florida found a density of 0.00076 conch.m $^{-2.}$ and in The Bahamas, Stoner and Ray (1996) reported a density of 0.002 conch.m $^{-2.}$

Another negative effect of fishing is reflected in the average size of the organisms. Data appear to show that conch at Alacranes reef include large organisms, however, the size distribution graphs indicate that the percentage of adults is low. For Alacranes reef, Aldana and Pérez reported in 2003 that the average size was 220 mm shell and we found a mean length of 184.22 mm for the entire area of the reef and the entire sampling period.

No other studies refer to the length of conch shell at Alacranes reef, but a similar decrease was observed in Banco Chinchorro, where an average size of 229.30 mm in 1994 which decreased to 128.30 mm in 1997 (of Jesus was found Navarrete, *et al.,* 2003).

Environmental parameters were within the range considered normal for the area. Aldana and Perez (2007) found that the temperature range at Alacranes reef ranged from 24.2 to 30.2 ° C, while salinity ranged from 36.4 to 37.2 UPS, which coincides with our data because they are within the same range, while dissolved oxygen

ranged from 5.2 to 6.5 mg / l, which means that there is less oxygen in the water column than we found in our study, but that may be due to the specific oceanographic conditions such as strong winds, or maybe Once a problem of calibration.

One of the main problems for recovery of conch populations in the Caribbean is undoubtedly the existence of illegal fishing, due to a lack of enforcement personnel in the government sector, either Fisheries or staff of protected areas, which has no authority to make arrests or seizures.

In conclusion, the diagnosis of the state of the population of queen conch *S. gigas* at Alacranes reef is that densities are very low, and in some places, the presence of the mollusc is zero. Considering the low density per hectare (56 conch.ha $^{-1)}$ we can say that 45% of the sampling sites are in a critical situation, since under this density, the probability of reproductive encounters declines. The sizes of conch present in the reef correspond mostly to juvenile classes that have not yet reached sexual maturity, according to the relative size and width of the lip (Aldana and Frenquiel, 2000) and therefore a quick recovery of the resource is not likely.

Further studies are needed related to the biology of the conch, and distribution and abundance of larvae, juvenile growth habits, juvenile recruitment sites and occurrence of reproductive events, to establish management measures and resource conservation. Examination of these elements is essential to make a proposal for comprehensive management of the species.

5.0 Acknowledgements

We appreciate all the support we received from CONANP authorities, Alacranes Reef National Marine Park, especially to Ing. Yrvin Ramirez, Biol. Axcan Moreno Enriquez and Captain José Ignacio Sobrino Naal, for their help in the field work.

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