In the Variety Is the Pleasure: More Diversity of Morpho-functional Coral Groups in the Reef, More Snappers, More Tourism

En la Variedad Está el Placer: Más Diversidad de Grupos Coralinos Morfo-funcionales en el Arrecife, Más Pargos, Más Turismo

Dans la Variete Est le Plaisir: Plus de Diversite des Groupes Coralliens Morpho-fonctionnels dans la Récif, Plus Vivaneaux, Plus Tourisme

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ABSTRACT

Reconciling economic interests (tourism and fishing) with the conservation of natural systems is a challenge; but it is the consolidation of the sustainable development paradigm. This study was carried out in order to establish the relationships between the corals and snapper taxonomic and functional structure on San Andrés Island. It was developed in tourism activity sites located in the Windward zone of the island during two years in rainy and drought season. The snappers were studied through visual censuses, and the coral coverages by carrying out 5 transects in each site. 96 Lutjanids were observed in which 69% were juveniles and 31% adults. A relationship was found between the development stage of fish and the morpho-functional structure of corals. Our results indicate that more complex reefs in their morpho-functional structure favor the abundance of juvenile, which is the most vulnerable snapper stages.

KEYWORDS: Snapper, tourism, coral, reef complexity

INTRODUCTION

San Andrés Island is an important tourist destination in the Caribbean. An important component for tourism, especially for divers, is the transparency of water for visibility, white beaches and diversity in the reef, which translates into a conserved ecosystem (James-Cruz and Márquez-Calle 2011). These characteristics go hand with the conservation of a place that therefore leads to better habitat for the organisms that live there, such as fish. For this reason, the Seaflower Marine Protected Area was created, which tends towards the conservation of ecosystems as well as the maintenance of commercial fish populations such as snappers (Huiberjs 2015). Ensure not only the protection of ecosystems but the tourism they produce is essential to maintain the economic resource in force over time. Knowing the characteristics that an ecosystem must have to protect fish such as snappers and also ensure tourism is a challenge. Therefore, this work determined the presence of snappers (Lutjanidae) with the morpho-functional diversity of leeward corals of San Andrés Island, in order to provide key information for the conservation of the reefs and the fishing resource.

MATERIALS AND METHODS

Study Area

San Andrés Island is located in the Caribbean Sea in northeastern Colombia. This is part of the Seaflower biosphere reserve named by UNESCO in 2000. For the registration of fish and coral cover, three sites were established: Luna Verde (LV), Wild Life (WL) and Bajo Bonito (BB), registering temperature and depth (Sierra-Rozo et al. 2012). Samplings were carried out in the dry and rainy seasons of 2013 and 2014 in leeward of the island. Visual censuses were taken for fish separating juveniles and adults. Coral cover was recorded taking into account hard coral, soft coral and other biota. Coverage of the reef was determined at the lowest possible level and it was also grouped in morpho-functional categories (CARICOMP 2001)

Numerical Analysis

Fish abundance and relative abundance of corals were found. Alpha (Jost 2006) and beta (Whittaker) diversity indices were calculated. NMDS was used to observe the ordering of data regarding coral morpho-functional groups (Kruskal 1964).

RESULTS

Ninety-six (96) lutjanids were registered belonging to two genera and four species, where 69% were juveniles and 31% adults. *Lutjanus apodus* (1.15 ind/100m^2) and *Lutjanus mahogoni* (0.36 ind / 100m^2), had the highest density compared to *Lutjanus jocu* and *Ocyurus chrysurus*, who presented 2 individuals to each one in the study (Figure 1). Juveniles of *L. apodus*, were recorded in greater amount in WL and LV structurally dominated by calcareous substrate and different coral morpho-functional groups, while the adults of both *L. apodus* and *L. mahogoni* were recorded more in BB where dominates the octocoral (Figure 2).

Regarding the reef, a total of 60 morphotypes were found, where the majority of the corals had close or less coverage than 5%, while the algae, the inert substrate and the octocorals had, among three, an approximate coverage of 60% of the total registered. Diversity was similar between sites (BB = 9.37, LV = 8.77, WL = 10.3) with little replacement among them (βwLV = 2.34; (βwWL = 2.19; βwBB = 2.03). However, differences were found between the amount and the aggregation of the coral morpho-functional categories by site WL presented six morpho-functional categories while in LV they dominated five categories: in Bajo Bonito dominated the octocorals over the other coral coverages (Figure 2) .Submassive and cerebriform corals tended to grow in the deepest areas, Wild Life (11.3 ± 2.4 m) followed Bajo Bonito (11.1 ± 2.3 m), where there is greater density of adults, while juveniles remained in shallower and warmer areas, Luna Verde (10.8 ± 2.4) m) where mainly star coral grows and there is presence of calcareous substrate.

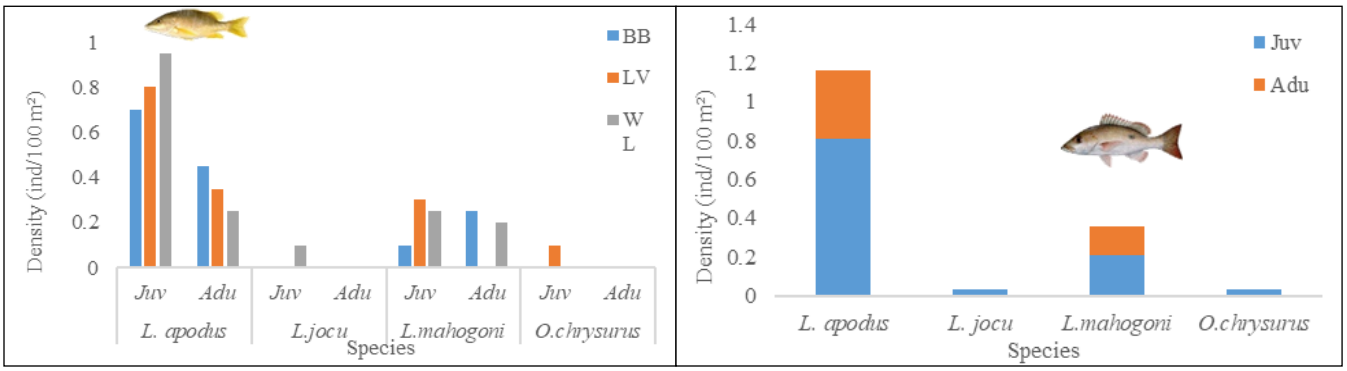

Figure 1. Abundance of snappers registered in the leeward zone of San Andrés Island.

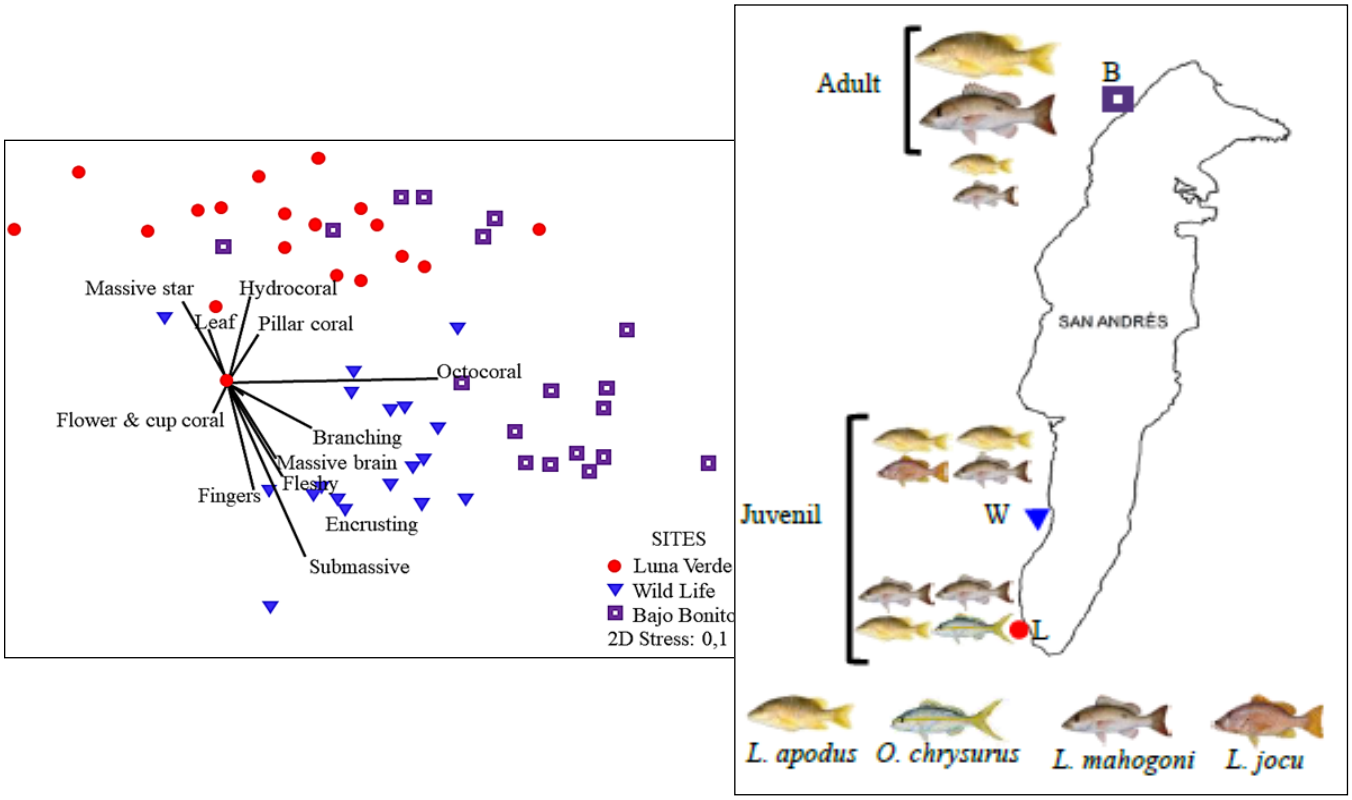

Figure 2. Bray-Curtis analysis of the morpho-functional groups present in the leeward reefs of San Andrés Island.

DISCUSSION

The highest density of juvenile snappers in WL and LV corresponds to the variety of coral morphologies available in these sites. For example, LV presented massive, leaf, hydrocoral, pillar and flower & cup forms, of which it dominated the *Siderastrea* spp species. Abundance of this and other hard coral species allows juvenile fish to use them as a potential refuge and therefore the fish in early stage abound in this site. However, areas with calcareous substrate can also be used by fish as described in other studies with other fish (Sierra-Rozo et al. 2012). WL presented a greater number of morpho-functional categories. This site had mainly encrusting forms of *Agaricia agaricites* and submassive species of *Porites astreoides*, which besides being the most abundant in the study are resistant to degradation (Darling et al. 2012). Additional to these in WL, there were branched, brain coral, fleshy and finger corals; all morphologically different from each other. This makes the fish "prefer" coral reefs with a variety of ways where they can find both food (adults) and refuge (juveniles). The loss or low structural complexity influences the low presence of organisms in important stages of their development, both in snappers and in other fish, which are also a fishery resource (Richardson et al. 2017). The factors that can possibly influence the low presence of snappers are the artisanal and industrial capture to which they are exposed, the habitat degradation and abundance of macroalgae (45%) that dominate a large part of the coral reefs of San Andrés and the Caribbean (Santos-Martínez et al. 2013, Alevizon and Porter 2015).

These prove that it is not only important to protect coral species but also to encourage the reef to remain as a diverse unit expressed in structural complexity, so that both fish and humans perceive the reef as "attractive".

CONCLUSION

Snappers are benefited from early stages by a diverse reef especially morpho-functionally. Wild Life and Luna Verde are important sites for fish, therefore, they must be effectively conserved and made responsible use of these sites due to their biological and commercial importance, whether for fishing and/or tourism, they will also allow them to be better habitat and visually more attractive for tourism. It is recommended to be more emphatic in the protection of Bajo Bonito due to its presence of adults.

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