Exploring the Effects of MPA's in a Tropical Marine Ecosystem. A Multi-Species and Multi-Gear Fishing Case

Luis Orlando Duarte

Laboratorio de Investigaciones Pesqueras Tropicales, Universidad del Magdalena, Colombia. gieep@unimagdalena.edu.co

Introduction

The scientific community involved in management of ecosystems has recognized the importance of including spatial considerations in complex marine systems. Spatial management could be the only available tool for high-diverse tropical systems (Sumaila et al. 2000). Therefore, spatial explicit evaluations are needed to explore management policies. The present work is an attempt to evaluate the ecosystem effects of Marine Protected Areas in a multi-species and multi-gear fishing system using spatial simulations. Our aim is to detect promising fishing management strategies, mainly where fishing effort is concentrated.

Methods

The Gulf of Salamanca (GofS) ecosystem (11° 00' N to 11° 19' N and 74° 12' W to 74° 50' W; Fig. 1) is an example of the Colombian Caribbean shelf systems according to its biological and physical structure and the social and economical characteristics of the artisanal fisheries operating in this area (including beach seines, gill nets, long lines and fishing lines) (Manjarrés, 2004). At least 140 species are recorded in the landings, including pelagic and demersal resources.

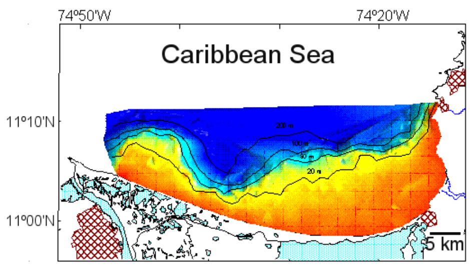

Figure 1. Gulf of Salamanca

ECOSPACE (Walters et al., 1999) simulations were based on an ECOPATH (Christensen y Pauly, 1992) model of 18 biological compartments previously constructed with information derived from three scientific cruises carried out in the continental shelf of the GofS during 1997 (Duarte and García, 2004).

Seven types of habitats were assigned according to the environmental and fishing conditions (Fig. 2). Higher primary productivity has been observed in the estuarine zones associated with a coastal lagoon (blue) and the Magdalena River (green). Some rocky bottoms occur in the middle of the Gulf (red) and some fleets only operate in the eastern part of the marine nearshore area (orange).

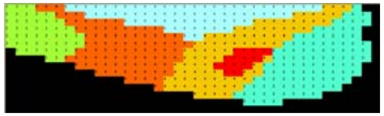

Figure 2. Sketch of habitats assigned in the GofS

The MPA´s scenarios tested were sizes of 0%, 20% and 40% of the total area represented in one MPA (western sector) or two MPA´s (western and easter sector) (Fig. 3). Effects of MPA's designs were evaluated over 20-year ECOSPACE simulations.

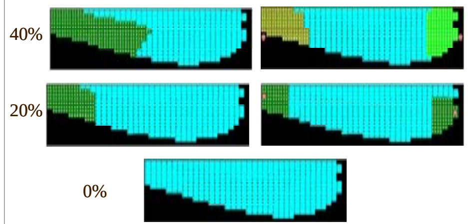

Figure 3. MPAs scenarios tested

Results

The ECOSPACE predicted change in biomasses and catches are presented in Figure 4. Scenarios suggest increase in the biomass of pelagic predators (PP), and rays/sharks (R/S) as the area of MPA`s are increased; Conversely, small pelagics (SP) and mullets/catfishes (M/C) result in a biomass decrease. Porgies/spadefishes (P/S) and croakers/mojarras (C/M) showed a low change in biomass. When the MPA is splitted in two sub-areas the biomass changes are amplified. Results show a typical cascade effect generated by a strong increase of the top predators.

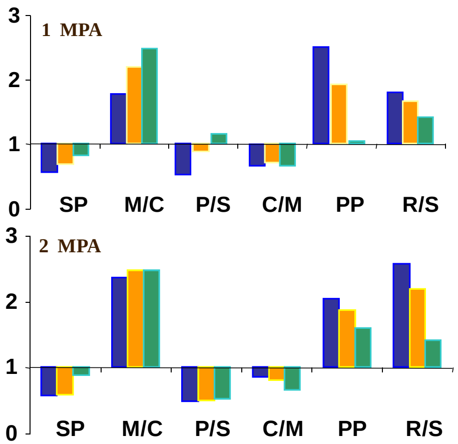

Figure 4. Predicted changes of biomass pools over the twenty year ECOSPACE simulations. The values are relative to the baseline simulation parameters. Blue bars are the results without MPA, orange bars are the results of protecting 20% of the total area and green bars are the result of protecting 40% of the total area.

Gill nets (GN) and fishing lines (FL) increase their catches during the simulations, meanwhile beach seines (BS) decrease lightly their values. The total predicted catches increase with the increase of the size of the MPA's, specially when the MPA is splitted in two sub-areas. This could be a negative social result because beach seines are important for the employment in the Gulf (Figure 5).

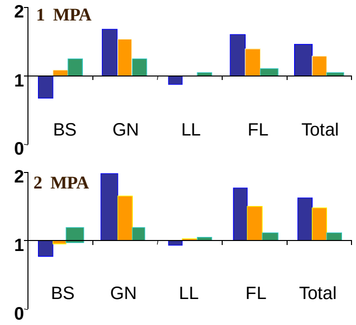

Figure 5. Predicted changes of catches of each fishing. Conventions as in figure 4.

Conclusions

The predicted biomass increments of top predator should be seen with care. Structural changes and other variation sources can produce very optimistic results. Effects on catches indicate potential conflicts in the multi-gear fishing.

References

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Acknowledgments

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