Marine habitat mapping: Estimation of wave exposure in Cabrera Archipelago National Park for identification of essential fish habitats

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Wind- induced exposure is one of the major forces shaping the geomorphology and biota in coastal areas. The effect of wave exposure on littoral biota is well known in marine environments (Ekebon *et al*., 2003; Burrows *et al*., 2008). Ballesteros and Zabala (1993) estimated that such effect decreases exponentially with depth, being more important in the first 20 meters of the water column. The aim of this work is to create wave exposure index maps of the Cabrera Archipelago National Park and to explore the effect of this variable on the size range distribution of dusky grouper (*Epinephelus marginatus*) being juveniles expected to use low exposure areas. This analysis has been carried out in the context of the project EPIMHAR (2007-2010), which focuses on the identification of essential habitat for this emblematic species in the Cabrera Archipelago (Balearic Islands, western Mediterranean sea).

MATERIAL AND METHODS

Wave exposure values in the Cabrera archipelago were estimated following the EXA (EXposure estimates for fragmented Archipelagos) methodology (Ekebon *et al*., 2003). Wave power was calculated for points located 50 m equidistant on the coastline.

Two integration periods were chosen for the calculation of wave exposure: summer and autumn. Wind data (direction and intensity) from 2008, registered at the Cabrera mooring located north of Cabrera Archipelago, were provided by IMEDEA (CSIC-UIB, TMMOS http://www.imedea.uib-csic.es/tmoos/boyas/).

Underwater visual censuses conducted in July and October 2008 were used to estimate abundance indices and size structure of the dusky grouper population along 30 x 5 m transect. For each fish observed total length was estimated.

In order to analyze the effect of wave exposure data from 0 to 20 meters depth were selected at 21 study areas along the Park, which were grouped according to their exposure in 3 levels: low, medium and high. Distribution of the size structure was compared among these 3 levels and correlation analysis between mean depth of the transects and wave exposure values was conducted to test for possible interdependence between these 2 variables.

Fish length was grouped in size classes of 10 cm and their frequencies at the 3 different exposure levels were compared with a Kolmogorov-Smirnov test. Analysis of variance was used to test for differences among mean length and the 3 exposition levels.

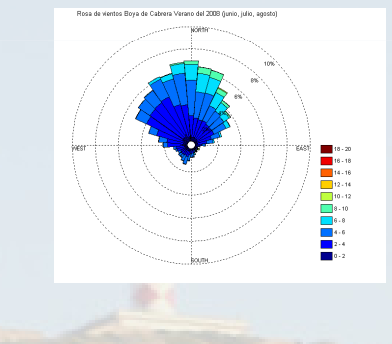

Figure 1. Wind direction and intensity in summer.

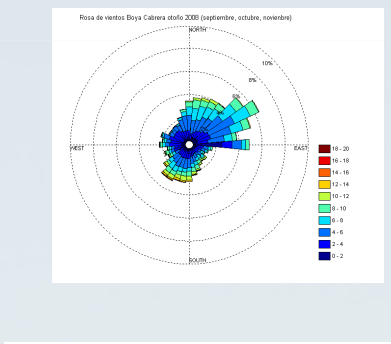

Figure 2. Wind direction and intensity in autumn.

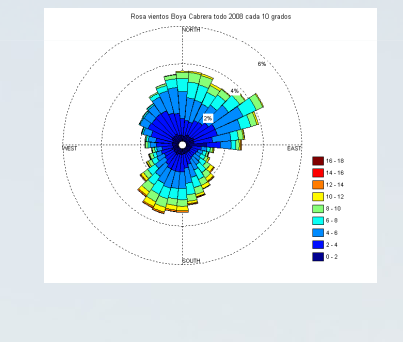

Figure 3. Average anual wind direction and intensity

RESULTS

- There are important spatial and seasonal differences in wave exposure driven by the local wind regimes, the location of Cabrera and the position of the islets within the archipelago.
- North winds were predominant during summer but North-East winds showed highest intensity (Figure 1). On the other hand, North-East winds prevailed in autumn being South-West winds the most intense (Figure 2). These regimes create areas of higher exposition values on the eastern side of the archipelago during summer and on the western side during autumn.

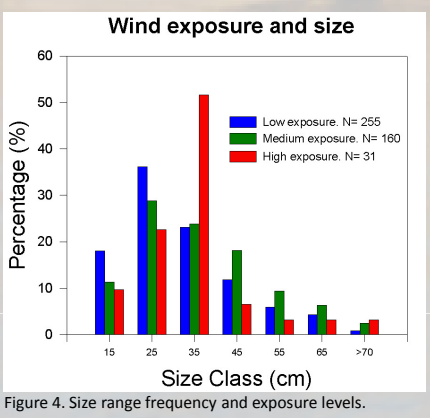

Figure 4. Size range frequency and exposure levels.

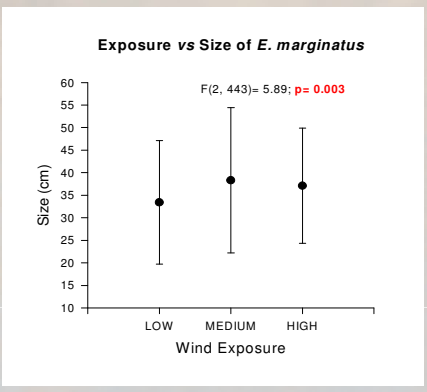

Figure 5. Average size at 3 exposure levels.

- Correlation coefficient between mean depth of the transect and average annual wave exposure was low (Pearson product moment correlation coefficient= 0.279) showing no association between these variables.
- Size distribution of dusky groupers ranged from 15 to 75 cm total length, representing a fraction of the population ranging from juveniles to adults.
- There are significant differences in the size range frequency of dusky groupers between areas of low and medium exposition (KS test, low versus medium: $p< 0.05$) and between areas of low and medium and high exposition (KS test, low versus medium+ high: $p< 0.025$) (Figure 4).
- No significant differences were found in the size range frequency of dusky groupers between areas of medium versus high exposition (KS test, medium versus high: $p>0.10$) and between areas of low versus high exposition (KS test, low versus high: $p< 0.10$).
- There are significant differences in the average length of dusky groupers found in areas of different exposure levels (ANOVA p= 0.03) (Figure 5).

DISCUSSION

- The EXA methodology has proved to be a useful tool for the classification of shoreline exposure in the Cabrera Archipelago and the data generated can be used in future research to analyze the effect of wave exposure on other species of interest.
- These preliminary results show a significant effect of wave exposure on the size distribution range of the dusky grouper in the Cabrera Archipelago affecting mainly the juvenile section of the population, which are commonly found in areas of lower exposition.
- Future research should include smaller size classes , which could be more vulnerable to the effect of wave exposure.
- Other variables could be playing an important role when determining the distribution of size classes of dusky grouper in the region such as potential shelter areas on the substrate.

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