

# EFFECTS OF FISHING RESTRICTIONS ON THE ABUNDANCE, SIZE STRUCTURE AND MORTALITY RATE OF A WESTERN MEDITERRANEAN POPULATION OF *SCORPAENA SCROFA* (LINNAEUS, 1758)

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## Abstract

This study evaluates the changes occurred in a population of *Scorpaena scrofa* after eight years of protection (fishing ban) in the Columbretes Islands Marine Reserve (western Mediterranean). Relative abundance, size structure and mortality rates of the protected stock are compared with those of exploited stocks in the region. Higher abundance and a greater number of large-size individuals characterise the protected stock. A first estimate of the natural mortality rate, together with estimates of the exploitation rates in the fished stocks, is also given.

**Keywords :** fishing ban, marine reserve, *Scorpaena scrofa*, western Mediterranean.

## Introduction

In the western Mediterranean *Scorpaena scrofa* is an important commercial species captured mainly in trammel-net artisanal fisheries. It is a slow growing benthic predator that inhabits mainly hard substrates between 20 and 200 m depth. The rather limited mobility of *S. scrofa* and its slow growth make this species particularly vulnerable to overfishing. For the same reasons, fishing restrictions are expected to be particularly effective in rebuilding populations of *S. scrofa* although to date no studies exist that evaluate this response. This study assesses for the first time the responses of *S. scrofa* to fishing restrictions in terms of population abundance, size structure and mortality. These changes are the most widely documented effects taking place in marine populations positively affected by protection.

## Material and Methods

**Study areas.** The study was conducted in the Columbretes Islands Marine Reserve (MR) and in two areas open to fishing (OF) : the Subarra area (OF-I) (40° 03' 30"N - 00° 40' 50" E) and the area off the NE coast of Mallorca island (OF-II) (39° 52' 00"N - 03° 29' 00"E). The MR was established in 1990, extends over an area of 14 km<sup>2</sup> and is located 30 miles off the eastern coast of the Iberian peninsula (39° 52' 50"N - 00° 40' 20"E). All fishing is forbidden in the MR with the exception of purse seine and pole-and-line fishing in restricted areas.

**Sampling design.** Trammel net fishing was carried out in the MR (surveys) and in the open fishing areas (commercial) between 50 and 80 m of depth during the summers of 1998, 1999, and 2000. Trammel nets were 600 m long and had a drop of 1.7 m. The mesh size of the inner and outer panels were 80 mm and 300 mm respectively. Given the complex morphology of *S. scrofa* (spines and appendices), trammel net selectivity for this species may be approximated by a logistic model where all animals over a certain size are entangled. Twelve sets were done in the MR and a larger number were sampled in the open fishing areas (OF-I and OF-II) each year. Abundance indices were estimated from catch rates (numbers caught per set) standardised to one night soak time.

**Statistical analysis.** To assess temporal and spatial differences in relative abundance, catch rate data were analysed by orthogonal analysis of variance with year and area as fixed factors. Multiple comparisons after ANOVA were done by SNK tests. Data were log-transformed to comply with the assumptions of the analysis. To obtain equal sample sizes in the three areas, random subsets of 12 replicates per year were drawn from the larger pool of samples available from the OF areas.

For the analysis of length data, samples of the three years were pooled to increase sample size. Spatial differences in mean size were assessed by one factor ANOVA.

**Mortality rates.** Total mortality (Z) was estimated for the protected and exploited populations from the size frequency distributions using the Beverton and Holt's Z equation for length data. The growth parameters were taken from Bradai and Bouain 1.

## Results and discussion

The abundance of *S. scrofa* did not vary significantly over time in any of the study areas ( $F_{0.05(1)2,99} = 0.361$ ,  $p = 0.70$ ). However, abundance was significantly higher in the marine reserve than in the open fishing areas at all times ( $F_{0.05(1)2,99} = 10.08$ ,  $p < 0.0001$ ), while it was similar in the two exploited areas (Fig. 1).

*S. scrofa* catches were comprised mainly of specimens between 26-40 cm TL in the exploited areas and between 32-46 cm TL in the MR (Fig. 2). The mean size of *S. scrofa* varied significantly among areas ( $F_{0.05(1)2,294} = 46.70$ ;  $p < 0.0001$ ) with a high proportion of large

(hence old) specimens in the MR. The modal and mean sizes in the MR ( $39.5 \pm 4.7$  cm TL) were larger than in any of the OF areas which showed similar modal and mean sizes (OF-I :  $33.7 \pm 4.2$  cm TL; OF-II :  $33.0 \pm 4.3$  cm TL) (Fig. 2).

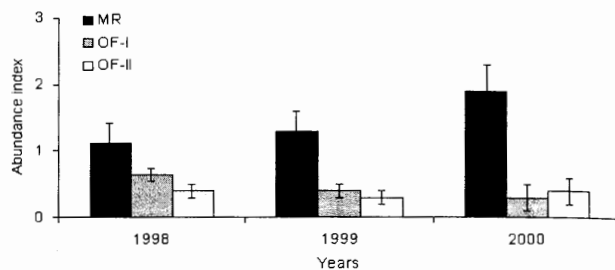


Figure 1. Abundance index (catch in number per standard set) ( $\pm$  standard error) of *S. scrofa*.

MR : Columbretes Islands Marine Reserve; OF-I : Subarra open fishing area; OF-II : NE Mallorca Island open fishing area.

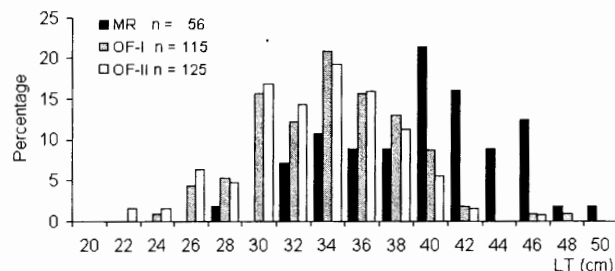


Figure 2. Size frequency distributions of *S. scrofa* in the three study areas.

MR : Columbretes Islands Marine Reserve; OF-I : Subarra open fishing area; OF-II : NE Mallorca Island open fishing area. LT : total length.

The total mortality rate estimated in the protected population provides a first approximation to the natural mortality rate (M) of the exploited phase of *S. scrofa*. The value of M ranges between 0.09 and 0.14 per year depending on the choice of first size group under full exploitation. Given the similarity of size frequency distributions obtained in the two OF areas, Z was calculated for both areas combined. The fishing mortality (F) in the OF areas, estimated by the difference between Z and M, ranged between 0.18 and 0.33 per year.

The results of this study suggest a swift response of *S. scrofa* to the cessation of fishing and a progressive recovery of the population in the marine reserve after 8 years of protection. On the basis of the estimated mortality rates, annual survival of the exploited phase of *S. scrofa* in the Columbretes Islands Marine Reserve is 15-24% higher than in the exploited areas.

## References

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