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The role of climatic variability on the short-term fluctuations of octopus captures at the Canary Islands

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ABSTRACT

The effect of temperature on the common octopus life cycle has been well studied. However, how other climatic patterns affect them is poorly understood. The present work emphasises the importance of the temperature on common octopus catches by the small-scale trap fishery off the Canary Islands, and also highlights the effect of the North Atlantic Oscillation (NAO) pattern. As well as an inverse and significant correlation between octopus abundance (measured as CPUE) and Sea Surface Temperature (SST), a direct relationship between abundance and NAO, off the Canary Archipelago, is reported. Using a linear model (lm) with a stepwise procedure, SST is found to be the most important and significant variable in autumn, accounting for 34.21%. Meanwhile, the NAO became more important in spring with 28.64% and a 31.13% of the explained variance in autumn.

1. Introduction

Due to the short life cycle and fast growth of many cephalopod species, the standing stock (or biomass) of a given area may not necessarily be a good indicator of its exploitation status. The short overlap in successive cohorts creates a lack of "buffering" for natural fluctuations in abundance that is driven by oceanographic or climatic factors. For these reasons, in these species it is more feasible to differentiate the climatic effect from the influence of fishing, because their response to environmental fluctuations should be faster (Hernández-García et al., 2002; Pierce et al., 2008).

Common octopus (*Octopus vulgaris*) is one of the most important target species for the industrial fleets which operate in the Northwest Africa upwelling system (Balguerías et al., 2000; Faure et al., 2000). It is also the case for the small-scale trap fishery off the Canary Islands, since it represents 2–32% of the total catch landed by the local fleet (Hernández-García et al., 1998, 2002; authors data unpublished).

This cephalopod fluctuates drastically on large spatial and temporal scales, due to changes in biological and physical variables that have been proposed as determining factors in its survival (Faure et al., 2000). Solari (2008) pointed out that the capture oscillations during the last 50 years of *O. vulgaris* in the Northwest African upwelling system are intimately connected to the North Atlantic Oscillation (NAO) index variation. However, although it may be one of the climate variables which could cause fluctuations in cephalopod abundance (Sims et al., 2001), its effect is complex even if it shows a positive and linear relationship with captures (Hsieh and Ohman, 2006). Locally changes due to atmospheric forcing can be rapid, but to see them on a large-scale, several years are needed (Bjerknes, 1964; Visbeck et al., 2003).

Capture oscillation could be a consequence of a combination of recent past climate variability and the effect of high fishing pressure on paralarvae and yearly recruitment. Moreover, it is necessary to bear in mind that this species has a very short life cycle, around 1 year, and the duration of its embryonic development and the planktonic stage of its paralarvae are highly temperature dependent (Mangold, 1983; Hernández-López et al., 2001). Also the seasonal temperature oscillations greatly affect its benthic settlement (Katsanevakis and Verriopoulos, 2006b). Therefore, delay between recruitment failure and captures should be short.

Off the Canary Archipelago, as in the neighbouring African grounds, copulation and spawning of octopus take place throughout the whole year (Nigmatullin and Ostapenko, 1977; Hatanaka, 1979; Hernández-García et al., 2002). However, two periods of maximum reproductive activity can be identified for this specie; one from January to July with the peak in April, and the second one from October to November, with slight local variations (Guerra, 1992; Faure et al., 2000; Hernández-García et al., 2002;

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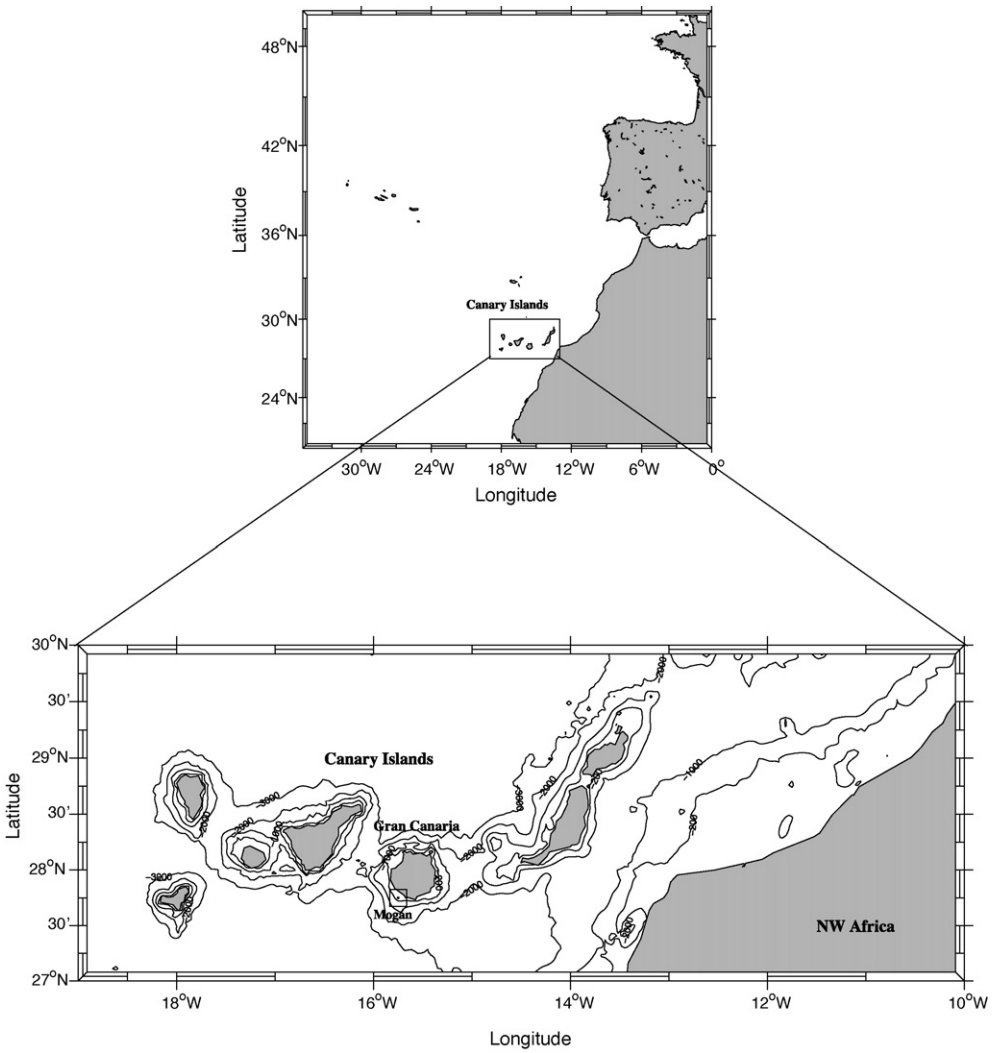

Fig. 1. Canary Archipelago map and catch location (SW Gran Canaria).

Katsanevakis and Verriopoulos, 2006a). In the northwest of Spain, the octopus reproductive cycle seems to be linked to the upwelling seasonality (Otero et al., 2008), while off Mauritania the relationship between recruitment and upwelling variability is seasonally dependent but not always related to the upwelling state; this is probably a reason for changes in the depth of the spawning grounds in spring and autumn (Faure et al., 2000). In accordance with this, Hernández-García et al. (2002) also pointed out that the intensity of the two annual maximum catches of octopus off the Canaries, related to the reproductive concentrations of individuals, are late winter-early spring sea water temperature dependent. In any case, this indicates the presence of, at least, two annual cohorts; generating well separated spawning-catching peaks. Of course, the relative importance of each seasonal peak is dependent on environmental conditions, although Katsanevakis and Verriopoulos (2006a) point out that the second settlement is much more environmentally dependent than the first one.

Studies that evaluate the effects of environmental variability on the cephalopods, and particularly octopus, are scarce and sometimes contradictory. However, the influence of temperature on octopus abundance is always highlighted due to its importance in the first stages of its development (Mangold, 1983; Villanueva, 1995). In line with this, Sobrino et al. (2002) found that the maximum octopus abundance coincided with the minimum Sea Surface Temperature (SST) registered at the studied domain (Gulf of Cádiz). In contrast, Balguerías et al. (2002) and Moreno et al. (2002) reported for the Saharan Bank and the Portuguese coast, respectively, that maximal captures coincided with the highest SST in those domains.

There is an increasing interest to understand how climate variability might affect different marine populations, mostly with the objective of predicting its possible evolution and to manage according to it. As it has been quoted previously, the common octopus varies its behaviour among localities due to regional conditions. In this sense, it is important to understand how climate is affecting octopus in the Canaries since it is one of the fisheries target species. With this aim, we hypothesis how Sea Surface Temperature (SST) and the North Atlantic Oscillation (NAO) may be controlling the *O. vulgaris* in the Canary domain, through a seasonal scale approach; to elucidate if climate is the possible main cause of the observed seasonal fluctuations in this population.

2. Materials and methods

2.1. Data set

2.1.1. Octopus fishery data

The fishing data from 1989 to 2007 were obtained from the daily catch recorded by a single fishmonger who marketed the total catch obtained in the trap fishery landed in the Southwest of Gran Canaria