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Benthic recovery during open sea fish farming abatement in Western Mediterranean, Spain

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Abstract

Fish farming is an important source of organic matter input in coastal waters, which contributes to eutrophication. In this study, the macrofaunal benthic community was studied after the cessation of fish farming with the aim of improving our understanding of benthic succession and sediment recovery in a marine ecosystem. The results showed that the best environmental variables for assessing organic pollution were acid-volatile sulfides (AVS) and redox potential. Succession and recovery was best explained by macrofaunal analysis based on community composition as well as on trophic groups. The patterns of recovery differed between each impacted station. For this reason, succession could not be accurately predicted due to the unique environmental parameters and the singular community functional structure of each location. The Azti Marine Benthic Index (AMBI) proved its validity for assessing pollution but did not distinguish between successional stages.

Keywords: Benthic; Succession; Feeding guilds; Trophic groups; Organic enrichment; Aquaculture

1. Introduction

During recent decades, fish farming in the open sea has undergone almost exponential growth (FAO, 2004). Fish-farms produce a large quantity of wastes (Gowen and Bradbury, 1987), which results in the accumulation of organic matter on bottom sediments,

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causing severe modifications of the physical and chemical characteristics of the benthic environment (Diaz and Rosenberg, 1995; Karakassis et al., 2000).

Many studies have focused on processes related to the environmental impact produced by aquaculture, using macrofaunal analysis and measuring a great number of environmental variables (Karakassis et al., 2000; Pawar et al., 2002). But very few studies have focused on the benthic recovery after fish farming cessation.

In previous studies of benthic recovery after fish farming cessation (Karakassis et al., 1999; Brooks et al., 2003; Pereira et al., 2004), the recovery rates observed in the different experiments differed to a large extent. In Greece (Karakassis et al., 1999), total benthic recovery had not been achieved after 23 months, while in British Columbia, Brooks et al. (2003) reported complete biological remediation after 6 months. At a Scottish sea loch, Pereira et al. (2004) found that sampled stations were highly to moderately disturbed after 15 months. In all these experiments, recovery was considered to have been achieved when benthic fauna assemblages were similar to those of control stations.

The study was carried out at a fish farm located in the Mediterranean Sea on the SE coast of Spain. At the time of the study, fish culture had been practised for more than a decade, with a mean fish biomass of between 30 and 60 ton per year. From January 2001 to March 2003, the installation was progressively dismantled and fish were transferred to another farm located 3 km NE. The singularity and interest of this study is based on two facts: (1) fish culture abatement involved different groups of cages at different times, which enabled us to study, the way succession occurs before, during and after organic pollution abatement in different locations within a single site over 2 years; (2) for a period of two months, in the summer of 2002, production increased enormously as extra fish cages were deployed. This fact produced substantial disturbance in the surroundings, including the sampled stations, each of which was in a different stage of succession at the time of the disturbance. The aim of the study was to monitor the three different groups of fish cages of the same fish-farm, which were in different stages of succession.

2. Materials and methods

2.1. Location and sampling

The study area was located at Hornillo Cove, Águilas, SE Spain (Western Mediterranean) (Fig. 1). The cove has an area of approximately 700,000 m^2 with an average depth of 21 m and a maximum depth of 37 m.

Four stations were sampled. Replicates were taken over an area of 10 m from the anchoring point. Three stations (N, S, and P) corresponded to each of the different fish cage groups (Fig. 1). The reference station, F, was chosen outside the cove due to its biotic and physico-chemical resemblance with the other stations. The depth for each station was N: 14 m, S: 18 m, P: 15 m and F: 20 m.

The fish farm had produced guilthead sea bream (*Sparus aurata*) and sea-bass (*Dicentrarchus labrax*) since 1989. During the last year of full production (2000) the cultured fish biomass was around 12, 12 and 6 ton and feeding rate was 13, 12 and 2 metric ton of food per month for stations N, S and P, respectively. During abatement, the cultured fish biomass and feeding rate fluctuated (Fig. 2). The cages were removed in January 2001, July 2001 and March 2003 (N, S and P stations, respectively), and moved to the new area leased for fish farming.