Available online at www.sciencedirect.com
SCIENCE DIRECT
Marine Pollution Bulletin 53 (2006) 332–349
MARINE POLLUTION BULLETIN
www.elsevier.com/locate/marpolbul

Monitoring the *Prestige* oil spill impacts on some key species of the Northern Iberian shelf

F. Sánchez [a,*], F. Velasco [a], J.E. Cartes [b], I. Olaso [a], I. Preciado [a], E. Fanelli [b], A. Serrano [a], J.L. Gutierrez-Zabala [a]

[a] *Instituto Español de Oceanografía, P.O. Box 240, 39080 Santander, Spain*
[b] *Instituto de Ciencias del Mar (CSIC), P. de la Barceloneta 37-49, 08003 Barcelona, Spain*

Abstract

Selected key components of the continental shelf benthic and demersal communities were monitored for the two years following the *Prestige* oil spill (POS) in order to identify the possible ecological effects of the oil. This work includes the first results regarding changes in abundance, distribution and food habits of hake (*Merluccius merluccius*), four-spot megrim (*Lepidorhombus boscii*), Norway lobster (*Nephrops norvegicus*) and Pandalid shrimp (*Plesionika heterocarpus*) populations of Galician and Cantabrian Sea shelves following the POS.

Significant reductions in the abundance of Norway lobster, *Plesionika heterocarpus* and four-spot megrim were detected in the POS maximum impact area, located over the Galician shelf. Noteworthy recoveries were observed in the 2004 abundance indices of four-spot megrim and *Plesionika*. On the other hand, no significant effects were detected in the abundance or distribution of hake juveniles even though the tar aggregates were bound by the same oceanographic drift events as the hake recruits were during the winter of 2003 (*Navidad* current) in different water column layers of the Cantabrian Sea. Feeding patterns of the four species analysed did not present apparent modifications that can be related to the POS.

Keywords: *Prestige* oil spill; Cantabrian Sea; Galicia; Food web; Hake; Four-spot megrim; Norway lobster; Pandalid shrimp; Tar aggregates

1. Introduction

The oil spill resulting from the accident of the oil tanker *Prestige*, initially during the towing operation (14–18 November 2002) and later during the breaking-up and sinking of the vessel 250 miles from the Galician coastline (19 November 2002), released about 50,000 tonnes of drifting heavy oil (type M-100) in an oceanic area and in the continental shelf waters off Northern Spain. In general terms, most of the surface of the northern Spanish shelf (Cantabrian Sea and Galician waters, ~30,000 km^2) was affected. This shelf includes unique habitats and communities, high biodiversity and species richness, and important fisheries (OSPAR, 2000; Sánchez and Olaso, 2004). During the first phase, the oil floated on the sea surface affecting organisms that inhabit the upper water layers (plankton, seabirds, etc.). Due to the rough winter weather conditions following the oil spill and the wave action, the oil might also have been mixed to a certain depth within the water column, where sensitive organisms may have been exposed and affected. Finally, a spill of this nature involves the deposition of oil in particulate and aggregate form on the sea floor, where it can also affect the benthic ecosystem. A particular characteristic of the *Prestige* oil spill (POS) is the large area and variety of habitats affected, covering tidal and subtidal levels to oceanic and bathyal habitats. The effects of oil spills on fisheries resources and marine communities have been well documented at tidal and subtidal levels (Dauvin, 1998; Gómez-Gesteira and Dauvin, 2000; Peterson et al., 2001, 2003), however scarce information is available on possible effects offshore, in deep shelf and bathyal communities.

* Corresponding author. Tel.: +34 942 291060; fax: +34 942 275072.
E-mail address: f.sanchez@st.ieo.es (F. Sánchez).

0025-326X/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.marpolbul.2005.10.018

A research project supported by the Spanish Science and Technology Ministry based on a multidisciplinary approach was designed to monitor the possible ecological impacts of the POS on continental shelf ecosystems and their fisheries resources. The aim of the study was to assess the possible effects of the oil through different basal ecosystem compartments and the trophic cascade of those effects to other compartments, such as those at high trophic levels. Assessment of these cascading effects through the food web is especially important if we take into account that, due to the particular productivity of Galician waters and the Cantabrian Sea (OSPAR, 2000; Sánchez and Olaso, 2004), the area affected by the POS includes important fisheries (200,000 tonnes per year), which directly or indirectly support the economies of many communities along the coast.

The design of the monitoring project involved sampling the different compartments of the benthic and demersal ecosystems in the area and studying the feeding patterns of several crustaceans and demersal fish species. Nevertheless, considering the economic importance of the fisheries operating in the area and the fact that the possible impacts on this particular ecosystem may have medium or long-term effects like those documented in earlier oil spills (Peterson et al., 2003), we conducted detailed studies on some economic and ecologically key species to determine the effect of the POS on their populations. Three criteria were used to select these species: (i) a wide distribution and sufficient abundance to permit efficient data collection; (ii) behaviour exposing them to high chronic biological exposure; (iii) species for which a considerable historical time series is available from the surveys regularly conducted in the area, allowing the assessment of the possible effects of the oil spill through the pre-and post-oil spill comparison. The key species selected were demersal fish that range into deep water, such as hake (*Merluccius merluccius*) and four-spot megrim (*Lepidorhombus boscii*), and the crustaceans Norway lobster (*Nephrops norvegicus*) and the Pandalid shrimp (*Plesionika heterocarpus*).

European hake (*Merluccius merluccius*) is the main target species of the ground fisheries in the north of Spain. Nowadays, the spawning stock biomass (SSB) is below safety limits and landings in the north of Spain have reached their lowest historical levels ($\sim$3500 t year^{-1}) due to overfishing. This unstable situation, in combination with likely exposure to sublethal doses of toxic hydrocarbons, compromising possible health, growth and reproductive effects, requires special monitoring in order to be able to explain the possible consequences for the hake population in coming years. Adults are at a high trophic level (Sánchez and Olaso, 2004) and it is now probably too early to detect any effects from the oil spill, but juveniles, mainly the 0 year class, feed on suprabenthic detritivorous organisms (Velasco and Olaso, 1998, 2000), which are the first to receive toxic detritus. Also, the main shelf area affected by the POS coincides with the main nursery of the southern stock of hake (Casey and Pereiro, 1995; Sánchez and Gil, 2000).

Four-spot megrim (*Lepidorhombus boscii*) is another noteworthy target species of the trawl fishery in the north of Spain (about 1000 t year^{-1} in the last decade). Annual variability in population parameters is relatively stable when compared to other fish species inhabiting the area. This flatfish lives on muddy grounds of the middle and outer shelf, at 100–300 m depth (Sánchez et al., 1998) and therefore in areas in which there is greater bioavailability of PAHs, given oil exposure, due to the presence of organic matter in sediments. This fish feeds mainly on detritivorous crustaceans (Olaso and Rodríguez-Marín, 1995), has low migratory capacity (Sánchez et al., 1998) and has previously been identified as sensitive to PAHs in the NW Mediterranean Sea (Pietrapiana et al., 2002).

Decapod crustaceans in general occupy a lower trophic level than fish in soft-bottom marine communities, as their diets are more closely linked to the exploitation of benthic organisms, detritus of different origins, and carrion (e.g. discarded fish). Mud and foraminiferans are usually found in stomach contents of a number of species. Therefore, decapods were considered to be important target taxa for the following objectives: (1) to measure the occurrence of oil in stomach contents of species, and (2) to test the correlation between the occurrence of oil in the environment and the degree of stomach fullness of these species. Among decapods, two target species were chosen, Norway lobster due to its economic importance, and the Pandalid shrimp *Plesionika heterocarpus* because, in spite of its secondary interest as a commercial species, it is the dominant and most widely distributed decapod in the trawlable area. In addition to its mainly benthos-based diet, Norway lobster is also characterised by its territorial behaviour associated with burrowing, a behaviour which could make this species particularly sensitive to the accumulation of hydrocarbons on the sea bed.

Cascading indirect effects can be as important as direct trophic interactions produced by oil spills, but current risk assessment models used to project possible biological injuries to marine communities ignore these indirect effects, treating species populations as independent of one another (Peterson et al., 2003). Food webs represent an essentially static account of the natural history and structure of trophic interactions, which can suggest potentially important direct and indirect links among component species (Peterson et al., 2001). The present work is a first account of the initial monitoring of the POS impacts and attempts to understand the effects on species and fisheries through ecosystem dynamics, which summarise the trophic interactions in space and time enabling a glimpse into long-term responses and recovery processes.

2. Material and methods

2.1. Survey design and data analysis

The data on species abundance and distribution come from the historical series of bottom trawl surveys carried