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Multibeam sonar detection of suspended mussel culture grounds in the open sea: Direct observation methods for management purposes

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Abstract

The exploitation of offshore mussel farms is becoming important throughout the world, but monitoring this activity remains a difficult task. Here, we propose a specific method for this purpose. A total of 140 long-lines were monitored on a mussel culture ground in the French Mediterranean Sea during four experimental surveys deploying multibeam sonar devices mounted on poles (Reson Seabat 6012, 455 kHz) on small boats. This allowed geo-referenced observations to be made of the submerged mussel long-lines, as well as three-dimensional (3D) drawings of the long-line structures and the sea bed shapes, using long-line longitudinal sonar sampling. Three sonar data-analysis methods were applied: (i) direct two-dimensional (2D) visual interpretation of raw sonar video images; (ii) indirect 2D long-line drawings; and (iii) 3D digital long-line reconstructions. The development of these acoustic methods in shallow water provides scientists, managers and local authorities with a tool for observing the 3D position (geographical position and depth) of mussel cultures, for counting each structure by the 'long-line echo-counting' method, for monitoring their shape in situ, and for classifying the mussel rope segments into three growth categories ('in growth', 'full' and 'empty'). The use of acoustic tools for monitoring underwater mussel culture grounds, for management purposes and for scientific studies, could be extended to other artificial structures in shallow water environments.

Keywords: Mussel; Long-line; Open sea; Sonar; Management

1. Introduction

The French Mediterranean area accounts for 10% of the national shellfish production. Oysters (*Crassostrea gigas*) and mussels (*Mytilus galloprovincialis*) were traditionally developed on suspended structures inside

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lagoons (Gangnery et al., 2003). In order to increase mussel production, which was previously limited to along the coastline (Smaal, 2002), the potential of the open sea has been explored. The first culture trials began in around 1975 along the Sète coastline. However, after a series of experiments adapting the technology to the regional rough climatic conditions, production really began in 1985 with the subsurface long-line described by Bompais (1991). The offshore mussel production equipment was adapted to survive the winter tempests and new types of apparatus were proposed (Fig. 1A). Economic studies and public subventions led to the development of four sites along the French part of the Lion Gulf (Vidal-Giraud, 1988) (Fig. 1B). The management of these offshore areas is not easy due to their distance from the coastline (2 or 3 MN) and the subsurface position of the structures. The only management method used by the national admin-

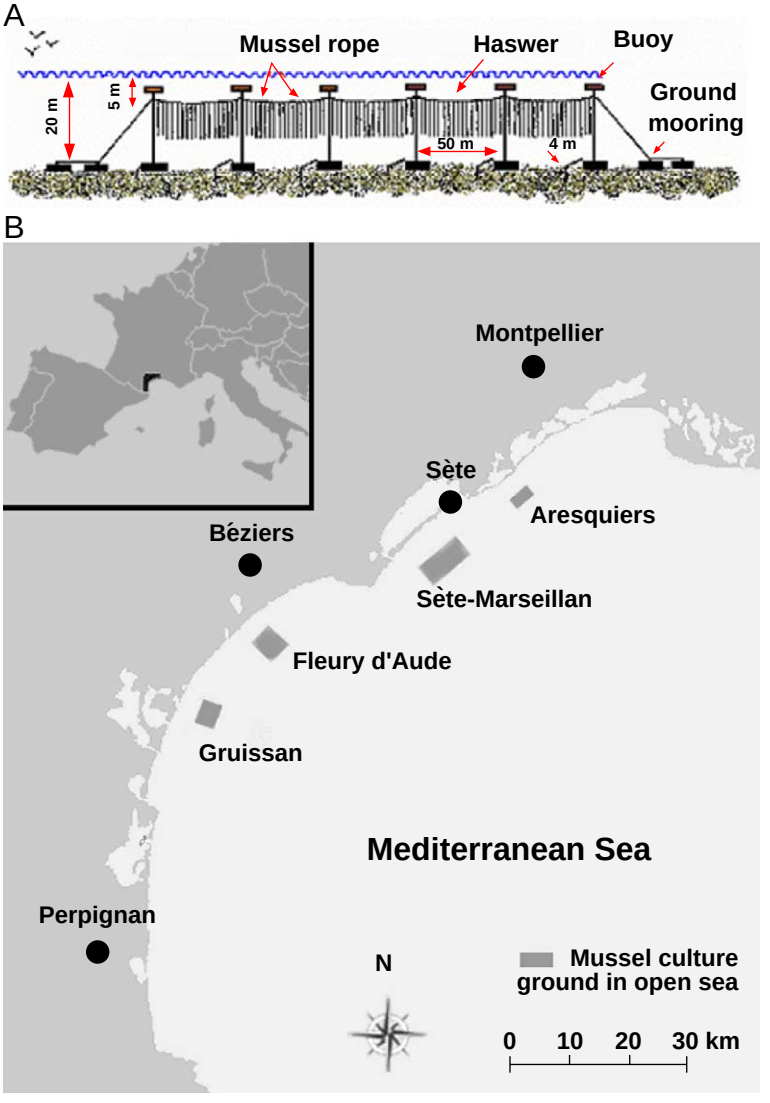

Fig. 1. (A) Map of mussel culture grounds (grey squares) along the Mediterranean French coast. The main study area was Sète-Marseillan (situated in a quadrilateral: 43°20.7N; 3°38.2E/43°19.6N; 3°39.7E/43°15.7N; 3°34.3E/43°16.7N; 3°32.8E). (B) Schematic diagram of a standard mussel long-line in the open sea. The whole structure is submerged at 5 m depth.