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FIN WHALES AVOID LOUD RHYTHMIC LOW-FREQUENCY SOUNDS IN THE LIGURIAN SEA

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INTRODUCTION

The fin whale, *Balaenoptera physalus*, is the only mysticete with a genetically distinct population that is regularly found in the Mediterranean Sea. It frequents the Ligurian Sea year-round,

forming feeding aggregations in summer. The area is shared with intense human activities that may pose a threat for the survival of this population.

We report the results of a study aimed at (a) describing rhythmic low-frequency sounds from 27 May to 24 July 2002 in the Ligurian Sea and (b) assessing concurrent fin whale presence as detected acoustically and visually.

METHODS

Sounds were recorded (7-500 Hz; n = 7,086 files, 3-channel, 20 min each) with autonomous pop-up recorders and analyzed with algorithms tuned for fin whale calls and specific anthropogenic sources. Sample files (n = 539) were inspected visually, whereas IPIs (n = 1,740; mean IPI: 11.3 s; SE: 0.022 s) and time delays were determined with an accuracy of 1 ms. For all delays, arrival angles were derived. Bearings were calculated for target anthropogenic sounds when the approximated source-receiver distance was in excess of 10 times the array aperture. Bearings were calculated applying plane trigonometry and verified with xBat's hyperbolic location functions (Table 1). We compared acoustic data with visual data from whale-watching platforms derived from sighting statistics for the same season in 2001-2005.

RESULTS

Rhythmic low-frequency sounds were consistent with human activities. The source bearing and characteristics were consistent over the entire sampling period, with the source being a long series of percussions alternating with brief pauses. Bearings suggested that the source was stationary and located between Saint Tropez and Ile du Levant (Hyères), France (Figure 1), some 200 km away from the

TABLE 1

Time frame	25 May-24 July 2002	Approx. source distance	>200 km
Est. source location	Ile du Levant (France)	No. of angles measured	1,740
No. of files containing pile driver	7086	Mean IPI	11,296 s
No. of files measured	539	SE	0.0215 s
No. of IPIs measured	1,740	Max. pulse duration	2 s
No. of pulses per hour	319	Approx. SNR at source (spherical spreading)	142 dB

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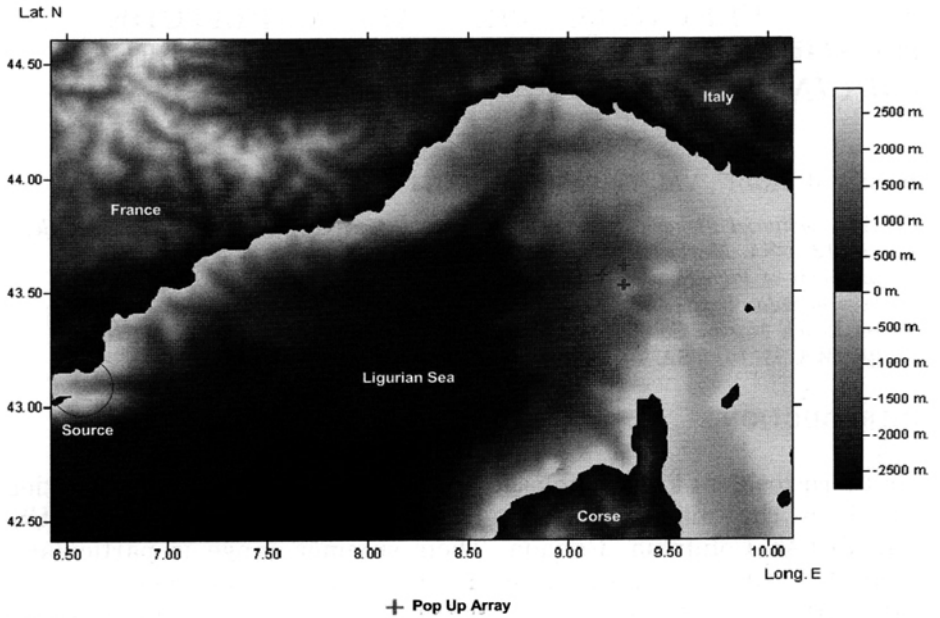

Figure 1.

receiving array. No concurrent acoustic detections or visual sightings of fin whales were made while the noise production was on; no fin whales were detected until a few days after the source stopped; and weak bioacoustic activity was resumed weeks after the source ceased operating.

DISCUSSION

A comparison with other years indicates that the absence of vocalisations and sightings from July to August for the same area is an anomaly. Acoustic characteristics of the source indicate that it was compatible with a pile driver. We conclude that the nature of the sound projected by that specific source caused fin whales to avoid the area (in excess of 200 km) for periods of time that extend after the disturbance has ceased.

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