EVALUATION OF FISHERIES SONAR FOR WHALE DETECTION IN RELATION TO SEISMIC SURVEY OPERATIONS

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1. Introduction

There is a concern that marine geophysical explorations based on air guns may adversely affect marine mammals by direct injury and behavioral disruption (Richardson et al. 1995). Therefore, establishing safety zones for seismic surveys has high priority. Methodology that can reliably detect marine mammals within the established safety zones during all operational conditions for seismic surveys is required for cost-efficient operations and to secure that marine mammals are not injured or affected. In the present work, we have evaluated the ability of traditional fisheries sonars to detect killer whales.

2. Methods

A commercial fishing vessel equipped with sonar was used to survey an area with a large number of killer whales in the northern part of Norway in November 2006. Two fisheries sonar systems were used: Simrad SP90 and SH80 operating at 20-30 kHz and 110-120 kHz, respectively. Maximum source levels (RMS) were 218 dB re 1 μPa (SP90) and 211 dB re 1 μPa (SH80). The sonar transmitted both horizontally (omnidirectionally) and vertically. The fishing vessel was searching randomly in the survey area during the day, and whale detections were always verified by visual observations. Sound-speed profiles were collected to model ray traces, sound transmission loss, and detection probability.

3. Results and Discussion

Whales appeared as distinct echoes on both sonar systems. The detection range on the SP90 sonar was at least 1,500 m, and for the SH80, reliable detections were obtained up to 400 m. In addition to the direct echo from the whale, vocalization was picked up on the sonar. It was easy to discriminate whistles and calls (long tones) from clicks, the fundamental social tones in killer whales (Thomson et al. 2001). Killer whale vocalization frequencies are within the operating frequency range of the SP90 sonar (>20 kHz) (Diercks et al. 1971) but not within the range for the SH80. The pickup on the sonar should therefore be both the fundamental vocalization frequencies and the harmonics. Wakes from swimming whales (surfacing) were also picked up by the sonar systems. The source of the wake is most likely echoes from whale air release and air being mixed into the water during surfacing.

Whales were detected during dives with no effect of water depth, as one would assume, due to lung volume compression and resulting reduction in whale echo strength.

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The whales did not show any apparent behavioral reactions during sonar operations, but this could be due to previous sonar transmission exposure from other fishing vessels in the area.

Simulations of ray tracing, transmission loss, and detection probability was in good agreement with actual observations. It is recommended that sound-speed profiles be measured and simulations conducted as a supplement to sonar observations.

Considerations on methodology for detecting whales in relation to seismic survey operations should include fisheries sonar. Sonar effectively detects the direct echo from whale at ranges sufficient for suggested safety zones (<500 m). In addition to the direct echo from the whale, both vocalization and wakes provide strong criteria for positive detection and classification of the target and can possibly be used to discriminate between species. Sonar is not limited by visibility, darkness, or sea state and is not dependent on whale vocalization as passive listening methods (hydrophones) would be.

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6. References

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