

Original article

## The effect of underwater ship noise on humpback whales in the waters of Ogasawara (Bonin) Islands, Japan

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### Introduction

In coastal waters, extensive marine traffic creates underwater sound, which could potentially affect marine fauna including cetaceans [e.g. 1]. A Japanese team launched a new project since 2015 to quantify possible effects of underwater ship noise on humpback whales in the breeding grounds of the Ogasawara (Bonin) Islands [2,3].

### Materials and methods

The study area was the Ogasawara (Bonin) Islands which is located 1000 km south of Tokyo, Japan (Fig. 1). An advantage of this field site is no other noise contamination of large ships because of less frequent presence of vessels in this remote water except for a passenger and cargo liner for local ferry service. Land-based visual observers recorded humpback whales by a theodolite [4] during 30 minutes before and 1 hour after the liner passing across the study area to locate surface

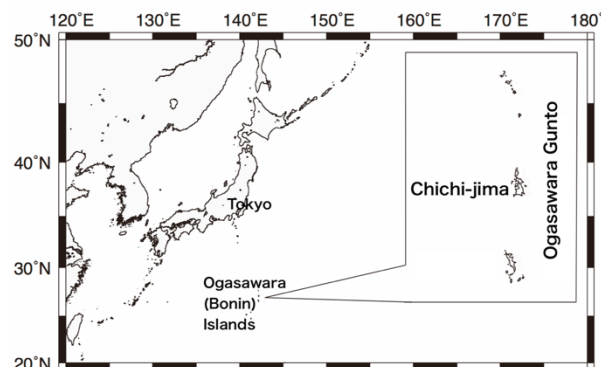
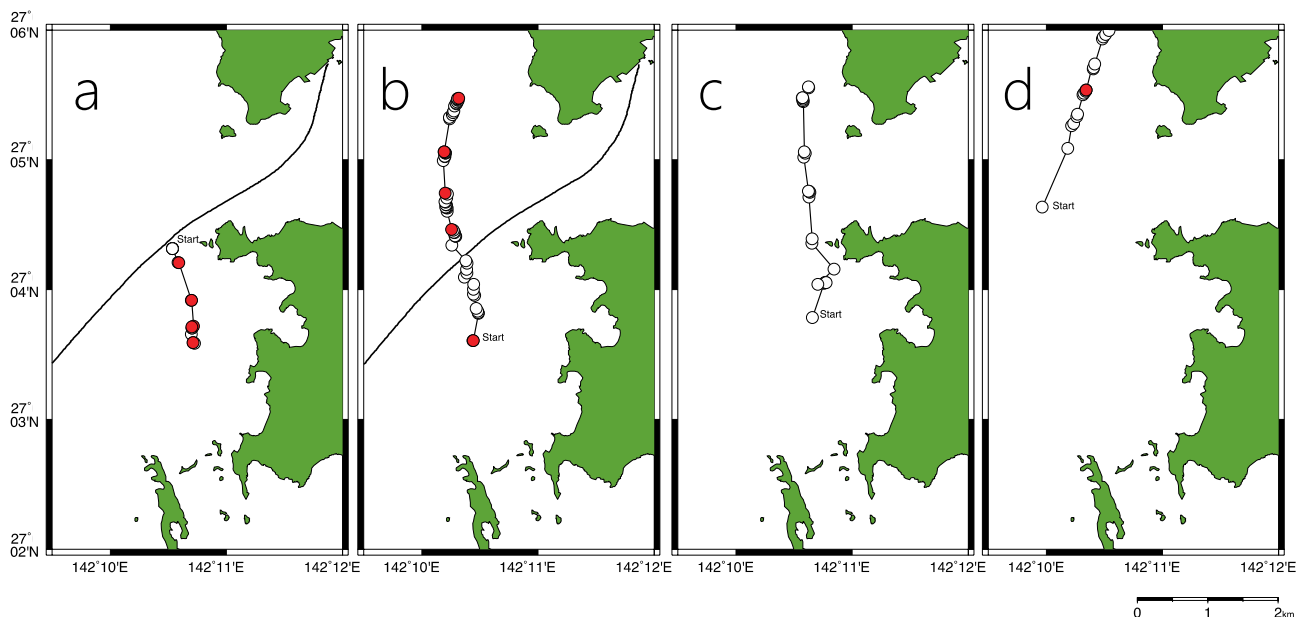


Fig. 1. Study site, Ogasawara (Bonin) Islands, Tokyo, Japan.



Fig. 2. Observers recorded the behavior of humpback whales from the observation deck which is located on the hilltop of Chichi-jima. This deck commanded a fine view of the west side of Chichi-jima waters.



**Fig. 3.** Typical examples of the liner passing across the study area (thick black line) and the surface behavior of humpback whales (blow position: white point and fluke up diving position: red point). At the presence of liner examples shown in Fig.3.a (Feb. 18, 2016) and b (Feb. 22, 2016), and at the absence of the liner examples shown in Fig.3.c (Mar. 3, 2016) and d (Mar. 21, 2016).

position and their surface behavior: blowing, fluke up/down diving, breaching and so on (Fig. 2). Total research effort was 32 days for 92 groups of humpback whales in 2016 and 24 days for 51 groups in 2017.

### Results and discussion

The typical examples are shown in Fig3. The average surface time was 87.3 sec and diving time was 339.6 sec at the presence of the liner ( $n=2$ ), and surface time was 57.3 sec and diving time was 268.5 sec at the absence of the liner ( $n=2$ ). Here the indicates the number of events.

Radiated noise from the liner was measured in a deep water separately and the position and operational conditions of the liner were precisely monitored onboard.

Two autonomous stereo sound recording systems were deployed horizontally at 20 m in depth under the study area [5]. We will analyze not only visual behavioral reaction of humpback whales but also acoustic reaction of this animal together with the simulated ship noise propagation from the liner.

This project would continue one more year to provide a scientific evidence of the minimum sound exposure level to elicit behavioral reaction of the humpback whales.

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