Technical Reports of the Institute of Cetacean Research (2023) pp. 69–73

Technical Report (not peer reviewed)

Using satellite-linked tags for studying the feeding ecology of fin whales in the southern Okhotsk Sea

Kenji KONISHI[1,*] and Lars KLEIVANE[2]

[1] *Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan*
[2] *LKARTS-Norway, 8290 Skutvik, Norway*

Contact e-mail: konishi@cetacean.jp

ABSTRACT

This paper reports the tagging of satellite transmitters on fin whales in the southern Okhotsk Sea to simultaneously collect data on their diving and movement behaviors during the spring season. This information is essential for understanding the feeding ecology of the species. Transdermal and LIMPET-type tags (attached to the fin with anchors) were deployed using a whale-watching boat in spring 2021 and 2022, and two fin whales (one tagged with transdermal and the other with LIMPET) were tracked for 40 and 50 days, respectively. The transdermal tag was deployed with a newly developed tether-type carrier using a pneumatic air launcher, while the LIMPET tag was deployed with a crossbow. The tracking data revealed that fin whales repeat foraging in waters shallower than 150 m. This marks the first instance of tagging a TDR-installed satellite transmitter by the Institute of Cetacean Research.

INTRODUCTION

Understanding the ecology of large whales has been challenging owing to their massive size and offshore distribution. In particular, information about their long-range movement and diving profiles, important for understanding their feeding habits, has been difficult to obtain through traditional techniques such as vessel observations.

The development of satellite-linked tags has made remarkable progress in studying the spatio-temporal distribution and diving behavior of baleen whales without recovering the tags (Ainley *et al.*, 2020; Andrews *et al.*, 2019; Heide-Jørgensen *et al.*, 2001; Mate *et al.*, 2007; Palacios *et al.*, 2022). These electronic tags can monitor whale behavior over time and transmit data via satellite systems. Tracking records are also valuable for deciphering the mechanisms behind whale distribution in specific ecosystems, helping us to understand their movement and feeding behaviors.

The Institute of Cetacean Research (ICR) has been planning satellite-linked biologging experiments since 2015 as part of the surveys conducted under NEWREP-A (the New Scientific Whale Research Program in the Antarctic Ocean; https://www.jfa.maff.go.jp/j/whale/pdf/151127newrep-a.pdf). These experiments aim to gain insights into the feeding behavior and movements of Antarctic baleen whales. This non-lethal technique was developed in collaboration with a Norwegian tagging specialist and has been utilized in ICR surveys in both the Antarctic and western North Pacific.

For successful tracking of whales, the development of tags and suitable tagging equipment is crucial. This paper provides technical insights into tagging experiments designed to monitor the concurrent movement and diving behavior of fin whales (*Balaenoptera physalus*) in the southern Okhotsk Sea during the spring season, with the objective of enhancing our understanding of their feeding behavior in this region.

MATERIALS AND METHODS

Tags

Streamlining the deployment procedure and tag arrangement for each whale species and survey platforms is a critical aspect for ensuring successful deployments and tracking. In our efforts, we tested a transdermal tag, designed for large whales, with a tether-type carrier using the pneumatic air launcher ARTS (Kleivane *et al.*, 2022). Additionally, we introduced the LIMPET-type tag from Wildlife Computers Inc., a compact tag that can be deployed on the dorsal fin with two anchors inserted into the whale's body to stabilize the transmitter. These tags enable tracking of whales over an extended period compared to recovery-type tags, which usually capture a large volume of data but over relatively short period (Cade

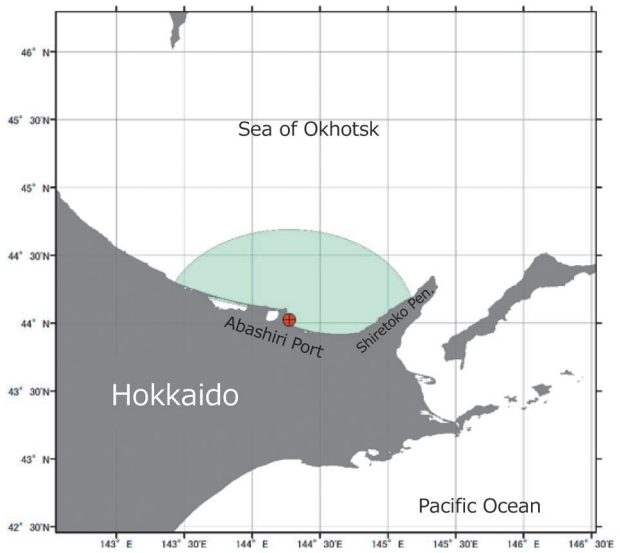

Figure 1. Research area for the satellite tagging experiments. Tagging was conducted in the area within 40 nautical miles of Abashiri port in the southern Sea of Okhotsk.

Figure 2. Whale-watching boat "*Chipashiri*" (4.9 t; 10.45 m). A safety fence was installed at the bow during the survey. The height of bow deck is 130 cm from the water.

et al., 2023; Friedlaender *et al.*, 2013; Savoca *et al.*, 2021).

Survey area and boat

The tagging experiments took place off the coast of Abashiri, Hokkaido, in the southern Okhotsk Sea (Figure 1). Recently, fin whales have been observed in the vicinity of the Abashiri area, enabling us to conduct experiments using a small boat that can closely approach the whales. We utilized the vessel "*Chipashiri*" (10.45 m)

Figure 3. Simultaneous shootings of a tag with ARTSTBC using LK-ARTS (left) and a biopsy dart with a crossbow on the bow of a boat, *Chipashiri*.

for these tagging experiments and made preparations for safety, including the installation of a safety fence and a small deck at the bow of the boat during the survey (Figure 2). Two highly skilled crew members with expertise in spotting and approaching marine mammals were present. In most instances, two shooters were responsible for tagging and conducting biopsy sampling within the confines of the safety fence (Figure 3).

Tags and equipment

We deployed two types of tags—a transdermal tag SPLASH10-302B (300 ∗ 24 mm; 390 g) and a fin mount LIMPET (Low Impact Minimally Percutaneous Electronic Transmitter) tag SPLASH10-F-333 (56 ∗ 50 ∗ 27 mm; 69 g) (Wildlife Computers; Redmond, WA, USA)—on adult-sized fin whales during the spring feeding season. The former tag has a long battery life and is larger, while the latter is a compact GPS positioning LIMPET tag with anchors designed to be attached to the dorsal fin (www.wildlifecomputers.com). All experiments off Abashiri were approved by Fisheries Agency of Japan under the permit SUIKAN3-367.

Tagging results

Case1 (transdermal tag SPLASH10-302B)

To launch the transdermal tags, we utilized a carrier known as ARTSTBC (the tethered ARTS carrier for Wildlife Computer tags in the 300 series, with simultaneous biopsy sampling), which was developed during the project (LKARTS-Norway; Figure 4). During the carrier's development, numerous tests were conducted in both Norway and Japan to enhance deployment procedures and address safety concerns (Figure 5 and 6). A tag was

Figure 4. Wildlife Computers SPOT303 SPLASH302B-type tag connected to ARTSTBC.

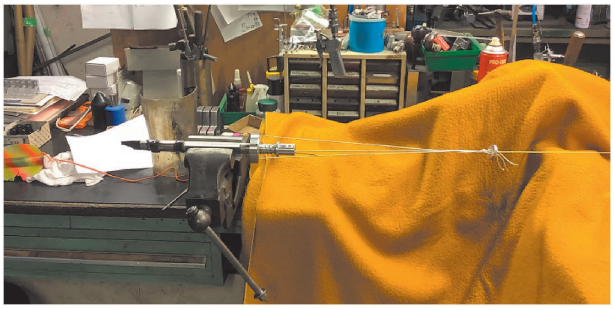

Figure 5. Test of releasing tag from ARTSTBC in the manufacturer's laboratory in Japan.

Figure 6. Test shooting of a dummy tag with ARTSTBC in Norway.

Figure 7. Transdermal SPLASH10-302B (Wildlife Computers Inc.) tag was deployed at the base of the dorsal fin off the coast of Abashiri on May 20, 2021. This picture was taken by a drone.

deployed on a fin whale on 20 May 2021, and tracked until 30 June, covering a period of 40 days (Figure 7). The shooting angle was set at 20 degree with a distance of 20 m. The ARTS pressure used was 16 bar, and the tag penetrated to a depth of 4–5 cm anterior to the triangle stopper. The ARTSTBC was released upon impact during deployment and subsequently recovered. This 2021 deployment marks the first use of TDR-installed satellite-linked tags for monitoring location and diving behavior at the ICR.

Case2 (LIMPET-type SPLASH10-F-333)

To deploy the LIMPET tag, we employed a combination of a 150lb compound crossbow and an arrow-type carrier (Figure 8). These anchors are designed to attach securely to hard fibrous tissues, such as the dorsal fin. The LIMPET

Figure 8. A set of SPLASH10-F-333 and its carrier are designed for a crossbow manufactured by Wildlife Computers.

tag was placed beneath the dorsal fin of the fin whale on May 10, 2022, and tracking was conducted until July 29, covering a period of 50 days (Figure 9).

Diving profiles

Fin whales in the southern Okhotsk Sea predominantly

Figure 9. LIMPET-type SPLASH-F-333 (Wildlife Computers Inc.) was attached to the dorsal fin of a fin whale off the coast of Abashiri on 10 May 2022. The arrow-type carrier is also visible in the image.

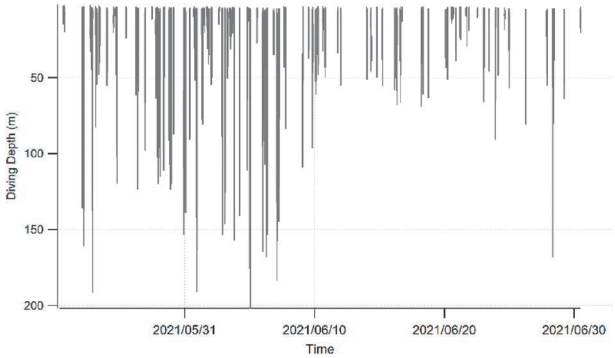

Figure 10. Diving profile of the fin whale (PTT ID 54121) tracked in May–June 2021. The record is depicted at ten-minute intervals using the *Ethographer* program (Sakamoto *et al.*, 2009) within the IGOR Pro 6.3.6 software.

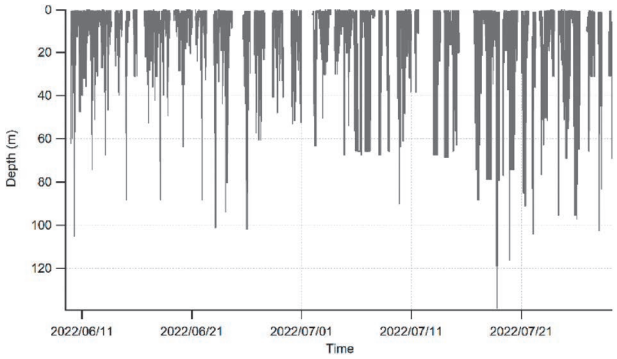

Figure 11. Diving profile of the fin whale (PTT ID 212345) tracked in June and July 2022. The record is plotted at ten-minute intervals.

feed at water depths shallower than 150 m (Figure 10 and 11). However, it's worth noting that their diving behaviors exhibit temporal variations on a daily and weekly basis. These tags also recorded positional data during their transmissions. The data collected from these two data loggers provides a substantial dataset that will enable us to gain a comprehensive understanding of their feeding behaviors. We plan to analyze this data in conjunction with environmental information, biopsy samples, and tracking records from other location-only tags to elucidate the feeding ecology of fin whales in the study area.

ACKNOWLEDGEMENTS

We thank crews of *Chipashiri* M. Maeda and S. Maeda and the staff of the Tokyo University of Agriculture, B. Kobayashi, S. Ikuta, H. Kobayashi, and K. Kikuchi, for their assistance during the field works. Thanks are also due to T. Isoda (ICR) for his participation to the field work and T. Tamura (ICR) for his useful suggestions. We also thank Luis A. Pastene for his assistance in preparing this report and the Editorial Team of TEREP-ICR for the editorial work .

REFERENCES

Ainley, D.G., Joyce, T.W., Saenz, B., Pitman, R.L., Durban, J.W., Ballard, G., Daly, K. and Kim, S. 2020. Foraging patterns of Antarctic minke whales in McMurdo Sound, Ross Sea. *Antarctic Science* 32 (6): 454–465.

Andrews, R.D., Baird, R.W., Calambokidis, J., Goertz, C.E.C., Gulland, F.M.D., Heide-Jørgensen, M.P., Hooker, S.K., Johnson, M., Mate, B.R., Mitani, Y., Nowacek, D.P., Owen, K., Quakenbush, L.T., Raverty, S., Robbins, J., Schorr, G.S., Shpak, O.V., Townsend, F.I.Jr., Uhart, M., Wells, R.S. and Zerbini, A.N. 2019. Best practice guidelines for cetacean tagging. *J. Cetacean Res. Manage*. 20: 27–66.

Cade, D.E., Kahane-Rapport, S.R., Gough, W.T., Bierlich, K.C.,

Linsky, J.M.J., Calambokidis, J., Johnston, D.W., Goldbogen, J.A. and Friedlaender, A.S. 2023. Minke whale feeding rate limitations suggest constraints on the minimum body size for engulfment filtration feeding. *Nature Ecology & Evolution* 7 (4): 535–546.

Friedlaender, A.S., Tyson, R.B., Stimpert, A.K., Read, A.J. and Nowacek, D.P. 2013. Extreme diel variation in the feeding behavior of humpback whales along the western Antarctic Peninsula during autumn. *Mar. Ecol. Prog. Ser* 494: 281–289.

Heide-Jørgensen, M.P., Kleivane, L., Øien, N., Laidre, K.L. and Jensen, M.V. 2001. A new technique for deploying satellite transmitters on baleen whales: Tracking a blue whale (*Balaenoptera musculus*) in the North Atlantic. *Marine Mammal Science* 17: 949–954.

Mate, B., Mesecar, R. and Lagerquist, B. 2007. The evolution of satellite-monitored radio tags for large whales: One laboratory′s experience. *Deep. Res. Part II Top. Stud. Oceanogr*. 54: 224–247.

Palacios, D.M., Irvine, L.M., Lagerquist, B.A., Fahlbusch, J.A., Calambokidis, J. and Tomkiewicz, S.M. 2022. A satellite-linked tag for the long-term monitoring of diving behavior in large whales. *Anim. Biotelemetry* 10: 26.

Savoca, M.S., Czapanskiy, M.F., Kahane-Rapport, S.R., Gough, W.T., Fahlbusch, J.A., Bierlich, K.C., Segre, P.S., Di Clemente, J., Penry, G.S., Wiley, D.N., Calambokidis, J., Nowacek, D.P., Johnston, D.W., Pyenson, N.D., Friedlaender, A.S., Hazen, E.L. and Goldbogen, J.A. 2021. Baleen whale prey consumption based on high-resolution foraging measurements. *Nature* 599: 85–90.

Sakamoto, K.Q., Sato, K., Ishizuka, M., Watanuki, Y., Takahashi, A., Daunt, F. and Wanless, S. 2009. Can ethograms be automatically generated using body acceleration data from free-ranging birds? *PLoS ONE* 4: e5379.