BISS Biodiversity Information Science and Standards
Biodiversity Information Science and Standards 10: e183408
doi: 10.3897/biss.10.183408
OPEN ACCESS

Conference Abstract

SPACEWHALE: Using Satellite Imagery to Survey Whales in Remote Areas and Thus to Enhance Conservation Efforts

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Received: 23 Dec 2025 | Published: 09 Jan 2026

Citation: Voß J, Höschle C, Can R, Mahjoub A, Kosarev V, Macleod K (2026) SPACEWHALE: Using Satellite Imagery to Survey Whales in Remote Areas and Thus to Enhance Conservation Efforts. Biodiversity Information Science and Standards 10: e183408. https://doi.org/10.3897/biss.10.183408

Abstract

There is an ambitious global goal to protect 30% of the ocean by 2030. However, currently, only 8.1% of the ocean is protected and over 80% of the ocean is still unexplored. We thus urgently need to collect data for evidence-based decision-making to help tackle the global climate and biodiversity crises and to support coastal communities. But mapping these areas and key indicator species like whales using ship-based and aerial surveys tend to be limited in scale/scope, time-consuming, expensive and pose safety risks to surveyors, while acoustic monitoring is difficult to convert into counts of individuals for most species.

To overcome these challenges, BioConsult SH and HiDef Aerial Surveying Ltd developed the service, SPACEWHALE. Bridging technological innovation with marine conservation, SPACEWHALE monitors whales and other wildlife species from space using satellite imagery and AI. We determine where whales are, provide a minimum count and investigate when they are in certain areas—quickly and over wide cross-border areas—yet at comparable costs to traditional survey methods.

The “SPACEWHALE” service uses very high-resolution satellite imagery (e.g., resolution of 0.3 m per pixel). At this resolution, we can distinguish between several large whale

species as well as between juveniles and adults. In addition, we can detect a diverse range of large cetaceans down to a body length of 9 meters and smaller. By taking a snapshot of the ocean area of interest, we can capture very large and remote areas almost instantaneously. Due to licensing restrictions, we are not permitted to share satellite imagery itself, but we summarise our findings in a report that contains easily processable data, such as the locations of the whales, for further analysis.

We developed a semi-automatic process to evaluate satellite images combining state-of-the-art artificial intelligence with marine mammal expertise. Artificial intelligence as applied in SPACEWHALE means that data are collected and processed in a standardized way: satellite imagery is first analysed by a convolutional neural network-based object detection algorithm. Our algorithm is highly effective: a study in collaboration with Stony Brook University in New York and HiDef Aerial Surveying Ltd from the UK showed that the algorithm correctly classified 100% of images containing whales and 94% of images containing only water (Borowicz et al. 2019). Once the automated process is complete, a large team of expert reviewers validates the outputs to ensure that misclassifications such as boats, rocks, waves or sea foam are minimized, implementing a human-in-the-loop framework for comparable and quality-checked data.

Applying this semi-automatic approach in diverse ecosystems, we have already successfully monitored fin whales and other species in the Bay of Biscay and in the Pelagos Sanctuary, blue whales and other marine megafauna off Mexico, humpback whales in Hawaiian waters, and southern right whales off Argentina and New Zealand. The methodology has been validated through comparison with conventional aerial and ship-based surveys demonstrating a strong agreement (Höschle et al. 2022).

Satellite snapshots can be taken over previously unexplored areas, providing baseline data for environmental impact assessments for offshore wind farm operators and contributing to the identification of Important Marine Mammal Areas and Marine Protected Areas. The service can be applied at different spatial and temporal scales, from local and regional to ocean basins and over time with repeated surveys, enabling long-term monitoring, generating robust, standardized data for marine spatial planning and complementing international efforts (e. g. Marine Strategy Framework Directive, Convention on Biological Diversity targets, United Nations Ocean Decade). We are at a step where satellite-based data informs applied conservation by providing useful guidance to find solutions that balance species conservation with human use of the seas. It has the potential to elevate conservation efforts to appropriate spatial scales for wide ranging species.

Keywords

AI, whale monitoring, baseline studies, impact assessment, adaptive management, conservation, high seas

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Presented at

Living Data 2025

Funding program

SPACEWHALE was funded through a Kick-Start Activity by the European Space Agency and supported by various innovation and challenge-based funding programmes.

Conflicts of interest

The authors have declared that no competing interests exist.

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