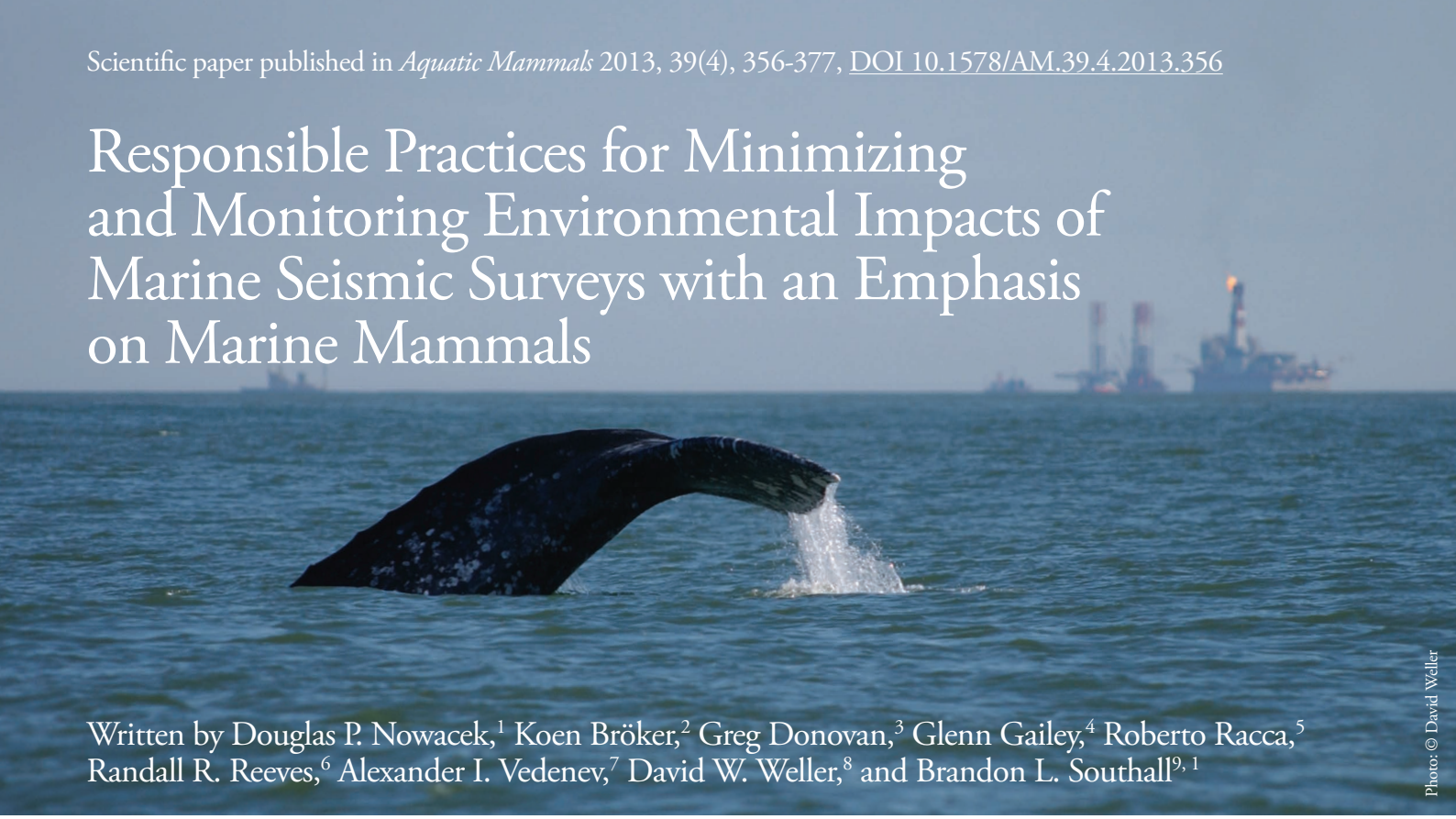
Scientific paper published in *Aquatic Mammals* 2013, 39(4), 356-377, DOI 10.1578/AM.39.4.2013.356

Responsible Practices for Minimizing and Monitoring Environmental Impacts of Marine Seismic Surveys with an Emphasis on Marine Mammals



Written by Douglas P. Nowacek,[1] Koen Bröker,[2] Greg Donovan,[3] Glenn Gailey,[4] Roberto Racca,[5] Randall R. Reeves,[6] Alexander I. Vedenev,[7] David W. Weller,[8] and Brandon L. Southall[9, 1]

Photo: © David Weller

Abstract

Marine seismic surveys, which use loud, primarily low-frequency sound to penetrate the sea floor, are known to disturb and could harm marine life. The use of these surveys for conventional and alternative offshore energy development as well as research is expanding. Given their proliferation and potential for negative environmental impact, there is a growing need for systematic planning and operational standards to eliminate or at least minimize impacts, especially when surveys occur in sensitive areas. Mitigating immediate impacts is obviously critical, but monitoring for short- as well as long-term effects and impacts is also needed. Regulatory requirements for both mitigation and monitoring vary widely from one country or jurisdiction to another. Historically, most have focused on acute effects but share a common objective of minimizing potential adverse impacts. Specific examples in different areas are given to illustrate general approaches for predicting, minimizing, and measuring impacts for operations in essentially any marine environment. The critical elements of a robust mitigation and monitoring plan for responsibly conducting marine seismic surveys include obtaining baseline ecological data; substantial advance planning, communication, and critical review; integrated acoustic and visual monitoring during operations; and systematic analysis of results to inform future planning and mitigation (see the practical roadmap on the next page).

This study is an outcome of work over the period of 2006-2012 within the context of the Western Gray Whale Advisory Panel (WGWAP), convened by the International Union for Conservation of Nature (IUCN) and supported by Sakhalin Energy Investment Company Ltd. A grant to IUCN from the UK Department for Environment, Food and Rural Affairs (DEFRA) was used specifically to enable lead authors Dr. Nowacek and Dr. Southall to devote time to prepare the manuscript.

Full text for the media upon request from:
Anete Berzina, IUCN
+41 22 999 0703
anete.berzina@iucn.org

More about WGWAP:
www.iucn.org/wgwap

[1]Nicholas School of the Environment and Pratt School of Engineering, Duke University Marine Laboratory, USA
[2]Shell Global Solutions, The Netherlands
[3]International Whaling Commission, UK
[4]Texas A&M University Galveston, USA
[5]JASCO Applied Sciences Ltd., Canada
[6]Okapi Wildlife Associates, Canada
[7]P. P. Shirshov Institute of Oceanology of the Russian Academy of Sciences, Russia
[8]Southwest Fisheries Science Center, USA
[9]Southall Environmental Associates and University of California at Santa Cruz, USA

Practical roadmap for planning, executing, evaluating, and improving the design of a responsible seismic survey

ASSESS ENVIRONMENT and PROPOSED ACTIONS

(1) Baseline environmental and biological data collection
In situ measurements of the biological environment with sufficient characterization of sources of natural variability. Key parameters include ecosystem features and their influence on spatial and temporal variability in density, distribution, and behavior of key species. **NEEDED FOR**: Risk assessment (3); Mitigation design (4a); Monitoring program design (4b); Assessment of mitigation efficacy (7)

(2) Describe proposed development actions and alternatives
Provide detailed characterization of key operational parameters (e.g., sound output parameters from seismic sources, vessels, and other sources) and quantitative modeling of their propagation in the environment. All process stages and alternative strategies should be described, regardless of economic feasibility.
NEEDED FOR: Risk assessment (3); Mitigation design (4a)

EVALUATE RISK and DEVELOP PLANS

(3) Evaluate risks of proposed development actions and alternatives
Conduct a quantitative risk assessment based on information from (1) and (2), including extrapolation and/or models derived from other species/areas if required. This should be precautionary but practical in the potential impacts formally assessed. **NEEDED FOR**: Mitigation design (4a)

(4a) Design effective mitigation actions
Agree on key objectives with all stakeholders. Measures must be shown to be likely to succeed in light of information on (1)–(3). When feasible, use time/areas when susceptible animals are absent/ low density. Develop full protocols including command chain and real-time actions required if measures not working. Integrate with (4b) and (5). Make plans publicly available.
NEEDED FOR: Mitigation implementation (5)

(4b) Design effective monitoring methods for before, during, and following operations
Integrated (with 4a) monitoring technologies and protocols using real-time and archival elements are required. These methods should be adaptable and with sufficient power to detect changes in key parameters (1), determine if mitigation measures (see 4a) are working, address data and information gaps, and contribute to long-term monitoring. Make plans publicly available.
NEEDED FOR: Mitigation implementation (5); Mitigation evaluation (7); Future mitigation design (8)

IMPLEMENT MITIGATION and MONITORING

(5) Implement mitigation and monitoring
Systems must be in place in the field to ensure that agreed mitigation measures and agreed monitoring actions are correctly and effectively implemented in a timely manner. Written protocols, based on anticipated scenarios, must be understood and practiced ahead of time by all involved parties. Clear chains of command and communication are essential as is honest assessment of the value and limitation of all observing systems. **NEEDED FOR**: Mitigation and monitoring

(6) Implement data collection, validation, and archiving
Must have systems in place to ensure that data are properly treated (QA/QC) and redundantly archived. **NEEDED FOR**: Mitigation evaluation (7);
Future mitigation design (8)

EVALUATE and IMPROVE

(7) Evaluate effectiveness of mitigation measures
Evaluation of monitoring results to determine if mitigation measures as implemented were adequate to meet agreed objectives in (4a).
NEEDED FOR: Future mitigation design (8)

(8) Evaluate effectiveness of monitoring program
Determine if monitoring results were sufficient to adequately address (7) and identify any residual risk to species of concern.
NEEDED FOR: Future mitigation and monitoring design

(9) Prompt analysis and publication of results
Ensure that analyses are completed promptly and results published (ideally in open, peer-reviewed literature) to inform future risk assessments and mitigation and monitoring actions.

The numbers in parentheses throughout the figure refer to other elements within the figure.

Photo: © Yuri Yakovlev