2022 Aerial Megafauna Surveys of the Massachusetts and Rhode Island wind energy areas

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Proposal overview for six months of aerial surveys
Aerial Survey Duration: March 1, 2022 through August 31, 2022
Project Duration: March 1, 2022 through Dec. 30, 2021
Proposed Start Date: March 1, 2022
Project Deliverables: Six months of aerial surveys, 1 mid-project progress report, and a final written report (see project narrative for details)

Funds Requested: $444,831

Proposal overview for eight months of aerial surveys
Aerial Survey Duration: January 1, 2022 through August 31, 2022
Project Duration: January 1, 2022 through Dec. 30, 2021
Proposed Start Date: January 1, 2022
Project Deliverables: Eight months of aerial surveys, 1 mid-project progress report, and a final written report (see project narrative for details)

Funds Requested: $554,692*
* Cost savings are achieved because some high cost items only occur once (e.g., insurance and fee for aircraft transport)

Background

The New England Aquarium (NEAq) has been conducting aerial surveys of marine megafauna since October 2011 in waters scheduled for wind energy development off Massachusetts and Rhode Island. Surveys follow consistent line-sampling methods and have provided valuable information about the abundance and distribution of multiple marine mammal and turtle species, including the critically endangered North Atlantic right whale (*Eubalaena glacialis*). At a September special meeting of the Regional Wildlife Science Entity (RWSE) Steering Committee, there was broad recognition of the importance of these aerial megafauna surveys. No decision was made during the meeting regarding a source of immediate funding to support the surveys beyond August 2021.

At the meeting, the NEAq presented an estimated monthly survey cost of $74,000. After the meeting, the NEAq and MassCEC reallocated funds in the current budget and contract to conduct surveys in the high-priority month of September 2021. Surveys were completed as planned. During and following the September meeting, RWSE Steering Committee members from NOAA Fisheries indicated a willingness to contribute funds to the NEAq survey beginning in federal FY 2022, with funds likely available in September 2022. Given this intention, the RWSE Steering Committee adjusted its focus for exploring funding for the megafauna surveys during the period of October 2021 through August 2022

Surveys need to be conducted in contiguous months to avoid incurring additional costs associated with ferrying the survey aircraft. Consequently, NEAq recommends conducting surveys during August 2022 and a number of contiguous months prior to August 2022 based on the availability of funds.

Within the last month, the Bureau of Ocean Energy Management (BOEM) agreed to contribute $200,000 to support surveys. Massachusetts, New York, and Connecticut are exploring whether they can provide cost-share funding to leverage commitments from BOEM and other potential partners. The states' combined funding target is approximately $245,000. Funding from BOEM and the states would be consolidated by MassCEC and MassCEC would write and manage the contract with NEAq. NEAq is also working to obtain funding from private individuals and foundations. This funding would go directly to NEAq.

It is critically important to continue these aerial megafauna surveys in the period leading up to and during turbine construction, which is scheduled to begin in 2023. A limited amount of funding for aerial surveys was included in a project funded by the United States Department of Energy (DOE) titled, "Wildlife and Offshore Wind (WOW): A Systems Approach to Research and Risk Assessment for Offshore Wind Development from Maine to North Carolina" (hereafter, the WOW proposal). The WOW project is led by Douglas P. Nowacek, PhD, of the Nicholas School of the Environment and the Pratt School of Engineering, Duke University. The surveys included in the WOW project would likely be conducted between May and August 2023. The exact timing and survey design will be determined during the first year of the project.

A preliminary power analysis[1] was conducted to determine whether the aerial survey effort included in the WOW project is sufficient to detect displacement of marine mammals during wind energy construction. These preliminary analyses show that the power to detect a change within the construction area is high, but that additional surveys prior to and during construction are needed to detect a redistribution of animals to surrounding areas. Detecting

[1] Scott-Hayward et al. 2021. Using aerial surveys to detect displacement of whales during wind energy construction. White paper dated 21st September 2021

changes in the surrounding areas is critically important for differentiating between changes caused by wind energy development and climate-driven changes (e.g., a regional decline).

Survey Objectives

1. Collect line-transect sightings from broad-scale surveys that can be used to map the distribution of large whales (with a focus on right, sei, humpback, fin, and minke whales) and turtles in the survey area and estimate their relative abundance.
2. Collect supplemental observer sightings of other cetaceans, seals, sharks, and fish.
3. Collect data from automated vertical photography to capture sea turtles, smaller cryptic species likely to be missed by observers scanning out to 2 nm (e.g., harbor porpoise, sharks, and fish), and fixed fishing gear.
4. Conduct condensed, directed, and calibration surveys as needed to obtain fine-scale sightings and effort data, increase sample sizes, and understand the effects of conducting surveys at 1,500 feet, rather than 1,000 feet, during and after turbine construction.

Survey Methods

We will use the survey area, design, and methodology that was previously reviewed and approved by MassCEC and BOEM. NEAq will provide a post-flight report to all survey partners within 24 hours of each survey. Details about survey methods are provided in Appendix 1.

Survey Plans and Project Management

If six months of survey funding is available, aerial surveys will be conducted from March 1, 2022 through August 31, 2022. If additional months of funding are available, we will start surveys earlier. This proposal contains a budget for six and eight months of surveys. Both budgets are provided to show the cost savings achieved by flying surveys for longer time periods. Cost savings are achieved because some high cost items only occur once (e.g., insurance and fee for aircraft transport).

One progress report will be completed at the midpoint of the surveys and a final report will be completed four months after the final survey. The proposed study area is shown in Figure 1. We will conduct a minimum of two broad-scale surveys each month. Depending on available flight time and data collection needs, we may fly additional broad-scale, condensed, directed, or calibration surveys. A summary of each type of survey is provided in Table 1. Deliverables are provided in Table 2.

This program will be managed by the principal investigator, Jessica Redfern, Ph.D. (C.V. provided in Appendix 2). Supporting staff will be responsible for aerial surveys, statistical analysis, photo-analysis, photo-identification, and mapping. Subcontractors will include an aircraft vendor and Robert Kenney Ph.D., at the University of Rhode Island. Dr. Kenney will conduct QA/QC on all survey data and incorporate it into the NARWC database.

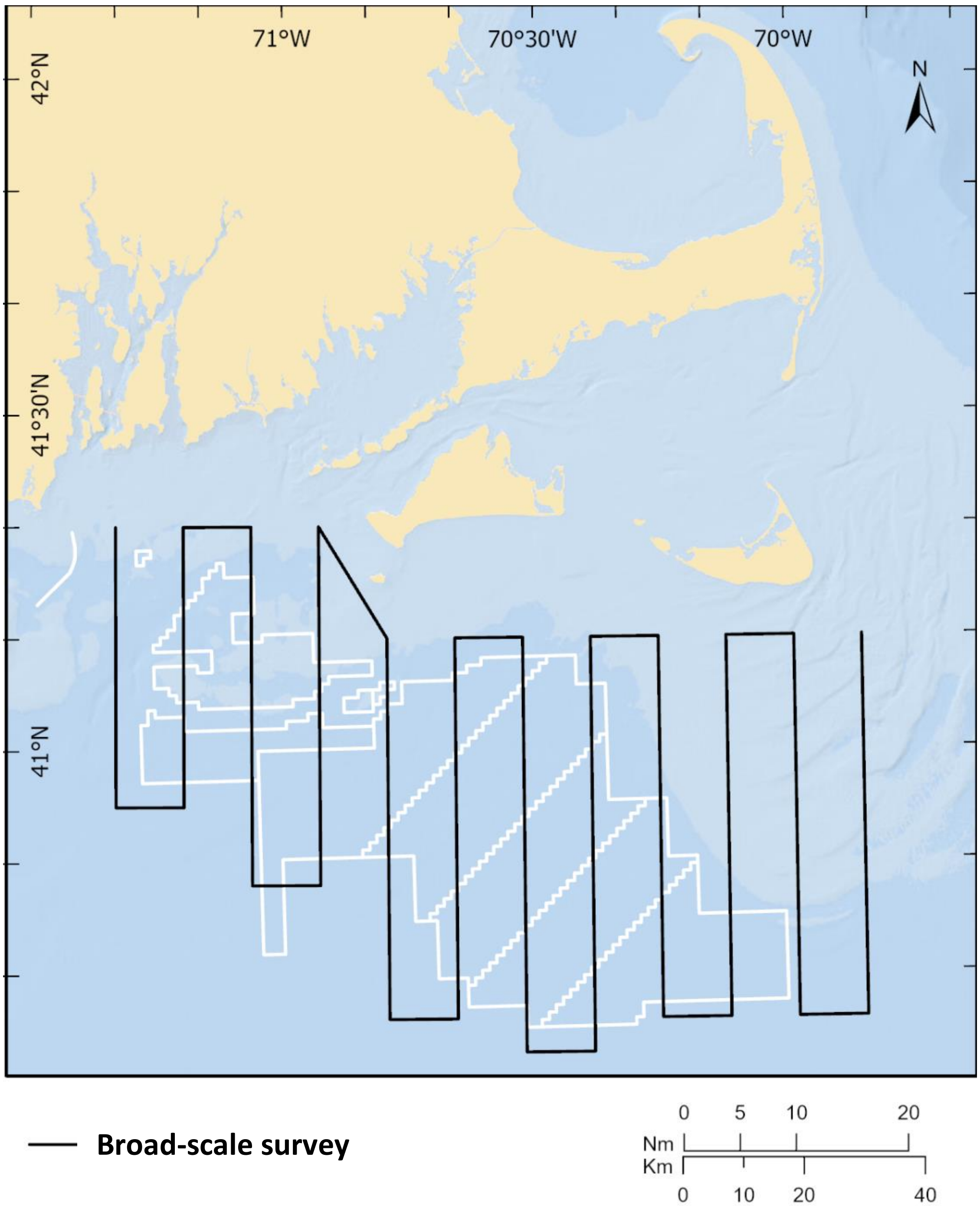

Figure 1. Wind energy areas in the offshore waters of Massachusetts and Rhode Island. Examples of tracklines for a broad-scale survey are depicted by black lines.

Table 1. Definitions of the different types of surveys flown by NEAq. Two broad-scale surveys will be conducted each month. Depending on available flight time and data collection needs, we may fly additional broad-scale, condensed, directed, or calibration surveys.

Survey Type	Survey Details
Broad-scale surveys	These line-transect surveys will cover the entire wind energy area (5,811 km^2) and extend slightly beyond the lease area boundaries. They will have north-south tracklines that are 6 nm apart and have a random start (drawn from 8 options).
Condensed surveys	These surveys will focus on areas used by aggregations of right whales to better determine demographic, distribution, and behavior patterns in the survey area. The tracklines for these surveys will be 3 nm apart and have a random start.
Directed surveys	Surveys will respond to aggregations of right whales within the survey area. These surveys will be coordinated with NOAA Fisheries' Northeast Fisheries Science Center survey team.
Calibration surveys	Surveys will be conducted to estimate the effect of changing altitude on our ability to detect different species. The same set of tracklines will be flown twice during each of these surveys: once at the standard 1,000 feet and once at 1,500 feet.

Table 2. Task and deliverable schedule for surveys.

Task and Deliverable	**Schedule**
1 Large whale and sea turtle surveys	Ongoing during period of performance
2.1 Progress report	Middle of the survey period
2.2 QA/QC survey data	Submitted to the NARWC two months after completing the final survey
2.3 Final survey report	Four months after completing the final survey – this report will provide a detailed summary of survey sightings and effort. It will also contain analyses of species abundance and distribution patterns.
3.1 Daily summary report	Within 24 hours of each survey
3.2 NARW sightings	Reported to NEFSC in real time (when teams are flying concurrently) to facilitate photo-identification efforts. If NEFSC is not in the air, we will communicate sightings of right whales to them at the end of the flight.

Proposed Data Products

1. Daily summary report with map and sighting details.

2. QA/QC survey data: effort and sightings data will be submitted to University of Rhode Island for quality assurance/quality control (QA/QC) checks and subsequent incorporation into the NARWC database. The QA/QC checks involve testing for errors, making corrections, communicating with contributors when questions arise, and providing feedback for future improvements. The NARWC database is archived as a Statistical Analysis System (SAS) dataset. SAS error-checking routines and subroutines have been designed and modified since 1986 to ensure data reliability and to accurately represent the surveys and sightings. SAS macros are updated and improved continuously.

Appendix 1 – Survey Methods

We will use the survey area, design, and methodology that was previously reviewed and approved by MassCEC and BOEM. Surveys will follow appropriate safety and communications protocols. NEAq will provide a survey report to all survey partners within 24 hours of each survey.

Aerial surveys – Three types of line-transect surveys and one type of directed survey will be conducted:

1. Broad-scale surveys will record all types of marine fauna visible from the aircraft. These line-transect surveys will cover the entire wind energy area (5,811 km^2) and extend slightly beyond the lease area boundaries. They will have north-south tracklines that are 6 nm apart and have a random start (drawn from 8 options). These surveys will be flown twice a month.
2. Condensed surveys will occur in areas used by aggregations of right whales to better determine demographic, distribution, and behavior patterns in the survey area. The tracklines for these surveys will be 3 nm apart and have a random start. The exact number of condensed surveys will be determined as surveys progress. For example, additional condensed surveys may be conducted if aggregations of right whales persist and monthly broad-scale surveys are completed in less time than budgeted (e.g., this situation could occur when we have good weather conditions).
3. Directed surveys will respond to aggregations of right whales within the survey area. These surveys will be coordinated with NOAA Fisheries' Northeast Fisheries Science Center (hereafter, NEFSC) to ensure they best contribute to their data collection efforts (e.g., occur during time periods when NEFSC is not able to survey). The exact number of directed surveys will be determined as surveys progress, similar to condensed surveys.
4. Calibration surveys will be conducted to estimate the effect of changing altitude on our ability to detect different species. Specifically, the same set of tracklines will be flown twice during each of these surveys: once at the standard 1,000 feet and once at 1,500 feet. Understanding the effect of changing altitude is important because surveys conducted during turbine construction and operation will need to be flown at 1,500 feet. The timing of these surveys will be selected to maximize the expected number of multiple species in the study area. The exact number of calibration surveys will be determined as surveys progress, similar to condensed and directed surveys.

All surveys will be flown at an altitude of 305 m (1,000 feet) or 457 m (1,500 feet) and a ground speed of approximately 185 km/h (100 kts) under Visual Flight Rules. A computer data-logger system will automatically record flight parameters (e.g. time, latitude, longitude, heading, altitude, and speed) at frequent intervals (every 2–5 sec). Two experienced aerial observers will be positioned aft of each pilot on each side of the aircraft and will scan the water out to 3.7 km (2 nm) from the transect line.

Photographic data collection - The aircraft will be fitted with a high-performance digital SLR camera for vertical photography. The camera will be equipped with a high-speed telephoto lens and set to shoot every 2-10 seconds while on track (see Taylor et al., 2014). At a survey altitude of 1,000 feet, this configuration will collect images from an area 337 feet by 226 feet directly beneath the aircraft (0.0071 km^2 or 0.0021 nm^2) and an area of 636 feet by 423 feet at an altitude of 1,500 feet (0.025 km^2 or 0.0073 nm^2). A precise position will be associated with each image by electronically linking the camera to a GPS. Analysis of these images will take place between survey flights and will consist of counts of individual animals per image. Animals will be identified to species whenever possible.

Identification photographs - During aerial surveys, photographs of right whales for individual identification will be taken with handheld SLR digital cameras equipped with telephoto lenses and rapid sequence photographic capabilities. Digital cameras will employ high-speed, high-resolution settings to maximize the likelihood of individual identification. From the air, photographers will attempt to obtain the high-quality photographs required to identify individual animals. This identification requires photographs of the entire rostral callosity pattern of a right whale and any other scars or markings that are obvious. The data recorder will keep a written record of frame numbers used by the photographer in sighting data sheets. In aerial photographic identification efforts, approaches to right whales will be limited to the minimum amount of time necessary to obtain photographs and complete the survey.

Photo-analysis and matching - Photographs of right whale callosity patterns will be used as a basis for identification and cataloging of individuals, following methods described by Kraus et al. (1986). Team members will process their photographic sightings data into the DIGITS (Digital Image Gathering and Information Tracking System) data management program curated by NEAq (Hamilton et al., 2007). These sightings will be confirmed in DIGITS by NEAq (under a different contract) and integrated into the North Atlantic Right Whale Consortium (NARWC) Identification Database. Preliminary identification data on individual right whales will be included in the final report. For any animal that has indications of a serious injury or apparent poor health, NEAq will compare the sighting to all previous sightings of this individual to determine the timeframe of when the injury may have occurred and provide this information to NOAA Fisheries as soon as possible.

Survey data collection for right whales and other large whales - The right angle sighting distance for each sighting will be recorded. For species with adequate sample sizes, the sighting distance can be used to estimate abundance and to compare detection rates at 1,000 and 1,500 feet. Sightings locations and effort data can also be used to calculate relative indices of abundance and information on seasonal occurrence and spatial distribution.

When right whales or other large whales not immediately identifiable to species are sighted, the aircraft will leave the trackline at a right angle to the sighting and circle the sighting. Any transect break and circle time will be recorded consistently to ensure this effort can be analyzed appropriately. An attempt will be made to photograph as many individual right whales within a given aggregation as possible to provide data about the residency and demographic patterns of the whales using the survey area. While circling and photographing a given right whale aggregation, the data recorder will record time and position from the GPS display at the first time the aircraft passes over a whale or whales to enable subsequent plotting of the extent of the aggregation and more accurate estimation of the actual number of whales present. Photograph frames, group composition, and general behavior will be recorded for all whale sightings. In the event of an unusual sighting, such as an entangled or dead whale, the survey team may circle the sighting to obtain more detailed information. These sightings will be reported to the appropriate authorities.

At the conclusion of the photographic work for each sighting, the aircraft will return to the trackline at the point of departure.

Turtles and other identifiable large whales (that are not right whales) will be counted and recorded. Typically, sightings of these species will be passed without breaking from the trackline to maximize available flight time. Data pertaining to environmental variables, effort, and marine animal sightings will be recorded on a digital voice recorder to be transcribed into the data-logging program post flight. Each voice recording will be time stamped. Trackline and sightings data will be entered into a data-logging program designed for compatibility with the NARWC Sightings Database at the University of Rhode Island. The program will collect continuous position data at regular intervals (e.g. between 2 and 5 seconds), which allows for calculations of survey effort and abundance.

References

Hamilton, P.K., Knowlton, A.R., and Marx, M.K. (2007). "Right whales tell their own stories: the photo-identification catalog," in *The urban whale: North Atlantic right whales at the crossroads,* eds. S.D. Kraus & R.M. Rolland. (Cambridge, MA: Harvard University Press).

Kraus, S.D., Moore, K.E., Price, C.A., Crone, M.J., Watkins, W.A., Winn, H.E., et al. (1986). The use of photographs to identify individual North Atlantic right whales (*Eubalaena glacialis*). *Report of the International Whaling Commission, Special Issue* 10**,** 145-151.

Taylor, J.K.D., Kenney, R.D., LeRoi, D.J., and Kraus, S.D. (2014). Automated vertical photography for detecting pelagic species in multitaxon aerial surveys. *Marine Technology Society Journal* 48(1)**,** 36-48. doi: 10.4031/MTSJ.48.1.9.

Appendix 2

Jessica Veneris Redfern, Ph.D.

Curriculum Vitae

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PROFESSIONAL EXPERIENCE

2019-present	Senior Scientist and Chair of the Spatial Ecology, Mapping, and Assessment Program (EcoMap), Anderson Cabot Center for Ocean Life, New England Aquarium, Boston, MA
2013-2019	Program Leader, Marine Mammal Spatial Habitat and Risk Program, Marine Mammal and Turtle Division, Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, CA
2010-2013	Program Leader, Ecosystem Studies Program, Protected Resources Division, Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, CA
2004-2010	Marine Ecologist, Protected Resources Division, Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, CA
2003-2004	Postdoctoral Associate, National Research Council, Protected Resources Division, Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, CA
2002-2003	Postdoctoral Researcher, Environmental Science, Policy, and Management, College of Natural Resources, University of California, Berkeley

EDUCATION

Ph.D.	University of California, Berkeley, May 2002 Department of Environmental Science, Policy, and Management
B.A.	The Colorado College, May 1995

SELECTED PROFESSIONAL SERVICE

2019	Member of ICES Working Group on Shipping Impacts in the Marine Environment
2019	Topic editor for a special issue of Frontiers in Marine Science that focuses on the impacts of shipping on marine fauna
2018	Member of NOAA Fisheries' humpback whale critical habitat team
2018	Member of the steering committee for NOAA Fisheries' second Protected Species Assessment Workshop

SELECTED PEER-REVIEWED PUBLICATIONS

Redfern, J.V., Becker, E.A., Moore, T.J. 2020. Effects of variability in ship traffic and whale distributions on the risk of ships striking whales. Frontiers in Marine Science 6:1-14.

Erbe, C., J.N. Smith, J.V. Redfern, and D. Peel. 2020. Editorial: Impacts of shipping on marine fauna. Frontiers in Marine Science 7: 1-5.

Becker, E. A., Carretta, J. V., Forney, K. A., Barlow, J., Brodie, S., Hoopes, R., Jacox, M. G., Maxwell, S. M., Redfern, J. V., Sisson, N. B., Welch, H., Hazen, E. L. 2020. Performance evaluation of cetacean species distribution models developed using generalized additive models and boosted regression trees. Ecology and Evolution 00:1– 21.

Smith, J.N., Kelly, N., Childerhouse, S., Redfern, J.V., Moore, T.J., Peel, D. 2020. Quantifying ship strike risk to breeding whales in a multiple-use marine park: the Great Barrier Reef. Frontiers in Marine Science 7:1-15.

Redfern, J.V., Moore, T.J., Becker, E.A., Calambokidis, J., Hastings, S.P., Irvine, L.M., Mate, B.R., Palacios, D.M. 2019. Evaluating stakeholder-derived strategies to reduce the risk of ships striking whales. Diversity and Distributions 25: 1575-1585.

Becker, E.A., Forney, K.A., Redfern, J.V., Barlow, J., Jacox, M.G., Roberts, J.J., Palacios, D.M., 2019. Predicting cetacean abundance and distribution in a changing climate. Diversity and Distributions 25:626-643.

Woodman, S.M., K.A. Forney, E.A. Becker, M.L. DeAngelis, E.L. Hazen, D.M. Palacios, and J.V. Redfern. 2019. esdm: A tool for creating and exploring ensembles of predictions from species distribution and abundance models. Methods in Ecology and Evolution 10:1923-1933.

Fiedler, P.C., Redfern, J.V., Forney, K.A., Palacios, D.M., Sheredy, C., Rasmussen, K., García-Godos, I., Santillán, L., Tetley, M.J., Félix, F., Ballance, L.T., 2018. Prediction of large whale distributions: a comparison of presence–absence and presence-only modeling techniques. Frontiers in Marine Science 5: 1-15.

Fleming, A.H., Yack, T., Redfern, J.V., Becker, E.A., Moore, T.J., Barlow, J., 2018. Combining acoustic and visual detections in habitat models of Dall’s porpoise. Ecological Modelling 384: 198-208.

Moore, T.J., Redfern, J.V., Carver, M., Hastings, S., Adams, J.D., Silber, G.K., 2018. Exploring ship traffic variability off California. Ocean & Coastal Management 163: 515-527.

Redfern, J.V., Moore, T.J., Fiedler, P.C., de Vos, A., Brownell, R.L., Forney, K.A., Becker, E.A. & Ballance, L.T. 2017 Predicting cetacean distributions in data-poor marine ecosystems. Diversity and Distributions 23: 394-408.

Redfern, J.V., Hatch, L.T., Caldow, C., DeAngelis, M.L., Gedamke, J., Hastings, S., Henderson, L., McKenna, M.F., Moore, T.J. & Porter, M.B. 2017. Assessing the risk of chronic shipping noise to baleen whales off Southern California, USA. Endangered Species Research 32: 153-167.

Van Noord, J. E., R. J. Olson, J. V. Redfern, L. M. Duffy, and R. S. Kaufmann. 2016. Oceanographic influences on the diet of 3 surface-migrating myctophids in the eastern tropical Pacific Ocean. Fishery Bulletin 114:274-287.

Becker, E. A., K. A. Forney, P. C. Fiedler, J. Barlow, S. J. Chivers, C. A. Edwards, A. M. Moore, and J. V. Redfern. 2016. Moving towards dynamic ocean management: how well do modeled ocean products predict species distributions? Remote Sensing 8:149.

Edwards, E. F., C. Hall, T. J. Moore, C. Sheredy, and J. V. Redfern. 2015. Global distribution of fin whales Balaenoptera physalus in the post-whaling era (1980–2012). Mammal Review 45:197-214.

Jensen, C. M., E. Hines, B. A. Holzman, T. J. Moore, J. Jahncke, and J. V. Redfern. 2015. Spatial and temporal variability in shipping traffic off San Francisco, California. Coastal Management 43:575-588.

Redfern, J. V., M. F. McKenna, T. J. Moore, J. Calambokidis, M. L. DeAngelis, E. A. Becker, J. Barlow, K. A. Forney, P. C. Fiedler, and S. J. Chivers. 2013. Assessing the risk of ships striking large whales in marine spatial planning. Conservation Biology 27:292-302.

Fiedler, P. C., J. V. Redfern, J. Van Noord, C. Hall, R. L. Pitman, and L. T. Ballance. 2013. Effects of a tropical cyclone on a pelagic ecosystem from the physical environment to top predators. Marine Ecology Progress Series 484:1-16.

Staaf, D. J., J. V. Redfern, W. F. Gilly, W. Watson, and L. T. Ballance. 2013. Distribution of ommastrephid paralarvae in the eastern tropical Pacific. Fishery Bulletin 111:78–89.

Van Noord, J. E., R. J. Olson, J. V. Redfern, and R. S. Kaufmann. 2013. Diet and prey selectivity in three surface-migrating myctophids in the eastern tropical Pacific. Ichthyological Research **60**:287-290.

Becker, E. A., D. G. Foley, K. A. Forney, J. Barlow, J. V. Redfern, and C. L. Gentemann. 2012. Forecasting cetacean abundance patterns to enhance management decisions. Endangered Species Research 16:97-112.