Seal Aerial Survey Mitigation Plan

I. Purpose of the survey

Aerial surveys of gray seal (*Halichoerus grypus*) and harbor seal (*Phoca vitulina*) populations in U.S. waters are conducted approximately every 5 years to collect data on the numbers and distributions of animals. These data are critical to meet statutory requirements of the Marine Mammal Protection Act (MMPA), which mandates that trends in abundance of a stock be measured periodically to evaluate whether recovery goals are being achieved. These surveys are different from other marine mammal abundance surveys, which are used to estimate abundance mainly for cetacean species. Data from the seal surveys support scientific products that are used in annual MMPA Stock Assessment Reports, Unusual Mortality Event (UME) investigations, Environmental Impact Reports, and public-facing data portals for other research investigations, which are used primarily by scientists and resource managers. Offshore wind energy developments have the potential to alter the operational design of these surveys, as well as the spatial or temporal scope of the surveys if animals redistribute as a result of development. The loss or alteration of seal surveys may preclude NOAA's ability to assess whether MMPA management objectives are being met to inform investigations of anthropogenic impacts or changes in the ecosystem. It may also diminish the added value from the surveys.

II. Survey Details

Beginning Year: For gray seals, National Marine Fisheries Service (NMFS) surveys began around 1994. For harbor seals, surveys began around 1981.

Frequency: Manned aerial abundance surveys are conducted approximately every 5 years, but this varies depending on funding and aircraft availability. Non-systematic, opportunistic flights at other times to target areas or animals of interest may occur in combination with other surveys (i.e., Atlantic Marine Assessment Program for Protected Species [AMAPPS], or North Atlantic right whale surveys). Uncrewed surveys at a limited number of authorized sites may occur more frequently than the 5-year schedule; these uncrewed surveys are operated by Northeast Fisheries Science Center (NEFSC) scientists or collaborators using line-of-sight uncrewed systems.

Season: Abundance surveys take place when seals are pupping. Ideally, surveys are timed to occur after all pups have been born (early January for gray seals and late May for harbor seals), though this is often logistically challenging to achieve. Other types of surveys (i.e., those which are not intended to estimate population abundance) may take place throughout the year.

Geographic Scope: For gray seals, abundance surveys take place at islands in the Gulf of Maine and off Cape Cod (Figure 1). The largest pupping colony in the U.S. is on Muskeget Island, in close proximity (<20 nautical miles) to several wind energy areas (WEAs) and to cable lines running from the platforms to Cape Cod. For harbor seals, abundance surveys take place over 1000 ledges in coastal Maine. Surveys at other times for either harbor or gray seals may occur anywhere along the coastline from the U.S./Canada border south to Virginia.

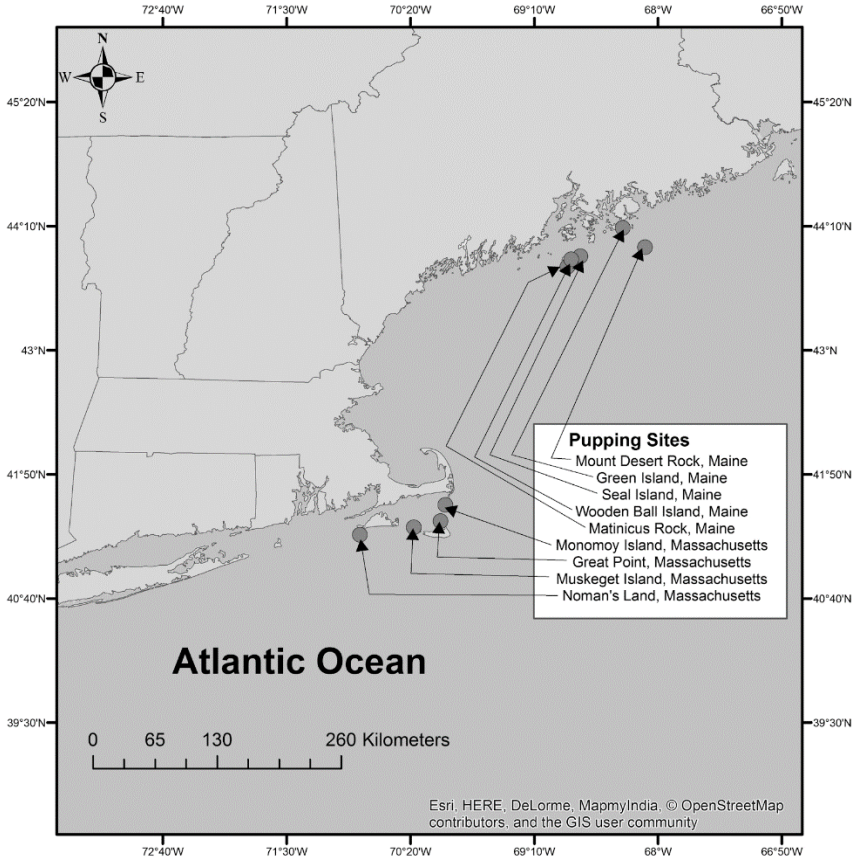

Figure 1. Map of islands surveyed for gray seal (*Halichoerus grypus*) pupping surveys. From Wood et al. (2020).

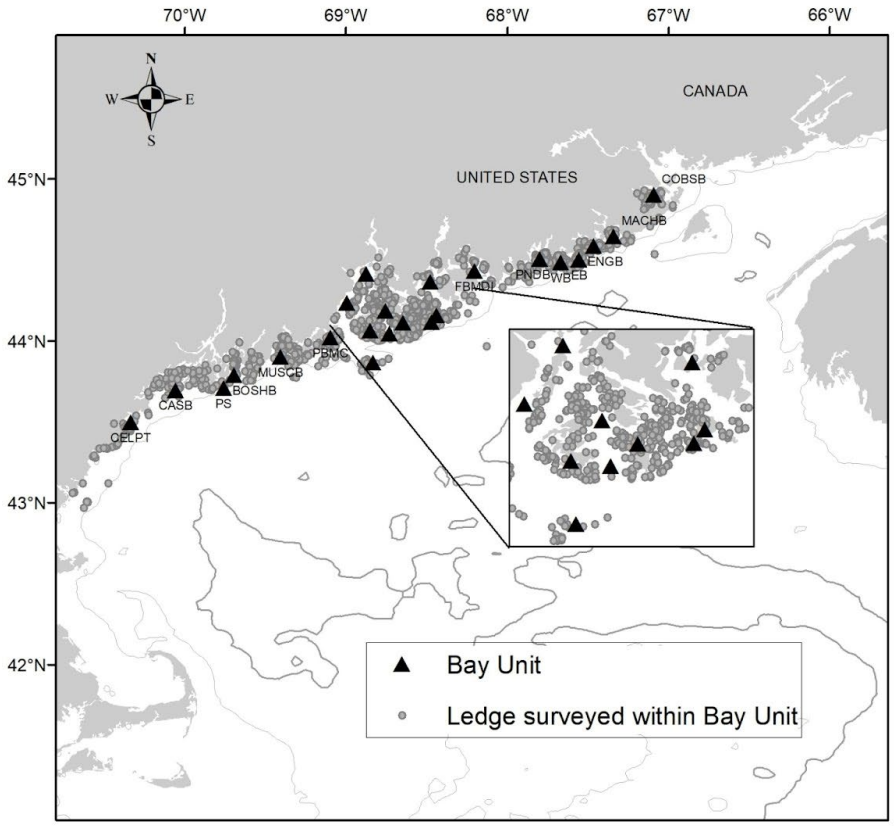

Figure 2. Map of surveyed ledges and bay units for harbor seal (*Phoca vitulina*) abundance surveys. From Sigourney et al. (2021).

Platform(s): NOAA Twin Otter or a similar chartered aircraft. At Muskeget Island, we also use uncrewed aircraft for gray seal surveys.

Statistical Design: We typically aim for a complete census of all sites where pupping is taking place. For gray seals, this entails surveying all 10 sites where pupping is known to currently occur (or more if a new site is suspected for pupping) over 2-3 days. Ideally, extra time is built in for reconnaissance flights to scout for new pupping areas, but funding is not normally available for these extra flights. For harbor seals, this entails surveying 1,000 or more ledges (i.e., small rocky islands or peninsulas) grouped within bays (referred to as “bay units”) over a 2-3 week period (Figure 2). If a complete census cannot be achieved for harbor seals, bay units are subsampled based on a stratified random design, informed by the probability of pupping in previous surveys. Ideally, the flight design is repeated for a replicate survey, if time and funding allows.

Methods: Surveys are flown parallel, around, or over terrestrial habitat (e.g., haul-outs and pupping colonies) with observers taking oblique angle or belly-mounted digital images from a minimum altitude of 600 ft and maximum altitude of 800 ft, from aircraft flying at a speed of approximately 100 knots (kts). Unmanned flights (Muskeget only) are flown line-of-sight at a

maximum altitude of 400 ft at air speeds of 0-30 kts in line transects or horizontal grids. Ground sampling resolution varies depending on the camera lens and altitude flown.

Images are either counted singly or combined into larger chunks or orthomosaics and are used to count the number of adults, pups, and dead animals at each site. Counts are conducted manually by 2 people, and time for counting varies substantially depending on the scope of the survey and camera set up in the plane (Wood et al. 2022). For instance, nadir (overhead) images collected from a belly-mounted camera system on gray seal surveys can be stitched together more easily than those taken obliquely with a hand-held camera; nadir imagery stitched into an orthomosaic facilitates counting because there is less need to evaluate duplicates and overlap. Counting for the gray seal surveys can range from 40-800 hours depending on how the images are collected, the flight patterns of the plane, and the number of seals present. For harbor seal surveys, only oblique images are taken due to the nature of the terrain on which animals are pupping, and due to the extent and scope of this survey (1000 sites versus 10 sites), counting takes several months.

III. Effect of Four Impacts

1. **Preclusion** of NOAA Fisheries sampling platforms from the wind development area because of operational and safety limitations.

   As most aerial surveys during pupping are conducted over terrestrial habitat close to shore, offshore wind development will not preclude aircraft from accessing a site unless development occurs close to land.

2. **Impacts on the statistical design of surveys** (including random-stratified, fixed station, transect, opportunistic, and other designs), which are the basis for scientific assessments, advice, and analyses.

   The current statistical design is to conduct a census. If a census is not possible, an estimation design would need to be developed. For harbor seal surveys in the Gulf of Maine, ideally all pupping ledges are surveyed for a full census of the breeding population. Pupping ledges are grouped geographically within bays, and each grouping is considered a “bay unit” for statistical analysis. If some bay units are not accessible depending on where floating or terrestrial foundations are situated, the statistical design of the surveys will need to be changed to account for this effect. For instance, if some bay units cannot be surveyed, a random-stratified survey design would need to be employed, informed by previous surveys. It is uncertain at this point how the change in design would affect the precision of the abundance estimates. Similarly for gray seals, if some pupping colonies located on offshore islands in Maine are not accessible, these areas will be missed leading to an underestimate and increased uncertainty of the total number of pups born.

3. **Alteration of benthic and pelagic habitats and airspace** in and around the wind energy development, requiring new designs and methods to sample new habitats.

   Alteration of benthic and pelagic habitats due to pile driving or prey shifts may influence the redistribution of animals and their choice for where they have their pups and forage. Seal usage around WEAs may decrease due to pile driving activity or increase from increased prey availability around turbines or from reduced fishing activity. As a result, animals may no longer be contained within the typical “survey footprint”; this affects our

ability to measure trends in abundance over time if some portion of the population is missed during a survey. Furthermore, if animals occupy new areas as a result of wind construction activities, these animals may be missed without additional monitoring or reconnaissance surveys.

4. **Reduced sampling productivity** caused by navigation impacts of wind energy infrastructure on aerial and vessel surveys.

   The large leased area south of Martha's Vineyard may interfere with aircraft trying to access pupping colonies on Muskeget Island (off Nantucket) such that they have to travel longer or higher distances to access the site depending on the point of origin.

   Typically, surveys are conducted from aircraft flying at 750 ft. If aircraft need to fly at 1500 ft to safely avoid wind towers and then maintain that altitude once reaching the colony, the change in altitude may affect observer ability to see and count animals. Moreover, if the mission is combined with other non-seal related surveys flown at 1500 ft (i.e., for right whales or other cetaceans), it may be difficult to adjust the camera settings in a belly-mounted camera system during a flight (which are configured to take overlapping images on a transect) to account for a change in altitude, resulting in incomplete coverage of an area.

IV. Mitigation Planned, as per Six Elements

1. ***Evaluation of survey designs***

   An evaluation of the overlap of planned development and sites surveyed for both gray and harbor seal pupping is needed to fully assess reduced sampling productivity or preclusion effects. If some sites cannot be surveyed, the impact of omitting certain sites could be evaluated by removing the sites from historic surveys and assessing the change in precision in the total abundance estimate. Going forward, omission of certain sites will need to be handled in the analysis for total population abundance and trend.

   Further evaluation is also needed of how seals use or do not use wind energy development areas and how this may affect the availability of animals to be observed during survey activities. If animals redistribute and establish new pupping areas as a result of wind energy development, reconnaissance flights would be necessary to know which areas to survey. Counts from these surveys form the basis for abundance estimates required in MMPA stock assessment reports and a change in the quality or coverage of the survey will add uncertainty to assessing the status of the stock.

2. ***Identification and development of new survey approaches***

   Identification and development of new abundance survey approaches will differ depending on the species. For gray seals, unmanned surveys have been successfully conducted at the largest pupping colony in the U.S., Muskeget Island. Unmanned surveys are flown below 400 ft and out of range of the wind energy developments. Adoption of unmanned surveys for this site on a consistent annual basis could mitigate effects of wind energy developments on the surveys flown with manned aircraft and provide information on rates of increase in the population at the longest, most established pupping colony. However, unmanned surveys could not fully replace

manned aircraft to measure total abundance in the population because other sites cannot be surveyed with unmanned aircraft due to regulated airspace and protected areas.

For manned aircraft, belly-mount camera system designs need to be developed and evaluated for missions flown at 1500ft. This entails: 1) establishing the appropriate orientation of the cameras to achieve a desired amount of image overlap to create orthomosaics, given the flight altitude and size of the camera lens; and 2) evaluating image resolution to assess if species and age class can be discerned and identified.

Unmanned aircraft and belly-mounted cameras in manned aircraft are not used for the harbor seal surveys. For these surveys, new survey approaches would entail changing the statistical design of the surveys if some pupping ledges are not accessible due to wind development areas, evaluating changes in observer ability to locate and reliably photograph animals at higher altitudes, or conducting surveys in new areas if animals redistribute.

New surveys or tagging studies within WEAs may provide insight into how wind energy development influences seal habitat use. Seals may be attracted to the area if prey concentrates around turbines or use the turbine platforms for hauling out, or conversely, they may be displaced due to vessel activity and pile driving disturbances. Either of these scenarios may have positive or negative effects on foraging success and consequent maternal investment in their pups. Increased time spent in WEAs, or navigating around wind energy areas, would influence the availability of animals to be observed during abundance surveys and may also affect pup survival.The NEFSC and research partners are currently deploying satellite and acoustic tags on seals in the vicinity of WEAs to help inform changes in habitat use; these data combined with additional aerial monitoring at specific sites may aid in the interpretation of abundance survey results or inform changes to aerial survey design.

3. ***Calibration and integration of new survey approaches***

Aerial surveys flown at 1500 ft will require evaluation of survey imagery compared to those taken at the standard altitude of 750 ft. The change in altitude, which is required to fly above wind turbine installations, could affect the resolution of the imagery such that species, life stage, and counts of animals may not be discernable or comparable to surveys collected in previous years. Multiple flights over the same colony of seals at different altitudes in the same day will allow us to adjust appropriate camera settings and evaluate differences in image resolution and coverage. Alternatively, we could experiment with more advanced camera systems to see if a different system could achieve the same ground sampling resolution at 1500 ft compared to the camera system flown at 750 ft. Calibration of data collected with belly-mounted camera systems flown at 1500 ft will be coordinated with other marine mammal surveys using the same technology (see Marine Mammals and Right Whales Aerial Survey Mitigation). The details of a calibration study will be flushed out should funding be available.

For uncrewed surveys, flights could be flown in conjunction with manned surveys to measure differences in animal counts to estimate a correction factor for different survey platforms. If unmanned surveys become the more common survey platform at some

sites, traditional analytical approaches used to estimate trends in population growth rates will need to be adjusted to account for the change in platform within a time series.

4. ***Development of interim provisional survey indices***

   It is unknown if interim indices to estimate abundance can be developed from historic data sets if data quality and quantity are affected by wind development. Estimated trends and variance from older analyses might be used to estimate an expected abundance; however, if WEAs influence animal behavior and abundance, these projections would not be accurate.

5. ***Wind energy monitoring to fill regional scientific survey data needs***

   More frequent uncrewed surveys of gray seals on Muskeget (and potentially other sites if permitted) and continued animal tagging of both gray and harbor seals can be used to assess changes in animal distribution as a result of wind development. Moreover, manned reconnaissance surveys can be flown in previously unsurveyed areas, and coordinated with other protected species surveys, to evaluate whether seals are using new areas to haul out for resting, pupping, or molting to help inform the design of regular abundance surveys.

6. ***Development and communication of new regional data streams***

   New data streams, particularly those acquired from unmanned surveys, will require dedicated IT support and infrastructure to house the large volume of sensor data collected from seal surveys. Changes in the surveys as they relate to the frequency and precision of marine mammal population abundance estimates for stock assessment reports will require input from NOAA's Office of Protected Resources and the Marine Mammal Commission.

V. Proposed Schedule for Implementation

1. Map pupping sites for both gray and harbor seals relative to both floating and fixed WEAs in the Gulf of Maine, New England, and the Mid-Atlantic to assess the position of such areas relative to WEAs and if there is enough distance for a plane to have sufficient time to descend to 750 ft. Also, analyze whether flight paths to and from survey areas will need to be modified.
2. Evaluate the relative contribution of different surveyed sites to the overall abundance estimate in terms of counts and uncertainty to assess the impact if some sites cannot be surveyed.
3. For sites directly impacted by surveys, evaluate changes in image resolution, species, and age class recognition from flying at 1500 ft. Coordinate with other marine mammal surveys on this effort.
4. Coordinate with other marine mammal surveys on the evaluation of more advanced camera systems (i.e., Phase One cameras) with respect to ground sampling resolution at higher altitudes.
5. Continue annual or biannual unmanned winter surveys on Muskeget. Fly on the same day as manned aircraft surveys to compare results and develop possible correction

factors for unmanned surveys to combine with historic unmanned surveys for an analysis of trends over time.
6. Work to develop the storage, discoverability, metadata, and archiving of the survey imagery.
7. Explore methods and software such as VIAME to automatically count seals in some imagery.
8. Continue tagging harbor and gray seals to evaluate changes in movements and choice of pupping colonies around WEAs.
9. Plan reconnaissance surveys to scout new pupping areas to survey, by either piggybacking off existing marine mammal surveys flying during winter or funding independent seal flights.

VI. Links to Other Surveys

Calibration of data collected with belly-mounted camera systems flown at 1500 ft will be coordinated with other marine mammal surveys using the same technology (see Marine Mammals and Right Whales Aerial Survey Mitigation). Manned reconnaissance surveys can be coordinated with other protected species surveys—to evaluate whether seals are using new areas to haul out for resting, pupping, or molting as a result of wind development—and possibly coordinated with other state programs flying coastal aerial surveys. Observational studies of seal behavior around turbines could coordinate with other research projects conducted from small- to moderate-sized vessels that are able to work within WEAs. Cameras mounted on turbine structures would also give more temporal coverage and might provide evidence as to whether the seals are using turbine structures for hauling out or as prey aggregating devices.

VII. Adaptive Management Considerations/ Opportunities

N/A

VIII. Statement of Peer-Review Plans

N/A

IX. Performance Metrics

N/A

X. References

Sigourney DB, Murray KT, Gilbert JR, Ver Hoef JM, Josephson E, DiGiovanni R. 2021. Application of a bayesian hierarchical model to estimate trends in Atlantic harbor seal (*Phoca vitulina vitulina*) abundance in Maine, USA, 1993-2018. Mar Mam Scie. 38(2):500-416. DOI: 10.1111/mms.12873.

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