Marine Mammal & Sea Turtle Aerial Survey Mitigation Plan

I. Purpose of the survey

The overarching objective of the marine mammal and sea turtle aerial (and vessel) abundance surveys is to collect the data needed to accurately and precisely estimate the distribution and absolute abundance of the species; these abundance estimates are necessary to assess the status of the species and to relate the abundance patterns to their physical and biological environment.

The Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) mandates the National Marine Fisheries Service (NMFS) to evaluate the status of all marine mammals that use U.S. waters. A major component of the assessment is a population-level absolute abundance estimate. To estimate the abundance of the marine mammals and sea turtles in the entire U.S. Atlantic requires both aerial and shipboard abundance surveys. Thus, the current mitigation plan is tightly tied to the Marine Mammal and Sea Turtle Vessel Abundance Survey Mitigation Plan.

What data are collected and standard operating procedures

Currently, the abundance estimates of marine mammals and sea turtles are from all of the U.S. Atlantic waters from Florida to Maine out to the Exclusive Economic Zone (EEZ) and from the Canadian waters in the Gulf of Maine along the Scotian shelf to about Halifax. These estimates are derived from concurrent aerial surveys (covered in this Mitigation Plan) and shipboard surveys (covered in the Marine Mammal and Sea Turtle Vessel Abundance Survey Mitigation Plan). See the Geographic Scope section before for more details on the extent of each of these surveys.

The marine mammal and sea turtle aerial abundance surveys collect line transect data from two teams of observers on the plane that simultaneously and independently collect data on the sightings of animals that each team detects. The data from the two teams are used in a mark-recapture analysis to estimate the number of animals missed by each team (termed perception bias) that is then part of the estimate of the absolute abundance of animals at the surface. Perception bias is due to observers missing an animal group that is available to be seen (that is at or near the ocean surface) but was missed due to factors such as poor weather conditions like glare. In addition, externally collected dive profile data are then used to adjust the abundance estimate to incorporate the animals missed because the animals were below the surface and so could not have been detected by an observer on the plane, (termed availability bias). In total, using the data from the two teams on the plane and the species-specific dive profile data results in estimates of absolute abundance that have been corrected for perception and availability bias. Details on the standard operating procedures used during the aerial line transect abundance surveys are described in Section II.

The aerial (and shipboard) abundance survey data are used to estimate abundance for as many species as the data allow. Usually, this is for about 20 species of marine mammals and sea turtles. The minimum needed data fields collected during the aerial surveys include a) information on detected sightings (at time of initial detection – location of the animal groups relative to the plane's flight path, species identification of groups, number of individuals in the detected group, and characteristics of group at initial detection, such as animal behavior, feature of animals/groups that caught the eye of the observer, indications of avoidance, direction of swimming, and presence of calves) and b) information on survey effort (location of plane, location of people at each observation station, and concurrent weather and sighting conditions). After the data are collected and checked for accuracy, the data are analyzed using distance sampling methods to estimate abundance corrected for perception and availability bias (Palka 2020; 2023).

Assessment pathway that use these data

The abundance estimates are reviewed and reported in NMFS Tech Memos and peer-reviewed journal articles. The Atlantic Scientific Review Group is required to review the abundance estimates before they are reported in the Atlantic and Gulf of Mexico Marine Mammal Stock Assessment Reports.

For each species, their approved abundance estimates and levels of uncertainty are reported in the Atlantic and Gulf of Mexico Stock Assessment Reports. The status of the stock is assessed by the Potential Biological Removal (PBR) level, which is dependent on the abundance point estimate (best estimate), the coefficient of variation (CV) of the abundance, and the CV of the average bycatch estimate. The value of the PBR level is compared to the estimated level of average human-caused mortalities to determine the population status (strategic or non-strategic). A population is given a strategic status when mortalities are greater than are sustainable, that is, greater than the PBRl level).

Strategic status triggers the development of Take Reduction Teams who are tasked with developing mitigation measures to reduce the leve

l of mortality to a sustainable level. These measures generally modify fishery or other human activities with the goal of reducing the levels of mortality while still allowing the fishery or other human activities to be economically viable.

Other scientific advice pathways and data users

The pooled abundance estimates and other analyses resulting from the data collected on these aerial and shipboard surveys are also used by industries and other government agencies that utilize the ocean and might interact with marine mammals and sea turtles. More specifically, the abundance estimates are used in ocean user's Environmental Impact Statements, and in other analyses required under the National Environmental Policy Act (NEPA), ESA, and MMPA. For example, the wind developers need to indicate how many protected species their activities will interact with.

Other products

In addition to the abundance estimates, the pooled aerial and shipboard abundance data are also used by industries and other government agencies to document how the marine mammals and sea turtles fit in their environment. That is, the data are used to document the animals' spatiotemporal distribution patterns, and the physical and biological characteristics that are associated with the marine mammals and sea turtles. Examples of results from these sorts of analyses include Chavez-Rosales et al. (2019), which shows the physical and biological characteristics that are associated with a cetacean species, and Chavez-Rosales et al. (2022), which shows most cetacean species have been moving northeasterly within the last decade.

How wind developments will impact the survey objectives

The aerial abundance survey objectives are to collect the data needed to estimate species-specific absolute abundance estimates that are used to assess the status of the species.The development of offshore wind energy turbines directly impacts these objectives in several ways. One way is the height of the turbines. At this time, the turbines are projected to reach nearly 1000 feet tall, while the current standard operating procedure is to fly the aerial abundance surveys at 600 feet above sea level. This flight altitude was selected to ensure high-quality species identification and high detection rate levels. Worldwide, this altitude is considered the standard altitude for visual marine mammal surveys. Thus, the turbines are a major physical obstruction for future flights. NOAA aircraft operations require flights to be at least 500 feet above obstacles. Thus, to continue aerial surveys, the flights will have to be flown at a minimum of 1500 feet altitude to avoid the turbines. This is consistent with the aerial surveys conducted over European and U.K. wind developments that range from 1000-2000 feet altitude. The impacts of flying at higher altitudes are that 1) it will become more difficult to identify which species were visually detected animals, particularly small-sized marine mammals and sea turtles; 2) more animals will be missed because it is too difficult to find them, particularly in higher wind conditions; and 3) days with good enough conditions will become more restricted if there are low cloud ceilings and rougher sea states.

Another type of impact is that the presence of the wind turbines and the additional associated traffic could cause changes in local distribution, abundance, and behavior of the marine mammals and sea turtles. These changes need to be accounted for during the abundance surveys, when analyzing the survey data, and when interpreting the results. It is expected that the effects will be different for different species and will vary in intensity and longevity.

Some species of marine mammals and sea turtles could be attracted to the turbine structures due to the “artificial reef” effect resulting from a localized increase in fish and other prey species in the vicinities of the turbines, thus leading to a localized increase in the density of foraging predator marine mammal and sea turtles.

On the other hand, some species of marine mammals and sea turtles could be displaced from the wind development areas or could reduce foraging activities, which could affect the individual's health, which could then lead to population level declining recruitment and abundance. The displacement (and reduced foraging) could be either temporary or longer term.

It’s also possible that some species could alter their foraging behavior due to the physical obstacles, change in prey distribution and abundance, and/or the boat traffic associated with the development. As mentioned earlier, the absolute abundance estimate is dependent on the correction for availability bias, that is, the relative amount of time an animal spends at the surface (and can be detected in an abundance survey) versus the amount of time an animal spends below the surface (and thus cannot be detected in an abundance survey). Thus, changes in foraging behavior may result in the need to adjust future availability bias correction factors.

In summary, to mitigate the effects of the wind energy developments on the aerial surveys that collect data to estimate the distribution, abundance, and behavior of the marine mammals and sea turtles, we will need to conduct abundance surveys that have modified data collection and analysis methods and collect additional dive pattern data inside and outside of the wind development areas. These monitoring tools will need to result in accurate and precise estimates of absolute distribution and abundance at the small scale (within and near the wind development areas) and at the larger scale (at the population level, at least within the U.S. waters).

II. Survey Details

Beginning Year: 1991

Frequency: Generally annually for a 40-90 day period

Season: Surveys are conducted in all seasons, although practically, we usually conduct only 1 survey each year, which is on a rotating schedule that ensures overall the data are collected in all months in all parts of the U.S. Atlantic waters.

Geographic Scope: All U.S. Atlantic waters from Florida to Maine from the coast to beyond the EEZ. The geographic scope also includes Canadian waters in the Gulf of Maine and along the Scotian Shelf to the Gulf of St. Lawrence since animals in U.S. waters also use the neighboring Canadian waters.

The NOAA aircraft cover waters from the shore to about the 100 m depth contour, and the NOAA white ships cover the rest of the waters from the 100 m depth contour to the EEZ. On years the ships are not surveying, the aircraft covers waters throughout the Gulf of Maine (U.S. and Canadian sides) and extends the track lines to cover waters to about the 2000 m depth contour north of Cape Hatteras and to the 100 m depth contour south of Cape Hatteras, NC, to the tip of Florida.

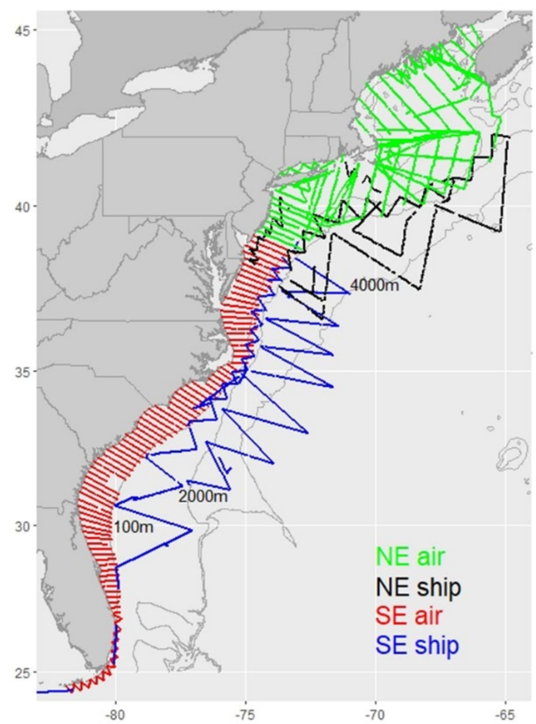

Figure 1: An example of the on-effort track lines from the 2021 ship and plane survey

Platform(s): NOAA Twin Otters

Statistical Design: The survey design is pre-specified systematic approximately parallel line transects, with a random start within a geographic stratum. The track lines are orientated approximately perpendicular to the coastline and across the depth contours to account for typical spatial gradients in the species density.

Methods: Line transect sampling methods are used to collect and analyze the data. Currently, surveys are flown at 600 feet above sea level at about 110 knots in NOAA Twin Otters. Along with 2 pilots, 2 teams of 3 scientists each are in the plane. To implement the 2-independent team methodology, each team has 2 scientists simultaneously visually searching waters in front of and to the side of the plane with the naked eye through bubble windows that allow an observer to see straight down below the plane to the horizon in front of and to the side of the plane. Each team also has 1 data recorder that records only data from 1 team.The 2 teams are physically and auditorily isolated from each other. The 2 teams are necessary to estimate perception bias (the probability of missing an animal group that is available to be seen but was missed due to factors such as environmental conditions or human error). These data are analyzed using mark-recapture covariate distance sampling techniques. In addition, externally collected dive profile data are then used to adjust for availability bias, resulting in abundance estimates that are corrected for both perception and availability bias (Palka 2020; 2023).

III. Effect of Four Impacts

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

   Turbines are projected to be nearly 1000 feet tall, while the current standard operating procedure is to fly aerial abundance surveys at 600 feet above sea level. This flight altitude was chosen to maximize animal detection rates, particularly of smaller species such as sea turtles and harbor porpoises, and to maximize the ability to see enough details of the animals to positively identify the species. Thus, due to the tall turbines, at least in the areas around the turbines, we would not be able to continue with the current standard operating procedure of flying at 600 feet altitude and, at least in the wind development areas, we will have to change survey methods that are used to estimate the absolute abundance of marine mammals and sea turtles, where these abundance estimates are necessary to assess the status of these populations. Possible alternative survey methods are discussed in the mitigation section.

   If in our future abundance surveys we simply ignored the wind development areas where the planes cannot safely enter or fly higher over these areas while continuing to use the current visual data collection methods, the effect would most likely be a decrease in the number of positively identified detected animal groups in the wind development areas, even if there are more detected animals within the development areas. This could probably result in lower stock abundance estimates and most likely result in higher estimates of abundance variability. Either of these results could then lead managers to a false conclusion that there was a declining trend in abundance and thus that the status of the stock was declining. This could potentially trigger the development of unnecessary regulations to reduce human interactions with the stocks. However, the true effect of not surveying in the wind development areas is not known, as it depends on how the marine mammals and sea turtles react to the turbines and the physical and biological local environment surrounding the turbines, as described in Section 1.

Under all of the possible effects of the wind developments on the marine mammals and sea turtles, including no effect, the preclusion of the survey planes in the vicinity of the developments will result in the NMFS having to change the data collection and analysis methods used to estimate the absolute abundance of marine mammals and sea turtles; these estimates are necessary to assess the status of these populations.

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 preclusion of flights in the wind development areas would violate the underlying assumption of the line transect methodology that states the areas surveyed are random representations of the habitats that the marine mammals and sea turtles inhabit. With the exclusion of large regions where the planes cannot enter due to the wind developments, the remaining areas that can be surveyed by planes may not be representative of the excluded wind development areas. Thus, it is essential to conduct surveys inside and outside of the development areas to estimate the whole population abundance estimates and to determine if the estimates of distribution and abundance change in the wind development areas.

   A priori, the type and magnitude of the effect of the developments on the estimates of the distribution and abundance of marine mammals and sea turtles will be species-specific and could be positive, negative, or have no effect. Given these uncertainties, the most obvious effect of violating this basic underlying assumption will be less precise (more uncertain) estimates of the distribution, abundance, and trends of marine mammals and sea turtles, where under different scenarios, the point estimate (best estimate) could be biased positively, negatively, or not all.

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 physical and biological habitats due to factors such as pile driving or the presence of turbines may influence the redistribution of animals at all trophic levels and would thus need to be documented to ensure future abilities to measure trends in potential changes in distribution and abundance of the predators, marine mammals and sea turtles. For example, the turbines will influence oceanic and atmospheric circulations, at least to some degree. These circulation changes could then change the distribution of planktonic species and consequently also change the distribution of planktonic predators (like fish or marine mammals). The wind energy areas (WEAs) could lead to localized attraction of some species or lead to the disappearance of other species. How these lower trophic changes affect marine mammal and sea turtle predators will most likely be species-specific. Given these uncertainties, the most obvious effect will be less precise (more uncertain) estimates of the distribution, abundance, and trends of marine mammal and sea turtles.These effects could result in decreased status of the stocks, which could then result in unnecessary regulations to develop mitigation strategies to reduce the human interactions with the stocks.

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

There would be a reduction in the sampling productivity (ability to confidently detect animal groups) if around wind development areas, we would need to either avoid the areas or fly higher over these areas. If flights were flown higher above the wind turbines, the probability of detecting animals would be reduced because it is much harder to visually detect marine mammals and sea turtles. The reduction of the number of positively identified detected animals will result in lower abundance estimates that are more uncertain, perhaps also implying a false population negative trend. These effects could result in decreased status of the stocks, which could then result in unnecessary regulations to develop mitigation strategies to reduce human interactions with the stocks.

IV. Mitigation Planned, as per Six Elements

1. *Evaluation of survey designs*

The largest effect on the survey design is that we can no longer fly at the standard 600 feet altitude on the currently designed track lines within the wind development areas that are included in the survey area. The current survey track lines were designed in a systematic pattern using a random start, which provides representative coverage of all marine mammal and sea turtle habitats. However, since there is still a need to estimate abundance, distribution, and trends within the development areas, this leads to the question, what alternative survey design should we use? There are several options:

- Option 1 is to ignore the wind development areas and continue to survey the rest of the U.S. Atlantic waters using the standardized track lines at 600 feet using current standard operating procedures.
- Option 2 is for the NMFS to continue to fly the rest of the U.S. and Canadian waters at 600 feet, then do something different in the wind development areas to collect abundance data within the wind development areas, such as fly higher (1500 feet or above) and use new high-definition cameras; use unmanned aerial or surface vehicles; use satellite images; use passive acoustics or use some other future new technology.
- Option 3 is for the NMFS to fly higher (1500 feet or above, currently) over the entire U.S. and Canadian survey area using the existing track lines (or some modification) and use a single technology, such as the new high-definition cameras. They will be required to fly at least 500 feet above obstacles.
- Option 4 is to estimate the coastwide abundance estimate using line transect data collected by the NMFS in waters outside of the wind development areas (using either the traditional 600-foot visual surveys or 1500-foot hi-definition camera surveys) and by the wind industry in waters within the wind development areas (using whatever technology they decide to use).

Option 1 could be evaluated using the previously collected data in simulations by removing the data from tracks within the wind development areas and reanalyzing the resulting data to see the effect on the population abundance estimate for the entire area and the development areas. This option is the least preferred because any changes within the wind development areas due to the development or any other reason cannot be accurately monitored, and we could not document if there were any changes within the development areas. Thus, this option will not be discussed further.

With options 2 and 3, it would be harder to evaluate the effects of the digital aerial survey since new data collection, processing, and analysis methods would need to be developed which will have an uncertain impact on the survey design and resulting abundance estimates.

Option 2 involves a hybrid of survey methods and analyses. Theoretically, such hybrids have their pros and cons, which depends on the size of the areas using the different methods and the accuracy/precision of each method. Using a single method that results in accurate and precise results is ultimately desired, if possible. However, a hybrid survey design may be a viable intermediate, at least until all the issues have been investigated to determine if a single or hybrid design is the most practical and statistically acceptable method.

Option 4 is a variation of Option 2, where the source of the abundance data within the wind development areas are derived from surveys conducted by the wind industry. The data collection methods would need to be of sufficient high quality to result in accurate and precise abundance estimates. We could also evaluate if the industry collected data could be incorporated into the estimation analysis process assuming the data are opportunistic sampling programs or used to validate the data and results from a survey designed under Options 2 or 3.

With any of the options, if we assume there will be species-specific shifts in distribution or abundance patterns of the marine mammals or sea turtles due to the existence of the wind development areas or any other factors that may or may not be related to the wind energy developments, simulations could be developed to model different types and degrees of shifts and then evaluate the effects on the abundance estimate. Obviously, the larger the shift or change, the larger potential effect on the estimate of abundance and its variability, particularly when using unrepresentative data. However, if standard random start, systematic line transect surveys are conducted over the entire area (inside and outside of the wind development area), then the shifts (changes) could probably be appropriately accounted for and documented, if the number of positively identified groups of animals that are detected is sufficiently large.

In summary, due to wind area development, there is no choice but to change the survey design of the aerial abundance surveys. Thus, the goal of future mitigation efforts for these abundance surveys is not to develop simulation scenarios evaluating the magnitude of the effects but to develop representative survey coverage over the entire U.S. Atlantic waters, use appropriate sampling data collection and analysis methods, and to explicitly account for perception and availability bias in the future abundance estimates.

2. *Identification and development of new survey approaches*

The goal of future mitigation efforts for the aerial abundance surveys for marine mammals and sea turtles is to develop data collection methods that provide representative survey coverage over the entire U.S. Atlantic waters, to use appropriate sampling data collection and analysis methods, and to explicitly account for species-specific and platform-specific detection functions, and perception and availability bias. It is important to explicitly account for such biases because the resulting abundance estimates have to be absolute abundance estimates that will be used to assess the status of the population. Accounting for these biases should also allow flexibility if multiple platforms or survey designs are used in different parts of the survey area (U.S. Atlantic waters), such as inside and outside of the wind energy areas (WEAs).

The benefit of continuing to use line transect sampling data collection and analysis methods is that these methods naturally document and account for changes in the probability of detection that may be due to changes in data collection methods or changes in the underlying distribution and abundance of the animals. This then allows easier integration and interpretation of time series of results that are derived from various platforms, where that platform could be digital images collected from manned aircraft, or unmanned aerial or surface vehicles.

There is still the question of which survey design option to employ:

- Option 2 is to continue to fly the rest of the U.S. and Canadian waters at 600 feet and then do something different in the wind development areas to collect abundance data within the wind development areas, such as fly higher (1500 feet or above), use unmanned aerial or surface vehicles, use satellite images, or use passive acoustic methods.
- Option 3 is to fly higher (1500 feet or above) over the entire U.S. and Canadian survey area using the existing track lines or some modification of the existing track lines and using a digital camera system to collect the needed data to estimate abundance.

Under either option 2 or 3 issues that need to be dealt with are:

- Digital line transect survey approach
    - When we fly at a higher altitude using a high-definition camera system, the effective area captured in the images may be smaller than when surveying at lower altitudes depending on the altitude. The effective area depends on the magnification level of the lenses, number of cameras, and the angle the cameras are pointed at. Taking this into account, our goal would be to have at least a 300-m strip coverage on each side of the trackline with enough resolution to have a good chance of identifying the species of an animal that is at the ocean surface.
    - We need sufficiently large sample sizes of detections (that is, the number of species-specific detections positively identified to species).
    - We need to document the false negative and false positive rates of detecting animals in the images (that is, estimate perception bias).
    - We need to investigate to what extent, if at all, the turbines block the view of the waters below the turbine.
- Corrections for availability bias
    - We need a better understanding of the species-specific diving patterns of animals throughout the study area, which may depend on factors such as season, region, or proximity to wind development structures. The dive patterns affect the estimate of availability bias.
- Other platforms

- We need to investigate other survey platforms that could provide the necessary line transect abundance data.

Currently, the platform most readily available is a manned aircraft equipped with a digital camera system. Thus, in the short term, this platform will be focused on. However, other platforms and methods could concurrently be investigated to determine if they will be a viable option.

Because there are few current wind development areas, the practical short-term mitigation solution is to continue to conduct aerial surveys using standard protocols for visual surveys at 600 feet altitude while avoiding the few existing turbines. At the same time, we will develop appropriate future survey and analysis methods. Since it is important to monitor the changes, if any, occurring in and around the turbines, it is necessary to develop the new methods in the near future—within 2 years.

We are currently starting an investigation into developing a camera system, analysis methods, and associated procedures for estimating bias that can be used in the future when aerial surveys would have to be flown at higher altitudes. We also need to collaborate with other researchers or monitor progress of other researchers who are developing other platforms/methods to collect abundance data for marine mammals and sea turtles.

Develop digital line transect survey approach

Over the wind development areas, we will have to fly higher (at 1500 feet or higher) to avoid the effects of the turbines. To continue to positively identify most of the animals, we will incorporate digital cameras to capture the images of marine mammals and sea turtles that are detected from belly-mounted cameras in the NOAA Twin Otters.

The use of digital images means the development of modified data collection procedures, data processing, and statistical analyses. This is not an impossible task but will take time and money to develop, test, and make a routine procedure that results in precise and accurate abundance estimates of marine mammals and sea turtles. To initiate this task, protected species scientists from all of the NMFS science centers and NOAA aircraft pilots and maintenance personnel are hoping to test 2 existing camera systems during the summer of 2024. This initial task is currently unfunded, although the request for aircraft and airtime has been submitted, and the camera systems and operators are onboard and want to be involved.

Work has begun on using the images collected in 2022/2023 to develop protocols to process the thousands of images taken and to identify animals in the images. Working with VIAME developers, we have started developing a library of annotated images that will be used to develop neural network algorithms to automatically or at least semi-automatically identify images that may have a marine mammal or sea turtle. It is anticipated that this effort will continue for a couple of years to collect the large number of images needed to develop accurate algorithms.

Develop new availability bias correction factors from animals using the wind development areas

An unknown related to digital abundance data is whether the previously calculated availability bias correction factors are applicable to digital data. Data need to be collected to quantify the average depth at which an image can accurately identify a marine mammal or sea turtle in a photograph and how the depth varies under different conditions. Since this correction factor is a multiplier in the abundance estimate, they have a very large effect on the abundance estimate; therefore, it is a priority to investigate this issue.

Another related issue that needs additional investigation is the effect on the availability correction factor due to the difference between the few seconds a visual observer has to collect data on a group while in an aerial survey versus the instantaneous image taken from a camera that can be studied repeatedly by a human or computer algorithm that is interrogating an image to determine the number of animals of which species is in each image.

Develop other sampling approaches to estimate abundance

We are currently following what other scientists around the world are doing to develop unmanned aerial and surface data collection vehicles that could be used to collect line transect distribution and abundance data within the wind development areas. Members of the NEFSC Protected Species Division (PSD) are currently participating in an Inflation Reduction Act (IRA) working group that is developing UxS platforms to enhance or replace manned NOAA's manned platforms (white ships and aircraft). We will develop collaborations when possible and develop a work plan that includes field and analysis work. As this develops into a potentially viable data collection method, we will conduct pilot studies and calibration experiments to see if this plan is applicable in our waters.

Members of the NEFSC PSD are currently collaborating with colleagues who are developing passive acoustic equipment and analyses so that in the future, passive acoustic monitoring could be used to result in precise and accurate absolute abundance estimates of as many species of marine mammals as the technology allows.

We also currently collaborate with colleagues who are exploring other methods to estimate abundance, such as through satellite imagery or other remote sensing methods. Members of the NEFSC PSD are currently on another IRA working group to explore remote sensing to enhance or replace NOAA-manned platforms. As this develops we will develop a work plan that may include field and analysis work, pilot studies, and calibration experiments.

3. *Calibration and integration of new survey approaches*

The goal is to integrate abundance estimates resulting from different survey platforms (such as visual observers flown at 600 feet and digital images collected at 1500 feet altitude) and not use calibration factors that compare these 2 data collection methods, if possible. For the marine mammal and sea turtle abundance surveys, we need to integrate abundance estimates resulting from different platforms that collected data in different areas within a single survey time period to result in 1 abundance estimate for that time period and also to integrate previous visual observer-derived abundance estimates with future image-derived abundance estimates to create a consistent, comparable time series.

We propose to continue to use line transect methods that explicitly incorporate estimation of species-specific detection functions, and perception and availability biases. We propose to account for the platform-specific biases in independent analyses of each type of data to result in absolute abundance estimates for the study area covered by each data collection method. Then, theoretically, we do not need to develop calibration factors between collection methods but can simply add the different platform-derived abundance estimates from within a single survey time period together. This then results in a time series of comparable abundance estimates.

To evaluate the assumption that imagery can provide comparable abundance estimates to human observers, we plan to a) explore the methods needed to analyze digital data using existing digital data, including exploring the associated assumptions; b) conduct side-by-side experiments by collecting both types of data simultaneously and compare the results; and c) investigate the dive patterns of individuals near and far from wind turbines to determine if the availability bias correction factors are different inside and outside of WEAs.

Work has begun on exploring the methods to analyze the image-derived data to estimate abundance that is both accurate and precise. We are currently analyzing image data from digital image surveys conducted over waters off New York by other researchers. This analysis has already shown work is needed to confirm all animals in an image are detected and identified to species. This could involve a) simultaneously collecting data from the images and from human observers in the same plane and then using established 2-team analysis procedures and b) having multiple people and neural network algorithms interrogate the images to identify animals to calculate the false positive and false negative rates.

To quantify and understand how environmental factors influence the absolute abundance estimates in a time series that is derived from visual surveys in the earlier years and digital data in the later years, we should conduct a few experimental field projects to examine the differences in the detection rates and estimated absolute abundance between data collected from images versus human observers in side-by-side comparison field studies. Such an experiment could involve 2 planes used to survey the same track lines at a similar time. One plane could use the current standard procedure of two teams of observers collecting data simultaneously and independently while flying at an altitude of 600 feet. The second plane could collect data from a camera system while flying at an altitude of 1500 feet or more altitude. These studies can then document the differences, if any, between collecting data from cameras versus human observers. Specifically document differences between species-specific detection rates of groups of animals, estimates of group size, influences of environmental factors such as Beaufort sea state and amount of glare, and in abundance estimates after using the platform-specific appropriate analysis method. Such side-by-side comparison field studies will also be useful in the future when new technologies (such as using uncrewed aerial platforms or passive acoustics) become available.

To investigate if the turbines affect the availability bias correction factors, which depend on the animals dive patterns, we will need to collaborate with other researchers who are collecting dive pattern data from tagged animals. For example, we will need to work with the results being collected on tagged sea turtles as described in the Marine Mammal and Sea Turtle Ecology Survey Mitigation Plan or with the results from other researchers funded by the Bureau of Ocean Energy Management (BOEM), the Department of the Interior, or the U.. Navy to tag marine mammals inside and outside of WEAs up and down the U.S. Atlantic coast. To investigate species not already being tagged, we should conduct our own tagging programs to get at least a small sample of tagged dive patterns to improve our availability bias correction factors.

4. *Development of interim provisional survey indices*

The proposed work should lead to survey indices, so it's not necessary to develop another interim survey index.

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

A recent National Academy of Sciences review of offshore wind energy development in Southern New England highlighted the difficulty of distinguishing impacts of climate change and other natural influences on the ecosystem from impacts due to wind development. Therefore, consistent long-term indices are key to monitoring and managing effects.

To achieve a long-term monitoring program, we need to conduct routine abundance surveys inside and outside of the WEAs for the entire U.S. Atlantic coast using the newly developed statistical designs, data collection methods, analysis methods, neural network algorithms to identify animals in images, and newly collected tag data to correct for location-based availability bias. We also need to continue to monitor and/or collaborate with other researchers to develop safe platforms to collect data within and outside of WEAs and to collect dive patterns from tagged animals.

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

The new survey approach of conducting aerial abundance surveys using digital cameras will require new data management, dissemination, and reporting systems.

Describe who needs to be involved. What key constituents need to be communicated with?

To develop the required new data collection, processing, analyses, dissemination, and reporting systems, the key constituents we need to collaborate with include the following partners:

- The marine mammal/sea turtle researchers at the other NMFS science centers are needed to develop standardized camera systems for the NOAA aircraft, data collection processes, and image libraries.
- NOAA aircraft pilots, engineers, and maintenance personnel to develop the structural camera systems to ensure the plane's structural integrity and develop protocols for how the planes need to be flown to accurately and safely collect image data.
- VIAME software developers to efficiently develop the species identification neural network algorithms on open source software.
- Manufacturers of the cameras to effectively integrate the cameras into data collection systems and to ensure they are safely installed in the planes.
- NMFS andNational Centers for Environmental Information (NCEI) personnel to assist in developing a system for storing, accessing (in the short term), and archiving and

disseminating (in the long term) the hundreds of thousands of images that will result from aerial digital abundance surveys. This is a huge task and will need to be started soon since we have started collecting images.

- Other scientists (internationally) who could contribute images to the image libraries used to develop the species identification algorithms.

Describe data management needs. Do existing data acquisition, management, and dissemination systems meet survey mitigation needs? If not, what is needed?

The new digital image data need to be collected in the field, quality control checked, stored online for the short term to be processed, and analyzed to develop abundance estimates and measures of variability. Then, the digital images and processed results need to be archived for the long term. The abundance results would then be documented in papers, reviewed, and then published in peer-reviewed journals. Finally, the raw data and data products need to be archived and become easily available to the public.

The data management needs for the image data that could be collected on crewed and uncrewed vehicles needs to be developed, nearly from scratch. The needs include efficient and fast methods to transfer the images from the cameras to databases that can be easily accessible while in the field. We also need a long-term archival location for the images themselves, image metadata, and measurements taken from the images that would be used in the abundance estimate analyses.

In addition, the dissemination systems need to be improved to make the raw data and processed results available to the public. For example, the abundance data currently collected are available in internal Oracle databases and online at OBIS-SEAMAP. However, we will probably also need to archive the data at the NCEI and link our data to the other data types (oceanographic, passive acoustic) that were collected on the same survey and will also be archived within NCEI.

V. Proposed Schedule for Implementation

FY24

1. **Element 1 (survey design)**
    a. Collaborate with other researchers to investigate using other platforms (like uncrewed aerial vehicles) that could potentially be used to collect data to estimate population abundance. Evaluate if the methods are viable and when they could be used. Then develop future field and analytical work needed.
    b. Collaborate with researchers with existing or planned future marine mammal and sea turtle dive profile data to estimate availability bias as it changes by important species-specific factors, such as season, latitude, and water temperature. Then develop future work needs.
    c. Investigate the most effective and statistically correct ways to use survey data collected by industry within their wind energy development area in a species-specific, U.S. Atlantic-wide abundance estimate.
2. **Element 2 (develop analyses and protocols):**

a. Continue to compare existing New York's visual and digital line transect data to investigate future analysis methods for digital data and provide insights into future data collection and analysis protocols for digital aerial surveys.
b. Using existing images collected by the NMFS in 2022/2023 and new images from summer 2024, continue to annotate the protected species in the images and then start training an algorithm to identify potential marine mammals, sea turtles, or sea birds in unannotated images. Start investigating false positives and false negative rates.
c. Collaborate with the Atlantic Fisheries Science Center (AFSC) and other science centers on the development of camera systems with new Phase One cameras.
d. Develop post-survey programs to process images.
    i. Develop quality assurance/quality control (QA/QC) procedures to detect animals and identify the species.
    ii. Process location data on images to develop a dataset to be used to estimate abundance.
e. Collaborate with other NMFS science centers to advance uncrewed aerial vehicles that can be used to collect images to estimate absolute abundance estimates

3. Element 3 (calibrate):

a. Conduct summer/fall 2024 aerial survey with the Southeast Fisheries Science Center (SEFSC) and AFSC using the Phase One camera system to collect as many images as possible of as many species as possible to improve the search algorithm. In addition to the camera system collecting images, we will also have a team of visual observers in the same plane to compare the human versus image detection rates, species identification ability, and group size estimates.
b. Start analyses to develop relationships between environmental factors and estimates of human and digital detection rates and group size. Environmental factors include Beaufort sea state and glare.

4. Element 6 (IT):

a. Start working with IT to develop the short- and long-term storage system and the long-term archival system of the massive numbers of images. Start development of the data management system and QA/QC processes. Start development of the data input and dissemination interfaces to the storage and archival systems.

FY25

5. Element 1 (survey design):

a. Continue collaborations on developing other platforms to collect data in WEAs.
b. Continue collaborations with tagging programs to improve estimation of availability bias and the factors that influence the dive patterns.

6. Element 2 (develop analyses and protocols):

a. Continue improving the neural network animal detection algorithm with the additional images, as needed. If possible, develop an algorithm that could be used in the plane while surveying to facilitate data collection and storage of images.
b. From calibration experiment between crewed digital versus human-observed study results: a) improve false positive and false negative estimates from the digital data; b) improve relationships between environmental factors and

estimates of human and digital detection rates and group size; c) expand digital abundance estimation analyses to include false positives and false negative rates and any other bias corrections; d) compare abundance estimates from the digital versus human data collected in calibration experiment.

7. **Element 3 and 5 (calibrate and routine monitoring):**
   a. Conduct calibration experiments using 2 planes that survey the same track lines on the same day. One plane would use current protocols—at 600 feet altitude with 2 independent visual teams—and another plane surveying at 1500 or 2000 feet altitude using 2 teams, 1 human and 1 digital camera system. Assume the plane conducting standard protocols will be paid for by the Atlantic Marine Assessment Program for Protected Species (AMAPPS) funds. Wind funds would pay for the second plane.
   b. Conduct pilot studies to investigate the feasibility of using uncrewed aircraft on a routine basis.

8. **Element 6 (IT):**
   a. Continue to work with IT to develop the storage and archiving of the massive numbers of images.

Beyond FY25

9. **Element 1 (survey design):**
   a. Continue collaborations on developing other platforms to collect data in WEAs.
   b. Continue collaborations with tagging programs to improve estimation of availability bias and the factors that influence the dive patterns.

10. **Element 2 (develop analyses and protocols):**
    a. Consider evaluating the effect of the distance between track lines when conducting digital surveys from an altitude of 1500 feet versus 2000 feet, or other modifications to the survey design.

11. **Element 3 (calibrate):**
    a. Conduct additional visual and digital surveys to calibrate different survey approaches, as needed.
    b. Develop relationships between abundance and distribution and environmental factors, such as water temperature, fish and plankton relative abundance, and distribution patterns.
    c. Conduct calibration studies with uncrewed aircraft with digital cameras as compared to crewed digital aircraft surveys.

12. **Element 5 (monitor):**
    a. Conduct at least 1 aerial abundance survey per year to monitor the distribution and abundance in WEAs using an appropriate platform in all seasons on a yearly rotating basis

13. **Element 6 (IT):**
    a. Continue to work with IT to develop the storage and archiving of the massive numbers of images.

VI. Links to Other Surveys

Other mitigation plans that we should collaborate with include the mitigation plans for EcoMon surveys, marine mammal and sea turtle shipboard surveys, North Atlantic right whale surveys, passive acoustic monitoring, seal surveys, and marine turtle ecology Palkasurveys.

VII. Adaptive Management Considerations/ Opportunities

The strategy of this mitigation plan is to develop the most promising survey methods and platforms that are currently available (that is, crewed planes with human and digital cameras) within the next 2 years. At the same time, advance the ability to conduct the surveys on other platforms (in particular, uncrewed aerial vehicles with digital cameras). At some point, the platform that is most efficient practically and statistically will become the routine methodology.

VIII. Statement of Peer-Review Plans

Standard peer review practices will be followed. That is, progress reports on field activities and papers with abundance estimates and other analyses are reviewed by the Atlantic Scientific Review Group. In addition, papers with abundance estimates and other analyses are reviewed by journals.

IX. Performance Metrics

Our performance metrics can be evaluated by our ability to estimate accurate and precise absolute abundance estimates from all marine mammal species. Another performance metric is how accurately we measure impacts of climate changes and WEA activities prior to, during, and after construction events. This will require sufficient data sampling within the area in order to be able to draw inference that is robust.

X. References

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