Marine Mammal & Sea Turtle Vessel Abundance Survey Mitigation Plan

I. Purpose of the survey

The objectives of the marine mammal and sea turtle vessel (and aerial) abundance and habitat surveys are two-fold: 1) to collect the data needed to accurately and precisely estimate the distribution and absolute abundance of the marine mammals, sea turtles, and sea birds, and 2) to relate the distribution and 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 Aerial Abundance Mitigation Plan.

Shipboard surveys that collect data to estimate the abundance of marine mammals and sea turtles use substantially different approaches than those shipboard surveys that collect information on the ecology of marine mammals and sea turtles, which is described in the Turtle Ecology Survey Mitigation document.

Data collection and standard operating procedures

Currently, the abundance of marine mammals and sea turtles off the U.S. continental shelf (deeper than about the 200 meter [m] depth contour north of Cape Hatteras, NC, and the 100 m depth contour south of Cape Hatteras, NC) is calculated using shipboard line transect data, which will be discussed in this Survey Mitigation document. The rest of the abundance estimates of marine mammals and sea turtles are of the animals on the U.S. Atlantic continental shelf and are calculated using aerial line transect data, which is discussed in the Marine Mammal and Sea Turtle Aerial Abundance Survey Mitigation document.

The marine mammal and sea turtle shipboard abundance surveys collect line transect data using the 2 independent team data collection and analysis methods to estimate abundance that includes a correction for perception bias. Perception bias is due to observers missing an animal group that is available to be seen but was missed due to factors such as poor weather conditions. In addition, externally collected dive profile data are then used to adjust the abundance estimate for availability bias, particularly for deep-diving animals. Together, this results in absolute abundance estimates that are corrected for both perception and availability bias. Details on the standard operating procedures used during shipboard line transect abundance surveys are described in Section II.

The 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 2 of sea turtles. The minimum needed data fields collected during the shipboard surveys include a) information on detected sightings (at time of initial detection, the location of the animal groups relative to the ship’s 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 ship, location of people at each observation station, and concurrent weather and sighting conditions). After the data are collected and checked for accuracy, they are analyzed using distance sampling methods to estimate absolute 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, the 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 level, which is dependent on the abundance point estimate (best estimate), the coefficient of variation of the abundance, and the coefficient of variation of the average bycatch estimate. The value of the Potential Biological Removal 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 Potential Biological Removal level.

Strategic status triggers the development of Take Reduction Teams who are tasked with developing mitigation measures to reduce the level of mortality to a sustainable level. These measures generally modify fishery or other human activities with the goal to reduce the levels of mortality and still allow the fishery or other human activities to be economically viable.

Other scientific advice pathways and data users

The pooled shipboard and aerial abundance estimates and other analyses resulting from the data collected on the shipboard and aerial 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 users' Environmental Impact Statements and in analyses required under the National Environmental Policy Act (NEPA), ESA, and MMPA. For example, wind developers need to indicate how many protected species their activities will interact with.

Formal quality standards

According to the Guidelines for Preparing Stock Assessment Reports Pursuant to the Marine Mammal Protection Act, abundance estimates used in the stock assessments should be absolute abundance estimates, correct for known biases, and be precise. If the coefficient of variation of the abundance estimate is above 0.3, then the Potential Biological Removal level is reduced to account for the uncertainty.

Are there added values that cannot be met without this survey?

Yes. The primary goal of the shipboard abundance surveys is to collect marine mammal and sea turtle data to estimate their distribution, abundance, and trends. However, due to the large sizes and capabilities of the NOAA ships, additional data are collected on the characteristics of the physical and biological environment. In particular, the following data are being collected concurrently that have been used to describe habitat characteristics and

shifts of the marine mammals: collection of data on other species that use the ocean surface or above (seabirds and large fish); data on species that use the water column (vocalizing marine mammals and other species, plankton, and fish); and data on the oceanographic characteristics of the surface and water column (Table 1).

Table 1. Data collected during shipboard marine mammal and sea turtle abundance surveys.

Type of data	How collected	Examples of uses of data
Distribution and abundance of marine mammals and sea turtles	Line transect data collected using high-powered binoculars conducted by marine mammal and sea turtle teams	Palka 2021, 2023; Chavez-Rosales et al. 2019, 2022; Sigourney et al. 2020; Miller et al. 2021; Roberts et al. 2016
Distribution and abundance of large species that come to the surface, such as sharks, ray, and other fish species	Line transect data collected using high-powered binoculars conducted by marine mammal and sea turtle teams	
Distribution and abundance of seabirds	Visual strip transect data collected by seabird team of observers	Winship et al. 2018; White and Veit 2020.
Locations of acoustic detections of vocalizing marine mammals and other species using the water column	Collected using towed passive acoustic hydrophones monitored by a team of passive acoustic monitors	Passive Acoustic Cetacean Map website; Cholewiak et al. 2013, 2017; DeAngelis et al. 2017, 2018
Distribution and abundance of other trophic levels (fish, plankton)	Collected using hull-mounted active acoustic transducers and by deploying continuous visual plankton recorders, bongo nets, mid-water trawls, and other types of nets	Orphanides et al. 2023; Richardson et al. 2016; Quigley et al. (in review); Govindarajan et al. (in review)
Physical oceanographic characteristics of the surface and water column	Collected by hull-mounted sensors and conductivity-temperature-depth deployments	

Other products

In addition to the abundance estimates, the pooled shipboard and aerial marine mammal and sea turtle 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 answer questions like: what are their spatiotemporal distribution patterns, and what physical and biological characteristics are associated with the marine mammals and sea turtles? Examples of results from these sort of analyses include Chavez-Rosales et al. (2019), which shows which physical and biological characteristics are associated with detecting a cetacean species, and Chavez-Rosales et al. (2022), which shows that most cetacean species have been moving northeasterly within the past decade.

The collection of the physical and biological characteristic data have resulted in an increased knowledge of various taxon from the relatively unknown waters that are off the continental shelf. Examples of publications from these other data types are mentioned in the table above. These publications are wide ranging: documenting dive profiles of beaked

whales (DeAngelis et al. 2017, 2018); using active acoustic backscatter data of potential marine mammal prey types to explain the spatiotemporal density patterns of cetaceans (Orphanides et al. 2023); discovering a previously unknown Atlantic bluefin tuna (*Thunnus thynnus*) spawning ground in the Slope Sea (Richardson et al. 2016); using otolith characterizations to integrative species identification of mesopelagic fishes from the western North Atlantic Ocean (Quigley et al. in review); and assessing mesopelagic fish diversity and diel vertical migration with environmental DNA (Govindarajan et al. in review).

How wind developments will impact the survey objectives

Wind energy areas (WEAs) are currently concentrated on the continental shelf; however, the Central Atlantic Call Areas are in offshore waters greater than 1000 m depth. All of these WEAs are currently surveyed by the shipboard marine mammal and sea turtle abundance surveys using the large NOAA ships. Development in these WEAs will result in the exclusion of the large NOAA survey ships. This exclusion will affect the objectives of the shipboard abundance surveys by eliminating all data from the portions of the WEAs that cannot be surveyed by the NOAA survey ships. If the data are not collected in a different way, the lack of the WEA data will reduce the marine mammal and sea turtle abundance estimates, increase the uncertainty in the abundance estimates, and make it impossible to monitor the WEA areas to evaluate the effect of the development within the WEAs.

II. Survey Details

Beginning Year: 1991

Frequency: Before 2012, nearly every year; after 2012, approximately every 5 years.

Season: Mostly summer, with infrequent spring surveys

Geographic Scope: Before 2007, abundance shipboard surveys were mostly north of New York from the shore, throughout Georges Bank, and in the U.S. and Canadian Gulf of Maine (such as the green lines in Figure 1). After 2007, shipboard surveys concentrated on the waters from Massachusetts to Florida (black and blue lines in Figure 1). The shipboard surveys focus on the shelf break and deeper waters (> 100 m depth), although shelf waters in the wind energy areas are also included to estimate abundance and document the physical and biological environment.

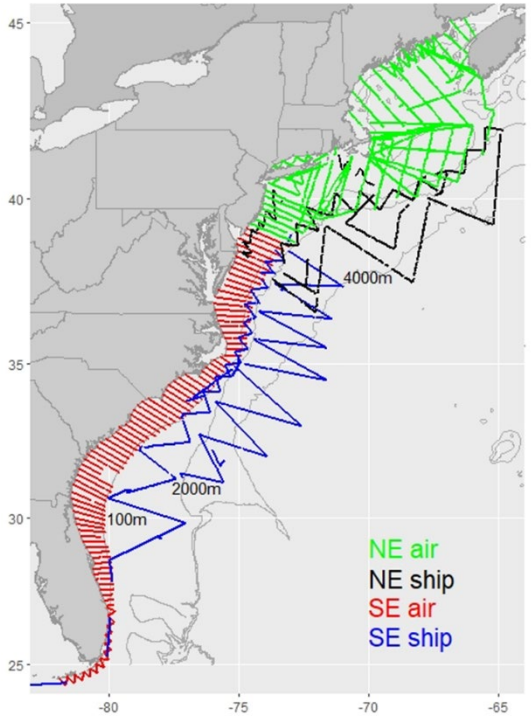

Figure 1. Tracklines completed by ship (blue and black lines) and aircraft (green and red lines) in a typical Atlantic marine mammal and sea turtle abundance survey

Platform(s): Since 2007, NOAA ships have been used, in particular the *Henry B. Bigelow* (black lines in figure above) and *Gordon Gunter* (blue lines in figure above).

Statistical Design: The survey design is pre-specified systematic approximately zig-zag transects, with a random start within a geographic stratum. The track lines are orientated approximately perpendicular to the coastline and across the depth contours. See Figure 1.

Methods: Line transect sampling methods are used to collect and analyze the data. Surveys are conducted at 10 knots on a NOAA ship like the *Henry B. Bigelow*. Marine mammal and sea turtle line transect data are collected by 2 teams of 4 scientists, where the teams are located on the flying bridge and bridge deck. Each team has 2 scientists visually searching with deck-mounted high-powered binoculars (25x150 powered), 1 data recorder, and 1 scientist on rest. Scientists rotate positions every 30 minutes from 0600 to 1800 on good weather days (winds less than 25 knots and visibility greater than 2 nautical miles [nm]). 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 environmental conditions, distance from the ship, or human error). After the data are collected and checked for accuracy, the shipboard data are analyzed using mark-recapture covariate distance sampling techniques to estimate abundance corrected for perception bias. Ancillary dive time pattern data are then used to estimate a correction factor for availability bias (bias due to the animals being unavailable, such as in a deep dive) which is applied to the shipboard perception bias corrected abundance estimates of only the deep divers (like sperm whales and beaked whales; Palka 2021, 2023). Finally, the abundance estimates are reviewed and reported in NMFS Tech Memos and peer-reviewed journal articles then reported in the

Atlantic Marine Mammal Stock Assessment Reports, where the status of each stock is determined.

On the ship, in addition to the above visual line transect data for marine mammals and sea turtles, there are 3 other teams of scientists collecting data. There is 1 team of 2 scientists (1 person on effort during daylight hours, the other at rest) that focuses on collecting strip transect data on seabirds that are used to estimate relative abundance and spatiotemporal habitat-density maps of seabirds (Winship et al. 2018).

There is another team of 2-3 scientists (at least 1 is on effort during daylight hours) that monitor the spatiotemporal vocalizations of cetaceans and other species using a towed hydrophone array. These scientists record cetacean vocalizations that are used to localize vocalizing animals in the 3D water column to document the foraging behavior and dive profiles of species like sperm whales and beaked whales (Cholewiak et al. 2013, 2017; DeAngelis et al. 2017, 2018). The sperm whale vocalizing data have also been used along with the concurrently collected visual sperm whale line transect data to estimate the absolute abundance of sperm whales incorporating availability and perception bias corrections (Sigourney et al. 2023).

There is also another team of 1-3 scientists that collect data on the physical and biological characteristics of the water column. This team collects active acoustic data on the backscatter patterns of planktonic and fish species during the day and night times. They also collect physical characteristics of the water column using flow-through ship-mounted monitoring systems and over-the-side deployed monitoring devices like a conductivity, temperature, and depth (CTD) monitoring device. In addition, this team samples the water column for the spatiotemporal distribution of planktonic life using bongo nets, other sampling nets, and visual plankton recorders, and the distribution of fish populations using mid-water trawls and other similar sampling devices.

III. Effect of Four Impacts

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

   Offshore wind development is focused mostly on the continental shelf; however, the Central Atlantic Call Areas are in offshore waters greater than 1000 m depth. Development in these areas will result in the exclusion of the large NOAA ships.

   Currently, the NMFS shipboard marine mammal and sea turtle abundance surveys focus on waters deeper than 100 m. However, the abundance surveys also survey the continental shelf wind development areas to collect data on marine mammals and sea turtles in addition to collecting the above biological and physical oceanographic data. The effects of not being able to survey with the NOAA white ships within these shelf break and offshore waters are multifaceted and affect multiple species. The effect of no access to these areas include the following:

   1) Abundance estimates of species occupying both shelf and offshore waters (such as bottlenose dolphins, fin whales, and humpback whales) will be less precise because the sample size of detected groups will be smaller and less accurate due to ignoring the animals in the development areas. Without shipboard access to the deep water Central Atlantic Call Areas, the abundance estimates of at least 10

species of cetaceans and 4 sea turtle species will be negatively biased because these Areas have many marine mammals and sea turtles, as has been documented in Palka et al. (2021).

2) We would lose all the concurrently collected biological and physical oceanographic data that are essential to document the physical and biological environment of plankton, fish, squid, etc., and help explain the reasons why the marine mammals and sea turtles are using these waters.

3) We will also not be able to monitor changes during construction and post-construction times that can be compared to the pre-construction conditions that we have already documented and can be compared to the naturally changing distributions of the marine mammals and sea turtles that we have already identified. Thus, there could be confounding reasons for changes in the distribution, abundance, and behavior of the marine mammals and sea turtles that occupy the waters inside the wind development areas.

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.

   An underlying assumption of the line transect methodology is that the regions surveyed are random representations of the habitats that the marine mammals and sea turtles inhabit. With the exclusion of large regions where the ships cannot enter due to the wind energy development, the remaining outside areas that can be surveyed by ship will probably not be representative of the regions inside the wind development areas. Thus, surveys are needed inside and outside of the development areas to determine if the developments directly or indirectly change the distribution and abundance patterns within the 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 biased.

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 are known to modify 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). Development in the 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 mammals and sea turtles.These effects could then 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 (detecting animal groups) if we have to avoid WEAs. The reduction of the number of detected animals will result in lower abundance estimates that are more uncertain, perhaps also implying a false negative population trend. These effects could then 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.

IV. Mitigation Planned, as per Six Elements

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

   The WEAs cannot be surveyed by the NOAA large ships currently being used to estimate the abundance, distribution, and trends of marine mammals and sea turtles and to collect associated physical and biological habit characteristics. Yet there is still a need to accomplish these 2 goals. Thus, we will need to restratify our study area (all U.S. Atlantic waters) to include separate new strata for the WEAs. Then, within the new strata, we will need to use different survey platforms, and possibly different data collection and analysis methods. The goal would then be to integrate results from all strata to estimate coastwide absolute abundance of each marine mammal and sea turtle species and to associate the corresponding spatiotemporal physical and biological habitat characteristics. To accomplish these 2 goals, there are 2 broad options to modify the survey design.

   Option 1:

   Do not survey in the WEAs; instead, develop estimates outside the WEAs then extrapolate the animal density and habitat characteristics estimated from outside the WEAs to inside the WEAs. This option assumes that the surrounding areas are representative of the areas within the WEAs.

   Option 1 could be evaluated using the previously collected data in simulations by removing the data from tracks within the WEAs and reanalyzing the resulting data to see the effect on the population abundance estimate for the entire area and the WEAs. This option is not viable because any changes within the wind development areas due to the development or any other reason cannot be accurately monitored and accounted for in future abundance estimates and other associated studies that use this extrapolation option. Thus, Option 1 will not be discussed further.

   Option 2:

Use an alternative platform hybrid survey design approach. This approach would involve continuing to survey outside the WEAs using traditional shipboard abundance and habitat surveys. In addition, during the same timeframe within the WEAs, use alternative platforms and possibly other data collection and analysis methods to collect the required abundance and habitat data. Within the WEAs, it may not be possible to use the same platform to collect both the abundance and habitat data. In addition, due to safety reasons, the survey design used in WEAs farther from shore off the shelf break could not be conducted using crewed aircraft.

Potential alternative platforms to collect abundance data are:

- NOAA Twin Otters flying above the wind turbines;
- small boats that can safely work in the development areas;
- uncrewed platforms (aircraft and/or surface vehicles);
- bottom-mounted passive acoustics;
- satellite-derived locations of marine mammals and sea turtles; and
- some combination of the above alternative platforms.

Potential alternative platforms to collect habitat data are:

- small boats that can safely work in the development areas;
- uncrewed platforms (surface vehicles);
- sensors attached to wind turbines; and
- some combination of the above alternative platforms.

An example of a possible survey design for a stratified hybrid survey in waters far from shore is during a traditional NOAA ship abundance survey, when at the edge of say the far offshore Central Atlantic Call Areas, the NOAA large ship deploys 1) uncrewed aircraft to collect digital line transect sightings data and 2) uncrewed surface vehicles equipped with digital plankton recorders and water samplers to sample the physical and biological environment, and with a passive acoustic hydrophone to record vocalizing marine mammals that might complement the uncrewed aircraft sightings data.

An example of a possible survey design in WEAs on the continental shelf (nearer to shore) is to conduct a crewed NOAA digital aerial survey over waters inside and outside of the WEAs and at the same time, within the WEAs, use chartered smaller vessels to collect physical and biological habitat data following the protocols developed within the EcoMon Survey Mitigation Plan document.

It is hard to evaluate the effects of the changed survey design in Option 2. Line transect methods are still the most appropriate method to estimate absolute abundance estimates of marine mammals and sea turtles from data collected with a stratified hybrid survey design because line transect methods are appropriate for data collected on different types platforms if the design allows the explicit estimate of platform-specific detection functions, perception bias, and availability bias. To evaluate the effect of using crewed aerial surveys instead of shipboard surveys, we could use previously collected data in an area where both planes and ships surveyed in the same area during the same general time period. During the 2021 shipboard and aerial surveys, both a plane and ship surveyed part of the shelf break and several of the wind development areas on the continental shelf. Exploring these data and the resulting abundance estimates for the 2 platforms could help define the effects of changing the survey design to aerial surveys in the WEAs that could not be surveyed by ships in the future. This might take about 6

months of time for a knowledgeable person to conduct the investigation of the 2 platforms surveying the same waters during the same season.

The number of track lines conducted by any of the platforms would need to be determined to ensure the results are sufficiently accurate and precise abundance estimates. The EcoMon Survey Mitigation Plan document discusses the pros and cons of the alternative platforms to collect habitat data and proposes mitigation strategies; thus, we would follow their recommendations.

There is limited information available on the appropriateness and efficiency to estimate marine mammal and sea turtle absolute abundance using digital aerials, smaller boats, or uncrewed vessels. Thus, the most reliable way to evaluate the survey designs, data collection methods, and data analysis methods is to conduct pilot studies with the alternative platforms to gather abundance and habitat data. Preferably, at least some of the pilot studies would be at the same time a traditional NOAA ship abundance and habitat survey is being conducted to compare the practicability, precision, and accuracy of resulting abundance estimates from the alternative platform.

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

The goal of mitigation efforts for the shipboard abundance and habitat 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; use appropriate sampling data collection and analysis methods; explicitly estimate species-specific and platform-specific detection functions, perception, and availability bias; and collect associated physical and biological habitat data. It is important to explicitly account for the platform-specific 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 also should allow flexibility of pooling results from multiple platforms and survey designs that may be used in different parts of the entire survey area (U.S. Atlantic waters), such as inside and outside of the WEAs.

A potential new survey approach we could use in the WEAs instead of large NOAA ships is to collect the required data from alternative platforms such as NOAA Twin Otters, smaller ships that can safely work in the development areas, uncrewed vessels (either aircraft or ship), bottom-mounted passive acoustics, satellite-derived data, or some combination of the above. Each platform will be discussed below.

Crewed aerial surveys: Within the WEAs closer to shore, crewed aerial surveys would have to fly higher than traditional surveys and therefore collect sightings data with high-definition cameras. This is discussed in detail in the Marine Mammal and Sea Turtle Aerial Surveys Mitigation document and not in this report.

Crewed smaller boats: We do not have enough information to accurately investigate the impact of using smaller boats within the WEAs instead of the NOAA large ships.

Although it is possible, using smaller boats instead of the large NOAA ships to collect the abundance data is not desirable, particularly in the far offshore WEAs. This is because it would require finding small boats that have 2 sighting platforms that are sufficiently high above the surface—preferably over 10 m above the water surface—and could accommodate the deck-mounted high-powered 25x150 binoculars. Lower powered

binoculars could also be investigated, though they are not preferred due to the resulting lower number of sightings. In addition, when surveying offshore waters 100 miles or more offshore, working on small ships would be less safe for the crew. In addition, it would be less efficient due to the limited weather conditions in which surveys could be conducted. This would result in fewer survey hours and detections, which could potentially result in increased bias and uncertainty of the abundance estimates. Of particular concern are species that show low profiles or are found in small groups sizes that will be detected less frequently from lower platforms on small boats.

However, using smaller boats is a viable option to collect the habitat data. See the EcoMon Mitigation Plan for more details that are not repeated here.

Uncrewed aerial and surface/underwater vehicles: The methods to collect and analyze abundance data that are corrected for detectability, perception bias, and availability biases from uncrewed vessels is still in its infancy, so further work includes trialing and developing the survey designs, data collection equipment and procedures, and analysis methods to develop abundance estimates. Using these platforms would involve collecting digital images while the vehicle transverses predefined transect lines. See the Marine Mammal and Sea Turtle Aerial Survey Mitigation Plan document for more on the plan to operationalize the use of digital imagery line transect surveys.

NOAA is currently exploring and improving upon innovative technologies to advance conservation and recovery of protected marine species (ASTER initiative). NMFS recently created a working group to advance the agency's ability to conduct uncrewed long-range aerial flights that require beyond visual line-of-sight so uncrewed systems can safely meet NMFS mission requirements, improve human safety, and augment NOAA's crewed aircraft fleet. These long-range aerial flights would be ideal to conduct abundance surveys for marine mammals and sea turtles within and around WEAs that are on the continental shelf and farther offshore.

Another recently created NMFS working group is advancing the capability to conduct digital surveys on crewed or uncrewed vehicles by improving the camera system technology and the processing of the massive numbers of images expected from these surveys.

In addition, NMFS recently created another working group to advance the technology to conduct uncrewed underwater vehicles that can support various measurement and sampling equipment. These uncrewed underwater vehicles could be used to collect various physical and biological characteristics of the waters at the same time uncrewed aerial surveys are collecting surface data of marine mammals and sea turtles.

As uncrewed vehicles develop into a viable data collection platform, we can conduct pilot studies and calibration experiments to reevaluate this type of platform.

Passive acoustics: Currently, it is not possible to estimate absolute abundance from passive acoustic data collected from bottom-mounted hydrophones. The biggest challenges are how to estimate the detection range of the hydrophone depending on its location, how to identify toothed dolphins, and how to translate the number of species-specific acoustic vocalizations into the number of unique animals of that species, including the non-vocalizing individuals. Several studies have explored ways to deal with these challenges. Thus, future work is needed to continue this research.

Sigouney et al. (2023) developed a new analytical method to use visual and towed hydrophone array data of sperm whales to estimate absolute abundance. This analysis method would be helpful in the future to use visual and towed hydrophone array data collected from uncrewed surface vehicles that are equipped with both cameras and a towed hydrophone.

Members of the NEFSC Protected Species Division are currently collaborating with colleagues who are developing all of these passive acoustic studies so that in the future, passive acoustic monitoring may be used to estimate precise and accurate absolute abundance.

Satellite imagery: The methods to find and identify large whales from satellite imagery are still considered difficult and in their infancy. However, researchers around the globe are now investigating this possibility. Members of the NEFSC Protected Species Division are currently on an Inflation Reduction Act working group to explore remote sensing, including satellite imagery to document the presence of whales. As this research develops, we could design a work plan that may include field and analysis work, pilot studies, and calibration experiments. We will not discuss this option any more in this document.

Summary: For the WEAs on continental shelf waters that are close enough to shore to conduct practical and safe crewed flights, the alternative platform that is currently the most developed to be used in the near future for marine mammal and sea turtle abundance estimates is digital high-altitude crewed aerial surveys. See the Marine Mammal and Sea Turtle Aerial Abundance Survey Mitigation document for more information.

For the WEAs that are too far offshore to conduct safe crewed aerial surveys, we will need to develop one or more of the other above options. The currently most fully developed platforms are using small boats to conduct visual line transect abundance surveys and/or to use uncrewed aircraft to conduct digital line transect abundance surveys.

It is expected that under all these options, the presence of WEAs will result in less precision abundance estimates due to this hybrid multi-platform survey design that would be necessary. The decreased precision in the abundance estimates could then directly affect the reported status of the stocks, which could then affect ocean users such as fishers, Navy, and wind energy manufacturers.

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

The goal is to integrate absolute abundance estimates resulting from different survey platforms and not use a single calibration factor to adjust relative abundance estimates from a new method to make it comparable to the traditional absolute abundance estimates. 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 all U.S. Atlantic waters during that time period. We also need to integrate previous visual observer derived abundance estimates with future abundance estimates derived from other data collection platforms to create a consistent, comparable time series.

We propose to continue to use line transect methods that explicitly incorporate estimation of species-specific and platform-specific detection functions, perception biases, and availability biases. Then, theoretically, we can simply add the different platform-derived absolute abundance estimates from within a single survey time period together, and that will result in abundance estimates comparable to traditional estimates that cover the entire study area (all U.S. Atlantic waters).

See the Marine Mammal and Sea Turtle Aerial Abundance Survey Mitigation Plan document for the work plan for the calibration and integration of digital aerial surveys.

See the EcoMon Survey Mitigation Plan document in regard to the issues related to using smaller boats within the WEAs. Most small boats are more equipped to collect the habitat data and not the abundance data. To collect the abundance data, we will need to design survey tracklines and data collection methods to estimate species- and platform-specific corrections for detection probability, perception bias, and availability bias.

Because the NMFS working groups on uncrewed vehicles and digital surveys are just starting, at this time in the planning for mitigation to marine mammal and sea turtle abundance and habitat surveys, the best way forward is to continue collaborating with these groups and then, in the Fiscal Year 2024 (FY24) and FY25, develop plans and budgets to cover the needed equipment development, field pilot studies and calibration studies, and statistical analyses of the pilot studies.

Since future crewed aerial surveys and uncrewed aerial and surface platforms will all likely collect digital images along a track line, a high priority is to develop the camera, image processing, and analysis methods to estimate species-specific corrections for detection probability, perception bias, and availability bias. After this, we will be able to calibrate and integrate the new data streams into accurate and precise absolute abundance estimates.

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

Because most of the alternative platforms that could be used to collect the needed data inside the WEAs are still in their infancy, the survey methodology for estimation of absolute abundance estimates will have to evolve. In the near future, we may have to use the platforms and methodology that are nearly developed (such as digital aerial surveys and small boat abundance surveys). At the same time, we will continue developing the other platforms and associated data collection/analysis methods. As the new platforms and data collection/analyses mature and become practical, we will then decide the most practical and statistically appropriate ways to estimate precise and accurate absolute abundance estimates of as many species of marine mammals and sea turtles as possible.

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 influences on the ecosystem from wind development impacts. Therefore, consistent long-term indices are key to monitoring and managing effects.

To achieve this long-term monitoring, we need to conduct routine abundance surveys inside and outside of the WEAs for the entire U.S. Atlantic coast using the traditional NOAA ships outside the wind development areas and using alternative platforms within the WEAs.

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

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

Substantial collaboration will be needed to determine the best alternative platform that could provide the absolute abundance estimates and other trophic-level ecological oceanographic data from within the WEAs that will be closed to the large NOAA ships. The major immediate collaborations will be with other parts of the NEFSC and other NMFS science centers that have similar challenges. In addition, we should collaborate with other scientific researchers who do similar work, such as Woods Hole Oceanographic Institution; other researchers around the world who are exploring the use of uncrewed vessels to collect marine mammal and oceanographic data (such as Australian scientists who are investigating the use of uncrewed aerial vehicles to collect line transect marine mammal data); or other researchers who are exploring the development needed to use passive acoustic monitoring data to estimate absolute abundance of cetaceans.

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

New data streams from the other platforms that would be used in the WEAs would depend on the platforms that are chosen. In all cases, the data need to be collected in the field, checked for quality control, processed and analyzed to develop abundance estimates and measures of variability, reviewed, documented and published in peer-reviewed journals, and archived. The raw data and products should then be made available to the public.

See the Marine Mammal and Sea Turtle Aerial Survey Mitigation Plan for discussion on the data management needs of the image data that will be collected due to the mitigation.

The data management needs for the currently collected data on shipboard surveys is sufficient. However, the dissemination and archiving systems need improvements and are discussed in the Marine Mammal and Sea Turtle Aerial Survey Mitigation Plan.

V. Proposed Schedule for Implementation

To mitigate the effects of the loss of abundance data from the continental shelf that are currently collected on the shipboard marine mammal and sea turtle abundance and habitat surveys, the schedule and budget in the Marine Mammal Aerial Survey Mitigation Plan document will also benefit the mitigation for marine mammal and sea turtle shipboard surveys.

To mitigate the effects of the loss of habitat data from the continental shelf that are currently collected simultaneously to the abundance data on the shipboard marine mammal and sea

turtle abundance and habitat surveys, the schedule and budget in the EcoMon Mitigation Plan will also benefit the mitigation for the marine mammal and sea turtle shipboard surveys.

To mitigate the effects of the loss of abundance data from the waters offshore of the continental shelf that are currently collected on the shipboard marine mammal and sea turtle abundance and habitat surveys, uncrewed aerial vehicles collecting digital images from a designed transect survey are probably the most feasible in the near future. In the longer term, other methodologies could be used as their development evolves into practical, efficient data collection and analysis methods for some or all species (such as using passive acoustics for sperm whale estimates).

To mitigate the effects of the loss of data on the physical and biological water column characteristics from the waters offshore of the continental shelf that are currently collected on the shipboard marine mammal and sea turtle abundance and habitat surveys, the most feasible data collection methods to be used in the near future include: crewed small boats, equipping the turbine bases with oceanographic sensors, or uncrewed surface/underwater vehicles.

To implement the mitigation of the lost of the offshore shipboard marine mammal and sea turtle abundance and habitat surveys, the major tasks and activities are:

FY24

1. ***Identification and development of new survey approaches.***
    a. Conduct a comparison investigation of the 2021 shipboard and aerial survey data collected in the same season in the same area to explore the effects of replacing shipboard data with aerial data.
    b. Collaborate with the EcoMon Mitigation Plan to collect the habitat data in far offshore waters.
    c. Using 2016 data, compare the absolute abundance estimates of sperm whales derived from the traditional methods using visual sightings (already available) with the upcoming estimates derived from passive acoustic methods.

2. ***Calibration and integration of new survey approaches.***
    a. Collaborate with the recently created NMFS working groups to advance the capabilities available to NMFS. The 3 working groups are:
        i. developing and improving camera imaging systems that can be used on crewed or uncrewed vehicles, standardizing and automating the associated procedures to process the large number of images that will be collected, and developing the artificial intelligence algorithms to identify target species in the images;
        ii. developing the “beyond visual line-of-sight” aerial uncrewed vehicles and dealing with the regulation issues related to collecting digital images from these platforms; and
        iii. developing the capabilities of uncrewed underwater vehicles that could be used to collect physical and biological ocean characteristics.
    b. Develop a plan and budget to achieve the NEFSC specific goals to mitigate the shipboard and aerial marine mammal and sea turtle abundance and habitat surveys in WEAs.
    c. Develop field studies to trial uncrewed aerial and/or underwater vehicles and compare to traditional data collection methods.

FY25

1. ***Calibration and integration of new survey approaches.***
   a. Follow the implementation plan and budget developed in FY24 that resulted from collaborations with the above 3 working groups.
   b. Initiate trialing uncrewed aerial and/or underwater vehicles in field studies.
   c. Analyze these trial data and compare to traditional methods.

FY26 and beyond

1. Continue developing alternative platforms, trialing new data collection methods, and analyzing these data.

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 surveys.

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 in WEAs on the continental shelf waters and crewed small ships in WEAs offshore of the continental shelf) within the next 2 years. At the same time, we will advance the ability to conduct the surveys on other platforms (in particular, uncrewed aerial vehicles with digital cameras to collect abundance data and uncrewed surface/underwater vehicles to collect habitat data). 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 will be reviewed by the Atlantic Scientific Review Group. In addition, papers with abundance estimates and other analyses will be 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.