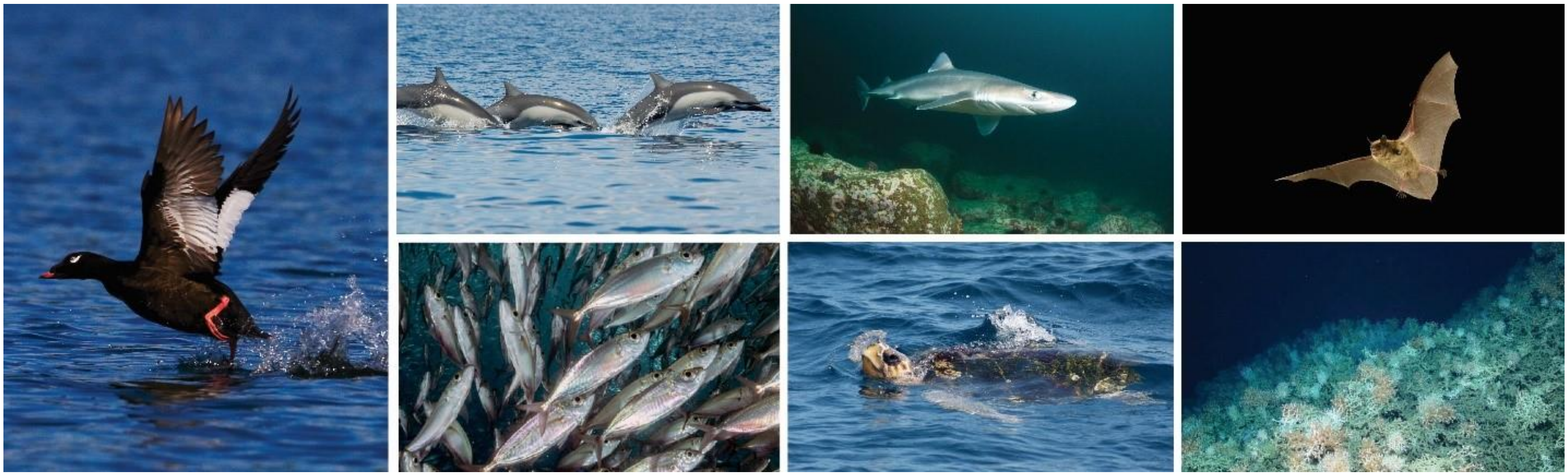

Sea Turtle Workgroup Report

State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts

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Disclaimer

Additional Information

This report is one outcome from a broader effort to review the state of knowledge regarding offshore wind energy development's effects on wildlife and identify short-term research priorities to improve our understanding of cumulative biological impacts as the offshore wind industry develops in the eastern United States. This effort, titled *State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts*, included a week of plenary presentation sessions and contributed talks in November 2020, as well as the formation of six other workgroups similar to the sea turtle workgroup that met over the winter of 2020-2021. This report, and those from the six other workgroups, are available on the workshop website at https://www.nyetwg.com/2020-workgroups.

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Contents

Background

The 2020 State of the Science Workshop, hosted by the New York State Energy Research and Development Authority (NYSERDA), was held virtually from November 16-20, 2020. This workshop brought together over 430 stakeholders engaged with environmental and wildlife research relevant to offshore wind energy development. The aim of the workshop was to assess the state of the knowledge regarding offshore wind development's potential cumulative impacts on wildlife populations and ecosystems. **For this effort, cumulative impacts were defined as interacting or compounding effects across spatiotemporal scales, caused by anthropogenic activities relating to the development and operation of multiple offshore wind energy facilities, that collectively affect wildlife populations or ecosystems** (see call-out box for definitions of "effects" and "impacts").[1] Attendees included a wide range of stakeholders from offshore industry, government agencies, non-profit organizations, and academia. More information can be found at http://nyetwg.com/2020-workshop.

Following the plenary sessions in November, workshop attendees formed seven taxon-specific workgroups focusing on benthos, fishes and mobile invertebrates, birds, bats, marine mammals, sea turtles, and environmental change. Workgroups, under the guidance of lead technical experts, met virtually in late 2020 and early 2021 to identify scientific research, monitoring, and coordination needs to improve our understanding of cumulative impacts from offshore wind energy development. **The goal for each group was to identify a list of studies that could be implemented in the next five years to position the stakeholder community to better understand potential cumulative biological impacts as the offshore wind industry develops in the U.S.**

The intended audience for this report encompasses a range of stakeholders including researchers, state and federal agencies, offshore wind energy developers, regional science entities, and other potential funding entities who could potentially target these priorities for future funding. The priorities identified below should not be interpreted as research that must occur prior to any development activity. Rather, these priorities are intended to further inform environmentally responsible development and minimize cumulative impacts, and many of these research needs are specifically directed at understanding and measuring effects as the industry progresses.

Workgroup members represented a wide range of perspectives from offshore wind developers, the fishing industry, government agencies, non-profit organizations, and academia, and provided key input based on their respective specialties. Workgroup meetings included presentations as well as small and large group discussions to identify and prioritize key topics of interest. Workgroup members also provided input on the relative priority of different topics via live polls during meetings and/or online surveys between meetings. All workgroup documents were shared with workgroup members via a document collaboration platform (e.g., Google Drive, Microsoft Teams), and workgroup members had multiple opportunities over the course of

Defining Impacts vs. Effects (from Hawkins et al. 2020)

Effect: a change caused by an exposure to an anthropogenic activity that is a departure from a prior state, condition, or situation, which is called the "baseline" condition.

Impact: a biologically significant effect that reflects a change whose direction, magnitude and/or duration is sufficient to have consequences for the fitness of individuals or populations.

[1] This effort was focused on better understanding effects specifically from offshore wind energy development. This was not intended to imply that offshore wind is causing greater impacts than other stressors. Cumulative impact estimates for offshore wind energy development will be useful in broader cumulative impact frameworks that include impacts from multiple types of anthropogenic activities.

several months to provide written input on earlier drafts of this report. The report indicates a general agreement among workgroup members, unless otherwise noted; where there was stated disagreement among workgroup members on a recommendation in this report, this disagreement is noted in the text. Despite the substantial input and influence of workgroup members on the workgroup reports, final report contents were determined by the technical leads, in some cases with support from an additional small subgroup of experts within the group. More information about the workgroups can be found at https://www.nyetwg.com/2020-workgroups.

The sea turtle workgroup was led by Gregg Gitschlag (National Oceanic and Atmospheric Administration, retired), with technical and logistical support from Ruth Perry (Shell Renewables and Energy Solutions), Kate Williams, Edward Jenkins, and Julia Gulka (Biodiversity Research Institute) and Ashley Arayas and others (Cadmus Group). The workgroup consisted of 30 workshop attendees (Appendix A), who met virtually twice in the winter and spring of 2020-2021 to discuss research priorities to improve our understanding of cumulative impacts to sea turtles from offshore wind development on the east coast of the U.S.

Introduction and Methods

Five species of sea turtles are present in the eastern U.S. in the vicinity of current offshore wind (OSW) planning areas and active OSW lease areas,[2] including the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and Kemp's ridley (*Lepidochelys kempii*) sea turtles. All are listed as threatened or endangered under the U.S. Endangered Species Act (16 U.S.C. § 1531 et seq.). Sea turtles can be challenging to monitor for a variety of reasons, including their long migrations, wide geographic range, long life spans, and behaviors (including minimal time spent at the surface and lack of vocalizations). Thus, data sharing and coordination is important for understanding these populations. Sea turtle density and species composition differs between the Mid-Atlantic, New York Bight, and New England regions, meaning that focal species and research needs should be tailored for each region.

Very little is known about sea turtle interactions with offshore wind energy developments, as species occurrence is relatively rare in most areas where OSW buildout has occurred to date, particularly in European regions such as the North and Baltic Seas. For example, 40 sea turtle records have been reported in the Netherlands since 1707 (Goverse 2014). However, some data are available from other offshore industries, perhaps most notably in relation to offshore oil and gas exploration and production in the Gulf of Mexico, which can inform our understanding of potential interactions. Studies of sea turtle in relation to Gulf of Mexico oil and gas development have included tagging and tracking for home range analysis in the vicinity of platforms (Renaud and Carpenter 1994), targeted site-specific surveys to inform mitigation (e.g., to avoid exposing turtles to explosive detonations during platform salvage and removal; Gitschlag and Herczeg 1994), and broader-scale aerial surveys to examine species distribution and abundance. There are also numerous anecdotal observations of turtles resting or sleeping under platforms and within platform structures that are open to the sea, as well as feeding at or around platforms. The ongoing broad-scale Gulf of Mexico Marine Assessment Program for Protected Species[3] effort includes a combination of boat-based and aerial surveys, satellite tracking, genetic analyses, and

[2] Marine Cadastre National Viewer https://marinecadastre.gov/nationalviewer/
[3] BOEM Gulf of Mexico Marine Assessment Program for Protected Species https://www.boem.gov/gommapps

species density modeling for a range of taxa, including sea turtles, to better understand their distributions across the Gulf of Mexico.

In addition, numerous government agencies and organizations have conducted or are actively pursuing a variety of sea turtle studies in the Mid-Atlantic, New York Bight, and New England regions, including the Atlantic Marine Assessment Program for Protected Species (AMAPPS)[4] and studies through the New England Aquarium.[5] Although not specifically designed to detect effects from OSW development, this research may provide relevant information on sea turtle populations and/or offer frameworks for potential partnering opportunities (e.g., acoustic tagging/tracking studies that already have receiver stations in place).

Possible short-term effects of OSW development on sea turtles include displacement, behavioral disruption, stress, temporary hearing impairment, vessel interactions, and changes to prey availability. Long-term effects may include changes in the distributions of sea turtles and their prey, changes in vessel traffic, and ecosystem enhancement (i.e., habitat creation via the development of artificial reefs on OSW infrastructure (Gulka and Williams 2019, Kraus et al. 2019). Previously identified knowledge gaps regarding sea turtle interactions with OSW development include distribution and behavior in OSW areas, and sensitivity and response of sea turtles to impulsive sound and electromagnetic fields (EMF; Bonacci-Sullivan 2018).

Building from other recent recommendations for studies of sea turtles and OSW in the U.S. (e.g., Bonacci-Sullivan 2018), the workgroup suggested eight specific short-term priorities that could be initiated in the next five years to improve our understanding of cumulative impacts to sea turtles from OSW development in the eastern U.S. The group also identified three longer-term priorities that were felt to be important, but not feasible to initiate in the next five years. Following development of these topic ideas, workgroup members participated in an online survey (n=14) and ranked the short-term topics in order from highest to lowest priority. Given the goals of this workgroup, members were asked to consider the following criteria when identifying priorities:

- *Urgency of information need.* Objectives should be prioritized that will most effectively improve our understanding of cumulative impacts and inform decision making.
- *Sequencing of objectives*. If the results of Study #1 are needed to inform the design of Study #2, the former should be designated higher priority in the short term.
- *Ability to inform cumulative impact models.* Studies should be prioritized that will improve our ability to model cumulative impacts to populations or ecosystems.
- *Effectiveness at addressing one or more key societal concerns,* as identified through multi-stakeholder engagement processes.

A weighted rank was assigned to each short-term topic based on these survey responses, and the below topics are listed in priority order (e.g., with the highest-priority topic listed first). The first two topics were by far the highest priority recommendations from the workgroup (they were ranked as the top two priorities by 86% and 72% of survey participants, respectively), and address similar gaps in our knowledge of sea turtle distributions, movements, and habitat use. These two topics were identified as being of highest immediate need due in part to the recognized need for sequencing of research studies (e.g., the need to better understand baseline distributions and movements before focusing too much on

[4] NOAA Atlantic Marine Assessment Program for Protected Species (AMAPPS) http://www.fisheries.noaa.gov/new-england-mid-atlantic/population-assessments/atlantic-marine-assessment-program-protected
[5] New England Aquarium https://www.neaq.org/

OSW-related changes); however, workgroup members also indicated that several of the identified short-term priorities in the below list may be addressed concurrently.

For each of the eight topics, information is included on the study goal, potential methods, and existing data and/or related information with relevance to the proposed study, such as other ongoing studies or efforts with which a proposed study should be coordinated.

Short-term Priorities

1. Develop an improved understanding of sea turtle movements, distributions, and habitat use patterns, including changes in habitat use in relation to offshore wind development

Goal: Determine fine-scale patterns of sea turtle movements and habitat use, and possible changes in these patterns over time, in order to better understand potential risk of interactions with OSW facilities and to inform models of abundance and vessel strike risk that require information on dive behavior and other metrics.

Potential methods: Use a combination of tracking and aerial surveys to improve our understanding of sea turtle distribution patterns across finer spatiotemporal scales within OSW lease areas and future lease planning areas. A review of existing data (see Topic #2, below) should inform targeted locations, species, methods, and questions for additional research; however, new studies can and should be initiated prior to completion of the desktop study recommended in #2, as it is already clear where some gaps exist in our knowledge (“Existing data,” below).

- **Aerial surveys:** Sea turtle detections from vessels tend to be challenging. However, both visual and digital aerial survey approaches are proven methods for detecting sea turtles. These methods can further provide valuable information on population abundance and distribution. Regional-scale baseline aerial surveys (e.g., NYSERDA-funded digital aerial surveys of the New York Bight, Department of Energy-funded surveys of the Mid-Atlantic Bight, and Bureau of Ocean Energy Management [BOEM]-funded surveys of the South Atlantic Bight) and OSW site-specific baseline aerial surveys (e.g., Equinor’s surveys of the Empire Wind lease area, among others) have been conducted in recent years, but other areas such as the Gulf of Maine and waters off of New Jersey lack recent aerial data.
- **Tracking:** Deploy large numbers of satellite and acoustic transmitters and acoustic receivers to conduct tracking of sea turtles at various life stages in the U.S Atlantic pre-, during, and post-construction of OSW facilities. Many acoustic arrays already exist for monitoring Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and other marine species in OSW areas that could be taken advantage of to record tagged turtles in the vicinity. Any gaps in the current acoustic array network should be identified and strategically filled. Other platforms for sensors may become available as OSW facilities are built, such as buoys and wind turbine foundations.
    - Ideally, transmitters should include sensors to provide data on vertical movements (i.e., dives) within the water column in addition to horizontal movements.
    - Regional coordination of resources and researchers would help to maximize return on investment. Regional government and academic networks, including the NOAA

    Integrated Ocean Observing System (IOOS) Animal Telemetry Network (ATN)[6], the Mid-Atlantic Acoustic Telemetry Observation System (MATOS)[7], and others could be leveraged to broaden and expand existing scientific and data sharing networks.
  - Species- and life stage-specific sample sizes should be carefully considered *a priori* to direct resources where they are most needed and ensure that resulting datasets are representative of broader populations.
  - Tagging should include and leverage a combination of wild-caught, rehabilitated, and bycaught individuals. There were some differences of opinion among workgroup members on which approach to obtain turtles for tagging should be prioritized. Some workgroup members felt that, while expensive, capture of wild turtles should be prioritized to ensure that their behavior will be representative of the broader wild population. However, free-swimming capture can be difficult for some species and regions. It also can be difficult to obtain permission to attach transmitters to bycaught individuals, especially with illegal bycatch. Some workgroup members with direct experience or current projects felt that tagging rehabilitated individuals, either with satellite transmitters (ideally) or with cheaper acoustic tags that can be detected by ocean observing platforms (such as gliders and buoys, as well as by acoustic arrays), could be a cost-effective way to improve our understanding of turtle movements. According to comparative tracking studies, rehabilitated cold-stunned animals held for short periods appear to act similarly to wild-caught animals following release (Robinson et al. 2020). Thus, a collaborative effort with stranding organizations to deploy transmitters on rehabilitated sea turtles could be one approach to quickly collect additional data and improve our knowledge on sea turtle distributions across the U.S. Atlantic regions, though workgroup members agreed that wild-caught turtles should also be part of any large-scale tagging effort.
  - Acoustic telemetry sensors are already being deployed around OSW lease areas to detect transmitters on certain species such as Atlantic sturgeon (Haulsee et al. 2020). Deployment of additional receivers on equipment already being deployed in the marine environment (for example, on gliders being used to conduct hurricane-related monitoring, IOOS buoys [8], and other platforms of opportunity) could greatly increase opportunities for detection of tagged individuals. However, a considerable number of acoustic receivers will be required to examine movements and habitat use in and around OSW lease areas.

- **Other field methods:** Bonacci-Sullivan (2018) briefly reviewed available methods and their respective strengths. There may also be other innovative technologies available for monitoring sea turtles as the OSW industry develops (e.g., as technologies change, offshore platforms become available for instrumentation). Other approaches for monitoring sea turtles should be explored where feasible.

- **Analysis:** A variety of movement ecology analyses could be used to assess habitat use, distributions, and movement patterns from survey and tracking data. It would be beneficial to examine changes in sea turtle movements and habitat over time – e.g., using pre-existing data to assess whether distributions are changing in relation to climate change – to inform assessments of changes relating to OSW development.

[6] NOAA IOOS Animal Telemetry Network https://atn.ioos.us/
[7] MATOS https://matos.asascience.com/home/about
[8] IOOS buoys https://ioos.noaa.gov/

Existing data: There is a variety of existing tracking data that could be used to inform the choice of new studies (Topic #2, below). For example, some dive data exists from loggerhead and leatherback turtles in the Northeastern U.S. Loggerhead and leatherback satellite tagging has been conducted as part of AMAPPS (NEFSC and SEFSC 2020). Resulting data are being used to develop a correction factor for biased counts caused by undetected diving turtles and to develop estimates of absolute abundance from aerial survey data. A range of other tracking study data are accessible via the ATN. However, gaps in tracking data remain, particularly for green and Kemp's ridley turtles.

In addition to the above satellite telemetry efforts, recent acoustic telemetry efforts for sea turtles have included:

- New England Aquarium and Inspire Environmental have been adding more receivers (beyond those already present for sturgeon) for highly migratory species such as sharks, tunas, and billfish in multiple lease areas in southern New England. Some of this work has been funded by BOEM through Massachusetts Clean Energy Center. There will be 70+ receivers going in this year, with ~50 receivers in the Massachusetts/Rhode Island lease areas and 20+ around Nantucket Island and Nantucket Sound.
- New England Aquarium deployed acoustic tags on leatherback turtles in 2019 and 2020. These tags are attached externally. Preliminary results show efficacy, with over 580 detections on multiple receivers between Massachusetts and Florida.

Related information:

- The New England Aquarium is planning to test implanted acoustic tags in rehabilitated sea turtles. The permit application was submitted to the U.S. Fish and Wildlife Service (USFWS) in early 2020 and the team anticipates starting this work in 2021. Implanting tags will allow for long-term retention and monitoring (5-10 years, depending on transmitter model).
- The National Marine Fisheries Service (NMFS) lists current permits online via the Authorizations and Permits for Protected Species (APPS) system[9] . It takes approximately 6-12 months to obtain a new NMFS permit for tagging research (USFWS are also involved in permits for tagging rehabilitated turtles, in addition to NMFS), so existing permit holders will be able to deploy tags much more quickly than organizations who have not yet been through the permitting process.
- Methodologies to address this objective may in some cases also help to address research priorities identified by other State of the Science Workgroups. For example, visual surveys were also recently identified as an approach to understand baseline distributions of marine mammals (Southall et al. 2021), and acoustic arrays and transmitters were suggested to understand changes in habitat and distributions of fishes(Degraer et al. 2021). Coordinated surveys and data collection networks could potentially help leverage limited resources across taxa.

Timeline: 1-3 years for baseline surveys and deployments to be initiated. Examination of post-construction periods around OSW facilities would require a longer timescale, as would analysis of resulting data. The technology to be deployed should be based on the temporal and geographic scale of interest.

[9] APPS system https://apps.nmfs.noaa.gov/

2. Collate existing tracking and survey data to update density/abundance estimates and characterize baseline habitat use patterns

Goal: Assess existing tracking and survey data across all sea turtle species for the U.S. Atlantic region, identify environmental drivers of distribution and habitat use patterns, update abundance estimates, and determine possible data compilation and modeling approaches for using these data collectively to inform decision making.

Potential methods:

- Desk-based review of available data in Movebank[10], Seaturtle.org[11], Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations[12], ATN, MATOS, and other databases, as well as in the published literature. This review should reach as far back in time as possible to enable examination of temporal trends; most tagging data originates in the 1990s or more recently. However, data from the past five years or so (e.g., indicative of current distributions) should also be considered separately. The review should consider factors such as the types of tag deployed, the types of surveys, and the spatial and temporal resolution of available data, in order to identify potential analytical approaches that could be used to assess exposure to proposed development.
- Survey data is helpful for identifying species presence in an area (especially data from digital aerial surveys; Bonacci-Sullivan 2018), but surveys are a relatively crude tool to assess sea turtle density and abundance, due to how seldom they are at the surface and available to be detected. Boat surveys tend to have particularly poor detection ranges. Survey data should be paired with dive data where possible to develop bias-corrected density estimates.
- Develop distribution models and determine what environmental factors may be affecting sea turtle distribution and habitat use in the area (e.g., topography, oceanographic variables such as temperature, salinity, oxygen, currents).

Existing data:

- Tracking and survey data available on aforementioned sites and sources, as well as in the published literature.
- Maps of monthly loggerhead sea turtle density in southern New England and the Mid-Atlantic[13] based on research by Winton et al. (2018).
- Loggerhead sea turtle habitat use in the Northwest Atlantic and projected shifts due to climate change (Patel et al. 2021).
- Loggerhead density and abundance in Chesapeake Bay and the southern Mid-Atlantic Bight (Barco et al. 2018).

[10] Movebank https://www.movebank.org/cms/movebank-main
[11] Seaturtle.org http://seaturtle.org/
[12] Ocean Biodiversity Information System Spatial Ecological Analysis of Megavertebrate Populations https://seamap.env.duke.edu/
[13] Mid-Atlantic Ocean Data Portal https://portal.midatlanticocean.org/news/maps-show-monthly-distributions-loggerhead-sea-turtles/

- The Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC) have done loggerhead and leatherback tagging as part of AMAPPS (NEFSC and SEFSC 2020) and there is currently a paper in review on dive times and spatiotemporal correction factors.
- New England Aquarium and Inspire Environmental have been adding large numbers of acoustic receivers for telemetry projects on highly migratory species in multiple OSW lease areas in southern New England.

Related information:

- This overarching need has previously been identified at the 2017 New York Bight Sea Turtle Workshop (Bonacci-Sullivan 2018).
- There are several ongoing projects focused on aerial survey data. The U.S. Navy is currently funding the development of density maps for sea turtles using data from a variety of survey efforts as well as environmental and habitat covariates. The NMFS NEFSC has conducted (and is continuing to conduct) similar analyses using aerial survey data from the AMAPPS.
- A similar need has also been identified for other taxa in relation to OSW development, including seabirds (Cook et al. 2021).

Timeline: 1-3 years

3. Assess sea turtle use of offshore wind structures and potential reef effects that may occur with presence of these structures

Goal: Assess the effect of OSW structures on sea turtle foraging and habitat use.

Potential methods:

- Possible techniques for monitoring sea turtle presence at OSW infrastructure include digital aerial surveys, cameras mounted above and/or below structures, and underwater surveys carried out by divers/remotely operated vehicles (ROVs). It is possible that data collected in Topic #1 above (e.g., tracking data) may also be able to help inform this question, although those data will likely be directed towards movements and habitat use on a broader scale.
- Monitoring prey around foundations could be done via sampling of prey species (e.g., trawl, bottom-grabs, eDNA, ROV, drop-cameras), and investigation of consumed prey via direct sampling of sea turtles (e.g., stomach lavage, dietary tracers).

Related information:

- Leatherback turtle diet is well understood from stable isotope analysis (e.g., Dodge et al. 2011).
- The State of the Science workgroup focused on benthos identified multiple research questions related to reef effects (Degraer et al. 2021), such as studies on changes in habitat use by juvenile fishes and invertebrates, the structural and functional ecology of artificial substrata, and trophic interactions and feeding opportunities for fishes and aquatic invertebrates. These potential studies could help to inform our understanding of reef effects on sea turtles. Both the marine mammal and bird State of the Science workgroups (Southall et al. 2021, Cook et al. 2021) also identified questions related to changes in prey resources, and there may be methodologies that could help address these data gaps for multiple taxa.

Timeline: 3-5 years, given OSW construction timelines for current OSW areas (from Massachusetts to North Carolina) and the time it takes artificial reefs to begin forming. Some initial studies could be possible at existing small-scale wind farms (e.g., the Block Island Wind Farm and Coastal Virginia Offshore Wind project) earlier.

4. Examine physiological and behavioral responses of sea turtles to offshore wind-related sound

Goal: Assess the effects of OSW-related sound on sea turtle physiology and behavior.

Potential methods: A behavioral response study (BRS) approach using tagging to investigate sound exposure in the field may be coupled with laboratory experiments (e.g., O'Hara and Wilcox 1990, McCauley et al. 2003, Tyson et al. 2017) to better understand how turtles are affected by sound, both behaviorally and physiologically. Pre-, during, and post-construction assessments are important. We need to expand beyond studies of just the acute stressor (i.e., pile driving) period.

- Studies of physiological responses should include a focus on temporary threshold shifts in hearing as well as stress responses.
- BRS studies tend to be challenging for turtles, since they are more cryptic and harder to follow than whales. As very limited data exist, any behavioral data in response to sound exposure would be informative. One approach could be to incorporate use of an unmanned tracking system with acoustic sensors to help assess sea turtle responses to sound sources. Other options include satellite transmitters and novel archival tags (similar to digital acoustic recordings DTAGs) and other multi-sensor tags that could collect fine-scale acoustic, behavioral, and 3-D movement data (i.e., pitch, roll, heading, depth, video).

Related Information:

- BOEM's Realtime Opportunity Development of Environmental Observations project may be a useful resource on this subject.
- BOEM has funded a new behavioral response study to help fill some of the gaps in our understanding. Additional studies will be needed.
- Brandon Southall et al. have been developing smaller-scale BRS study approaches for marine mammals to obtain data on both received sounds and animal movements; it may be possible to conduct similar studies with sea turtles.
- Behavioral and physiological responses to OSW sound exposure were also recently identified as topics of interest for marine mammals (Southall et al. 2021) and fishes and aquatic invertebrates (Popper et al. 2021). In particular, behavioral response studies were a key methodology identified across these workgroups to examine this question for various taxa.

Timeline: 1-3 years for laboratory studies; 2-5 years for field BRS studies

5. Improve scientific understanding of sea turtle hearing and morphology

Goal: Examine whether sea turtles use particle motion to detect sound, and further explore turtle hearing capabilities and morphology for species and life history stages for which there are gaps in our knowledge.

Potential Methods: In order to inform the development and application of appropriate sound exposure criteria for sound pressure and particle motion, develop behavioral audiograms and/or examine auditory evoked potential (AEP) responses (e.g., Martin et al. 2012, Lavender et al. 2014, Piniak et al. 2016) for species and life history stages for which there are gaps in our knowledge and examine sea turtle detection of particle motion.

Related Information:

- Available data suggest that sea turtles have a relatively narrow range of hearing sensitivity focused on lower frequencies, with some variability by age and species (Martin et al. 2012, Lavender et al. 2014, Piniak et al. 2016, Ketten and Bartol 2005). This range suggests that sea turtles can hear a range of anthropogenic sounds, such as seismic airguns and pile driving (Dow Piniak et al. 2012).
- There is some existing information on turtle hearing (AEP studies) for examining overlap in their hearing capabilities with the sound frequencies emitted by geophysical sources such as airguns, as well as some modeling and characterization of sea turtle hearing structures (Ketten 2008, Willis 2016). New data on sea turtle hearing have been developed in the last decade (e.g., Martin et al. 2012, Lavender et al. 2014, Piniak et al. 2016), but gaps remain.
- BOEM has funded a hearing study to help fill some of these gaps (studies still in development).
- The U.S. Navy funds research on hearing measurements and modeling, so it would be helpful prior to initiating any new work to approach the Office of Naval Research, Living Marine Resources Program, and other Navy funding mechanisms to avoid any potential duplication.
- The process of obtaining permits to conduct this type of research will take time (similar to tagging studies described above); collaboration with organizations and researchers that have already been authorized would maximize efficiency and allow projects to be completed on the suggested timeline.
- Knowledge of hearing capabilities is limited for multiple taxa, including fishes and aquatic invertebrates, which complicates our ability to predict OSW impacts (Popper et al. 2021).

Timeline: 1-3 years

6. Assess potential vessel strike risk posed to sea turtles from offshore wind development

Goal: Evaluate threat of mortality/injury from vessel strikes associated with OSW activities and identify spatiotemporal patterns of risk to inform potential mitigation approaches.

Potential methods: This topic is focused on the integration of data on vessel patterns with data on sea turtle habitat use patterns from Topics #1-2, above. The objectives would be to 1) identify possible high-risk areas for collisions (important habitats and prey aggregation areas, areas with higher density/abundance of sea turtles, and/or areas with higher densities of vessels, particularly larger vessels moving at higher speeds), and 2) model and measure changes in vessel patterns both associated with and not related to OSW activities. Evaluations of vessel strike risk could become a more extensive effort because of the need to consider non-OSW activities and how these are affected by OSW development in areas with current vessel traffic (e.g., changes in fishing effort, traffic patterns in relation to collision risk).

- **Vessel activity:** Use Automatic Identification System data and other available data on vessel traffic, including vessel traffic specifically related to OSW (in relation to specific ports, for example).

- **Turtle distributions and habitat use patterns:**
    - This effort should be integrated, where possible, with above Topics #1-2, focused on collating existing survey and tracking data and collecting new data on sea turtle habitat use patterns. However, tracking data focused on dive behavior (to understand how much time sea turtles spend at or near the surface, diel patterns, etc.) will be particularly important for identifying the potential for vessel interactions. Not all tags collect this type of data, and there are study design tradeoffs that must be considered. New tagging efforts specifically focused on these questions may be needed for some species, life history stages, and locations.
    - Data from existing tracking efforts should also be used (including those by the NEFSC and others, as listed in the APPS system, as well as datasets in the ATN and other publicly available databases).

- **Patterns of stranding and mortality.** Existing stranding/mortality spatial data from groups working with stranded sea turtles are available through the NMFS Sea Turtle and Stranding Salvage Network[14] strandings/mortality database. In the case of unpublished data, it would be useful to identify geographic constraints for areas of interest and then query groups for data from those areas. Additional support for stranding response, carcass recovery, and necropsies may be needed to document potential vessel interactions in the vicinity of OSW lease areas and related vessel traffic.

Related Information:

- Effect of vessel speed on collision risk for green turtles (Hazel et al. 2007)

- Rate of mortality due to vessel strikes for loggerhead, green, Kemp's ridley, leatherback and hawksbill turtles in Florida (Foley et al. 2019).

- BOEM recently funded a modeling study to assess risk of interactions between large whales and OSW-related vessel traffic on the Atlantic Outer Continental Shelf[15] (Barkaszi et al. 2020, Malhotra et al. 2021), which will provide better information on the distribution and behavior of vessels during OSW-related operations.

- The State of the Science workgroup focused on marine mammals developed research objectives related to assessing changes in vessel traffic due to OSW development as well as evaluating relative threat of injury/mortality from vessel strikes (Southall et al. 2021). There is particular overlap with data gaps for sea turtles in relation to understanding vessel activity patterns and potential methodologies for examining habitat use patterns as they relate to risk.

Timeline: 3-5 years

[14] Sea Turtle Stranding and Salvage Network https://www.fisheries.noaa.gov/national/marine-life-distress/sea-turtle-stranding-and-salvage-network

[15] Vessel Risk Calculator Program https://www.boem.gov/environment/vessel-risk-calculator-16-setup-105-ocs2021-035

7. Assess risk to sea turtles from entanglement with fishing gear

Goal: Evaluate the potential risk posed to sea turtles from the interaction of OSW development with commercial and recreational fishing. This could broadly include fishing gear that is being actively used, e.g., gear being used in new locations (such as in the vicinity of turbine foundations) or different types of gear used within OSW areas (and other types of industries that may coincide with OSW development, i.e., aquaculture), as well as possible aggregation of existing ghost gear that could entangle OSW structures.

Potential Methods:

- Develop a conceptual framework to assess how to study the issue at different spatiotemporal scales, preferably integrated across organizations including BOEM, NMFS offices, various states engaged in ghost gear recovery programs, the Responsible Offshore Science Alliance, the Responsible Offshore Development Alliance, and recreational fishing organizations, as well as OSW developers. A common framework is needed for both marine mammals and sea turtles.
- Quantification of recreational fishing activity in OSW areas.
- Possible monitoring techniques to 1) inform estimates of the amount of fishing gear that becomes entangled on OSW structures and could pose an entanglement risk, and 2) understand frequency of ghost gear interactions include cameras mounted above and/or below structures and underwater surveys carried out by divers/ROVs.

Related information:

- Previous BOEM studies on ghost gear entanglement are available for different structure types in the Gulf of Mexico and offshore California.
- Some states have ghost gear recovery programs. For example, the Center for Coastal Studies in Massachusetts has a ghost gear removal project funded by the National Fish and Wildlife Foundation that's been ongoing for at least eight years, mostly focused on Cape Cod Bay.
- Interactions have been observed between recreational fishers and Kemp's ridley sea turtles at artificial reefs (e.g., fishing piers) in Mississippi and Alabama (Lyn et al. 2010, Coleman et al. 2016).
- Trauma and treatment of Kemp's ridley sea turtles caught on hook-and-line by recreational fishers in Texas, including in the vicinity of fishing piers (Byles and Fernandez 1998).
- Entanglement with derelict fishing gear on OSW structures has also recently been identified as a potential concern for pinnipeds (Southall et al. 2021).

Timeline: 3-5 years. Focus on current OSW areas (Massachusetts to North Carolina) with expected construction in next 5 years.

8. Examine sea turtle behavioral responses to electromagnetic fields (EMF) generated by offshore wind infrastructure

Goal: Assess the potential effects of OSW-related EMF on sea turtle movements and behavior.

Potential methods: Acoustic tagging combined with receiver arrays in close proximity to cable locations to compare movements pre- and post-installation[16], ideally for multiple species. Other types of tags that can provide more detailed movement data might also be useful, though probably will only be feasible at smaller sample sizes due to cost. The cable burial depth is important, so responses need to be examined in relation to the cable burial depths being used.

Existing data: Several species of sea turtles are known to be magnetosensitive, and it is generally assumed that all species present in the U.S. are similarly sensitive to magnetic fields. Existing data suggest that sea turtles are able to detect magnetic fields from undersea cables up to a range of several dozen meters (Normandeau et al. 2012). It has been suggested that EMF from OSW cables could affect sea turtle navigational behaviors when they come within range of these fields, perhaps particularly for hatchlings navigating away from nesting beaches at night (e.g., without visual cues) that may rely more heavily than adults on geomagnetic cues for migration (Normandeau et al. 2012). For adult and juvenile turtles, exposure to magnetic fields from subsea cables are generally expected to produce no more than minor deviations from their intended routes, but the importance of the geomagnetic sense for navigation may vary by migration stage, and there is limited available data (Normandeau et al. 2012).

Related information:

- Sea turtles use EMF for calibration, navigation, and natal beach homing. Sea turtles in the vicinity of shielded subsea cables may be able to detect small changes in EMF. However, there are no definitive studies on resulting effects. The lack of information on EMF effects on marine species, including sea turtles, is a common issue that arises during OSW environmental permitting processes.
- EMF could affect sea turtle prey, as well as sea turtles themselves; the potential response of species to OSW-related EMF was also identified as a research topic by the State of the Science benthos workgroup (Degraer et al. 2021).

Timeline: 2-5 years

Longer-term Priorities

Examination of the distributions of prey species at regional and site-specific scales, including time series sampling around turbine foundations

Prey studies are important for understanding potential shifts in sea turtle habitat use in relation to OSW development, climate change, and other factors; however, the workgroup judged this to be a lower immediate need than the other studies listed above, in part because this effort may require multiple intermediate steps over longer time periods to complete, and/or we may not have adequate methods to meet identified needs at the current time. For example, jellyfish (a key prey item for leatherback turtle) distribution data currently do not exist, only modeled proxies.

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[16] Some workgroup members noted potential concerns about audibility of acoustic tags to animals carrying the tags. Other workgroup members noted that acoustic tags are 69 KHz, and thus are above sea turtles' hearing range (as well as the hearing range of sharks, which are key predators of sea turtles), and that several hundred such tags were deployed by the New England Aquarium in the last year without any problems. It was noted that tag audibility may be a concern for some fishes, however, as well as potentially for implanted acoustic tags.

Comparison of detection probability for sea turtles in digital aerial surveys vs. traditional visual aerial surveys to inform integration of different survey datasets and improve distribution models

Some evidence suggests that sea turtles may be more easily detectable in digital aerial survey imagery than in visual aerial surveys, perhaps due in part to the angle at which imagery is recorded and reduced glare. However, a comprehensive analysis of this question to inform integration of visual and digital aerial surveys datasets has not yet been completed. This effort could also feed into Topic #2, above.

Compile unpublished datasets

Many smaller groups (typically those involved with strandings and rehabilitations) have spatial datasets that are not published or widely available. It could be helpful to compile available data on stranding locations, movement studies, etc. from smaller groups that have unpublished/unavailable data.

Conclusions

Multiple approaches will be required to understand the cumulative impacts of OSW development on sea turtles. There are substantial spatial and temporal data gaps in our understanding of sea turtle populations and distributions in wind energy areas, as well as our understanding of the potential effects to sea turtles posed by OSW development. Generally speaking, workgroup members prioritized research to fill gaps in baseline data on sea turtle distributions, abundance, habitat use, and movements above stressor-specific investigations of effects to turtles, such as artificial reef effects, entanglement, vessel strike, or EMF. This included an emphasis on understanding the environmental drivers of sea turtle presence and movements. This prioritization of baseline data is, in part, due to a recognition of the need for sequencing of priorities and the current status of OSW development in the U.S. However, a focus is also needed in the immediate term (e.g., within the next five years) on improving our understanding of the potential effects of OSW on sea turtles as development proceeds, including the above-listed stressors as well as potential effects from cabling landfall near sea turtle nesting beaches. Substantial information is available from research and mitigation efforts relating to the offshore oil and gas industry in the Gulf of Mexico, which may help inform these studies.

Literature Cited

Barco, S.G., M.L. Burt, R.A. DiGiovanni Jr, W.M. Swingle, and A.S. Willard. 2018. Loggerhead turtle *Caretta caretta* density and abundance in Chesapeake Bay and the temperate ocean waters of the southern portion of the Mid-Atlantic Bight. Endangered Species Research 37:269-287.

Barkaszi, M.J., M. Fonseca, T. Foster, A. Malhotra, and K. Olsen. 2021. Risk assessment to model encounter rates between large whales and vessel traffic from offshore wind energy on the Atlantic OCS. OCS Study BOEM 2021-034. U.S. Department of the Interior, Bureau of Ocean Energy Management. Sterling, Virginia. 54 pp. Available at: https://espis.boem.gov/final%20reports/BOEM_2021-034.pdf

Bonacci-Sullivan, L. 2018. Summary report of the New York Bight sea turtle workshop. New York State Department of Environmental Conservation. East Setauket, New York. 23 pp. Available at: https://www.dec.ny.gov/docs/fish_marine_pdf/dmrturtlereport.pdf.

Byles, R. and Y. Fernandez (Compilers). 1998. Proceedings of the sixteenth annual symposium on sea turtle biology and conservation. NOAA Technical Memorandum NMFS-SEFSC-412. 158 pp. Available at: https://repository.library.noaa.gov/view/noaa/3051

Coleman, A.T., E.E. Pulls, J.L. Pitchford, K. Crocker, A.J. Heaton, A.M. Carron, W. Hatchett, D. Shannon, F. Austin, M. Dalton, C.L. Clemons-Chevis, and M. Solangi. 2016. Population ecology and rehabilitation of incidentally captured Kemp's ridley sea turtles (*Lepidochelys kempii*) in the Mississippi Sound, USA. Herpetological Conservation and Biology 11(1):253-264.

Cook, A., K.A. Williams, E. Jenkins, J. Gulka, and J. Liner. 2021. Bird Workgroup Report for the State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts. Report to the New York State Energy Research and Development Authority (NYSERDA). Albany, NY. 37 pp. Available at https://www.nyetwg.com/2020-workgroups.

Degraer, S., Z.L. Hutchison, C. LoBue, K.A. Williams, J. Gulka, and E. Jenkins. 2021. Benthos Workgroup Report for the State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts. Report to the New York State Energy Research and Development Authority (NYSERDA). Albany, NY. 45 pp. Available at http://www.nyetwg.com/2020-workgroups.

Dodge, K.L., J.M. Logan, M.E. Lutcavage. 2011. Foraging ecology of leatherback sea turtles in the Western North Atlantic determined through multi-tissue stable isotope analyses. Marine Biology 158:2813–2824.

Dow Piniak, W E., S.A. Eckert, C.A. Harms, and E.M. Stringer. 2012. Underwater hearing sensitivity of the leatherback sea turtle (*Dermochelys coriacea*): Assessing the potential effect of anthropogenic noise. OCS Study BOEM 2012-01156. Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. 35pp. Available at: https://www.cbd.int/doc/meetings/mar/mcbem-2014-01/other/mcbem-2014-01-submission-boem-05-en.pdf.

Foley, A.M., B.A. Stacy, R.F. Hardy, C.P. Shea, K.E. Minch, and B.A. Schroeder. 2019. Characterizing watercraft-related mortality of sea turtles in Florida. The Journal of Wildlife Management 83(5)1057-1072.

Gitschlag, G.R., and B.A. Herczeg. 1994. Sea turtle observations at explosive removals of energy structures. Marine Fisheries Review 56(2): 1-8.

Goverse, E, M. Janse, H. Zwartepoorte, P. McLean, P. Bonnet, A. Oosterbaan, M. Hilterman, and E. Dondorp. 2014. Notes on sea turtles from the Netherlands: An overview 1707-2013. Marine Turtle Newsletter 141:3-7.

Gulka, J.G, and K.A. Williams. 2019. The state of the science on wildlife and offshore wind energy development: Proceedings for a workshop held November 13-14, 2018, in Woodbury, New York. Report to the New York State Energy Research and Development Authority, Albany NY. 84 pp. Available at: https://www.nyetwg.com/past-workshops.

Haulsee, D.E., D.A. Fox, and M.J. Oliver. 2020. Occurrence of commercially important and endangered fishes in Delaware wind energy areas using acoustic telemetry. OCS Study BOEM 2020-020. Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Lewes, DE. 80 pp. Available at: https://espis.boem.gov/final%20reports/BOEM_2020-020.pdf.

Hawkins, A.D., C. Johnson, and A.N. Popper. 2020. How to set sound exposure criteria for fishes. The Journal of the Acoustical Society of America 147: 1762-1777.

Hazel, J., I.R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed collision risk for the green turtle *Chelonia mydas*. Endangered Species Research 3:105-113.

Ketten, D.R. 2008. Underwater ears and the physiology of impacts: Comparative liability for hearing loss in sea turtles, birds, and mammals. Bioacoustics 17:1-3, 312-315.

Ketten, D.R., and S.M. Bartol. 2005. Functional measures of sea turtle hearing. ONR Award No: N00014-02-1-0510. Report by Woods Hole Oceanographic Institute to the Office of Naval Research, Boston MA. 5 pp. Available at: https://apps.dtic.mil/sti/citations/ADA446809.

Kraus, S.D., R.D. Kenney, and L. Thomas. 2019. A framework for studying the effects of offshore wind development on marine mammals and turtles. Report to the Massachusetts Clean Energy Center and the Bureau of Ocean Energy Management. 48 pp. Available at: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/A-Framework-for-Studying-the-Effects.pdf

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach. Journal of Experimental Biology 217(14): 2580–2589.

Lyn, H., A. Coleman, M. Broadway, J. Klaus, S. Finerty, D. Shannon, and M. Solangi. 2012. Displacement and site fidelity of rehabilitated immature Kemp's ridley sea turtles (*Lepidochelys kempii*). Marine Turtle Newsletter 135:10-13.

Malhotra, A., M. Fonseca, M.J. Barkaszi, and K. Olsen. 2021. Vessel risk calculator: Graphical user interface user's manual. OCS Study BOEM 2021-035 Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, VA. 46 pp. Available at: https://espis.boem.gov/final%20reports/BOEM_2021-035.pdf

Martin, K.J., S.C. Alessi., J.C. Gaspard., A.D. Tucker., G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the Loggerhead Sea Turtle (*Caretta caretta*): A comparison of behavioral and auditory evoked potential audiograms. Journal of Experimental Biology 215:3001-3009.

McCauley, R., J. Fewtrell, A. Duncan, C. Jenner, M.-N. Jenner, J. Penrose, R. Prince, A. Adhitya, J. Murdoch, and K. McKabe. 2003. Marine seismic surveys: analysis and propagation of air-gun signals; and effects of exposure on humpback whales, sea turtles, fishes and squid. Report R99-15. Report to the Australian Petroleum Production Exploration Association. 198 pp. Available at: https://espace.curtin.edu.au/handle/20.500.11937/80319.

Normandeau, E., T. Tricas, and A. Gill. 2011. Effects of EMFs from undersea power cables on elasmobranchs and other marine species. OCS Study BOEMRE 2011-09. Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Camarillo, CA. 426 pp. Available at: https://espis.boem.gov/final%20reports/5115.pdf.

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2020. 2019 annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the western North Atlantic Ocean – AMAPPS II. NOAA Tech. Rep. 26467. 112 pp. Available at: https://doi.org/10.25923/v2pq-ht50.

O'Hara, J., and R. Wilcox 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. Copeia 1990(2): 564-567.

Patel, S.H., M.V. Winton, J.M. Hatch, H.L Haas, V.S. Saba, G. Fay, and R.J. Smolowitz. 2021. Projected shifts in loggerhead sea turtle thermal habitat in the Northwest Atlantic Ocean due to climate change. Scientific Reports 11: 8850.

Piniak, W.E.D., D.A. Mann., C.A. Harms., T.T. Jones, and S.A. Eckert. 2016. Hearing in the juvenile Green Sea Turtle (*Chelonia mydas*): A comparison of underwater and aerial hearing using auditory evoked potentials. PLoS ONE 11(10): e0159711.

Popper, A.N., L. Hice-Dunton, K.A. Williams, and E. Jenkins. 2021. Workgroup Report on Sound and Vibration Effects on Fishes and Aquatic Invertebrates for the State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts. Report to the New York State Energy Research and Development Authority (NYSERDA). Albany, NY. 20 pp. Available at https://www.nyetwg.com/2020-workgroups.

Renaud, M.L., and J.A. Carpenter. 1994. Movements and submergence patterns of loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through satellite telemetry. Bulletin of Marine Science 55(1):1–15.

Robinson, N. J., K. Deguzman, L. Bonacci-Sullivan., R.A. DiGiovanni Jr, and T. Pinou. 2020. Rehabilitated sea turtles tend to resume typical migratory behaviors: satellite tracking juvenile loggerhead, green and Kemp's ridley turtles in the northeastern USA. Endangered Species Research 43:133-143.

Southall, B., L. Morse, K.A. Williams, and E. Jenkins. 2021. Marine Mammals Workgroup Report for the State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts. Report to the New York State Energy Research and Development Authority (NYSERDA). Albany, NY. 50 pp. Available at https://www.nyetwg.com/2020-workgroups.

Tyson, R.B., W.E.D. Piniak, C. Domit, D. Mann, M. Hall, D.P. Nowacek, and M.M.P.B. Fuentes. 2017. Novel bio-logging tool for studying fine-scale behaviors of marine turtles in response to sound. Frontiers in Marine Science 4:219.

Willis, K.L. 2016. Underwater hearing in turtles. In: Popper A., Hawkins A. (eds) The effects of noise on aquatic life II. Advances in experimental medicine and biology 875:1229-1235. Springer, New York, NY.

Winton, M. V., G. Fay., H.L. Haas., M. Arendt., S. Barco., M. James., C. Sasso, and R.J. Smolowitz. 2018. Estimating the distribution and relative density of satellite-tagged loggerhead sea turtles using geostatistical mixed effects models. Marine Ecology Progress Series 586:217-232.

Appendix A. Workgroup Collaborators

Table A1. Collaborators who attended meetings and/or provided feedback on the report (listed in alphabetical order by first name).

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