Title: Harbor seal satellite tagging and health assessment in southern New Jersey: Implications for local and regional population patterns

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Problem Statement / Needs Assessment

Harbor seals (*Phoca vitulina concolor*) commonly occur in coastal areas along much of the northeastern United States (Gilbert et al. 2005, Waring et al. 2015). While harbor seals are most abundant from the east Canadian Arctic to northern New England waters (Jacobs and Terhune 2000), the population extends into the mid-Atlantic with sighting reports as far south as North Carolina (Waring et al. 2015.)

Great Bay, New Jersey is a consistently abundant harbor seal seasonal haul-out along the Atlantic coast (up to 350 individuals) (Fig. 1), with most animals observed from approximately October-April (Slocum 2009, Waring et al. 2006, Toth et al. 2018, Toth et al. 2022, Toth personal obs.). This serves as an important resting and foraging area for these highly mobile animals as they carry out seasonal movements throughout the region.

While these seasonal haul-out and migration patterns are well-established, the offshore movement patterns of harbor seals utilizing Great Bay as they overwinter are not known. As the installation, operation, and maintenance of offshore wind farms becomes a consistent variable in New Jersey, questions remain regarding the level of impact these practices have on proximate marine mammal populations.

The purpose of this study is to better understand movement patterns of harbor seals both locally (New Jersey) and regionally (northwest Atlantic), as well as identify variability of harbor seal health throughout this region. Because multiple wind-farm lease areas are within proximity of the harbor seal haul-out site in Great Bay NJ, it is important to gather both fine-scale and regional-scale data on current population dynamics of the animals that utilize this haul-out site. Potential impact of offshore wind development stages (installation, operation) can be more accurately assessed with current and comprehensive movement behavior, distribution, and health data on these harbor seals.

The proposed project would add Stockton University to the current partnership between Atlantic Marine Conservation Society, Northeast Fisheries Science Center, Naval Undersea Warfare Center in RI, Naval Facilities Engineering Systems Command, Marine Mammals of Maine, The Runstadler Lab at Tufts University and Orsted.

Background

Anecdotally, it appears that both Harbor seal (*P. vitulina*) and Gray seal (*Halichoerus grypus*), distribution, and abundance are changing throughout the northwest Atlantic Ocean. These species are extending their ranges and have been recolonizing previously common haul-out sites throughout southern New England (Wood et al. 2011, den Heyer et al. 2020). Research currently ongoing in Rhode Island, Connecticut and the New York Bight suggest the same trends are occurring in this region as well (Robert A. DiGiovanni, Jr., personal comm., Toth et al. 2018, Toth et al. 2022).

These changes have brought on perceived conflict between seal populations and human ocean uses. Without current data on harbor seal movements and seasonal changes in occurrence and abundance, these potential conflicts cannot be mitigated effectively. In recent years, through projects led by Robert A. DiGiovanni, Jr. (authorized under the Northeast Fisheries Science Center's MMPA research permit), over 30 pinnipeds were satellite tagged at various haul-out sites from Maine through Virginia. Tracking data from these tags show that there are large-scale movements through this region (www.amseas.org, 2022). For example, animals tagged in the New York Bight traveled to Delaware Bay, the Gulf of Maine and off the coast of Canada; distances of hundreds of miles from original tagging locations. Satellite tracking of harbor seals can provide a wealth of information on habitat use and movement patterns for these highly migratory animals that utilize both local and large-scale geographic areas. Understanding these habitat-use and movement patterns is critical to inform offshore energy development projects.

Seasonal movement patterns and overwintering time frames seem to be shifting, with seals arriving earlier and staying later than previously understood (R. DiGiovanni, Jr. personal obs., Toth personal obs., Toth et al. 2022). In addition, recent work from satellite tagged animals and opportunistic surveys suggest that seal haul-out patterns may be spatially variable and population-specific (R. DiGiovanni, Jr., personal comm., Toth personal obs.). These changes have not been formally documented in the last decade, making it difficult to assess potential impact on seal populations from large-scale near-shore and offshore development.

Historically, seals were predicted to migrate to southern New England, New York, and New Jersey waters in late November and move out of these waters around the eastern portion of Long Island by May. Recent opportunistic and systematic surveys have documented spatial and temporal shifts in population dynamics. Seals are found in these waters regularly from September through May, with some animals being documented in New York waters year-round. Since the mid-2000's, pinniped populations utilizing New York Bight waters are experiencing an overall increase. For example, during ten aerial surveys conducted in lower New York by Robert A. DiGiovanni, Jr. in 2003-2004, an average of 15 harbor seals (*P. vitulina*) were observed at the Shinnecock Bay, New York haul-out site, with a maximum sighting of 60 seals during one flight (R. DiGiovanni, Jr., personal comm.). By 2010, 50-100 seals could be observed at Moriches and Shinnecock Bay haul-out sites. During a boat survey of Shinnecock Bay in March 2021, approximately 164 harbor seals (*P. vitulina*) were observed at the haul-out site. Similarly, a 10-year study in Great Bay, NJ estimated a maximum of 250 seals overwintering in the Great Bay in 2011 (Toth et al. 2018), while 350 seals were documented by a Stockton/Orsted remote camera system installed in Great Bay in

February of 2022 (Fig. 2, Toth personal obs., Toth et al. 2022). While this remote camera system is an excellent tool for fine-scale monitoring of abundance and behavioral patterns within Great Bay, it cannot assess behavioral patterns of these animals when they are not hauled out within the estuary. The proposed survey adds invaluable data for a comprehensive understanding of both inshore and offshore population dynamics of these harbor seals.

Figure 1. (Left) TrueLook remote camera system monitoring the Great Bay harbor seal haul-out, and (Right) photo of hauled-out harbor seals February 22, 2022.

The Bureau of Ocean Energy Management (BOEM) has issued 19 individual lease sales, noncompetitive leases, and interim policy leases on the U.S. Atlantic Coast since 2009 (Bureau of Ocean Energy Management, April 2021, Figure 3), however questions remain as to the impact of offshore development on marine life in the Mid-Atlantic region. Many of these leases are in the Northeast U.S., with large areas almost adjacent to the Great Bay harbor seal haul-out site. The proposed satellite tagging and health assessment work will be critical for documenting pinniped activity before, during and after construction of wind-farm lease areas within close proximity of the overwintering haul-out site in Great Bay.

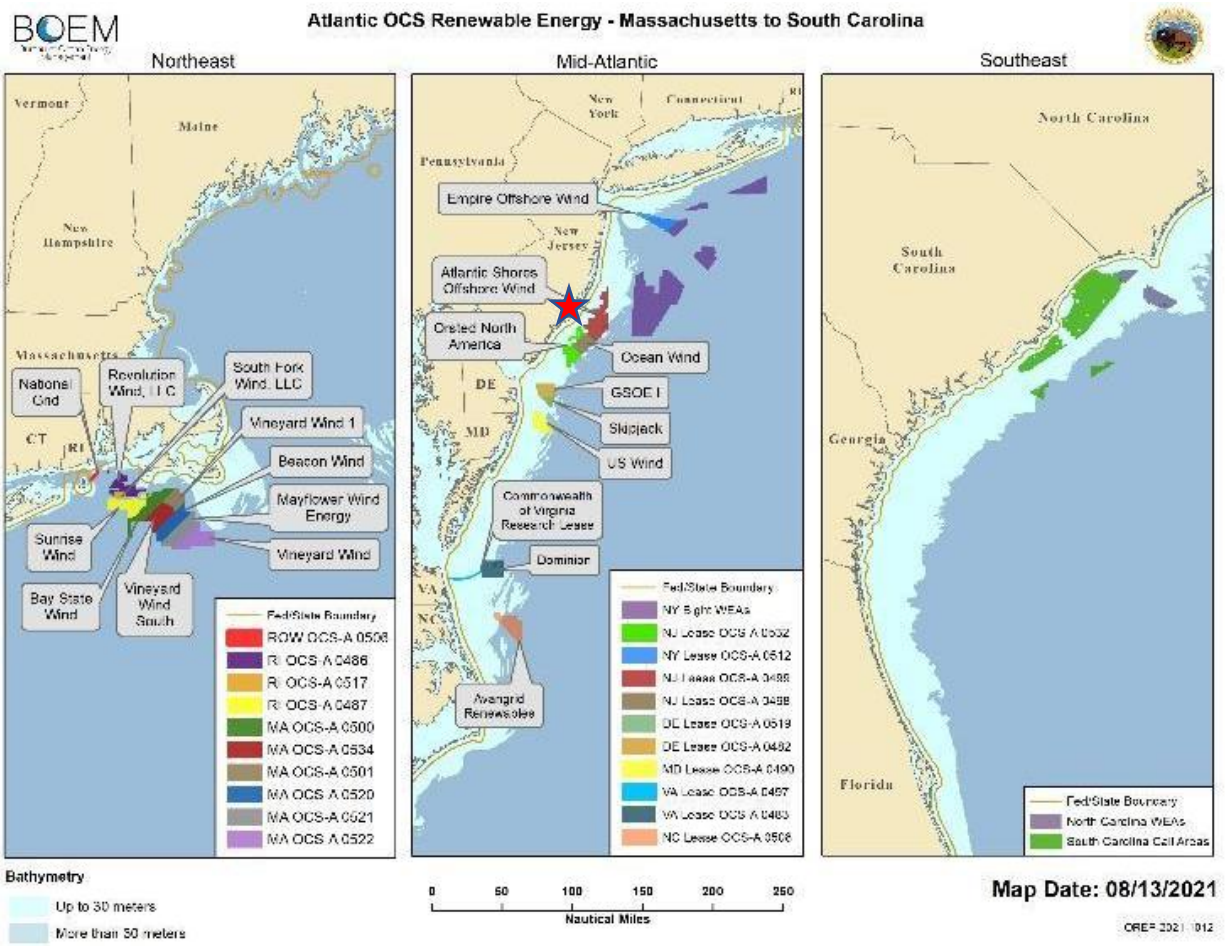

Figure 2. BOEM wind energy lease areas on the east coast. The red starred area in the middle panel shows lease areas in proximity to Great Bay

Though harbor seals are not listed as endangered, they are protected species under the Marine Mammal Protection Act and are an important part of the local ecosystem. Seals provide many ecological benefits as a top marine predator, helping to regulate prey populations and transferring nutrients throughout the ocean (Roman et al. 2014). The presence of large marine animals like pinnipeds is often thought to be indicative of improving ocean/ ecosystem health as well (Northwest Atlantic Seal Research Consortium, 2021). The recovery and subsequent increase of pinniped populations brings challenges that ecosystem-based management needs to address. Understanding how seals interact throughout the region will enable managers to better understand the role of pinnipeds in the ecosystem, and how to balance public and environmental needs. More detailed work needs to be done in the mid-Atlantic region to understand the ecology of these animals, especially regarding imminent offshore wind development.

The comprehensive study proposed here includes both health assessment and satellite tagging of the harbor seals that overwinter in Great Bay, New Jersey. These methods will provide an in-depth

look at individual animals, health status, and movement patterns beyond the haul-out site in Great Bay.

Objective 1: Satellite Tagging

Satellite tags will be attached to seals after being captured by seining methods. Once attached, the tag will emit a signal when at the surface; data on the seal's location, movements, and dive patterns will be accessible to researchers via satellite communication with the satellite tag through the ARGOS network of satellites (Wildlife computers https://wildlifecomputers.com/).

Objective 2: Health assessment

In addition to satellite tags, health assessments will also be conducted on wild harbor seals (*P. vitulina*) at their overwintering site in Great Bay, NJ. Data collected through this project component will be comparable to historical stranding data to help determine baseline data about the overall health of the wild populations It is important to continue consistent data collection to assess the impacts these industries may have on pinniped populations.

Methods

Satellite tracking studies and health assessments will provide an in-depth look at the status of local harbor seal populations, and their movements both locally (New Jersey) and regionally (mid and northeastern US coast). Seals will be captured by a trained team of biologists utilizing small vessels to set a modified seine net near a haul-out site, utilizing modified procedures developed by Jefferies et al. (1993).

Captures will be attempted when environmental conditions and harbor seal behavior maximize the chance for safe and successful capture. When these conditions are met, the vessel/personnel action plan is as follows:

The haul-out site will be approached by a ~21' vessel containing a ~450ft x 20ft seine net (including a float line and lead line). When seals begin to flush into the water, the head boat will place the lead buoy in the water and release the seine in an arch shape in front of the haul-out site. The second 21' vessel will recover the end float and pull it to shore on the opposite end of the haul-out site. Both ends of the seine net will then be pulled onshore (site specific conditions may vary) by personnel on either vessel, with a third vessel tending the net remaining in the water as it gets pulled onshore.

The nets will be tended continuously, and all animals will be removed from the net as quickly as possible. If animals are on land, hand-held hoop or scoop nets will be used to capture the animals. After capture, life history data will be collected from the seals including molt stage, length, weight, girth, and sex. Biological samples, including blood serology and ocular, nasal and rectal cultures, are collected for disease surveillance. Some of the diseases currently being monitored in pinniped populations include a new variant of Avian Influenza, morbillivirus, and COVID. Biopsies will be collected for genetic studies and for toxicology analysis. Scat samples will be collected as well (when available) for diet analysis and contaminant exposure. After all samples are collected, the seals will be outfitted with satellite and flipper tags. These health assessment data with help

establish baseline data on the causes of strandings and the current health of the wild harbor seal populations. This is critical as additional anthropogenic challenges continue to develop in the Northwest Atlantic Ocean including offshore energy development. The following table outlines all biological samples that will be collected, the analyses that will be run, and collaborative laboratories.

Samples Collected	Testing/ Analysis	Laboratory	Additional Information
Blood samples	Serology/ Blood chemistry, Complete Blood Cell Count	Antech Laboratories/ Idexx Laboratories	Serum is also archived in -80C for additional comparison and historic analysis
Blood samples	Contaminents	Mystic Aquarium/ University of Connecticut	Serum is also archived in -80C for additional comparison and historic analysis
Blood samples	Stress Hormones	Mystic Aquarium	
Blood samples	Avian Influenza	Tufts University Runstadler Lab	
Biopsy Samples	Diet, Fatty Acid, Stable Isotopes	Northeast Fisheries Science Center	
Nasal/ Ocular/ Rectal Swabs	Avian Influenza	Tufts University Runstadler Lab	
Vibressae	Diet analysis		Samples are archived for retrospective studies
Blood samples	Morbillivirus	University of Georgia, Athens	
Swabs	Morbillivirus	University of Georgia, Athens	Samples are archived in a -80C freezer for comparison and historic analysis
Fur	Contaminents		Samples are archived for retrospective studies
Fecal samples	Endoparasites	Antech Laboratories/ Idexx Laboratories	AMSEAS, UMASS Boston, Mystic Aquarium
Fecal samples	Stress Hormones		AMSEAS, UMASS Boston, Mystic Aquarium

Table 1. Base samples collected during health assessment, analyses, and collaborators.

When available, the collection of seal scat will support an understanding of diet composition that can help managers assess the impact seals may have on the local prey populations. Sampling scat will also be used to look at stress hormone levels, contaminants, and biotoxins (ex. domoic acid); this will provide valuable baseline data for future comparison

Satellite tag attachment methods follow protocols developed by Robert A. DiGiovanni, Jr. and have been used on over 200 pinnipeds throughout the last 25 years (Tagging resources https://wildlifecomputers.com/our-tags/splash-archiving-tags/). The tags are attached to the pelage between the animals' shoulder blades or head using Devcon® five-minute two-part epoxy. The positioning of the tag is chosen to have minimal disturbance to the animal when moving its head and on the high point of the animal's back or head, allowing the saltwater switches to lose conductivity when the animal is at the surface. The tag attachment does not appear to alter the animals' mobility, as previous tagging efforts have shown animals returning/resting at the haul-out site after tagging. No sedatives are used in harbor seal tagging and health assessment efforts. Tags made by Wildlife Computers, including but not limited to, SPOT (position only) and SPLASH (satellite linked time depth recorders) will be deployed

during these wild capture studies (https://wildlifecomputers.com/our-tags/splash-archiving-tags/). Other capture/processing equipment that will be utilized during tagging and health assessment procedures includes: dry bag and transport case for Tags, flipper Tags, Tagging supplies (epoxy), computer program GIS/IGOR plus, biological sampling bags for sample processing (blood, stress), capture net (rental), hoop nets (rental), Pro grip rubber gloves, dock lines 3/8" by 25 ft, industrial duct tape, shackles, heavy duty cable ties.

Although life of satellite tags can range (project and tag variability), about 120 days of data transmission per tag is average. Tags will be programmed 1) to fit the needs of the Great Bay project, 2) to account for time of year / annual molt, and 3) with the ability to be incorporated into other existing tagging projects.

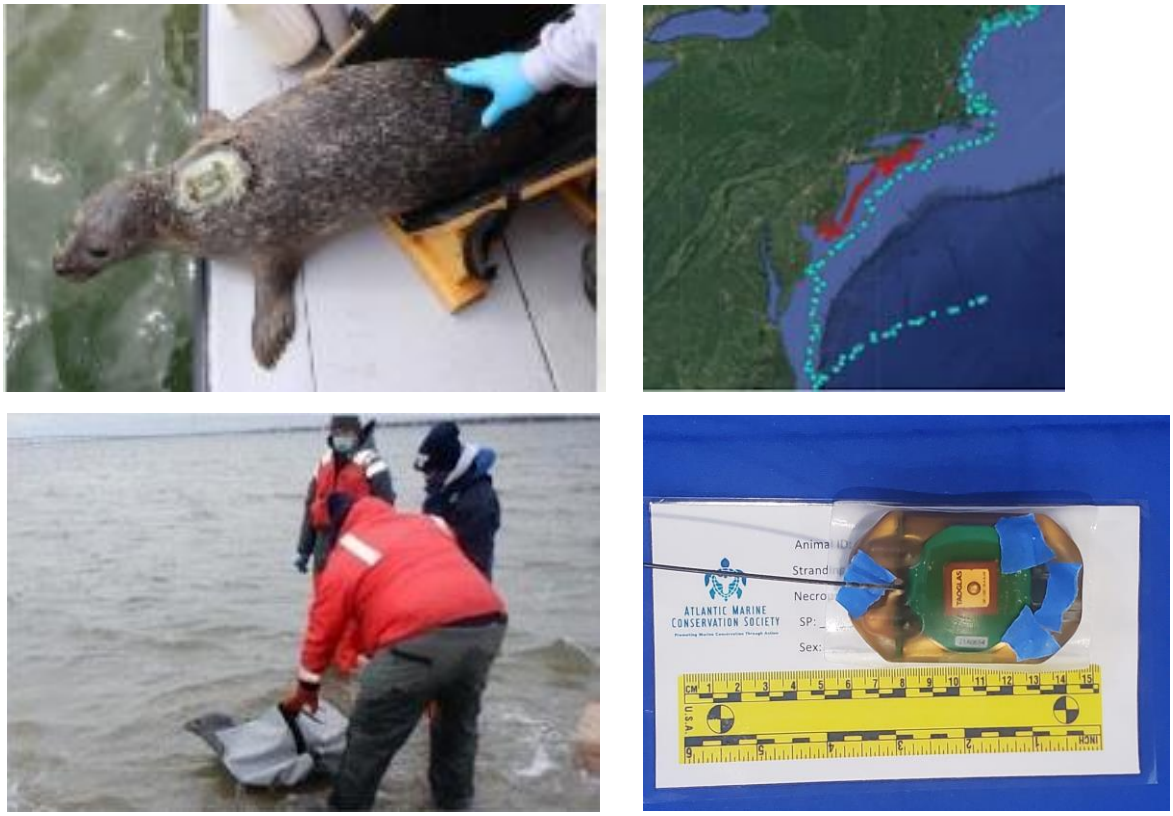

Figure 3. Satellite tagged harbor seal (top and bottom left), example of potential satellite tag (bottom right), and two track-lines showing movement patterns of tagged harbor seals (top right)

The training protocol being used for this project includes the development of an Incident Action Plan (IAP) for each field day to identify the objectives of the field operations, each individual's role and responsibilities, safety protocols and transportation logistics. Training exercises are also conducted regularly to demonstrate net and animal handling and disentanglement techniques, sampling protocols and procedures, and safety measures. Field operations are reviewed after each day to discuss challenges and identify solutions. Operation scenarios are included in training exercises to bring practical knowledge to the trainees.

Coast-wide, this multi-institution collaborative project anticipates 35 field dates per year to attempt wild captures of pinnipeds at regional haul-out sites from Maine though Virginia. In Great Bay specifically, we anticipate two days of pre-planning and six field days per year with an average of ten harbor seals captured and subsequently handled by technicians each year. Data obtained from the already existing remote-camera study of harbor seals in Great Bay will better assess animals' behavior and determine window of operation. The proposed window extends from October through May throughout the region; within Great Bay, it is anticipated that December and January will be suitable for capture attempts, as seal haul-out numbers increase at this time (Toth et al. 2018, Toth per obs. 2022). We will attempt to attach 10 satellite tags per year for three years, and conduct individual health assessments on these 10 individuals each year for three years (30 tags, 30 seals biologically assessed).

The satellite tags have different expectancies due to timing of the animal's annual molt. Tags applied later in the season may provide fewer days sampled, but provide larger-scale migration behavior. The animals tagged earlier in season will provide more information on the animal's local movements. Data from early tagging efforts in the northeast suggests that animals (harbor seals) move north towards Maine in late spring and into summer. Data from the Virginia tagging project showed animals moving between Virginia and Delaware Bay between February and April, and then head north to Maine in late April. These animals followed the coast, and have data points close to known haul-out sites along the coast.

These tags are programmed to signal location daily, and upload data on time at temperature, dive data, environmental variables (sea surface temperature, chlorophyl a, wind speed, direction, and temperature). These data will be combined with fisheries and environmental data for the area, when available, to identify factors related to occurrence.

The addition of Great Bay, NJ (a consistently large seasonal population) would add valuable data to the health and movements of these animals in the mid-Atlantic region. The addition of these data to the already existing project collaborations can provide valuable information on the local movement around wind energy lease areas and how those movement relate the larger region.

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- What are the movement patterns of harbor seals that occur in New Jersey? Where do these animals spend their time when not hauled on in Great Bay, and are there identifiable habitats of importance? Do these animals use habitats within offshore wind lease areas, and how does this change during and after wind farm installation?
- Does harbor seal distribution change due to natural or anthropomorphic causes? How does the installation and operation of wind turbines affect behavioral patterns, dive behaviors, and foraging dives of these marine mammals?
- Has the diet of harbor seals changed over time both in New Jersey, and throughout the mid-Atlantic/northeast region? What is the impact of offshore wind installation and operation on harbor seal diet?
- Is there a difference in disease prevalence latitudinally in the northwest Atlantic?

Table 1. outlines many of the possible uses of biological samples taken during harbor seal capture/satellite tag attachment. Some biological samples will be archived for future use for

historical analyses (ex. Blood samples stored at -80C can be used in the future to answer any number of biological questions that arise over time). Other biological samples can help answer more acute questions; for example, fecal samples (eDNA analyses) and biopsy samples/stable isotopes analyses can help establish which fishes seals are eating before, during, and after wind-farm installation. As found in studies in Europe, we might find that wind-turbines act as artificial reef communities that attract fish populations and as a result, see changes in harbor seal diet composition. In addition, understanding changes in blood chemistry (electrolytes, fats, proteins) before, during, after installation, will be possible.

Through satellite tagging and biological sampling, this project will document the seasonal distribution and health patterns of the largest population of overwintering harbor seals in New Jersey, while helping us understand how estuarine, coastal, and/or offshore areas are utilized. The immediate goal of this study is to elucidate local patterns regarding harbor seal habitat use and health before, during, and after wind-farm installation. After gaining an understanding of Great Bay seal dynamics in relation to the installment/operation of the wind-farm, larger coast-wide data connections will be the next step in the process.

Schedule of activities

New Jersey / Great Bay site visits: October 2023 (2 days)
Activities: Trial boats, check field site, trial net deployment, check and practice with all equipment, discuss roles, build site-specific Incident Action Plan

Tagging effort and health assessment: December 2023, 2024, 2025 (6 days each year)
Activities: Satellite tagging and biological sampling

Data Analysis: December 2023 – December 2026
Activities: Ongoing data analysis for duration of tag – each tag likely has a different life expectancy. Wildlife Computers (satellite tag manufacturer) and associated embedded software programs (IGOR) will allow for integrated analysis, manipulation, and presentation of transmitted data (https://wildlifecomputers.com/data/tools/igor/).

All health assessment samples will be analyzed at respective locations according to expertise. See Table 1. for detailed information.

Expected Outcomes
Data collected by this project will fill in the gaps in movement data on harbor seals locally in New Jersey / New York Bight, as well as regionally in the northeastern US. These data will provide a better understanding of habitat use and distribution of northwest Atlantic harbor seals overall, while providing a unique time-series of data specifically for animals that spend time in southern New Jersey. There is currently no information on the offshore habitat use, movement, patterns, or dive behavior of harbor seals that utilize Great Bay near wind-farm lease areas. These data will improve our understanding of the impact of offshore wind development on harbor seal population dynamics, and provide insight for future development projects on the US east coast.

In telemetry studies conducted in Europe looking at impact of wind-farm installation and operation on Harbor seals, the active pile driving period was determined to reduce pinniped presence in the installation area up to 25km. Once pile driving was complete however (monopiles installed and operational), pinnipeds spent notably more time traveling to and from these structures, while exhibiting dive patterns associated with foraging activities (Russell et al. 2014, Russell et al. 2016).

The proposed study will target similar data through the programmed satellite tags (harbor seal movement, distribution in/around turbine areas, dive behavior, dive time, diving depths). By collecting these data before, during, and after wind-farm installation, significant and acute changes in these variables will be evident. Like the studies in Europe, we might expect to see changes in Great Bay harbor seal behavior, habitat use, and foraging activity (installation-phase dependent).

The broader northeast and mid-Atlantic pinniped tagging/sampling effort has been collecting data over the last four years (VA, NY, MA). Although these sample sizes are smaller, they help provide a base understanding of movements and can be compared with future projects to identify differences in movements and behavior. Data collected by the tag on these current projects include dive data, time at depth, type of dive, and time at temperature. In addition, movement and behavior data can be combined with co-occurring projects collecting environmental information (temperature, chlorophyll a, sound, etc.) in the effort to identify characteristics common between occurrence of animals and habitat. Movement data, coupled with environmental variables, can help us understand factors contributing to behavioral patterns and potential drivers of these patterns. These data can help establish time spent in particular areas (such as wind energy lease areas) before construction, during construction and after.

In addition, coordination to understand ongoing acoustic activities in the area would be useful. For example, do animals avoid specific areas, spend more time on the surface, or spend more time hauled during specific acoustic activity? Identification of environmental and ecosystem data collected from previous, current, and ongoing projects will help to identify common values. The sharing of data will be essential in assessing factors contributing to behavior. For example, data collected by environmental gliders being deployed by other researcher teams in New Jersey (Rutgers University) can potentially be used to relate ecosystem processes/sound to harbor seal movements and patterns (data-resolution dependent).

While the anecdotal comment that seal distributions are changing in the northeast and mid-Atlantic is based on long-term observations from various researchers conducting work on seals in the region, the proposed work will allow systematic/directed observations to detect more acute shifts in specific variables. These data will be comprehensively shared and built upon with similar programs/datasets in areas where mid-Atlantic pinniped population dynamics are being investigated.

As these data are collected under the NOAA scientific research permit, they will be submitted to NEFSC and housed there for use/sharing. Each partner has a set of questions related to their area and these data sets can be shared to increase sample size in each area. An example of this is the

collection of baseline data on seal movements in the New York Bight (NYB) from the New York based haul out sites. These data will be used to assess home range movements in NYB and identify habitat and area use inside and outside of the wind lease areas. The collection of health data helps us identify not only the life history data (length, weight, estimated age class), but also potential adverse health status.

A recent example on the use of pinniped health samples includes examination for Avian Influenzas from animals in the field. Health swabs were collected from tagged seals and provided to Tufts University, enabling the Tufts team to assess the extent of the virus and identify its geographic range (samples taken from tagged animals in ME, MA, NY, VA). There is currently a paper in review documenting these High Path Avian Influenza in harbor and gray seals. Although the tagging data and health sample collection can be considered two separate projects, tracking data from satellite tags could potentially inform managers about disease transmission (a difficult phenomenon to assess in highly mobile species). Collecting these biological samples can provide valuable insight into the prevalence of diseases in an area/region, or difference in stress levels.

Another example of how stress hormones can be used to draw conclusions about animal behavior and environment: In a study on North Atlantic right whale stress level in the Bay of Fundy, whales were shown to have significantly lower stress hormone levels post 9/11/2001 (when large-scale shipping traffic was drastically reduced). It was suggested that a decrease in shipping traffic and ocean noise was correlated to this decrease in stress hormone level in these whales at that time (Rolland et al., 2012). Observing stress hormones in Great Bay seals throughout wind-farm development will potentially provide an interesting time-series and allow us to draw evidence-based conclusions.

The project PI's will analyze data obtained from the tags and address home range estimates, movements, time hauled out, dive depth, dive duration, percentage of time spent near shore or offshore, percentage of time spent in wind farm lease areas, and statistical variability therein. Home range analysis will include the 50 and 95% isopleths and be conducted using R (statistical package) and GIS (ArcMap). The dive behavior in the area will be analyzed to assess the mean dive duration and depth, and these data will be analyzed between years to identify difference during phases of development. Since we do not have a base level for these factors (including stress hormones), the first stage is to collect these samples and identify differences, if any, regionally. This data set will be used as the best available data (base level data) to compare to other phases of operation and areas of study. Data from this project will continue to build our base knowledge of these animals and their use of the ecosystem. The survey plan of tagging ten animals per year from Great Bay represents about 5-10% of the total animals that utilize the site depending on time of year (based on 2021-22 population estimates). Because these data are pooled with other NOAA permitted satellite tag studies, collaborators are welcome to use/publish results using the tagging and/or health data where it compliments their area of study. Similarly, if other satellite tag studies being conducted support the analytical goals of this study (NY, VA, MA), those data may be incorporated into these analyses. Statistical support will be contracted where necessary.

Data will also be shared with state/regional committees and stakeholders to support ongoing efforts to better understand where and how to focus future research efforts (NYSERDA, ROSA, RWSE). For example, Rob DiGiovanni was part of the RWSE July 2022 wind energy meeting to remain updated and informed on northeast and mid-Atlantic work and projects, while Jackie Toth Sullivan attended the biennial Marine Mammal Conference (Jul 29-Aug 5 2022, West Palm Beach, FL) to coordinate/collaborate/build partnerships. This project will add to existing health assessment projects in Virginia, New York Bight, Eastern Long Island New York, Southern New England, Massachusetts and Maine. The collection of biological samples will provide valuable data on prevalence of disease and contaminants in the Northeast, while the movements and health of these animals will help evaluate changes in the environment, and increase understanding of how these animals (and animal strandings) relate to both natural and anthropogenic threats.

Expertise and Qualifications

See supporting documentation for Jacalyn Toth Sullivan (CV) and Robert A. DiGiovanni (CV)

Jacalyn Toth Sullivan: Jackie has conducted research on marine mammals in New Jersey for 20 years (bottlenose dolphins and harbor seals). She has executed photo-identification surveys/analyses, biopsy sampling, population analyses, pinniped ecology studies, and most recently, population dynamics studies on the harbor seals that overwinter in Great Bay. She is currently the PI on a grant-funded study looking at Great Bay harbor seal population dynamics, haul-out patterns, and food habits within Great Bay. She brings depth of knowledge to this Great Bay harbor seal tagging and health assessment effort, having studied this population for many years.

Robert A. DiGiovanni Jr.: Rob has worked in the marine mammal rescue and rehabilitation field for over three decades. During that time, he has collected biological samples on thousands of animals and satellite tagged over 250 animals comprising seven species of pinniped, three species of dolphins and four species of sea turtles. Rob has worked as an instructor at Aquavet and has trained numerous Veterinarians and biologists. Rob has worked on health assessment projects in Virginia, New York, Massachusetts, Maine, Canada and Sweden. Rob has led marine mammal and sea turtle aerial, vessel and land-based surveys. Rob is the PI on seal captures throughout the region. Rob has collected biological samples from both stranded animals in rehabilitation and on health assessment projects.

Lynda Doughty: Lynda has worked in the marine mammal stranding and research field for over a decade. She is the Executive Director for Marine Mammals of Maine and runs a rescue and rehabilitation facility. Lynda has worked on seal capture and health assessment projects in the northwest Atlantic since 2011. Lynda has drawn blood, collected biological samples, assessed the health status of seals both in the rehabilitation setting and on wild capture projects. Lynda has worked on health assessment projects in Virginia, New York, Massachusetts, and Maine.

Gordon Waring: Gordon retired from NOAA Fisheries after over 30 years of service and now continues the fieldwork he began in seals decades ago. He has been working on pinniped research form aerial surveys, capture and assessment projects since the early 1990's. Gordon has coordinated seal capture and health assessment programs for three decades. Gordon has led and worked on health assessment project in Virginia, New York, Massachusetts, Maine, Canada and Sweden.

Kim Durham: Kim has worked in the marine mammal rescue and rehabilitation field for over three decades. During that time, she has conducted health assessments on both stranded and wilt caught animals. She has worked as an instructor at Aquavet and has trained numerous Veterinarians and biologists. Kim has worked on health assessment projects in New York, Massachusetts, Maine and Canada. Kim has collected biological samples from both stranded animals in rehabilitation and on health assessment projects.

Allison Deperte: Allison Deperte has worked in the marine mammal rescue, rehabilitation and release program for two decades. Allison has worked on numerous seal health assessment projects in New York and Massachusetts. Allison serves as a planning section chief on these projects and

coordinates scheduling. Allison is experienced in working with animal handling, nets and sampling procedures.

Kimberly Murry: Kimberly is from NOAA Fisheries and is the PI on the seal capture work on Muskeget Island and Massachusetts. Kimberly is the team lead for the pinniped ecology program at the Northeast Fisheries Science Center.

Monica DeAngelis: Monica works for the Naval Underseas Warfare Center in Rhode Island and is an essential member of the team. Monica has worked on numerous seal research projects including surveys and capture of pinnipeds and otariids.

Steven Evert: Steve is the Director of the Stockton University Marine Field Station (Facility & resource management, marine operations). He has a U.S.C.G. Merchant Mariner Credential, Master Near Coastal Waters to 100 tons, with 30+ years of marine experience in various field capacities.

Nathan Robinson: Nathan is Stockton University Marine Field Station Assistant (Marine operations, hydrographic survey, vessel and instrument maintenance***)***. He has a U.S.C.G. Merchant Mariner Credential, Master Near Coastal Waters to 25 tons/Master Inland Waters to 100 ton, with 20+ years of marine experience in various field capacities.

Elizabeth Zimmermann: Elizabeth us a Stockton University Marine Field Station Assistant with 25+ years of experience in various marine operations (Marine operations, YSI water quality programs, hydrographic survey, and wet-lab operations)

David Ambrose: David is a Marine Research Technician with 15+years of marine experience in various field capacities (Marine operations and field research support).

Vessel Resources

Stockton University Marine Field Station will provide the vessels and boat captains for this tagging and health assessment effort.

1) Research vessels *Scoter* and *Skimmer* are 21' x 8' Privateers (Belhaven, NC) and are used extensively to transport students to sampling sites throughout the coastal bays. These boats provide faculty and staff the ability to navigate shoal waters, accessing our many near-shore seining and marsh sites. They will be able to access shallow and deeper waters in and around the Fish Island haul-out site in Great Bay.
2) The Research Vessel *Rudy G. Arndt* was built by Jennings Boatyard (Reedville, VA) and delivered to Stockton in March 2022. The "Rudy" is a 26' molded garvey hull, shallow draft flat bottom boat with a chicken-breast entry. The Rudy is wide and stable, and capable of supporting various estuarine studies. For this tagging effort, the seine net will be deployed from the bow of this vessel; the bow depth and cleat-free nested bow is ideal for net deployment.

Literature Cited

AMSEAS (2022) https://www.amseas.org/northwest-atlantic-harbor-seal-assessment-and-monitoring

BOEM (2021) Commercial Wind Leasing Offshore New Jersey https://www.boem.gov/commercial-wind-leasing-offshore-new-jersey

Cornelia E. den Heyer,W. Don Bowen,Julian Dale,Jean-François Gosselin,Michael O. Hammill,David W. Johnston,Shelley L. C. Lang,Kimberly T. Murray,Garry B. Stenson,Stephanie A. Wood. (2020) Contrasting trends in gray seal (Halichoerus grypus) pup production throughout the increasing northwest Atlantic metapopulation. 37(2): 611-630.

Gilbert, J.R., G.T. Waring, K.M. Wynne, and N. Guldager. (2005) Changes in abundance and distribution of Harbor Seals in Maine, 1981–2001. Marine Mammal Science 21:519–535.

Jacobs, S.R., and J.M. Terhune. (2000) Harbor Seal (Phoca vitulina) numbers along the New Brunswick coast of the Bay of Fundy in autumn in relation to aquaculture. Northeastern Naturalist 7(3):289–296.

Jeffries, S. J., R.F. Brown, J.T. Harvey (1993). Techniques for capturing, handling and marking harbor seals. Aquatic mammals, 19, 21-21.

Northwest Atlantic Seal Research Consortium (2021) https://www.sealconsortium.org/role-of-seals-in-ecosystem

Rolland, R.M., S.E. Parks, K.E. Hung, M. Castellote, P.J. Corkeron, D.P. Nowacek, S. K. Wasser, S.D. Kraus. (2012) Evidence that ship noise increases stress in right whales. *PubMed* 2012 Jun 22;279 (1737): 2363-8. doi: 10.1098/rspb.2011.2429.

Roman, J., Estes, J. A., Morissette, L., Smith, C., Costa, D., McCarthy, J., ... & Smetacek, V. (2014). Whales as marine ecosystem engineers. *Frontiers in Ecology and the Environment*, *12*(7), 377-385.

Russell, D., et al. (2014). Marine Mammals trace anthropogenic structures at sea. *Current Biology*, *24*(14).

Russell, D., et al. (2016). Avoidance of wind farms by harbour seals is limited to pile driving activities. *Journal of Applied Ecology*, *53*(6), 1642–1652.

Slocum, C. (2009) Threats assessment, baseline abundance data, and habitat characterization of the Great Bay seal colony. State Wildlife Grants, NJ Division of Fish and Wildlife Final Report. Trenton, NJ. 34 pp.

Toth, J., Evert S., Zimmermann E., Sullivan M., Dotts L., Able K.W., Hagan R., and Slocum C. (2018) Annual Residency Patterns and Diet of Phoca vitulina concolor (Western Atlantic Harbor Seal) in a Southern New Jersey Estuary. Northeastern Naturalist 25(4):611–626

Toth et al. (2022) Impact of offshore wind turbines on harbor seals (*Phoca vitulina*) in Great Bay, NJ, Preliminary Results. Poster presentation at the Conference of Marine Mammals. West Palm Beach, FL August 1-5, 2022.

Waring, G.T., J.R. Gilbert, J. Loftin, and N. Cabana. (2006) Short-term movements of radio-tagged Harbor Seals in New England. Northeastern Naturalist 13(1):1–14.

Waring, G.T., R.A. DiGiovanni Jr., E. Josephson, S. Wood, and J.R. Gilbert. (2015) Population estimate for the Harbor Seal (Phoca vitulina concolor) in New England waters. NOAA Technical Memorandum. NMFS NE-235, Woods Hole, MA. 15 pp.

Wood, S.A., T.R. Frasier, B.A. McLeod, J.R. Gilbert, B.N. White, W.D. Bowen, M.O. Hammill, G.T. Waring, and S. Brault (2011) The genetics of recolonization: an analysis of the stock structure of grey seals (Halichoerus grypus) in the northwest Atlantic. Canadian Journal of Zoology **89**:490-497