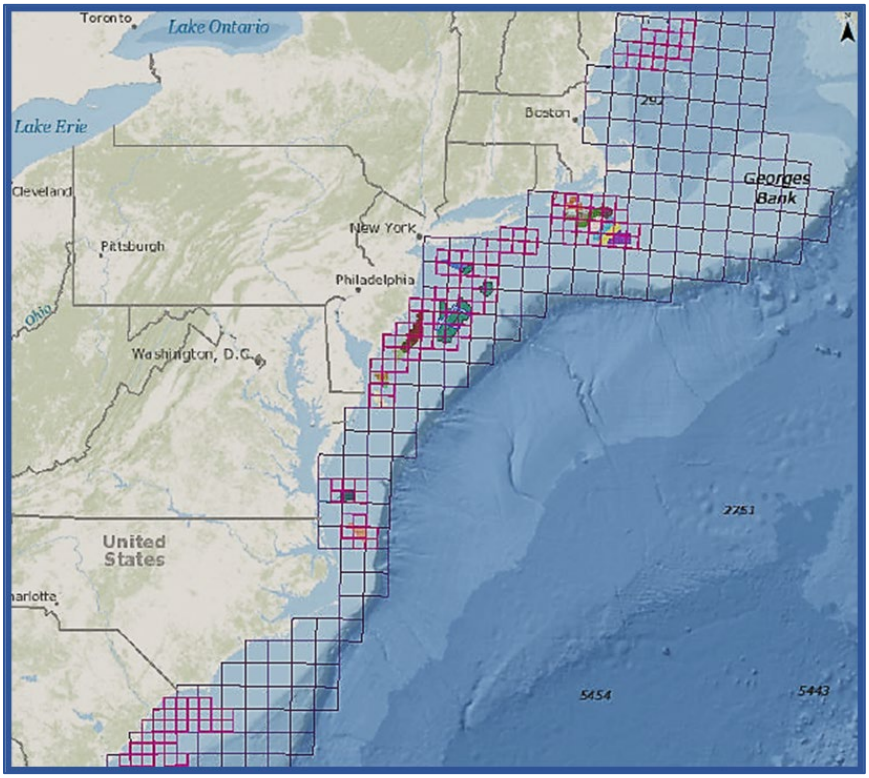
OCS Study
BOEM 2021-078

Improving Monitoring, Data Consistency, Archiving, and Access for Improved Regional Integration of Renewable Energy Science

Workshop Summary on Passive Acoustic Monitoring and Marine Mammals June 2-3, 2021

December 2021



U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs
Sterling, VA

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Improving Monitoring, Data Consistency, Archiving, and Access for Regional Integration of Renewable Energy Science

Workshop on Passive Acoustic Monitoring and Marine Mammals - June 2-3, 2021

October 2021

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WORKSHOP IN BRIEF

On June 2 and 3, 2021, the Bureau of Ocean Energy Management (BOEM) convened the first of two workshops entitled *Improving Monitoring, Data Consistency, Archiving, and Access for Improved Regional Integration of Renewable Energy Science: Passive Acoustic Monitoring and Marine Mammals.* Approximately 45 people attended the workshop with participants including state and federal agencies, academics, and offshore wind developers. Attendees' expertise included offshore wind development, federal permitting, study design and statistics, marine biology and ecology, marine mammal biology and behavior, and marine species advocacy. The workshop was facilitated by Patrick Field, Senior Mediator at the Consensus Building Institute (CBI).

THE OBJECTIVES OF THE WORKSHOP

- Consider a regional strategy for passive acoustic monitoring (PAM) and data collection for marine mammals for northwest Atlantic areas of offshore wind development from Maine to the Carolinas, with some emphasis on species of concern, including, but not limited to, the North Atlantic Right Whale (NARW).
- Consider approaches for acoustic data management and coordination
- Explore more consistent approaches to PAM including equipment specifications, study design, collection, analysis, and storage for data before and after wind farm construction with a goal of detecting regional changes in marine mammal habitat use patterns

For additional information, the Workshop agenda can be found in Appendix A.

In summary, the workshop participants:

- Reviewed a 20 x20 grid monitoring design for placement of PAM detectors across whale habitat off the US east Outer Continental Shelf (OCS);
- Explored details relating to minimum standards for stationary PAM detectors;
- Explore potential study designs that could be part of an overall grid monitoring design to address questions specific to wind energy areas or to further understand movement between major subareas of the coast;
- Discuss the opportunities and barriers for such a regional approach, including but not limited to cost, allocation of costs and responsibilities, challenges of maintaining

detectors over longer periods of time and the hypotheses that can be tested with such an approach.

- Many, but not all participants as invited, agreed the proposed regional monitoring design is important and would be feasible over time, and suggested improvements and refinements to advance the approach (a list of workshop participants can be found in Appendix B).

DAY 1 | JUNE 2, 2021

PRESENTATION: WHY WE ARE HERE

BOEM Marine Biologist Kyle Baker provided a level-setting presentation to review why BOEM convened these workshops on PAM as well as the scope and focus of this workshop: exploring a regional approach from the Gulf of Maine to the Carolinas, using PAM for monitoring of marine mammals, not mitigation. Mr. Baker touched on the broad trends and understanding of PAM, the outcomes of recent workshops, as well as pre- and post-construction objectives for offshore wind (OSW) activities (see presentations in Appendix C). Attendees did not raise any questions or comments following Mr. Baker's presentation.

PRESENTATION: EXPLORING USE OF PAM ON THE ATLANTIC COAST FOR MARINE MAMMALS

NOAA Passive Acoustic Research Group's Sofie Van Parijs and BOEM bioacoustician Erica Staaterman then shared a presentation on what PAM is and where and why PAM is being deployed on the Atlantic Coast to monitor marine mammals (see presentations in Appendix C). Dr. Van Parijs provided a brief overview on PAM methods and emerging technologies, analyses, data, storage, and archiving. She then reviewed PAM monitoring efforts by multiple actors over the last 10 years, narrowing in on the geographic focus, intent, sponsor, scale, and data produced from the efforts.

Below are attendee questions and comments raised following Dr. Van Parijs and Dr. Staaterman's presentation. Answers from NOAA and BOEM are *italicized*. Attendee questions/comments following up on exchanges are in plain text.

How hard was it for people to release their data / were there any barriers to data sharing for the archival PAM study?

- *It was surprisingly easy to have people join in and share their information - there was only one person who did not want to share. For this approach, we ran one single software program over the shared data. We'll talk a little bit later about acoustic detection software.*

When you received the shared data, how much work was it to ensure it was comparable?

- *The biggest hurdle for comparable data was it had been collected from many different types of recorders. But overall, the challenges associate with different recorder types were overcome since they covered the frequency range of large whales. We had a whole plethora of different recording types - some continuous data, some duty cycled data. Some standardization would have been extremely helpful. However, with a lot of work we were able to pull information out.*

Looking at a larger scale, does the data management framework and the funding required to implement exist? Data operationalization efforts often do not receive funding.

- It's what we are working on quite heavily, and Carrie Wall Bell will present later tomorrow. Data management is one of our biggest discussions, and that's why we are having a second discussion on it next time around. Who processes the data? Who manages the data? Who archives the data? Those are all questions we're hoping to answer.
- *For now, we need to just focus on: Where do we want these recorders? When do we get them in the water? How do we set them up? And then once you've got that started, then we could talk about data management.*

Where did the funding come from for the PAM archival study?

- *Funding came from a hodgepodge of different places. We identified the need for this work and really pushed to get it done. We used a graduate student to complete the work, and the data was already collected and available. What we are talking about here is a concerted and thought-through data collection.*

There are significant learnings from a multi-year effort funded by BOEM, NOAA, and Shell in the Chukchi Sea and Arctic for over 10 years of long-term recording. There are valuable learnings both from how the effort went about doing the monitoring as well as how the data was managed that could benefit this group (more can be found from the OCS Study: BOEM 2019-024, https://www.boem.gov/sites/default/files/boemnewsroom/Library/Publications/2019/BOEM-2019-024.pdf)

- *Did that effort have a formal, organized study design?*
- It was fairly organized and evolved over many years. There were discrete efforts, with different kinds of recorders in different locations and, between the NOAA efforts and the work that Shell led, they all worked together over time. The lesson here is that over time they came together, but they were siloed efforts to begin with. There are learnings from this period that can help this group avoid repeating mistakes.
- BOEM has also funded work in the Gulf of Mexico, which may be applicable, plus some longer-term PAM studies (that are funded from post Deepwater Horizon) that could also serve as learning examples. As well as some West Coast examples.

What are some of the advantages and disadvantages of stationary PAM recorders versus mobile PAM recorders? Can data collected through different methods be correlated?

- *We will get more into this in a moment, but bottom-mounted recorders provide you with a localized, long-term detailed look. Gliders would primarily be used for reconnaissance, scanning for activity that might not otherwise be captured. The main issue with comparison between glider data and bottom-mounted recorder data is that a glider is a moving point-line transect, resulting in points of time where you have information, but few repeated points in the same area. This is an appropriate distinction to have in mind for study design.*

PRESENTATION: A REGIONAL MONITORING FRAMEWORK FOR PAM

Sofie Van Parijs and Erica Staaterman then shared a presentation on a potential regional monitoring approach for PAM along the Atlantic Coast, from the Gulf of Maine to the Carolinas (see presentations in Appendix C). Dr. Van Parijs and Dr. Staaterman explored the purpose or value add of a regional PAM monitoring approach as well as the scale and scope required for a regional approach to meet its purpose. Their presentation addressed considerations regarding the deployment and temporal scale of a regional approach, how it could build on efforts already in place, and the limitations of a regional approach.

Below are attendee questions and comments raised throughout Dr. Van Parijs and Dr. Staaterman's presentation. Answers from NOAA and BOEM are *italicized*. Attendee questions/comments following up on exchanges are in plain text.

Was there discussion to extend geographic scope of study to the Gulf of Maine? Or could it be added in future? How flexible is study design to change study area over time?

- *The intent is that this would include the Gulf of Maine down to the Carolinas to cover existing and planned wind energy planning areas. Yes - the study design certainly can be extended and modified over time. There are no funded efforts yet, but something we need to keep in our focus.*
- Localizations (not real time) can be quite valuable. DASAR deployments in the Beaufort did provide these on a multi-year basis offering animal movement data relevant to overall activity. Localization was core to Chris Clark's work evaluating bowhead population; we should not dismiss localization. There's some excellent data that comes out of that that's been beneficial to looking at overall movements of a population relative to an activity footprint. So, it likely can't answer all the questions that we want to ask, but I think it could be a component of an overall long term monitoring regional plan. The glider really appeals to me because of the oceanographic data collection, and we had a very tantalizing detection of NARWs off of New Jersey off our glider. I think that kind of data from gliders is very informative to understanding what's drawing animals to the area. I would like that to be part of the consideration over the next two days -- the value of that added oceanographic data collection.
- *The original reason we didn't include localizations was the increased number of recorders and concerns the expense would be prohibitive. But certainly, on leases, if different developers wanted to do that, then they ought to, especially during that construction phase. We believe that a lot of oceanographic data is being collected concurrently through the IOOS system.*

Was the cabled array option considered? Why was it not included here?

- *The feasibility of the cable array option is unknown, but likely not impossible. This would be multiple hydrophones on the same system cabled back to a headquarter spot. This approach would be useful for localization, because you need that time synchronization, which can be harder to get across stationary individual recorders. The question becomes where do you feed those cables into? Where is the data hub? Another idea raised to save costs is if you could put the cable from the hydrophone array next to or in the same corridor as the wind facility cables.*
- *This approach would also provide real-time data, which could be a priority for certain phases, like construction. The question was raised about whether a PAM device could be repurposed to provide real-time monitoring during certain phases and longer-term monitoring during others.*

What timeframe is proposed for coverage? ASAP through ~2028, after much construction is planned?

- *From Kyle's presentation, it is obvious that there is a need to move quickly. When we break out into discussion groups later, we would like to explore perspectives on the timeline for a regional PAM approach. A key question is, if we want this regional monitoring, what is already out there that we can add value to in the short term.*

Who is going to pay for this? Right now, there is a lot of load on the developers. Are there other funding sources that we are not aware of? Are there plans by BOEM and NOAA to also contribute funding?

- *We are going to need more funding coverage than just what the developers would contribute -- maybe PAM in those grids between the leases [on the map] could be something that the government pays for. BOEM does not have explicit funds ready to go, but it's certainly something BOEM will be talking about. Especially if the outcome from this workshop is a collective decision on a specific grid design, like the 20x20 grid, which BOEM can then bring back to explore gaps where the government needs to fill in funding.*
- *BOEM wants to rethink their approach for funding PAM and do it in a more coordinated environment with everyone. Looking at that construction schedule, where we need baseline and what's going to be constructed, is a starting point for determining coordination.*

Developers are "under the gun" to execute on some of these things. We are running out of time to put out RFPs needed to meet requirements by BOEM. We aren't afforded the luxury of time to have a regional framework set up before we act. We will need to grab what guidance is available in the short-term and run with it (please see breakout topic discussion items under Temporal Scale, Timing and Funding, and Covariates).

Presume the 20x20 grid is using the same grid as in Roberts et al. for density?

- *The Roberts et al. scale is a 100km square with 10x10 grids. And for NARWs in 2020, it went to 5x5km resolution. Most visual surveys are done on a 10x10 scale, in terms of the visual distance modeling. However, sound propagates further; particularly if we're focusing on NARWs, it tends to be further than that, which is why we came up with a 20x20 grid. The larger grid size obviously brings down costs. You can overlay data in the 20x20 grid over the 10x10 scales. We're currently talking to folks working on bat mitigation to see whether we can fit in our forthcoming acoustic data into their scale.*

Is there a minimum requirement for the number of sensors in a given area/location?

- *The thought so far has been one sensor per grid block, with more if you want to localize.*

What is the cost of buying, installing, and maintaining each detector? What's the annual cost or capital plus operating in the approach described?

- *Buying a single recorder can vary from $12-25,000 with the components included, costs ranging based on the specifications required. If the recorder is not lost, it can be reused and placed out in the area of interest again, which can cost $3-500. If recorders are being reused, cost considerations center around batteries and maintenance.*

- The field has evolved so quickly within the last 5-10 years, and now there is off-the-shelf tech that was not available previously. It is tempting to look at a unit cost to understand expenses, but you need to consider the recording duration, the ship time to get out to site to fix or replace things, and the depth at which it can be deployed and numerous other variables. A lot of these components start to add up quickly. It's not always just as easy as what that initial price indication is on a website.

- Discussions to date haven't included the cost of data analysis, often more expensive than data collection.

- Additional cost considerations that have to be considered to get a real time cost are: vessel time, equipment replacement; unmanned system piloting if a glider; communications if real/near real time; human safety requirements (high priority for developers requirements); data processing and data management.

Could a regional effort be a National Ocean Partnership Program (NOPP) project? This would allow federal and industry dollars to intermingle.

- *That is a great idea we've had in the back of our minds. In order for it to qualify as a NOPP, this effort would need funding from multiple sources.*

- Three federal partners must commit to qualify for NOPP funding, and this opportunity is designed to bring in industry, philanthropy, and other non-federal dollars. Depending on how NOPPs are structured, it's one method to set up multi-year, sustained funding. Something that will be important from the private industry perspective is how that funding mechanism is going to work, especially in terms of how we commit to have it be an equitable collaboration among funding partners.

- I would like to see it explored. First thing we are going to ask BOEM with how the condition is worded – we need certainty that if we commit to a NOPP project in the future, that meets the requirement in the Record of Decision for Construction and Operations Plans.

- One-third of these projects are scheduled in 2023. There are concerns that a NOPP project is not realistic given the timeframe.

I brought up 10x10 grid squares more as a footnote query re checking to be sure that the points within squares or circles in which a sensor is located be consistent with an existing grid, or in general that every modality collection system conforms to. Has the "interesting" difference in acoustic detection geometry (polar) versus visual observation geometry (cartesian) been explicitly noted somewhere given its influence on detection area? There is also a difference between when you are looking at acoustic footprints from an activity where sound radiates out not in a square but in a polar coordinates framework. We tend to do our maps in Cartesian coordinates and our acoustics in polar coordinates. We should be aware of these differences between how visual data and acoustic data are mapped.

- *Polar coordinates are something for us to consider; it could entail upscaling some of the models depending on what exactly you are looking at. There are concerns that, if the grid*

approach was shifted to a 10x10 scale, would parties be able to logistically or financially manage the kind of effort required to secure that scale? We view 20x20 as a more realistic and adaptable approach to secure regional buy-in.

How does detection space-time distribution data answer "impact?"

- *There are two perspectives at play here. One is "can we detect changes in distribution prior to or after the time period in which pile driving happened?" or, "do the whales come back to that area, do they leave it?" I am talking about that level of impact, not the acoustic impact from the pile driving or the kind of modelling that could be undertaken in those smaller scales.*
- Impact is a loaded term and detecting the change in some number of parameters is different than claiming impact. We should be careful about using terms that could be interpreted as pejorative.
- *Those are good points. The compatibility and accessibility of data will be important as we move forward and collect other data and look at oceanographic data. The compilation of data in a coordinated fashion will help to start answering those impact questions.*

Following Q&A, participants engaged in a brief Mentimeter online poll to identify additional key questions that would need to be addressed regarding a regional PAM approach.

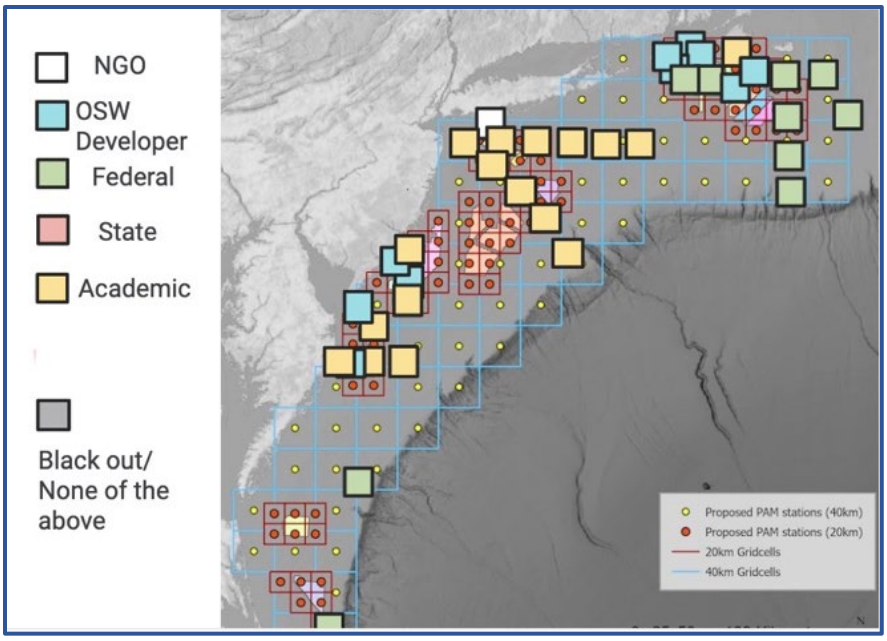
Table 1. Mentimeter poll to identify key questions in developing a Regional PAM approach.

Response	Number of Upvotes
Are species' occurrences and distributions shifting or affected during/after construction?	12
How can we state there is (or is not) a statistically significant change in distribution (what kind of statistical power do we need to answer that)?	11
At most basic level: spatial and temporal changes of marine mammal distribution associated with various stages of OSW development (construction, operation/maintenance, decommissioning)	9

What changes in distribution are occurring over time?	9
If correlate environmental covariates could get at habitat modelling	8
How does presence shift and for how long during and after construction? How is use of the habitat (e.g., foraging, migratory path) changing in the face of project construction and operation?	8
How does species movement change in space and time and correlate with large scale stressors (ship noise, ship density, etc.)?	7
How do oceanographic conditions affect presence?	6
Can one link data with zooplankton distribution that ultimately may be used to predict where whales can be found?	5
How do we differentiate between long-term phenological changes from shorter-term human impacts?	4
How do regional changes in acoustic behavior affect broad scale presence/absence detections - what do we know about changing cue rates?	4
Regional distribution changes are important, but smaller scale changes may be equally (or perhaps more) important (think displacement from a feeding area that is only a few kilometers in size).	3

BREAKOUT DISCUSSIONS: CONSIDERATIONS FOR A REGIONAL PAM APPROACH

Following the day 1 presentations, attendees were asked to collaboratively map areas where they have placed detectors for PAM in the past three years or expect to place monitors in the coming three years. The results are captured in the below image.



After building a better group understanding of where existing PAM efforts are targeted, attendees were then organized into breakouts to address a series of questions regarding a regional PAM approach, exploring the purpose of a regional approach, species of interest, a regional grid approach, temporal scale and timing, covariates (oceanographic data), minimum recording technology parameters, and potential considerations for different study designs per sub-region.

The following subsection provide a brief synthesis of key discussion threads raised in breakout discussions, organized by theme. Attendees worked in four small groups. Breakout groups includes participants across the sectors attending, and each included state and federal agencies, OSW developers, and academics.

Temporal Scale, Timing & Funding

- Answers to questions of how to best achieve PAM on lease areas are urgently needed, and developers will likely need to move forward before a full regional framework is implemented. That will require leveraging and integrating existing data, though it may not be perfect. It will be necessary to clarify what stakeholders could be doing now that will fit into a broader plan as it is developed. How to make “no regret” decisions as this approach is developed.

- Existing data on propagation should be assessed. There is also lots of oceanographic data from the Integrated Ocean Observing Systems regional associations (i.e., MARACOOS and NERACOOS) that is available. There should be some effort to put those data sets together and let MARA/NERACOOS know what is missing.

- Resources are limited, and urgency is high. Statisticians should be brought in early to help plan out an approach. It is likely that this sort of network would be implemented in a phased or distributed fashion. As resources become available, a new recorder goes in, and then a year later, another one, and so on.

    - Acknowledging a phased approach, the framework can be implemented immediately, and adapted as different recorders come online and more data is collected. There should be an entity responsible for revisiting the framework on a regular basis.

- Real-time PAM buoys could be a valuable tool to help mitigate ship strikes (please note current and future Records of Decision for projects will have specific marine mammal mitigation requirements).

- For risk mitigation, it could be important to have ~3 years data before construction due to inter annual variations that have been observed among species in different studies, but that may not be possible for some construction timelines.

- To establish baseline data, it could be important to have replicates within the area of interest as well as replicates elsewhere for comparison; the framework could focus on making sure that the areas that are going to come online soon get monitored as well as focus on comparative areas where there will not be any activity.

Covariates

- The framework should include recommendations for what variables are recorded and other environmental variables that impact how the detection functions and how data are calculated.

- There is a lot of effort being put into broad-scale surveys to collect myriad oceanographic data, and there is a lot of extra data out there. The approach should be strategic about

what additional data collection is needed (e.g., for purposes related to establishing a baseline and advancing wildlife conservation).

Species of Interest

- While the regional PAM framework focuses on NARWs and other baleen whales, there is an opportunity to use the data for other species, like fish (esp. commercially and recreationally important species). There are other cetaceans, like odontocetes, that will be in the areas of interest, and collecting that data could prove important. The framework should consider how it could detect tagged species specifically and also consider trade-offs with frequency ranges of systems such as duty cycles, battery life, and operations and maintenance cycles. Previous work (such as Duke and the Marine-life Data and Analysis Team marine-life data) on how to group species by their sound sensitivity could be used to identify species of interest in particular areas, noting that species of interest is highly dependent on place and time of year.

- Range of species should be expanded, especially if there are units that cost the same and cover a larger frequency range. There will be a need to balance the cost of analysis with the cost of trying to understand in a scientifically sound way all the species protected under the Marine Mammal Protection Act.

Data Collection & Management

- Participants agreed that a regional approach makes sense, but questions were raised about the objectives of such an approach. What are we really designing for? What do we want to do with this information when it comes out? How can we use this approach to assess cumulative impacts? Will we be data rich, but information poor?

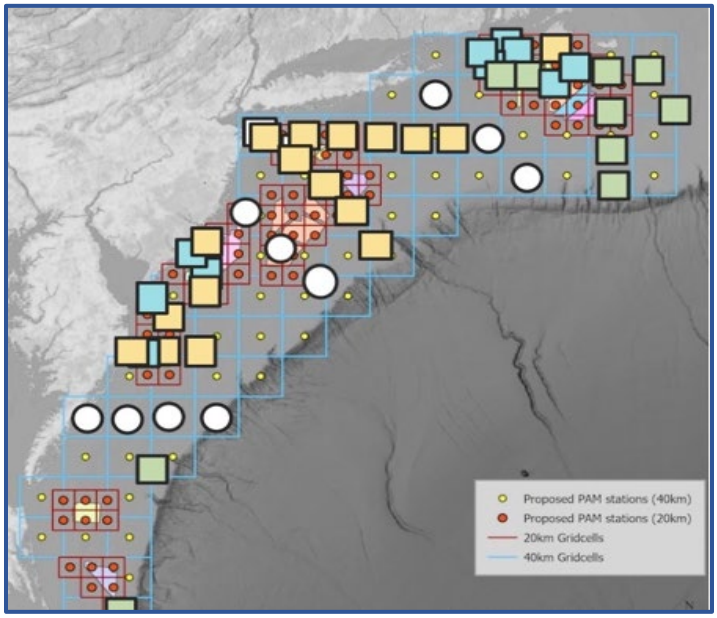
- Autonomous systems such as gliders could be useful in fitting into a strategy, at a local lease or regional scale, to fill spatial and temporal gaps between buoy deployments and be used for localization and other parameters. Short- and long-term needs also apply to data collection methods; autonomous systems could serve a specific purpose in answering both short- and long-term monitoring questions.

- Gliders are useful in providing information for all depth strata that can improve the actual propagation characteristics of the environment from the buoy detections at that time.

- Key questions for data management include: Who will process this data? Who will manage this data?

Grid Approach & Sub-regional Design

- One proposed approach to prioritize PAM regional efforts, utilizing the grid approach, was a "tollgate" design in which recorders set in lateral or diagonal lines off the coast. There could be candidate spots for a before and after control impact (BACI) design, and this approach could help to connect regions and capture animals migrating between them. Placing these limited number of buoys in these "tollgate" areas could be done almost immediately to establish a baseline. The below image shows the mock-up of what this design could look like, with the white circles representing potential hydrophone locations in a "tollgate" pattern.



- Another proposed approach to prioritize regional efforts would be to place recorders in a BACI design in the Nantucket area (i.e., the four vertical proposed green squares in map above) because we know that animals are going through that area of interest and it's important for feeding and there will be extensive OSW development. Populating the grid in that specific area could allow researchers to look for changes in behavior as well as movement.

FINAL DAY 1 POLLING

At the end of Day 1, the participants were polled on following questions. The questions, scale and average responses are provided below.

Question	Scale	Number of Responses and Average Score
Given what I know today, building a regional PAM monitoring network built over time is important.	On a scale of one to five with one being strongly disagree and 5 strongly agree	N = 42 Average = 4.53
Given what I know today, it is feasible to build out a regional PAM monitoring network in the next five (5) years	On a scale of one to five with one being strongly disagree and 5 strongly agree	N = 42 Average = 3.86
Given what I know today, we should try to build out a PAM monitoring network in one sub-region soon and learn from that for more later.	On a scale of one to five with one being strongly disagree and 5 strongly agree	N = 42 Average = 3.72
Given what I know today, my organization would try and support (financial and non-financial) in some way building out such a PAM regional network.	On a scale of one to five with one being strongly disagree and 5 strongly agree	N = 42 Average = 3.45

DAY 2 | JUNE 3, 2021

DISCUSSION: SUMMARY OF DAY 1 & FURTHER REFINING A REGIONAL APPROACH

To open Day 2, CBI Facilitator Patrick Field presented a summary of the discussions from Day 1, reviewing the proposed grid design and the collaborative map of where attendees have placed detectors for PAM in the past three years or expect to place monitors in the coming three years. He then shared a synthesis of primary and secondary priorities related to the various components of a regional PAM approach, including purpose, species of interest, detector type and minimum parameters, sub-regional geographic scope, temporal scale, covariates, and grid approach and study design.

Below is a brief synthesis of key discussion threads, organized by theme.

Grid Approach & Study Design

- One attendee suggested exploring a grid design where the boxes are offset to increase the probability of detection of animals traveling between sensors in an aligned grid approach.

- Another attendee raised the importance of having a good overview of what could be defined as "control areas" - outside areas that could act as control. This could mean making the grid boxes smaller and increasing the level of surveillance outside of the areas of interest.

    - *NOAA noted that it could be unrealistic to assume that a regional approach could cover everything at the same level of detail (20x20) and emphasized that one of the biggest challenges with control areas is defining a control area in an acoustically open environment.*

- Another attendee asked if there would be studies of small-scale impacts around wind farm construction activities to feed into the regional scale. BOEM noted that there have been some proposed studies looking at construction impacts, acknowledging that there is a lot of focus right now on mitigation. Another participant noted that detectability near shipping lanes is lower due to sound interference and thus one would likely need a greater concentration around those features to achieve the same level of detectability.

- One attendee emphasized that sampling design is not assuming a 100% sampling coverage.

- Looking for actionable near-term steps coming out of this workshop, attendees raised that, if there is an agreed-upon framework and grid approach that is available to the community, then single projects could consult the framework and utilize it, to the extent possible, with their ongoing efforts, collaboratively building value in the near-term and over time.

Temporal Scale & Timing

- One attendee commented that the value of monitoring post-construction depends on how much inter-annual variability exists. Having a better understanding of that variability would lead to a better understanding of how many years would be required for monitoring to detect a change due to wind farm construction.
    - *NOAA noted that there is some data that could be explored from work with blue whales to better understand inter-annual variability. Another attendee noted that, from their multi-year PAM surveys in wind areas (VA, MA, MD), they see significant inter-annual variability*

- Attendees stressed the importance of collecting enough years of temporal samples in order to conduct an accurate analysis of inter-annual variability, noting that if the inter-annual variability is large, it becomes that much harder to identify the effect of wind farm construction.

- One attendee emphasized the spatial-temporal nature of OSW activity, clarifying that areas will not be "flooded with noise at all times," but rather experience specific noises for specific amounts of time at different points of construction. This OSW wind noise will be detected along with any other noise, say, existing noise from vessel traffic.

- Looking at post-construction monitoring, one attendee noted that three years is not enough for annual effects to be a random effect in a generalized linear mixed model thus suggesting that five years would be a better data collection period.
    - *NOAA commented that one approach could be to focus most immediately on areas where we've had greater data collection in the past if a longer time record is required.*

- One attendee noted that the discussion had touched on temporal considerations for baseline and post-construction data but failed to capture considerations for PAM activity during construction.

Covariates & Existing Data

- Attendees named the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) and the Northeast Regional Association Coastal Ocean Observing System (NERACOOS) data sets as important existing resources to utilize.

- One attendee raised concerns about how the questions that developers face under the National Environmental Policy Act (NEPA) at the lease level relate to a regional approach for PAM. Concerns named about covariates and shifts for marine mammals, given observed inter-annual changes tied to ecosystem shifts and challenges. It was noted the marine ecosystem is facing any number of changes, including climate, beyond offshore wind development. "Will the developers be to blame if there is a shift in movement, that if we hadn't had that high-resolution measurement, we would not have been able to capture?"

    - *BOEM commented that, for NEPA, they are considering the geographic area for analysis of protected species from Canada to Florida, with several projects having vessel operations proposed. BOEM is interested in the impact to whales over the larger area, not just looking at lease areas, acknowledging that much industry focus is on lease areas and questions around whether covariates need to be focused on within leases. Different levels of analysis can be done, from the lease level to the broader scale to help understand the broader impacts from OSW activity on protected species.*

- One attendee suggested creating areas of special interest to create data that can later feed into model development, as modelers like to have a location where they can connect the presence of a particular species with confounding factors.

Detector Technology & Parameters

- One attendee noted that, when looking at recording packages, it might be worth paying attention to the clock drift, especially if localization is a secondary priority, as too much clock drift will interfere with localization. They also highlighted that Instrument costs may have an initial cost that is low compared to deployment and analysis costs, so instruments should be chosen based on their capacity to meet all priorities, less based on initial cost.

- Another raised concerns about relying on a 20km detection range for NARW in some areas with elevated low-frequency ambient conditions from vessel noise around 105-115

decibels, noting that considerations around how to adapt detection ranges to confounding noise conditions within a grid approach raise questions about what work has been done to separate scientific issues that are independent of OSW activity. The member emphasized the importance of baseline information to assess impact.

    - One attendee noted that a grid spacing of 20 km means a detection range of 10 km in Cartesian coordinates, but if you look diagonally, it may present a detection range of ~14 km.

    - *NOAA commented that recorders are often placed where we know that we are not going to lose them or where it's feasible to retrieve them easily so they will not all be placed in the center of each grid.*

- Attendees discussed whether the 2KHz sample rate with 1000Hz frequency range is viewed as sufficient, informed by the optimal sampling duration of a 2KHz simple rate with a 1000Hz Nyquist as well as a recent study in the NY Bight indicated that baleen whale vocalizations are detectable below 5KHz. One attendee suggested investing in raising the minimum sampling rate up to 4KHz to enable a more comprehensive data collection.

- When asked about preferences between continuous versus duty cycle recording, attendees commented that it will be reliant on detectability - if sounds will be produced more infrequently, continuous could be a better choice, acknowledging that data processing and analysis will come with its own costs to consider. Attendees stressed the need to determining the primary task and then design their approach around meeting that objective.

BREAKOUT DISCUSSIONS: BARRIERS AND OPPORTUNITIES FOR ADVANCING A REGIONAL APPROACH

Following the plenary discussion, attendees were then organized into four breakouts by sector to explore a series of questions related to identifying barriers and opportunities for advancing a regional PAM approach within their sector (state, federal, developers, and academia and non-governmental organizations (NGOs).

Below is a brief synthesis of key discussion threads raised in breakout discussions, organized by sector.

Academia & Non-governmental organizations

- **Barriers to academia/NGO sector:** Lack of sustained funding; capacity for coordination of multiple projects and operating at a large regional scale; lack of clarity on the end goal so that the right data is collected.

- **Barriers to other sectors:** Funding at the state and federal level, including very heterogeneous ability for states to pay; lack of clarity as to where regional coordination could truly sit.

- **Potential contributions from academia/NGO sector:** Academics anticipate continuing to participate in workshops like this, gathering and sharing data, and publishing their findings. NGOs stated that they could share information across all levels and serve as an advocate for funding.

- **Practical next steps:** Look at existing data to inform future OSW and monitoring projects, with an urgency behind advancing monitoring efforts; set up a regional science community, looking into existing regional groups like the Regional Ocean Partnership and Wind Research Council to organize as a hub for data sharing; potentially starting at a sub-regional level in New England to get started initially, setting up standards and methodology for monitoring; looking at precedents that have been set for other large scale regional monitoring projects.

States

- **Barriers to state sector:** Funding, for both instrumentation and long-term data storage and analysis; permitting, in terms of where a sensor is placed.

- **Barriers to other sectors:** States noted that a regional approach would break down many barriers, but some barriers to other sectors include: interactions with other uses (e.g., PAM deployments being trawled up in gear) as well as permitting aspects of sensor placement, noting that regional data portals could be used to help address this.

- **Potential contributions from state sector:** States highlighted their participation in the Regional Ocean Partnerships (NROC and MARCO) and in the formation of the Regional Wildlife Science Entity (RWSE) as good examples of how they are working on advancing this regional approach. States also noted that regional data portals could be useful tools in siting some of these detectors. To advance regional collaboration, states suggested bringing in MARA/NERACOOS to leverage deployment opportunities.

Section 309 funding allows states, in some cases, to set aside money for data collection, and many states have been conducting baseline data collection on marine mammals for the past several years, often using PAM.

- **Practical next steps:** Some states indicated they may be able to fund a few grid cells of PAM that developers wouldn't target for various reasons. States also noted that they'd be willing to work on the Gulf of Maine planning as this framework develops, with a lot of focus on the southern New England and Mid-Atlantic regions.

Developers

- **Barriers to developer sector:** better understanding of costs associated with deploying and maintaining PAM sensors as well as with data storage and analysis; fairness in allocation of costs across multiple sector (e.g., expectations that developers could bankroll all proposed efforts is neither fair nor realistic).

- **Barriers to other sectors:** Funding and allocation of costs across sectors; limited regulatory reach for government sectors to address noise impacts of maritime industries.

- **Potential contributions from developer sector:** Developers named a desire to work in partnership with other sectors, with their primary focus and purpose remaining on the mitigation and monitoring of their projects specific to regulatory and other requirements.

- **Practical next steps:** Exploring a professional, independent host entity to run this regional approach from a science-based perspective; capturing and sharing lessons learned from previous developer efforts to inform the advancement of a regional approach; clarifying the objectives of a regional data collection and monitoring to inform the approach design

Federal

- **Barriers to federal sector:** Funding and logistics to move beyond the conceptual; determining the kinds of monitoring regulatory agencies can require for projects.

- **Barriers to other sectors:** Funding; meeting regulatory requirements for monitoring (developers).

- **Potential contributions from federal sector:** Interest from the Navy's marine species monitoring program to contribute to data collection and analysis where it aligns with training and testing monitoring priorities (i.e. locations and focus species) and perhaps broader Navy support if it is a part of the evolution of AMAPPs.

- **Practical next steps:** Establishing a steering group or consortium-type structure (RWSE) to help advance this effort, determining the level of independence and collaboration for that group; generating a cost estimate for the entire regional approach to inform discussions about cost allocations; explore how to best manage the data that will be emerging from this approach; focus on New England and work with developers to try to meet monitoring expectations.

Group Discussion & Polling

Following report outs from breakout discussions, attendees engaged in a brief discussion about whether the RWSE could suffice as an independent entity to manage a regional PAM approach, with some attendees indicating that RWSE could be a good fit and that there should be discussion and evaluation of who would be involved in management efforts. Emily Shumchenia, the new director of the RWSE, provided a brief overview of what the RWSE is, an entity conceived of and developed by the four sectors present at the workshop and hosted by NROC, MARCO, and the Coastal States Stewardship Foundation (CSSF) to help advance wildlife science efforts at a regional scale. The Marine Mammal Commission was also highlighted as an important voice in this space to spark collaboration and advance this effort.

To close, attendees participated in a brief Mentimeter online poll to indicate their agreement with a variety of statements related to establishing a regional PAM approach. Results follow below:

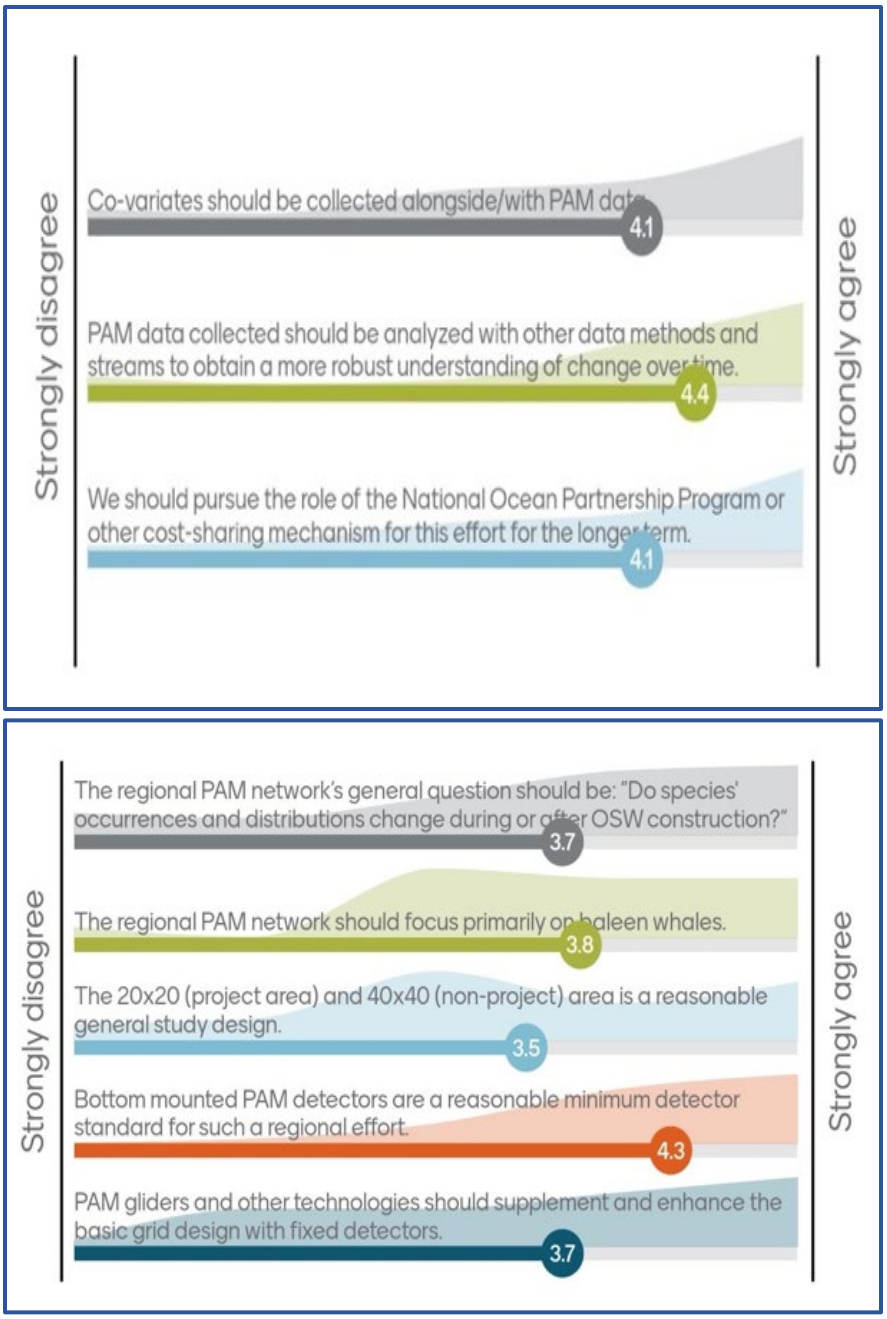


Figure 1. Mentimeter poll results for agreement or disagreement with elements of a regional PAM strategy.

PRESENTATION: DATA CONSISTENCY, REPORTING, STORAGE, AND ACCESS

Following breakout discussions and report outs, NOAA NCEI Fisheries Acoustics Archives' Carrie Wall Bell shared a brief presentation on data management and access (see presentations in Appendix C). She highlighted the challenges for greater consistency for comparability, storage, and access that are present with existing PAM data and previewed what BOEM and NOAA hope to cover in the second PAM Workshop in the late summer/fall of 2021.

Below are attendee questions and comments raised following Dr. Wall Bell's presentation. Answers from NOAA and BOEM are *italicized*. Attendee questions/comments following up on exchanges are in plain text.

If you are compressing data using FLAC, does that mean that each time somebody requests it, do you need to decompress it? And kind of how does that work?

- *FLAC is a standard format for data and can be played as an audio file, so there is a lot of functionality built into the standard data processing routines that could be used with this format. It can also be easily converted to another format.*

ACTION ITEMS

Table 2. The following action items emerged from the two-day workshop and its discussion

TOPIC	ACTION
Grid Design and Minimum Tech Specs Recs	Review grid design for statistical power/issues, shipping lane considerations, grid size, detection limits of detectors and so forth; refine and hone purpose/intent/hypotheses. Review the various specs for detectors (continuous, time clock, kHz) and requirements and additional, low-cost supplemental detectors for basic co-variates. Consider GIS data and centroids place on Portal development site (non-public)
Costs	Develop a somewhat detailed unit cost deployment for sensors, to the extent possible, given the range of variables like ship time, distance from shore, etc.
Lessons Learned	Potentially talk to, host webinar or short write up from Alaska and Beaufort Sea, Gulf of Mexico, or elsewhere for informing regional stakeholders on lessons learned from elsewhere (for all data) on large scale, integrative efforts, PAM & beyond
Rapid Deployment	Coordinate among one another; identify limited number of detectors needed (toll gate, NE gradient design), justification for them, develop general framework based on guidance from NOAA above; individual organizations possibly procure and deploy
Inventory	Inventory existing PAM recorders and identify which ones may want to keep in water if possible after their currently planned end time passes

CLOSING REMARKS

Kyle Baker thanked attendees for their engagement and contributions to the two-day workshop, noting that the planning team will regroup and begin to prepare for the upcoming second workshop potentially focused more on data management and archiving.

APPENDIX A WORKSHOP AGENDA

Improving Monitoring, Data Consistency, Archiving, and Access for Improved Regional Integration of Renewable Energy Science
PAM and Marine Mammals

Bureau of Ocean Energy Management (BOEM)
June 2 and 3, 2021
Draft Agenda

Objectives for Workshops:

- Develop regional strategies for passive acoustic monitoring (PAM) and data collection for marine mammals for northwest Atlantic areas of offshore wind development from Maine to the Carolinas;
- Create approaches for acoustic data management and coordination;
- Explore more consistent approaches to PAM including equipment specifications, study design, collection, analysis, and storage for data before and after wind farm construction with a goal of detecting regional changes in marine mammal habitat use patterns.

Pre-Reads:

- MA CEC Wind and Whale Framework
- WCS New York Bight Workshop Summary

Day 1: June 2 Agenda

TIME (ET)	PURPOSE	ITEM	PRESENTER
8:45	Tech Check	**Opening of Platform** • Participants may sign-on up to 15 minutes ahead of the start of the conversation to get adjusted to the web-based technology, sound and video check	CBI
9:00	Introduce	**Welcome** • Welcome, agenda, rules of the road • Mentimeter poll on who is in the room by sector, expertise, geography • Registrants and titles/orgs shared ahead of time	CBI
9:10	Level Set	**Why We Are Here** • Why BOEM decided to host these workshops • What we are covering and not covering in this workshop (regional from the Gulf of Maine to the Carolinas, PAM for monitoring of marine mammals, not mitigation • Broad trends and understanding, pre and post construction objectives • What we'll produce as a product • Q&A	Kyle Baker, BOEM

TIME (ET)	PURPOSE	ITEM	PRESENTER
9:40	Learning	**What is PAM, Where and Why it is being deployed on the Atlantic Coast for Marine Mammals** • Brief overview on methods and emerging technologies, analyses, data, storage, and archiving • Overview of PAM monitoring efforts by multiple actors over the last 10 years – geographic focus, intent, sponsor, scale, data produced • Q&A	Sofie VanParijs, NOAA, and Erica Staaterman, BOEM
10:15	Discussion starter	**A Regional Monitoring Framework for PAM** • What might a regional PAM monitoring approach help us learn and know that we do not know now? • What might it look like at scale and size to meet that purposes? • How might it be deployed? • When should it start? • How would it build on what is already in place? • What couldn't it do? • NOT discussing practically how, who pays, who analyzes the data, costs, etc. (for Day 2) • Mentimeter tool to explore possible hypotheses	Sofie VanParijs, NOAA, and Erica Staaterman, BOEM
11:00	Break	**At break, participants will use an interactive mapping tool to locate existing PAM detectors on regional map**	
11:15	Discussion	**Breakout Groups** • Look at Map together • Set approach to breakouts • Group broken down into groups of about 15 (assume 3 groups with 45 participants) in mixed groups • Discussion Questions for Breakouts	
12:15	Report Back	**Report Backs and Final Discussion** • Each breakout group reports back succinctly • Mentimeter allows others to add more detail as needed • Full group makes additional comments	CBI
12:45	Closing	**Summary and Next Steps** • Plan for Day 2	CBI

Day 2: June 3 Agenda

TIME (ET)	PURPOSE	ITEM	PRESENTER
8:45	Tech Check	**Opening of Platform** • Participants may sign-on up to 15 minutes ahead of the start of the conversation to get adjusted to the web-based technology, sound and video check	CBI

TIME (ET)	PURPOSE	ITEM	PRESENTER
9:00	Welcome Back	**Welcome** • Welcome, agenda, rules of the road • Summary of Day 1 and key issues raised	CBI
9:15	Deepening Discussion	**Further Refining the Regional Framework** • Discussion of the Framework, possible improvements, and outstanding questions • Further exploration of the map tool as needed	CBI
10:15	Discussion	**Identifying Barriers and Opportunities for Advancing a More Regional Approach** • Breakout groups by sector (state, federal, developers, academic and NGO) • The groups discuss: 1) what are barriers to making this happen from your sector (not others!); 2) what are barriers you see from other sectors; 3) what could your sector contribute to advancing a more regional approach – how could you be part of a more regional approach; 4) what might be some practical if modest next steps?	
11:00	Break	**Break**	
11:15	Report Back	**Report Backs and Final Discussion** • Each breakout group reports back succinctly • Mentimeter allows others to add more detail as needed • Full group makes final comments • Role of the regional wildlife science entity • Next steps	CBI
12:00	Previewing the Next	**Data Consistency, Reporting, Storage, and Access** • With existing data, the challenges of greater consistency for comparability, storage, and access • What we hope to cover in PAM Workshop #2 in late summer • Q&A	Carrie Wall Bell, NOAA NCEI
12:20	Closing	**Where to from Here** • Brief summary of two days • Next steps and what BOEM and NOAA intend to do with this discussion	CBI and Kyle Baker, BOEM
12:30	Adjourn	**Adjourn**	

APPENDIX B WORKSHOP PARTICIPANTS

Attendee Name, Affiliation	Day 1	Day 2
Kyle Baker, BOEM	Yes	Yes
Shannon Barber-Meyer, USGS	Yes	Yes
Mark Baumgartner, WHOI	Yes	Yes
Joel Bell, US Navy Marine Species Monitoring	Yes	Yes
Tiff Brookens, MMC	Yes	Yes
Colleen Brust, NJDEP	Yes	Yes
Jordan Carduner, NMFS	Yes	Yes
Christopher Clark, Cornell	Yes	Yes
Mary Cody, BOEM	Yes	Yes
Peter Corkeron, NEAq	Yes	Yes
Amanda Cross, MDIFW	Yes	
Corrie Curtice, MGEL Duke	Yes	Yes
Jaclyn Daly, NMFS	Yes	Yes
Genevieve Davis, NOAA NEFSC	Yes	Yes
Sam Denes, BOEM	Yes	Yes
Karin Dolan, US Navy	Yes	Yes
Lisa Engler, MA CZM	Yes	
Carter Esch, NMFS	Yes	Yes
Paula Estornell, DOI	Yes	Yes
Patrick Field, CBI	Yes	Yes
Jason Gedamke, NOAA	Yes	Yes
Shane Guan, BOEM	Yes	Yes

Cameron Hager, CBI	Yes	Yes
Erin Healy, Mayflower Wind	Yes	
Kyle Hilberg, Atlantic Shores	Yes	Yes
Brian Hooker, BOEM	Yes	Yes
Laurie Jodziewicz, US Wind	Yes	Yes
Francine Kershaw, NRDC	Yes	Yes
Anu Kumar, Navy	Yes	Yes
Erin LaBrecque, MMC	Yes	Yes
Elizabeth Lange, NJDEP Marine Fisheries	Yes	Yes
Catherine McCall, MDNR	Yes	Yes
Laura McKay, VA CZM Program	Yes	Yes
Jennifer Miksis-Olds, UNH	Yes	Yes
Laura Morse, Orsted	Yes	Yes
Anita Murray, WCS	Yes	Yes
Nick Napoli, NROC	Yes	Yes
Chris Orphanides, NOAA Fisheries	Yes	Yes
Maggie Osthues, CBI	Yes	Yes
Susan E Parks, Syracuse University	Yes	Yes
Ruth Perry, Shell	Yes	Yes
Kelsey Potlock, NMFS	Yes	Yes
Cynthia Pyc, Vineyard Wind	Yes	Yes
Shannon Rankin, NOAA	Yes	Yes
Aaron Rice, Cornell	Yes	Yes
Meghan Rickard, NYSDEC	Yes	Yes
Matt Robertson, Vineyard Wind	Yes	Yes

Marie Roch, San Diego State University	Yes	Yes
Howard Rosenbaum, WCS	Yes	Yes
Amy Scholik-Schlomer, NMFS	Yes	Yes
Emily Shumchenia, NROC	Yes	Yes
Nick Sisson, NMFS	Yes	Yes
Erica Staaterman, BOEM	Yes	Yes
David Stormer, DE Fish & Wildlife	Yes	
Todd Sumner, US Wind	Yes	Yes
Sofie Van Parijs, NOAA NEFSC	Yes	Yes
Prassede Vella, MA CZM	Yes	Yes
Carrie Wall, CU/NCEI	Yes	Yes
Stephanie Watwood, US Navy NUWC Newport	Yes	Yes
Jürgen Weissenberger, Equinor	Yes	Yes
Tina Yack, MGEL Duke	Yes	Yes

APPENDIX C WORKSHOP PRESENTATIONS

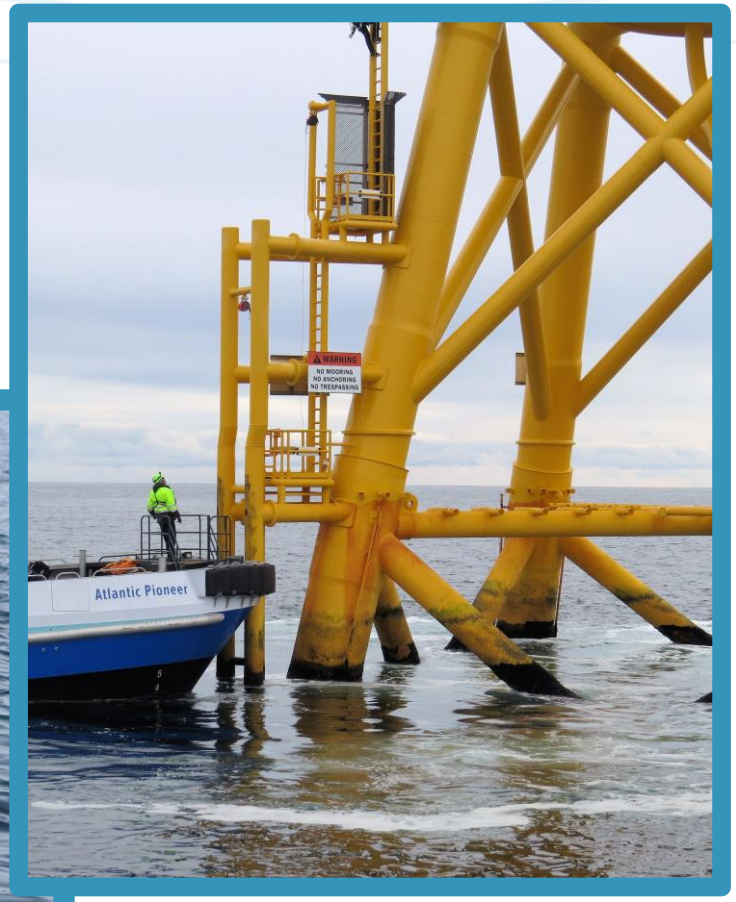
BOEM
Bureau of Ocean Energy Management

Improving Monitoring, Data Consistency, Archiving, and Access for Regional Integration of Renewable Energy Science

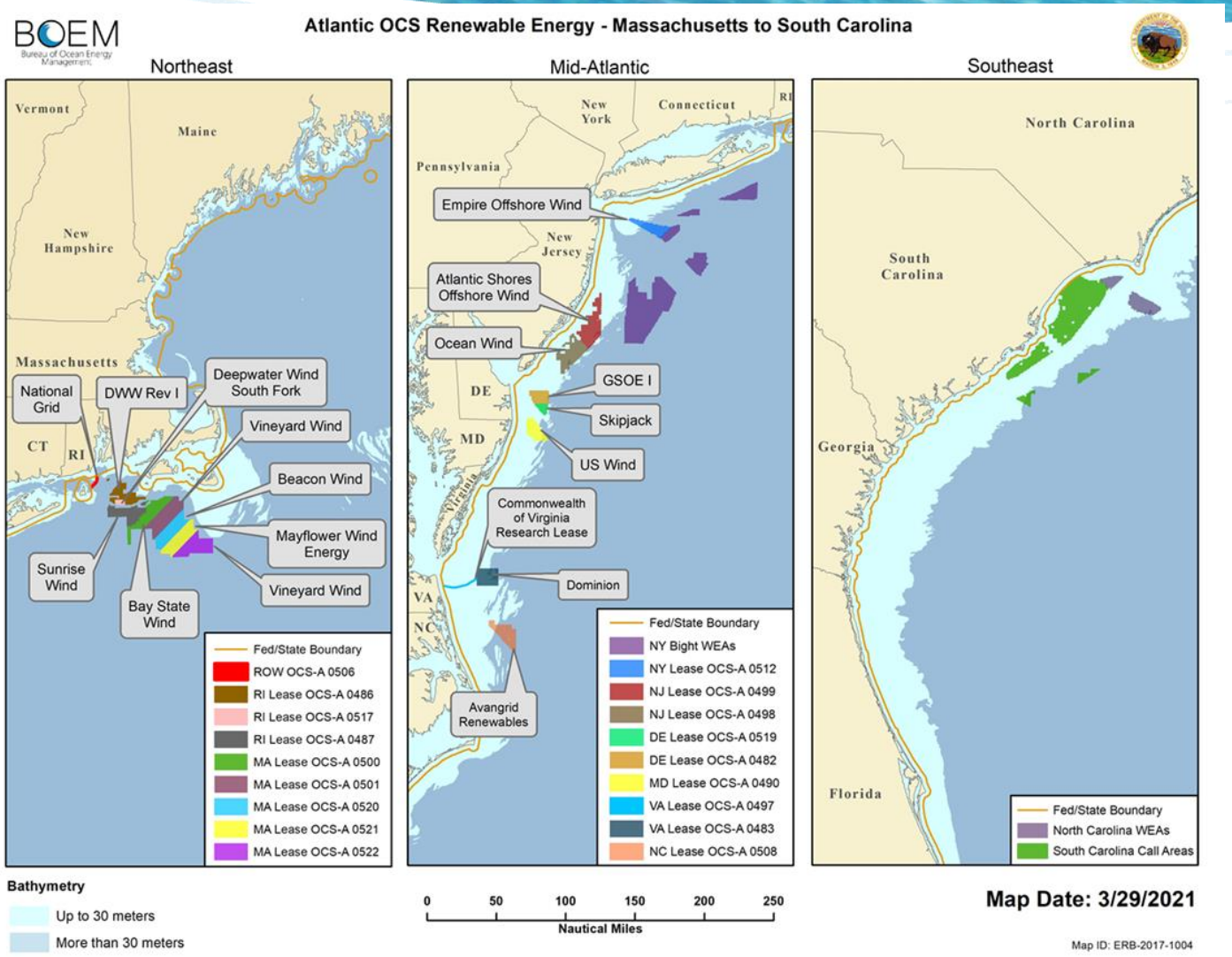
June 2-3, 2021

Kyle Baker, Marine Biologist, Office of Renewable Energy Programs

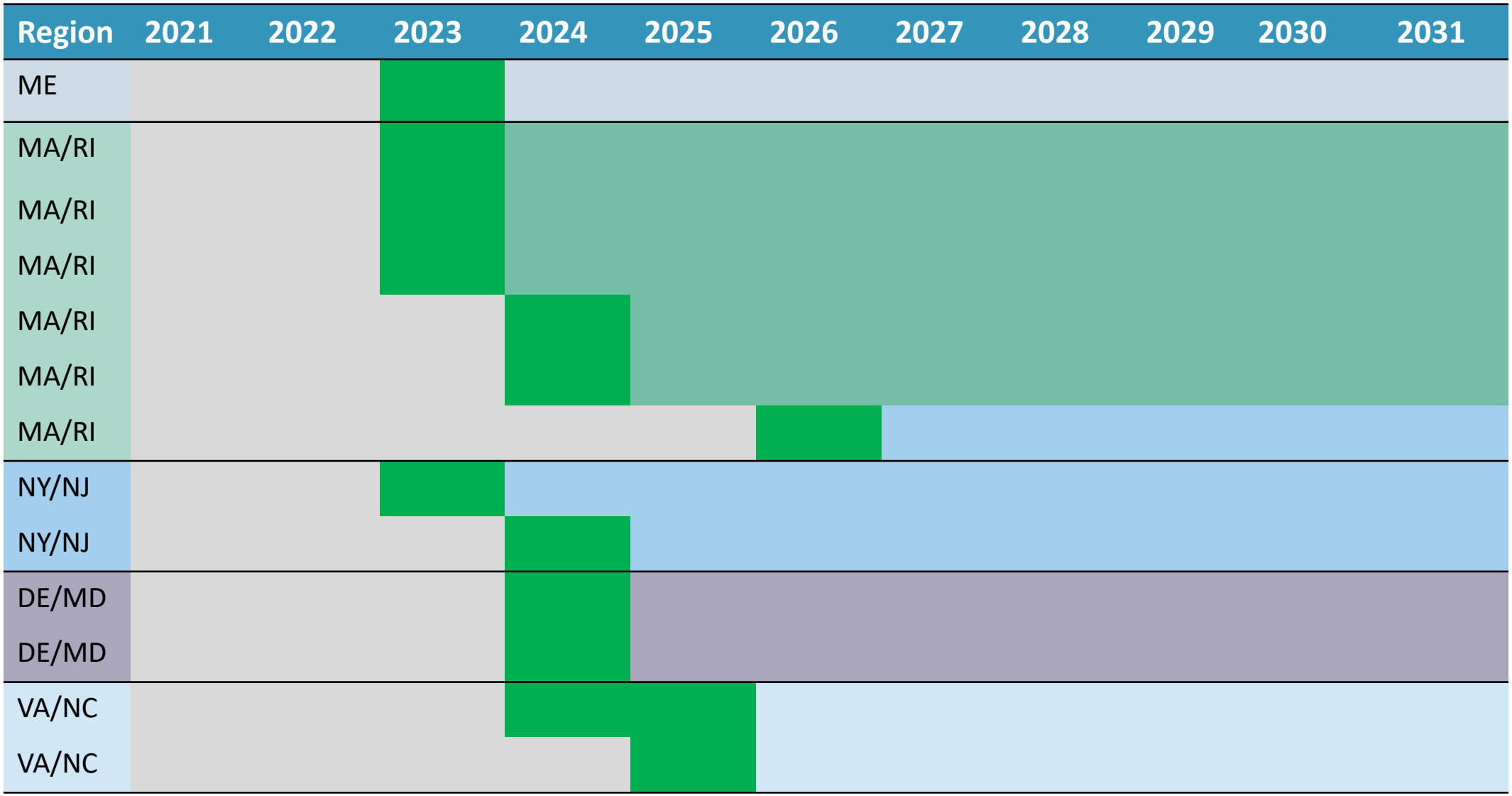
Welcome!



Background – Current Snapshot of Atlantic Offshore Wind



Potential Construction Schedules for Active Projects by Region



Total Estimated Annual Number of Foundations for Current and Future Projects (Maximum Impact Scenario)

Area	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030 and Beyond
ME			1							
MA/RI	0	0	181	353	139	401	0	0	0	0
NY/NJ	0	0	101	121	131	200	0	0	0	
DE/MD	0	0	11	129	0	0	0	0	0	0
VA/NC	0	0	0	139	131	0	0	0	0	0
Total	0	0	294	742	401	601	0	0	0	0

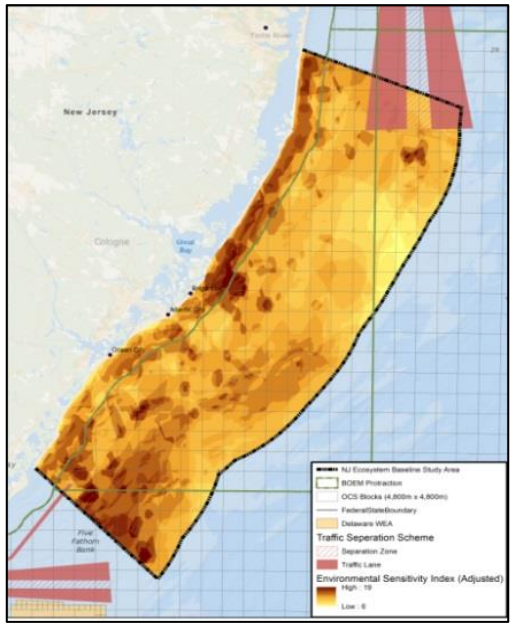
* Estimates are a maximum case scenario as of April 2021. These estimates are subject to future changes and updates.

PAM Data Before Construction and Construction & Operations

Pre-Construction Data

Construction

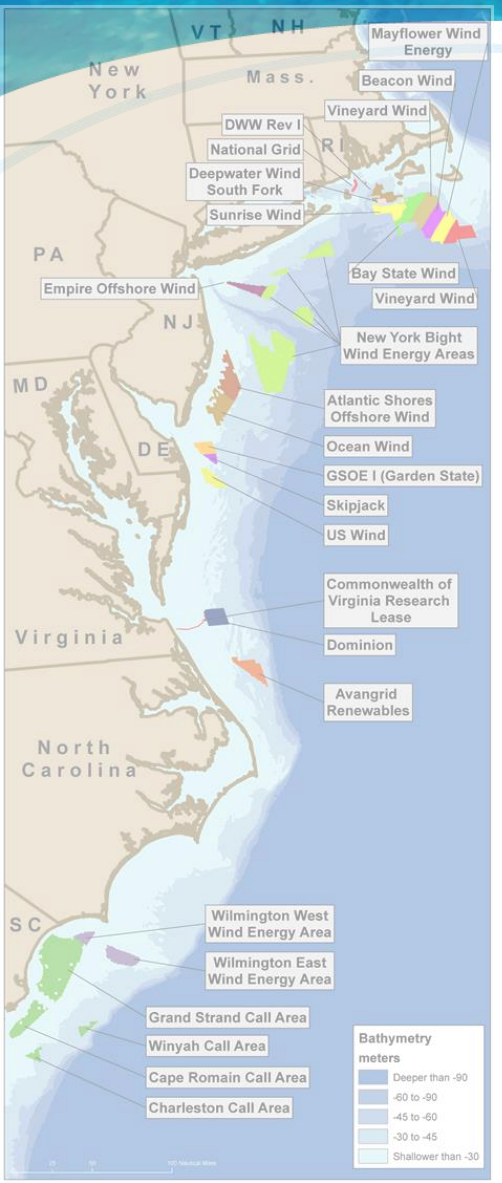
Planning, Analysis, & Leasing (0-2yr)



Site Assessment and Surveys (0-5 yr)

Construction & Operations (~30 yr)

Pre-Construction PAM Efforts in Atlantic Wind Energy Areas



Region-wide: *2010-Present:* RODEO (Real-Time Opportunity for Development Environmental Observations)

- 2010-Present: Atlantic Marine Assessment Program for Protected Species.

MA/RI 2019: Evaluating the Accuracy and Detection Range of a Moored Whale Detection Buoy near the Massachusetts Wind Energy Area.

- 2016-2021 (may be extended): Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles.

NY 2017-2019: Annual Survey Report for New York Bight Whale Monitoring Passive Acoustic Surveys

- 2016-Present: WCS/WHOI Acoustic Buoy

MD 2019: Determining Habitat Use by Marine Mammals and Ambient Noise Levels Using Passive Acoustic Monitoring Offshore of Maryland.

VA 2019: Understanding Whale Presence in the Virginia Offshore Wind Energy Area

NC 2015: Baseline Bioacoustic Characterization for Offshore Renewable Energy Development in the North Carolina and Georgia Wind Planning Areas

- **2018:** Documenting fish response to seismic surveying and establishing a baseline soundscape for reefs in Onslow Bay, North Carolinas.

Background: Recent Workshops and Reviews

- 2020 New York Bight Passive Acoustic Monitoring Workshop
- 2018 MassCEC Research Framework Workshop
- March 2017 BOEM Best Management Practices Workshop for Atlantic Offshore Wind Facilities and Protected Species
- November 2016 BOEM Atlantic Ocean Energy and Mineral Science Forum PAM Session

Let’s build upon the good work already accomplished!

Research Framework Strategy Goals

New Bedford Research Framework Workshop on May 30-31, 2018

- Guide the long-term study of impacts from wind development
- Review current knowledge
- Develop research questions & hypotheses
- Evaluate design and statistical power to test those hypotheses

Jan 15, 2021 DOE Funding Opportunity Announcement Topic Areas were partly based on this workshop report

Background: 2018 Research Framework Workshop

Three categories of hypotheses

1. Displacement from wind energy area (e.g., noise, construction, operations, and foundations)

2. Animal behavior and or physiology changes (e.g. changes to calling rates, feeding, breathing, movements, stress hormone levels)

3. Habitat alteration disrupts prey species availability for whales

*In regard to cumulative effects, research studies should be designed in such a way that they can contribute to a PCoD or PCoMS models.

A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/A-Framework-for-Studying-the-Effects.pdf

Importance and Testability of Hypotheses from 2018 Workshop

Hypotheses relating to short-term effects of wind energy development

Hypothesis 1 (H, H): Construction displacement of whales away from activity locations.
Hypothesis 2 (H, M): Construction disrupts critical behaviors of whales.
Hypothesis 3 (H, H): Construction causes elevated stress hormone levels in whales.
Hypothesis 4 (L-M, L): Construction causes zooplankton or fish prey to change their vertical distribution, density or patch structure.

Hypotheses relating to long-term effects of wind energy operation

Hypothesis 1 (H, H): Wind turbine presence either excludes or attracts whales.
Hypothesis 2 (L, L): Wind turbine presence affects long-term feeding opportunities for whales.
Hypothesis 3 (L, L): The development of artificial reefs on wind turbine foundations affects the regional ecosystem, potentially enhancing some characteristics of marine productivity.

Research Framework Workshop

Short-term Effects Study Designs

- Passive acoustic study
  - Gradient design
- Movement response
  - Tagging; which species and what type of tags?
- Pseudo-experimental exposure (PEE) studies
  - Individual level; sample size, timing, and regulatory issues
- Aerial Survey
  - Population level, but need lots of flights
- Prey Study
  - Plankton and fish

Research Framework Workshop

Long-term Effects Study Designs

- Acoustic study
- Index sites as proxy – hard to attribute causation if only in Wind Energy Areas
- Aerial/shipboard survey
- Individual-based study – tags
- Oceanographic monitoring
- Develop PCoD model/energetic model/understand inputs

2018 Research Framework Workshop

Other Recommendations

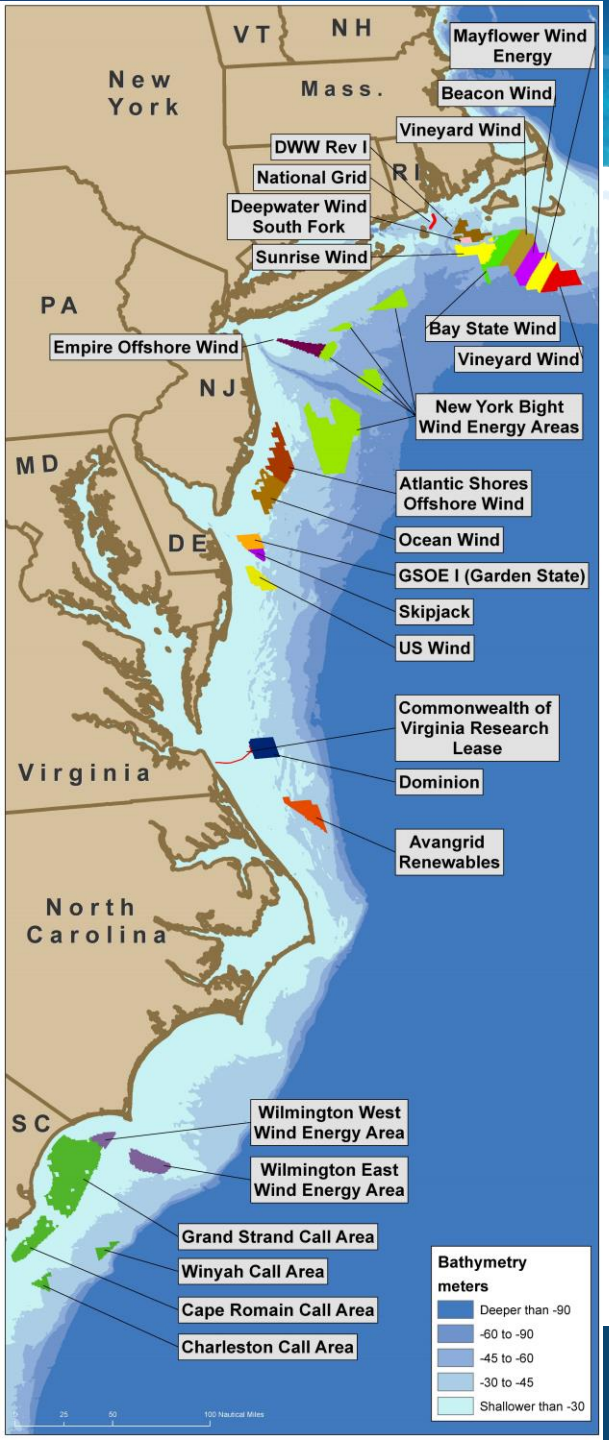
- A review of all passive acoustic work to date
- Updated supplementary spatial density models are needed for wind energy areas (e.g., from digital aerial surveys)
- Review of behavioral, physiological and population effects of impulsive sound sources
- Empirical data collection on the behavioral and physiological effects of impulsive sounds on marine mammals to help validate the existing population consequences modeling efforts
- Research studies should be designed in such a way that they can contribute to PCoD or PCoMS models.
- Zooplankton modelling to better understand the processes that generate patches that whales can feed on

Research Framework Strategy Goals

2020 New York Bight Passive Acoustic Monitoring Workshop

- Develop a NYB (and ideally regional) PAM network with standardized data collection and reporting standards,
- Long-term, broad-scale questions could be answered and used to inform mitigation and best practices, would
- Would require significant resources but may be possible within the context of forthcoming OSW activities and funding in the NYB.

Some Workshop Questions to Consider



- Spatial connectivity/spatial array of PAM deployments
- The type of PAM data to collect
- Consider scope of both short-term long-term impact questions.
- Pre-construction and post construction data, gradient designs, BACI designs, and proxy sites
- Compatibility of data collected across the Atlantic.
- What future studies are planned?
- Accessibility of data for analysis?
- Future coordination and collaboration

PAM Requirements in the Vineyard Wind ROD

- Use devices to record ambient noise and marine mammal species vocalizations in the lease area (before, during, and after construction [at least 3 years of operation]) to monitor impacts.
- The archival recorders must have a minimum capability of detecting and storing acoustic data on vessel noise, pile-driving, WTG operation, and marine mammal vocalizations in the lease area.
- No later than 30 days prior to buoy deployment, the Lessee must submit the PAM plan and receive written concurrence.
- The underwater acoustic monitoring must follow standardized measurement and processing methods and visualization metrics (e.g., the Atlantic Deepwater Ecosystem Observatory Network (ADEON)).
- At least two devices must be independently deployed within the lease area or one or more buoys must be deployed in coordination with other acoustic monitoring efforts in the RI and MA Lease Areas.

✓ A regional strategy is still needed!

https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Final-Record-of-Decision-Vineyard-Wind-1.pdf

Important Topics We Can't Cover at this Workshop

- PAM for mitigation purposes
  - It has been proposed by Developers
  - Supported by BOEM as a detection method in additional to visual observations
  - Required by NOAA under ESA Consultation and MMPA Incidental Harassment Authorizations
- Real-Time detection
- Sound Source Verification (field verification)

Summary

- Consider the Gulf of Maine to the Carolinas
- Focus on regional monitoring and research goals using previous workshops as a guide
- Think about research goals at both the lease scale and regionally
- Consider pre- and post-construction monitoring
- Keep in mind construction schedules of regional neighbors as well as non-neighbors
- Compatibility of PAM data
- PAM data archiving and analysis (next workshop focus)

Workshop Outcomes

- **Workshop Summary**
  - Workshop highlights
  - Action items and next steps
- **PAM Data Standards Workshop later this summer/early fall**
- **Continue to work with multi-sector coordinating groups and meetings to establish common goals**
- **Work with the newly established Regional Science Entity**

Regional Wildlife Science Coordination

- Regional Science Coordination
  - Northeast Regional Ocean Council (NROC), Mid-Atlantic Regional Council on the Ocean (MARCO), and the Coastal States Stewardship Foundation (CSSF)
- Can further facilitate standardizing data collection

BOEM

Bureau of Ocean Energy Management

BOEM.gov

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Section 1
Passive Acoustic Monitoring For Offshore Wind-Applications for Marine Mammals

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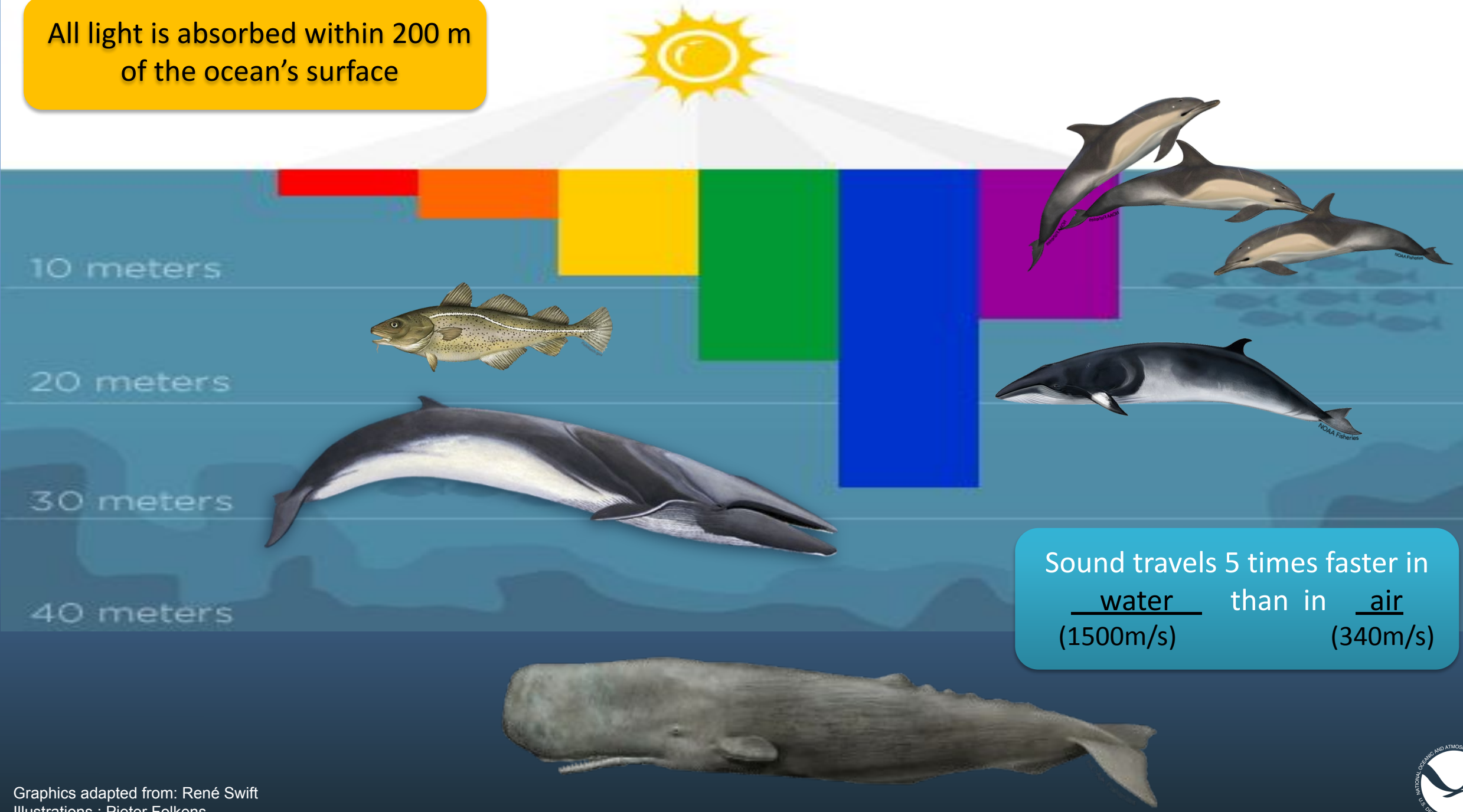
All light is absorbed within 200 m of the ocean's surface



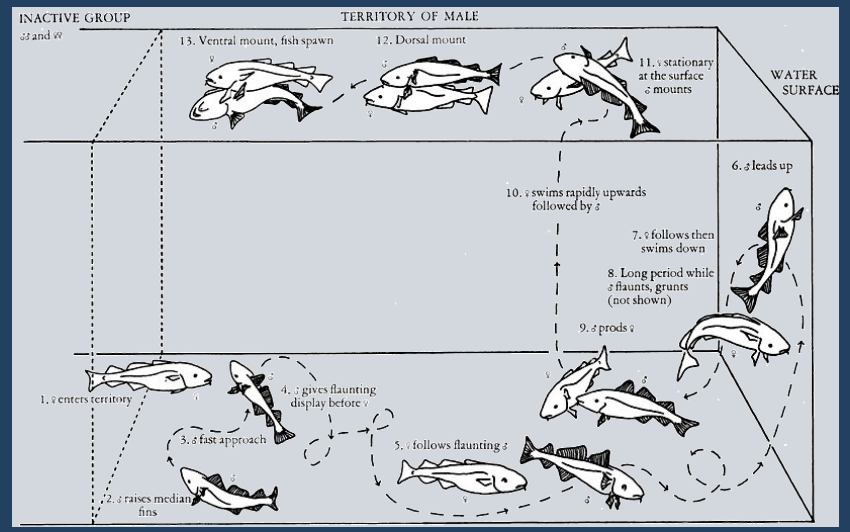
Sound travels 5 times faster in water (1500m/s) than in air (340m/s)

Graphics adapted from: René Swift
Illustrations : Pieter Folkens

Marine Animal Sounds

Communication

- Identification between individuals
- Find mates
- Maintain group structure
- Establish territories or spawning aggregations
- Mother – calf contact
- Aggressive interactions

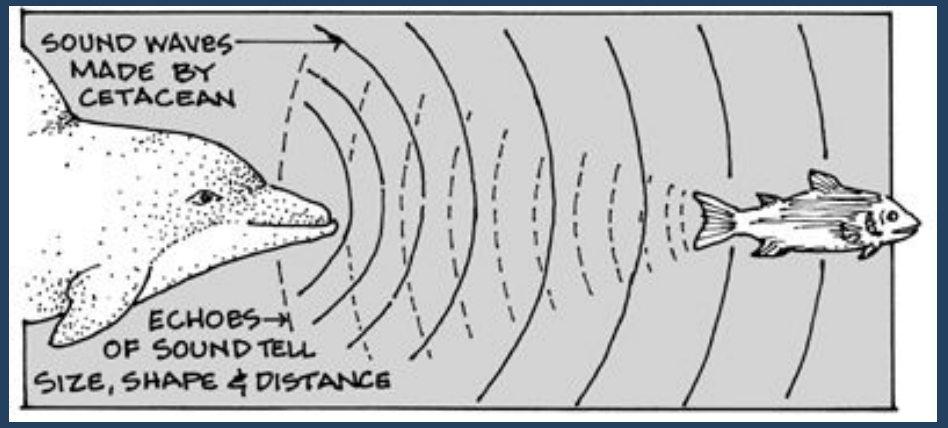


Graphics adapted from: René Swift
Illustrations : Pieter Folkens

Marine Animal Sounds

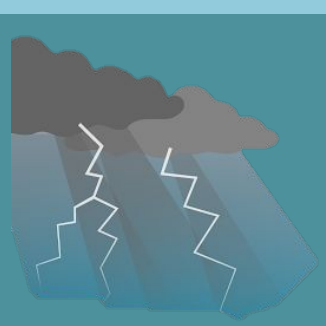
Echolocation/Foraging/Navigation

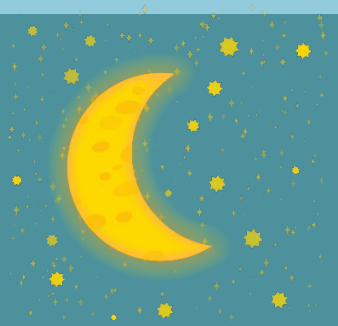
- Detect, localize, and characterize objects
- sharing information about food
- startling prey to aid capture



WHY PASSIVE ACOUSTIC MONITORING? (PAM)

- Provides a non-invasive, valuable alternative or addition to traditional survey methods





+ Benefits +

- Can detect animals at night and in bad weather
- Can do long-term monitoring with reduced field effort and cost
- Can cover wide spatial range

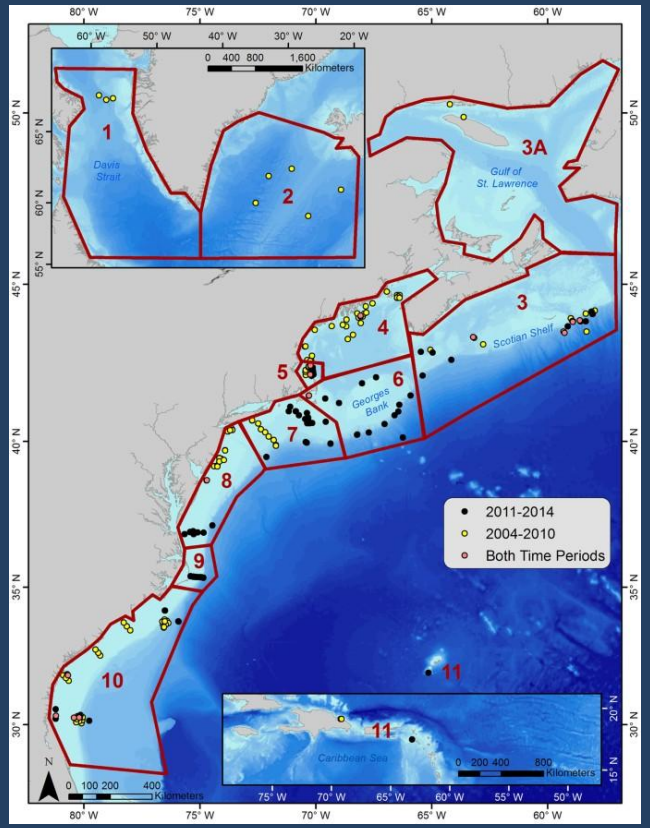
- Limitations -

- Presence only: cannot tell when animals are NOT around
- For most species, difficult to determine number of individuals present
- Many sounds are still unknown

Graphic: NOAA Fisheries

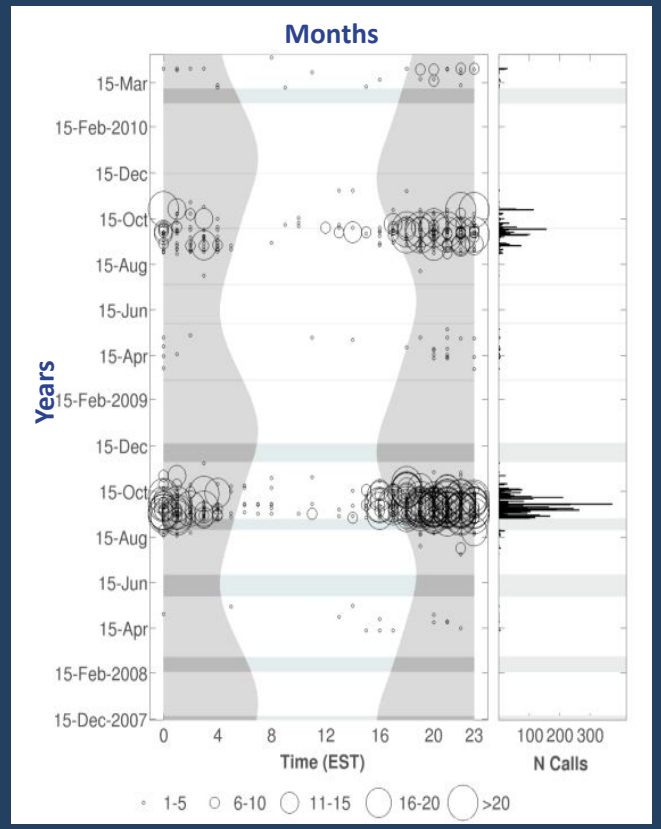
WHY PAM?

Spatial Coverage



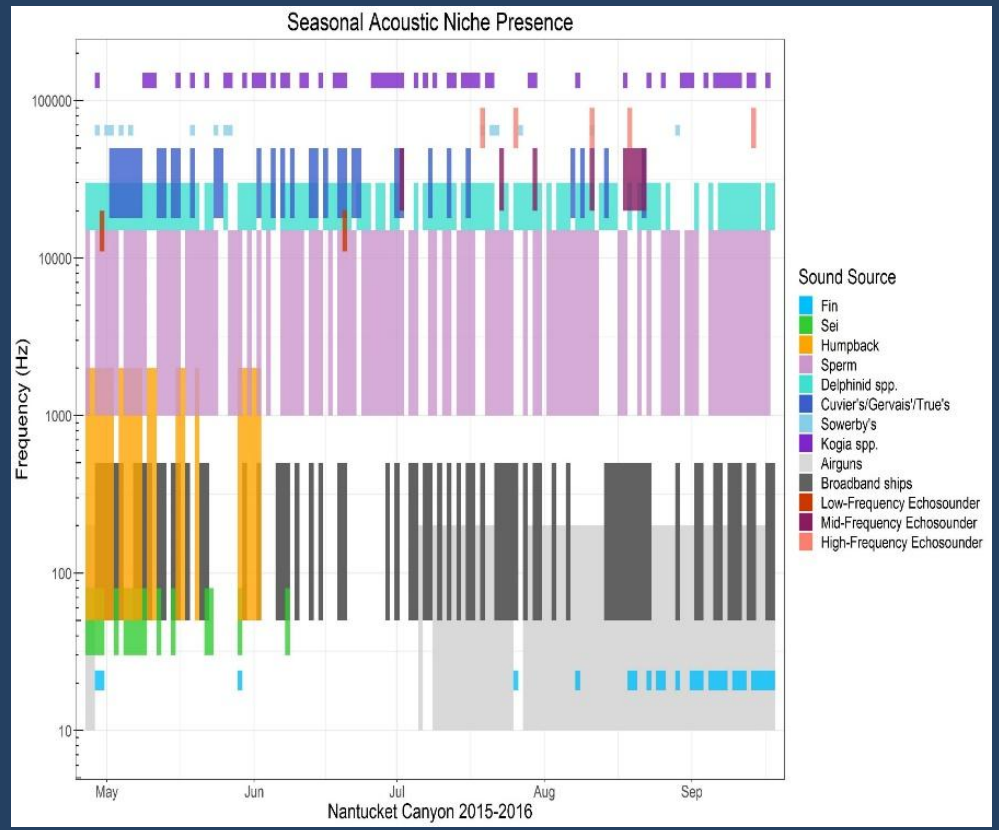
Davis et al. 2017

Long Time Periods



Risch et al. 2014

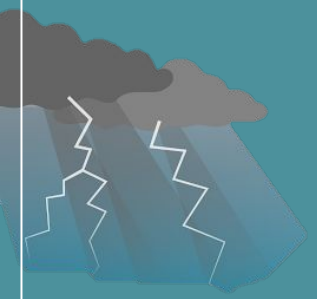
Species Ecology/Soundscape



Weiss et al. *2021*

What is Passive Acoustic Monitoring? (PAM)

Routine recording of underwater sounds in the marine environment over long time periods



Questions:

Q1. Can we detect regional level changes in species presence?

Q2. Can we detect shifts in patterns during and/or after construction?

Graphic: NOAA Fisheries

PAM Applications for Offshore Wind

MITIGATION OF IMPACTS

- Real-time detection of marine mammals
- PAM may be combined with other tools (visual PSOs, AUVs, drones)
- Localization generally preferred
- Shut down of operations when animals in the area
- Decrease vessel strike risk

Focus of this workshop:

REGIONAL MONITORING

- Large scale ecological monitoring focused on species presence, distribution, and shifts in patterns
- Long term PAM design

SOUND FIELD VERIFICATION

- Measuring sounds from pile-driving
- Compare to model results
- Required for IHAs

Graphic: NOAA Fisheries

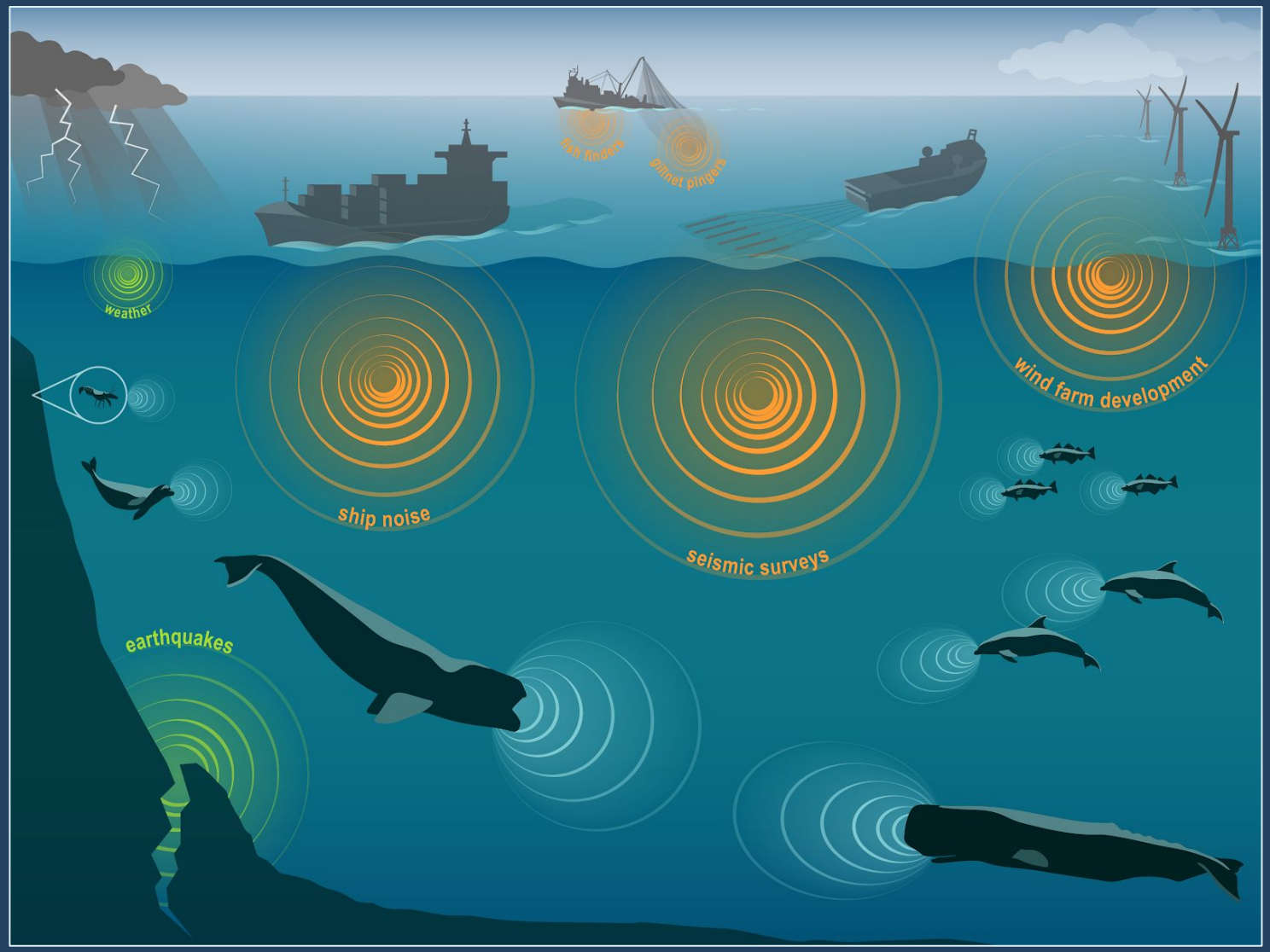
Questions to Consider when using PAM

1. **What are your Species of Interest?**
2. What are your PAM Recording Technologies ?
3. What are your PAM System Requirements?
4. What is your PAM Data Collection Design?
5. What information does your PAM Data provide?
6. How will you Report and Archive your PAM data?

* Is Our Approach Realistic? Is it Affordable? Can it Answer the Basic Questions?*

1. Multi-Species & Ecological Focus

- ESA listed large whales (sei, fin, blue, sperm, right whales)
- Other marine mammals
- Soniferous Fish
- Invertebrates



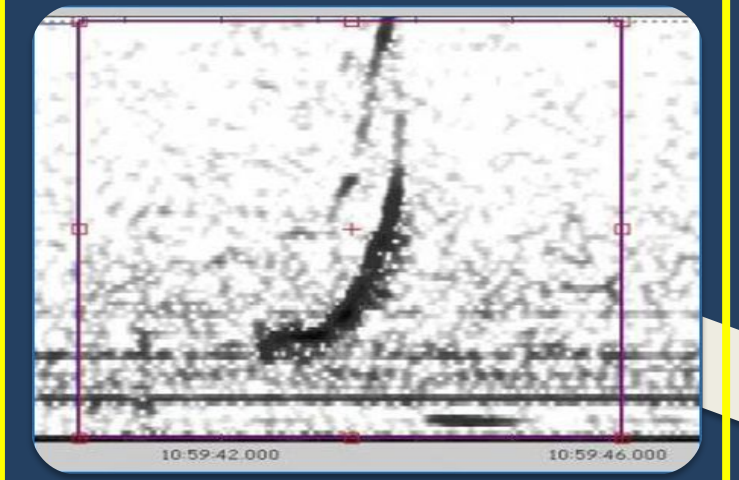
Graphic: NOAA Fisheries

- Anthropogenic Sounds
- Environmental

1. Our Species of Interest?

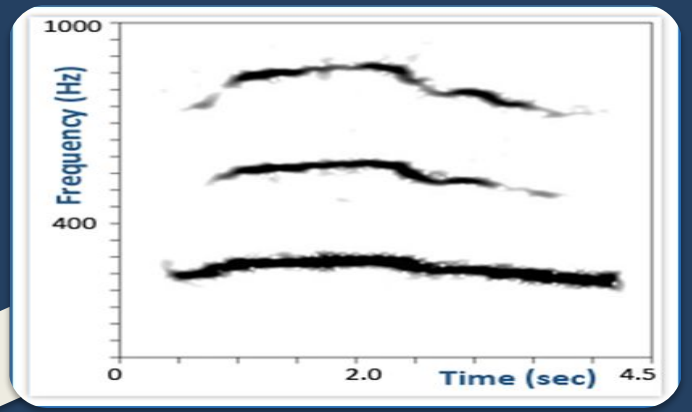
Call Type of choice

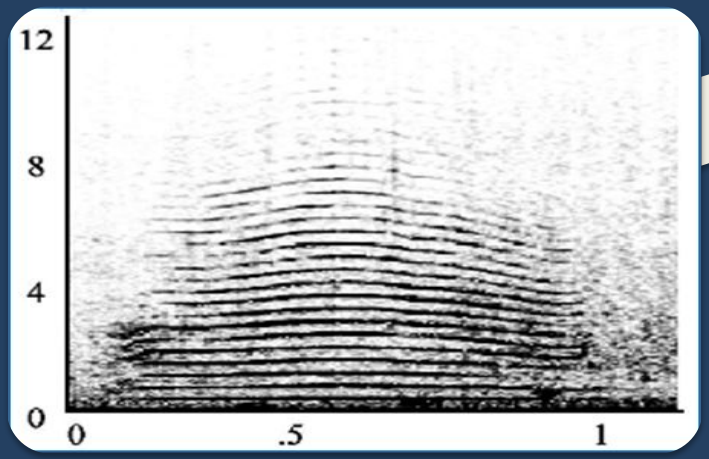
North Atlantic Right Whale



Upcall

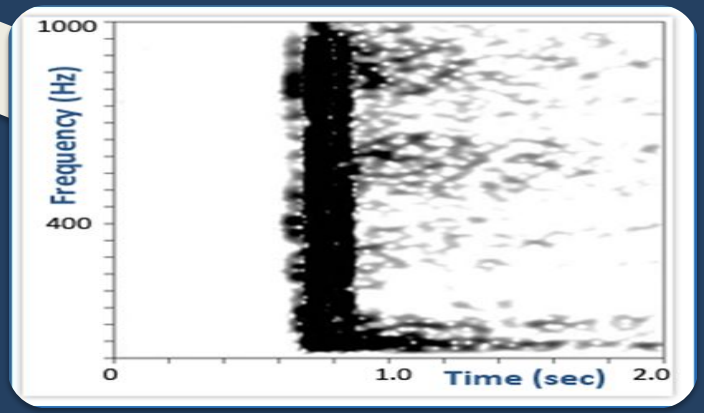
Moan



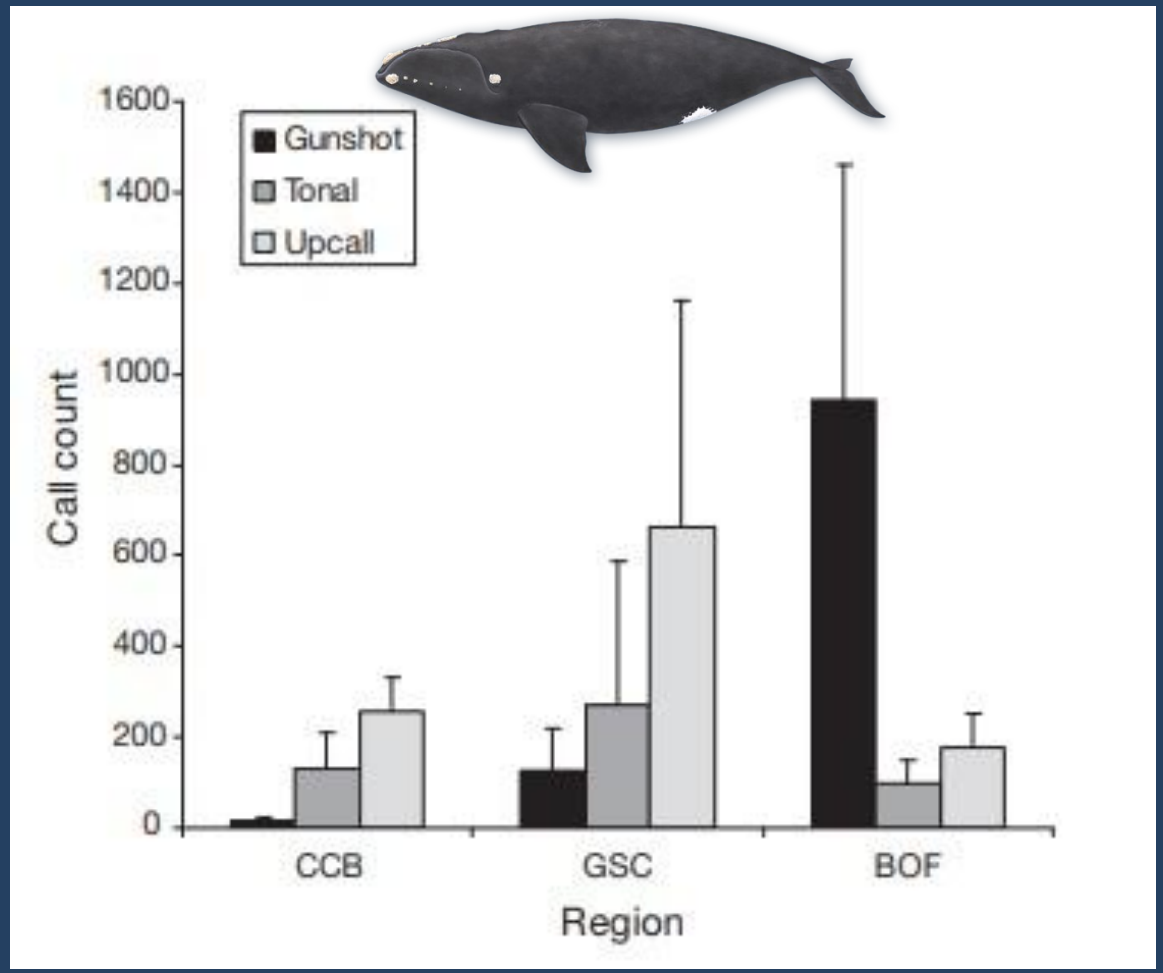


Scream

Gunshot



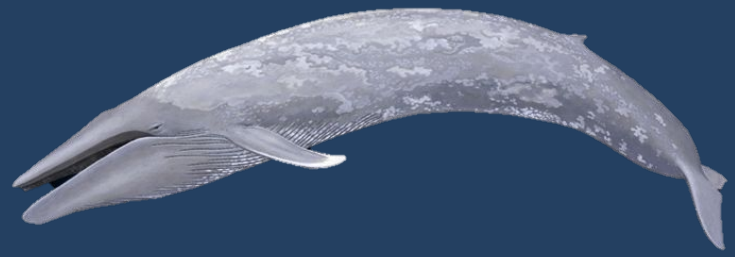
1. Why the NARW Upcall?



Upcall used across all habitats in US NE region

Van Parijs et al. 2009 Marine Ecology Progress Series

1. Other Large Whales



Blue whales
Fin whales
Sei whales
Humpback whales
Minke whales

Primary focus is **NOT** on toothed whales (sperm whales, dolphins), harbor porpoise, or fish

- However, if desired, additional hydrophones and increased sample rates could be used

Questions to Consider when using PAM

1. What are your Species of Interest?
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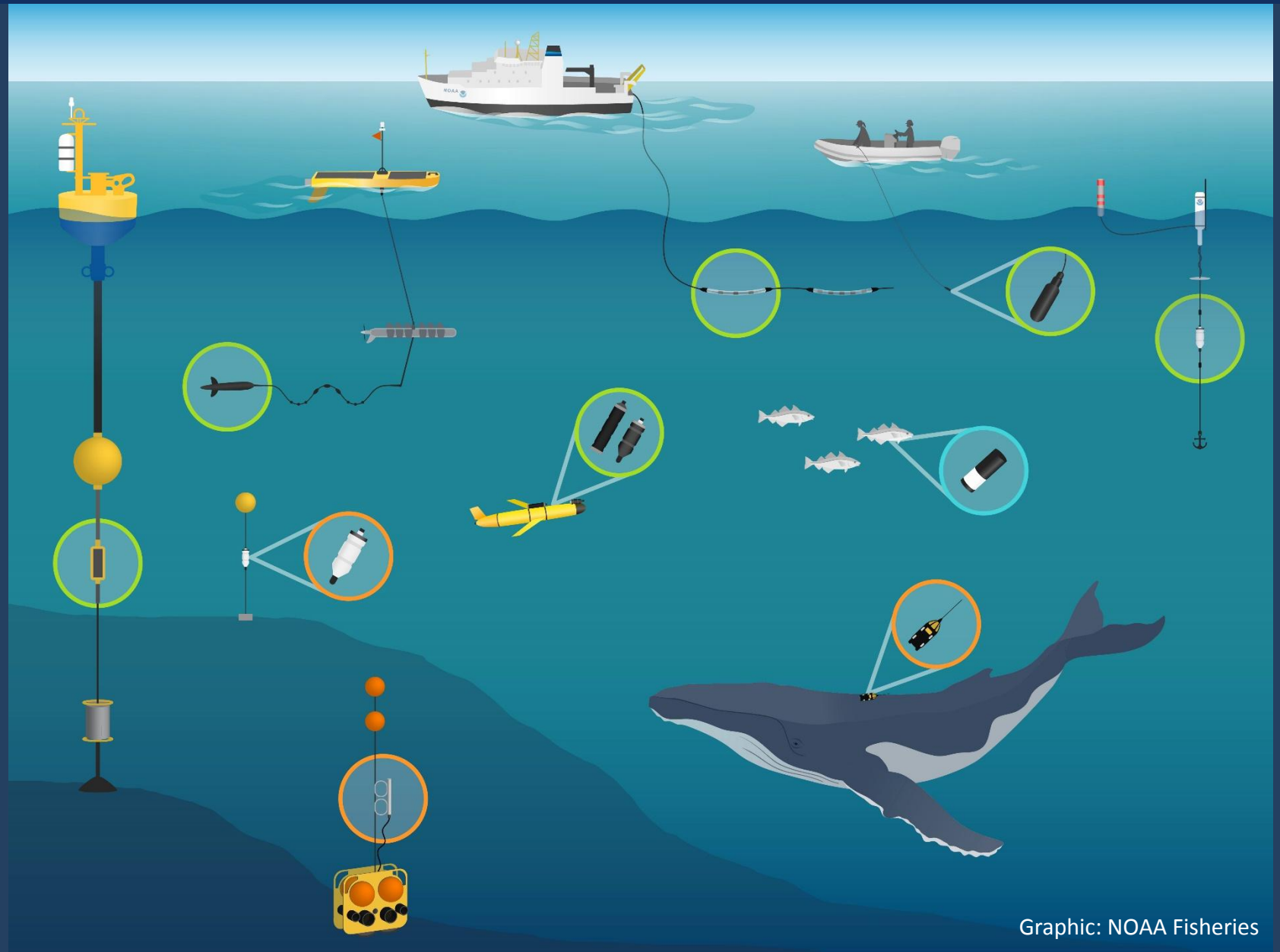
4. What is your PAM Data Collection Design?
5. What information does your PAM Data provide?
6. How will you Report and Archive your PAM data?

2. PAM Data Collection: technologies

ARCHIVAL

- Bottom-mounted recorders
- Acoustic tags
- Telemetry tags (active)



Graphic: NOAA Fisheries

REAL TIME

- Moored buoys
- Gliders
- Towed Arrays
- Drop hydrophones
- Drifting buoys

Questions to Consider when using PAM

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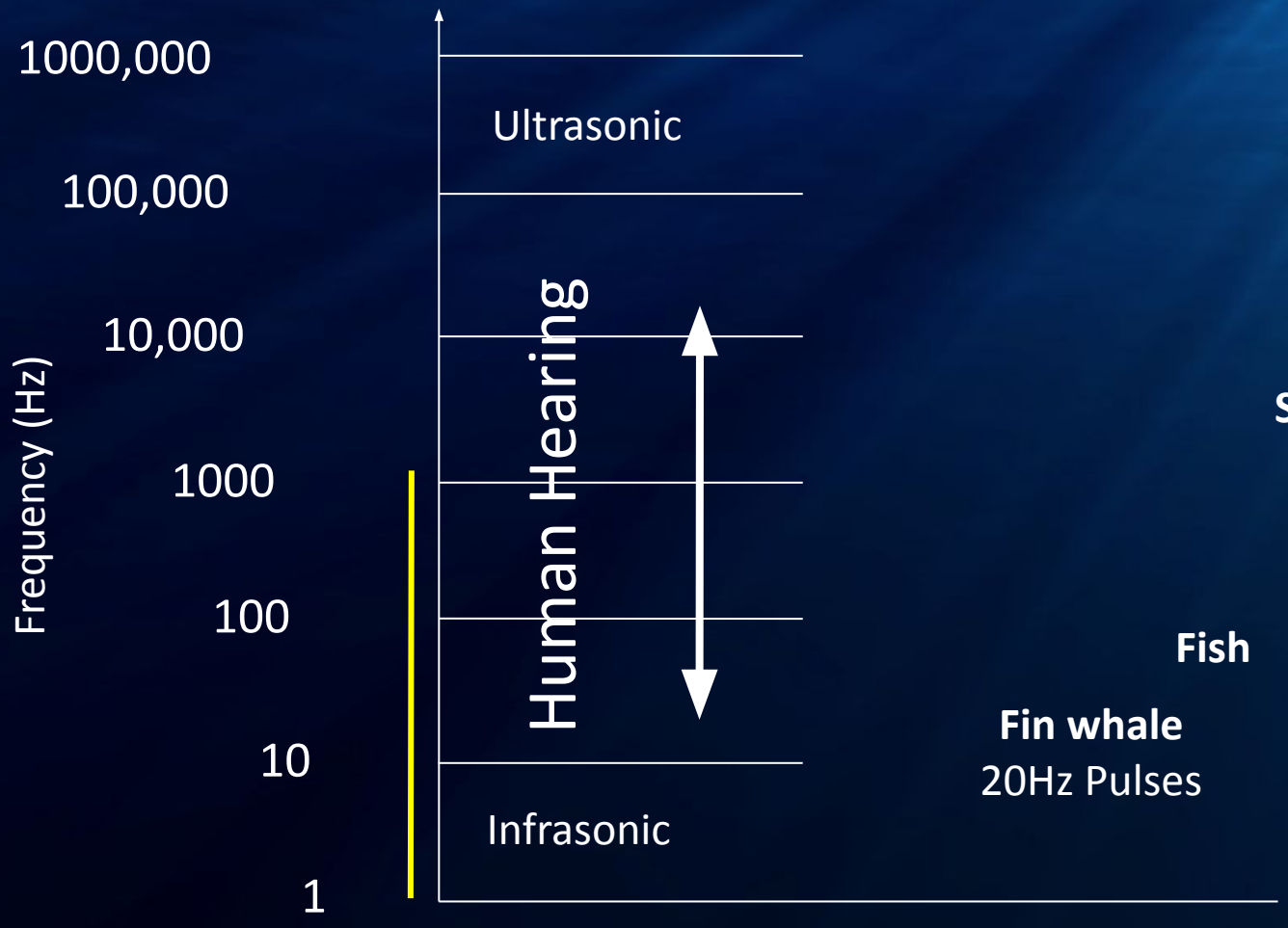
3. Species Frequency Range

Baleen whales - most acoustic energy under 1kHz



Harbor porpoise
Ultrasonic clicks

Dolphins
Whistles & clicks

Sperm whale
Clicks

Fish

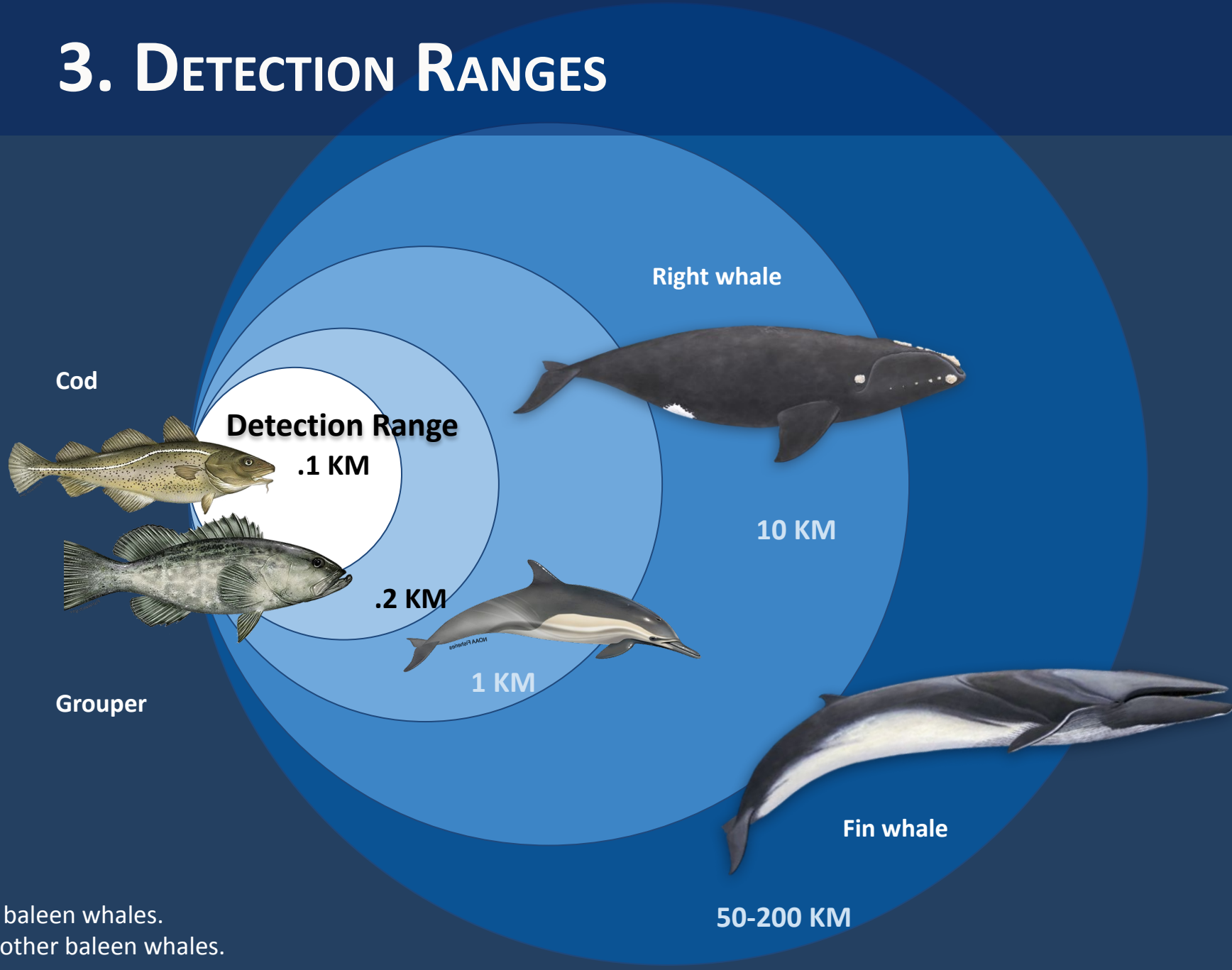
Fin whale
20Hz Pulses

Graphics courtesy of R. Swift

Yellow line covers suggested sampling range for baleen whales. sampling higher frequencies would allow for detection of other species

3. Detection Ranges

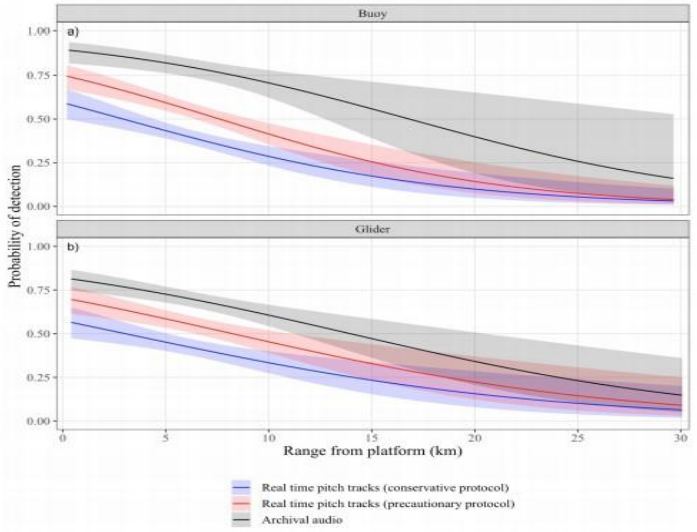
How far can your species be heard on average?



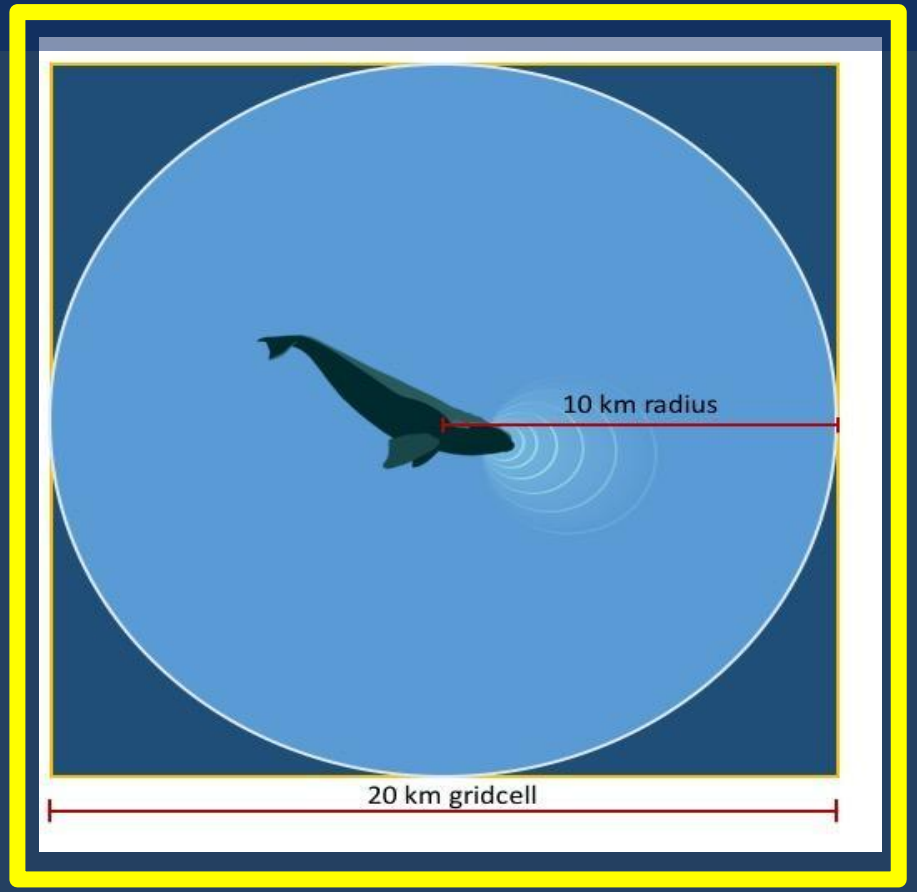
Right whales are relatively quiet compared to other baleen whales.
Prioritizing design for NARW will allow detection of other baleen whales.

3. Detection Ranges for NARW

Probability	Range (km) Real time pitch tracks (conservative protocol) Glider	Buoy	Real time pitch tracks (precautionary protocol) Glider	Buoy	Archival Audio Glider	Buoy
0.5	3.0	3.0	8.2	7.6	14.0	16.8
0.33	10.2	8.4	14.9	12.5	20.5	22.3
0.25	14.1	11.5	18.6	15.2	24.1	25.3
0.1	25.2	19.9	29.0	22.8	N/A	N/A
p-value	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0004



Hansen et al. in press



Therefore,we estimated that the **detection** range of the MARU array was 25 km for **right whales.** Morano et al. 2020 Con Biol.

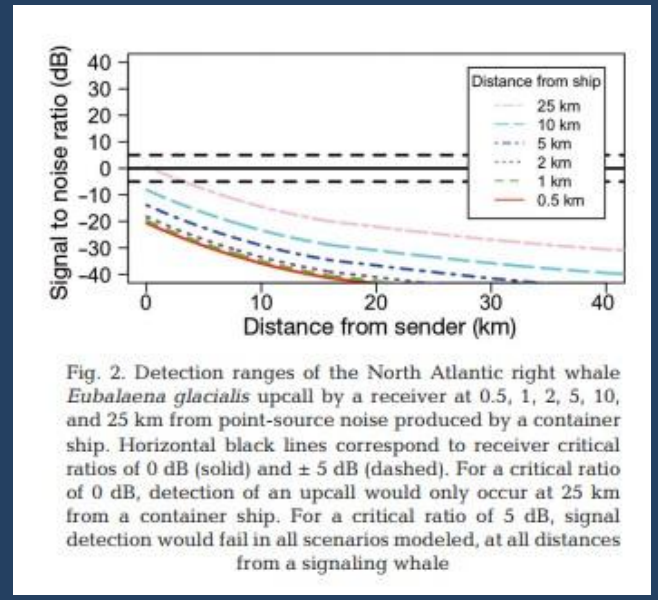
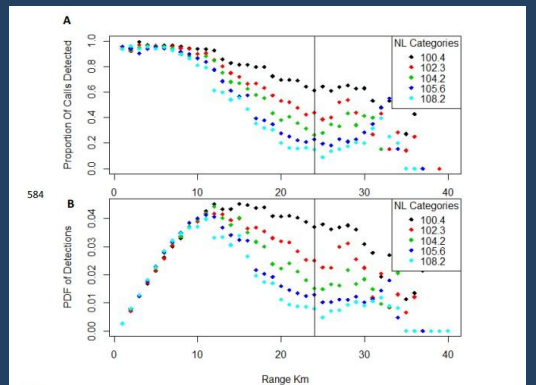


Fig. 2. Detection ranges of the North Atlantic right whale *Eubalaena glacialis* upcall by a receiver at 0.5, 1, 2, 5, 10, and 25 km from point-source noise produced by a container ship. Horizontal black lines correspond to receiver critical ratios of 0 dB (solid) and ± 5 dB (dashed). For a critical ratio of 0 dB, detection of an upcall would only occur at 25 km from a container ship. For a critical ratio of 5 dB, signal detection would fail in all scenarios modeled, at all distances from a signaling whale

Tennessen & Parks 2016 *Endangered Species Research* 30 (2016): 225-237.



" up-calls produced less than 10km from a sensor 312 were loud enough to easily overcome the masking effects of ambient noise - Palmer, Shui Clark from CCB

Desharnais et al. 2000.. "A scenario for right whale detection in the Bay of Fundy." In *OCEANS 2000 MTS/IEEE Conference and Exhibition. Conference Proceedings (Cat. No. 00CH37158)*, vol. 3, pp. 1735-1741. IEEE,

5 to 9 km

Questions to Consider when using PAM

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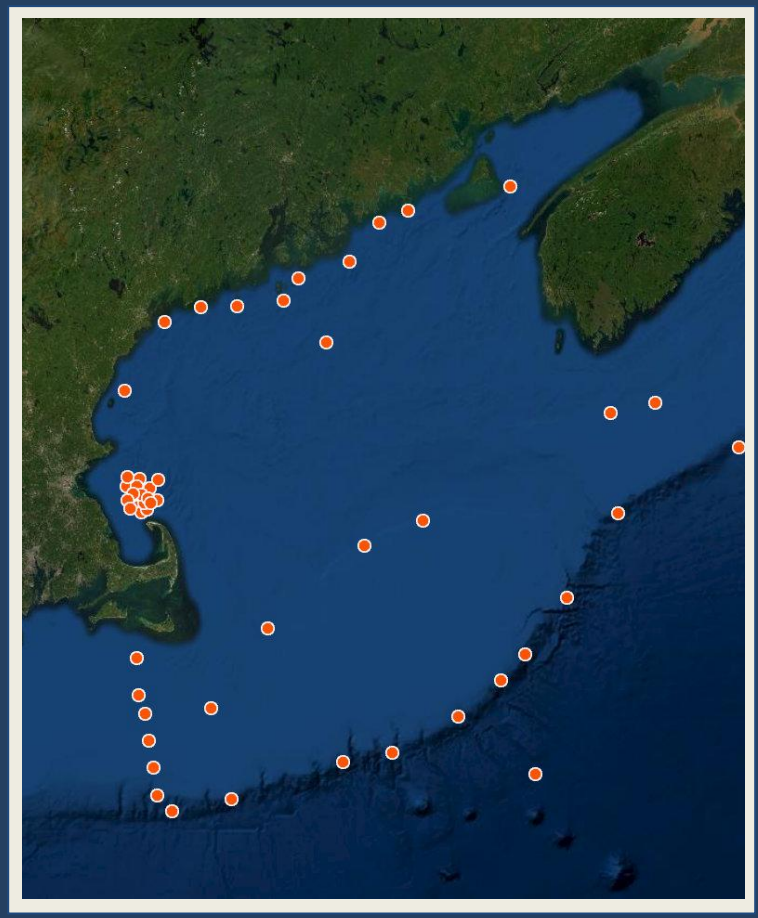
3. What are your PAM System Requirements?
4. **What is your PAM Data Collection Design?**
5. What information does your PAM Data provide?
6. How will you Report and Archive your PAM data?

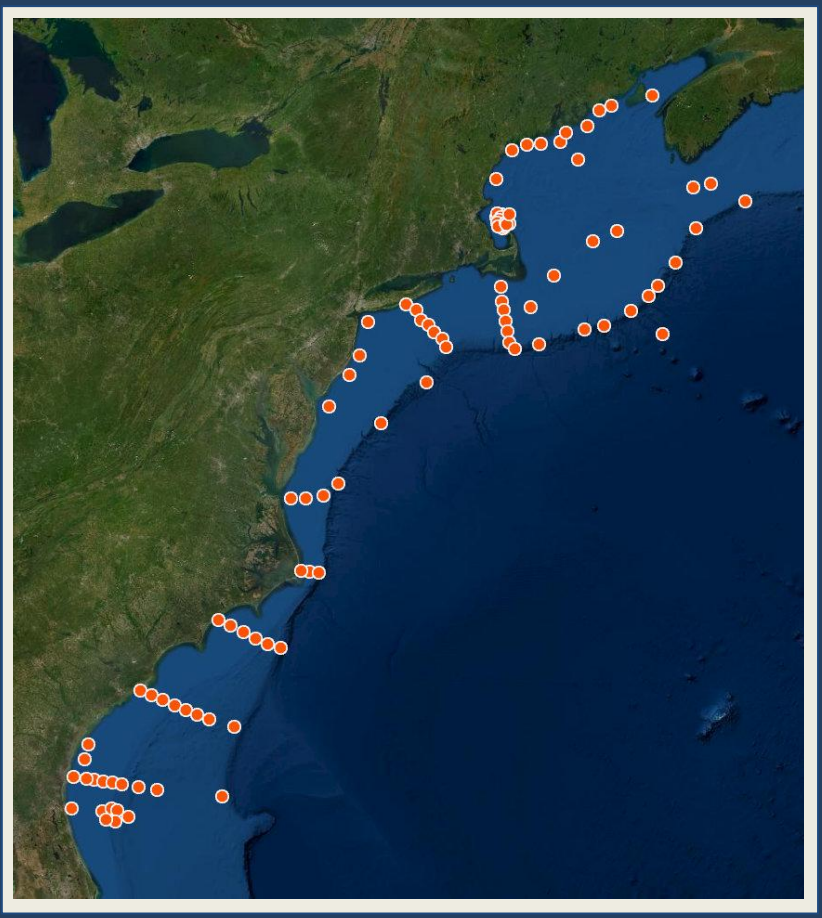
4. PAM Data Collection Design

Site

Regional



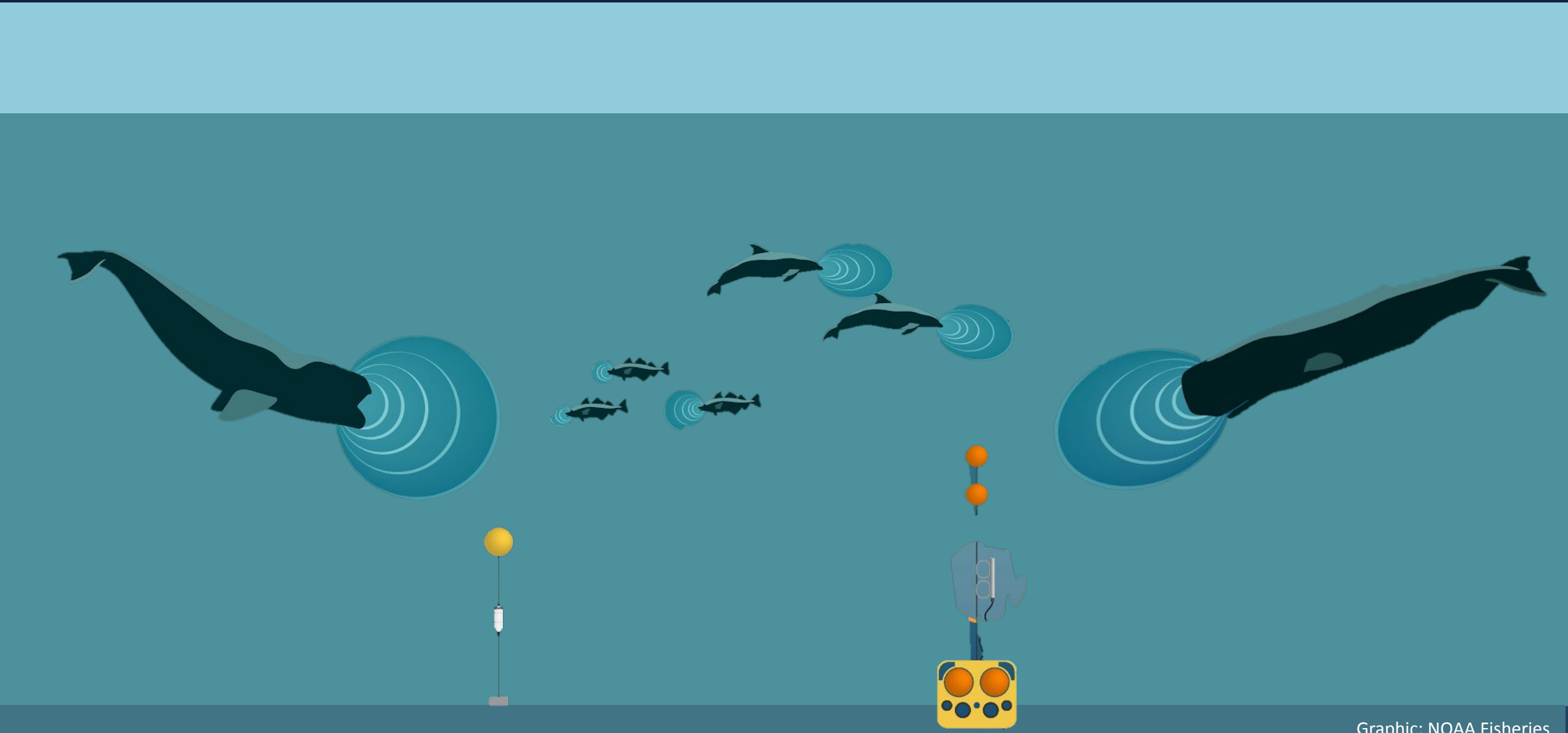
Ocean



Questions to Consider when using PAM

1. What are your Species of Interest?
2. What are your PAM Recording Technologies ?
3. What are your PAM System Requirements?
4. What is your PAM Design?
5. **Historical PAM Monitoring**
6. How will you Report and Archive your PAM data?

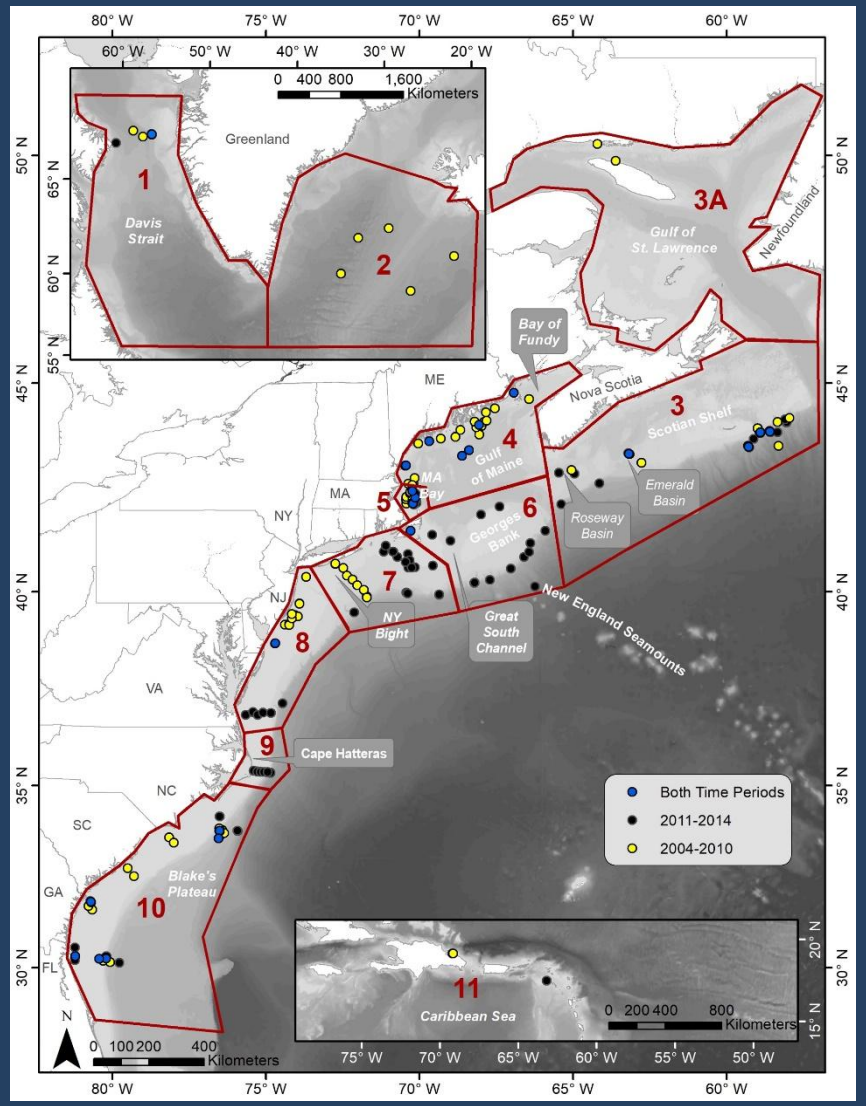
Long Term Changes in Distribution and Occupancy



Graphic: NOAA Fisheries

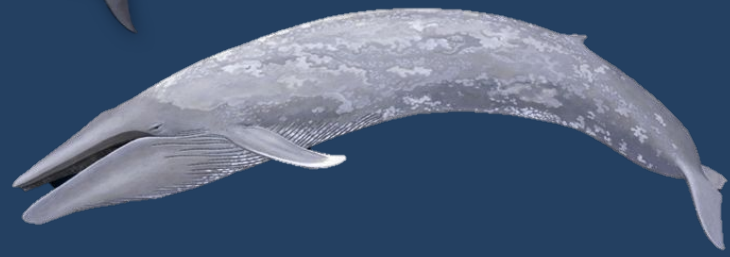
Changing Distributions - Baleen Whales

2004 – 2014



North Atlantic right whales

fin whales



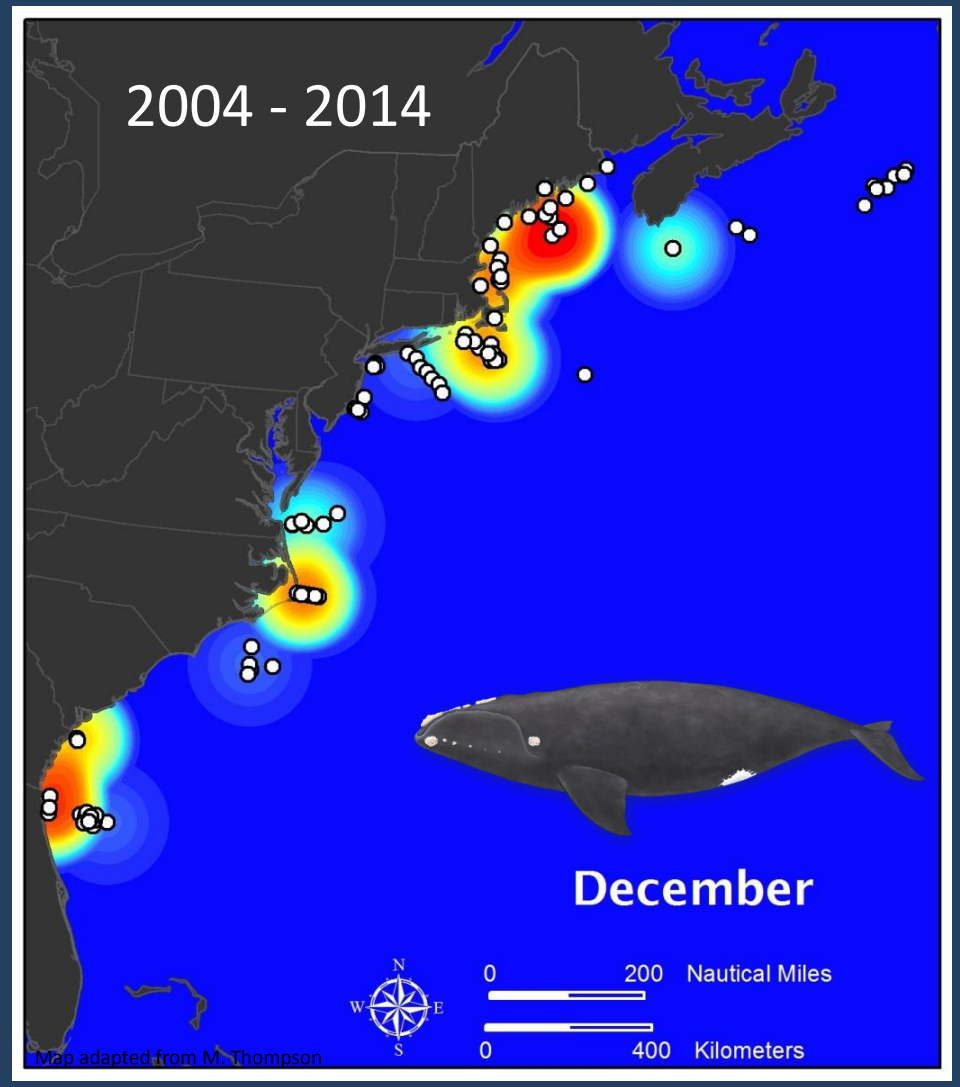
blue whales

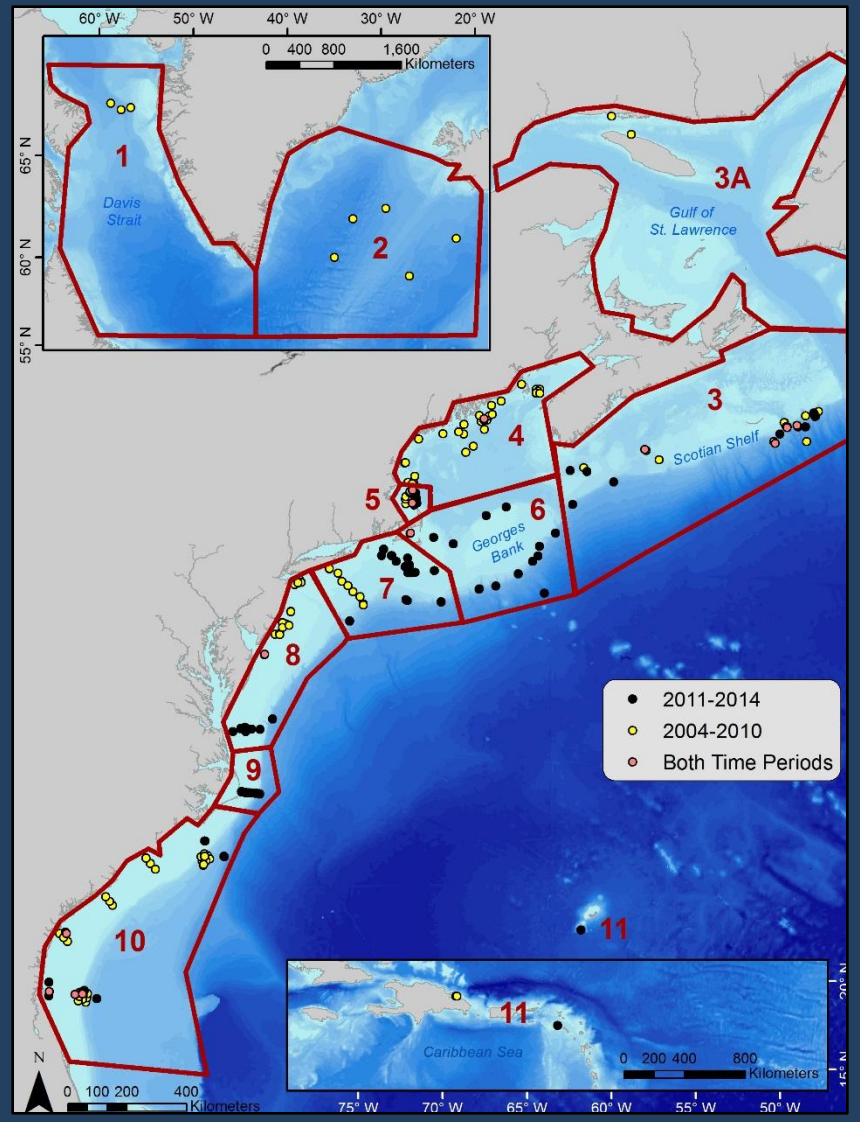
humpback whales

sei whales

Davis et al. 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Global Change Biology 26: 4812-4840

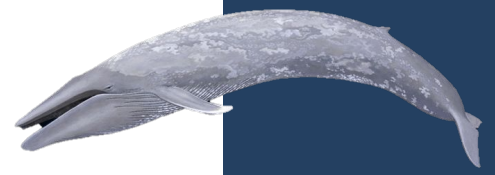
NARW Long Term Changes: Spatial



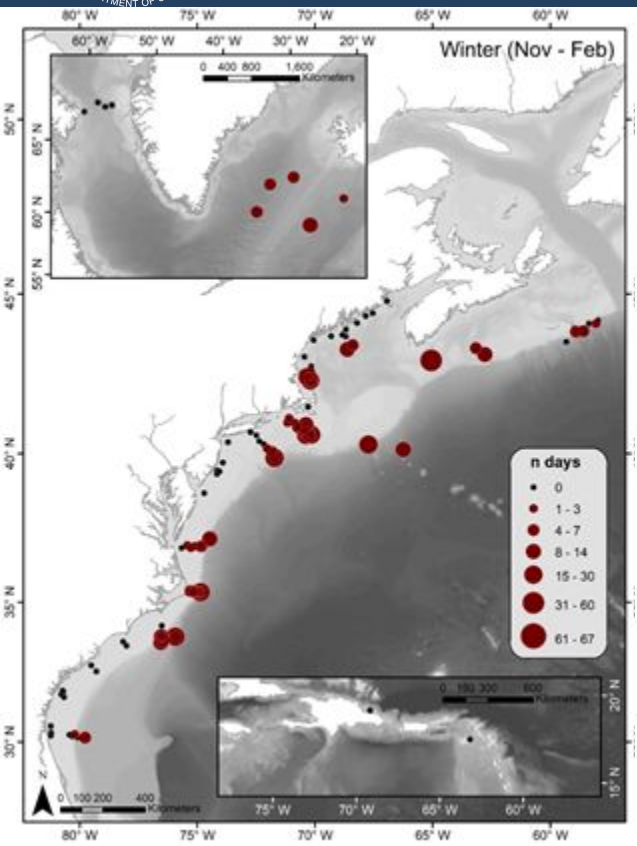


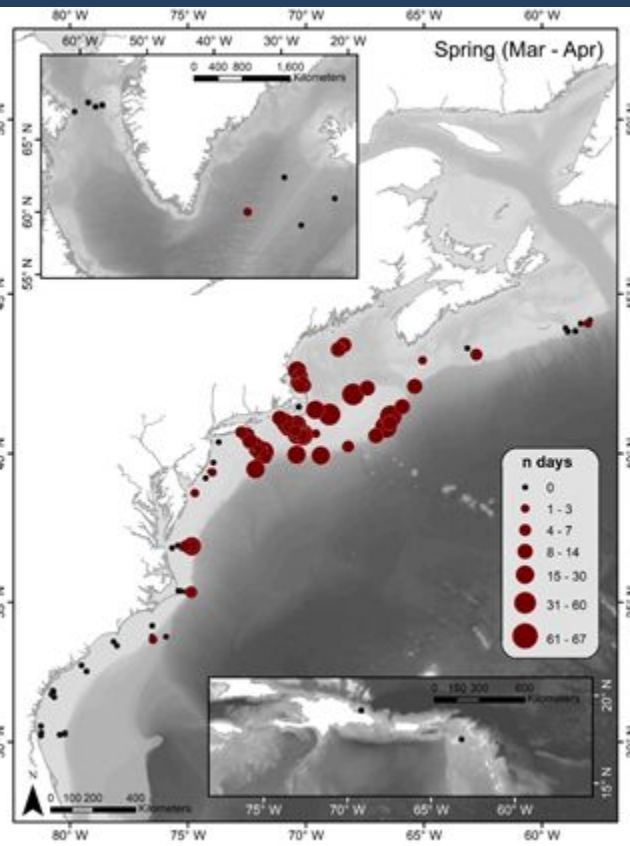
Davis et al. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales. Scientific Reports 7: 13460.

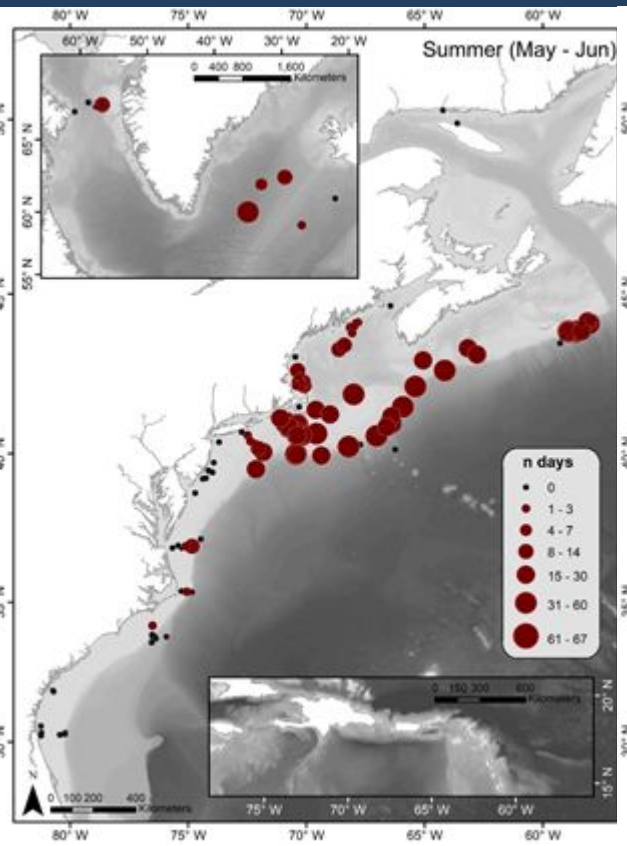
Baleen Whales: Temporal

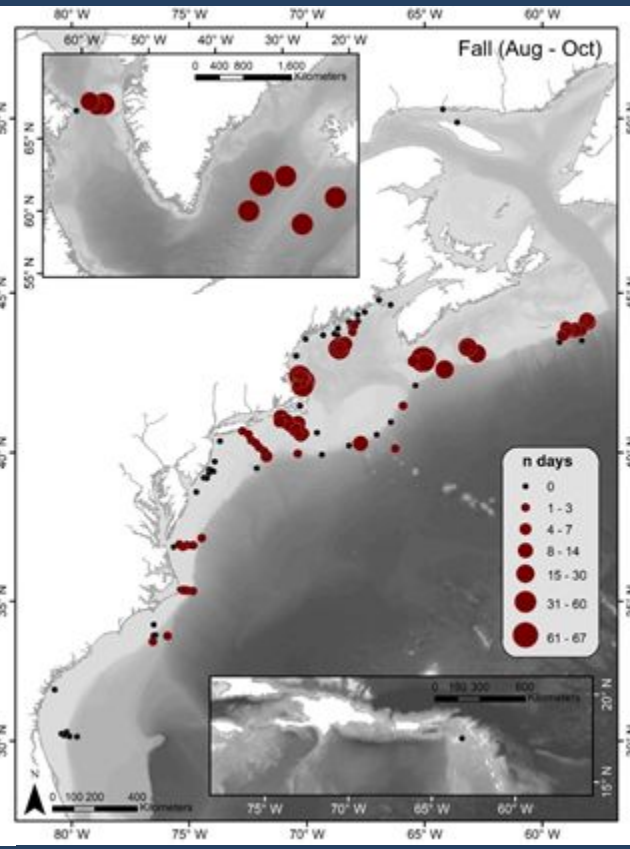


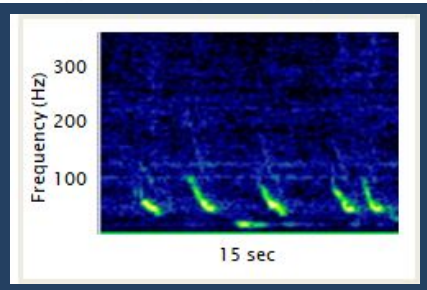
Sei Whales: Seasonal





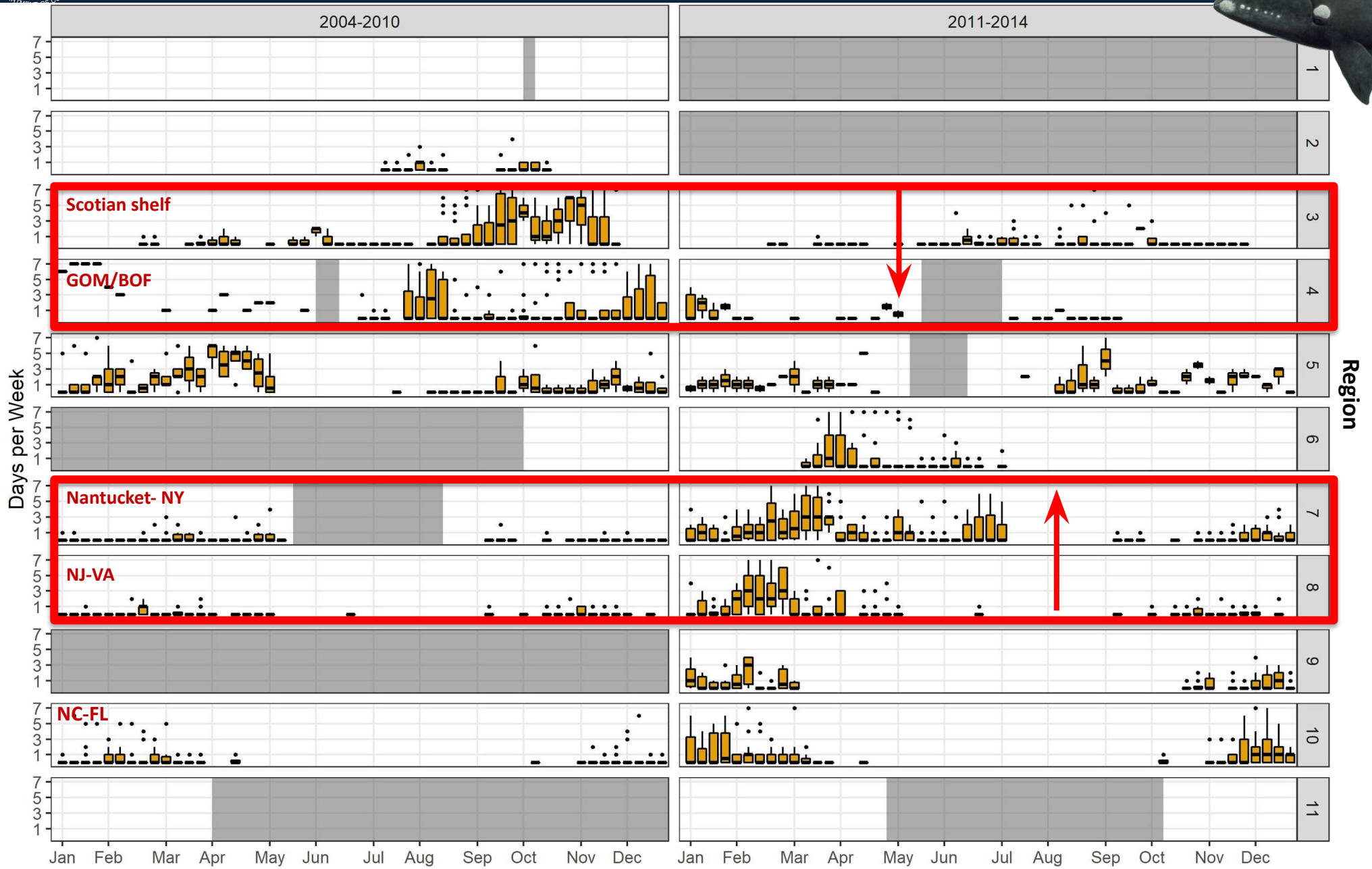






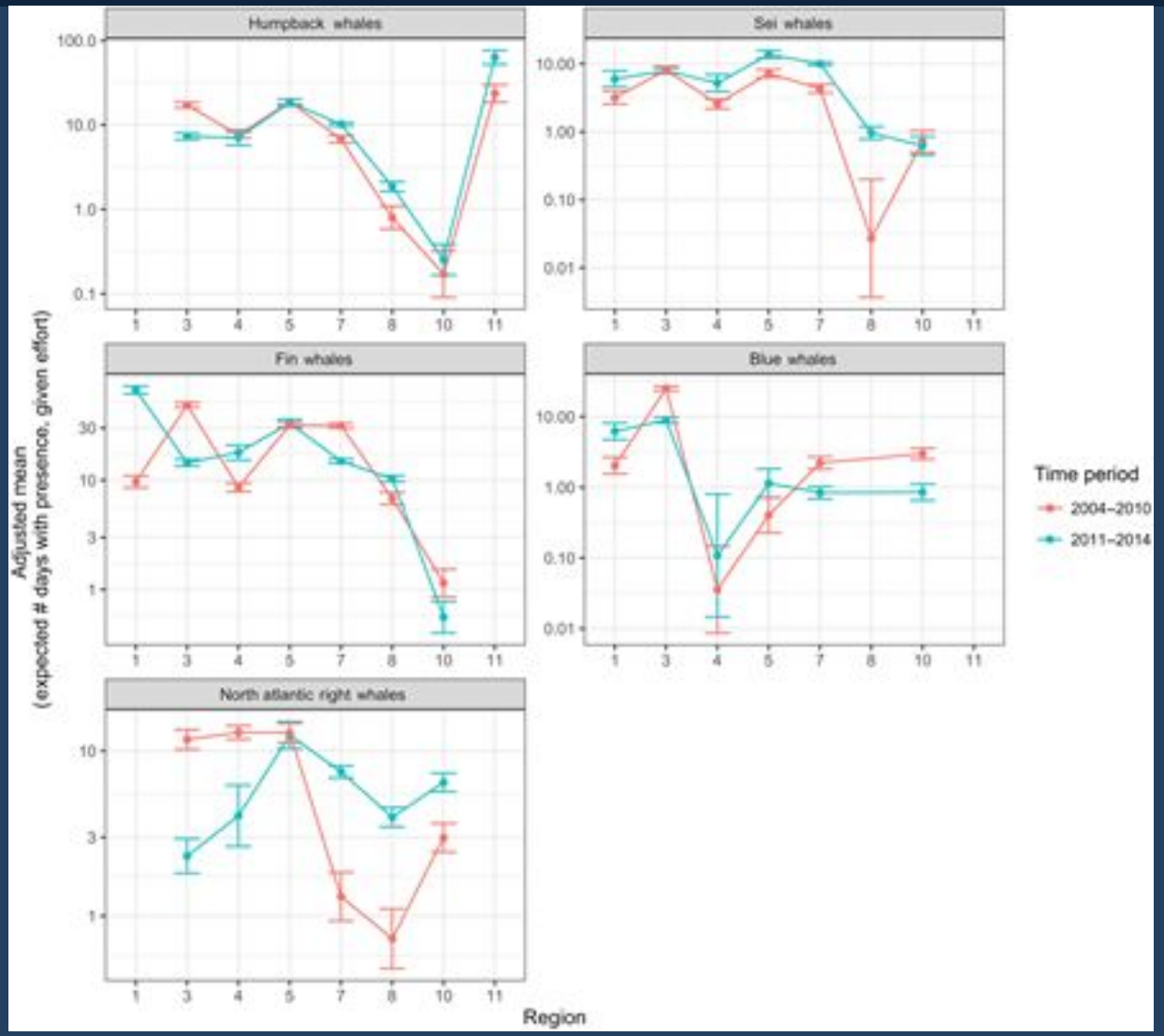
Davis et al. 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Global Change Biology 26: 4812-4840

NARW Shifts Across Time



Davis et al. 2017. Scientific Reports

Baleen Whales: Changes Across time



Poisson generalized linear model (GLM) testing whether the annual occurrence of each species across regions differed over two time periods (A: 2004–2010; B: 2011–2014).

Davis et al. 2020. Exploring movement patterns and changing distributions of baleen whales in the western North Atlantic using a decade of passive acoustic data. Global Change Biology 26: 4812-4840

THE POWER OF ARCHIVAL PAM

- Collaboration is *essential*
  (33+ scientists, 19+ organizations contributed data)
- Although not collected for the same purpose data still very valuable at a broad scale
- Detailed records over long time and spatial scales on species we knew very little about
- Able to detect major shifts in movement patterns and distribution.

Questions to Consider when using PAM

1. What are your Species of Interest?
2. What are your PAM Data Collection Types?
3. What are your PAM Recording Technologies ?
4. What is your PAM Data Collection Design?
5. What information does your PAM Data provide?
6. How will you Report and Archive your PAM data? (to be addressed next workshop)

* Is Our Approach Realistic? Is it Affordable? Can it Answer the Basic Questions?*

Section 2.
PAM Design for Regional Monitoring

Sofie Van Parijs

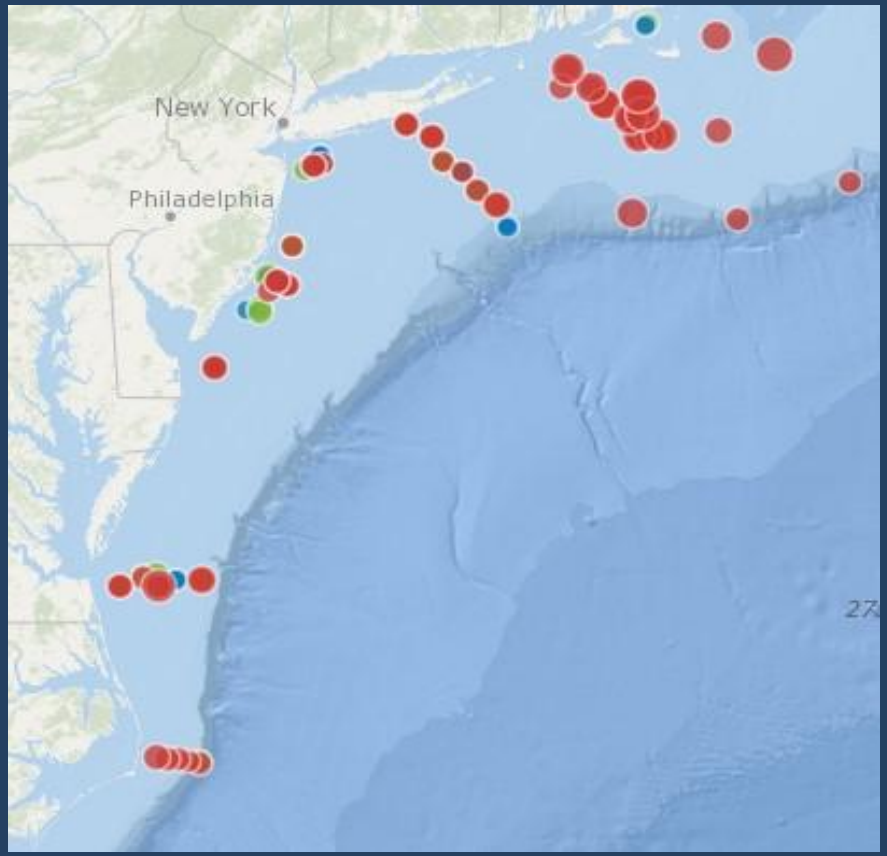
NOAA NMFS Northeast Fisheries Science Center

& Erica Staaterman

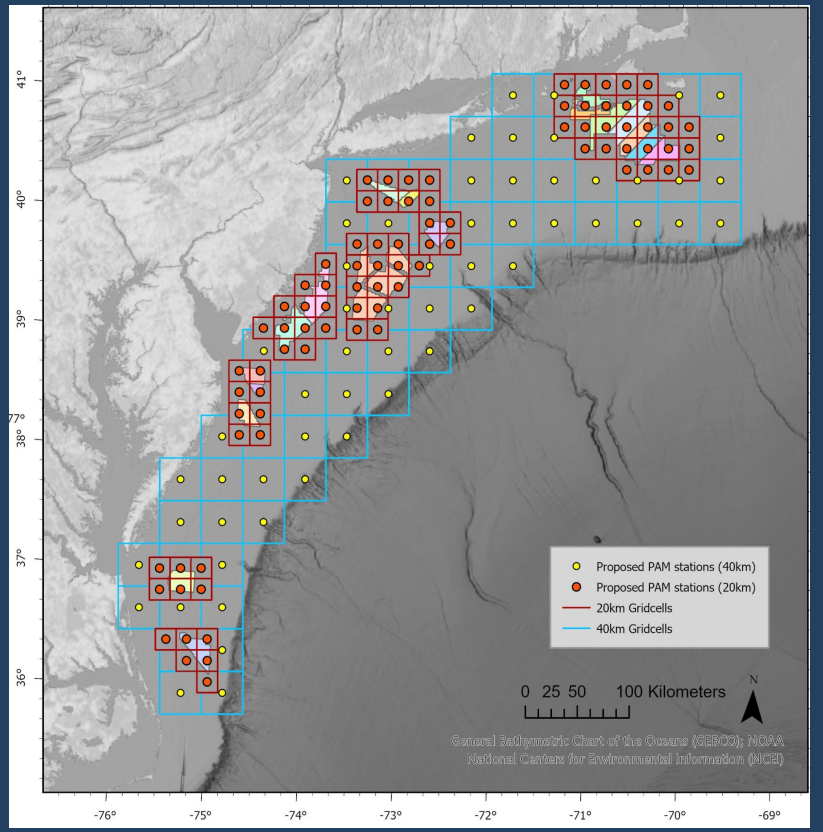
Bureau of Ocean Energy Management

PAM Design: Design It Before You Start!

Opportunistic Study



Planned Study



What do we mean by “regional monitoring?”

- **Not** measurements of pile-driving noise →
  - different questions, different temporal scales, different systems

- **Not** “real-time” PAM used for detecting cetaceans in WEA during construction →
  - this is PAM for mitigation purposes, covered elsewhere, and potentially combined with other detection methods

- **Not** focused on localization →
  - this requires a different system design with many more hydrophones and different analysis approach

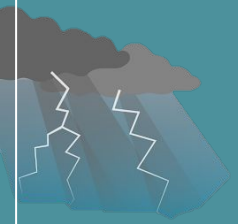
- **We aim to detect broad-scale spatial and temporal patterns in species’ distribution in relation to offshore wind development**

What assumptions have we made?

- A regional approach will not be built overnight
- A regional approach will take funding and support from a host of players, and not just government or just industry
- A regional approach will provide project specific research efforts the ability to support and enhance a shared, regional approach without taking away individual project control and objectives
- A regional approach can increase efficiencies, enhance knowledge, and conservation of key marine species

What questions are we asking with PAM?

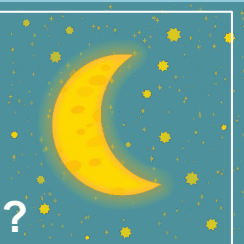
Routine recording of underwater sounds in the marine environment over long time periods



Questions:

Q1. Can we detect regional level changes in species presence?

Q2. Can we detect shifts in patterns during and/or after construction?



Graphic: NOAA Fisheries

1. Who are our Species of Interest?

Minimum Species:

NARWs

Baleen whales

Low frequency sampling design

Minimum Call Types:

Upcalls, fin 20Hz, minke pulse train, humpback social and song, sei whale upsweep, blue whale song.

- However, some vessel noise and fish calls are detectable with this low-frequency design and could be analyzed if desired
- Additional species (odontocetes) could be recorded but this is a “bonus” and **not the primary focus** of this regional effort (requires **different sampling design**)

2. What PAM Recording Technologies?

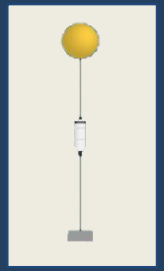
Minimum Technology: Bottom Mounted Recorders
Continuous recording preferable, duty cycle if needed

Minimum Frequency range: To cover baleen whales = 2kHz sampling rate (at least)

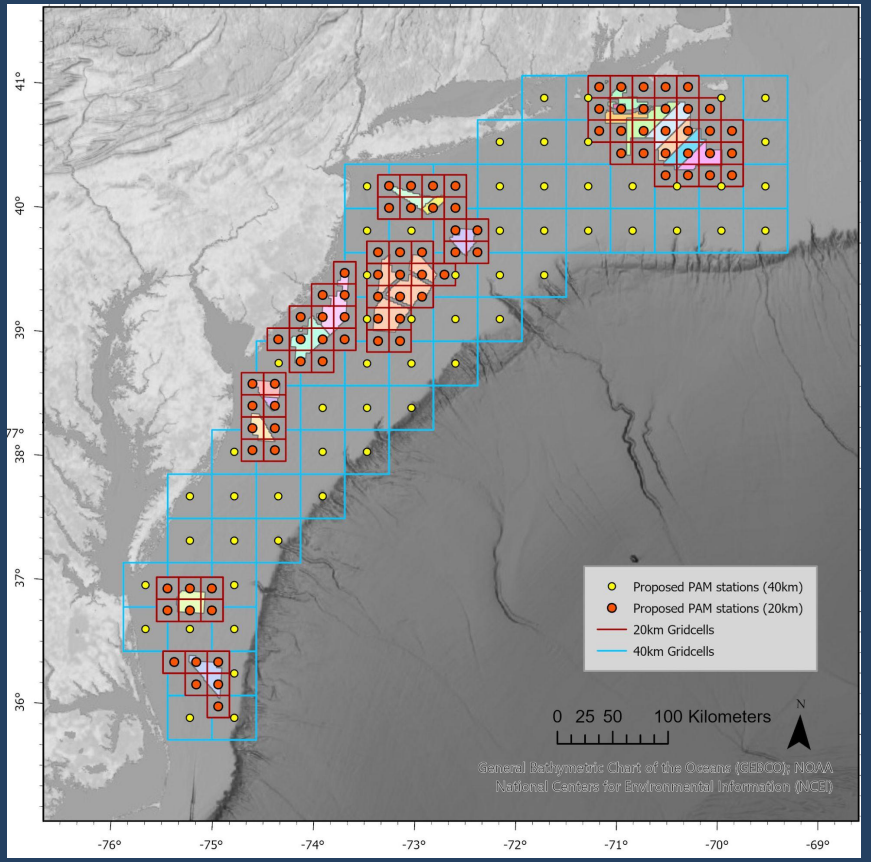
Minimum Detection range: NARWs (20x20km)

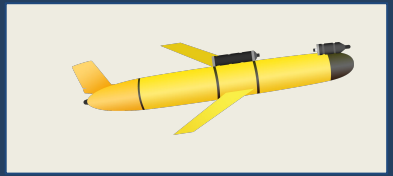
Minimum: Use a calibrated professionally build acoustic recorder

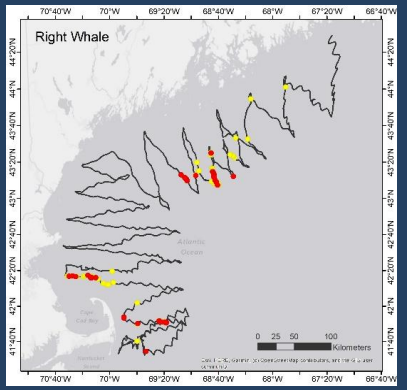
PAM Data Collection Design - Proposed Regional



24/7 monitoring in small area provides continuous site specific information - great for detailed presence







Provides sparse point sample data over a large area - great for reconnaissance

Questions for Discussion

What do you think about:

- **The stated purpose of a regional approach?**
  - Detect broad-scale spatial and temporal patterns in species' distribution in relation to offshore wind development
- **The species focus?**
  - NARWs and Baleen whales
- **The recording technology general parameters?**
  - Minimum parameters
- **The regional grid approach?**

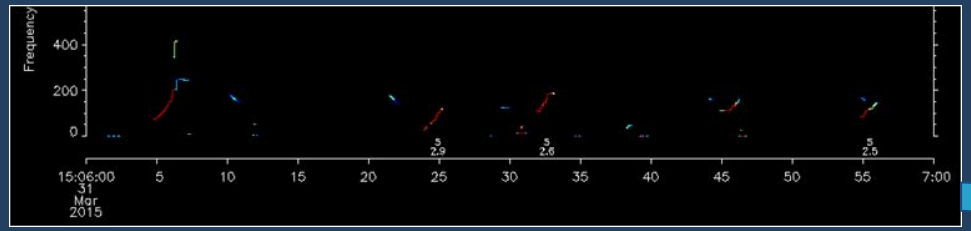
3. PAM Software Requirements

Automated detection software can look for NARW upcalls over long periods of time

Minimum Software Requirement: Several different softwares are available - need to have published or have information of performance of the software publicly available.

Software

Detects upcalls in data

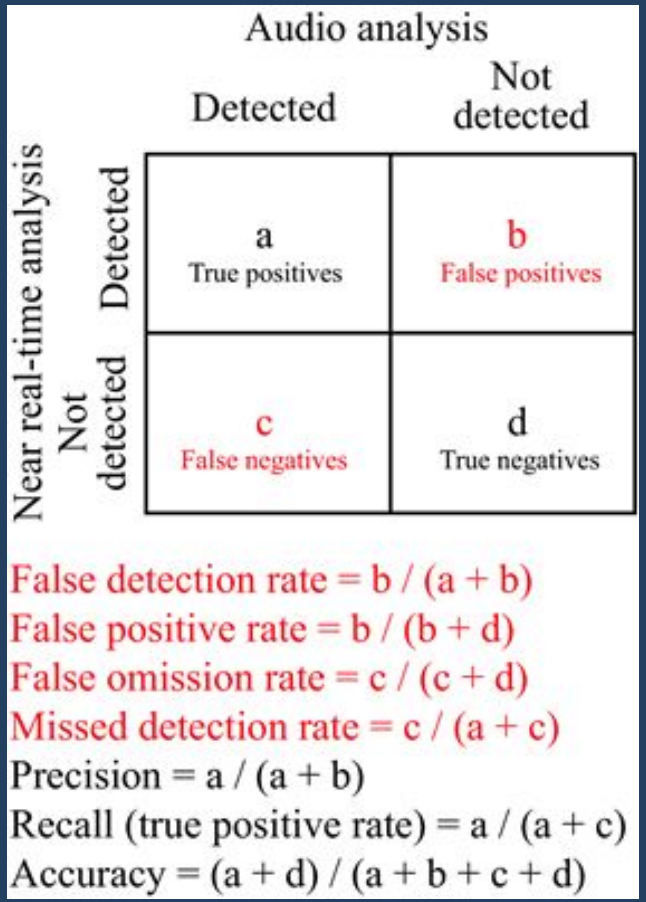


Acoustic expert evaluation

acoustic detections

3. PAM Software Requirements

Example of software evaluation and performance

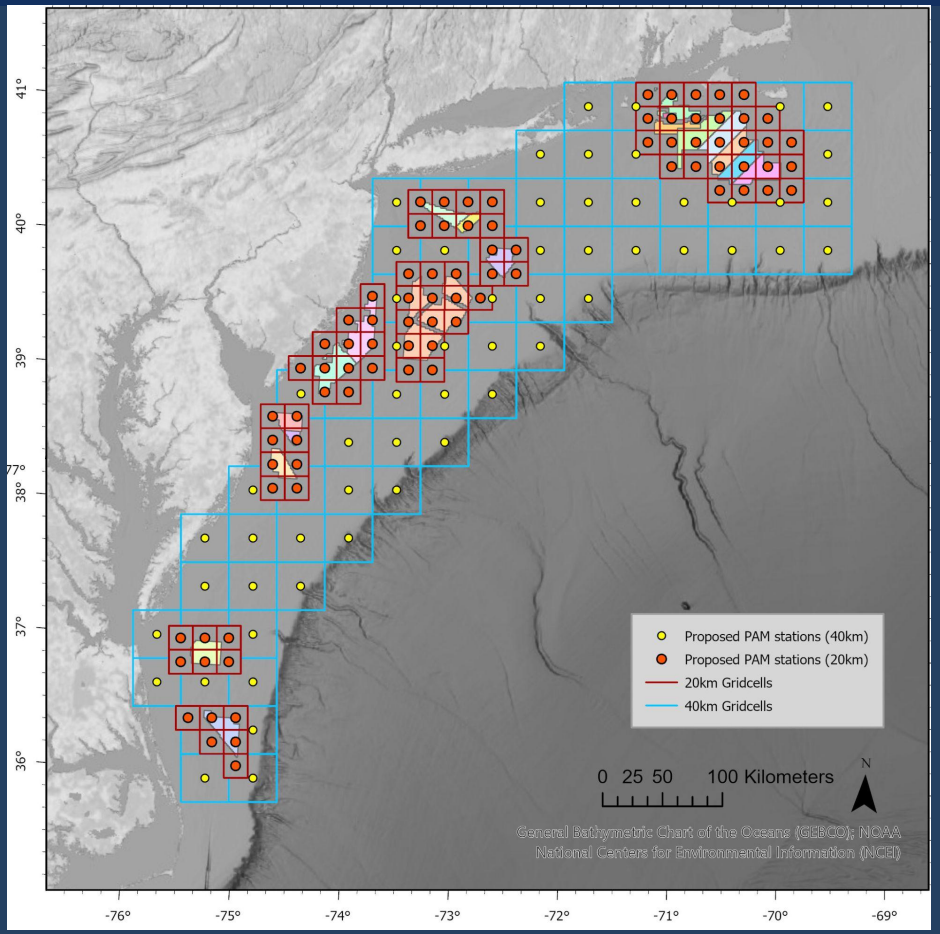


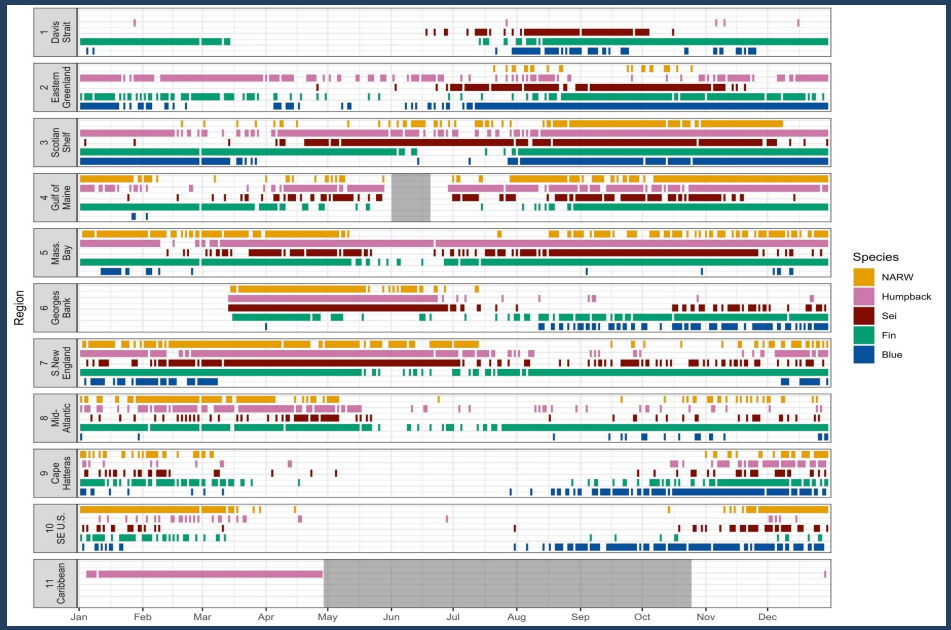
Baumgartner, M. F., **Bonnell, J.**, **Van Parijs, S. M.**, Corkeron, P.J., Hotchkin, C., Ball, K., Pelletier, L-P., Partan, J., Peters, D., Kemp, J., Pietro, J., Newhall, K., Stokes, A., Cole, T. V. N., Quintana, E., & Kraus, S. D. 2019. Persistent near real-time passive acoustic monitoring for baleen whales from a moored buoy: system description and evaluation. Methods in Ecology and Evolution 10: 1476-1489.

Questions for Discussion

Questions about PAM potential software requirements?

4. What Is Your PAM Data Collection Design?





Time Series of Acoustic Detections showing presence of baleen whales

4. Analysis Design Points To Consider

1. PAM monitoring will provide **time series** on species distribution.

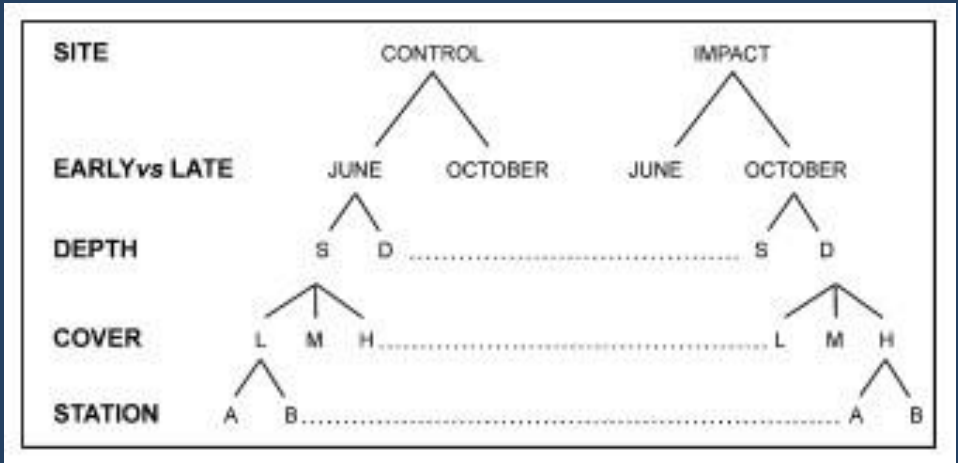
2. This will provide the data to answer **impact or change** questions.

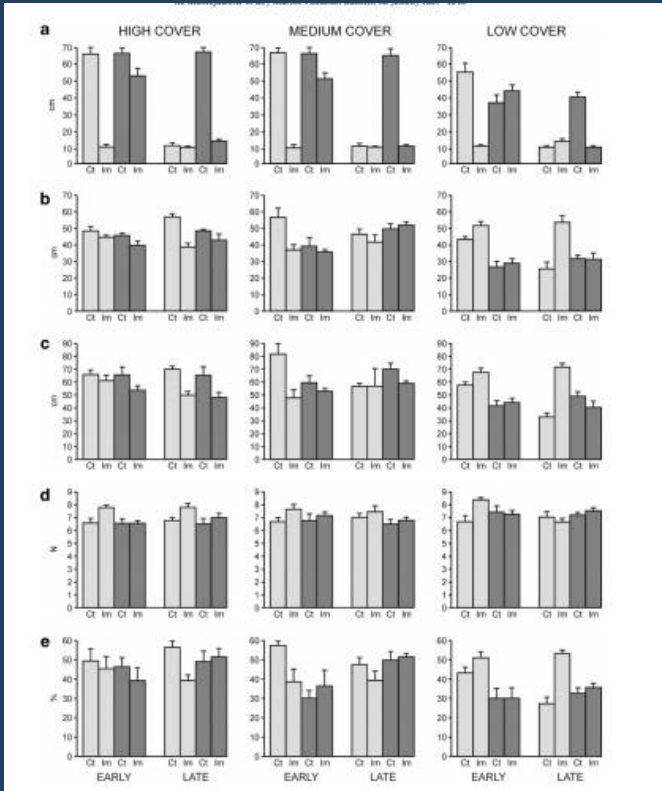
3. Thinking of the baseline monitoring data analyses
   a. **BACI** and **CI** Impacts are the most commonly used analyses for offshore wind farms.
   b. **Gradient** design - useful since you don't need a control.
   c. Other analyses methods e.g. **GLM** (Davis et al. 2020), **Bayesian** modeling of impacts

4. **Power** - will monitoring design provide enough power to give answers? Will only know this once data is collected. Make sure to target high species occurrence areas. Bayesian approaches can deal with this.

4. Analysis Design Points To Consider

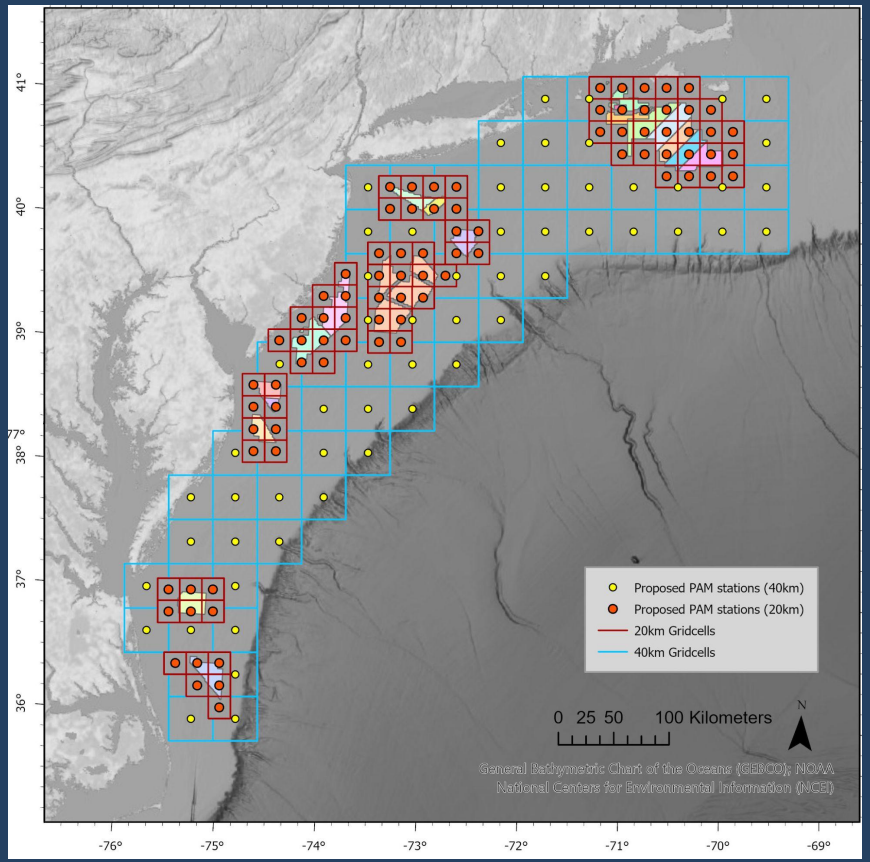
BACI Design - Before/During/Control/Impact Assessment





Montefalcone, Monica, Mariachiara Chiantore, Alessio Lanzone, Carla Morri, Giancarlo Albertelli, and Carlo Nike Bianchi. "BACI design reveals the decline of the seagrass Posidonia oceanica induced by anchoring." *Marine Pollution Bulletin* 56, no. 9 (2008): 1637-1645.

4. BACI Analysis Design Points To Consider



DESIGN: What is your Impact Area? What is your Control Area? Is there a suitable Control Area available?

TEMPORAL(Timing): When do you need to collect data to ensure BEFORE and AFTER data?

SPATIAL (Area): What area(s) would you want to focus on? Why?

4. Gradient Analysis Design Points To Consider

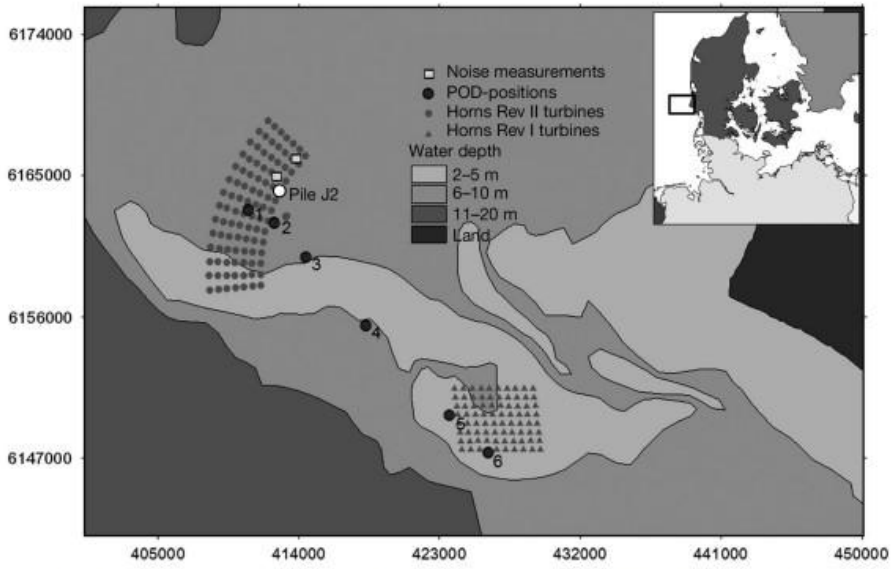


Fig. 1. Study area. Positions of the wind turbines of the windfarm Horns Rev II, where pile driving took place during this study (*), and the windfarm Horns Rev I (▲) that was already installed. ● 1 to 6 = positions of the T-PODs. □ = positions where noise measurements were conducted during pile driving of monopile J2 (○). Grid reference system is UTM 32 N

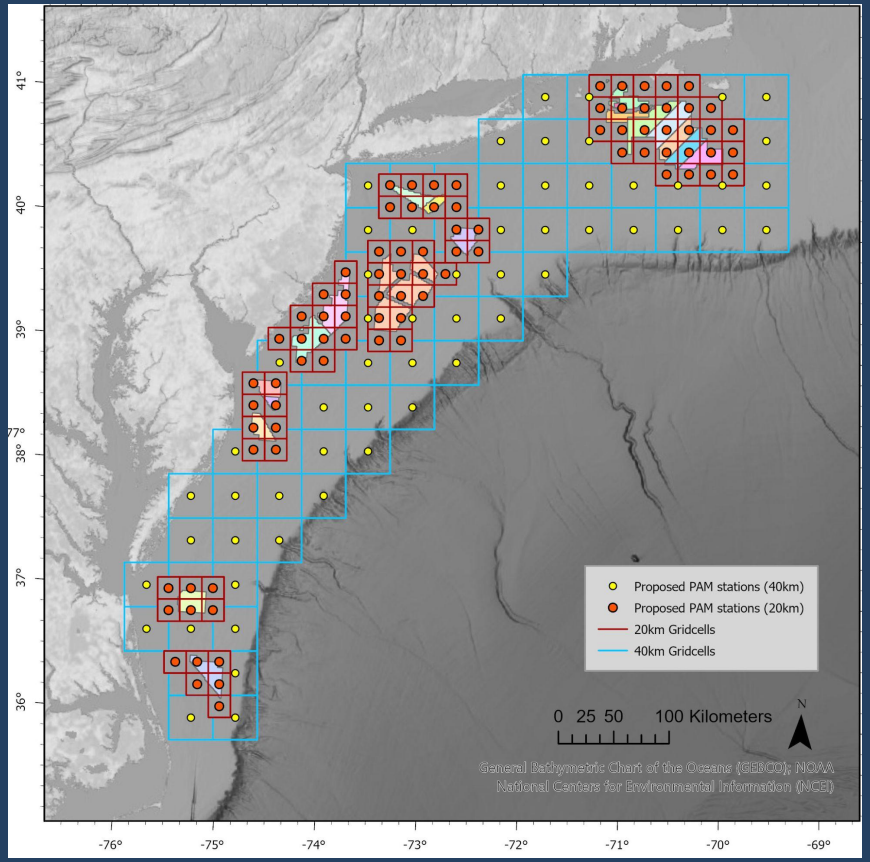
Sampling stations are along a gradient with increasing distance from the turbines

Don't need a control area

Focused on sampling multiple sites along a spatial gradient within and around the wind farm area

Brandt, M.J., Diederichs, A., Betke, K. and Nehls, G., 2011. Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. *Marine Ecology Progress Series*, *421*, pp.205-216.

4. BAG Analysis Design Points To Consider



DESIGN: Where is your gradient ? Impacted area / on edge and further out.

TEMPORAL(Timing): When do you need to collect data to ensure BEFORE and AFTER data?

SPATIAL (Area): What area(s) would you want to focus on? Why?

4. What Is Your PAM Data Collection Design?

Additional information for you to use:

1. Historical PAM data for the W Atlantic
https://apps-nefsc.fisheries.noaa.gov/pacm/#/

2. Marine mammal density models
https://seamap.env.duke.edu/models/

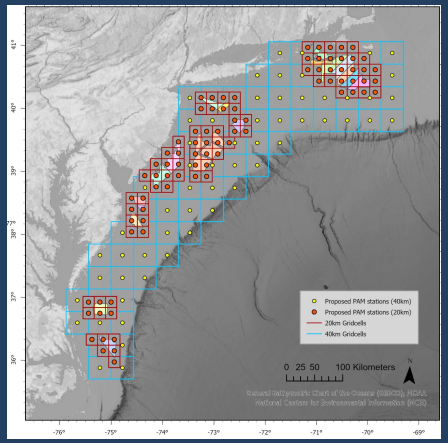
Polling, Break work, and Breakouts

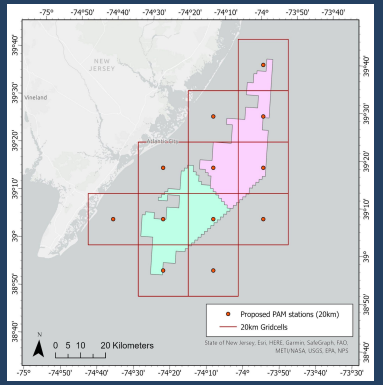
1. Using Menti, we are going to ask for input on:
   a. The key questions or hypotheses that a regional monitoring approach could potentially answer

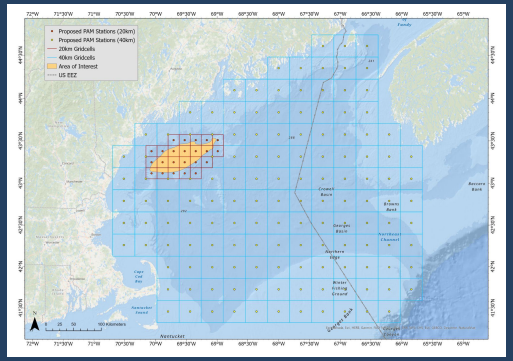
2. At Break, please identify specific blocks, to the best of your ability, where your organization has placed stationary PAM detectors of some sort in the last three years or are planning to do so in the coming three years.
   a. Use blocks color-coded by sector
   b. You can resize blocks as needed
   c. Jamboard allows simultaneous use
   d. Not looking for perfection, but a rough sense of coverage

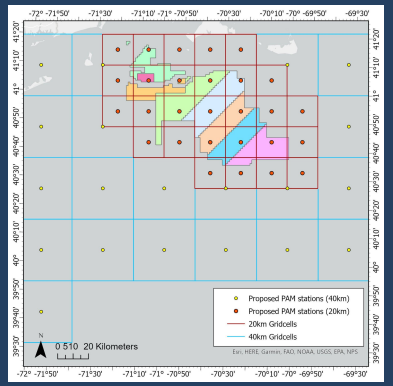
3. Breakout groups after break, mixed by Sector

Breakout Groups









1. What do you like about this approach?
2. What would you change to improve the general approach presented?
3. Consider honing in on a sub-region (GOM, NE, NYB, MD to Carolinas) to explore how you would modify or adjust the approach, say, to consider a study design such as a BACI, BAG, or other?

NOTE: hold off on barriers to this approach -- we'll cover that tomorrow

Data Consistency, Reporting, Storage, and Access

Carrie Wall

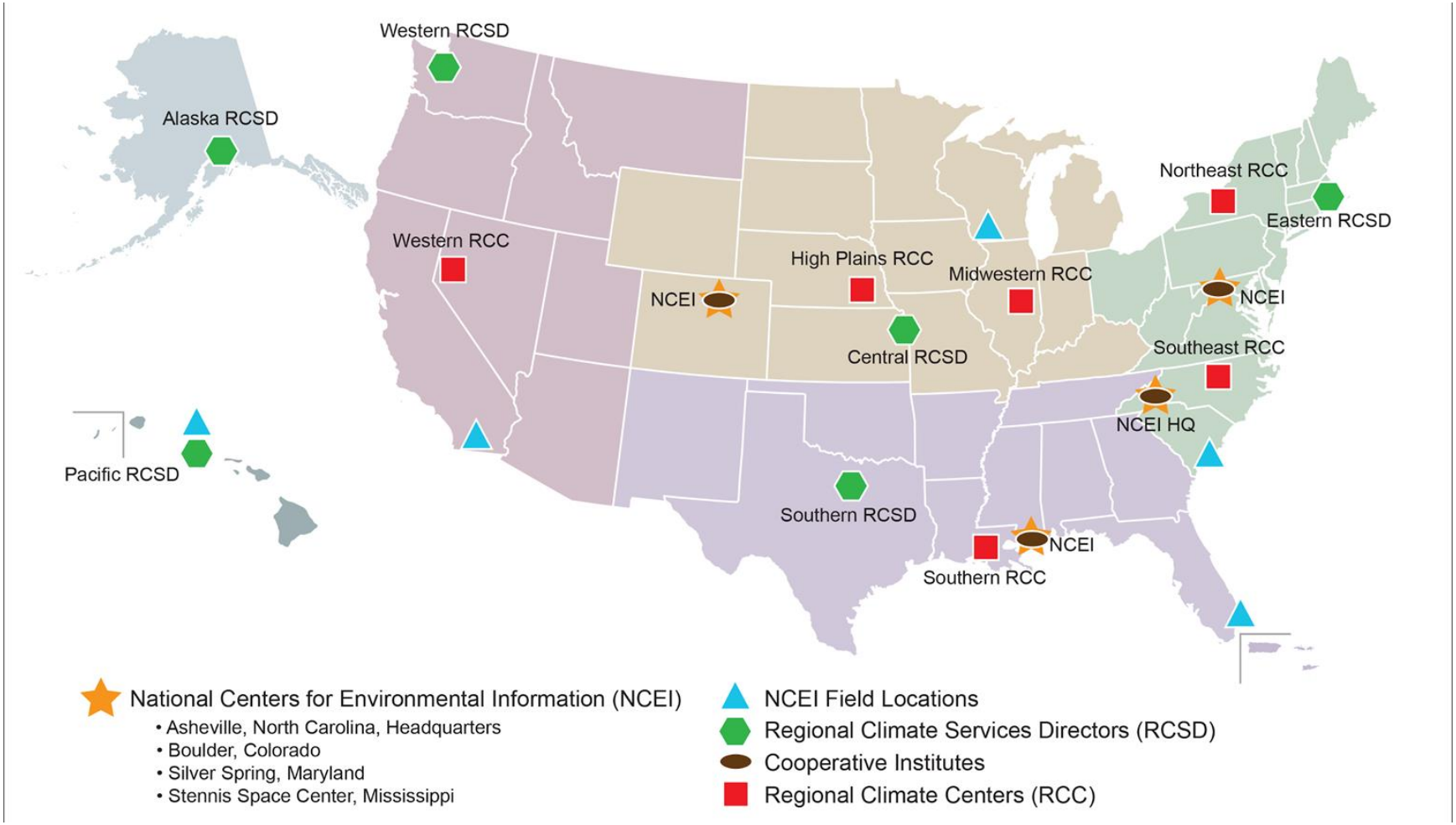
Carrie.Wall@noaa.gov

www.ngdc.noaa.gov/mgg/pad

National Centers for Environmental Information (NCEI)

- Responsible for hosting and providing access to one of the most significant archives on Earth, with comprehensive oceanic, atmospheric, and geophysical data
- From the depths of the ocean to the surface of the sun and from million-year-old sediment records to near real-time satellite images
- Nation's leading authority for environmental information

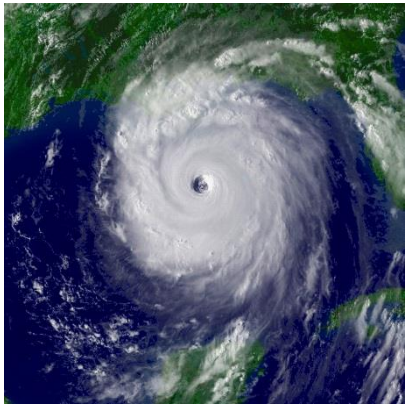
NCEI's Nationwide Presence



Climate & Weather

Providing climate information to inform the future

Monthly U.S. & Global Climate Reports



U.S. Billion-Dollar Weather & Climate Disasters report

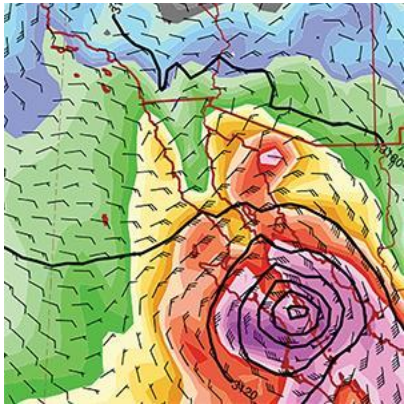
U.S. Drought Monitor

Regional Snow Fall Index

Tornado Climatology

Hourly Precipitation Data

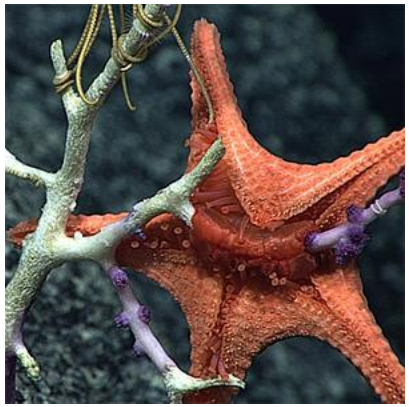
Climate Extremes Index



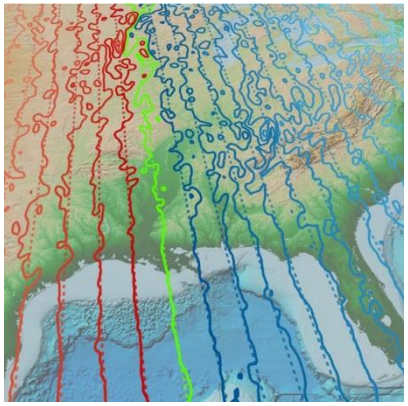
Blended Sea Winds

Coasts, Oceans, & Geophysics

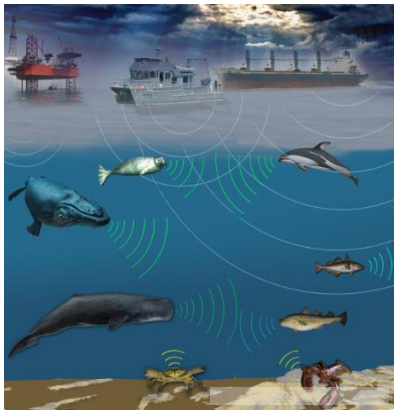
Providing data & information from the Sun to Earth's seafloor



Ocean Exploration Digital Atlas

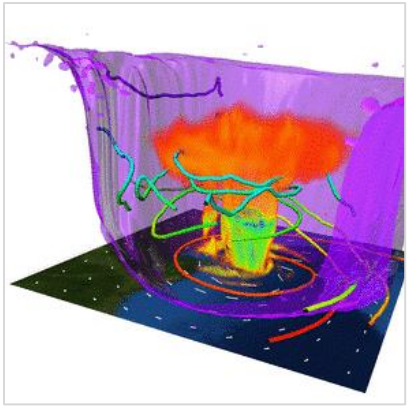


Enhanced Magnetic Model



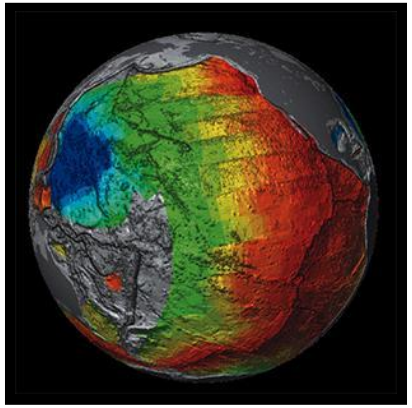
Passive Acoustics

Gulf of Mexico Data Atlas

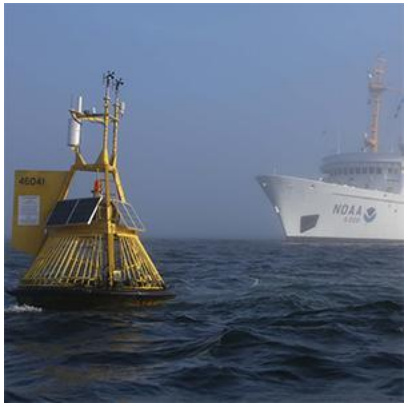


Model Reanalysis

Deep Sea Corals Data Portal



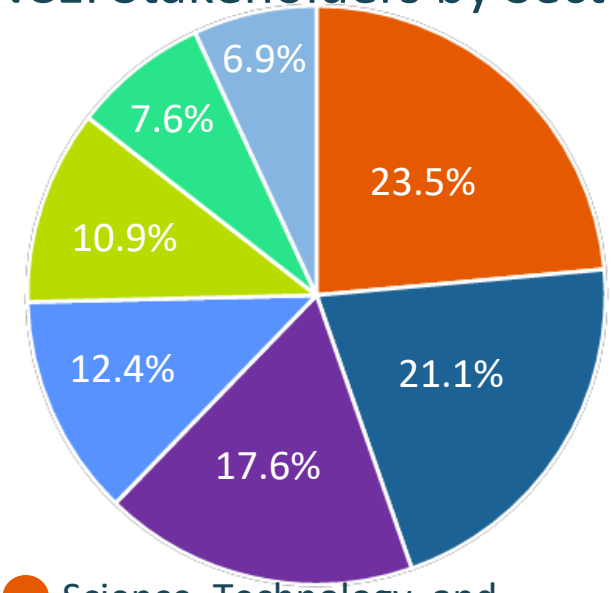
Bathymetry and Global Relief



World Ocean Database

NCEI's Value to the Nation

NCEI Stakeholders by Sector

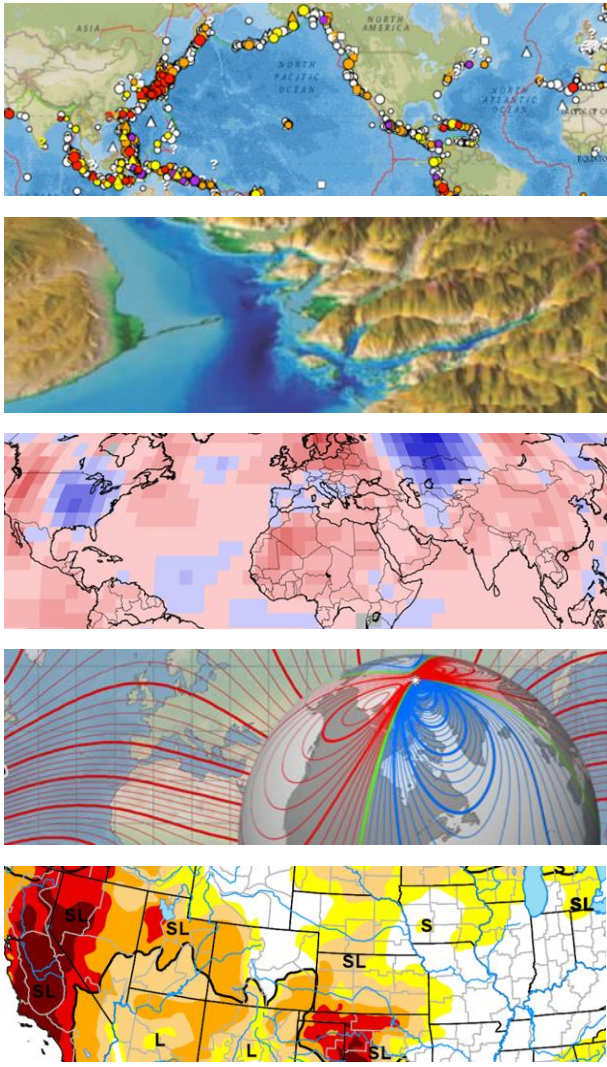


Range of Products

- Time scale: Hourly to Decadal
- Geographic scale: Local to Global

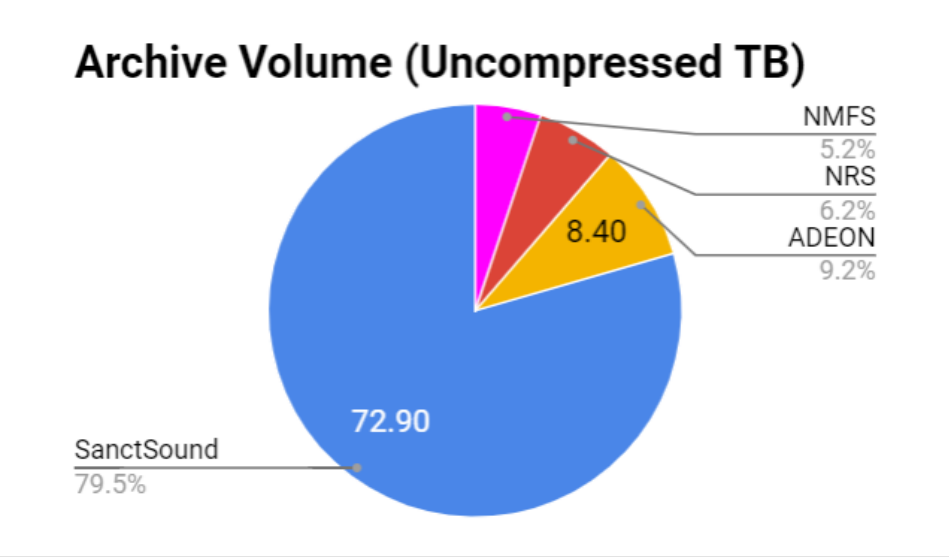
Technical Expertise

- Aerosols to Coastal Inundation
- Drought Monitoring to Ocean Surface Winds
- Paleoclimatology to US/Global Climate Monitoring

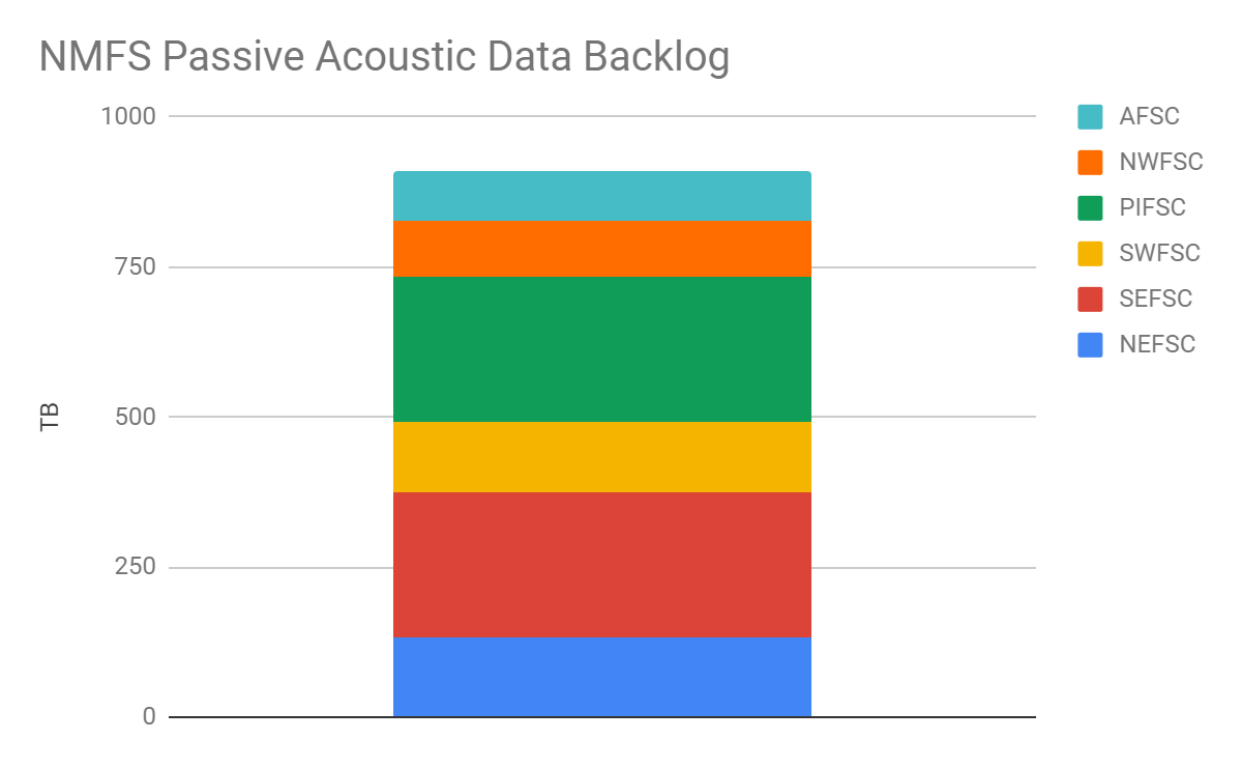


NCEI Passive Acoustics Archive

- Established in 2017
- Archive team
  - Data Managers: Chuck Anderson, Veronica Martinez
  - Dedicated passive acoustic data manager: Job announcement
  - Lead: Carrie
- Grown to over 91 TB
- Primarily consists of stationary recorders



Passive Acoustic Potential - NMFS



We have a long way to go

AFSC Passive Acoustics Archive

Data

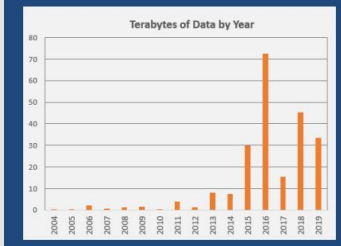
- Digital Archive ~ 80 TB
- Additional ~ 30TB/yr

SWFSC

... And a closet full of old tape drives

Total NEFSC Data holdings by year

*224 Terabytes total
*Expect 35-40 TB/year



Data sizes have been > 30 Terabytes per year for 4 out of the last 5 years

Average data size for the last five years is 40 TB

Data increase due to:
Larger scale projects
Longer deployments
Additional platforms
More sampling locations

livingmarine RESOURCES

NAVY INTEREST IN NCEI ARCHIVE

Is NCEI ready for Navy? FY 20-21 need topics:

- Navy has petabytes of historic HARP data archived at SIO. Will need screening for public release per OOS Navy guidance.
- Monitoring program continues to invest in PAM data that is potentially publically releasable:
  - HARP in SOCAL and Norfolk Canyon
  - PAM glider in SOCAL
  - EAR data in PAC NW
  - DTAG data from Atlantic BRS
  - *NUWC M3R led by Stephanie Watwood. SCORE and PMRF developing archive and data management protocols*
- CTBO and OBS data? Navy is interested in developing tools to estimate PAM density for blues and fins from OBS and CTBO data.

BOEM

AMAPPS I and II
HARP array along shelf break
distribution, abundance, habitat use

GOMMAPS and PACMAPPS

Atlantic Deepwater Ecosystem Observatory Network (ADEON)): An Integrated System
Assess baseline soundscape and ecosystem conditions in support of predictive environmental modeling and trend analyses
Assess the spatial and temporal distribution of the soundscape and biological scatterers

PIFSC Totals (TB)

Currently in-house	362
2020 estimate	85

Melissa's archiving prioritization:

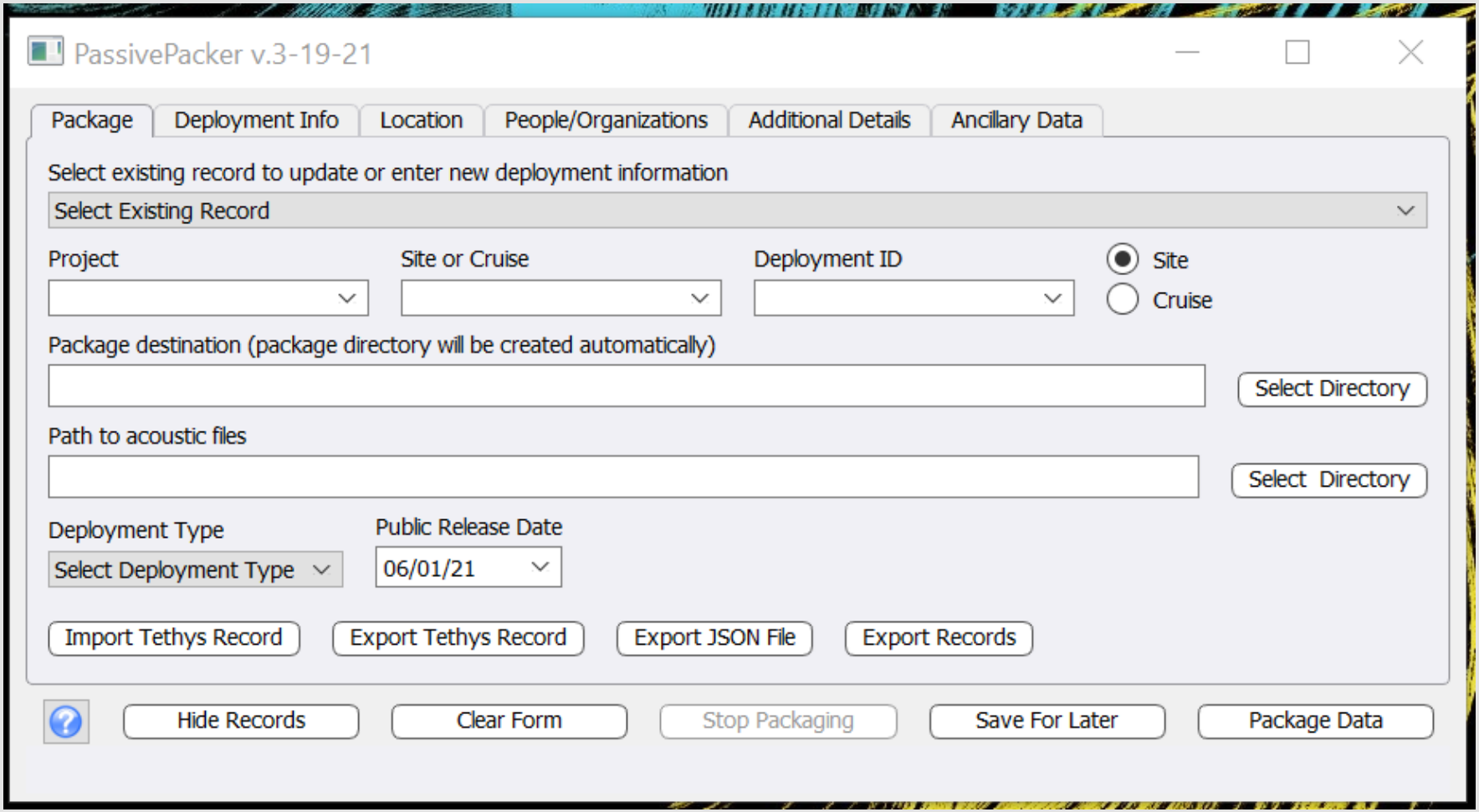
SEFSC

- Restore sonobouys
- GoMMAPPS towed array and sonobouys
- GOM Bryde's whales Gulfwide
- GOM Bryde's whales BIA
- After that I'd start thinking of the older data holdings...

Total NWFSC Holdings

- About 33 TB total
- Additional 14 TB/year

PassivePacker



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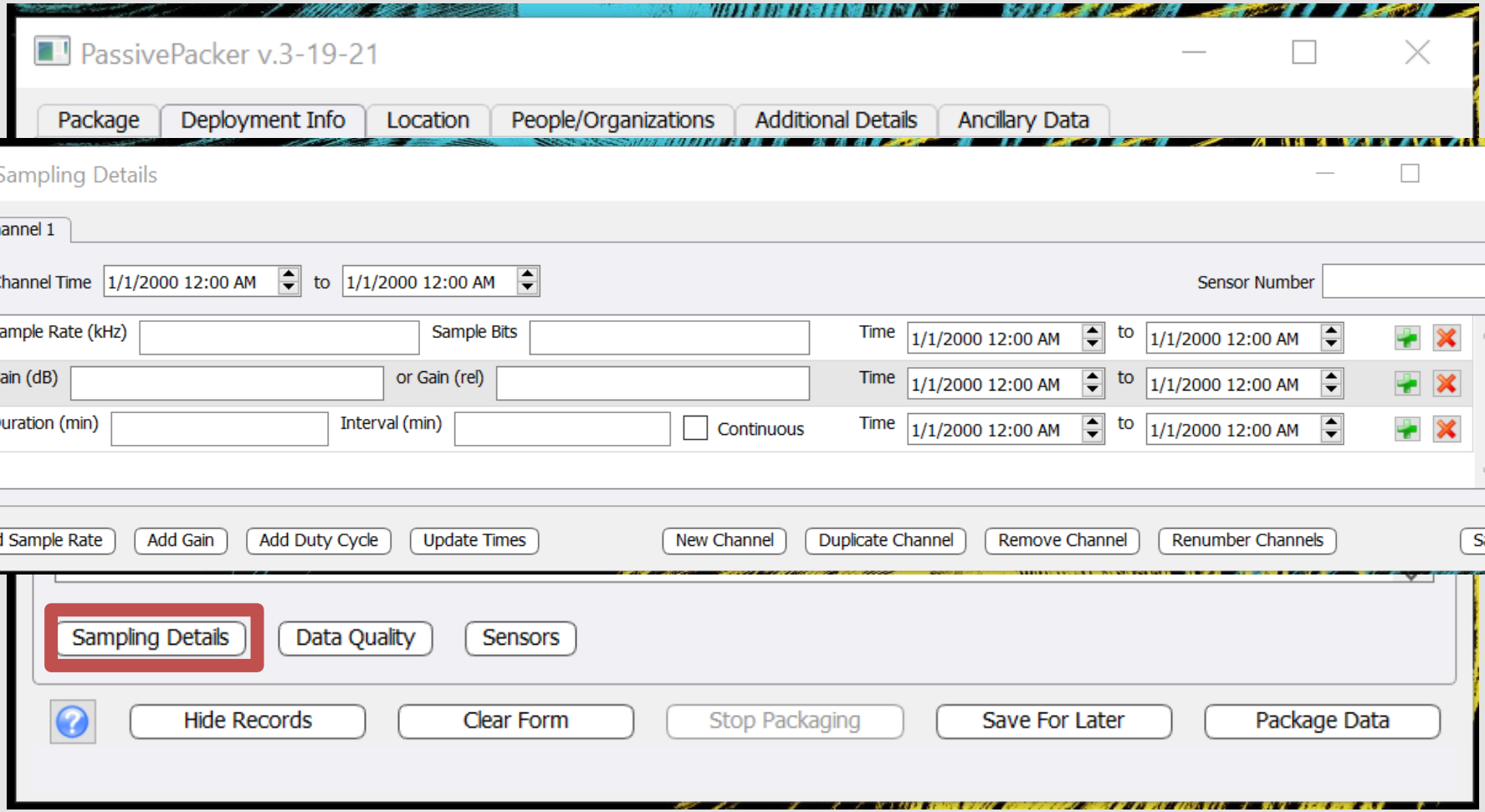

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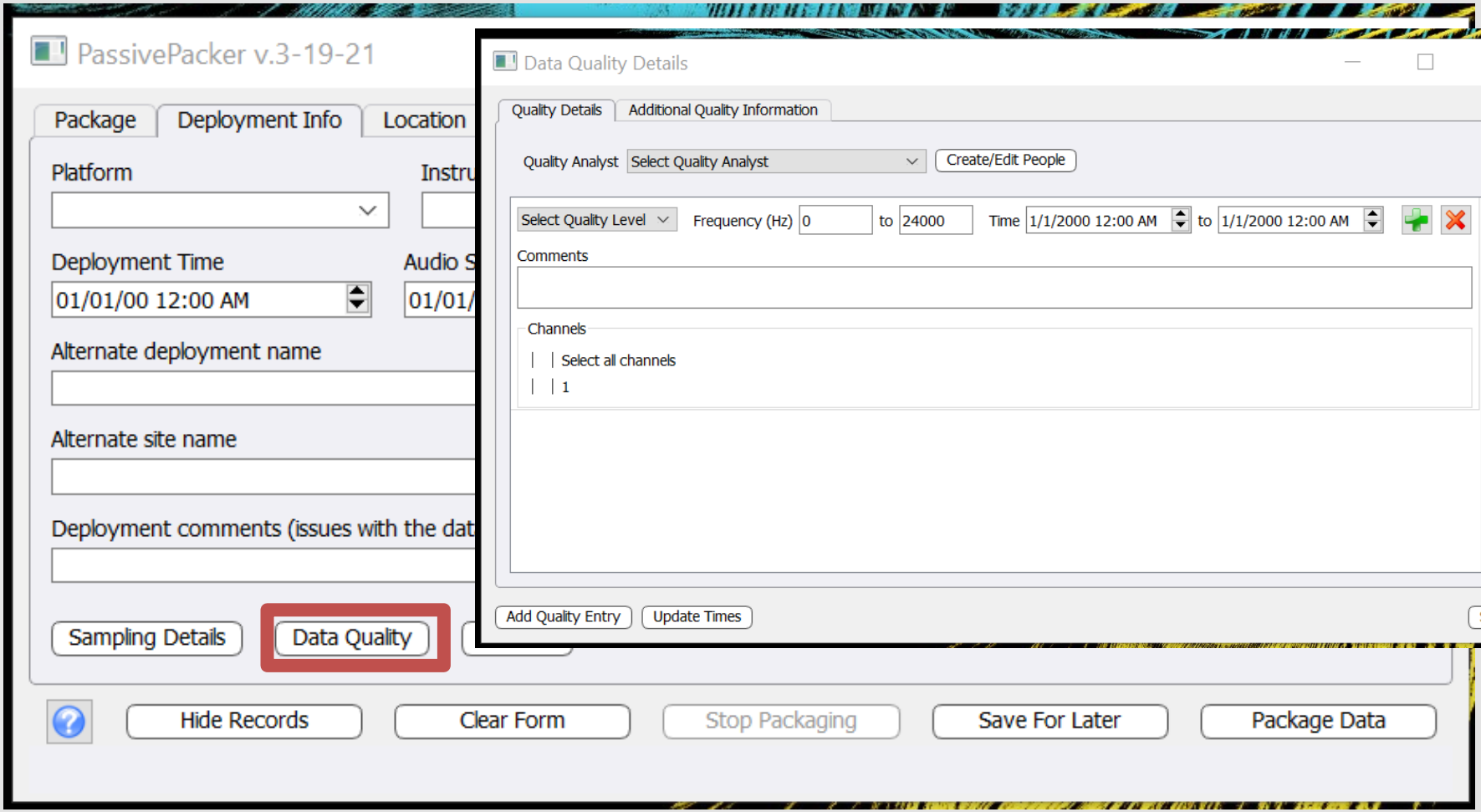

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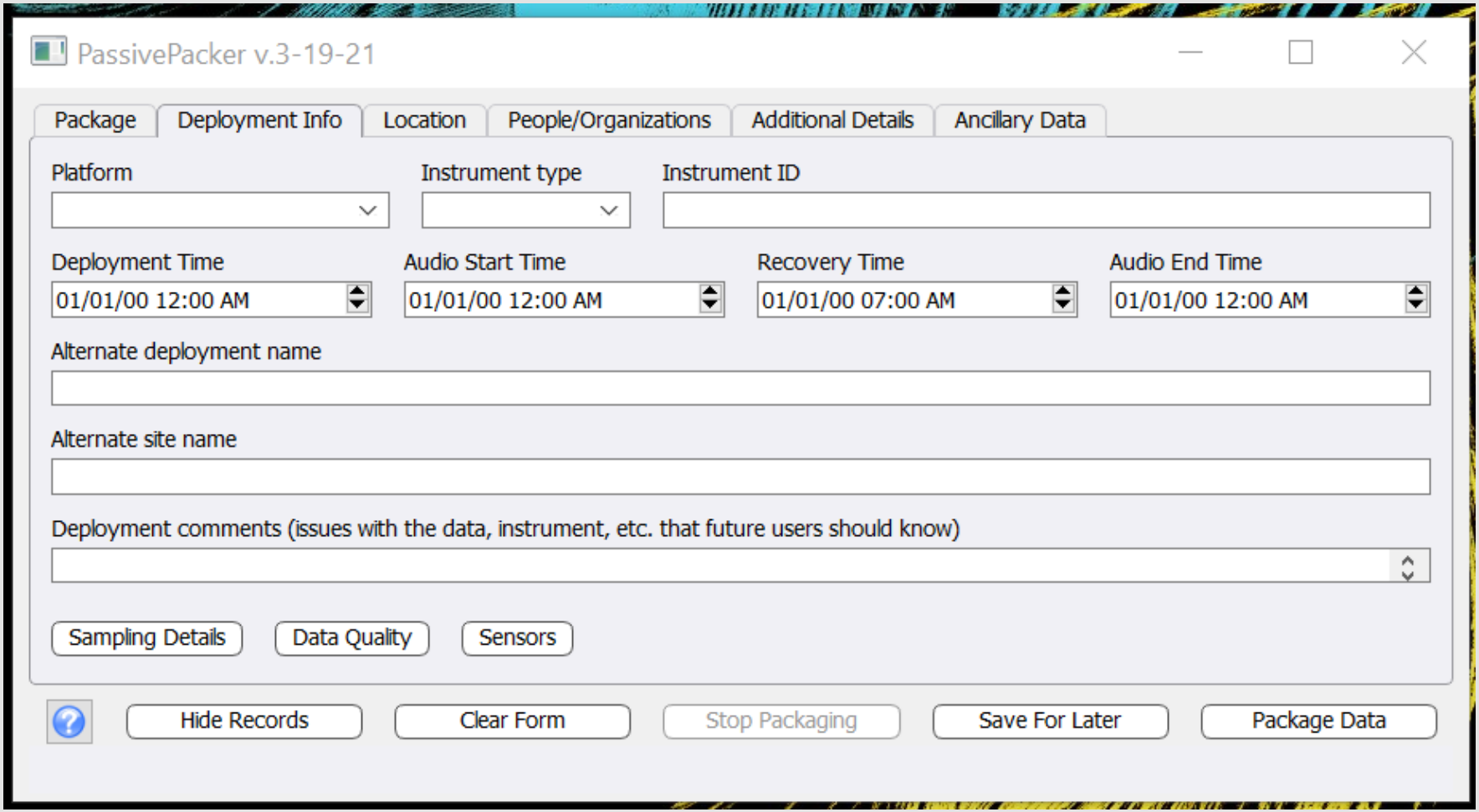

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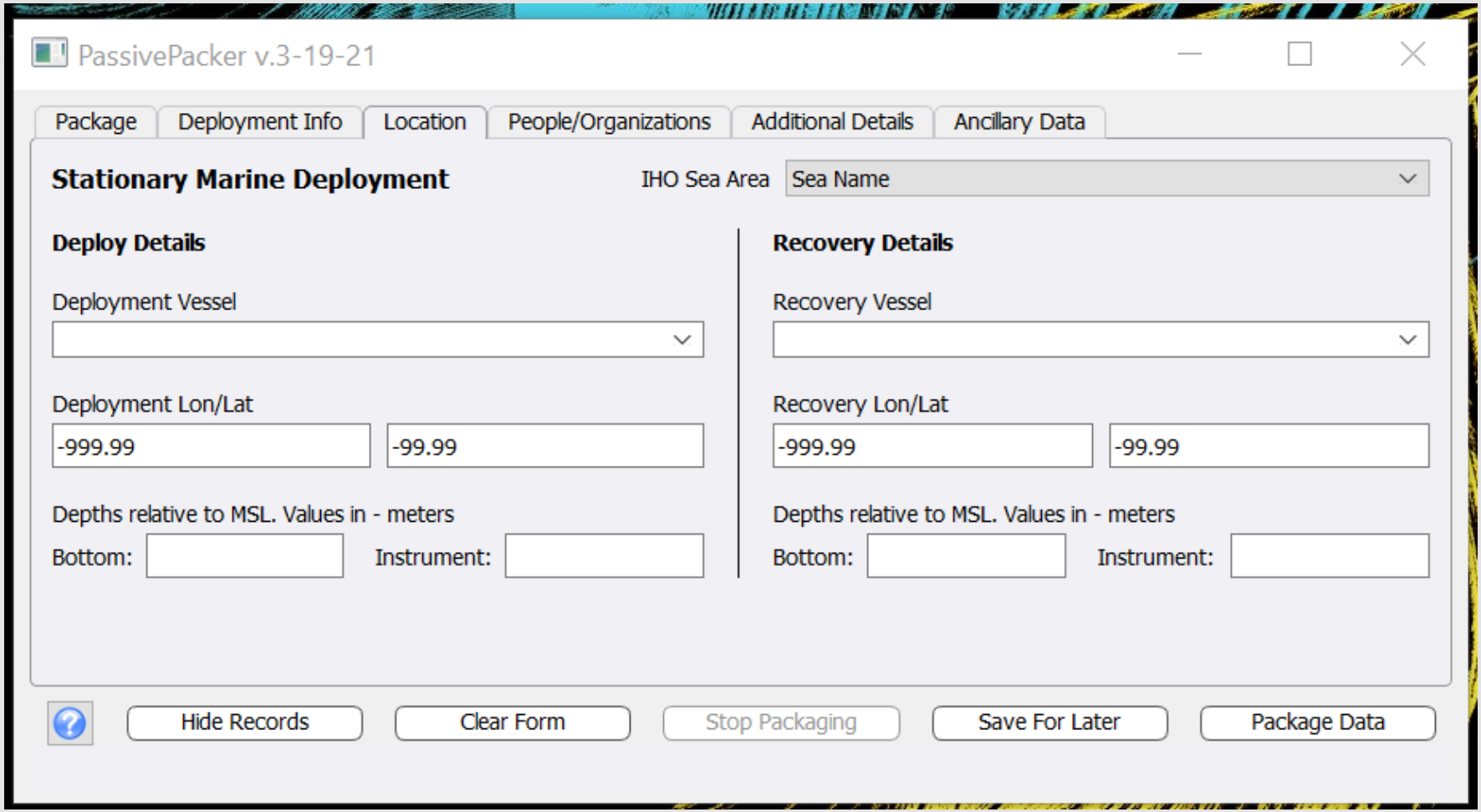

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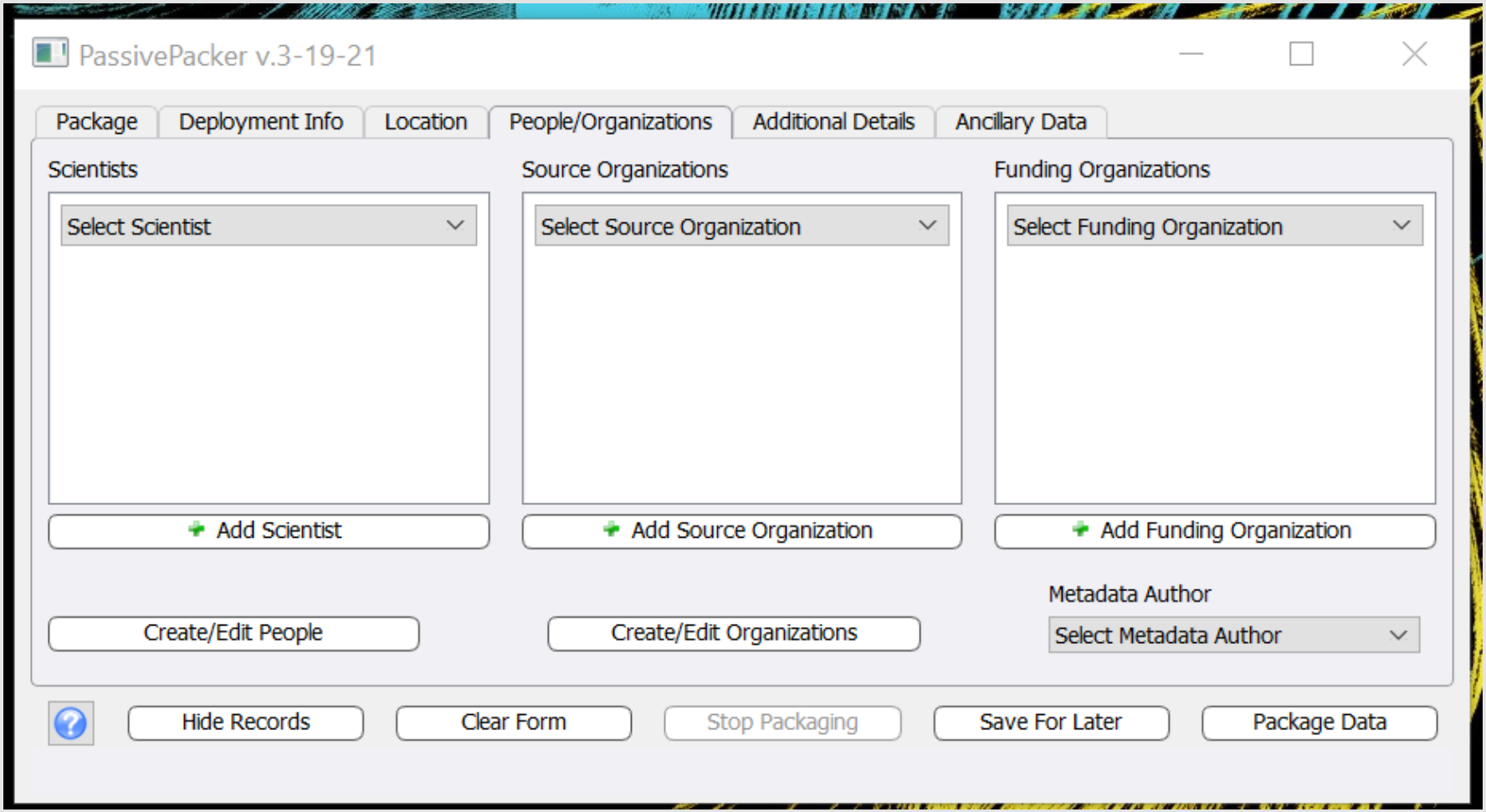

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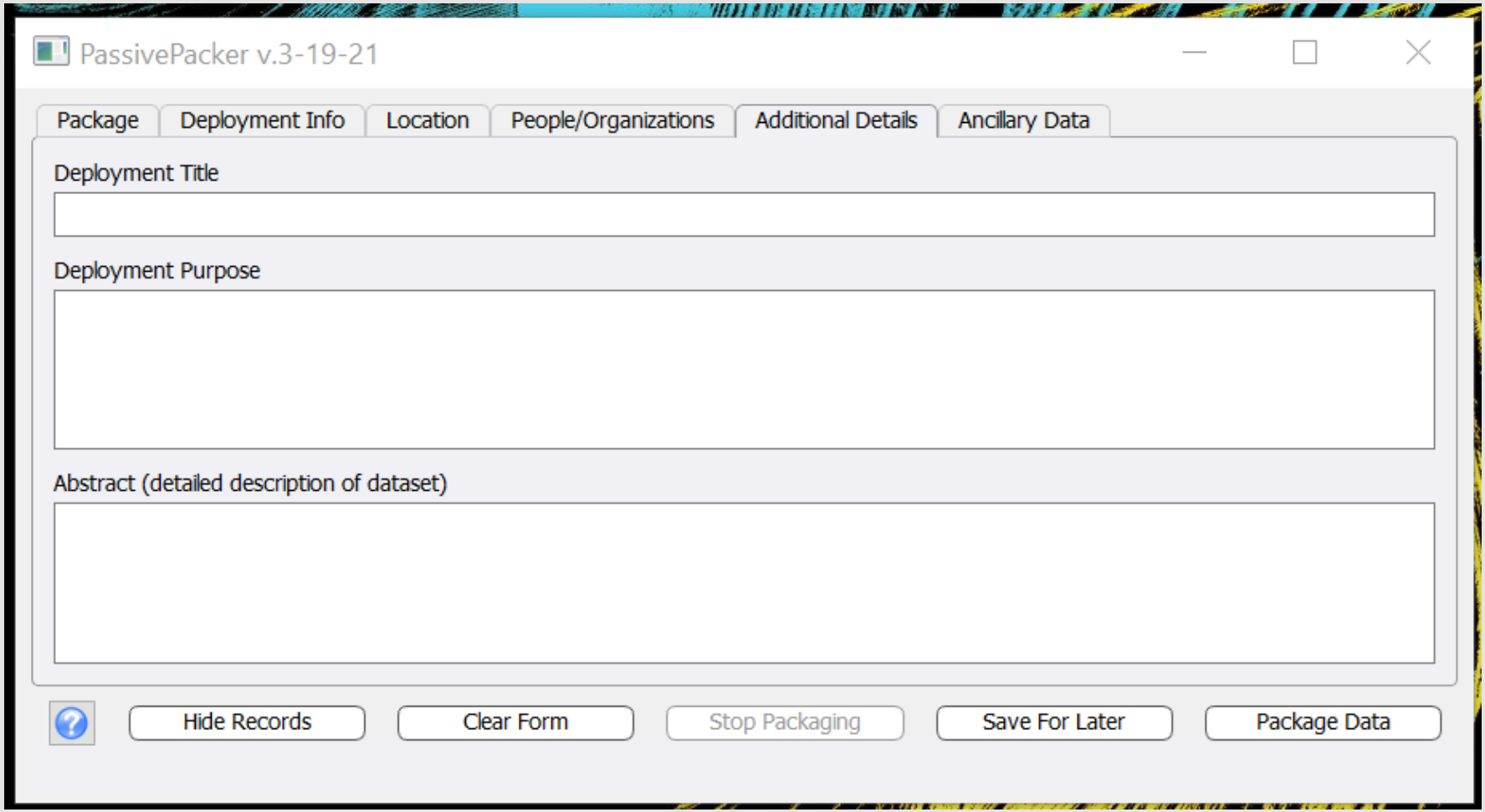

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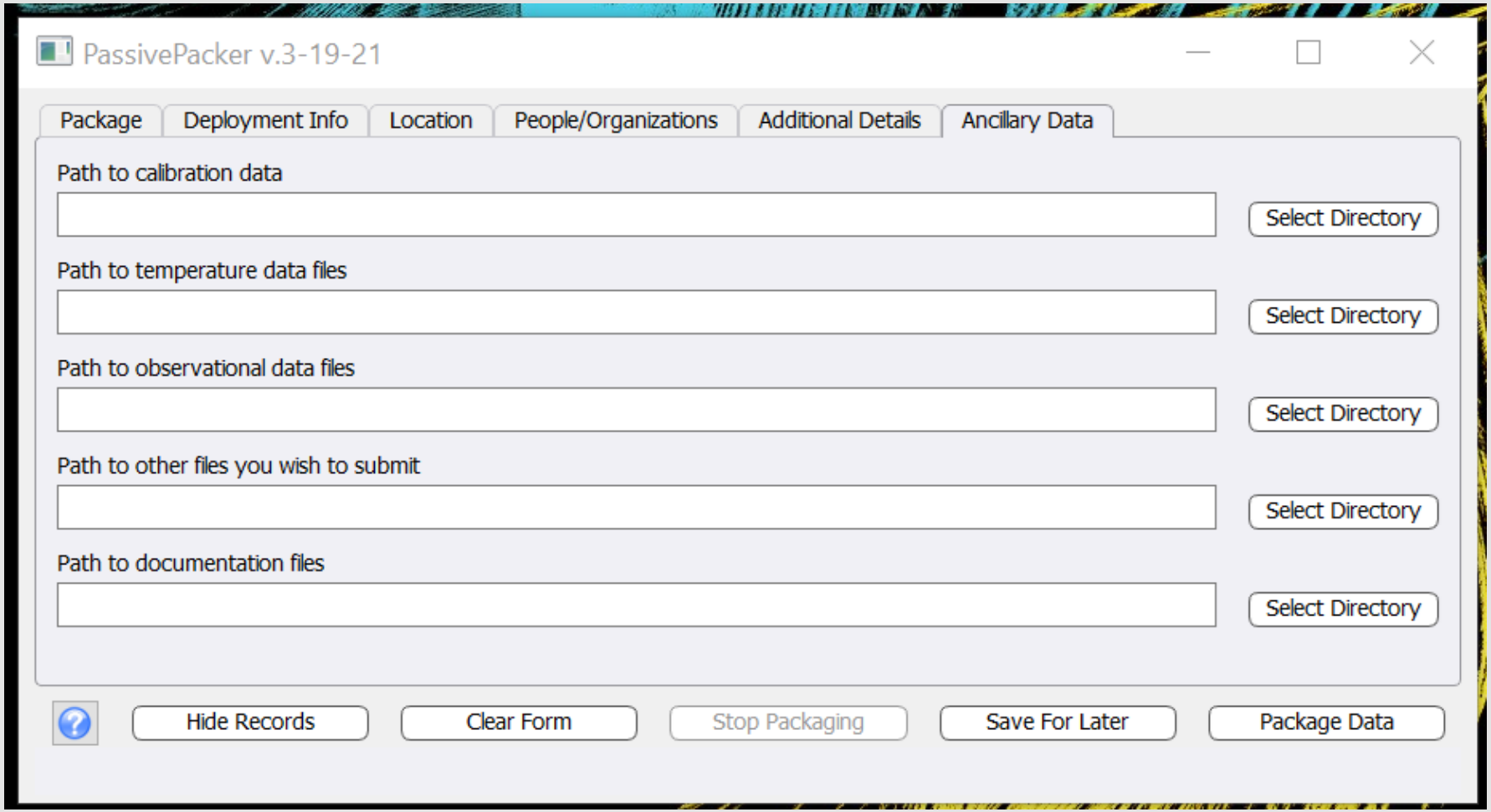
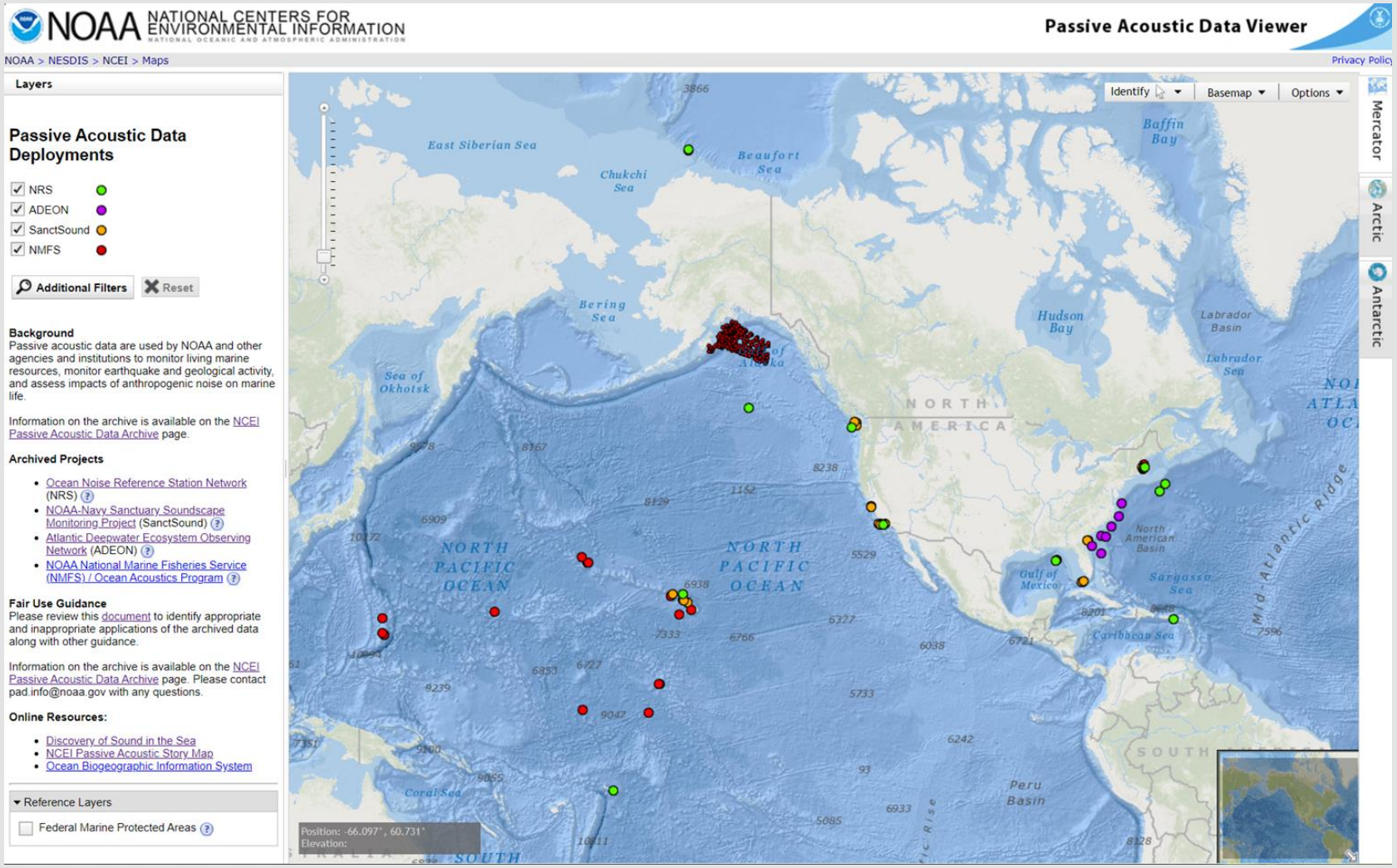
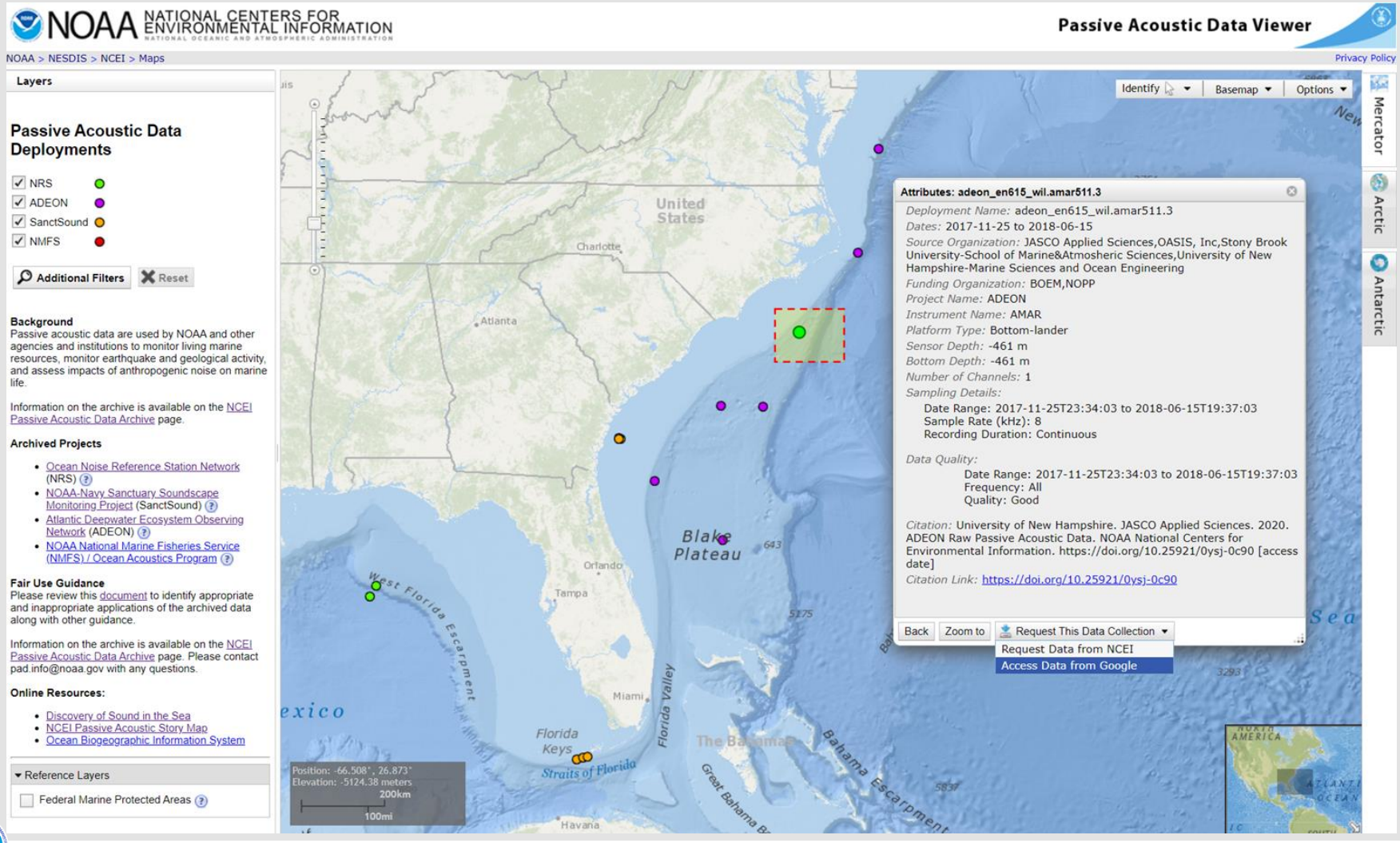


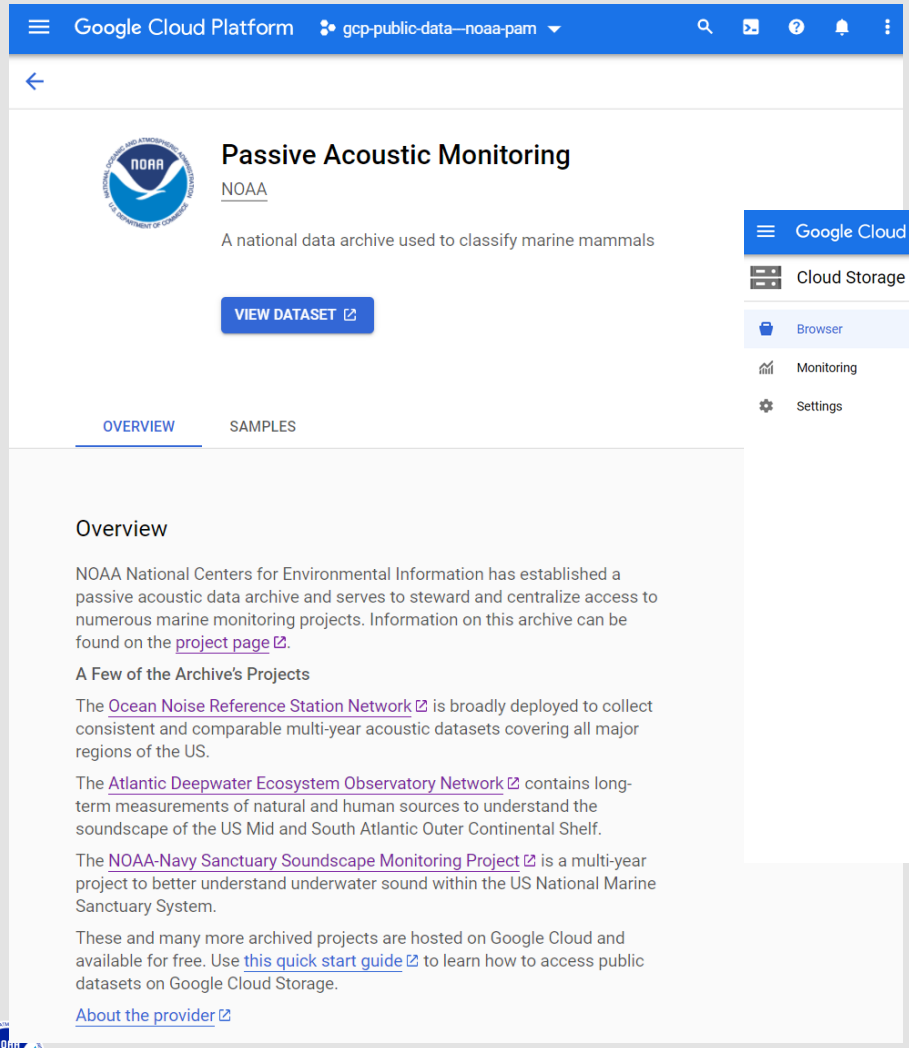
Passive Acoustic Archive

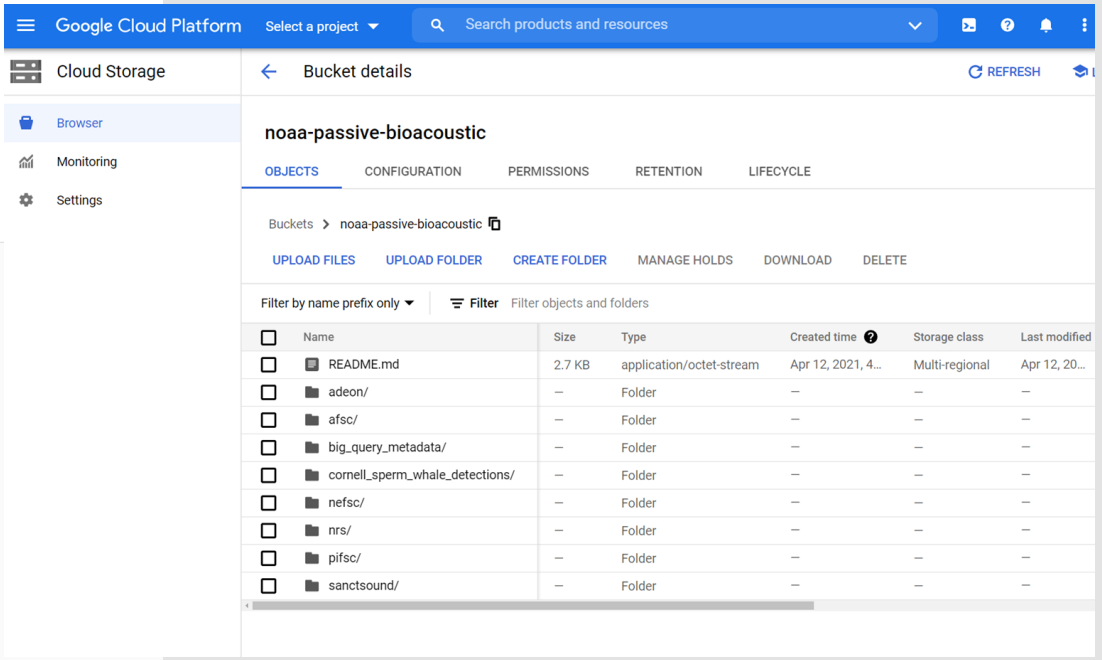


Passive Acoustic Archive



Cloud Access through NOAA Big Data Program





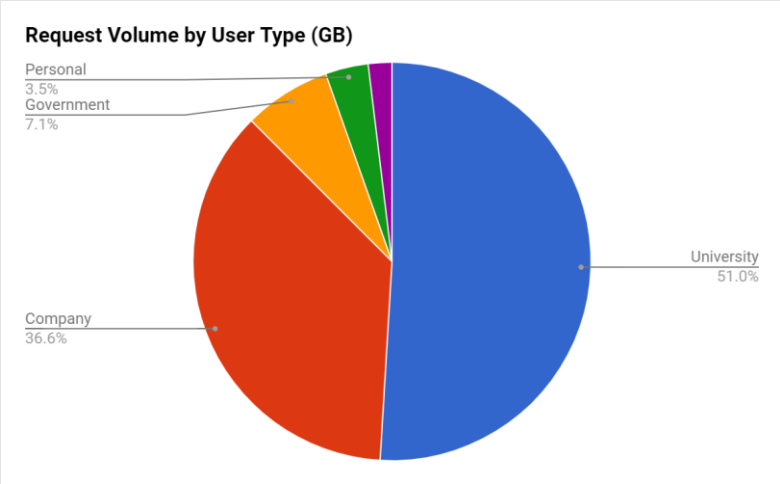
Public Access

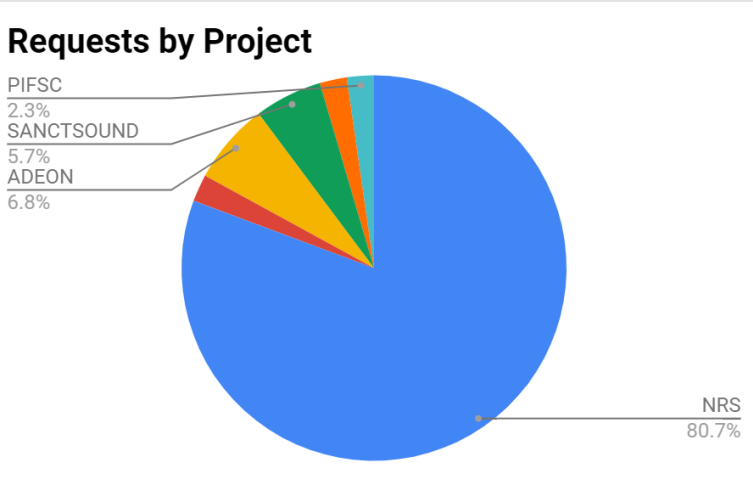
Volume Delivered

31.4 TB

… plus data accessed directly from GCP

Data Uses	Examples	Project
Whale sounds	Characterize fin whales and blue whales sounds	NRS
Support small business	Small Business Innovation Research, an incubator to develop technology with government and commercial applications	ADEON
Ambient noise	Characterize ambient noise near Channel Islands	NRS
Visualization	Visualize the underwater acoustic environment	NEFSC, NRS





What We Will Cover in August

- Additional details on the archival process
  - Data formats
  - Deep dive into PassivePacker
- Costs associated with archiving at NCEI
  - $ per TB, accompanying agreements
- In depth understanding of your data
  - Confidential data vs open access data

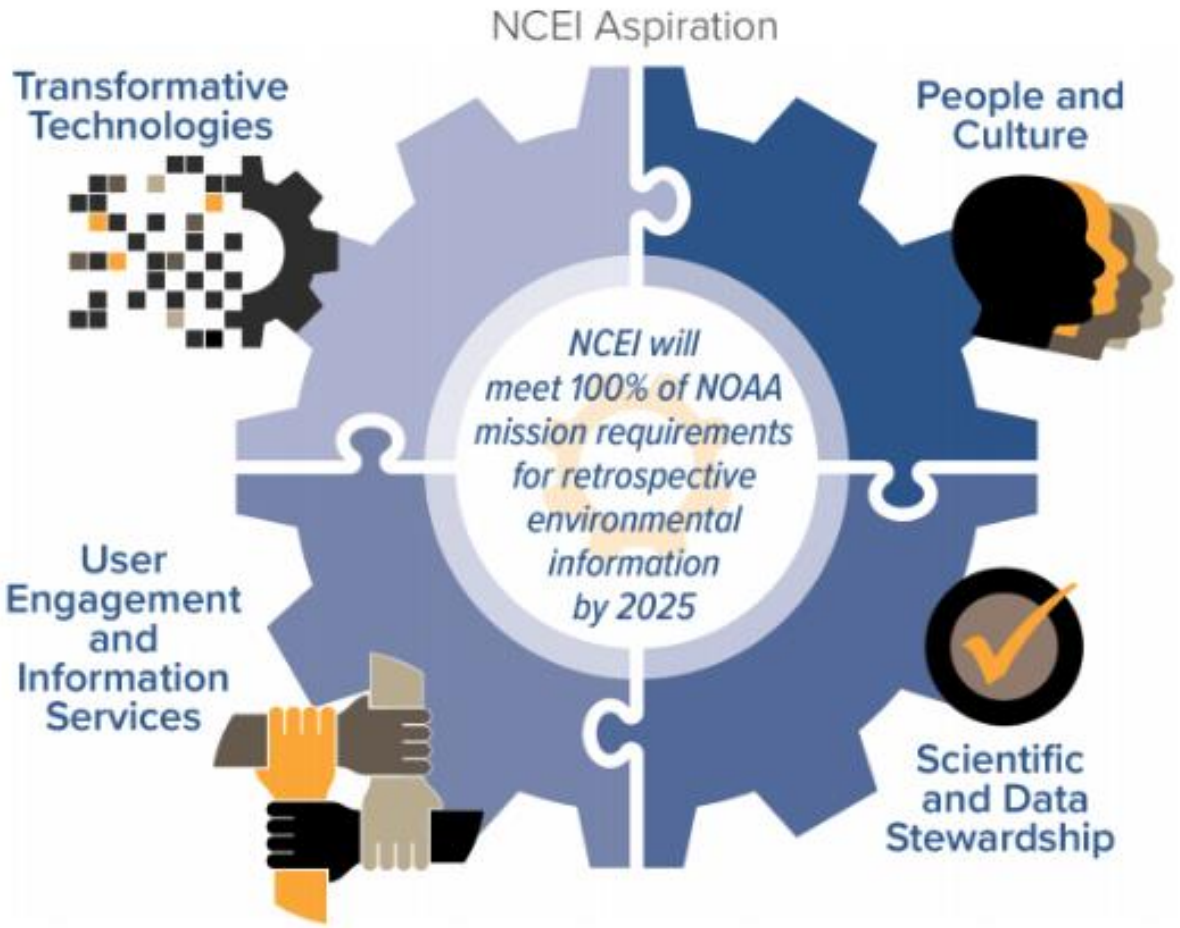
Thank You

Passive Acoustic Archive

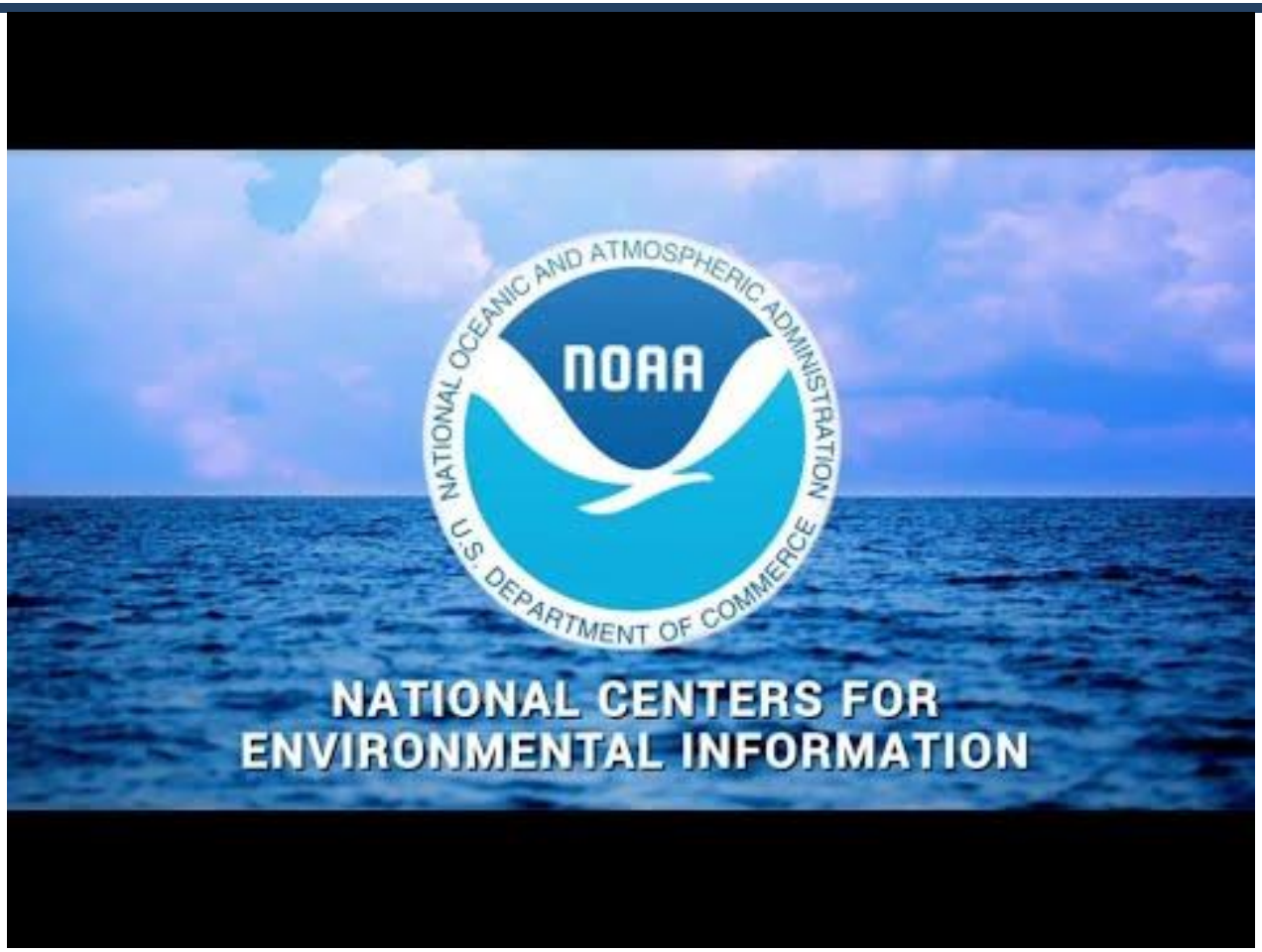
www.ngdc.noaa.gov/mgg/pad

Carrie.Wall@noaa.gov

The NCEI Roadmap: 2020-2025



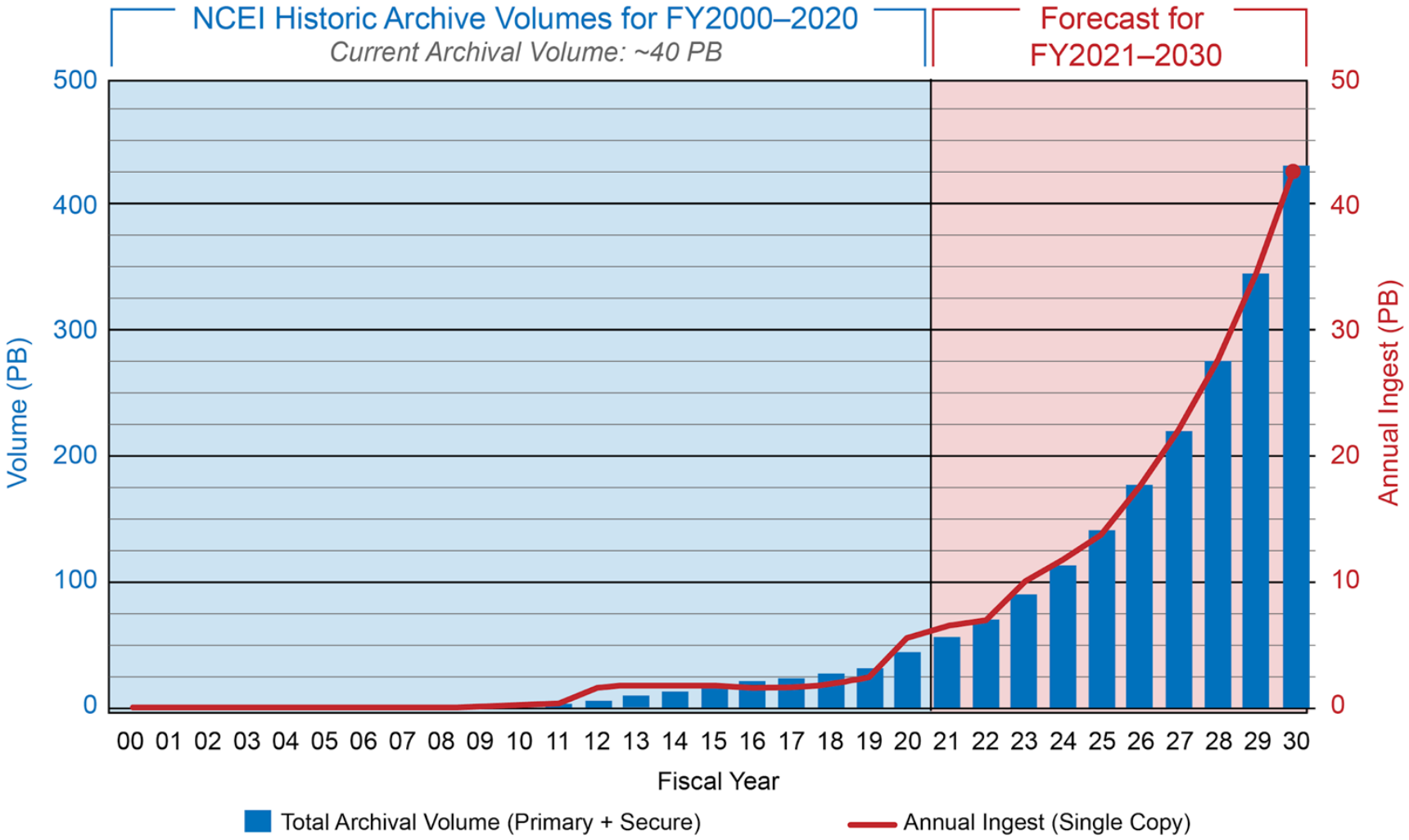
Learn More About NCEI



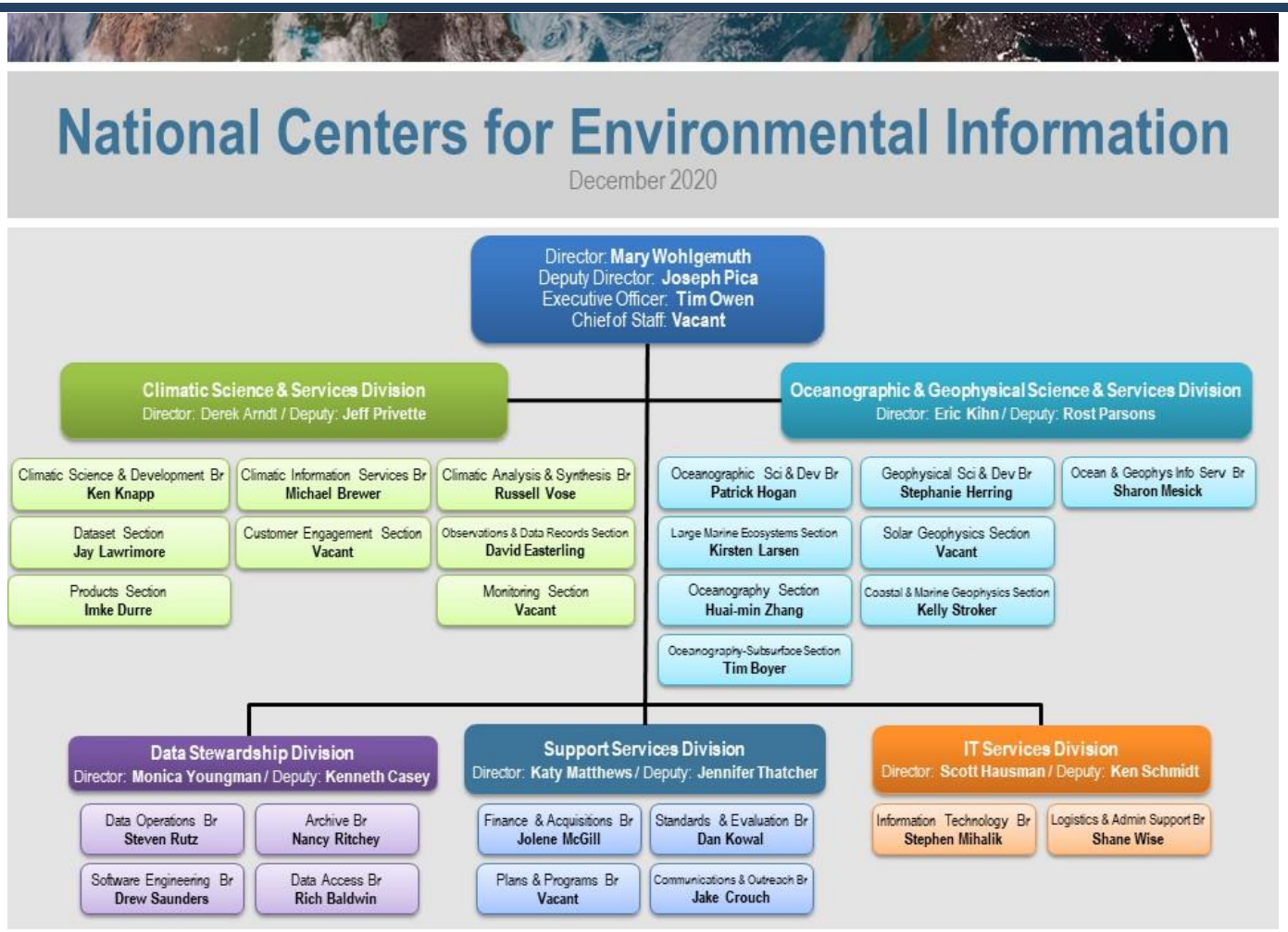
www.ncei.noaa.gov

NCEI Archival Volume History and Forecast

Increasing Data Volumes from Station, Model, Radar, UxS, Acoustics, 'Omics, and Satellite Sources



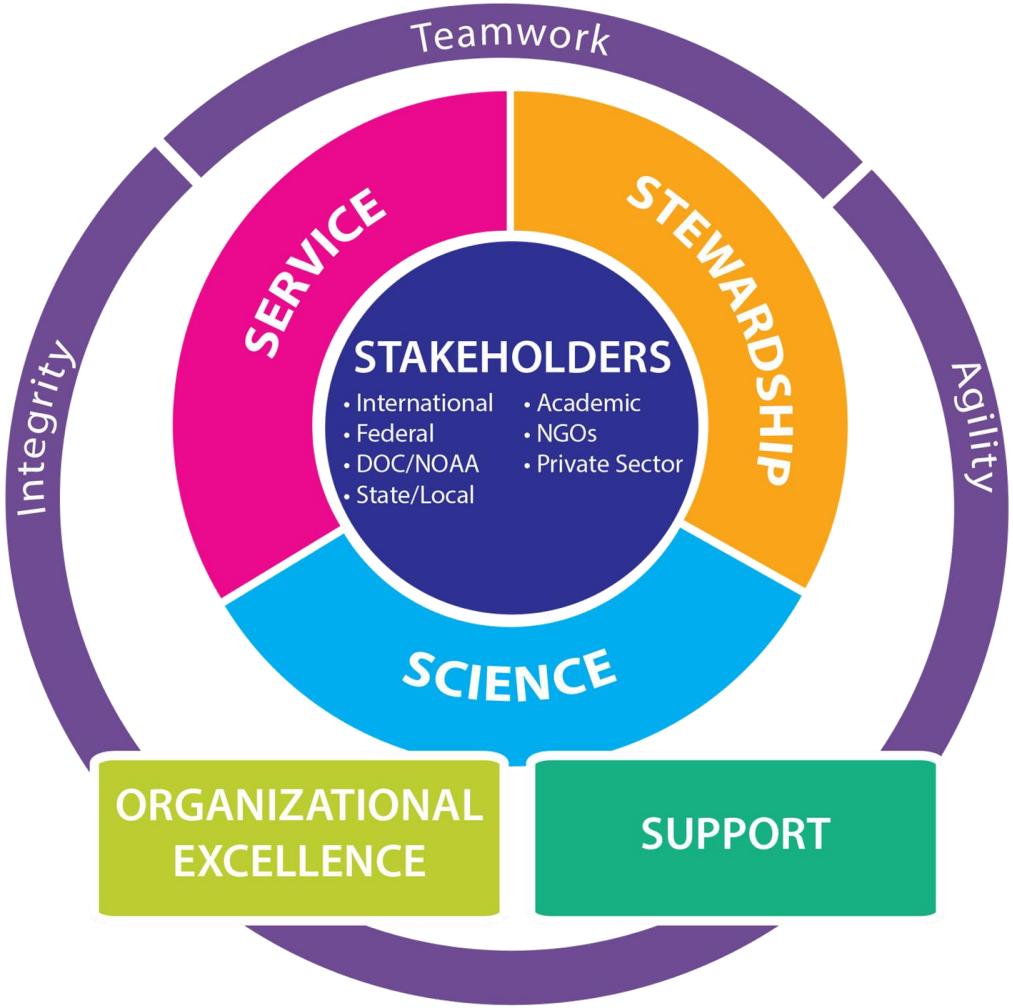
NCEI's Organizational Structure



NCEI Organizational Excellence

Building a culture based on integrity, teamwork, and agility

- INTEGRITY
  We hold the public's trust by demonstrating ethical behavior in all aspects of our operations
- TEAMWORK
  We cultivate cohesive, highly functioning teams
- AGILITY
  We embrace and rapidly respond to change



NCEI: High Impact, Global Reach

Earth Observing Systems








NCEI

Scientific Data Stewardship

Research-quality products for decision making

Oceans & Coasts

- Tsunami Warning
- Coastal Digital Elevation Models
- Extended Continental Shelf
- World Ocean Database

Climate & Weather

- Climate Assessments
- Billion $ Disasters
- Temperature & Precipitation Outlooks

Geophysics

- Space Weather
- World Magnetic Model

Tiers of Data Stewardship

From Acquisition to Archive to Access

U.S. Department of the Interior (DOI)

The DOI protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management (BOEM)

BOEM's mission is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.