Final Report and White Paper

Partners in Science Workshop:
Offshore Wind and the Mid-Atlantic Cold Pool

Hosted on: Wednesday, 17 July 2019
Hosted at: Coastal Education Center at the
Jacques Cousteau National Estuarine Research Reserve
130 Great Bay Blvd, Tuckerton, NJ 08087

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Workshop participants (listed in Appendix 2) had an opportunity to review and provide comments on the draft version of this report, which have been addressed in this final version. The authors thank all of the participants for their contributions!

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Partners in Science Workshop:
Offshore Wind and the Mid-Atlantic Cold Pool

Jacques Cousteau National Estuarine Research Reserve, Tuckerton, NJ
July 17, 2019

Organizers: Josh Kohut and Joseph Brodie
Rutgers University Center for Ocean Observing Leadership

Sponsored by the New Jersey Board of Public Utilities and the Mid Atlantic Regional Association Coastal Ocean Observing System (MARACOOS)

The Mid-Atlantic Bight Cold Pool

The Mid-Atlantic Bight (MAB) is bounded by Cape Cod, Massachusetts to the north and Cape Hatteras, North Carolina to the south, and is intersected by the Hudson Shelf Valley extending from the mouth of the Hudson River out to the continental shelf-break. The physical oceanography of this region is influenced by local topography, freshwater input from the large watersheds that empty through multiple rivers and estuaries, large scale atmospheric patterns over the North Atlantic, and tropical or winter coastal storm events. Therefore, the ocean characteristics undergoes remarkable variability across time scales from hours, days, and weeks to seasons, years, and decades. Time scales of variability must be considered when delineating areas of offshore wind lease areas with expected lifetimes of decades, and when evaluating environmental impacts from proposed and constructed wind farms.

Seasonally, this area experiences one of the largest temperature changes from summer to winter of any part of the ocean around the world. From winter to summer, swings in the surface temperature drive strong transitions in stratification with cold, well-mixed conditions in the winter months and strongly stratified conditions during the summer (Houghton et al. 1982). In late spring and early summer, a strong thermocline develops at about 20 m depth across the entire shelf, isolating a continuous mid-shelf "cold pool" of water that extends from Nantucket to Cape Hatteras (Houghton et al. 1982). Local river discharge can augment this thermal stratification across most of the shelf (Chant et al. 2008) and provides pulses of nutrients and other material to the MAB shelf. These riverine inputs are only a fraction of the supply from upstream sources delivered by a mean southwestward flow along the shelf (Fennel et al. 2006). In addition, upwelling along the coast occurs annually each summer. It is driven by southwest winds associated with the Bermuda High (Glenn and Schofield 2003; Glenn et al. 2004). Local upwelling can deliver cold pool water all the way inshore and to the surface near the coast (Glenn et al. 2004). This upwelled water can drive the development of very large phytoplankton blooms that are advected offshore (Sha et al. 2015). The result is a unique ocean feature called the cold pool, a band of cold bottom water that extends the length of the Mid-Atlantic Bight from spring through early fall.

The cold pool initially develops in spring of each year as remnant winter water over the shelf is capped by developing stratification created by increased solar insolation, fresh water runoff, and reduced wind mixing (Lentz et al. 2003). During the spring and early summer, stratification increases over the cold pool, primarily through surface heating, but with a contribution from freshwater runoff (Houghton et al. 1982). During the summer, surface-to-bottom temperature differences are about 10^{o}C. The cold pool gradually warms from 7^{o}C in May to 10^{o}C in September, presumably due to heat fluxes through its surface and lateral boundaries. The cold pool loses its distinctive identity in early fall, as water temperatures become vertically uniform at a relatively warm 10^{o}-15^{o}C due to vertical mixing.

Ecological Links to the Cold Pool

The seasonal evolution of the cold pool plays a central role in structuring the MAB ecosystem. The intense ocean variability drives an equally variable ecosystem from the primary producers (Malone et al. 1988) to the highly migratory fisheries throughout the currently existing and proposed wind lease areas. The tight coupling between the ocean conditions and the habitat preference of the commercially and recreationally targeted species lead to a distribution of effort that can significantly vary from season to season and year to year. Rutgers and its collaborators have shown that many mobile marine species in the Mid-Atlantic Bight respond to changes in temperature in many ways – including changes in fecundity, mortality, migration patterns and timing, and stock distributions. Work coupling an Atlantic butterfish (*Peprilus triacanthus*) thermal niche model to a 50-year ocean bottom temperature hindcast helped to narrow a previously very wide confidence band in the stock assessment abundance indices for butterfish. Furthermore, it established a biological reference point by providing a better-defined estimate of the amount of total habitat actually available to fishery independent trawl surveys (Northeast Fisheries Science Center 2014). The temperature dependence of so many fish species coupled with the high variability of temperature in the region on a seasonal, interannual, and climate scale suggests that mid-Atlantic species of interest to fishermen are likely to show significant variability in their distributions on both short and long time scales. This is confirmed by Nye et al. (2009), who used NOAA National Marine Fisheries Service (NMFS) survey data to show that several species in the Mid-Atlantic Bight have shifted northward and/or into deeper water with climate change over the past few decades. Certain species have also expanded or contracted their total occupied range in the region. As these population shifts continue to progress, fish currently exploited in the region may move into wind energy areas they had not previously occupied, and there is also the opportunity for new warmer-water species to move into the region and initiate the opening of a new fishery.

MARACOOS Technologies Monitor the Dynamics of the Cold Pool

Ocean observing systems are now deployed around the world. These networks of integrated technologies deliver continuous oceanographic data around the world. The Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS), is the regional component of the Integrated Ocean Observing System deployed between Cape Hatteras, NC and Cape Cod, MA. MARACOOS integrates observing platforms, sensors, and models to monitor and predict the fine scale variability of the MAB. Three key technologies allow for fine scale characterization of the coastal ocean including the acquisition of data streams from U.S. and foreign satellites in space, a network of high-frequency radars deployed along the shore, and a fleet of robotic gliders flying beneath the ocean surface. These data are assimilated into a 3D numerical model of the ocean physics that is run daily to predict the ocean state out two to three days into the future. All these MARACOOS resources are used to respond to research and product development needs in support of regional needs within 5 thematic areas:

- Maritime Commerce & Safety
- Fisheries
- Water Quality
- Coastal Hazards
- Energy

As a central feature to the region, it is critical that the dynamics within and between years is understood so that ecological and environmental influence of and on the cold pool can be accurately considered. MARACOOS resources including data, models, and regional expertise are an important resource available to the research, policy, and decision-making communities.

Offshore wind development in the Mid-Atlantic has accelerated rapidly over the past couple of years, with states stretching from Virginia to Massachusetts making firm commitments to purchase offshore wind and advance their renewable energy goals. These goals include, so far, a commitment to over 18 GW of installed wind capacity in the Mid-Atlantic Bight in the next decade. Due to these expectations, it is vital that the relationships between offshore wind and the Mid-Atlantic physical and ecological environment be thoroughly explored and understood, particularly how offshore wind development may influence the cold pool.

Workshop Goals

Given this context, we organized a workshop that would bring together experts from the many communities working in and around the Mid Atlantic Bight familiar with the oceanography, the ecology, and the various ongoing and planned future offshore wind uses of this space. The workshop attendees (See Appendix 2) included experts from academia, fisheries and the wind development industry, non governmental organizations, and local, state and federal government engaged in shared uses and understanding of the Mid-Atlantic Bight. The specific goals of the workshop were to:

- Share the current state of the scientific knowledge of the Mid-Atlantic ocean physics and ecology as it relates to the cold pool.
- Brief the workshop participants on the suite of available cold pool relevant regional observations and data management systems provided through MARACOOS.
- Identify knowledge/resource gaps that must be addressed in order to better understand the potential impacts of offshore wind development on the Mid-Atlantic Bight Cold Pool.
- Develop an action plan with community input to engage partnerships between scientists, managers, and commercial fishermen that prioritizes research needs to better assess the impact of offshore wind development on the cold pool.

The input received before and during the workshop by the participants highlighted the variety of resources available to support scientific research, assessment, and decision making related to cold pool variability and impacts in the MAB. The workshop agenda was organized into three primary sections. The first was focused on ocean science experts sharing the latest state of knowledge on the physics (Dr. Travis Miles and Dr. Scott Glenn) and the ecology (Dr. Grace Saba and Dr. Daphne Munroe) of the cold pool. Following those presentations Dr. Gerhard Kuska presented the expertise, observations, modeling and regional data systems that are available to monitor and map cold pool variability. The second section of the agenda was a panel titled *'Partnership Frameworks for Offshore Wind and Cold Pool Research and Monitoring.'* The panel, moderated by Dr. Josh Kohut, included:

- Tom Dameron, Surfside Foods LLC
- Jessica Dealy, Atlantic Shores Offshore Wind
- Peter Hughes, Responsible Offshore Science Alliance (ROSA)

- Angel McCoy, US Bureau of Ocean Energy Management (BOEM)
- Vincent Saba, NOAA National Marine Fisheries Service (NMFS)

Finally, the workshop participants broke into smaller groups to enable targeted discussion intended to seek their input. The instructed outcome of each breakout was to identify action to be taken in the near term (<2 years) and long term (>2 years). The following sections of this report summarize the presented material and discussion topics throughout the workshop.

Section 1: State of the Science: The Mid-Atlantic Bight Cold Pool

Cold Pool Physics: Dr. Travis Miles and Dr. Scott Glenn

In the first presentation, Dr. Miles gave an overview of the physical ocean properties governing the formation of the cold pool. The Mid-Atlantic is essentially a unique location where polar and tropical circulations meet, both in the ocean and atmosphere. It is therefore a highly dynamic environment that consists of a variety of factors that drive the circulation in the region including: coastal currents, freshwater input, the formation of eddies and ocean fronts, boundary currents, tidal mixing, air-sea interaction, seasonally dependent radiative heat flux, and shelf-break canyons. In 1933, Henry Bigelow published the first publication on the cold pool, noting a 7ºC change in the upper 5 m ocean layer (Bigelow 1933). However, it wasn't until 1982 that Robert Houghton defined the phenomenon as the Mid-Atlantic Cold Pool (Houghton et al. 1982). The cold pool is largely confined to coastal waters of the Mid-Atlantic Bight, and can feature substantial spatial and temporal variability, but is generally present from May through September, where the subsurface water is generally colder than 10ºC and salinity values are below 34 psu.

Following Dr. Miles's introductory presentation, Dr. Glenn updated the group on some of the latest research around the physics of the cold pool. He emphasized that the Mid-Atlantic Cold Pool is an example of some of the strongest stratification in the world; this stratification is enhanced by freshwater input from the coast, and salt water intrusion onto the continental shelf. The cold pool also influences sea breezes, which are driven by the land/sea temperature difference. Sea breezes in New Jersey peak during the summer months, when cold water from the cold pool is frequently upwelled causing surface water temperatures to decrease, enhancing land/sea temperature gradients and intensifying the sea breezes, which is particularly relevant to offshore wind due to coincidence with the peak summer energy use period. The downwelling and mixing of the cold pool forced by surface winds has an important impact on hurricanes, as well. In one example, Hurricane Irene, cross-shore winds were prevalent, which resulted in mixing the colder waters into the warmer surface waters, cooling the ocean surface prior to eye passage and weakening the storm. However, during Hurricane Sandy, the along-shore winds resulting from that storm's path resulted in downwelling, keeping the warm water at the surface, and aiding the storm's intensification. Proper understanding of the cold pool in ocean models can have a huge impact on the accuracy of hurricane forecast intensity.

Cold Pool Ecology: Dr. Grace Saba and Dr. Daphne Munroe

In the first ecology presentation, Dr. Saba outlined the seasonality of the cold pool and the resulting impacts to the ecology: uniform mixing in wintertime, transitioning to a start of thermal stratification in spring, to fully stratified in the summer before breaking down in the fall. Spring can result in large phytoplankton blooms, where chlorophyll is typically more offshore. An oxygen maximum layer exists, which is the result of phytoplankton producing oxygen and affecting the pH, with lower pH in bottom waters. During summer there is less chlorophyll. Stratification can also result in low oxygen bottom water and lower pH due to high respiration in bottom waters. The biggest blooms start in the fall with stratification and can last through winter. A bloom of phytoplankton results in a bloom of zooplankton, with a slight lag. Wind events and storms break down stratification, resulting in a surface which is relatively cooler and a bottom which is relatively warmer.

Life histories of many species are tied to the cold pool. Organisms are strongly driven by temperature, resulting in changes in metabolic rate, heart rate, and possible behavioral impairment. Optimal thermal conditions are indicated by aerobic scope, which is the difference between maximum aerobic rate and standard metabolic rate. Oxygen demand increases with temperature, but at higher temperatures, it is more difficult for blood to absorb oxygen. Finally, the timing of fall migrations is linked to the breakdown of the cold pool: for instance, winter flounder move inshore; summer flounder, black sea bass, and butterfish move offshore. Abundance of yellowtail flounder can be tied to the cold pool, as they die outside of the cold pool temperature boundaries. Additionally, the cold pool can act as a temporary refuge for more northern species. This is connected to changing ocean conditions: distribution of several species has shifted northward over the years, with decent variability.

Finally, Dr. Munroe discussed the connections between the cold pool and shellfish. Mollusks can't move or control their body temperature, so cold pool characteristics are even more critical to their habitat. Energy demand increases with temperature. Energy absorption ability increases with temperature to a maximum, then decreases. In surf clams, a 10% decrease in length is a 40% decrease in biomass, which significantly impacts fisheries. Furthermore, the distribution of surf clams is shifting: the median depth of the surf clam catch is increasing in response to increasing temperatures, resulting in the bulk of biomass of clams moving offshore to deeper waters. In one study, she modeled clam population and compared with bottom water temperature time series. This was combined with an assessment record showing biomass of clams. In 1974, there was a boom in biomass, then a few years later decline in abundance. Ocean quahogs live for hundreds of years and their shells show the conditions, allowing one to back calculate temperatures and growth rates. The location and intensity of the cold pool is related to the mortality of various species, and sets constraints on the northern and southern edges of range. For instance, sea scallop fitness decreases in cold winter temperatures, and bathymetric depressions/valleys affect habitat range with the elephant trunk scallop. The reproductive cycles of the wave whelk are also connected to the cold pool. Finally, mortality is related to animals, predators, and parasites, as well, and without data, we can only guess at mortality and its connections to stock assessments.

These workshop presentations are available online at https://maracoos.org/Partners-in-Science.shtml.

Section 2: Partnership Frameworks for Offshore Wind and Cold Pool Research and Monitoring Panel

The panel discussion began with each member describing their role in Mid-Atlantic Bight research and/or offshore wind development.

- Vince Saba, NOAA National Marine Fisheries Service NMFS
  Research interests include dynamic climate projections of fish habitat along the Northeast Shelf. The cold pool is an important feature defining current and future fish habitats in the MAB.
- Angel McCoy, US Bureau of Ocean Energy Management (BOEM)
  Indicated a need to advance our understanding of wind turbine impacts on the cold pool relative to seasonal and event scale variability including nor'easters and hurricanes.
- Peter Hughes, Responsible Offshore Science Alliance (ROSA)
  Stressed the importance of cold pool research, particularly its critical role in both defining fisheries habitat and impacting the intensity of approaching storms. Further stressed the importance of identifying and prioritizing cold pool research tasks.
- Jessica Dealy, Atlantic Shores Offshore Wind
  Identified research areas centered both wind turbine impacts on the MAB cold pool and the local impacts of the cold pool on the wind resource from event scales (sea breeze) to longer term climatic scales.
- Tom Dameron, Surf Side Seafood Products LLC
  Identified a research priority focused on the impacts of the extracted wind energy by collective wind farms on the cold pool and associated ecosystem. Specifically, how will the extraction of wind energy impact fisheries.

Discussion Summary

The workshop participants were then invited to ask questions of the panel. The key discussion points from this interaction are summarized here:

The cold pool as a central fish habitat

- The commercial fishermen see clear connections between certain species and the cold pool. There are changes on short time scales (wind driven upwelling shifting the cold pool location) to longer time scales (general warming of the cold pool over the last several decades).
- To account for this critical connection between the cold pool and fisheries, there is a need to ensure the best science is informing the management of our natural resources.
- Research is needed to better understand the connection of protected species and the cold pool. What are the important time scales the models must capture to inform these studies? How can these research needs be met in a timely why to inform management?

Environmental Impacts of Offshore Wind Development

- There is a clear need to begin to use available tools to model the impact of wind farms from scales of single turbines, to entire wind farms to the cumulative scale of multiple wind farms. This has not been done with realistic Mid-Atlantic Bight conditions (including unique features like the cold pool).

- How will existing surveys (vessel and aircraft) be impacted by the wind farms?
- There needs to be a coordinated regional plan to monitor the MAB environment before, during, and after construction of the wind farms. This can be done by engaging stakeholder expertise and existing regional partnerships.
- At the turbine scale, we need to better understand the effect of the structures on local mixing and turbulence given the strong thermal gradients associated with the cold pool.

Available Data and Funding opportunities:

- o Existing partnerships in the region provide a real opportunity to make the necessary progress on the identified cold pool specific research and monitoring needs including programs like MARACOOS, RODA, and ROSA.
- o Several funding sources were identified from federal (NOAA, BOEM, DOE), state, and private (wind developers) sources.
- o Partnerships are key to ensuring that available funding is properly focused on the research and monitoring needs identified by the entire stakeholder community.

The panel concluded by asking each panelist to elaborate on the importance of partnership and collaboration in addressing research needs

- Peter Hughes (ROSA): Collaborative research is the only way to address needs. The federal government, commercial fishermen, developers, universities, all need to collaborate
- Angel McCoy (BOEM): BOEM heavily relies on partnerships in order to inform the industry and its responsible development.
- Vincent Saba (NOAA): NOAA relies on academic partners, working through existing cooperative institutes like CINAR partners.
- Tom Dameron (Surf Side Seafood Products LLC): The fishing industry is very willing and able to do collaborative research.
- Jessica Dealy (Atlantic Shores Offshore Wind): Collaborative research ensures that developers don’t start from scratch. It’s good development for developers to fund collaborative projects with universities and agencies. Cooperation makes science and research more efficient.

Section 3: Roundtable discussion

Following the lunch break, the attendees were divided into three groups which were pre-determined in order to ensure representation of all of the various stakeholder concerns in each group, to allow for a free, diverse exchange of ideas. The outcome of each roundtable was to identify action to be taken in the near term (<2 years) and long term (>2 years) in response to the following guiding questions:

- What are the key cold pool specific research and/or data needs that you think must be addressed or provided to ensure it is properly considered in the development of offshore wind?
- How do we leverage new and existing partnerships between government, academia, and private sectors to ensure the most relevant environmental questions are being asked and addressed by the appropriate research?

The main ideas from each group were summarized by a note-taker and moderator onto easels. Following the group discussions, attendees returned to the main room, and were asked to look at the ideas from each of the groups on those easels, and flag with stickers the ideas they felt were most important. Then, the entire group was brought together again to discuss as a whole. The below summarizes the ideas discussed both in the individual groups and the overall discussion that followed.

Actions to be taken right away (<1 year)

One of the key items discussed for immediate action is assessing and expanding partnerships between all stakeholders to ensure the proper questions are being asked and addressed, and trust is being built across all groups. Partnerships will enable cross-cutting studies to be conducted, while minimizing unnecessary duplication of effort. Since data-sharing is an essential element of answering questions around the cold pool, these partnership efforts can provide for information sharing of necessary information, while preserving proprietary information. It is only through effective communication amongst all partners that this can be accomplished. It is also essential that this communication and partnership building occur as early as possible in the process, to ensure the proper work can be done in a time-effective way. Some key partners that were discussed included (but are not limited to):

- National Renewable Energy Laboratory (NREL)
- Pacific Northwest National Laboratory (PNNL)
- Responsible Offshore Science Alliance (ROSA)
- U.S. Integrated Ocean Observing System (IOOS)
- NOAA National Marine Fisheries Services (NMFS), Northeast Fisheries Science Center (NEFSC), and Greater Atlantic Regional Fisheries Office
- Offshore Wind Developers
- Commercial Fisheries
- Recreational Fisheries
- Academic Institutions
- State Agencies throughout the region

Many of these groups already have existing partnerships between each other; it is essential that these existing partnerships are preserved and additional partners are added. The establishment of a dedicated task force composed of representatives of these key partners would be beneficial to preserving and expanding these important collaborations.

One of the key initial outcomes of these partnership discussions is the establishment of universal metrics to clearly establish what is already known about the cold pool, and be able to track any ongoing or expected changes due to offshore wind development and other factors. It's essential to establish these metrics early in the process, to allow for any preconstruction studies or surveys to be collecting the correct data in the correct formats for later comparison with new data. Having agreed upon data formats and data sharing mechanisms early in the process will allow for a smoother and more efficient use of data throughout the timeline of work in this area. Additionally, it is important for all stakeholders to be able to provide relevant data to the process, including stakeholders who are not typically in the business of assembling and sharing data. Early discussions in this area will allow for all to be able to participate and provide valuable, quality data.

Longer term action (<2 years)

Following the immediate goals established above, the next phase begins with a thorough understanding of previous studies, data collection activities, relevant expected wind farm parameters, and an establishment of the most pertinent questions and the types of data that will be needed to answer those questions. This also includes previous modeling studies that add to the understanding of the cold pool and its interactions, along with development of new and improved modeling tools to answer the established questions. This medium-range time period will be the early establishment of longer-term studies, and establishing and collecting all of the benchmark data required during pre-installation of wind farms in order to be able to quantify later impacts. It is also recommended that an in-person workshop on the available data, models, and study goals be held, to allow all stakeholders the opportunity to fully understand what is available, and what is needed.

Actions that require more time (>2 years)

The longer-term will include focusing on detailed modeling studies of the interactions between offshore wind and the cold pool, and continuous monitoring work in order to better inform those models. The longer term will ultimately include the time frame during which wind farms will be built and operated, and so during this stage it is essential to continue the monitoring work conducted pre-installation, in order to begin to quantify any impacts the wind farms may be having. As this monitoring occurs, it will be imperative to validate the models established in the earlier stages, and use this new data to improve the models. Some areas deemed essential for ongoing monitoring include sediment movement and the maintenance of proper cable burial depth, species habitat and migration patterns, and the physical characteristics of the ocean and atmosphere. Some specific topics that are recommended for focus in the long-term include:

- Cold pool processes:
    - Interannual variability in the setup and breakdown
    - Regime shifts
    - Climate scale changes

- Cold pool impact on:
    - Fisheries
    - The wind resource
    - Species migration

- Wind farm environmental impacts on:
    - Fisheries migration and production
    - Local turbulence, mixing and circulation (ocean and atmosphere)
    - Sediment transport

Workshop Summary

The following summary is organized into the general topics discussed among the workshop participants including the recommended Research, Tools, and Partnerships needed to better understand the potential impacts of offshore wind development on the Mid-Atlantic Bight cold pool.

Research:

- Identify the specific environmental metrics and cold pool processes to inform baseline studies.
- Advance our understanding specific to the impacts of turbines on ocean and atmospheric processes (e.g. upwelling, wind stress, mixing, etc.)

To address the research priorities, there should be:

- Access to regional scale ocean observing systems.
- Common data formats and data access points
- Flexible modeling systems to support research goals
- Coordination and collaboration among the communities familiar with the Mid-Atlantic Bight Cold Pool.

Partnerships will significantly accelerate our progress through:

- Coordinated regional scale initiatives managed by a single entity or coordinated among a few.
- Minimizing duplication of effort while maintaining necessary scientific rigor.

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Appendix 1. Agenda

Partners in Science Workshop:

Offshore Wind and the Mid-Atlantic Cold Pool

Wednesday, 17 July 2019
Coastal Education Center at the
Jacques Cousteau National Estuarine Research Reserve
130 Great Bay Blvd, Tuckerton, NJ 08087

Morning

8:30 AM	Registration
9:00 AM	Welcome and Introductions Josh Kohut & Joseph Brodie, RUCOOL
9:15 AM	The Physics of the Cold Pool Travis Miles & Scott Glenn, RUCOOL
9:45 AM	The Biological and Ecological Impacts of the Cold Pool Daphne Munroe, Rutgers Haskin Shellfish Research Laboratory Grace Saba, RUCOOL
10:15 AM	MARACOOS Overview Gerhard Kuska, MARACOOS
10:30 AM	Networking Break
11:00 AM	Partnership Frameworks for Offshore Wind and Cold Pool Research and Monitoring ***Panelists:*** Tom Dameron, Surfside Foods LLC Jessica Dealy, Atlantic Shores Offshore Wind Peter Hughes, Responsible Offshore Science Alliance (ROSA) Angel McCoy, US Bureau of Ocean Energy Management (BOEM) Vincent Saba, NOAA National Marine Fisheries Service (NMFS) ***Moderator:*** Josh Kohut, RUCOOL

Lunch

Afternoon

1:15 PM	Introduction to Roundtables
1:20 PM	Small Group Roundtable Discussion on Research Questions
2:30 PM	Networking Break and Prioritization of Group Ideas
3:00 PM	Full Group Roundtable Discussion
4:00 PM	Wrap-up and Closing Remarks

This workshop, organized by the Rutgers University Center for Ocean Observing Leadership (RUCOOL), is sponsored by the New Jersey Board of Public Utilities (NJ BPU) Clean Energy Program and the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS).

Appendix 2. Workshop Participants:

First Name	Last Name	Job Title	Company
Cristina	Archer	Professor	University of Delaware
Eleanor	Bochenek	Director Fisheries Cooperative Center	Rutgers University
Bill	Boicourt	Prof. Emeritus	University of Maryland
Joseph	Brodie	Director of Atmospheric Research	Rutgers University
Wendell	Brown	Professor	University of Massachusetts Dartmouth
Colleen	Brust	Research Scientist	NJDEP
Brandon	Burke	Clean Energy Specialist	NJBPU
Matthew	Campo	Senior Research Specialist	Rutgers University
Michael	Crowley	MARACOOS Technical Director	Rutgers University
Kira	Dacanay	Fisheries Biologist	NJDEP
Tom	Dameron	Govt. Relations and Fisheries Science Liaision	Surfside Foods LLC
Jessica	Dealy	Offshore Project Developer	Atlantic Shores Offshore Wind
Jaden	Dicopoulos	Research Project Assistant	Rutgers University
Jennifer	Draher	Oceanographer	BOEM
Stephen	Drew	Fisheries Liaison Officer, Equinor Wind US	Sea Risk Solutions LLC
Richard	Dunk	Meteorology Consultant	Rutgers University
Paul	Eidman	Advocate	Anglers for Offshore wind
Steve	Evert	Field Station Manager	Stockton University Marine Field Station
Mary	Ford	Director of Engagement and External Relations	MARACOOS
Jeff	Freedman	Research Associate	University at Albany, Atmospheric Sciences Research Center
Scott	Glenn	Distinguished Professor	Rutgers University
Tom	Herrington	Associate Director	Monmouth University
Brian	Hooker	Biologist	BOEM
Peter	Hughes	Director of Sustainability	Atlantic Capes Fisheries, Inc.
Sherryll	Jones	NYS Ocean Coordinator	NYSDEC
Josh	Kohut	Professor	Rutgers University
Gerhard	Kuska	Executive Director	MARACOOS
Elizabeth	Lange	Biologist Trainee	NJ DEP Fish and Wildlife
Ron	Larsen	Project Manager	Sea Risk Solutions, LLC
Katie	Liming	Program Coordinator	MARACOOS/IOOS
Angel	McCoy	Meteorologist	BOEM
Anne Marie	McShea	Offshore Wind Program Administrator	NJ BPU

First Name	Last Name	Job Title	Company
Travis	Miles	Assistant Professor	Rutgers University
Daphne	Munroe	Professor	Rutgers University, Haskin Shellfish Laboratory
Laura	Nazzaro	Research Analyst	Rutgers University
Anna	Pfeiffer-Herbert	Assistant Professor	Stockton University
Grace	Saba	Assistant Professor	Rutgers University
Vincent	Saba	Research Fishery Biologist	NOAA NEFSC/GFDL
Guy	Simmons	Sr. VP Marine Science and Government Relations	Sea Watch International
Nick	Sisson	Environmental Specialist	NOAA GARFO
Nick	Smith	Meteorologist	Shell
Sebastien	Trudel	Wind and Metocean manager	EDF EN Canada
Kevin	Wark	Owner operator	GSSA/ Viking Village
Brick	Wenzel	Fisherman	Saltys Enterprises LLC
John	Wilkin	Professor	Rutgers University
Douglas	Zemeckis	County Agent III (Asst. Prof.)	Rutgers Cooperative Extension