OCS Study
BOEM 2013-0010

Offshore Wind Energy Development Site Assessment and Characterization: Evaluation of the Current Status and European Experience

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EXECUTIVE SUMMARY

The Bureau of Ocean Energy Management (BOEM) hosted this workshop to engage with European scientists and regulators who have experience in offshore wind energy projects. The goal of this workshop was for BOEM to learn from the European experience with offshore wind development about the types of information that should be gathered during site assessment and characterization activities that best informs decisions about the siting of offshore wind facilities and potential mitigation measures. Three areas of particular interest were the focus of this workshop – birds, benthic habitats, and archaeology. These areas were selected because of the timeliness with respect to the preparation and release of BOEM guidelines for information collection. While the current focus is on pre-construction information collection, BOEM recognizes that this information is also the foundation for post-construction impact evaluation.

BOEM sought to learn from the European experience in order to maximize the potential success of U.S.-based offshore renewable energy. Participation during the workshop of individuals representing five of the six European countries with operating offshore wind energy facilities enabled BOEM to compare and contrast strategies for site assessment activities and managing the stewardship of environmental and archaeological resources on the OCS. The workshop was held on February 26-28, 2013 at the Crowne Plaza in Herndon, Virginia. The workshop as attended by approximately 110 persons, including the 17 invited European experts who were at the core the technical subject breakout sessions. The workshop started with a plenary session for all attendees during which some key BOEM managers welcomed the participants and provided an overview of BOEM's goals for the workshop. The first morning's plenary session was followed by a day and a half of detailed technical discussion in the three separate subject matter breakout sessions: avian, benthic habitats, and archaeological resources. The technical breakout sessions each followed a general format where invited European experts discussed a list of questions that had been developed by BOEM technical staff prior to the workshop. As a result of the different technical subject topics and the diversity among the scientists, regulators and other participants in the sessions, each of the individual breakout sessions progressed in somewhat different fashion.

BOEM's goal for the third morning of the workshop was to use a model that is being developed to evaluate the wide array of factors and to assess methods of bringing together the three different topical areas into a cohesive method for communicating decisions regarding offshore wind siting. After a presentation about the model, the breakout groups discussed how their particular resource of interest could be incorporated in the model and the challenges that arise.

Within the avian break out session, the most widely agreed upon point between the European experts was the need for robust survey designs that clearly define the conditions under which surveys will be carried out and also those conditions that are unsuitable for avian surveys. Once surveys have been completed the results should be made available to insure consistency in the quality of data and allow better functionality for review and conclusions, publication of data collection methods, protocols, and results should be required. There was also significant general agreement that both pre- and post-construction surveys should be tightly focused on answering specific questions about effects of wind farms by comparison of pre- and post-construction data.

In essence, no preconstruction survey should be undertaken without knowing what is desired to be known from the post-construction survey and how the post-construction survey will be conducted. Experience has shown the Europeans that pre-construction surveys did not provide the right data for comparisons with post-construction information. Furthermore, there was also strong general agreement that surveys must include a large enough area around a wind farm, not just the actual proposed project footprint because birds are often clumped and may use different areas within the vicinity of the wind farm from year-to-year.

From the benthic habitat break out session, the following suggestions were made relative to guiding the collection and assessment of benthic data during the offshore wind farm development process:

- Need to accept some level of impact. Local effect likely, but may not be meaningful at the regional scale. Focus effort to understand/evaluate ecosystem service.
- If you want to detect a change, define a change to monitor for, don't just monitor. Need to find a cause and effect within a wind farm area to understand/monitor.
- If you don't have enough information to establish impact thresholds, take an adaptive management approach. Adapt policy/regulations as you learn more. If regulations are too stringent, you may end up monitoring for illogical parameters.
- Develop an inventory of knowledge gaps and design monitoring program to fill in gaps. Possibly coordinate monitoring efforts across individual developers to ensure robust monitoring at the proper scale.

Participants in the marine archaeology sessions agreed that the discussion in this session was tremendously beneficial for both the Americans and the Europeans. It is strongly recommended that this line of communication be maintained for the benefit of both groups. The Europeans acknowledged that their industry has developed numerous conventions that are not always evident, but that a forum such as this forces reflection and consideration of better alternatives. Similarly, the Americans acknowledged that qualified researchers and reviewers (technical experts) are very limited in this country and that collaboration with European counterparts will be a tremendously valuable strategy for managing this resource limitation until the US offshore renewable energy industry becomes more mature. Marine archaeology is highly inter-disciplinary and requires a high degree of technical specialty. Based on the discussion, it is evident that the remote sensing requirements are well established but that the physical sampling required to identify human activity is the biggest challenge facing marine archaeologists. Definitive indicators of human activity are required to differentiate paleolandforms from submerged archaeological sites. Finally, good archaeology and good development are not contradictions. BOEM and developers working together forms a starting point. Combining information from multiple surveys to feed common goals will help historic property identification surveys become more efficient and minimize the perception of burden.

The workshop provided an opportunity for BOEM and other Federal agencies, as well as the interested public, to discuss key questions about offshore wind development with scientists and regulators from Europe, who have direct experience. The format of the workshop allowed for an interactive opportunity to fully discuss, beyond the initial questions posed, the lessons learned from the experience of European colleagues in siting, permitting, developing, and operating offshore wind energy projects. While much was learned, the most important lesson was that we must maintain the lines of communication and continue to learn from each other as wind development progresses into new areas, with new technologies.

1.0 INTRODUCTION, BACKGROUND, AND WORKSHOP OBJECTIVES

The Bureau of Ocean Energy Management (BOEM) hosted this workshop to engage with European scientists and regulators who have experience in offshore wind energy projects. The goal of this workshop was for BOEM to further inform the development of site assessment and characterization guidelines that provide useful information for decision making. BOEM wanted to learn from the European experience with offshore wind development about the types of information that should be gathered during site assessment and characterization activities that best informs decisions about the siting of offshore wind facilities and potential impact mitigation measures. Three areas of particular interest were the focus of this workshop – birds, benthic habitats, and archaeology. These areas were selected because of the timeliness with respect to the preparation and release of BOEM guidelines for information collection. While the current focus is on pre-construction information collection, BOEM recognizes that this information is also the foundation for post-construction impact evaluation.

Wind energy is the technology closest to commercial production status of any form of offshore renewable energy. Development of wind energy facilities requires assessments of proposed sites, including potential conflicts with other human uses, geological and geophysical characteristics, archaeological resources, and use by biological resources (e.g. birds, bats, fish, marine mammals, turtles). BOEM is in the process of collecting foundational information about these topics and has proposed initial guidelines for industry to use in collecting site specific information. European countries already have several commercial facilities in operation, and BOEM organized and held this workshop to learn from the progress that the Europeans have made.

This workshop focused on the development of offshore wind energy projects on the Atlantic Outer Continental Shelf (OCS). The regulations that apply to these activities require the offshore wind industry to submit information as part of their site assessment, general activities, or construction and operation plan. BOEM has developed guidance to assist industry in the collection of this information and has recognized the benefits of learning from the European experience to inform how these guidelines will be refined.

1.1 OVERVIEW OF THE WORKSHOP

The workshop was held on February 26-28, 2013 at the Crowne Plaza in Herndon, VA near the location of BOEM's offices. The workshop was attended by approximately 110 persons, including the 17 invited European experts who were at the core the technical subject breakout sessions. The workshop started with a plenary session for all attendees during which some key BOEM managers welcomed the participants and provided an overview of BOEM's goals for the workshop. The plenary session also included an overview of the BOEM regulatory program for offshore wind energy development as well as an overview of European framework for offshore wind energy regulation.

Following the opening plenary session, the afternoon began with technical discussions in the three breakout sessions for avian, benthic and archaeological resources. At this point in the workshop, each technical track proceeded individually to begin discussing issues that BOEM technical leaders for each of the areas had presented to the European experts in preparation for the workshop. The breakout sessions were facilitated by subject area experts from the ESS Group, Inc. ESS also provided experienced technical staff to function as notetakers during the breakout sessions.

While the breakout sessions for avian, benthic and cultural resources were planned to follow similar formats, in actual execution, each technical session proceeded somewhat differently from one another. Each breakout session had a facilitator, a notetaker, a group of invited experts from Europe and at least one technical expert from BOEM. Scientists and managers from other regulatory agencies and members of the public who had registered for the workshop also participated in each breakout session. There were very noticeable differences in the flow and content of each breakout session. This was a result of both the differences between the three scientific subjects as well as the wide variety of the backgrounds and interests of the participants of each session. This report reflects both the similarities and the differences that were evident in the conduct of the breakout sessions.

Following a day and a half of technical breakout sessions, on the third morning the workshop resumed in a plenary presentation and discussion. The topic of the final day was a “Cumulative Use Evaluation Model or CUEM. BOEM has been working on the consideration and development of a modeling approach that can handle the wide array of factors that could result in impacts to an ecosystem or a community as a result of offshore renewable energy development actions. During the final session of the workshop one of the CUEM developers provided an overview of how the model was developed, and how the model has been designed to weigh and evaluate factors that make up a cumulative consideration of human actions.

1.2 WELCOME AND OPENING REMARKS

Ned Farquhar, Deputy Assistant Secretary of the Department of the Interior, opened the workshop and thanked the team at the BOEM for initiating and organizing this effort. He noted the attendance of the international experts at the workshop, who provided perspectives from their experience with offshore wind energy. He emphasized that a clean energy future is a high priority for President Obama. The United States is working hard to begin utilizing its offshore wind energy resources to supplement onshore wind energy development. The first permitted offshore wind energy project in the U.S., Cape Wind, is expected to be under construction within about a year.

BOEM is focus on identifying low-conflict areas with high energy production potential by coordinating through state task forces and holding stakeholder workshops. At present, six Wind Energy Areas have been proposed for further analysis. In those areas, BOEM is transitioning from the planning stage to the leasing stage. With the help of its partner agencies, BOEM is developing protocols for site assessment, characterization, and monitoring. Particularly in Oregon and Hawaii, research and development is underway on floating turbines and other deepwater turbine technologies, as well as wave and tidal energy technology and offshore transmission. He concluded by highlighting the importance of data gathering and sharing, a rigorous science program, and continued relationships with international partners.

1.3 Overview of Workshop Purpose and Goals

Dr. Mary Boatman, Environmental Studies Chief in BOEM's Office of Renewable Energy Programs who organized the workshop for BOEM, gave a brief overview of the context and format for the workshop. BOEM recently published guidance for assessing potential impacts to avian, benthic habitat, and cultural/archaeological resources from offshore wind energy development. These are "living documents." She explained that the workshop was expected to help BOEM refine its guidance about what type of information BOEM should collect, and what it should ask developers to collect on their proposed project sites. However, she indicated the BOEM guidance documents should provide a framework for discussions and not the focus. While there are many resource areas requiring more detailed consideration, the workshop selected three: avian, benthic, and cultural/archaeological resources, in order to allow for substantial discussion on each of them.

1.4 Overview of European Offshore Wind Energy Regulatory Framework and Current Status

Beverly Walker with BlueWind Consulting LTD gave a presentation on offshore wind energy in Europe to set the stage for discussions at the workshop. She highlighted the following points:

> The European Union has established approximately 250 directives (i.e., objectives) related to the environment, including the Renewable Energy Directive, which sets binding targets for percentages of renewable energy by 2020. With seven years remaining before this deadline, there is significant pressure to meet those targets.
>
> The European Wind Energy Association identified the five key challenges for offshore wind energy in Europe as: leadership, accountability, and resourcing; constructive development of the supply chain; increasing grid capacity and availability; optimizing governmental input and permitting; and enabling economic and financial feasibility.
>
> She also noted the need for improvements in technology, and the way in which efforts to reform and streamline the permitting process have reduced public involvement. It is also a challenge to ensure that regulations are flexible enough to account for the pace of technological development, and ports are able to handle evolving machinery.

Questions and comments from workshop participants included:

> What are the penalties for not meeting the EU's "binding targets"? Ms. Walker explained that to her knowledge these have not been specified, although the targets have the force of regulation.

Clarification of several terms was requested: “resourcing” refers to financial funding, and a “heat map” refers to GIS constraint layering (the more constraints, the “hotter” the area).

1.5 Overview of U.S. Offshore Wind Energy Regulatory Framework and Current Status

Maureen Bornholdt, Program Manager of the Office of Renewable Energy Programs at BOEM, provided an overview of the government structure for permitting offshore renewable energy in the U.S., and the range of activities underway at BOEM. BOEM is the lead federal agency for offshore wind siting and development. For the Outer Continental Shelf (OCS, from three nautical miles out to 200 nautical miles) marine hydrokinetic energy projects, BOEM is the lead Federal agency for siting and the Federal Energy Regulatory Commission is the lead Federal agency for operation. Key partners include federal agencies, state governments, tribal governments, and local officials. She emphasized that coordinating with these partners is a high priority for BOEM.

The Energy Policy Act of 2005 initiated the creation of BOEM’s Renewable Energy Program. BOEM has set up 12 State Task Forces to provide input at each phase of BOEM’s process (the phases are: planning, leasing, site assessment, and commercial development and decommissioning). Most areas are in the planning phase, with a few areas transitioning into leasing (descriptions and updates on activities in each state can be found here).

Currently BOEM is continuing to develop its environmental studies program and is collecting baseline data in coordination with its partners. After they obtain a lease, developers will gather site-specific data for BOEM’s review. BOEM has published guidance on providing survey information on potential impacts to avian, benthic habitat, and cultural/archaeological resources. These documents are primarily oriented toward the Atlantic Coast, and are considered “living” documents that can be modified as the study methods evolve.

BOEM hopes that communication with European experts will continue after this workshop, potentially on other technical topics such as marine mammals.

Ms. Bornholdt addressed some questions and comments from workshop participants:

Ms. Bornholdt explained that concerns about climate change and ocean acidification, and the human health impacts from our current methods of generating electricity are generally addressed through the National Environmental Policy Act process, which considers cumulative impacts, as well as a “No Action Alternative” to address the potential outcomes of not permitting a project.

BOEM considers social and cultural issues in many ways, including through programmatic agreements with the First Nations and consultation with the state historic preservation offices. Ms. Bornholdt noted that in several cases, BOEM has adjusted its designated Wind Energy Areas in response to input from tribal governments, the fishing community, and others. BOEM’s Task Force meetings have proven to be excellent starting points to learn about and begin addressing these issues. One commenter suggested that BOEM is not engaging sufficiently with the public, since the Task Forces are confined to government representatives, and that this will slow BOEM's process down later. Ms. Bornholdt responded that BOEM is attempting to be responsive to the level of public involvement desired in different regions. In regions where the public has indicated that it wants to be significantly involved, BOEM has been holding numerous public information sessions.

Ms. Bornholdt summarized how BOEM's planning areas were based on which states were ready to engage with them on offshore renewable energy, although analyses and consultations will not be confined to those areas, and that BOEM's process will take into account ecosystem-based boundaries, not solely political boundaries.

Ms. Bornholdt further explained that the first three nautical miles offshore are designated as State Waters. Several states began data collection before federal permitting authority for the OCS had been given to BOEM. BOEM is coordinating with state and local efforts to ensure their planning processes are as compatible as possible. There is the possibility that additional areas could be considered later, through another planning process.

Ms. Bornholdt explained that wind energy is a very different technology from oil and gas-based generation and that a key role for her position is providing education and guidance for BOEM, energy project developers, and the public is the most important element of working in this new industry.

Before closing her remarks, Ms. Bornholdt reviewed how the Regional Ocean Councils were initiated in July 2010 through an Executive Order from the White House, which created the National Ocean Policy and National Ocean Council. The Regional Ocean Councils are intended to lead marine spatial planning efforts, facilitate partnering between diverse stakeholders, and address cumulative impacts.

2.0 AVIAN RESOURCES BREAKOUT SESSION

2.1 INTRODUCTION

2.1.1 Background

BOEM-permitted undertakings require consultation on potential affects to avian resources under the provisions of Section 7 of the Endangered Species Act. A very early step in the process of developing offshore wind energy is to determine whether federally-listed species occur within the project area, either as a resident, or as a migrant. Non-listed avian resources in the project area and the nature and magnitude of the potential impacts must also be identified to inform the NEPA process.

Although an individual project may trigger many concerns, most concerns related to avian resources tend to extend beyond the relatively small footprint of a single wind facility. These concerns drive BOEM's information needs to identify areas that are least likely to negatively impact avian resources. To satisfy this information need, BOEM is developing various approaches to increase its understanding about the distribution, abundance, and movement patterns of avian species vulnerable to offshore wind development. BOEM works in close cooperation with the USFWS in evaluating and resolving avian resource issues.

Based on preparatory discussions with the invited European experts prior to the workshop, BOEM was interested in getting European perspectives on the following issues during the workshop:

1. It seems that pre-construction baseline monitoring is generally too broadscale to properly inform post-construction comparisons. For example, an initial review of "lessons learned" from the UK indicated that much pre-construction data turned out not to be useful when evaluating post-construction impacts.
2. How do you ensure that the avian research area surrounding a proposed project site is large enough to best inform subsequent research?
3. If a wind farm is built and operated in an avian "cold spot" how would one determine if any birds are being affected post-construction?

At the start of the avian breakout session, USFWS asked some additional questions to help focus the presentations from the European experts:

1. What were the biggest pitfalls in European avian studies? What did not work?
2. Which data were collected that did not prove useful? In other words, what data were collected, but should not have been?
3. What data was not collected, but should have been?

2.1.2 Participants

Participants in the Avian Resource Session included the European experts, BOEM, US DOE, industry representatives, and consultants. Some of the invited European experts presented slides at the start of the breakout session (see Appendix D). Biographies of the invited European participants are provided in Appendix D to the report and a list of attendees is provided below.

European Experts:

Philip Bloor, Pelagica (Scotland)
Ib Krag Petersen, (Denmark)
Thomas Merck, German Federal Agency for Nature Conservation (Germany)
Jan Blew, BioConsult SH (Germany)
Sjoerd Dirksen, Bureau Waardenburg (Netherlands)

BOEM Staff:

David Bigger
Jim Woehr
Mary Boatman
David Pereksta
David Panzer

USFWS Staff:

Eric Kershner
Melanie Steinkamp
Christi Johnson-Hughes
Scott Johnston

Other U.S. Participants:

Darrell Oakley (Facilitator)
Chris Rein (Note Taker)
Caleb Gordon
GeroVella
Chris Long
Tabor Allison
Dale Strickland
Kate Williams
Jocelyn Brown-Saracino

2.2 EUROPEAN EXPERIENCE AND HINDSIGHT

The discussion that took place during the avian breakout sessions was very active and lively. The session facilitator guided the conversation in a manner that focused on answering the questions that are summarized in Section 2.1.1 above. However, the European experience is varied from country to country and, from time to time while focusing on a particular question, the individual European experts provided a response that covered two or more questions from the list above. As one would expect, in the process of answering the specific questions, each European expert had the opportunity to share certain findings from their individual experience that added support for their opinions about how avian studies should be carried out. Following the discussion of specific questions posed to the European experts (see Sections 2.2 through 2.5), there is a summary and compilation of the key points made by the European experts as they offered their experience and opinions (see Section 2.6).

2.2.1 What would Europeans do differently?

Essentially all of the European experts agreed that they would have invested more thought and effort in developing their initial data collection programs. The Europeans expressed that not enough thought went into what questions would need to be answered during post-construction. In the case of the Netherlands, it was found that the general baseline pre-construction monitoring was insufficient to draw conclusions on potential impacts. A suggestion from the Netherlands was that the government should undertake a more general, larger area, baseline preconstruction surveys of bird distribution, density and migration rather than only the footprint proposed. The government would then be repaid by the energy developer once a project is operating.

Denmark started their environmental investigations in 1999 under a government financed demonstration program, which lasted for six years. An international expert panel reviewed the program contents during that process, during which the programs were refined. In Denmark, it was shown that it is not always fruitful to require a specific number of surveys. This can lead to surveys being conducted during unfavorable conditions just to satisfy the requirement and poor data - bad data are worse than no data.

In Germany[1] there is movement towards not only defining standards and procedures for data collection, but also for the publication and use of data so that there is better functionality in the process for reviewing data and drawing conclusions as a result of the review. This comprehensive data collection includes surveys of seabird abundance and distribution as well as bird migration and has to be carried out site-specifically by the respective developers. The German approach to assessing collision risk, which is investigating flight paths, altitude, and behavioral activity to facilitate spatial activity analyses, indicates that these data are necessary for all seasons and all weather conditions. It turns out that investigating collision risk must be conducted during unfavorable weather, which is the most difficult time for data collection. The assumption is that collision risk is highest during inclement weather. Collision risk is species-specific and that species-specific avoidance behavior is very important when modeling the risk to a regional population.

2.2.2 Have data collection priorities changed over time?

Generally, there is a shift from aerial surveys conducted by human observers to aerial surveys using aerial digital imagery. In the UK, the data collection methods have generally remained the same as when the first avian data were collected. In recent projects, aerial-based survey techniques are becoming more common than boat-based surveys. For the most recent

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1 In Germany most of the offshore development takes place in the exclusive economic zone (EEZ) where the federal authorities have the responsibility. Nevertheless, some offshore wind farms are located in the coastal waters and fall under the responsibility of the federal states (Laender).

projects however, the quantity of data collected has grown. Also in the UK a great deal of data has been collected regarding avian flight heights (see SOSS report on the Crown Estate website).

In Europe, the average flight height for the species is used when calculating collision risk keeping in mind that flight height information is difficult to collect in adverse weather conditions. It was also pointed out that flight height estimates differ between ship-based and land-based observations.

Most of the Europeans concurred that there needs to be more serious consideration of cumulative impacts. Acceptable levels of impact and "take" have not been settled on among the European nations. There has been some consideration of developing acceptable take numbers for certain species and then apportioning that take between the countries. Progress on this matter is unlikely to be rapid given the number of countries involved and the proximity of wind farms to international borders.

2.2.3 How do you measure the success of mitigation and which mitigation strategies have proven to be effective?

The invited experts did not have much in the way of measurement of successful mitigation. Nearly all of the experts agreed that some kinds of impacts could be mitigated, particularly those related to collisions during migration. It was suggested to use models to predict weather patterns that could lead to mass collisions during migration. In the German North Sea and Baltic Sea, wind farm permissions include a clause, saying that if data indicate potential mass collision events / mass migration events during inclement weather, additional data have to be collected. Also, the approval administration reserves its right to ask for mitigation action, even though neither the criteria nor the mitigation actions (scaring away the birds or shut-down of turbines) are further detailed. Wind farm developers have agreed to shut down during periods of mass migration. However, the Germans are still studying migrations to determine thresholds for curtailment of operations.

In the UK, improvements to avian breeding habitats have been considered to be valid mitigation for wind farm related avian mortality. Scotland is investigating how displacement effects on species may be offset or mitigated by nearby suitable alternative habitat. The UK primarily addresses mitigation in the preconstruction process. Written plans are developed that describe actions to be taken if avian impacts are documented once a project is operating. If the mitigation is not successful, wind farm operating curtailments may be required.

2.3 European Planning and Siting Criteria

2.3.1 How do Europeans consider avian resources in the planning process?

For the most part the consideration of avian resources during the planning process has been evolving toward a more planning intensive approach. European regulators reviewing the first wind farms relied on the developer to gather data and define potential avian impacts. Currently there is a range in the level of government-based planning depending on the country. Danish resource agencies still have not published criteria for avian data collection for new wind farms.

In the UK, the process has evolved as a result of a leasing process with the Crown Estate. The Crown Estate must derive revenue from commercial use of the seabed. In the first round of leasing, there was no environmental assessment by the government. However, much was learned during the course of the first two rounds of leasing and the Crown Estate has now developed a comprehensive environmental assessment process for Round 3. The Crown Estate has collected and reviewed data that allowed it to identify zones where wind farms would be allowed. Developers then carry out avian data collection and evaluation programs called zonal assessments to identify appropriate wind farm sites within the Crown Estate-identified zones.

The Germans began their avian resource planning by setting aside areas that would be unsuitable for wind farms based on available data (e.g. military use, shipping lanes, seabird distributions, distance to coast etc.) and their best professional judgment. Also, it was agreed that offshore wind farms must be at least 12 miles off the coast; however, at least three wind farms are planned within the 12-mile zone. Germany then began to designate protected areas based on some already ongoing government data collection programs in the framework of the EU Bird Directive (which also applied to UK, NL and DK). Following the set aside of protected areas, the German government continued to collect data that would allow identifying areas that could support wind farm development. However, developers quickly outpaced the government and began to propose offshore wind projects well outside of protected areas, largely disregarding the strategic planning areas where the government had collected data.

Currently the Netherlands has implemented a ban on wind farms within 12 miles of the coast[2] and the planning process there has already excluded many areas outside of shipping lanes and oil and gas lease areas. The Dutch government planning efforts are now focused on setting aside areas that will be considered suitable for offshore wind development based on government collection and evaluation of avian data.

Denmark has designated specific areas for future offshore wind farms. These sites have been selected with considerations of avian resources, though not through a thorough strategic impact assessment.

2.3.2 Which studies have been the most useful?

It is generally recognized that the Danes, the Dutch and the Swedes have the broadest array of published studies addressing avian issues. These studies are acknowledged as the best information and discussion for comparison of pre- and post-construction monitoring data. In Denmark, the program has evolved to include survey methods that allow pre-construction environmental impact assessment data to be suitable for comparison with post-construction data. While the European nations do not have much formal, official agreement on post-construction monitoring, the methods are generally known throughout the industry and most studies are done similarly. It was recommended that workshop participants follow-up with a review of published European reports.

[2] Recently, this policy has been re-evaluated and parliament has asked for new studies looking at feasibility of wind farms within the 12 mile zone.

Among the websites that contain published studies, www.nordzeewind.nl was specifically recommended; In Germany, the following two websites provide some insight mainly in offshore research projects and results:

1. http://www.alpha-ventus.de/index.php?id=80
2. http://rave.iwes.fraunhofer.de/rave/pages/projects.

It is often asked if linking avian and benthic data studies will help to predict avian distributions. While in theory this would seem to be helpful, these kinds of studies in Europe have been mismatched in geographic scale, limiting the ability to draw conclusions.

The findings of pre- and first post-construction surveys in Germany have been used to revise German Environmental Impact standards. In Germany, it is currently forbidden to use airplane-based survey techniques within existing wind farms and this has limited the use of some avian survey methodologies; however, the advance of survey flights recording videos or taking digital images carried out at much higher altitudes will circumvent this problem. The Danes are definitely moving in the direction to identify hot and cold spots of avian activity, but have not made significant progress yet.

2.4 European Monitoring

2.4.1 What types of pre- and post-construction studies have been most informative?

Most of the European experts expressed there needs to be two kinds of pre-construction avian studies. The first are studies that allow one to make impact predictions useful for assessing potential risk and permitting. The second type of pre-construction survey would be designed to support confirmation of conclusions when compared to post-construction monitoring.

In Germany, a goal is to have a large scale governmental pre-construction monitoring program that covers the whole German seas territory. The Germans are moving towards monitoring programs that can be used to assess the overall avian importance at an individual offshore wind site. A comprehensive pre-construction monitoring carried out by the individual developers then forms the basis for "effects monitoring" in the post-construction period. In the Netherlands, it is believed that the same pre- and post-construction monitoring programs may not be appropriate for different projects. You must begin by knowing the specific avian resources occurring within the project area. It is critical to deliver the same quality of answers as a result of the monitoring, but not critical to do exactly the same studies at every site.

In the UK the focus of post-construction monitoring is primarily to confirm the pre-construction impact predictions and conclusions. Thus, in the UK the trend is not to implement broad scale post-construction monitoring, but rather to develop and implement surveys focused on validating specific critical conclusions from the pre-construction period. Broad scale monitoring is seen more as a tool to inform future siting decisions and not for post-construction monitoring.

The Danish monitoring programs has been based on aerial surveys to describe changes in bird distribution between pre- and post-construction as well as radar surveys to illustrate collision risk and barrier effects. Visual observations were used to make these investigations species specific. In Denmark data collection on bird distributions and collision risk have been collected by the same method under EIA-related surveys and the pre-construction effort, thus extending the data background for later comparisons between pre- and post-construction conditions for birds.

2.4.2 What benefits have been obtained from pre- and post-construction monitoring?

The benefits of pre- and post-construction monitoring programs are still being evaluated in Europe. In the Netherlands, the feeling is that even if a project is small and the general agreement is that its negative effects could not be significant, post construction monitoring to confirm impact predictions is important. It is felt that there is also value derived from the effort required to observe the demonstrated effects and to be able to replicate those observations over time.

2.5 EUROPEAN DATA AND DATA COLLECTION CONSIDERATIONS

2.5.1 Which data sets have been the key to answering regulatory and conservation biology related questions?

The general feeling was expressed by several of the European experts that conservation biology related questions have not been well addressed throughout Europe. An EIA directive requires analysis of cumulative impacts, but the vast majority of European projects have not addressed this well. Some of the questions that arose during this discussion were centered around defining what is meant by a cumulative impact. Is it necessary to just address the impacts of offshore wind farms, or to include all human-caused impacts to avian species? Should we be addressing from facilities just within a single nation or all facilities within a specific flyway?

Thus far in Denmark, most of the reports address cumulative impacts qualitatively. In Germany, a working group of scientists and regulators is looking to define an approach to this matter. German EIA process must address cumulative habitat loss in terms of area and numbers of birds. The area and number of displaced birds is summed up. However, what is the right number to compare to? Once compared, is the impact determined to be a significant percentage of total habitat or population?

There was a discussion about the fact that cumulative effects may not necessarily be "additive." In the Netherlands, the approach to the cumulative impact issue is to understand the factors that make up the potential impact. Once this has been examined, then identify the largest, most serious impact and determine what factors would make that impact more serious. There is no value in simply adding up a number of small, insignificant impacts and citing that as the cumulative impact.

2.5.2 How are data collection methods standardized and do European developers share data they have collected?

The scientist and regulators in Europe are publishing studies and communicating with one another, the methods used throughout Europe do have quite a bit of commonality.

In Germany, a Standard (Investigation of the impacts of offshore wind turbines on the Marine Environment) has been published and is regularly updated (2007). Further development will lead to a new update in 2013, focusing on post-construction studies. These standards include all fauna and flora investigations, also on birds regarding surveys, radar studies, visual and acoustic studies.

2.5.3 How are data used at larger scales and to understand cumulative effects?

Currently in the UK environmental impact assessments consider the overall benefits from individual projects. While the air quality benefits from a single wind project would not have a large effect, there would very clearly be a cumulative air quality benefit from the great offshore wind market sector. In Germany the environmental impact assessment process generally looks at single project effects. While some topics are addressed on a regional scale, there have not been any global considerations. It was expressed by at least one European expert that this question resides in the category of "saving the planet" which is very much outside of the typical regulatory processes and the consideration of project-specific cumulative effects.

2.6 CONSOLIDATION OF KEY POINTS FROM THE AVIAN BREAKOUT SESSIONS

Perhaps the most widely agreed upon point between the European experts was the need for robust survey designs that clearly define the conditions under which surveys will be carried out and also those conditions that are unsuitable for avian surveys. Once surveys have been completed the results should be made available to insure consistency in the quality of data and allow better functionality for review and conclusions. Publication of data collection methods, protocols, and results should be required. There was also significant general agreement that both pre- and post-construction surveys should be tightly focused on answering specific questions about effects of wind farms by comparison of pre- and post-construction data. In essence, no pre-construction survey should be undertaken without knowing what is desired to be known from the post-construction survey and how the post-construction survey will be conducted. Experience has shown the Europeans that pre-construction surveys did not provide the right data for comparisons with post-construction information. Furthermore, there was also strong general agreement that surveys must include a large enough area around a wind farm, not just the actual proposed project footprint because birds are often clumped and may use different areas within the vicinity of the wind farm from year-to-year.

By the end of the breakout sessions, each of the European experts had the opportunity to emphasize concepts that they felt strongly about based on their experience in their respective countries. At the conclusion of the avian breakout sessions, each European expert was asked to provide some point of advice that could be thought of as a primary "take-away" that resulted from the day and a half of detailed breakout session discussions. Here is what was offered:

1. Establish a demonstration program that would cover several offshore wind facilities. The environmental program should be reviewed by an expert panel. In such a set-up, there will be opportunity for more general and experimental research that could benefit many other offshore wind facilities in the future.
2. Have a flexible framework for information gathering.
3. Work in partnership with developers and consultants.
4. Accept that you cannot know everything and that you may have to proceed with the information at hand.
5. European countries are at different places in their approach to monitoring, reflecting a diversity of perspectives. Countries with the most experience have determined that some of the broad-scale investigation designs were collecting too much data and few meaningful data. The focus is moving towards targeted investigations appropriate for the location of the wind facility.
6. Avoid the "mire of mindless monitoring". Collect data that results in conclusions. Broad scale monitoring is valuable mostly to inform future siting decisions. Post-construction monitoring is in part meant to confirm the validity of preconstruction conclusions to inform future decisions.

3.0 BENTHIC HABITAT BREAKOUT SESSION

3.1 INTRODUCTION

The purpose of this breakout session was for BOEM to learn from the European experience in wind energy development and benthic habitat assessment. At the beginning of the session, each European expert gave an overview presentation based on questions provided to them by BOEM in advance. During the remainder of the breakout sessions, the European experts discussed the various European processes for characterizing benthic habitat and modeling potential impacts, and engaged in a dialogue with BOEM, other federal agencies, and public observers about lessons learned.

3.1.1 Background

BOEM has statutory obligations to "protect the environment" under the U.S. Energy Policy Act of 2005 and consult with NMFS regarding impacts to essential fish habitat (EFH), including benthic habitat, associated with offshore energy development. Benthic habitat vulnerability from renewable energy projects on the OCS is an important topic to understand since these impacts have the potential to affect a number of other resources through food chain shifts or disruption.

Impacts to benthic habitat can be both short- and long-term depending upon the type of habitat that is impacted. Potential effects on benthic habitats and resources due to offshore renewable energy development include:

- Changes to seafloor morphology and structure
- Changes in median grain size or organic content
- Turbidity during construction/decommissioning
- Change in target species abundance and distribution (e.g., species of importance)
- Reef effects (colonization density, composition of communities on foundations)
- Current speed/direction

While many types of monitoring protocols exist and are currently employed, there are no standards for monitoring benthic resources in offshore locations in the U.S. The selection of appropriate sampling and assessment methodologies is vital to understanding the potential effects on benthic habitat and resources, particularly since natural variability is extremely high in benthic communities. Based on past experience, the monitoring protocols have been project- and site-specific, determined by the size of the project and the potential for environmental effects, which in turn have been determined by the location and the species present at the project site.

BOEM is interested in developing best practices for characterizing benthic resources and evaluating impacts to benthic resources associated with the construction and operation of offshore renewable energy projects. A recently completed study funded by BOEM, *Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship* (BOEM 2012-082), identified protocols for consideration by BOEM to adopt. After publication of this report, BOEM developed benthic survey guidelines to provide guidance for developers as they collected information for their site assessment and construction and operations plans.

In order to further refine the site assessment and characterization guidelines for offshore wind development, BOEM convened this session to learn from the European experience in wind energy development and benthic habitat assessment directly from those engaged in assessments for offshore wind facilities that were recently constructed and are now in operation. Specifically, BOEM was interested in getting the European's perspective on the following issues during the workshop:

- Habitat classification
    - Is there a standard habitat classification system? If so, in what ways has it been successful, and in what ways has it not been successful? How would you improve it?
- Pre-Construction Surveys
    - At what scale/density should habitat be surveyed prior to development?
    - What is most critical to measure/observe prior to development, and at what scale?
    - How is habitat survey data being used?
- Post-Construction Monitoring
    - What have been the results of habitat impact monitoring during construction and operation at existing offshore wind energy projects?
    - How are post-construction impacts being monitored? What is most critical to measure after development?
    - What are the significant habitat impacts you have observed?
- Predictive modeling
    - Are models used to characterize habitats? Which models?
    - How do monitored impacts compare with model prediction?
- Habitat Vulnerability
    - What habitat types are most vulnerable to impacts from offshore wind energy?
    - Use of habitat vulnerability indices

3.1.2 Participants

Participants in the Benthic Habitat Session included the European experts, BOEM, NOAA, state agencies, researchers, industry representatives, and consultants. Some of the invited European experts presented slides at the start of the breakout session (see Appendix E).

Biographies of the invited European participants are provided in Appendix E to the report and a list of attendees is provided below.

European Experts:

Martin Attrill, PhD, Plymouth University (England)
Arjen Boon, PhD, Deltares (Netherlands)
Bryony Pearce, Gardline (Scotland)
Tom Wilding, PhD, Scottish Marine Institute/Scottish Association of Marine Science (Scotland)

BOEM Staff:

Brian Hooker
Greg Boland
Callie Hall
David Panzer
Mike Rasser
Michelle Morin

U.S. Participants:

David DeCaro
John King
Rich Langton
Mark Monaco
Carl Nielsen (facilitator)
Matthew Nixon
Jeff Reidenauer
Jennifer Samson
Chris Taylor
Sue Tuxbury
Stephanie Wilson (Note Taker)
Roberto Llanso
Jill Rowe
Aileen Kenny
Steve O'Malley
Marcia Bowen
Jennifer Harris

3.1.3 Overview of European Perspective

The European Union (EU) has established the Habitat Directives, which requires each country in the union to designate areas of importance for protection. These areas are given formal protection by law and are considered as part of the site selection process for offshore wind energy development. Currently, the designation of these areas is features-based and considers rarity of the habitat, diversity and vulnerability; commercially important species are not always a consideration. Subsequent to the establishment of the Habitat Directives, a Marine Strategy Framework Directive was established, which presented an ecosystem-based approach to ensure healthy ecosystems.

The monitoring of the habitats identified by the Habitat Directive is regulated by law; however because the EU has established a risk-averse approach to monitoring at the local scale, the resulting data are not necessarily appropriate for the assessment of system-wide impacts over broad spatial scales. It was noted that one of the keys to being able to establish a system-based approach is to identify and accept risk at the local level and focus monitoring on the broader spatial area to better understand changes to the system. To date, mostly baseline surveys and a few impact assessments have been conducted in the EU related to offshore wind energy development.

While much of the European perspective is relevant to all countries within the EU, there were differences identified between certain areas, particularly the United Kingdom (UK, encompassing England, Scotland, Wales, and Northern Ireland) and the Netherlands. In the discussion below, it is assumed that points made apply to the entire EU, unless noted as specific to the UK or Netherlands.

3.2 BENTHIC HABITAT CLASSIFICATION SYSTEMS

The BOEM Benthic Habitat Guidelines requires use of the Coastal Marine Ecological Classification System (CMECS), which was developed by NOAA in coordination with other Federal agencies. This classification system has been accepted by the Federal Geographic Data Committee (FGDC), making it a recommended standard for use by the Federal government. Included in the classification system are water column, geological formation, and biological components, sediment, as well as spatial and temporal information.

Classification systems have also been successfully used in the EU. The European Nature Information System (EUNIS) is the standard European habitat classification guideline. EUNIS was developed based on the framework of the EU Habitat Directives and incorporates data on species, habitats and sites. The Netherlands use the EUNIS guidelines; however the UK uses the Joint Nature Conservation Committee (JNCC) guidelines, which preceded, but are compatible with, EUNIS. The JNCC guidelines are based mainly on nearshore environments and consist of five levels of classification, incorporating environment, habitat types, and biotopes. The biotope levels are in the process of being revised to include a functional group prior to species identification. Both classification systems include invasive species.

UK projects are legally required to use the JNCC guidelines and establish level 4 classifications (i.e. species level). Video and remote sensing techniques are typically used to assign classification. In the Netherlands, EUNIS is the standard, but its use is not legally required. Because there is less diversity in the seabed composition, physical parameters such as hydrographic regime and salinity drive the classification scheme in the Netherlands.

Questions from the participants focused around the concept of scale as it relates to benthic habitat classification.

- What is the spatial distribution of benthic habitat samples (e.g. benthic grabs, video, etc.) for a typical wind energy facility?
    - In the EU it is typically a negotiation between industry and the regulators. It was recommended, for wind farms, that samples be collected at a minimum of one sample per one kilometer grid area.
- Is it is possible to have a gradient or continuum for habitat classification?
    - Habitat can be classified on a continuous scale using predictive models (discussed in more detail below). For example, biotopes can be predicted based on physical parameters, such as slope and grain size. These models are typically used to generate habitat maps. However it was cautioned that scale is an important factor to consider in the development and interpretation of these maps.

3.3 PRE-CONSTRUCTION SURVEYS

In the U.S., the government has taken on the responsibility of identifying wind energy areas (WEAs), but it is the responsibility of the developer to collect site-specific data. Although there is not a specific mandate to do so; in the U.S., Federal and state agencies have been working cooperatively to conduct regional baseline assessments for potential wind energy areas. In the EU, countries are responsible for mapping and identifying zones appropriate for offshore energy development, which is based primarily on the presence/absence of vulnerable species. Generally, benthic habitat in a broad context is not often a priority in the selection process in comparison to species-specific or human use (e.g., endangered species, military uses, etc.) criteria. However, benthos does play role in the overall biodiversity of an area via the food web. In the UK, site characterization and pre-construction surveys of specific wind farm areas are the responsibility of the developer. In the Netherlands, there exists a country level (large-scale) characterization of marine habitat. Once a license is awarded, the developer is responsible for the site-specific pre-construction monitoring.

The BOEM Benthic Habitat Guidelines state that one pre-construction survey must be conducted prior to the submittal of the Construction and Operations Plan (COP). The pre-construction survey may also serve as the baseline. The purpose of the pre-construction survey is to characterize and delineate the abundance, diversity, percent cover, and multivariate community composition of the seafloor in the area of potential effect. The area of potential effect is defined as the lease area as well as any adjacent area where site disturbance activity could occur. Recommended sampling techniques include grab samples (~ $0.1 m^2$/sample [soft bottom]) and underwater video or still imagery (soft and hard bottom). Special attention should be given to the presence of sensitive benthic habitats, including areas with exposed hard bottoms of high, moderate, or low relief; hard bottoms covered by thin, ephemeral sand layers; seagrass patches; or kelp and other algal beds, as well as the presence of anthozoan species. Although reconnaissance should be conducted on the entire area, more detailed monitoring should be conducted where activity is expected (i.e. monopiles, anchoring, cable lay, etc). The guidelines also recommend the identification of control sites for post-construction monitoring, based primarily on physical characterization.

In the EU, site characterization surveys are separate from pre-construction surveys. Site characterization surveys are reconnaissance level and serve as the baseline. Sampling is typically conducted in a grid pattern to get a broad characterization of the area. Standard Best statistical practice is to obtain three years of baseline data; however it was acknowledged that the length of the baseline study is typically negotiated to be a practical balance between ideal science and cost. The results of the site characterization survey are then used to refine the design of the pre-construction survey. Pre-construction monitoring is conducted as close to construction as possible, but must be conducted within 2 years of initiation of construction. Pre-construction monitoring typically employs a stratified sampling design with the objective of being able to assess impacts post-construction.

Three key components were identified as being vital to the development of site characterization and pre-construction surveys: scale, sampling technique, and variability. Scale was identified as a key component for any monitoring program; however it has not been specifically defined for site characterization or pre-construction surveys in the EU. Scale is often negotiated with the regulating agency; a commonly employed scale is 1 sample per 1-2 km. However the density of sampling may be smaller depending upon the heterogeneity of the benthic environment being sampled. It was noted that it is preferable to have an understanding of the natural variability of the system being studied when defining the scale of a monitoring program. It was suggested that monitoring be conducted at the lease area scale or broader in order to understand regional and population effects. For example, monitoring of benthic function, rather than species presence/absence, provides more relevant information for an ecosystem-based model.

The selection of appropriate sampling techniques was also identified as a key component to a monitoring program. Traditional tools used in benthic habitat monitoring include:

- Grab sampling (traditional VanVeen) – appropriate for soft sediment
- Video
- Sledge sampling (benthic sled) – better sampling of rare species
- Hamon grab – more appropriate for hard habitat
- Sediment Profile Imagery (SPI) – able to efficiently cover large areas

There were advantages and disadvantages noted for each of the techniques mentioned above. For example, benthic grabs have been used in the evaluation of trawling and scour, but are only able to characterize relatively small areas. However, grabs are also used to ground truth the results of both acoustic and SPI sampling conducted over broader areas. Alternatively, SPI is able to efficiently cover a large area and provide information about community function; however detailed species analysis is not possible. In the EU, the sampling technique is defined by the regulators. The most commonly used techniques are video and the Hamon and VanVeen grabs.

Seasonal and temporal variability were also identified as important considerations in the development of monitoring programs. Current U.S. guidelines don't address the seasonal or inter-annual variability of benthic communities. However, it was recommended that monitoring be conducted at the same time of year in order to differentiate between changes that are the result of seasonal or annual variability versus development activities. It was again emphasized that by establishing the pre-existing condition of an area you develop an understanding of the natural variability of the system, which is vital to developing a robust and meaningful monitoring program.

The establishment of impact thresholds also elicited a great deal of discussion, including a discussion on the difference between impact thresholds and baseline. Although impact thresholds have not been formally established in the EU, informal guidelines are often established based on the impact assessment documentation and are conveyed as part of the lease/license agreement. It was acknowledged that practically-speaking, there is a balance between ideal science and what is acceptable for costs in the establishment of impact thresholds. It was recommended that impact thresholds be established early in the process, prior to construction, preferably during the site characterization process. There was also concern that there might not be enough data to establish a statistically robust impact threshold. It was then recommended that expert judgment be used in the establishment of impact thresholds. However, impact thresholds established via expert judgment tend to be more difficult to enforce from a regulatory standpoint. The EU experts cautioned against setting rigid impact thresholds and monitoring protocols and recommended that the U.S. maintain flexibility in the establishment of impact thresholds and take an adaptive management approach to monitoring.

An example was provided of a site characterization survey conducted in the North Sea. The North Sea has a 50 year monitoring history, including the collection of bathymetry, chemistry, and biology. Benthic mapping was done using high resolution multibeam sonar combined with benthic sampling. Benthic sampling was conducted in a grid pattern with stations spaced 50-80 km apart and employed box cores and benthic sled sampling. The benthic mapping followed the approach of the Mapping European Seabed Habitats (MESH) classification system, which has established guidelines for seabed habitat mapping over the coastal and shelf zones of the Atlantic Area in order to help informed spatial planning and management.

Lessons learned from site characterization/pre-construction surveys conducted in the EU include:

- It is important to sit with regulators pre-survey and engage stakeholders prior to license assignment.
- It is prudent to do both a baseline and pre-construction survey
- Use regional/large scale data to understand population level effects
- Use results of long term monitoring programs to understand naturally occurring temporal variability in benthic communities
- Identify an appropriate response variable in characterization survey, use pre-construction survey to quantify selected response variable.

- Identify the ecological question in need of an answer, involving stakeholders such as fishermen. Focus surveys on the ecosystem function you are interested in protecting. This ecosystem function is usually identified as a societal term.
- Tailor monitoring program to the question and expected changes in the specific habitat you are looking at.

3.4 Post-Construction Monitoring

In the EU, post-construction monitoring surveys are similar in design to the pre-construction surveys. In the UK, post-construction monitoring typically consists of a nested random sampling design focused on the area adjacent to the impacted area. Although programs exist to examine the immediate local effects, such as scour; they are not typically part of the post-construction monitoring program. The most common sampling techniques used in the EU are grabs and video. In the UK, post-construction surveys are required to be conducted the first year after construction and then every 5 years. To date, limited (expected) impacts from scouring and shadowing on seabed organisms have been observed, but no significant effects on marine mammals or fish have been noted. Overall, results of post-construction monitoring have indicated that outside of the small immediate area of scour, there is no noticeable difference in the adjacent area (approximately 10 m away) compared to the reference area.

When designing the pre- and post-construction monitoring program, it is important to understand what kind of change matters and how much change is unacceptable. Scale was again noted during the discussion of identifying change and establishing impact thresholds. It should be assumed that changes will occur at the small scale, (i.e. in the immediate vicinity of the installation footprint of the pilings), but those changes may not likely be meaningful if these changes do not result in impact on a regional or population level. It is therefore the identification of change at scales relevant to the question being asked (e.g. regional or site-specific) that should be the focus of the monitoring program. In order to determine the significance of the change, it is important to understand the natural variation of the system being studied. Once the natural variation is understood, impact thresholds can be established that fall outside of the natural variability of the system. Otherwise it is difficult to determine whether the changes are significant and attributable to the operation or construction of the wind farm or part of the natural variability of the system. A Belgium example was given in which change was examined across multiple groups (benthic, fish, birds, mammals). A meaningful change could not be identified within individual groups; however the relative change among groups was examined to determine whether the change was consistent.

One of the primary concerns voiced by U.S. Federal agencies was whether the installation of structures (pilings, etc.) in the wind energy areas would change the community structure of the surrounding environment. In Belgium and the Netherlands, higher abundances of structure-associated fish were observed around the wind farm structures post-construction, but it was not clear whether that was due to attraction of fish from outside the area or internal production. They also documented an increase in the number of porpoises present in the area. However, there was not a change in the abundance of bottom fish present in the area. One of the only demonstrated changes in the Netherlands was a significant increase in sand eels within the wind farm area. It was hypothesized that this result was an artificial reef effect due to the aggregation of pelagic species around the hard substrate introduced by the wind turbine foundations.

Of the impacts noted during post-construction monitoring of wind farm areas in the EU, the size of the scour pits was most surprising. Although dramatic in depth, the scour footprint was still relatively local (tens of meters). It was also noted that hydrographic models didn't accurately convey the extent of the scour impact. Additional scour protection was placed as a mitigation measure. Invasive species were also noted as a sensitive indicator of impact on the larger scale. It was suggested that species with both benthic and pelagic phases may be the most sensitive to impacts from wind farm development.

3.5 PREDICTIVE MODELING

In the EU, predictive models have been used to predict habitat but not impacts. Predictive models are typically developed using data from the characterization survey in order to characterize a broader area. The most common models used in the UK are EUNIS-based, in which simple techniques are used to predict more complex habitats. Techniques employed to predict habitat classifications across soft sediment in the EU include multi-beam bathymetry, side-scan (backscatter), sediment grabs, ADCP, and wave buoys. The most common employs grab samples to classify the local habitat and provide niche descriptions, combined with the physical characterization provided by the side-scan and backscatter data, to create a continuous habitat map of an area.

Other models used in the EU include:

- Eutrophication process models – combined with benthic habitat models to understand the variation in hydrodynamic processes and the impact on the benthic habitat.
- Scouring models – model turbulence around structure
- EcoSim/EcoPath – model the impact of adding hard structure to the system
- Nutrient model – assess the supply of nutrients and food over space and time.
- Logistic regression models – classify habitats types

Although the European experts indicated that many of these models performed reasonably well, few were able to detect meaningful changes due to wind farm effects on a local or regional scale. These results suggest that either significant changes did not occur or the models did not have adequate resolution to identify change.

Resolution and coverage were two of the major limitations identified with the use of predictive models. Although one of the benefits of predictive models is the ability to develop a continuous surface using discrete measurements, there are assumptions made as part of the extrapolation process that carry with them varying degrees of uncertainty, which itself is unquantifiable or difficult to quantify,, including the need to assign arbitrary boundaries to a continuous system. It was recommended that a confidence (or uncertainty) assessment be performed when using predictive models because variability in the dependent variables as well as the presence of covariates can significantly limit the resolution of predictive models.

3.6 HABITAT VULNERABILITY INDICES

Both the EU and U.S. participants acknowledged that some habitats are more vulnerable to impacts than others. In the U.S. there is a joint effort by Environmental Protection Agency (EPA) (National Coastal Conditional Assessment) and NOAA to derive a species sensitivity list and develop indicators for coastal and estuarine environments. In the UK, species vulnerability indices exist, but are not habitat specific. One of the parameters included in the index is recoverability (resilience), which depends not only on the species characteristics, but also the nature of the impact. Benthic quality indicators also currently exist in the Europe, employed in the UK under the EU Underwater Framework Directive, which ranks species with respect to vulnerability to waste water impacts. They are in the process of retooling the index to evaluate species vulnerable to trawling. The Marine Life Information Network (MARLIN) is also used in the UK in the assessment of species vulnerability. MARLIN includes sensitivity tables for species, specific to certain activities. Vulnerability indices do not exist in the Netherlands.

3.7 ADDITIONAL DISCUSSION ITEMS

In addition to discussing the specific questions identified in the agenda, various other related topics were discussed. A summary of the additional discussions is provided below.

How does the EU approach ecosystem-based management?

Ecosystem–based management is complex and difficult to define. As a result, it was acknowledged that it might not be reasonable or possible to enforce such an approach on developers. It will likely require a cooperative approach between agencies and developers to obtain the correct data to implement an ecosystem-based management approach.

Who is responsible for assessing cumulative impacts?

In the U.S., the government has the responsibility of assessing impacts on a regional scale; however developers are required to assess the impacts of their projects in combination with other nearby projects. To date, cumulative impacts have focused on birds, mammals, fish and not the benthic community. In the Netherlands the government is responsible for identifying cause and effect level habitat disturbance, whereas the developers are responsible for site-specific impacts.

How is trawling/fishing regulated within wind farm areas?

In the UK there are no formal restrictions to trawling within wind farm areas; however there are practical restrictions in the form of spatial maneuverability. If restrictions exist, they are documented in the lease agreement. In the Netherlands trawling is not allowed in wind farms as a safety measure.

Is there an expected benefit in the nearby waters from fishing restrictions at wind farm areas?

There is no clear answer. Additional research, in the form of artificial reef projects, needs to be conducted. When examining the compatibility of offshore fishing with offshore wind, it was noted that the turbine array is a key feature. It was also recommended that the socio-economics of fishing be considered when considering potential fishing restrictions.

Are the piles or cables in the EU armored?

Armoring of cables is not common because it tends to be more damaging to the environment than the initial burial. However, where scour, sand waves, or hard substrate make cable burial unwise or cost prohibitive cables are armoured.

How do you measure system-level impacts, such as for invasive species?

Wind turbines enable species movement by potentially providing stepping stones to facilitate dispersal of invasive species. Turbines also provide novel habitat, which may promote the proliferation of invasive species. Connectivity studies were recommended in order to further understand the movement of larvae from platform to platform. Some of these studies are being undertaken at the Scottish Association for Marine Science (SAMS). It was also questioned whether the impact of sessile invasive species could be mitigated with cleaning, painting, etc? Mitigation is typically included as part of the license agreement. The example was given that Cape Wind is being required to clean/scrape the turbine structures to minimize biofouling. The resultant biomass to the seabed (e.g. of mussels) will cause localized impacts in the form of increased organic content in sediments and the attraction of predator/scavenger. There is no reason to think that a localized increase in productivity would be associated with such structures and that this enhanced productivity could extend to fisheries species.

What have been the effects of storms (i.e. increase hurricane frequency with climate change) and has there been any related effect on benthic community?

The current industry standard in the EU is the monopole, although the tripod design provides more stability. The tripod base is typically filled in with rock to provide added stability, but this also results in more hard structure habitat. The gravity base design is used in Belgium. There have been no studies on the differences between bases and their effect on benthic habitat.

What are the effects of EMF? (see reference for suggested readings)

The results of EMF impact studies are inconclusive. Burial of the EMF emitting source doesn't appear to have an effect. In general it was found that some fish would move when exposed to EMF within a few hundred meters. In other studies elasmobranches were found to be attracted to cables. There was also little evidence of EMF affecting marine mammal communication. In fact, heat from the transmission cables was more likely to have an effect than EMF.

Will data be made available, and if so, how and when?

One of the major problems in the development process in both the U.S. and parts of the EU is that there isare a lot of data but the data are not shared among developers and are not made available to the public, leading to discrepancies in how data are collected and replication of effort. In some case, data may eventually become available, but not until after a long review process. The UK uses the Marine Resource System (MaRS) to catalog and manage their data. Data (raw and processed) are required to be loaded in a particular format every 3 months and data become available during Round 3 of development, once the application is submitted. In the U.S., developers are protective of data due to the high level of uncertainty associated with the project development process. BOEM's intent is to make data (processed data layers) available via the Marine Cadastre. Additional data will also be available from the National Oceanographic Data Center (NODC) and the National Geophysical Data Center (NGDC).

3.8 Summary of Benthic Habitat Session

There were a great number of lessons learned from the European experts during the benthic habitat session. The following suggestions were made relative to guiding the collection and assessment of benthic data during the offshore wind farm development process:

- Need to accept some level of impact. Local effect likely, but may not be meaningful at the regional scale. Focus effort to understand/evaluate ecosystem service.
- If you want to detect a change, define a change to monitor for, don't just monitor. Need to find a cause and effect within a wind farm area to understand/monitor.
- If you don't have enough information to establish impact thresholds, take an adaptive management approach. Adapt policy/regulations as you learn more. If regulations are too stringent, you may end up monitoring for illogical parameters.
- Develop an inventory of knowledge gaps and design monitoring program to fill in gaps. Possibly coordinate monitoring efforts across individual developers to ensure robust monitoring at the proper scale.

Although there was a large amount of valuable information exchanged during the benthic habitat session, one of the concerns that came up multiples times and remains unresolved is the question of scale. In order to understand and answer the question of scale, a meaningful and relevant question needs to be defined. Suggested questions to consider when determining scale in the development of benthic monitoring and assessment programs include:

- What effects are you interested in measuring? Local, regional, population?
- What is natural variation? Need to know natural variation to understand change and its significance.

In summary, based on the overall lack of large scale effects found from benthic monitoring of offshore wind farms in the EU, impacts to benthic habitats do not appear to be a limiting factor in the continued development of offshore wind energy. A well-defined monitoring framework is important; however the ability to take an adaptive management approach was identified as key to developing an effective monitoring program. In the U.S., there appears to be an existing framework within which to begin the assessment process, namely the essential fish habitat (EFH) and Habitat Area of Particular Concern (HAPC) designations under the Magnuson-Stevens Fishery Conservation and Management Act. There also exists a long term independent fisheries program, through the NMFS spring and fall bottom trawl surveys, which translate to regional scale, ecosystem-based scale knowledge. These two items provide a solid foundation upon which to further refine the assessment and characterization guidelines. It was agreed that continued dialogue between the EU and BOEM would be beneficial to the continued development and assessment of offshore wind energy.

3.9 References

Includes references and suggested readings from participants.

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4.0 ARCHAEOLOGICAL RESOURCE BREAKOUT SESSION

4.1 INTRODUCTION

The purpose of this breakout session was for BOEM archaeologists to learn from the European experience in wind energy development and submerged pre-contact archaeology. During the breakout session, BOEM agency archaeologists and invited European experts discussed the European regulatory process for the identification and mitigation of impacts to cultural and archaeological resources, with an opportunity each day for attendees to ask technical questions and engage the European experts directly. Each session for this topic addressed a specific area, as discussed below.

4.1.1 Background

Under Section 106 of the National Historic Preservation Act, BOEM is required to take into account the effects of the bureau's undertakings on historic properties[1]. To gather baseline information on historic properties, BOEM commissioned and recently released the *Inventory and Analysis of Archaeological Site Occurrence on the Atlantic Outer Continental Shelf* (TRC, 2012). This study is not intended to replace site characterization studies that will be completed to identify historic properties, but rather to accomplish two goals: first, the study presented a model for identifying areas of the Atlantic OCS where there is potential for preserved pre-contact archaeological[2] sites. Second, the study presented compiled research in a database of known and reported historic shipwrecks along the Atlantic OCS and provided a written historic context for these wrecks. The database contains over 11,000 entries and incorporates extant databases, literature on shipwrecks, state and federal data on shipwrecks, and the results of limited archival research at a number of institutions along the east coast.

Equipped with a baseline inventory of potential shipwrecks and a model that identified areas of the Atlantic OCS that have the potential to contain pre-contact sites, BOEM is contemplating best practices for the identification of, and resolving adverse effects to, historic properties as related to offshore wind development. To that end, BOEM was interested in gaining the European perspectives on the following issues during the workshop:

1. Compare how, through environmental planning, both the US and the international regulatory regimes work to prevent impacts to historic properties.
2. Discuss success stories and lessons learned from European mitigation strategies which, by definition reduce the severity or seriousness of impacts to historic properties from offshore wind developments.
3. Identification of submerged pre-contact sites on the OCS, both remotely and through direct sampling.
4. Development of standards for direct sampling.

4.1.2 Participants

Participants in this session included the invited European attendees, BOEM, US DOE, Narragansett Indian Tribe, and industry representatives and consultants. Biographies of the invited European participants are provided in Appendix F to the report and a list of attendees is provided below.

Invited Attendees:

Paul Baggaley, PhD, Wessex Archaeology (England)
Jonathan Benjamin, PhD, Wessex Archaeology (Scotland)
Jørgen Dencker, PhD, The Viking Museum (Denmark)
Michael Faught, PhD, Panamerican Consultants (United States)
Antony Firth, PhD MIfA, Fjordr Limited (England)
Christopher Pater, English Heritage (England)
Kieran Westley, PhD, University of Ulster (Northern Ireland)

BOEM Staff:

David Ball
Brandi Carrier
William Hoffman
Brian Jordan
James Moore

U.S. Participants:

Stefan Claesson
Amanda Evans
Jeremy Firestone
Stephen Geiger
Doug Harris
Michael Krivor
David Lockledge
Scott Lundin (Facilitator)
Terry Orr (Note Taker)
JB Pelletier
David Robinson

4.2 Archaeological Resources in the European Planning Process

In the UK, different regulatory leasing approaches had previously been used in Rounds 1 and 2 and in Scottish Territorial Waters. Currently, the Crown Estate Round 3 leasing process requires a post-lease, Zonal Assessment (ZA) prior to Final Licensing/Consent of an individual project. In the ZA-phase, the lease area awarded to a developer is refined to identify project-specific development areas within a zone, each of which may be on a different timetable for consent and construction. As part of this regional assessment, a regional-scale cultural/archaeological survey is conducted and paid for by developers. This ZA-phase survey involves wider line spacing as compared to consent period surveys (100 to 200 meters) and subsequent post-consent / pre-construction level surveys (~ 30 meters) that are focused on obstruction avoidance.

Once the development area is identified, based on the regional-scale survey, an Environmental Impact Assessment (EIA) is conducted by the developer, who generally commissions specialty environmental consultancy services and sub-contractors (to include archaeological specialists). The government is obliged to provide advice on the scope of the EIA and in practice there is often quite a lot of communication between developer and government agencies to ensure that the EIA will prove to be "adequate." The EIA is carried out and reviewed by relevant internal parties, submitted to the appropriate regulatory bodies and reviewed by the agents therein; often consultations with curators and specialists take place during the review process.

Cultural resources that may be identified during the EIA process are more closely examined in the post-consent phase, unlike in the U.S. where cultural resource impacts are a critical component of NEPA review and therefore must be thoroughly reviewed prior to project approval. Instead, through the EIA process, resolution of possible adverse effects to archaeological heritage must be addressed to include the identification of mitigation measures where a significant effect is anticipated. Typically, mitigation measures are formalized in a Written Scheme of Investigation, which is reviewed and approved by the appropriate regulatory body (e.g. Historic Scotland in Scotland and the Northern Ireland Environment Agency in Northern Ireland). The critical distinction between the UK-process and the US process is that historic property identification must be fully documented and assessed in the US prior to project approval, whereas this occurs post-consent / pre-construction in Europe.

Final Consent of the project is issued following the EIA process. One of the conditions of the Consent decree is implementation of the approved Written Scheme of Investigation, which describes post-consent / pre-construction activities that must be conducted by the developer. Written schemes of investigation are specific about data gathering activities and how to manage findings. These activities include archaeological assessments, like those described in Section 4.4.

BOEM staff acknowledged that regional level surveys would be of great value in informing project-specific site characterization activities. Although regional surveys are outside the scope of current regulations, they have been solicited by BOEM through the environmental studies program and conducted through partnerships with other federal agencies. For example, BOEM has funded regional surveys in Massachusetts and North Carolina. BOEM also can incorporate requirements for the treatment of historic properties into lease and plan approval conditions.

The Europeans acknowledged that visual impacts to onshore resources have not been as critical as they are here in the US, though this is changing. As visual impacts to onshore resources constitute an area of increasing concern, European regulators (like English Heritage) expressed the same difficulty as regulators in the US in assessing visual impacts and what constitutes effective mitigation. The European attendees are trained archaeologists and therefore visual impact issues are a relatively new consideration within their area of technical expertise.

The Europeans are still trying to clarify how best to understand what is important to protect with respect to visual appearance of wind energy facilities upon the seascape and landscape.

4.3 European Cultural Resource Mitigation Strategies

To date, avoidance has been the primary mitigation strategy implemented for archaeological resources in the UK offshore renewable energy industry. However, the European attendees agreed that avoidance should not be the only acceptable strategy for three reasons: 1) avoidance maybe burdensome for developers in that they may redesign project elements to avoid remote sensing targets that may appear to represent archaeological sites, but that are not verified as such; 2) in some cases avoidance of a confirmed archaeological site may not be feasible based on the extensive footprint of a wind energy project; and 3) avoidance does not result in an increased understanding of the archaeological resource nor does it provide feedback to refine survey methods and interpretation of remote sensing anomalies. If developers always choose to avoid potential cultural resources, the opportunity is lost to gather information that could feed back into a better understanding of the best practices for identifying submerged archaeological sites and also for determining both appropriate avoidance measures and their effectiveness.

4.4 Identification of Submerged Archaeological Sites in Europe

Workshop participants discussed the relationship between submerged paleolandscapes, submerged paleolandforms, and submerged pre-contact archaeological sites. A submerged paleolandscape consists of the surviving remains of the once terrestrial environment that are now submerged following post-glacial sea level rise. A paleolandscape may include geomorphological features that provide evidence of what an area of the OCS (e.g. river or stream channels and floodplains, estuary complexes, shoreline terraces, etc.) in addition to other types of evidence of a past paleo-environment (e.g. pollen, diatoms, foraminifera, or micro-charcoal concentrations/horizons). Thus, a paleolandscape may contain many paleolandforms. In contrast, a pre-contact site is a distinct geographic location within a single paleolandform that bears direct, physical evidence of human activity (e.g. stone tools, evidence of stone tool-making in the form of lithic debitage, or anthropogenically-modified specimens of fauna [exhibiting butchery marks]). Based on analogies that are drawn from terrestrial correlates, submerged paleolandforms may retain evidence of past human activity and therefore have the potential to contain archaeological sites; however, not all submerged paleolandforms or paleolandscapes are archaeological sites.

4.4.1 Archaeological Site Identification

Where they have been preserved, the remnants of submerged paleolandscapes on the OCS are located not only underwater, but in some cases buried below the seafloor, superimposed by more recent landform surfaces. These present a technically challenging environment in which to identify archaeological sites. The primary methods used to gather information on submerged paleolandscapes, and to identify archaeological sites that may exist within a paleolandscape, consist of high resolution geophysical survey and geotechnical sampling.

In most offshore industries in the US and Europe, submerged archaeological sites have been identified in the following process: first a geophysical survey is conducted using a standard suite of remote sensing equipment and then a geotechnical sampling program is conducted to ground-truth the geophysical interpretations resulting from the initial phase. The COWRIE document: *Historic Environment Guidance for the Offshore Renewable Energy Sector* provides a summary of this process (2007, Chapter 8; see also Gribble and Leather 2011).

The standard suite of remote sensing equipment employed includes a multi-beam echo sounder, side scan sonar, magnetometer, and sub-bottom profiler system(s). Sub-bottom profilers use acoustic energy to penetrate the seafloor and provide information on the underlying geology and sediment layers and, because of this, are the most relevant system for identifying paleolandforms. Various types of sub-bottom systems exist including chirp, pinger, sparker, and boomer profilers and the effectiveness of each system is dependent on the seafloor substrate in a particular survey area and the desired resolution (i.e. the thickness and separation of sediment layers that are observable in the data) and the targeted depth of investigation (i.e. the lowest sediment layer that is observable in the data). At different ends of the spectrum, a pinger sub-bottom profiler generally exhibits the highest resolution and lowest penetration depth, while a sparker sub-bottom profiler is characterized as providing the lowest resolution data but highest penetration depth. Boomer sub-bottom profilers are standard in the UK as they provide a balance between resolution and penetration for most areas around the UK.

Parametric Sonar is a relatively new type of sub-bottom profiler utilized in the UK that presents several potential advantages. These advantages include the ability to mount the equipment to the survey vessel, rather than towing the instrumentation, in order to utilize motion sensors and improve data quality as well as levels of resolution and penetration that are generally considered to be superior to traditional sub-bottom profiler systems.

Following geophysical survey, a geotechnical sampling program is typically conducted using a variety of methods that directly gather samples of sediments at, or below, the seafloor. These methods of direct sampling may include coring systems, benthic grabs, or dredging to obtain representative samples of the seabed. Cores are typically collected for the purpose of verifying the geophysical data and informing the geologic interpretation of a survey area. Cores can also be examined for evidence of a paleolandform (including the presence of paleosols or other evidence of terrestrial environments) and can also be subjected to radiometric dating. Radiometric dating informs the geologic interpretation of a region and may also be used to evaluate the potential for human activity for a particular soil horizon (see Gribble and Leather 2011). The sediments within the cores may also be also subjected to paleoenvironmental analysis (for example, analysis of pollen, diatoms, ostracods, foraminifera) which provides information on the environment at time of deposition as well as providing a proxy for relative dating of sediment horizons through a comparative analysis of floral and/or faunal assemblages.

The workshop participants acknowledged that while the geophysical survey and geotechnical sampling methods are capable of providing information on paleolandscapes, identifying an archaeological site within a paleolandform comprising a part of these landscapes is an extremely challenging task. Direct evidence of human activity is difficult to definitively identify because these archaeological sites are likely to be ephemeral, in some cases consisting only of small concentrations of lithic material.

The industry standard geotechnical techniques are used to identify and characterize sediment horizons of archaeological interest, and, in conjuncture with the sub-bottom profiler data, to interpret and ground-truth remnant paleolandforms; however, coring techniques are not typically used to sample directly for archaeological materials. This is based on the size of the coring devices (for example, industry standard vibracores may have a diameter less than 5-inches) and the density of the samples typically taken, themselves functions of the extreme cost of sampling in this environment. Therefore, while terrestrial paleolandforms are directly sampled, for example, every 30 meters, submerged remnant paleolandforms are only sampled every kilometer. The spatial resolution of coring is typically not sufficient to detect pre-contact archaeological sites. Instead, this technique is used to define paleolandforms, and characterize their age and nature, rather than used to discover archaeological sites themselves. Because such a small portion of a landform is sampled in this way, the probability of recovering artifacts (such as projectile-points or lithic debitage) is very low. European experts have noted, however, that recent work (Weerts et al. 2012) has shown that dense targeted coring, in some instances, has been successfully employed to identify concentrations of archaeological materials.

The participants did acknowledge that artifacts or other direct evidence of an archaeological site could be recovered in a vibracore, even if the sample was not taken for that purpose. A further point was raised that the method of analysis for core sampling typically operates on standard marine geological procedures (i.e. opening and logging cores and extracting small samples for further analysis and/or archiving), but that core samples are rarely screened for archaeological materials, as is standard practice on a conventional terrestrial archaeological sites.

An additional issue was raised with regard to materials recovered through direct sampling that may present indirect evidence of human activity. For example, materials such as charcoal, un-butchered or unmodified animal bone, and plant remains may be related to human activity, but may also be naturally occurring. A site characterization study of this type may inform our understanding and reconstruction of a paleolandscape; however, it does not necessarily provide conclusive and direct evidence for the presence of a pre-contact archaeological site. Discussion among the group focused on the distinction between direct and indirect evidence of human activity and the importance in looking for, and considering, both types of evidence when reconstructing a paleolandscape and the potential for pre-contact archaeological sites to exist within that landscape.

No prehistoric submerged archaeological sites have yet been identified in the UK as a consequence of offshore renewable energy development. This fact is partially influenced, however, by the general policy of avoidance of paleolandforms that have the potential to contain archaeological sites. Many of the European submerged archaeological sites have been identified through extensive study and/or dredging activities that uncover artifacts of human activity. The aggregate industry is one where submerged prehistoric sites have been identified in part, because extensive dredging activities result in artifacts being raised to the surface and identified through the mechanical screening process that is standard for dredging operations. Such a process mimics the standard archaeological screening of direct samples taken from terrestrial paleolandforms.

The dredging used as part of the aggregate industry, however, is extremely destructive to archaeological sites. Large volumes of sediment are generally not recovered on offshore renewable energy projects because submarine cables are typically installed using a jetting-tool installation technique and foundation structures are often driven into the seabed.

4.4.2 These systems are already in common use in Denmark and Germany

The geotechnical sampling program is conducted using a coring system, benthic grab, or dredge sampler to obtain representative samples of the seabed. Cores are typically collected for geophysical data verification and geologic interpretation and will often be examined for evidence of terrestrial environments (paleosols) and radiometric dating can be performed on any paleosols recovered in order to evaluate the potential for human activity for that particular soil horizon. The sediments within the cores are also subjected to paleo-environmental analysis (pollen, diatoms, ostracods, forams) which can give information on the environment at time of deposition as well as providing a proxy for dating through recognizing plant assemblages.

Predictive Modeling

Workshop participants discussed the use of predictive modeling as a tool to delineate areas of the OCS that may present a high-probability for the presence of submerged pre-contact archaeological sites. While some workshop participants advocated for using predictive models, several of the Europeans emphasized the limitations of the application of predictive models alone. Some of the European participants urged caution in reliance on predictive models without the necessary context generally achieved by acquiring and interpreting substantial volumes of data in order to understand the physical nature and environment, as well as preservation conditions, of the modern coast and offshore environments.

Denmark was identified as an example where predictive models have been shown to be successful, however the Danes have been collecting data relevant to submerged paleolandscapes and archaeology prehistoric archaeological sites for decades. The Danes have collected abundant data, both environmental and cultural, to feed into the predictive models, which have been proven to be very accurate in determining site locations. Their predictive models are additionally robust because, in comparison to other countries, the Danes have generally had more interest and support in excavating these sites, rather than solely avoiding areas, as discussed above. In addition, it was noted by many of the workshop experts that the environmental conditions related to coastal and marine morphology that exist in Denmark do not exist in the UK or US. For example, the Danish coast has not gone much modification in the course of becoming submerged, and there is less sedimentation. Therefore, submerged prehistoric sites are found close inshore in shallow water and generally near the seafloor. In comparison, similar submerged archaeological sites in the UK or US have been exposed to much higher energy conditions during sea-level rise and have been exposed to higher rates of sedimentation and therefore are likely to be buried below many meters of sediment. Because of this, many of the challenges outlined above are not encountered in Denmark. Such data are not available for the US at this time and any model would have to consider the dataset on which they are built; at present, a large scale model used to exclude potential would be of little scientific value due to the paucity of available high-resolution data.

4.5 DEVELOPMENT OF STANDARDS FOR DIRECT SAMPLING

Participants in the breakout session agreed that there is no "One Size Fits All" approach to the direct sampling of potential pre-contact submerged archaeological sites on the OCS. Sampling requirements are contingent on many variables including environmental conditions (water depth, sedimentological and geomorphological conditions) and cultural context (i.e. what artifacts are expected [lithic scatters/concentrations, shell middens, organic remains, evidence of subsistence or habitation activities such as concentrations of faunal material or structures, etc.])

Additionally, site conditions will dictate the type of sampling techniques that could be implemented. For example, from a technological perspective, sampling in deep water will be more complicated than sampling in shallow water. Similarly, sampling in finely compacted sands will require a different technique as compared to sampling in a coarse gravel environment.

The historic context provides insight into what type of site or artifacts may be expected in a given area and what type of sampling technique is most appropriate. For example, in the US and Denmark, a shell midden (a conglomeration of shells) is considered an indicator of potential human activity, while in the UK a shell midden may or may not be anthropogenically-constructed as opposed to naturally occurring.

The group discussed what a vibracore containing evidence of a submerged pre-contact site on the Atlantic OCS would look like. It was agreed that the presence of charcoal and lithic tools or debitage could potentially be identified in vibracore material. However, as discussed above, some items may not be distinct indicators of human activity because they can occur naturally. However, since there are so few definitive pre-contact sites that have been identified on the OCS and the understanding of these sites offshore is limited, almost any potential indirect indicator of human activity may satisfy criteria D under the National Register: that the object or objects "may be likely to yield information important to prehistory or history."

Curation was discussed and there were two primary facets of the discussion. The first is related to the curation of artifacts and samples from archaeological sites. This is a broad issue, generally referred to as the "curation crisis" that is problematic for federal agencies and related to their ability to fund the long term storage and maintenance of archaeological collections. The second is related to the curation of vibracores or other sediment and organics samples that may not necessarily be archaeological in nature, but that still contain valuable environmental information. Many on the panel suggested that these samples should also be archived and raised the issue that they have long term scientific value beyond the project-specific need they were taken for by a developer. Consideration should be made early about how data and physical samples will be archived, both on an industry level as well as project-by-project. Curators, developers, and consultants must work together to set parameters and requirements in order to maximize the long-term value of data.

4.6 SUMMARY OF ARCHAEOLOGICAL RESOURCE SESSION

There was unanimous agreement amongst all of the participants that the discussion in this session was tremendously beneficial for both the Americans and the Europeans. It is strongly recommended that this line of communication be maintained for the benefit of both groups. The Europeans acknowledged that their industry has developed numerous conventions that are not always evident, but that a forum such as this forces reflection and consideration of better alternatives. Similarly, the Americans acknowledged that qualified resources (technical experts) are very limited in this country and that collaboration with European counterparts will be a valuable strategy for managing this resource limitation until the US offshore renewable energy industry becomes more mature. Ideas for future discussions include:

- Data and physical sample storage; what should be stored, how long should it be stored, who should be responsible for the financial obligation of long-term data storage?
- How to design identification surveys, how to process the data, why is open/transparent data processing important, what are the limitations of the data being collected?
- Potential for Autonomous Underwater Vehicles (AUV) and remote investigations to replace divers
- Capacity Building: finding qualified technical experts is challenging for both BOEM and industry. There is a need for students trained in geoarchaeology. Perhaps BOEM could support training programs to get geoarchaeology students to perform field work at ongoing sites in Europe to gain experience.
- A need to understand the field of study on two scales: landscapes and sites –and to integrate the approaches in terms of practical research, management, response to chance discovery, resource-procurement (and funding) and skills development / capacity building.

Marine archaeology is highly inter-disciplinary and requires a high degree of technical specialty. The focus often turns to methodology, due to the challenge of investigating these environments. Based on the discussion, it is evident that the remote sensing requirements are well established but that the physical sampling required to identify human activity is the biggest challenge facing marine archaeologists. It is expected that the OCS around North America, based on cultural practices and an understanding of past (and present) human land usage combined with the positively demonstrated examples around the continent where paleolandforms have been identified (in a preserved state for tens of millennia), that archaeological sites do exist in a preserved state on and under the seabed on the US continental shelves. Their discovery, interpretation and an understanding of the resource is still challenging, mainly due to a lack of resources and projects aimed to carry out primary fieldwork to investigate these environments.

Finally, good archaeology and good development are not contradictions. BOEM and developers working together forms a starting point. Combining information from multiple surveys to feed common goals will help historic property identification surveys become more efficient and minimize the perception of burden.

Early engagement between all parties (developers, BOEM, archaeologists, tribes) is critical and BOEM should work with state agency counterparts because it is impossible to understand the archaeological context of the OCS without understanding the near coastal environment.

1. The term ”historic property”, as defined under the National Historic Preservation Act, means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria.
2. A note on the use of pre-contact and prehistoric; pre-contact is the preferred term used when referring to people living in, what is today, North America prior to contact with European cultures. In the UK and Europe, “prehistoric” is the preferred term when referring to ancient archaeological remains.

4.7 References

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5.0 CLOSING PLENARY SESSION OVERVIEW

BOEM's goal for the third morning of the workshop was to use a model that is being developed to evaluate the wide array of factors, to evaluate methods of bringing together the three different topical areas into a cohesive method for communicating decisions regarding offshore wind siting. The model creates composite maps from disparate types of resource data that enable an assessment of potentially cumulative effects of the action. BOEM has not yet committed to using this model, but realizes that a comprehensive consideration of potential competing uses of resources under its management may be enhanced by using a model. Following the presentation describing the model, the workshop participants (divided into their breakout session groups from the previous two days) were asked to discuss whether and how this model could be useful, from the perspective of each resource category (avian, benthic habitat, cultural/archaeological).

5.1 CUMULATIVE USE EVALUATION MODEL

Dr. Deborah French-McCay with RPS ASA presented the Cumulative Use Evaluation Model (CUEM), which is described in the document: *Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship* (BOEM 2012-082). An overview presentation of the CUEM can be found in Appendix C to this report. Dr. French-McCay explained the following main points about the CUEM:

The intended uses of the CUEM are:

- Identification of areas most suitable for facility siting (from an ecological and human use value perspective)
- Evaluation of the relative impacts of an offshore development considering ecological and human use values
- Evaluation of the cumulative impacts of multiple and competing uses

The CUEM has two parts: an ecological model and a human use model. Thus far, the model provides a framework for evaluating tradeoffs and is not a complete model. The ecological portion of the model is the most developed. The CUEM uses Ecological Value Models by compiling data on the continuous topologies of different resources (GIS-based maps that can be valuable standalone tools as well), then uses weighting schemes to modify the composite data based on a set of criteria. The current weighting schemes are purely exploratory. A "CIM-Eco Calculator" was created so that different numbers could easily be inserted, to see how they change the model's output. This calculator function is important because it allows the model user to perform "what if" types of evaluations and determine the potential sensitivities of resources and uses considered in the model to changes in levels of the uses and their assigned values. The next step for the CUEM is developing a statistical summary of the output.

The current challenges with the CUEM include:

- Obtaining continuous topology for broad-scale coastal zones (comprehensive sampling cannot be done, so other methods are needed)
- Differing levels of data robustness because of different sources/funding levels/species characteristics
- Scale: some species are moving across vast distances, and the importance of an area can depend on the scale of analysis

The presentation was followed by questions from the workshop participants that ranged widely based on their technical interest and their positions as scientists and regulators. Participants asked questions that related to both what factors might be considered under the CUEM and the data necessary to allow the model to make good predictions. There was further interest in understanding how animal migrations, viewsheds, and other large-scale factors could be considered. One important consideration not currently included in the CUEM is the specific consideration of positive impacts. Dr. French-McCay responded that the CUEM user can accommodate this when adjusting weighting factors. Incorporating ecological functions and food web relationships has been a challenge during the development of the model. For example, benthic resources can't be displayed using just a density map. The project team looked for areas with the potential for growth in biodiversity, and resources that might need to be mapped out more specifically because they also affect other resources.

In response to a question that asked if stakeholders in a process would be able to manipulate the model during a project review process, Dr. French-McCay explained that it currently envisioned that the user of the model would primarily be the regulator or resource manager, who could coordinate with participating stakeholders and re-run the model after evaluating and understanding their suggestions.

5.2 GROUP DISCUSSION AND REPORT-OUTS

Following the presentation, workshop participants were asked to discuss the CUEM with others from their technical breakout sessions, focusing on how to incorporate their resource data into the model, and what would be the constraints, opportunities, and questions associated with using this model. Following are the key points from the three technical breakout session groups on their primary impressions regarding the utility of, and potential problems with, using models such as the Cumulative Use Evaluation Model. BOEM and the model developers will use these points to further explore the utility of using cumulative models in the decision making process.

Avian Breakout Group:

- More useful for static resources.
- Conservation status may not be a good index because endangered species may not necessarily be vulnerable to wind energy. Sensitivity to impacts could be evaluated instead, and conservation status included as part of that evaluation.

- Include a map with exclusion areas (military zones, etc) to narrow down the baseline area.
- May be more helpful for the Pacific Region because much of the East Coast has already identified Wind Energy Areas.
- Need to be able to break down seasonal data as well, not just look at it in the aggregate.

Benthic Habitat Breakout Group:

- Need data to represent both benthos and its food source (pelagic).
- Large-scale habitat mapping is essential for continuous coverage.
- Standardizing data across a broad area is a significant challenge.
- ADCP (Acoustic Doppler Current Profiler) may be a useful tool for assessing benthic habitat.
- Seasonality is important to capture, as is scale, which may have significant impacts on outcomes (a particular habitat may be important on a local scale but not on a regional scale).
- How representative is the ecological value index?
- Benthic habitat data may be useful in building up other types of resource layers.
- Provides an opportunity for input from scientists, and from stakeholders who may then be more likely to buy-in to the data.
- Don't have a way to address data that is NOT available, and how this impacts the weighting scheme.
- Each resource layer should have a level of uncertainty attached to it, which impacts its weighting; the uncertainty of the model itself should also be quantified.

Cultural Breakout Group:

- CUEM may be more useful as a planning tool (to identify a general area) than a siting tool (there is too much information for it to be useful); use CUEM for larger-scale decision making rather than smaller-scale decision making.
- Use CUEM to organize data, determine data gaps, and support expert-led judgment.
- Address/incorporate ecosystem resilience into the model.
- Interactions and relationships of resource impacts are important (pairing up data may be more valuable than layering it spatially).

- Segregation of ecological and human uses is problematic for cultural and archaeological resources, because the resource and the stakeholders transcend these categories. Many physical resources have both ecological and cultural significance.
- Archaeological resources can be very unique – a single site could have international significance.
- There isn't enough data to support archaeological modeling; there is no baseline for prehistoric site data.
- The weighting scheme is heavily subjective.
- Certain data may be lost or blurred as a result of the composite layering.
- How will CUEM allow for moveable timeframes/temporal components for each resource, since human activities in particular will continue to change?

5.3 CONCLUDING REMARKS

The workshop provided an opportunity for BOEM and other Federal agencies, as well as the interested public, to discuss key questions about offshore wind development with scientists and regulators from Europe, who have direct experience. Participation during the workshop of individuals representing five of the six European countries with operating offshore wind energy facilities enabled BOEM to compare and contrast strategies for managing the stewardship of environmental and archaeological resources on the OCS. The format of the workshop allowed for an interactive opportunity to fully discuss, beyond the initial questions posed, the lessons learned from the experience of European colleagues in siting, permitting, developing, and operating offshore wind energy projects. BOEM was particularly interested in understanding what data collection efforts and analyses have been useful (or, by contrast, ineffectual) in the prediction and confirmation of environmental and resource impacts from offshore wind development in Europe. As a result of the workshop, it is hoped that valuable European experiences may be repeated in the U.S. While much was learned and is already presented in the sections above, the most important lesson was that we must maintain the lines of communication and continue to learn from each other as wind development progresses into new areas, with new technologies.

Appendix A

Agenda

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Workshop Overview Agenda

Offshore Wind Energy Development Site Assessment and Characterization: Evaluation of the Current Status and European Experience

February 26 - 28, 2013

Workshop Purpose: To learn from both the challenges and successes of Europe's experiences with pre- and post-construction site evaluations, and further BOEM's development of clear requirements and guidance for offshore wind energy in the United States.

Monday, February 25, 2013	
4:30 – 5:30 pm	**Early Registration** for participants arriving at the hotel on Monday. **(outside of the Grand Ballroom, Salons B/C)**
Tuesday, February 26, 2013	
8:00-9:00 am	**Registration (outside of the Grand Ballroom, Salons B/C)** *NOTE: Coffee and tea will be provided at the meeting; hotel guests receive complimentary breakfast in the dining area.*
9:00-9:15	**Plenary Session: Welcome and Opening Remarks** *Ned Farquhar, Deputy Assistant Secretary, Department of Interior* • Welcome to invited guests and participants
9:15-9:30	**Plenary Session: Overview of Workshop Purpose and Goals** *Dr. Mary Boatman, BOEM Workshop Organizer* • Introduction/background on the workshop goals
9:30-10:15	**Plenary Session: Overview of European Wind Energy Regulatory Framework and Current Status** *Beverley Walker, BlueWind Consulting LTD, United Kingdom* • Europe's range of offshore wind energy programs (a synthesis)
10:30-11:15	**Plenary Session: Overview of US Wind Energy Regulatory Framework and Current Status** *Maureen Bornholdt, Program Manager, Office of Renewable Energy Programs, BOEM* • BOEM offshore wind energy program **Facilitated Q&A**

Please note that the times (other than start and end times) are flexible and subject to change.

11:15 – 11:30	**Overview of Afternoon Breakout Session Agendas and Directions** *Abby Arnold, Facilitator* • *Each technical track (Avian, Benthic Habitat, and Cultural/Archaeological) will follow a slightly different format. Please see more detailed agendas specific to each breakout session for more information. These sessions will meet during the afternoon of Day One and all of Day Two. On Day Three, please reconvene in plenary.*
11:30 – 1:00 pm	*Lunch (on your own)*
1:00 - 5:00 *(including break)*	**Facilitated Breakout Sessions** *Please see breakout session agendas for more information.* ❖ Avian Track (Salon C) ❖ Benthic Habitat Track (Salon B) ❖ Cultural/Archaeological Track (Reagan National/Dulles)
Dinner (on your own)	
Wednesday, February 27, 2012	
9:00 – 11:45 am	**Facilitated Breakout Sessions Continued** *Please see breakout session agendas for more information.*
11:45 - 1:00 pm	*Lunch (on your own)*
1:00 - 4:30	**Facilitated Breakout Sessions Continued** *At the end of the session, the Facilitator will review the agenda and format for Day Three's Plenary session.*
Dinner (on your own)	
Thursday, February 28, 2012	
9:00–9:15 am	**Brief Overview of Purpose, Agenda, and Format for Day Three** (Facilitator) *Participants sit at round tables with others from their breakout groups (tables will be marked). There will be about 3 tables for each breakout group, and participants may sit anywhere at those tables.*
9:15 - 10:15	**Presentation on Cumulative Use Evaluation Model (CUEM)** • Followed by facilitated Q&A
10:15 – 11:15 (including break)	**Group Discussions** *At their tables, participants address the following questions (volunteers from each table will report out on main points from discussions):* • How would you come up with the data inputs to this model/map, for your technical track?

	• If this data is not sufficiently representative of the resource distribution, what would you do to proceed to fill the gaps or move forward?
11:15 – 12:00 pm	**Report-out and Plenary Discussion** • Volunteers from each table summarize their responses to the questions • Facilitated plenary discussion
12:00 – 12:15	**Closing Remarks**
12:15	**Adjourn**

Appendix B

Participants

BOEM Workshop
Offshore Wind Energy Development Site Assessment and Characterization: Evaluation of the Current Status and European Experience

February 26-28, 2013
Herndon, VA

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Appendix C

Plenary Presentations

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Office of Renewable Energy Programs

Offshore Wind Energy Development Site Assessment and Characterization: Evaluation of the Current Status and European Experience

Workshop Purpose and Goals

Mary C. Boatman, Ph.D.
Environmental Studies Chief
Office of Renewable Energy Programs

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Purpose and Goal

To learn from both the challenges and successes of Europe's experiences with pre- and post-construction site evaluations, and further BOEM's development of clear requirements and guidance for offshore wind energy in the United States.

2

Setting the Stage

- Collecting information, both regional and site specific
- Still in the pre-construction stage, but…
- Guidelines for developers
- Focus on three areas
  - Avian
  - Benthic Habitat
  - Archaeology

Avian Breakout Session

- **Experience and Hindsight**
- **Planning and Siting Criteria**
- **Monitoring**
- **Data and Data Collection**

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Benthic Habitats Breakout Session

- Habitat Classification
- Pre-Construction Surveys
- Post-Construction Monitoring
- Predictive Modeling
- Habitat Vulnerability

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Archaeology Breakout Session

- Comparison of U.S. and international regulatory and commercial planning for the purposes of preventing impacts to archaeological resources.
- Mitigation strategies for impacts to cultural resources from international offshore wind farms
- Identification of submerged archaeological sites
- Development of standards for direct sampling

Cumulative Model

- Cumulative Use Evaluation Model
- Combining ecological considerations with human use
- Geographic Information System (GIS) based
- Under evaluation for potential uses

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Office of Renewable Energy Programs

Overview of the Regulatory Framework for Offshore Wind Development in the United States

Maureen Bornholdt
Program Manager
Office of Renewable Energy Programs

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Overview

- Government Structures in the United States
- Laws and Executive Orders
- Bureau of Ocean Energy Management
- Regulatory Process
- Current Status
- Guidelines

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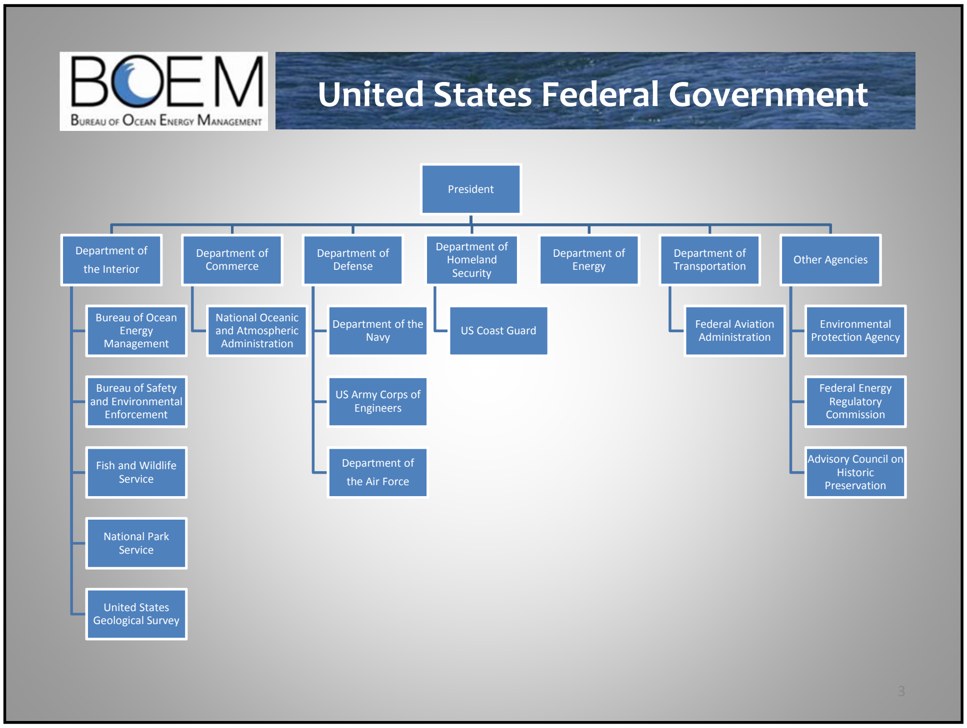
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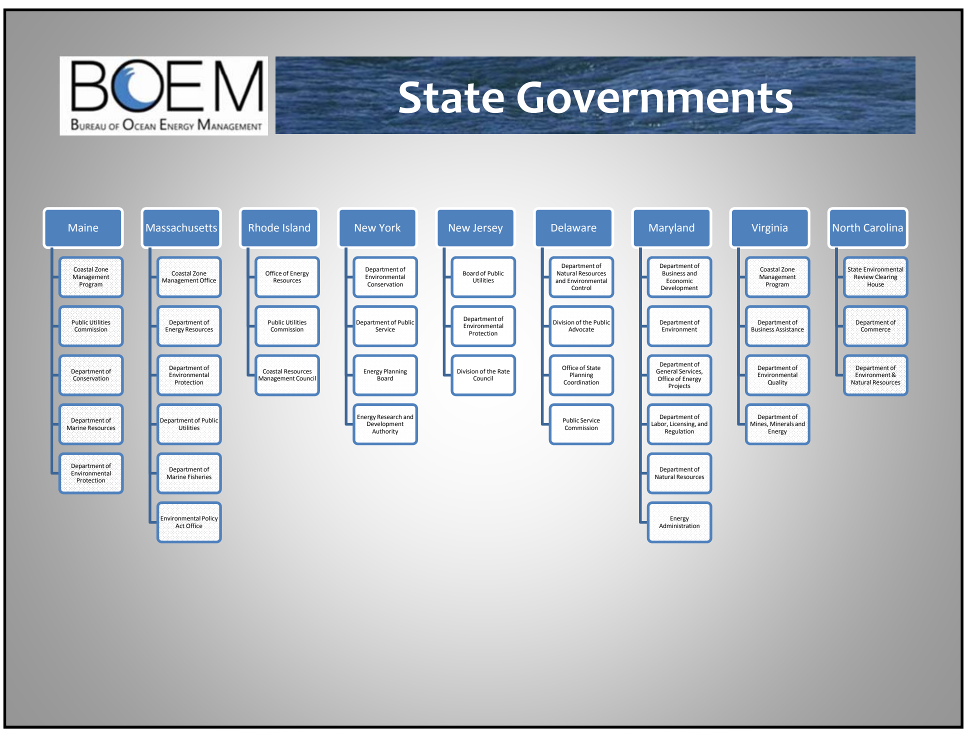
Bureau of Ocean Energy Management
United States Federal Government
President
Department of the Interior
Bureau of Ocean Energy Management
Bureau of Safety and Environmental Enforcement
Fish and Wildlife Service
National Park Service
United States Geological Survey
Department of Commerce
National Oceanic and Atmospheric Administration
Department of Defense
Department of the Navy
US Army Corps of Engineers
Department of the Air Force
Department of Homeland Security
US Coast Guard
Department of Energy
Department of Transportation
Federal Aviation Administration
Other Agencies
Environmental Protection Agency
Federal Energy Regulatory Commission
Advisory Council on Historic Preservation
3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State Governments
Maine
Coastal Zone Management Program
Public Utilities Commission
Department of Conservation
Department of Marine Resources
Department of Environmental Protection
Massachusetts
Coastal Zone Management Office
Department of Energy Resources
Department of Environmental Protection
Department of Public Utilities
Department of Marine Fisheries
Environmental Policy Act Office
Rhode Island
Office of Energy Resources
Public Utilities Commission
Coastal Resources Management Council
New York
Department of Environmental Conservation
Department of Public Service
Energy Planning Board
Energy Research and Development Authority
New Jersey
Board of Public Utilities
Department of Environmental Protection
Division of the Rate Council
Delaware
Department of Natural Resources and Environmental Control
Division of the Public Advocate
Office of State Planning Coordination
Public Service Commission
Maryland
Department of Business and Economic Development
Department of Environment
Department of General Services, Office of Energy Projects
Department of Labor, Licensing, and Regulation
Department of Natural Resources
Energy Administration
Virginia
Coastal Zone Management Program
Department of Business Assistance
Department of Environmental Quality
Department of Mines, Minerals and Energy
North Carolina
State Environmental Review Clearing House
Department of Commerce
Department of Environment & Natural Resources

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Tribal Governments

- Passamaquoddy
- Penobscot
- Wampanoag Tribe of Gay Head (Aquinnah)
- Mashpee Wampanoag
- Narragansett Indian Tribe
- Shinnecock Indian Nation

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Applicable Laws & Executive Orders

- Outer Continental Shelf Lands Act
- **National Environmental Policy Act**
- **Endangered Species Act**
- Marine Mammal Protection Act
- **Magnuson-Stevens Fishery Conservation and Management Act**
- Marine Protection, Research, & Sanctuaries Act
- National Marine Sanctuaries Act
- Coastal Zone Management Act
- Clean Air Act
- Clean Water Act
- **Migratory Bird Treaty Act**
- **E.O. 13186 (Migratory Birds)**
- Rivers and Harbors Appropriation Act
- Resource Conservation and Recovery Act
- **National Historic Preservation Act**
- American Indian Religious Freedom Act
- Federal Aviation Act
- Federal Power Act
- E.O. 12898 (Environmental Justice)
- Ports and Waterways Safety Act
- Marking of Obstructions

Office of Renewable Energy Programs

- Outer Continental Shelf Lands Act of 1953
- Energy Policy Act of 2005 – Section 388(a)
  - Amends the OCSLA by adding Section 8(p)(1)(C) and (D)
  - OCS renewable energy development and alternate use of existing infrastructure (i.e. "other than oil and gas and covered by other legislation")
  - Regulations at 30 CFR Parts 250 and 285

Program Philosophy

- **Coordinate** with federal, state, and local agencies, tribal governments, and stakeholders
- Apply our renewable energy regulatory framework in conjunction with **interagency-led planning activities**
- Focus on **multiple-use**
- Work within the current authorities and responsibilities of agencies and **continue ongoing activities**

Intergovernmental Task Forces

- Affected State, local, & tribal governments and federal agencies participate (12 Task Forces)
  - Does not replace consultation under existing federal laws and regulations
- Forum to:
  - Educate each other about permitting and statutory responsibilities, and stakeholders' issues
  - Exchange data about biological and physical resources, uses, and priorities
  - Continue dialogue about renewable energy activities throughout the leasing process
- BOEM considers task force input in our renewable energy program decisions

Stages of Renewable Energy Program

Planning and Analysis

Lease or Grant

Site Assessment

Commercial Development

Process for Commercial Lease Issuance (30 CFR 585)

Planning and Analysis
- BOEM engages with the Intergovernmental Task Forces to identify priority Wind Energy Areas (WEAs) offshore. WEAs are locations that appear most suitable for wind energy development
- BOEM prepares an Environmental Assessment for Lease or Grant Issuance and Site Assessment Activities

Lease or Grant
- BOEM notifies the public and developers of its intent to lease through Sale Notices
- BOEM determines whether Competitive Interest exists
  - *If Competitive Interest exists,* BOEM holds a lease or grant auction
  - *If Competitive Interest does not Exist, BOEM* negotiates a lease

Site Assessment
- Lessee conducts site characterization studies
- Lessee submits Site Assessment Plan (SAP)
- BOEM conducts environmental and technical reviews of SAP, eventually deciding to approve, approve with modification, or disapprove the SAP
- If approved, Lessee assesses site (usually with meteorological tower(s) and/or buoy(s)

Construction and Operations
- Lessee may conduct additional site characterization
- Lessee submits Construction and Operations Plan (COP)
- BOEM conducts environmental and technical reviews of COP, eventually deciding to approve, approve with modification, or disapprove the COP
- If approved, Lessee builds wind farm

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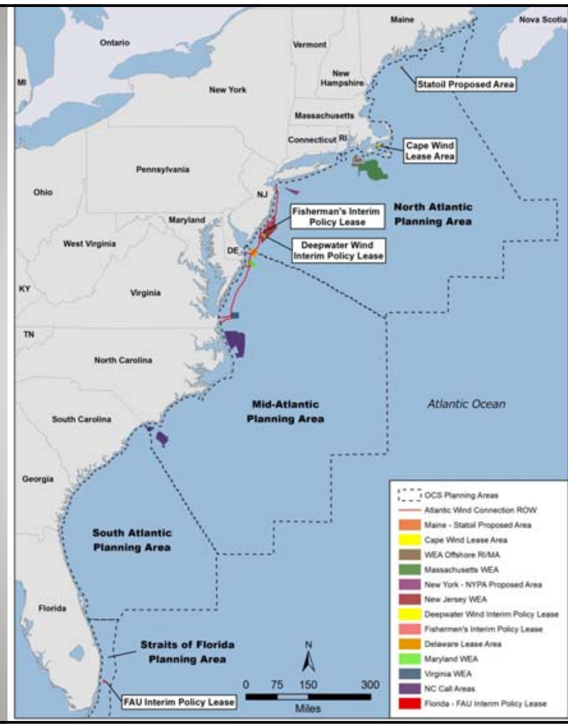
Consultation & Coordination

- Serve as lead Federal Agency for environmental compliance reviews under NEPA (will use cooperating agency agreements)
- Complete all required consultations (e.g., Endangered Species Act, National Historic Preservation Act)
- Document compliance with the Federal consistency provisions of CZMA
- Assure compliance with all other applicable laws
- MOUs with DOE, FWS, NOAA (Working on agreements with DOD, USACE, and USCG)
- Recently updated joint BOEM/FERC guidelines for marine hydrokinetic developers



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Scientific Information

- Regional scale – ecosystem
- Wind Energy Area scale – leasing
- Site specific – construction and operation

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Research and Study Efforts

- Environmental Studies Program
- Technology Assessment and Research Program
- Partnering with Fish and Wildlife Service (FWS), the National Oceanic and Atmospheric Administration (NOAA), Department of Energy (DOE), and States
- Participation in International Energy Agency (IEA) Annex Efforts
- Industry

Guidance Documents

- Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585 *(11-09-2012)*
- Guidelines for Providing Avian Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 (*2-1-2013*)
- Guidelines for Submission of Spatial Data for Atlantic Offshore Renewable Energy Development Site Characterization Surveys (*2-1-2013*)
- Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585 (*2-15-2013*)

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Workshop Outcomes

- Provide information as we implement our guidelines
- Learn what is most useful
- Learn what has not been most useful

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blue wind consulting limited

BOEM Bureau of Ocean Energy Management

Offshore Wind Energy Site Assessment and Screening

The European Experience

Beverley Walker

Offshore Wind Energy Development Site Assessment and Screening
BOEM 2nd Atlantic Workshop
26th – 28th February 2013

www.bluewindconsulting.co.uk

Contents

- Setting the Scene
  - Background to Europe and the EU
  - A Common Regulatory Framework – Relevant Directives
- The Renewables Directive – what it means for Offshore Wind
- Key Challenges for Europe
- The Site Screening and Selection process
- Lessons Learnt
- Next Steps

Setting the Scene

Background to the EU

- Originally known as the EEC (European Economic Community) – set up to establish an equal economic trading ground
- Member states found to have significant inequality in terms of environmental protection = unfair economic advantage
- Strong relationship between pollution and poverty
- >700 Directives since the establishment of the EEC/EU
- +250 Directives related to environment
- What is a Directive?

A directive is a legislative act which requires member states to achieve a particular result without dictating the means of achieving that result. Directives normally leave member states with a certain amount of leeway as to the exact rules to be adopted. Directives can be adopted by means of a variety of legislative procedures.

Key Directives (Offshore Wind) – A Common Framework

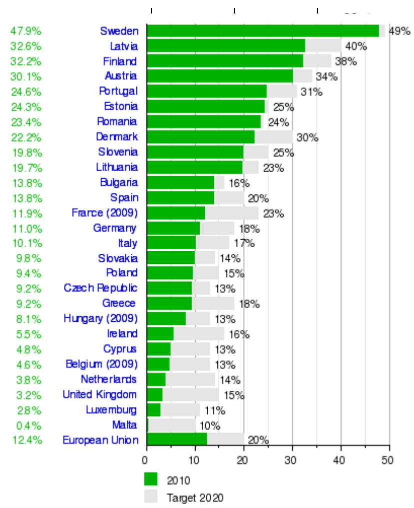
1. The 2009 Renewable Energy Directive
2. Marine Strategy Framework Directive (MSFD)
3. Habitats and Birds Directives (Natura 2000 Network)
4. Aarhus Convention
5. Strategic Environmental Assessment (SEA Directive)
6. Environmental Impact Assessment (EIA Directive)

The Renewable Energy Directive 2009/28/EC on the promotion of the use of energy from renewable sources

- European Energy Policy
  - Legally binding targets for CO2 emission reduction by 2020 (20%).
- Renewable Energy Directive
  - Sets binding targets on member states based on capacity, but such that target renewable energy mix of 15% (total 20% for EU) by 2020, with an individual binding target for the Transport sector of 10%
  - It also improves the legal framework for promoting renewable electricity, requires National Renewable Energy Action Plans (NREAPS) to set the RE mix, the target objectives and why.

Targets are extremely challenging – require unprecedented rate of growth in new sectors

The Renewable Energy Directive



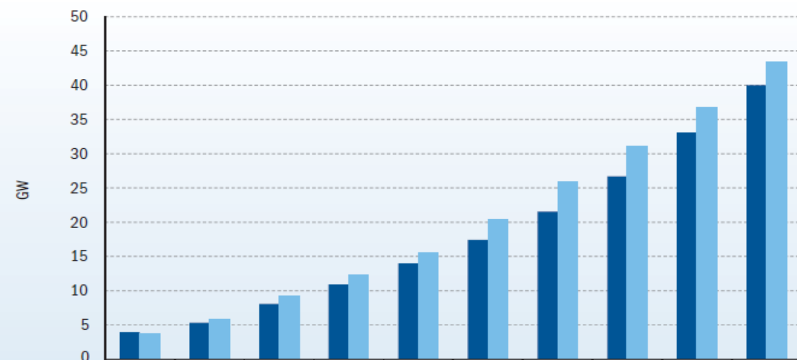
Cumulative Offshore Wind Capacity 1991 – 2010 (pre- Directive)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cumulative non EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102
Cumulative EU	5	5	5	7	12	29	29	32	32	36	86	256	515	605	695	787	1,106	1,479	2,063	2,946

Source: EWEA

Cumulative Offshore Wind Capacity 2011 – 2020 (Post Directive)

FIGURE 1.7 PROJECTED CUMULATIVE OFFSHORE WIND CAPACITY (EWEA AND NATIONAL RENEWABLE ENERGY ACTION PLANS)

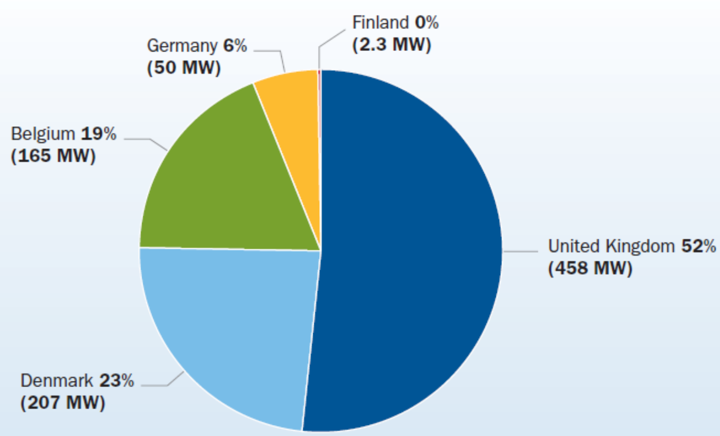


	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EWEA	3.9	5.3	8.1	10.9	14.0	17.4	21.6	26.7	33.1	40.0
NREAPs	3.7	5.8	9.1	12.4	15.6	20.4	25.8	31.1	36.8	43.3

Source: EWEA

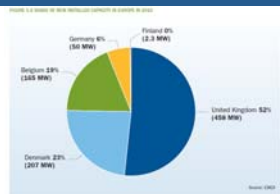
Share of installed capacity in 2010

FIGURE 1.4 SHARE OF NEW INSTALLED CAPACITY IN EUROPE IN 2010

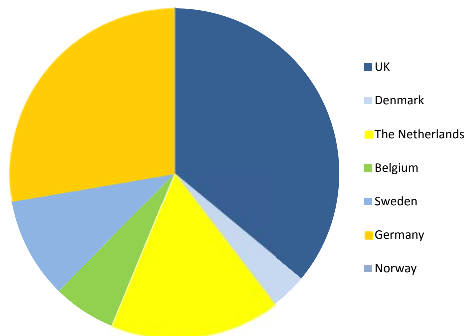


Source: EWEA

- Offshore Wind 2020



Total Offshore Wind Capacity Targets 2020



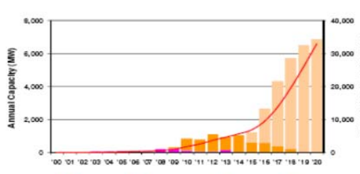
Offshore Wind Energy Site Assessment and Screening

www.bluewindconsulting.co.uk

Offshore Wind Energy UK

UK Ports for the Offshore Wind Industry: Time to Act

Offshore Wind Energy – 33GW by 2020



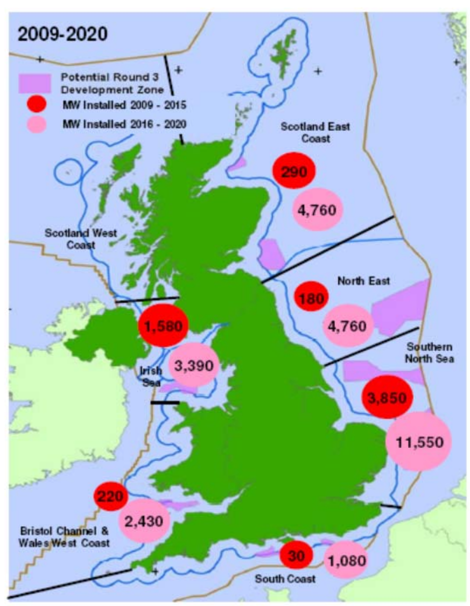
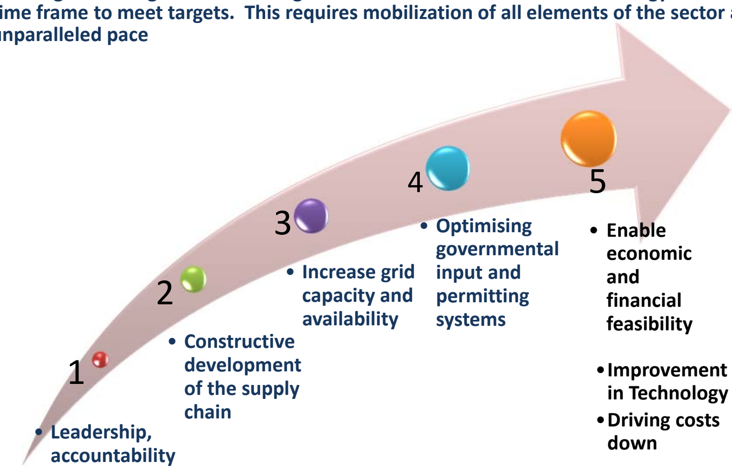


Figure 4.1 – Offshore Wind Capacity (MW) Expected to be Installed off UK (split by coastal region), excluding projects in Scottish and Northern Irish territorial waters.

Meeting the Challenge

Offshore Wind in Europe – The Challenges

The single most significant challenge for the installation of renewable energy in Europe is the time frame to meet targets. This requires mobilization of all elements of the sector at an unparalleled pace



1. Leadership, accountability and resourcing
2. Constructive development of the supply chain
3. Increase grid capacity and availability
4. Optimising governmental input and permitting systems
5. Enable economic and financial feasibility
   - Improvement in Technology
   - Driving costs down

Economics

- The costs of offshore wind power are currently too high compared to other carbon free solutions
- High upfront capital costs and relatively low operational costs. Typical capital expenditure per MW has increased significantly, from EUR 1.5 – 2.0 million per MW (2005) to around EUR 3.0 – 3.5 million per MW (2009)
  - Increased water depth impacting the size and type of support structures and installation
  - Increased distance to shore requiring longer transmission cables
  - Increase distance to shore = vessel time and risk (from survey to construction)
  - Lack of competition and supply chain bottlenecks
  - Increasing raw material costs and currency fluctuations
- A stable, long term, attractive economic support mechanism is required
- Keeping up to date with these economic mechanisms and how they vary from country to country presents a major challenge for developers and investors.

Financing

- Financial crisis has had a very different impact on the two sectors active in developing offshore wind farms – utilities and independent project developers.
- Projects stalled because:
  - The lack of precedent for the offshore wind industry is curtailing the banks' appetite for the sector and they are taking a more conservative approach to lending; and
  - the reluctance of banks to commit to any significant underwriting of loans leads to difficulty in financing the deals necessary for large offshore wind farms
- **These have had a significant impact in the target schedule**

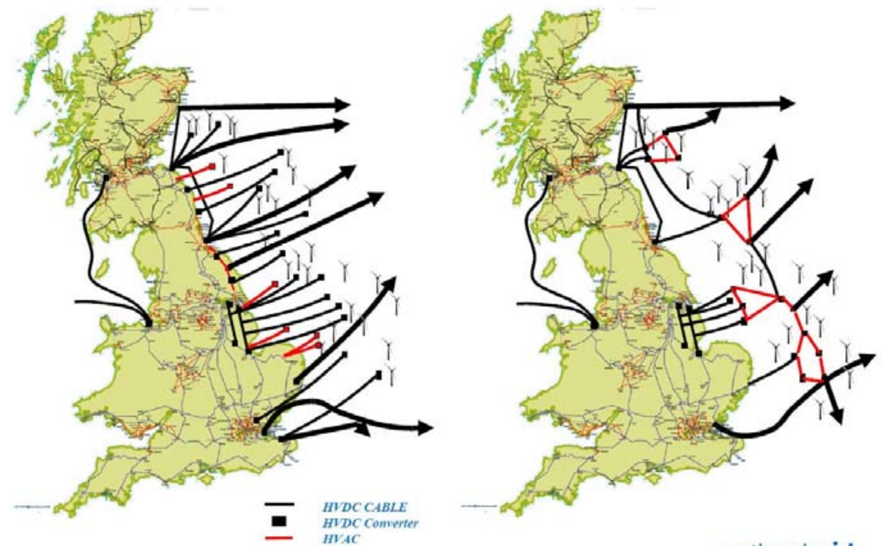
Supply Chain

- Insufficient turbine manufacturing capacity to provide the volume of turbines that will be required for the worldwide offshore wind market
- This requirement is now predicted to equate to an additional 5,500 to 7,000 offshore turbines and all the other supporting elements..
- Limited competition and bottlenecks caused by shortage of component parts for turbines, vessels, cables, yards and harbours,
- Skills shortage predicted with offshore experience, leading to inadequate delivery.
- Skills shortage causing salary level rises. Skills also in competition with O&G
- **Supply chain issues are currently perceived as the most significant factor which would cause delays to future targets.**

Grid Connection

- A point to point connection system will be unwieldy for the scale of growth
- Connecting individual projects to shore could be very expensive and would require individual approval for cable routes, landfall and onshore connection; unnecessarily duplicating the efforts of other developers.
- A more strategic approach to connection and a new transmission regime is required which is flexible enough to allow for an offshore wind hub or offshore network.
- Must be onshore infrastructure in place to support growth offshore
- Transmission capacity must be made available in quantities that avoid delay or abandonment.

Developing efficient offshore grids



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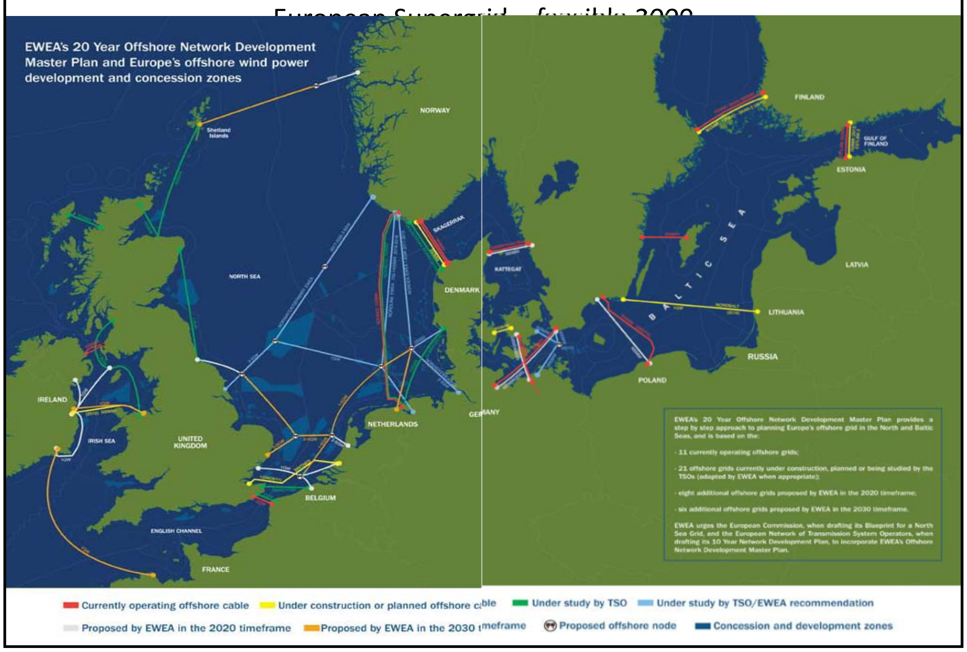
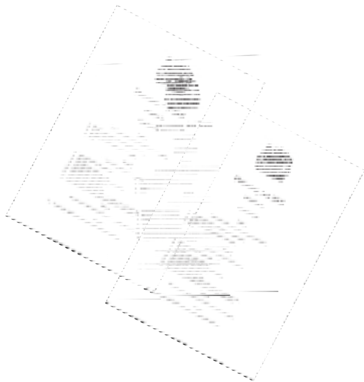
nationalgrid
The power of action:



Optimising governmental input and permitting systems



- Consensus throughout Europe - a need for governmental and regulatory reform
- **'leadership, accountability and resourcing'** being identified as a high priority.
- 'unprecedented strategic leadership and **cross-departmental commitment**' to ensure central consideration for all department and agencies involved in the planning process,
- The requirement to optimise the consenting/permitting system to deliver sustainable, consistent and timely decisions.
- As marine spatial planning is rolled out under the requirements of the European Marine Strategy Framework Directive (MSFD) there is a recognised danger that spatial conflict could lead to entrenched fighting for access to the sea by different interest/user groups

Site Screening and Selection

The Regulatory Toolbox

- **Marine Spatial Planning**
- **Habitats and Birds Directives**
- **SEA**
- **EIA**

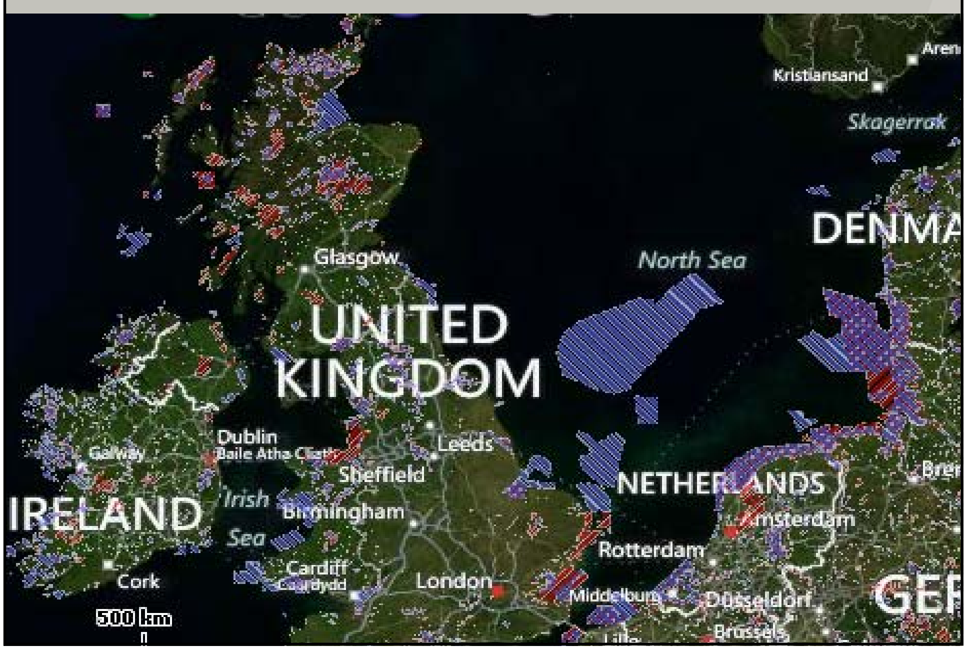
A Common Framework

- These Directives are important because they define the objectives and common principles for environmental protection for all EU member states when developing offshore wind
- The regulatory approach and consent mechanisms may be different **– how does each country balance uncertainty vs target dates**

Aarhus Convention

- The UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, usually known as the Aarhus Convention, 1998.
- Aims are to ..'further the accountability of and the transparency in decision-making and to strengthen public support for decisions on the environment."
- Links environmental protection with Human Rights
- Is intended to ensure that environmental regulation occurs at the level of the citizen (ie environmental democracy)
- Three pillars
  - Right of access to environmental information
  - Right to public participation in decision making (SEA/EIA-PPD)
  - Access to environmental justice (3rd party right of appeal)

Habitats & Birds Directives – Nature 2000 Marine Network



SEA Directive 2001/42/EC – "The assessment of the effects of certain plans and programs on the environment"

- ❑ Strategic Environmental Assessment (SEA) is a system/process of incorporating environmental considerations into policies, plans and programmes.
- ❑ Triggered when a policy, plan or programme will lead to a requirement for EIA
- ❑ Will be strongly linked to Marine Spatial Planning

Objectives of SEA

- ❑ To ensure environmental issues are considered within decision making
- ❑ To allows the setting of transparent objectives
- ❑ **To allow for adequate assessment of alternatives;**
- ❑ **To ensure that all related policies and plans are not conflicting;**
- ❑ **To enable a systematic impact assessment process;**
- ❑ **To enable predictions to be refined and improved by a monitoring programme.**
- ❑ To ensure sustainability objectives are integrated into decision making.
- ❑ **It is also a fundamental vehicle for the delivery of the 2nd pillar of the Aarhus Convention (early public participation)**

EIA

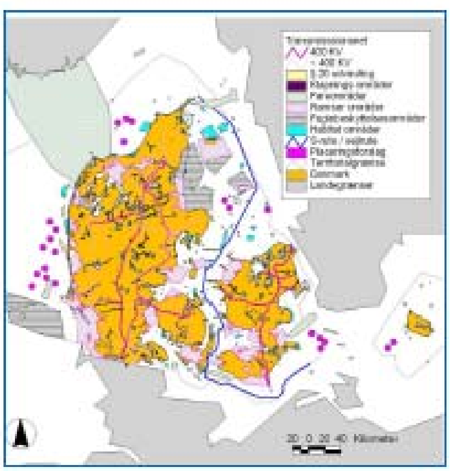
Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment

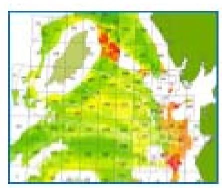
- ❑ Seen as one of the most potent tools for establishing equality between member states with regard to environmental regulation;
- ❑ Reviewed every 5 years in terms of application and effectiveness
- ❑ Continuously evolving in terms of scope, technical quality, but also purpose and objectives
- ❑ EIA amended 3 times to date, including the integration of the Public Participation Directive (PPD)
- ❑ EIA and SEA is regarded as one of the tools to integrate the Aarhus Convention and to develop the human right – 'right to a clean environment'
- ❑ **Direct Effect**

Direct Effect

- EIA is one of the few Directives with Direct Effect
- Direct Effect is a principle of European Community Law according to which certain pieces of European legislation are enforceable by citizens of the Member States and the results of case law are directly applicable to all.
- Hence complaints can be made directly to the European Court of Justice
- Complaint by Issue Implications for the offshore sector
- X
- X
- X
- x

Site Screening and Selection





PLANNING THE GERMAN EEZ
North Sea Section

Site Screening and Selection

- Combination of developer methodology, SEA and marine spatial planning

Site selected by...	Example projects
Government	Horns Rev (DK), Nysted (DK), OWEZ (NL)
Developers	Alpha Ventus (DE), Butendiek (DE), Lillgrund (SE), Scroby Sands (UK), Prinses Amaliawindpark (NL)
Developers - within zones selected by government	C-Power (BE), Greater Gabbard (UK), Sheringham Shoal (UK), Belwind I (BE)

- Early search areas which only focused on physical /buildability constraints have stalled or failed due to environmental and socio-economic factors becoming apparent later.
- Early **heat mapping protocols** have helped to identify environmental and physical constraints for site screening and selection
- Sectoral SEA's helped integrate environmental and socio-economic aspects with effective public consultation, however must now be placed in context with marine spatial planning and other users of the sea
- Ideally once set up and top down, reduces repetitive consultation and consultation fatigue
  - Eg: 8 year consent strategy identified 28 consultation exercises within 2 years needed before submission of scoping

Marine Spatial Planning –

A DEFINITION OF MARINE SPATIAL PLANNING

"An integrated, policy-based approach to the regulation, management and protection of the marine environment, including the allocation of space, that addresses the multiple, cumulative and potentially conflicting uses of the sea and thereby facilitates sustainable development."

(MSPP Consortium 2006, p1)

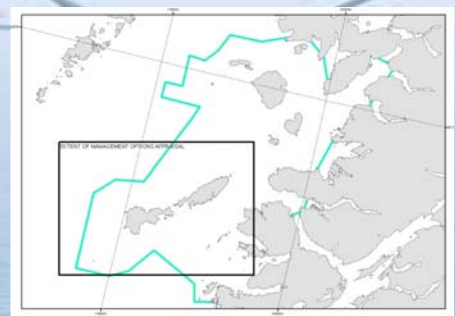
Activity in the Belgian North Sea	% Claim for Space
Fishing	99
Shipping	97
Military use	26
Sand and gravel extraction	15
Dredging and dumping	1.2
Wind parks	0.6
Cables and pipelines	18
Coastal defence	0.1
Nature conservation	4
Coastal recreation	1.9
TOTAL	**264%**

(Maes et al 2005)

Marine Spatial Planning

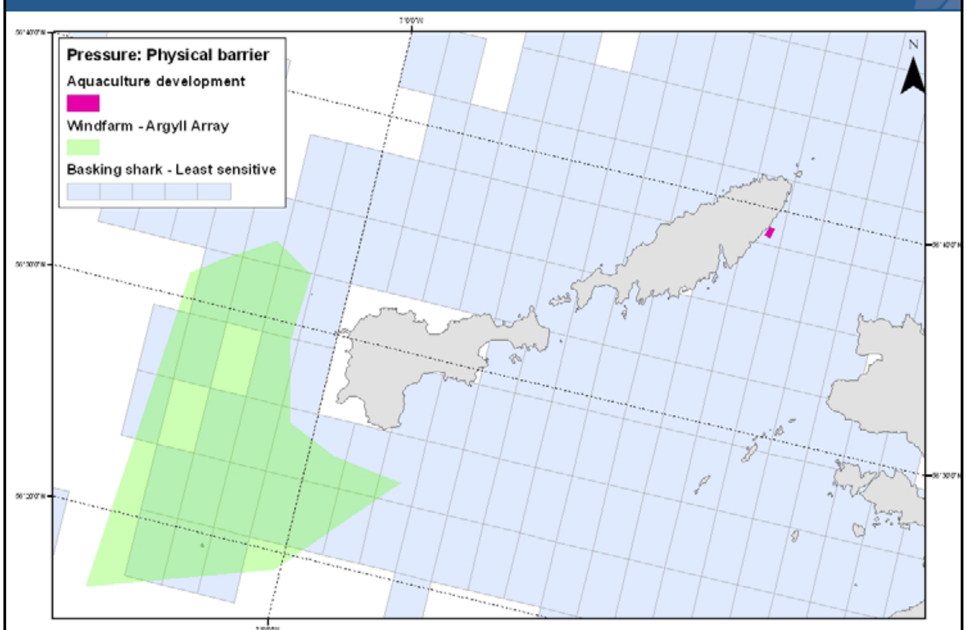
- National Marine Plan to include marine ecosystems objectives along with economic and social objectives
- Marine Protected Areas (MPAs) (MPZ's in the UK)
- Will form part of a network of sites in the marine environment that will also include marine elements of the Natura network, Ramsar sites, and Sites of Specific Scientific Interest.
- Will not be exclusion and/or 'no take' zones
- Regional areas currently being consulted on – targeting areas of potential sensitivity and user conflict

The area covered by basking shark case study (insert box) and the Skye to Mull search location boundary (blue line) as presented at the 4th MPA workshop

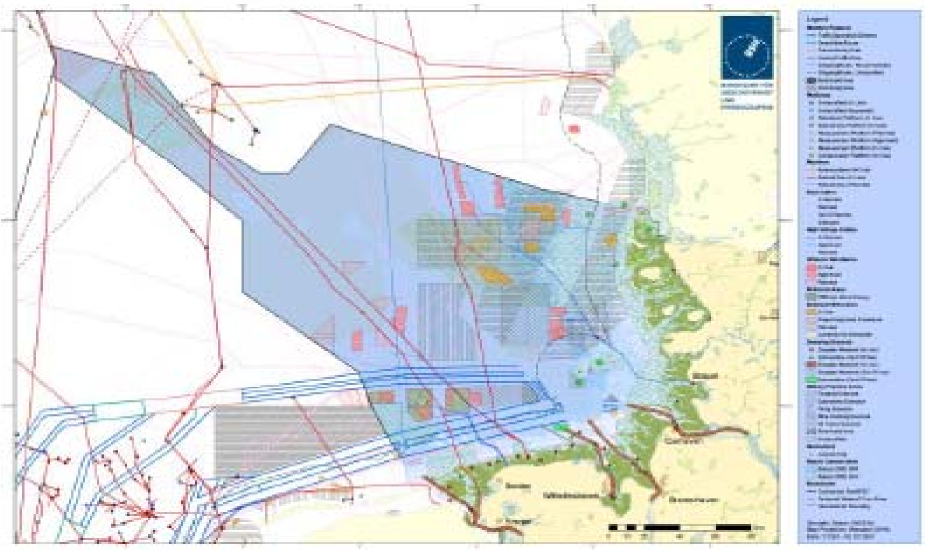


1. Physical barriers e.g. barriers to species movement
2. Collision damage e.g. death or injury from boat collisions
3. Physical loss/damage e.g. removal of non-target species from entanglement/bycatch

Marine Spatial Planning – Site area of concern

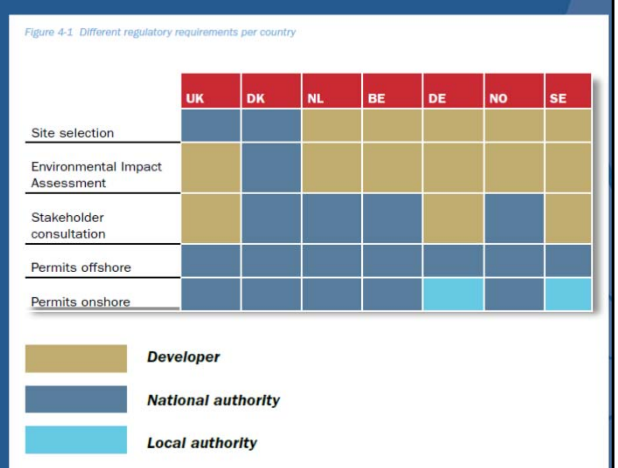


Marine Spatial Planning – Cumulative Use



EIA and Consenting

- Different from State to State
- Case Law affecting way regulators operate
- Precautionary vs Proportional



Issues with EIA – Managing Uncertainty

The Rochdale Principle (UK Case Law)

- Supports projects where the **final design is not available** at the consent application stage.
- Allows the developer to put forward the **range of options** being considered - environmental impact assessment is made on the 'worse case' for each environmental receptor.
- Enables the legal requirements of the relevant EIA regulations to be complied with, **provided appropriate conditions** are placed in the resulting consents to ensure that the 'worst case' likely impacts **will not be exceeded**.

Issues with EIA – Managing Uncertainty

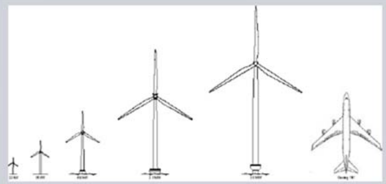
Types of Technology Changes

- Turbine size and power
- Arrays
- Foundation Design
- Offshore Substations
- Cable Arrays
- Deployment and Installation Methods
- Secondary Impacts – eg transortation networks, location of supply ports etc

Issues with EIA – Managing Uncertainty

Turbine Technology

- ❑ structural components
  - maximum hub height
  - maximum rotor diameter
- ❑ operational parameters
  - rotor speed
  - noise emission



Sensitive Environmental Parameters

DIRECT
- Ornithology
- Navigation, Aviation and Radar
- Seascape / Visual Impacts

INDIRECT
- Array size / footprint
- Installation and Deployment Methods
- Programme

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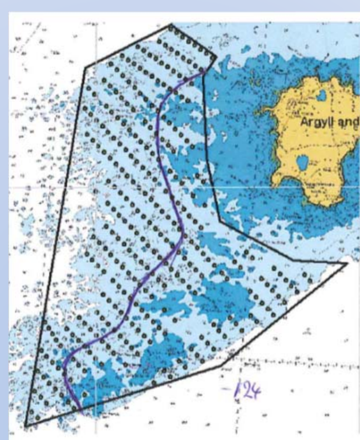
The Role of Impact Assessment

Issues with EIA – Managing Uncertainty

Technology Changes = Change in Array Layout

- ❑ Density
  - Collision risks
  - Barrier effects
- ❑ Number (footprint)
- ❑ Project Area



Sensitive Environmental Parameters

DIRECT
- Ornithology
- Physical Processes
- Benthic Ecology
- LVIA

INDIRECT
- Water Quality and Ecological effects
- Navigation / H&S Risk
- Marine mammals
- Hearing Sensitive Fish Species
- Programme

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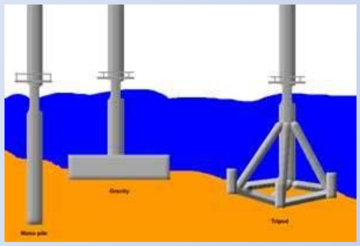
Issues with EIA – Managing Uncertainty

Technology Changes – Foundation Design



- ❑ Monopile
- ❑ Gravity Base
- ❑ Tripod

Sensitive Environmental Parameters

DIRECT
- Benthic Ecology
- Sediment Disturbance
- Construction Methods – Subsea Acoustic Noise

INDIRECT
- Water Quality and ecological effects
- Marine mammals
- Hearing Sensitive Fish Species
- Programme

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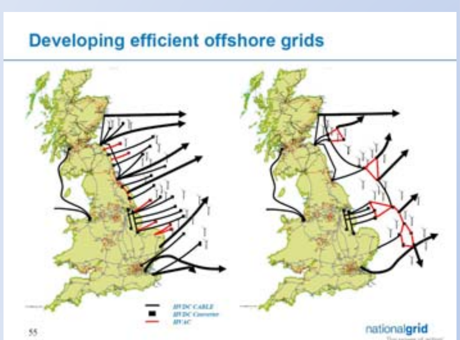
Issues with EIA – Managing Uncertainty

Technology Changes – Substation Electricals & Cable Array



- ❑ Substation Electricals
  - Size
  - Number
  - Power Up = fewer
- ❑ Cable Array Design
  - Serial
  - Hub

Sensitive Environmental Parameters

DIRECT
- Benthic Ecology
- Sea-time 'Disturbance'
- EMR – Skates, Rays and Sharks
- Commercial Fishing

INDIRECT
- Shipping & Navigation risk
- Health & Safety Risk
- Operations and maintenance
- Programme

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Issues with EIA – Managing Uncertainty

Technology Changes – Impacts on Deployment & Installation Methods

- ❑ Larger turbines
  - Tonnage – bespoke cranes and equipment
  - Port hardstand reinforcement
  - Installation method – eg onshore vs offshore assembly
- ❑ Number (sea time)
- ❑ Project Area

Sensitive Environmental Parameters

DIRECT
- Ornithology
- Physical Processes
- Benthic Ecology
- LVIA

INDIRECT
- Water Quality and Ecological effects
- Navigation / H&S Risk
- Marine mammals
- Hearing Sensitive Fish Species
- Programme

Photo: © Yobidaba | Dreamstime

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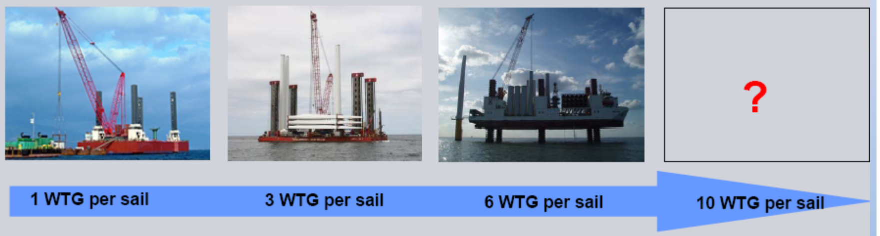
Issues with EIA – Managing Uncertainty

Technology Changes – Impacts on Deployment & Installation Methods

- Installation Technology and Vessel Evolution



- Pre-Installation harbour
- Transport to wind farm site
  - Transportation time has a cost impact

Slide 15 Energy Sector © Siemens AG 2008

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Issues with EIA – Managing Uncertainty

Technology Changes – Impacts on Deployment & Installation Methods

- Staff Transfer Issues
- Potential transboundary assessment required
- Secondary impact – socio-economic effects

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Issues with EIA – Managing Uncertainty

Nine outline principles for CIA in OWFs

1. Proportionality
2. Reasonable Foreseeability
3. Broad Participation
4. Early, pragmatic scoping
5. Historic and future baselines
6. Embrace uncertainty and precaution
7. Emphasise development of sustainability themes
8. Building knowledgeable institutions
9. Survey data as a common resource

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Issues with EIA – Managing Uncertainty

Cumulative Impact Assessment

Renewable UK and Offshore Developer Working Groups currently working together to develop nine outline principles for CIA in OWFs

1. Proportionality
2. Reasonable Foreseeability
3. Broad Participation
4. Early, pragmatic scoping
5. Historic and future baselines
6. Embrace uncertainty and precaution
7. Emphasise development of sustainability themes
8. Building knowledgeable institutions
9. Survey data as a common resource

Summary – Current Key Issues for Europe

- Managing the Uncertainty
  - Wide range of Technology (turbines and foundations)
  - Secondary and Indirect Impacts (eg port of entry/transport/construction methods)
  - Programme
  - Type of Mitigation
  - Inconsistency of approach/method
  - Complex = difficult for consultation?
  - No sensitivity weighting
- Cumulative Impact Assessment
  - Cumulative worse case or realistic case?
- Habitats Regulation Assessment (HRA) – are we in or out of Natura sites
- Need for Adaptive Monitoring

Offshore Wind Energy Site Assessment and Screening

www.bluewindconsulting.co.uk

Questions?

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BOEM 2nd Atlantic Workshop
Offshore Wind Energy Site Assessment and Screening
Washington DC 25-28th February 2013

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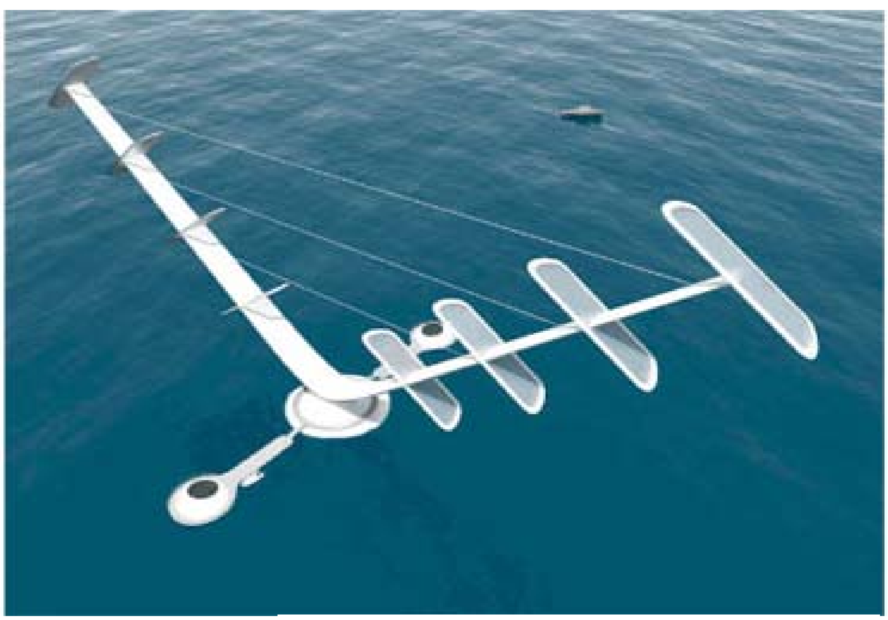
Futuristic Wind-turbine Farms (Image Via: cnngo.com)



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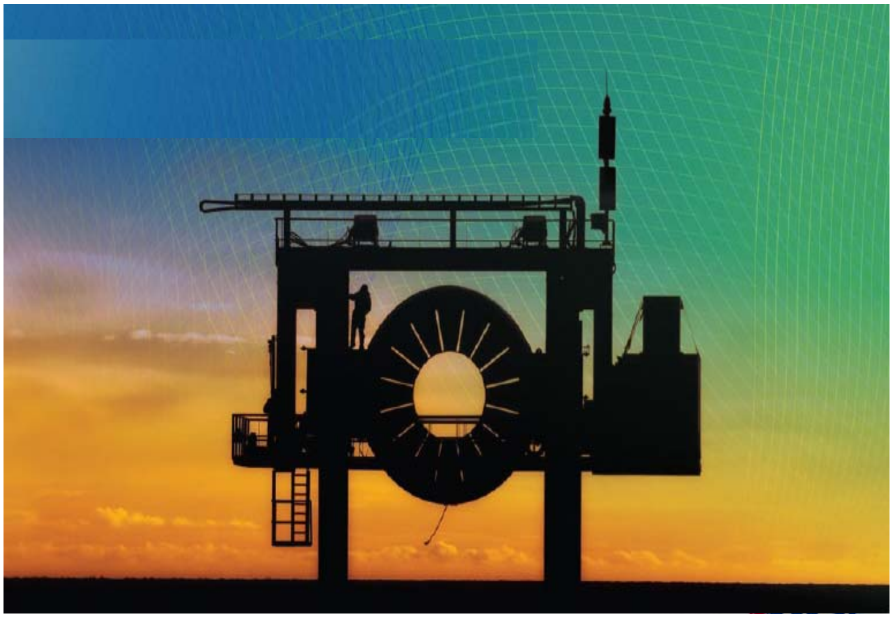
Offshore Aerogenerator NOVA (Novel Offshore Vertical Axis) - Objective 1 GW of power by 2020. Photograph: Grimshaw architects



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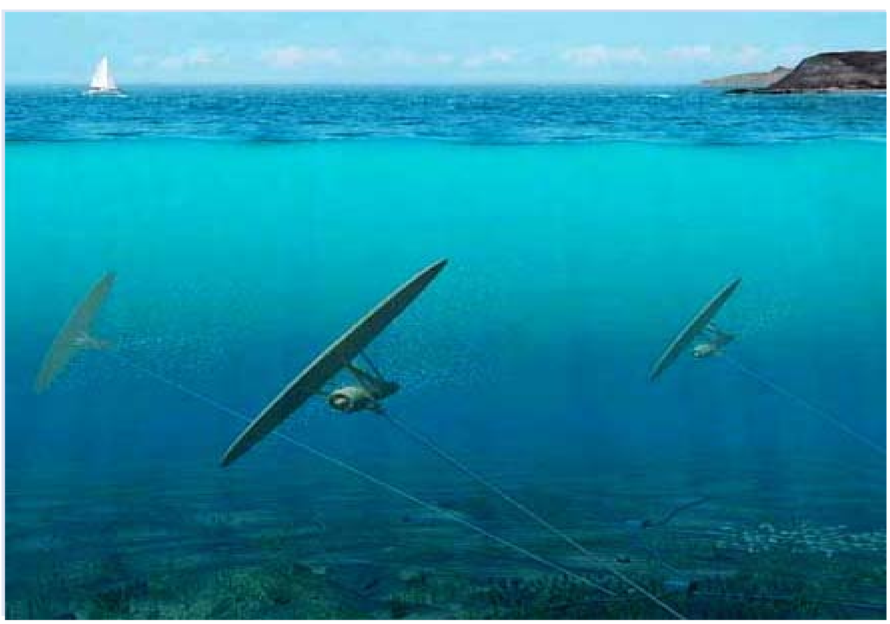
Open Hyro – Emec test facilities in Scotland



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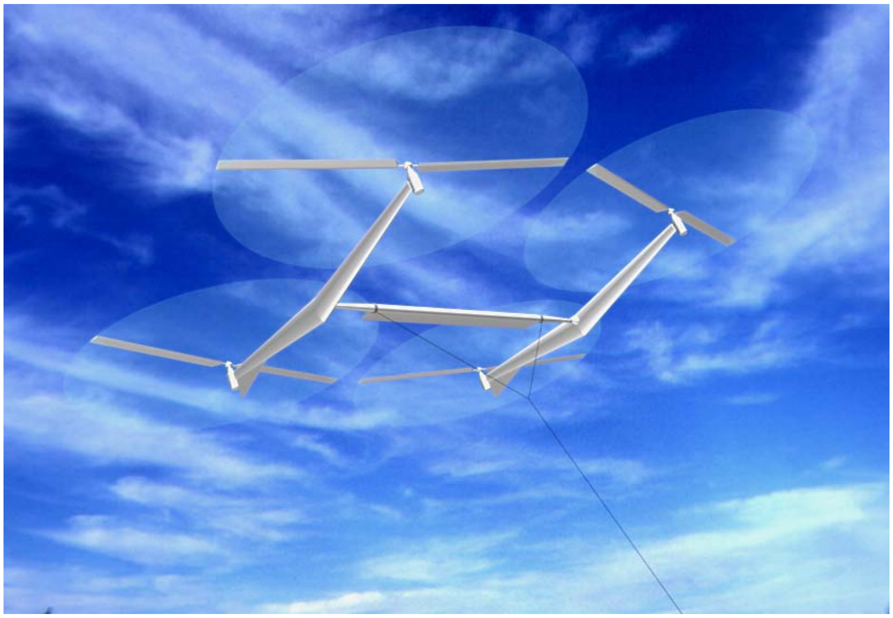
Sub-sea Kite Turbines



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Futuristic Wind-turbines)

The Cumulative Use Evaluation Model (CUEM) Framework

BOEM Contract M10PC00097

Dr. Deborah French McCay and Danielle Reich
RPS ASA, South Kingstown, RI USA
DFrenchMcCay@asascience.com

Presentation Outline

- Introduction to the Cumulative Use Evaluation Model (CUEM)
- Cumulative Impact Model – Ecological (CIM-Eco) Framework Overview
- Cumulative Impact Model – Human Use (CIM-HU) Framework Overview
- Limitations and Challenges
- Moving Forward

Introduction to the Cumulative Use Evaluation Model (CUEM)

- Developed for the National Oceanographic Partnership Program under funding from BOEM
  - Project Name: Developing Environmental Protocols and Modeling Tools to Support Ocean Renewable Energy and Stewardship
  - with University of RI
- Expands on the ecological value model developed by RPS ASA for the Rhode Island Ocean Special Area Management Plan (RI Ocean SAMP)
- Objectives:
  - Develop a new conceptual framework and approach for a **cumulative environmental impact evaluation** of offshore renewable energy development, considering both ecological values and human uses

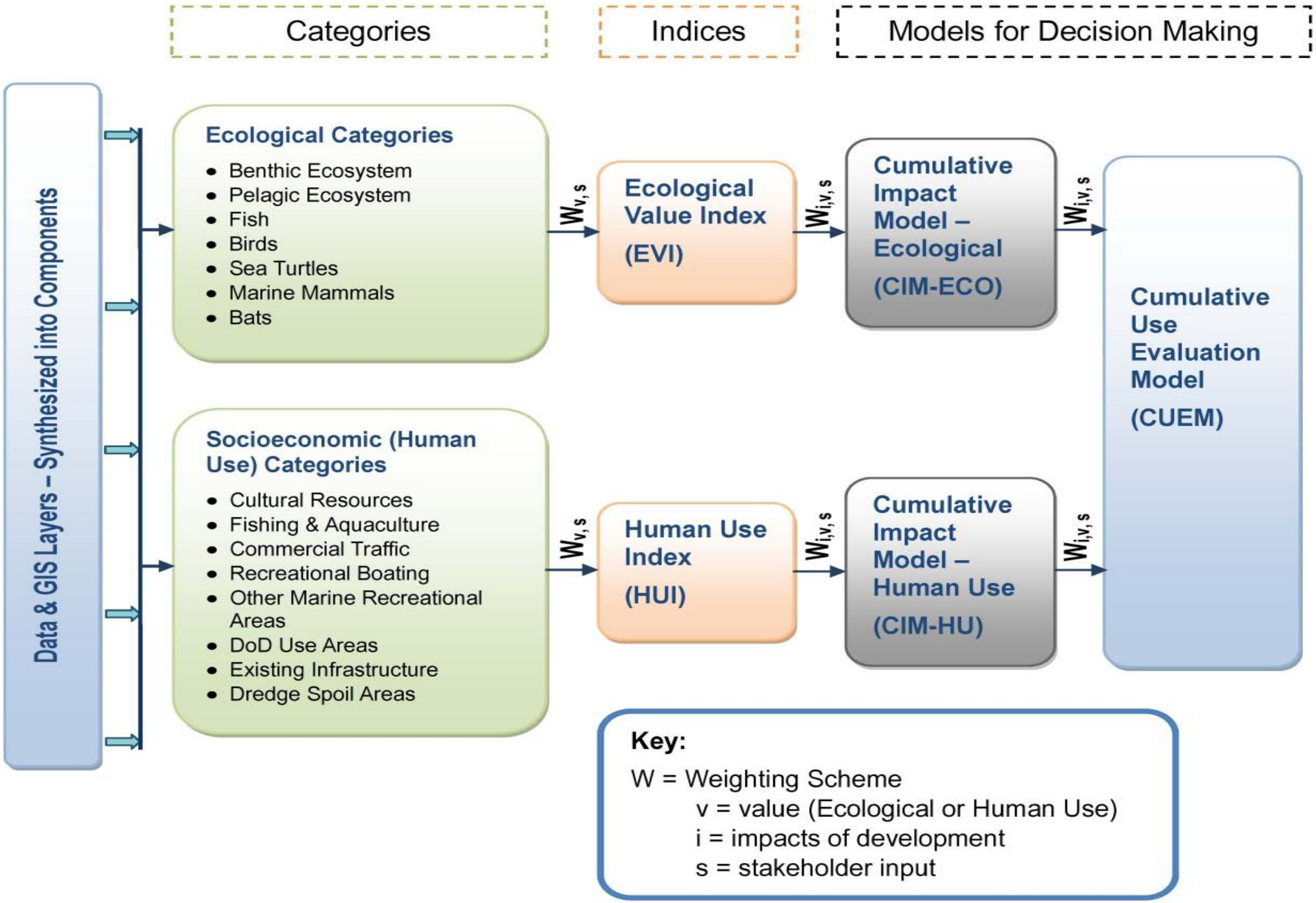
Cumulative Use Evaluation Model (CUEM): Basic Structure

- Consists of two indices based on ecological and human use values, scaled by relative potential impact of development:
  - Cumulative Impact Model – Ecological (CIM-Eco)
  - Cumulative Impact Model – Human Use (CIM-HU)

- Intended uses of the CUEM:
  - Identification of areas most suitable for facility siting (from an ecological and human use value perspective)
  - Evaluation of the relative impacts of an offshore development considering ecological and human use values
  - Evaluate cumulative impacts of multiple and competing uses
  - Help inform and make transparent the analysis of alternatives pursuant to NEPA

RPS asa

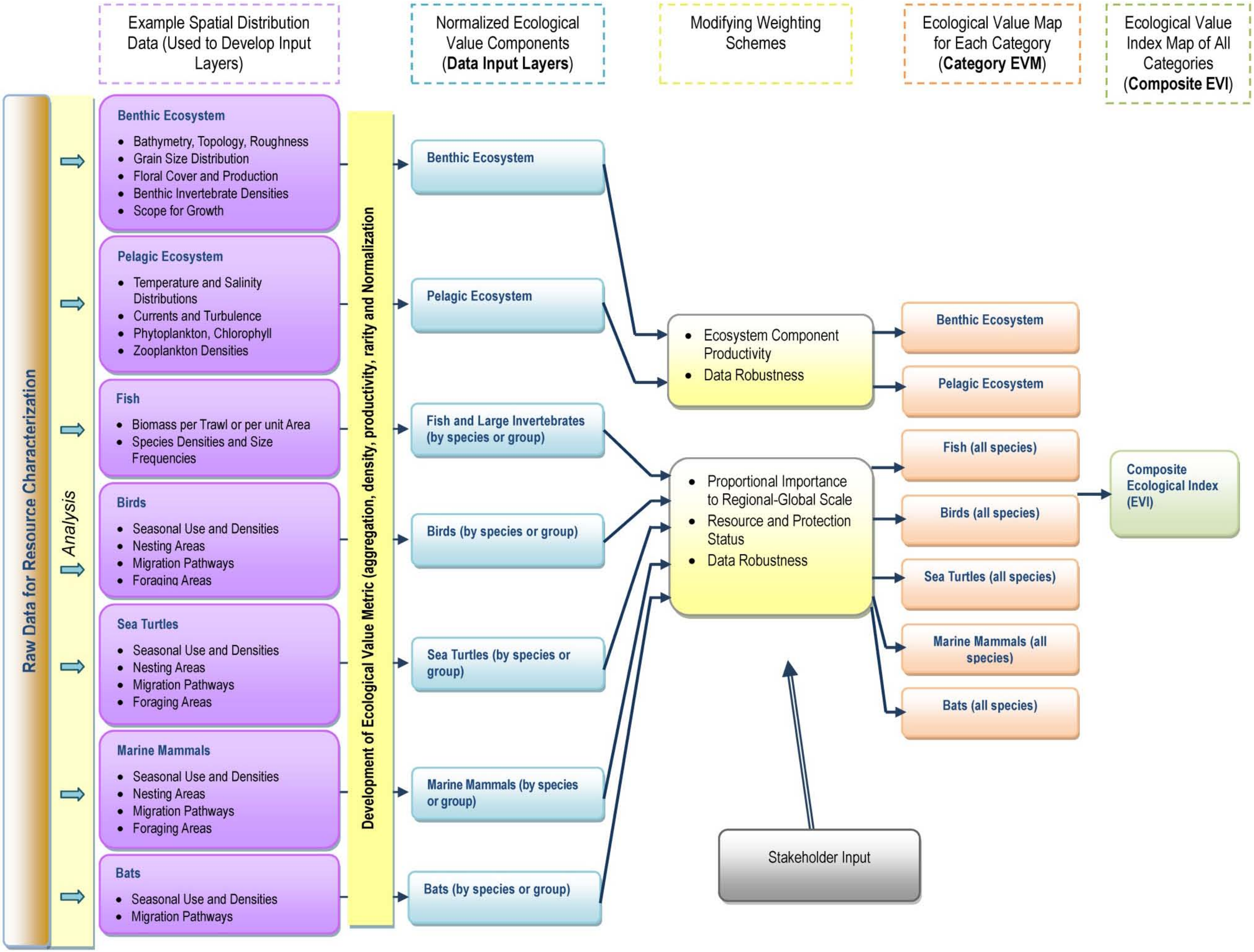
Cumulative Use Evaluation Model (CUEM)



CIM-Eco Framework: Overview

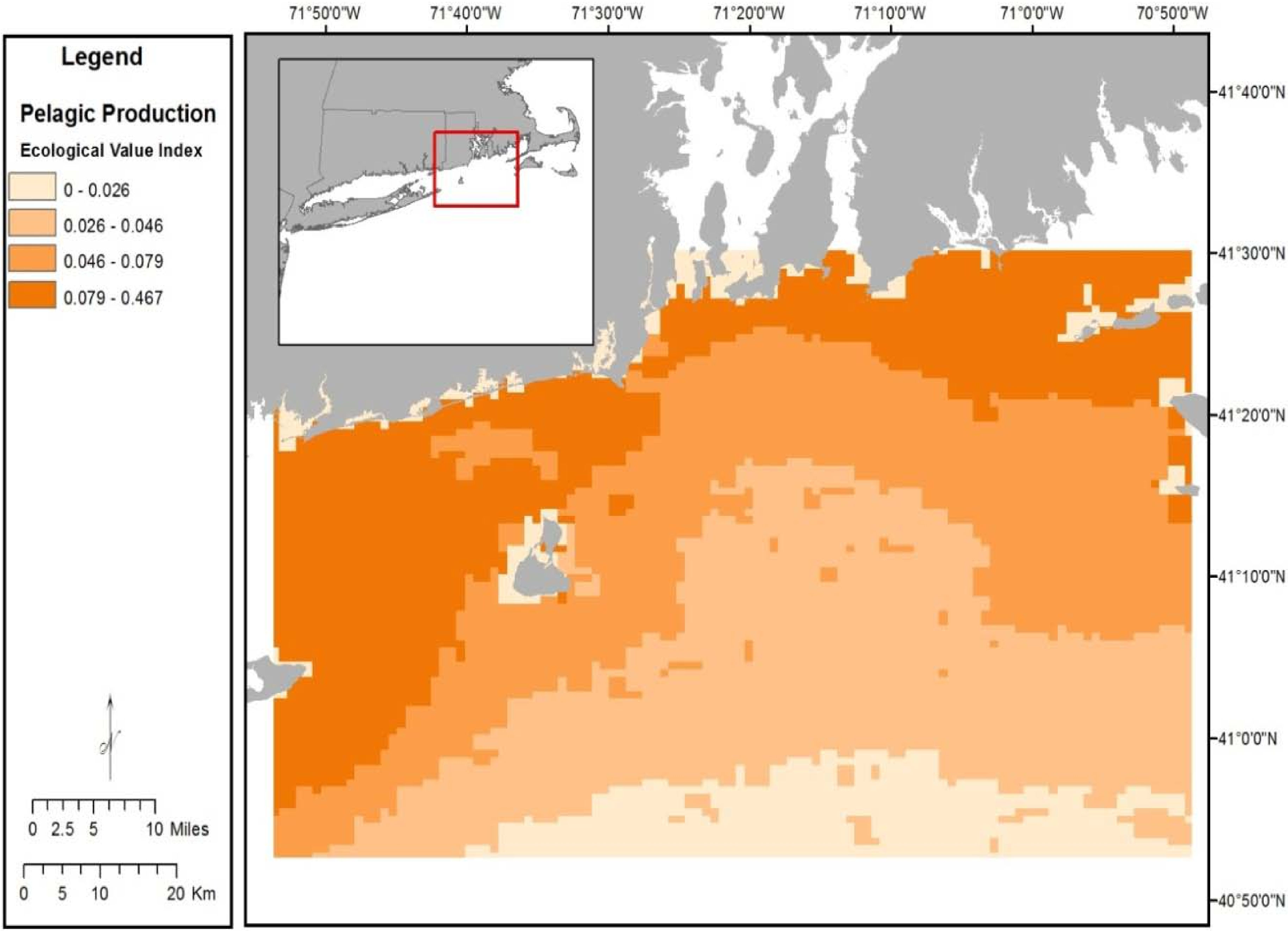
- Integrates various ecological data categories (e.g., birds, fish, benthic ecosystem) into Ecological Value Models (EVMs)
- Applies weighting factors to composite all the EVMs into an Ecological Value Index (EVI); and
- Develop and apply weighting factors to modify the ecological category weights in the EVI based on the potential impacts of development, resulting in a Cumulative Impact Model (CIM-Eco)

Ecological Value Index (EVI) Mapping



CIM-Eco Framework: Data Inputs

- Includes the following categories:
  - Benthic Ecosystem
  - Pelagic Ecosystem
  - Birds
  - Marine Mammals
  - Sea Turtles
  - Fish and Invertebrates
  - Bats
- Data for each category are continuous topologies based on measures of aggregation
  - Density, contribution to fitness, productivity, rarity, or uniqueness of attributes
  - Normalized, so on a relative scale; an index
- Example: Pelagic production offshore Rhode Island


Legend
Pelagic Production
Ecological Value Index
0 - 0.026
0.026 - 0.046
0.046 - 0.079
0.079 - 0.467
0 2.5 5 10 Miles
0 5 10 20 Km
71°50'0"W
71°40'0"W
71°30'0"W
71°20'0"W
71°10'0"W
71°0'0"W
70°50'0"W
41°40'0"N
41°30'0"N
41°20'0"N
41°10'0"N
41°0'0"N
40°50'0"N

CIM-Eco Framework: Weighting Schemes

- Each weighting scheme is on 1 to 10 scale (1= no additional weight, 10 = highest additional weight)
- Fish and Wildlife Layers:
  - Proportional importance to regional/global scale
  - Resource and protection status
  - Data robustness
- Benthic and Pelagic Ecosystem Layers:
  - Ecosystem component productivity
  - Data robustness
- All Category Layers:
  - Relative potential impact of development

Weighting Schemes: Proportional Importance to Regional/global Scale

- 10 – Distribution endemic to study area
- 8 – Distribution endemic to the study area's Ecoregion
- 6 – Distribution covers only a subset of the study area's Province
- 4 – Distribution covers only a subset of the study area's Realm
- 2 – Distribution throughout the study area's Realm
- 1 – Global distribution

CMECS definitions:

- Realm – a very large region across which biota are coherent at higher taxonomic levels.
- Province – large areas where distinct biota have some cohesion over evolutionary time due to distinctive abiotic features.
- Ecoregion – areas of relatively homogenous species composition, clearly distinct from adjacent systems.

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Weighting Schemes: Resource and Protection Status

- 10 – Listed as endangered at the federal level
- 9 – Listed as endangered at the state level
- 8 – Listed as threatened at the federal level
- 7 – Listed as threatened at the state level
- 6 – Listed as a species of concern at the federal level, a candidate species for listing, or afforded special protection under regulations other than the Endangered Species Act (e.g., MMPA, MBTA)
- 5 – Listed as a species of concern at the state level or a candidate species for listing
- 4 - Not listed, but at low population size relative to historical levels
- 3 - Not listed, but decreased or decreasing population size
- 2 - Not listed, at approximately historical population size
- 1 - Not listed, highly abundant compared to historical levels

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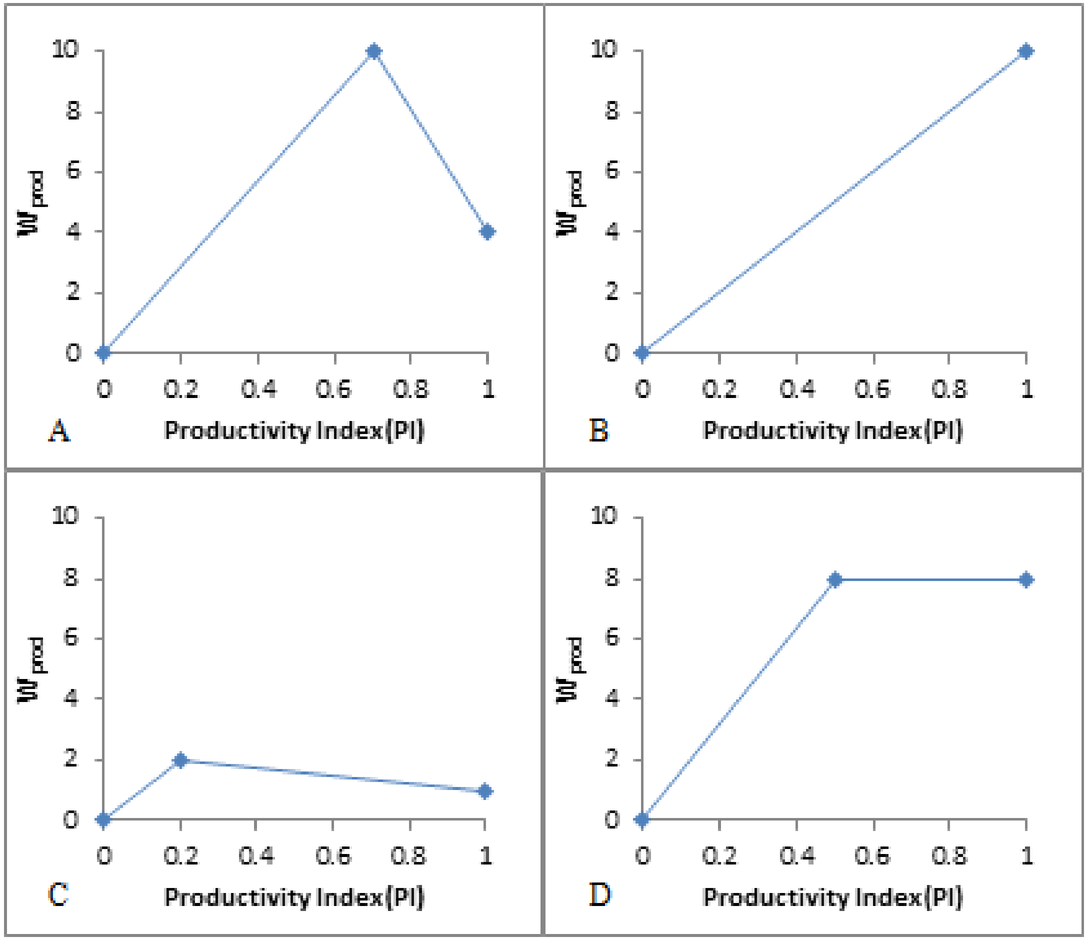
Weighting Schemes: Ecosystem Component Productivity



Weighting Schemes: Data Robustness

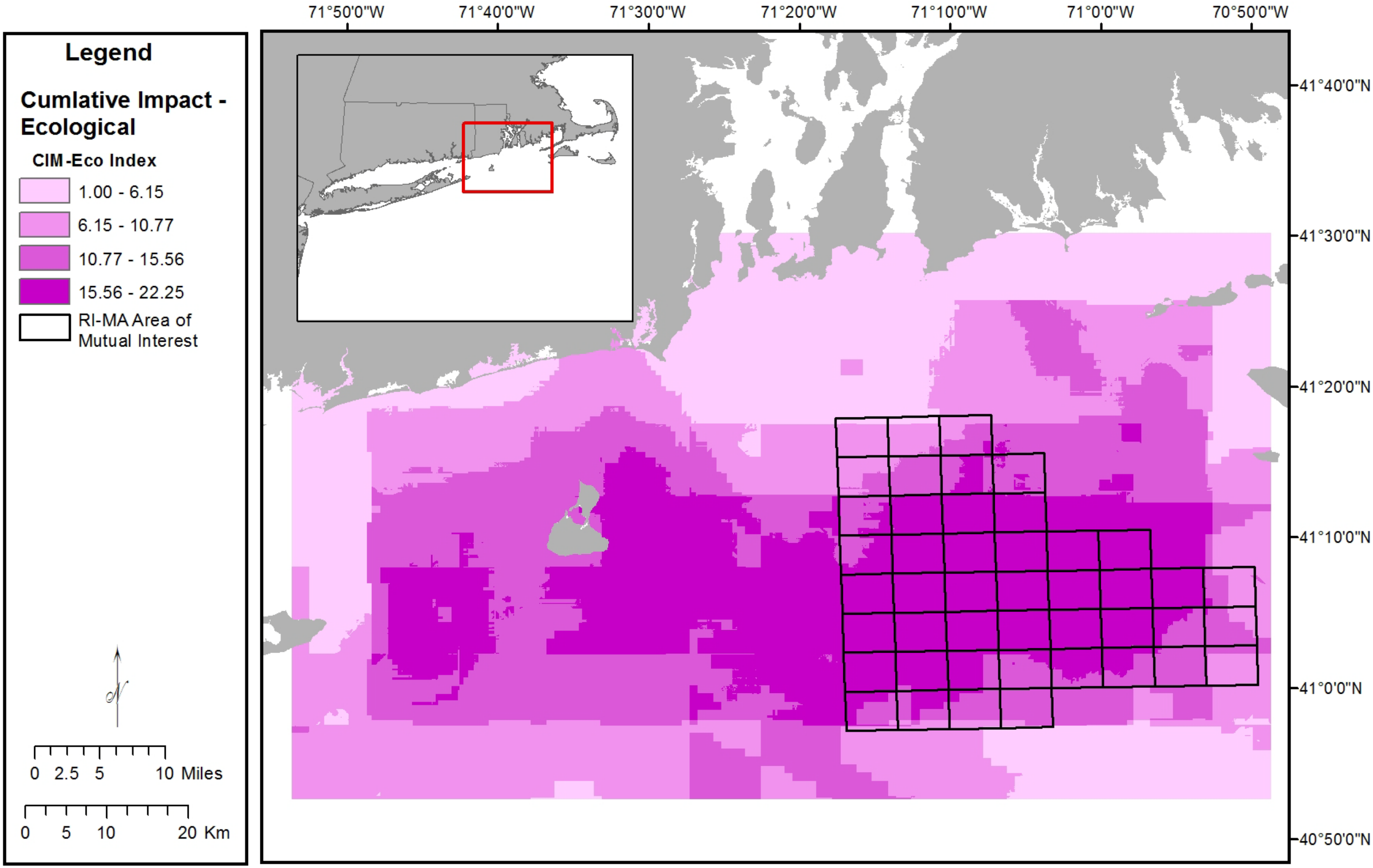
- Define values based on relative relationship between data sources used
- Factors to consider in applying weighting:
  - What is the sampling resolution (spatially and temporally)?
  - How many years of data are included?
  - How frequently were the data collected?
  - What methods were used to create a continuous surface?

Weighting Schemes: Relative Potential Impact of Development

- 10 – Major adverse impact
- 8 – Moderate-major adverse impact
- 6 – Moderate adverse impact
- 4 – Minor-moderate adverse impact
- 2 – Minor adverse impact
- 1 – No adverse impact

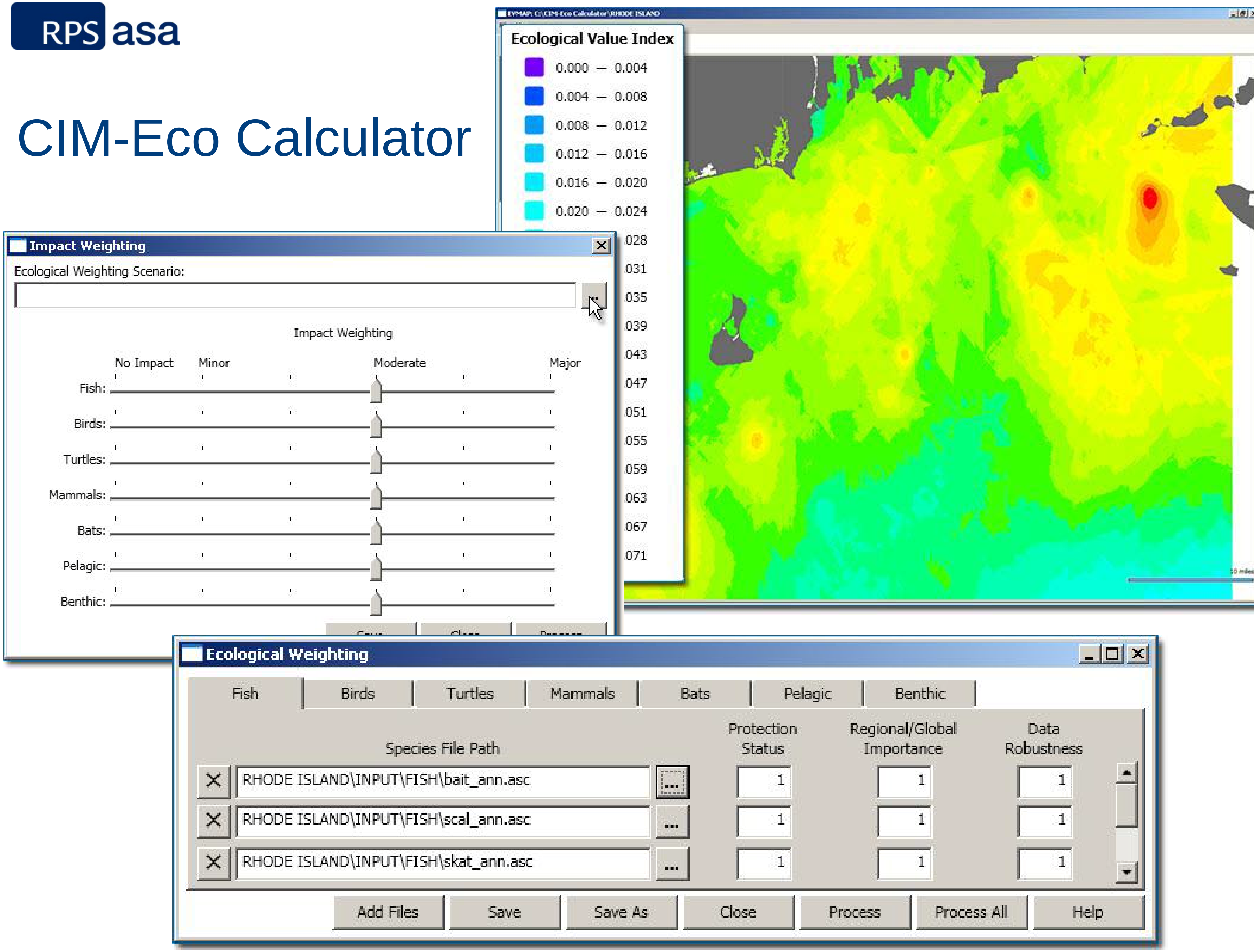
Other NOPP deliverables are intended to be used as a guide in applying this weighting:

- Task 1.2 Offshore Renewable Energy Effect Matrix
- Task 1.5 Effects Decision Tree


Legend
Cumlative Impact - Ecological
CIM-Eco Index
1.00 - 6.15
6.15 - 10.77
10.77 - 15.56
15.56 - 22.25
RI-MA Area of Mutual Interest
0 2.5 5 10 Miles
0 5 10 20 Km
71°50'0"W
71°40'0"W
71°30'0"W
71°20'0"W
71°10'0"W
71°0'0"W
70°50'0"W
41°40'0"N
41°30'0"N
41°20'0"N
41°10'0"N
41°0'0"N
40°50'0"N

RPS asa

CIM-Eco Calculator



RPS asa

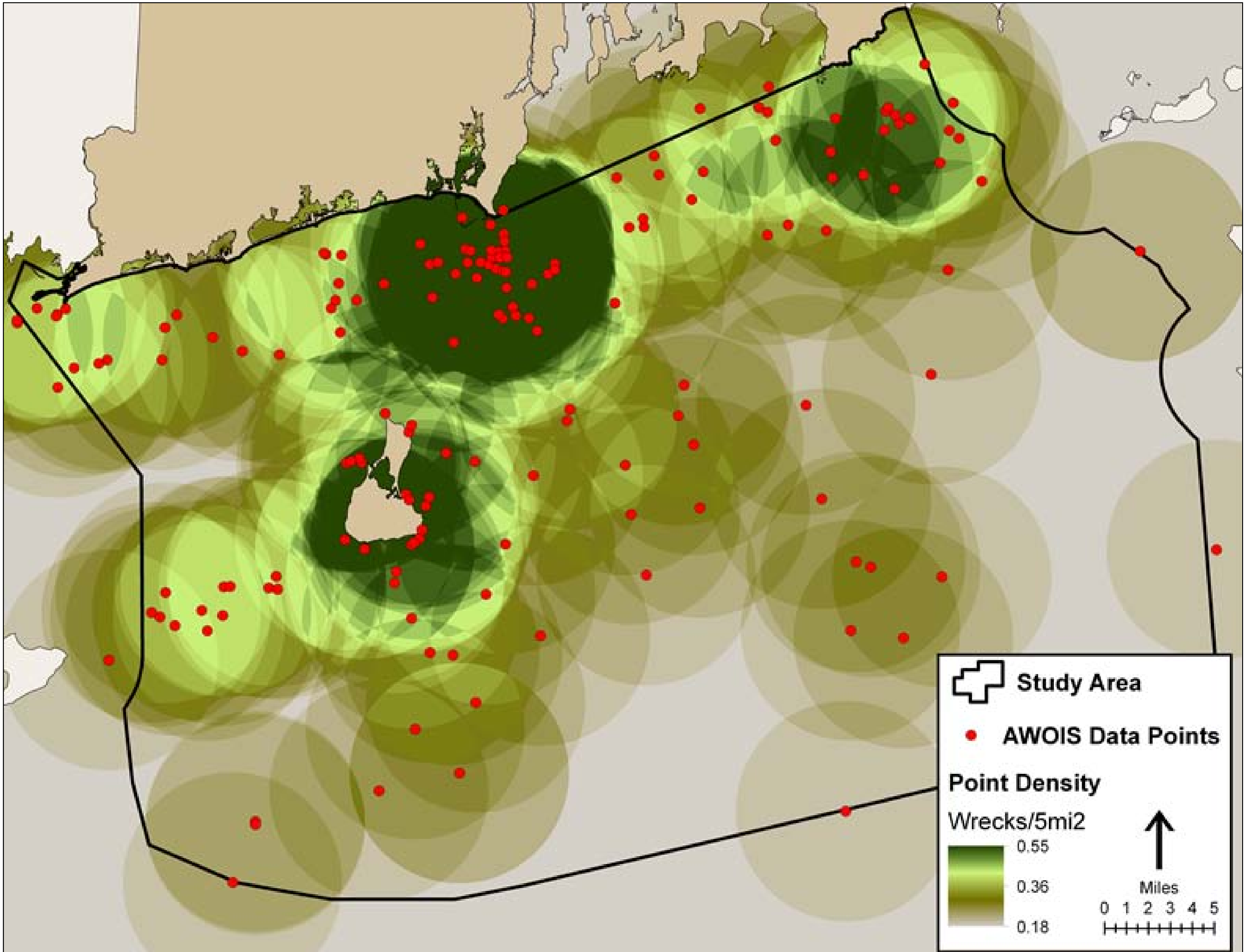
CIM-HU Framework: Overview

- Would follow same general procedure/calculations as for the CIM-Eco framework
- Includes the following categories (at a minimum):
  - Cultural Resources
  - Fishing and Aquaculture
  - Commercial Traffic
  - Recreational Boating
  - Other Marine Recreational Areas (e.g., scuba diving sites)
  - Department of Defense Use Areas
  - Dredge Spoil Areas
  - Existing Infrastructure (pipelines, telecommunications, energy facilities, etc.)

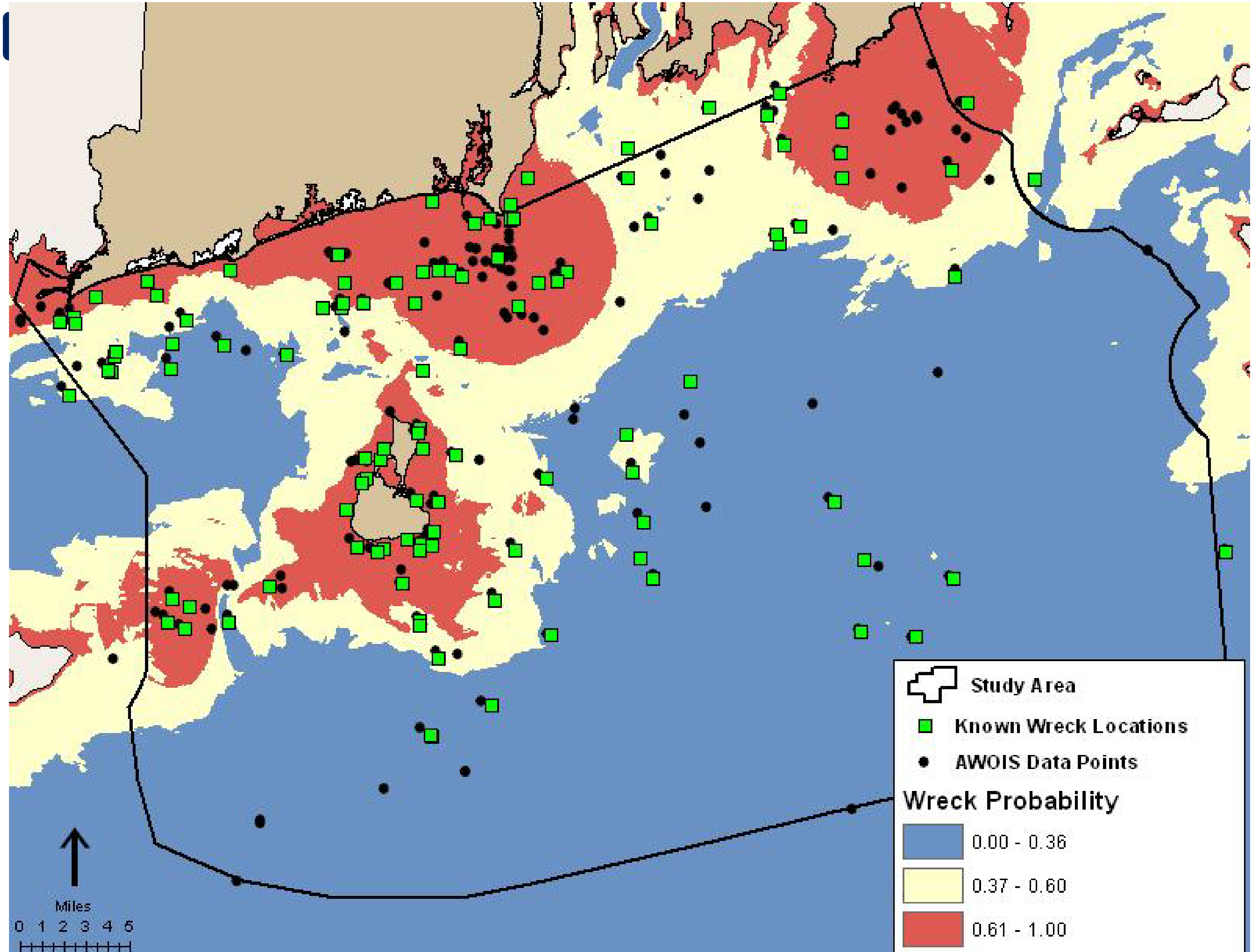
CIM-HU Framework: Data Inputs

- Data could consist of:
  - Continuous topologies (e.g., maps of gridded fisheries landings data, ship traffic density, maps resulting from an Archaeological Sensitivity Analysis)
  - Delineated features (e.g., existing submarine pipelines, dredge spoil areas, artificial reefs)

- Example: Submerged shipwrecks offshore Rhode Island



Mather et al., URI



Mather et al., URI

RPS asa

CIM-HU Framework: Weighting Schemes

- Relative Importance
  - Could be assigned based on management priorities, stakeholder input, or economic measures of value (e.g., willingness-to-pay, travel cost, consumer surplus, commercial revenues or profits)
- Regulatory Protection Status
  - Would add further weight to components that have an additional regulatory protection (e.g., cultural resources)
- Data Robustness
- Relative Potential Impact of Development

CUEM Limitations & Challenges: Data Inputs (Outline)

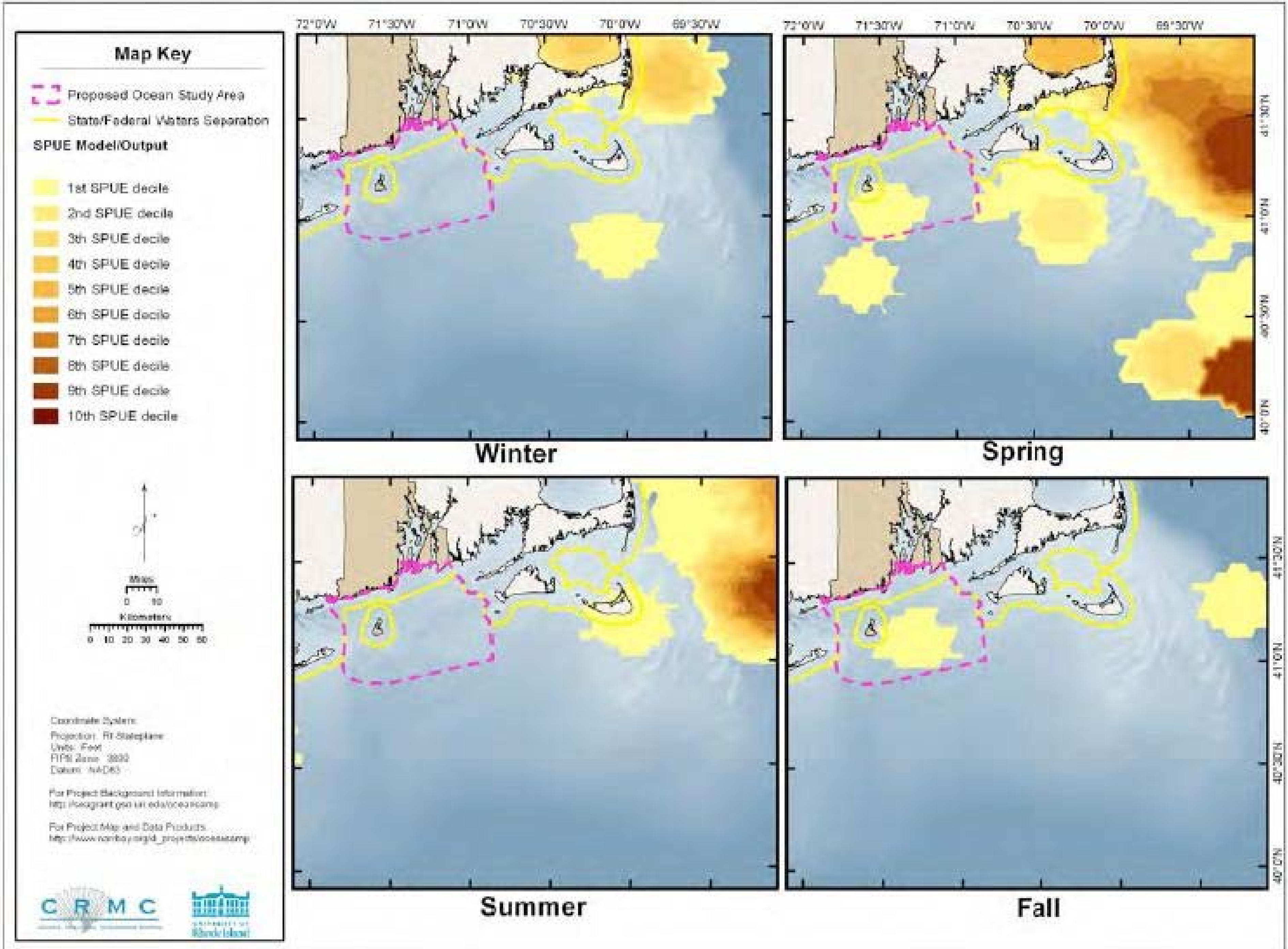
- Data completeness and quality
  - Robustness, standardization, completeness
  - Scope
    - Missing components
- Issues of scale
- Generation of continuous topologies
  - Spreading methodologies (modeling, Kriging)
  - Patchy data shows as highs and lows – influential

Data Completeness and Quality

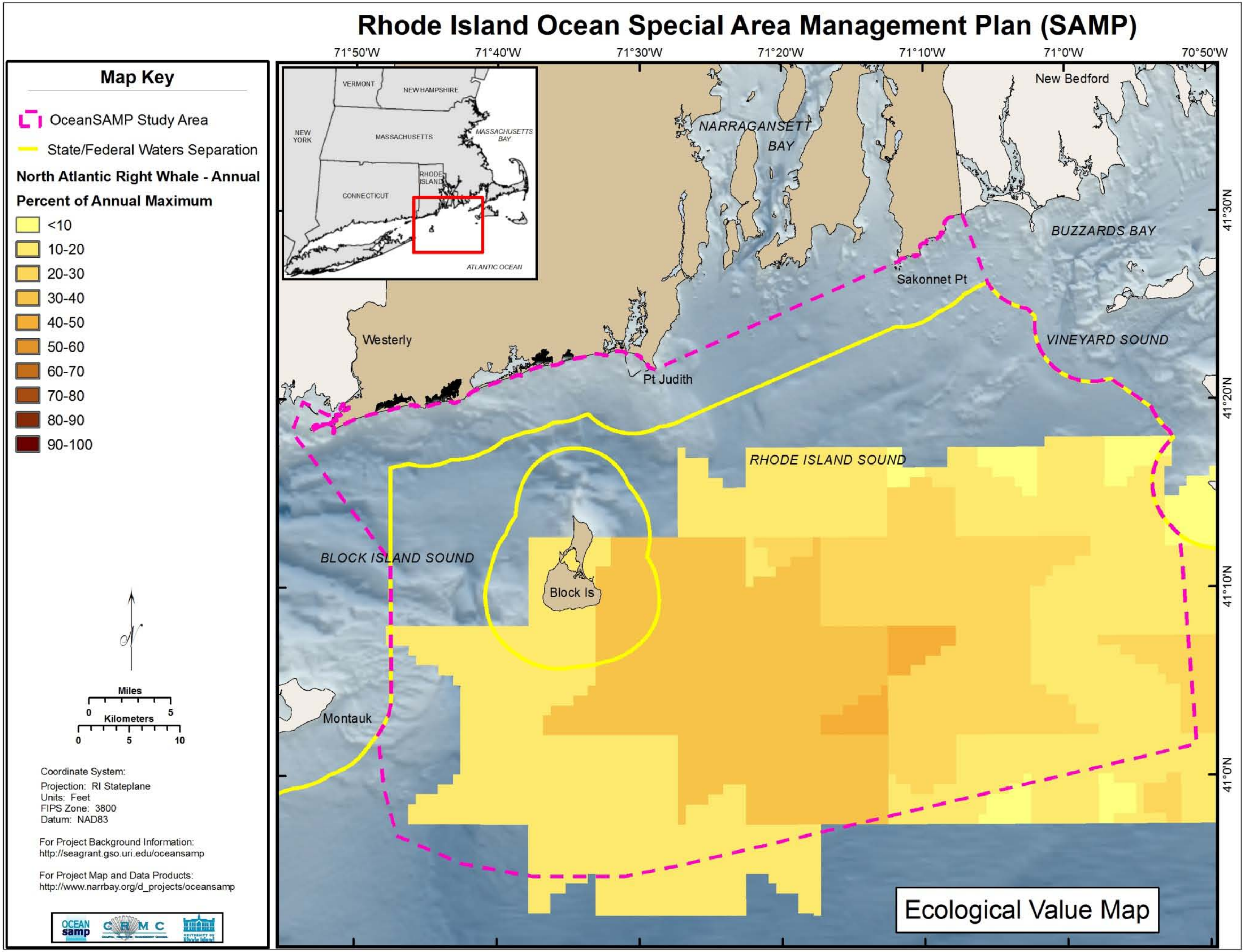
- Model requires continuous topologies for broad scale coastal zones
- Sampling coverage needed to represent broad-scale study areas is often unavailable and costly/infeasible to obtain
  - Particularly for highly migratory species
- Data inputs are typically pulled from a variety of sources
  - Can include multiple studies with varying scope, methodologies, and objectives
  - Challenging to standardize these datasets so they can be combined in a meaningful way
- Data may not exist for particular ecosystem components (e.g., bats)

Issues of Scale

- Scale heavily influences results
- Scale of analysis must be appropriate for geographic scale of, and processes affecting, the resource
  - Migratory species with large geographic ranges (e.g., whales, turtles, birds) – need to consider larger area
- Example: North Atlantic Right Whale distribution offshore Rhode Island



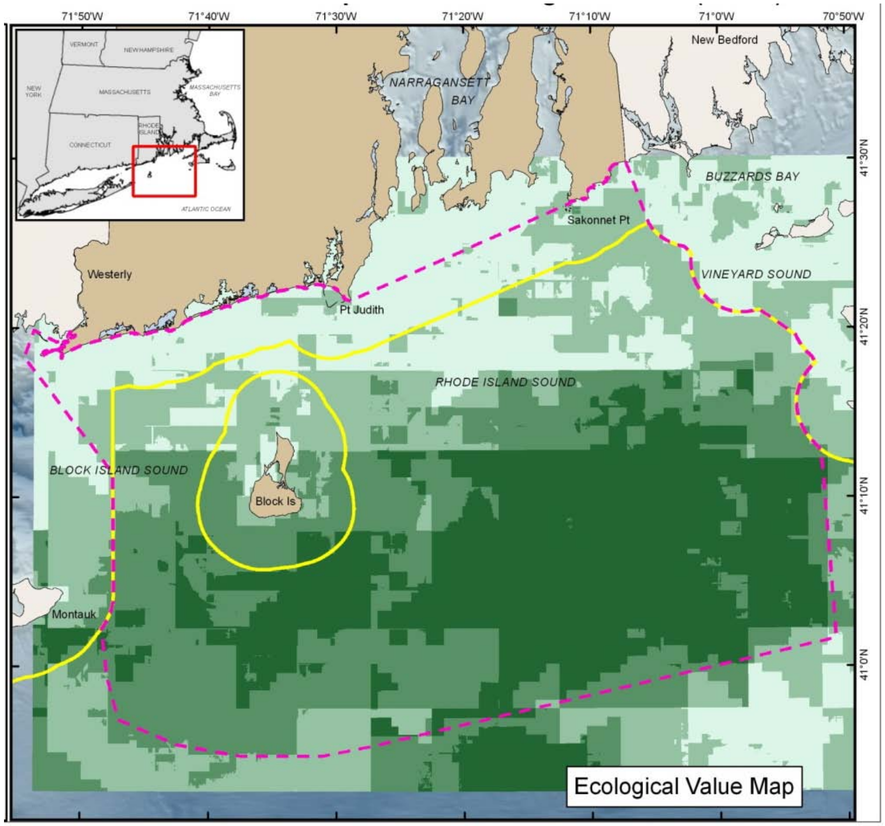
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
SPUE Model/Output
1st SPUE decile
2nd SPUE decile
3th SPUE decile
4th SPUE decile
5th SPUE decile
6th SPUE decile
7th SPUE decile
8th SPUE decile
9th SPUE decile
10th SPUE decile
Miles
0 10
Kilometers
0 10 20 30 40 50 60
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
CRMC
72°0'W
71°30'W
71°0'W
70°30'W
70°0'W
69°30'W
41°30'N
41°0'N
40°30'N
40°0'N
Winter
Spring
Summer
Fall



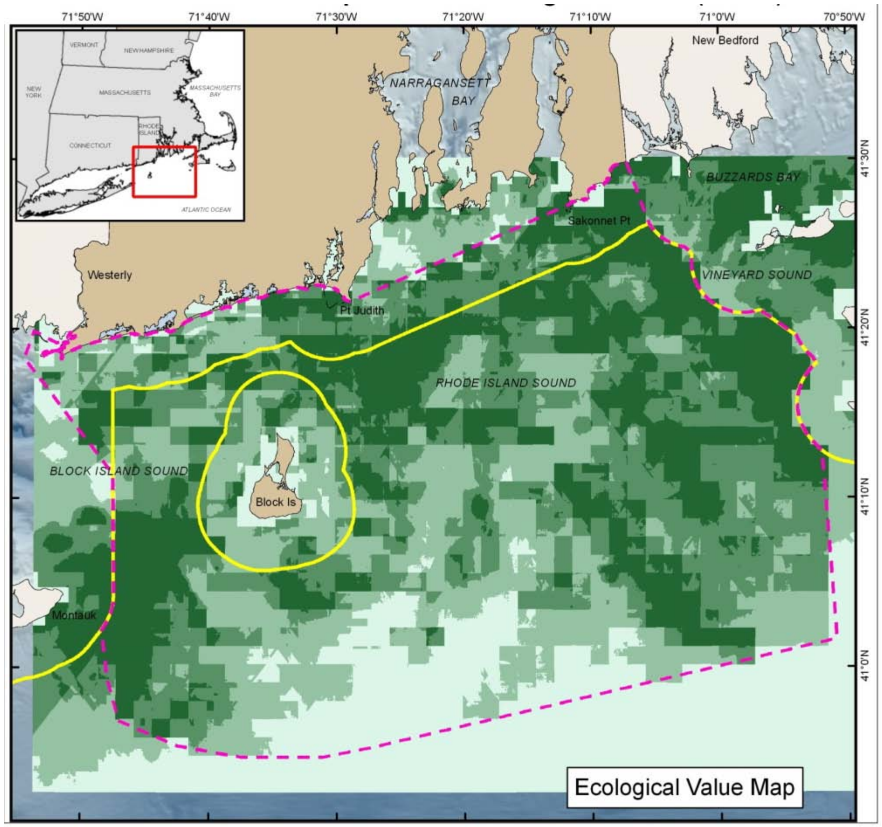
Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
OceanSAMP Study Area
State/Federal Waters Separation
North Atlantic Right Whale - Annual
Percent of Annual Maximum
<10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
Miles
0
5
Kilometers
0
5
10
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
41°30'N
41°20'N
41°10'N
41°0'N
VERMONT
NEW HAMPSHIRE
NEW YORK
MASSACHUSETTS
MASSACHUSETTS BAY
RHODE ISLAND
CONNECTICUT
ATLANTIC OCEAN
NARRAGANSETT BAY
New Bedford
BUZZARDS BAY
Sakonnet Pt
VINEYARD SOUND
Westerly
Pt Judith
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
Ecological Value Map

RPS asa

Ecological Value Map
(all data)



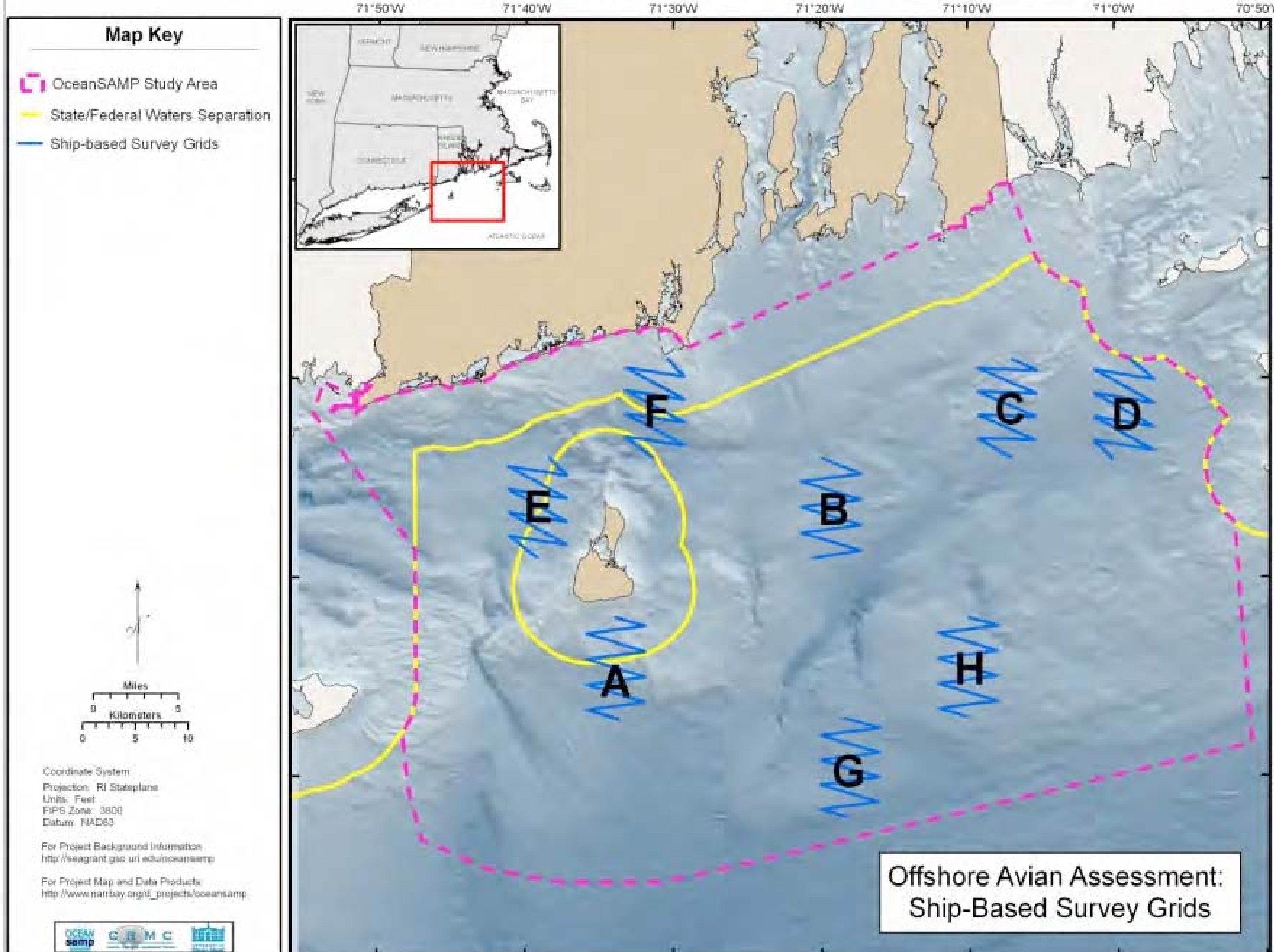
Ecological Value Map
(marine mammals & turtle data excluded)

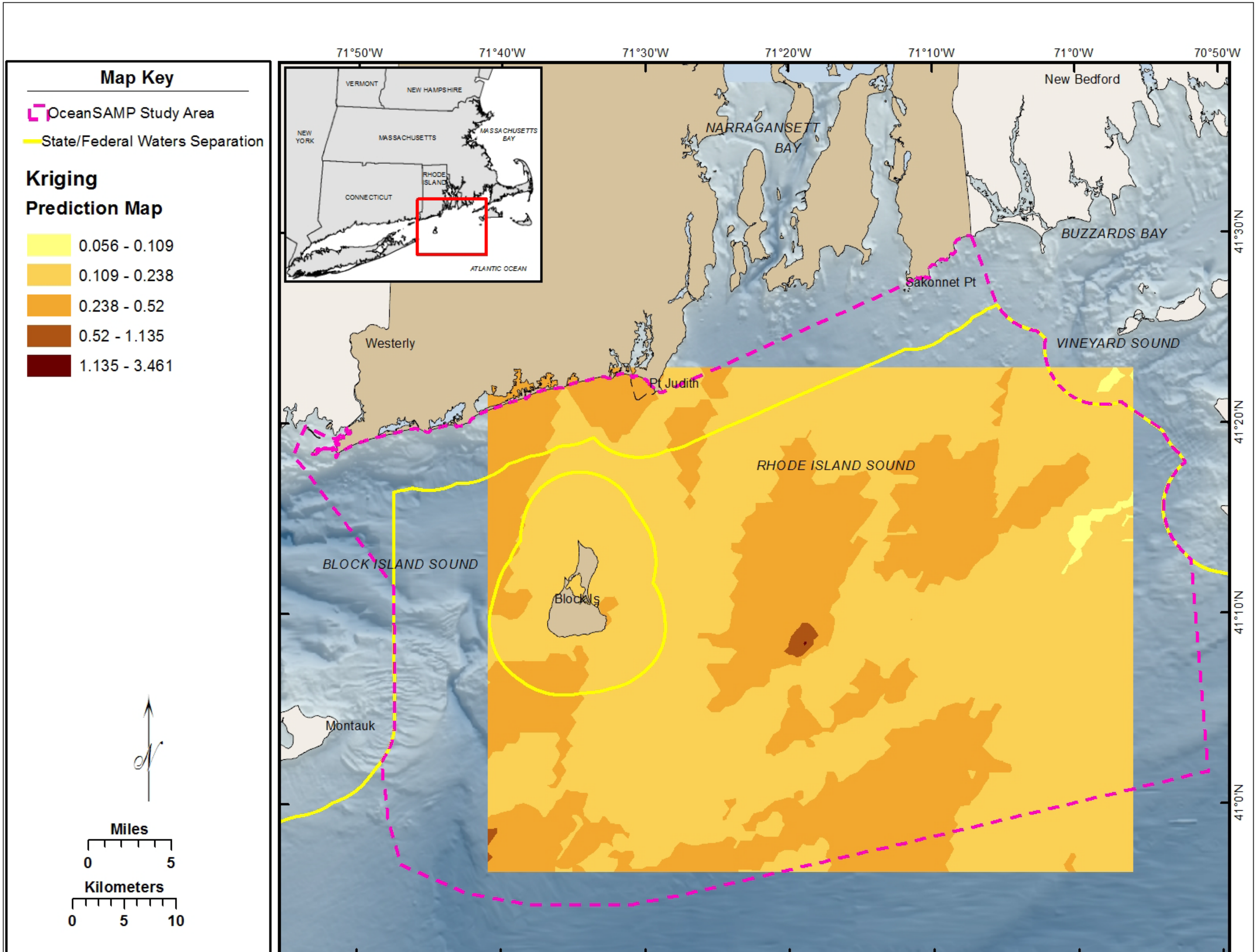


Generation of Continuous Topologies

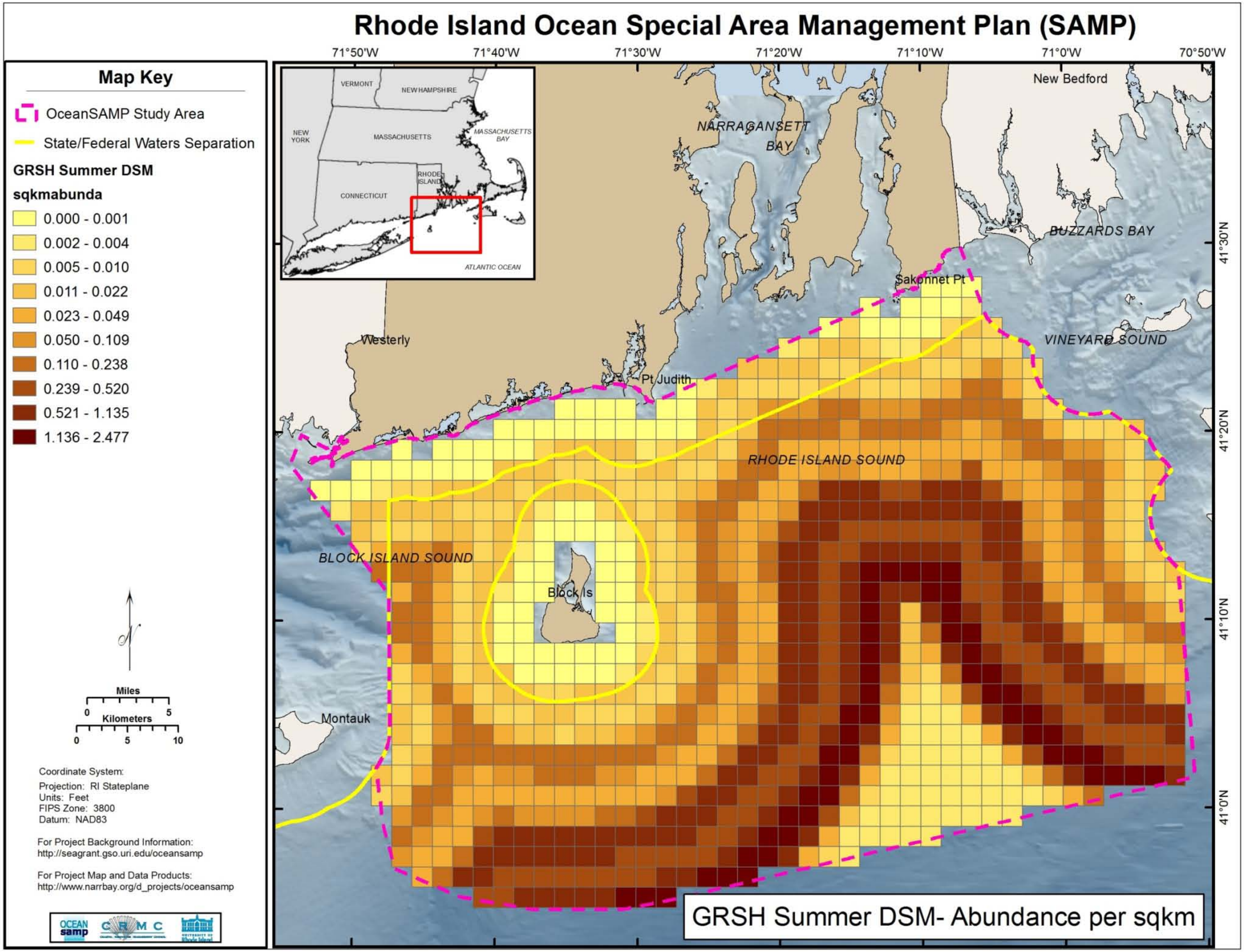
- Available data are typically highly variable, patchy, collected for another purpose and/or focused on a particular area of concern
- Modeling data layers based on spatial interpolation is one way to create a continuous surface
  - Can be difficult to do with data not collected specifically for geospatial spreading (less statistically robust, can lead to artifacts)
- Method used can heavily influence the result and create unreliable information and biases
- Example: Greater shearwater distribution offshore Rhode Island

Rhode Island Ocean Special Area Management Plan (SAMP)





Map Key
OceanSAMP Study Area
State/Federal Waters Separation
Kriging
Prediction Map
0.056 - 0.109
0.109 - 0.238
0.238 - 0.52
0.52 - 1.135
1.135 - 3.461
Miles
0
5
Kilometers
0
5
10
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
41°30'N
41°20'N
41°10'N
41°0'N
VERMONT
NEW HAMPSHIRE
NEW YORK
MASSACHUSETTS
MASSACHUSETTS BAY
RHODE ISLAND
CONNECTICUT
ATLANTIC OCEAN
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt
Westerly
VINEYARD SOUND
Pt Judith
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk


Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
OceanSAMP Study Area
State/Federal Waters Separation
GRSH Summer DSM
sqkmabunda
0.000 - 0.001
0.002 - 0.004
0.005 - 0.010
0.011 - 0.022
0.023 - 0.049
0.050 - 0.109
0.110 - 0.238
0.239 - 0.520
0.521 - 1.135
1.136 - 2.477
Miles
0 5
Kilometers
0 5 10
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
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71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
41°30'N
41°20'N
41°10'N
41°0'N
VERMONT
NEW HAMPSHIRE
NEW YORK
MASSACHUSETTS
MASSACHUSETTS BAY
RHODE ISLAND
CONNECTICUT
ATLANTIC OCEAN
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt
VINEYARD SOUND
Westerly
Pt Judith
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
GRSH Summer DSM- Abundance per sqkm

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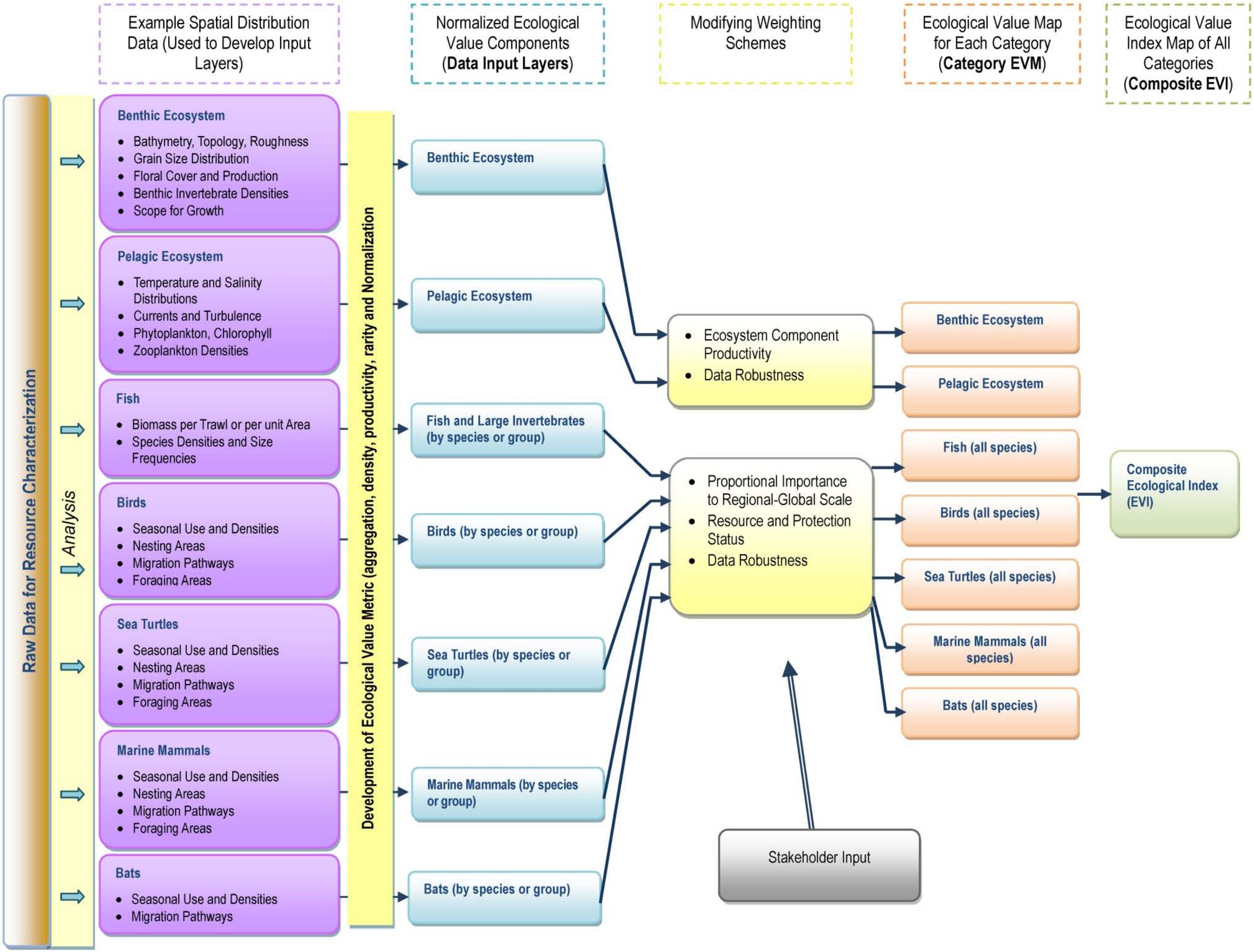
Moving Forward…

- Focus to date has been on development of the CIM-Eco component of the model
  - CIM-HU component needs further development prior to application of the CUEM model
- Main limitation to model application is developing high quality data for large geographic areas
  - Standardizing data collection would allow broad-scale analyses or even regional comparisons
  - Develop modeling techniques for generating topologies
- Weighting schemes currently employed the study are considered exploratory, and could be modified to integrate stakeholder input or other factors

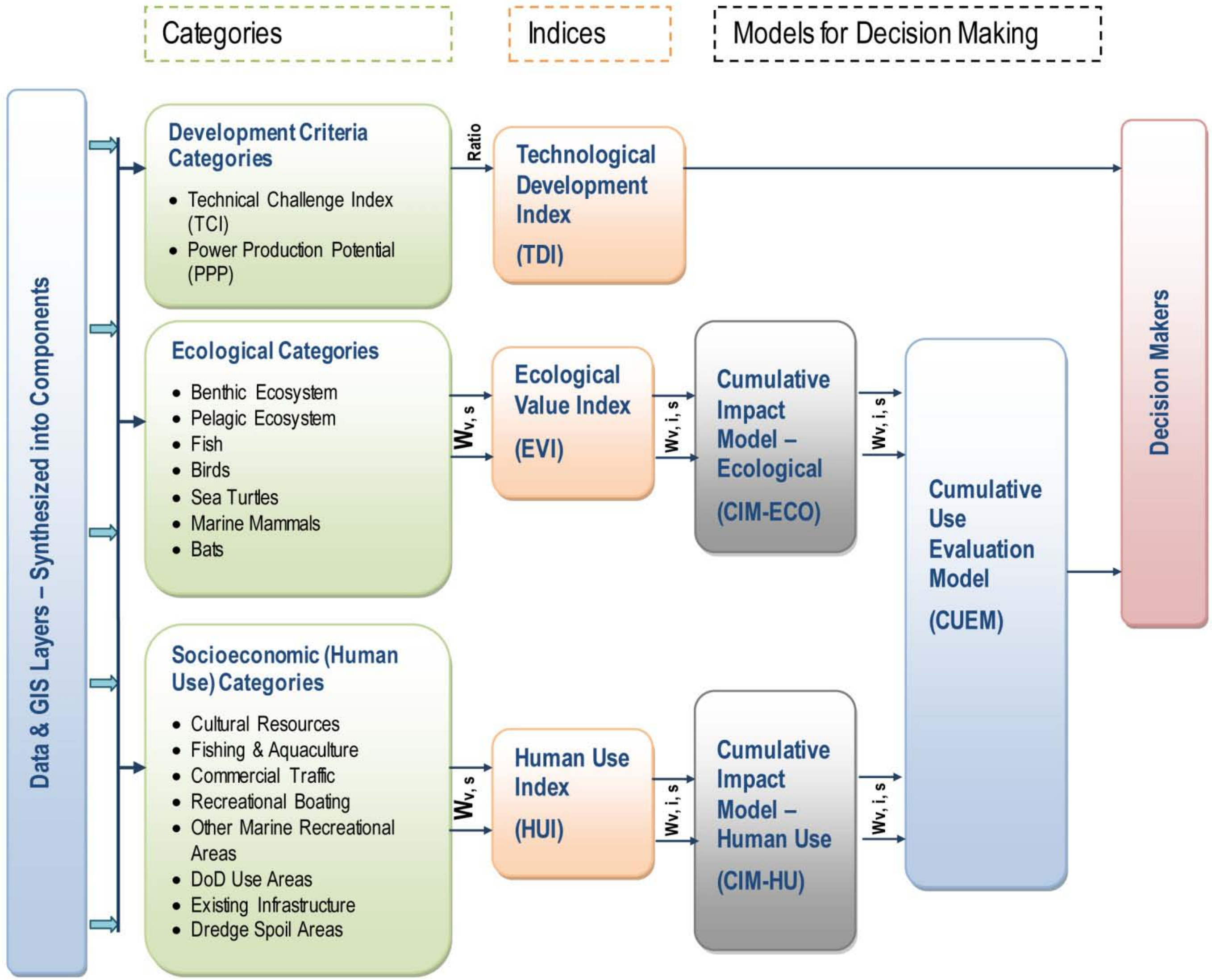
Potential Techniques for Developing Topologies…

- Standardizing data collection
  - Consistent terminology
- Develop modeling techniques for generating topologies
  - Geospatial spreading (e.g., Kriging) based on observational data
  - Habitat utilization models
    - Indices
    - Probability of occurrence models (presence/absence in habitats)
    - Stratified density models (uniform animal density within each stratum)
  - Spatial and temporally-varying empirical models
    - Habitat-based density models
    - Environmental co-variates
  - Wildlife movement models

Ecological Value Index (EVI) Mapping



Siting Evaluation Model (SEM)



Key:

W = Weighting Scheme

v = value (Ecological or Human Use)

i = impacts of development

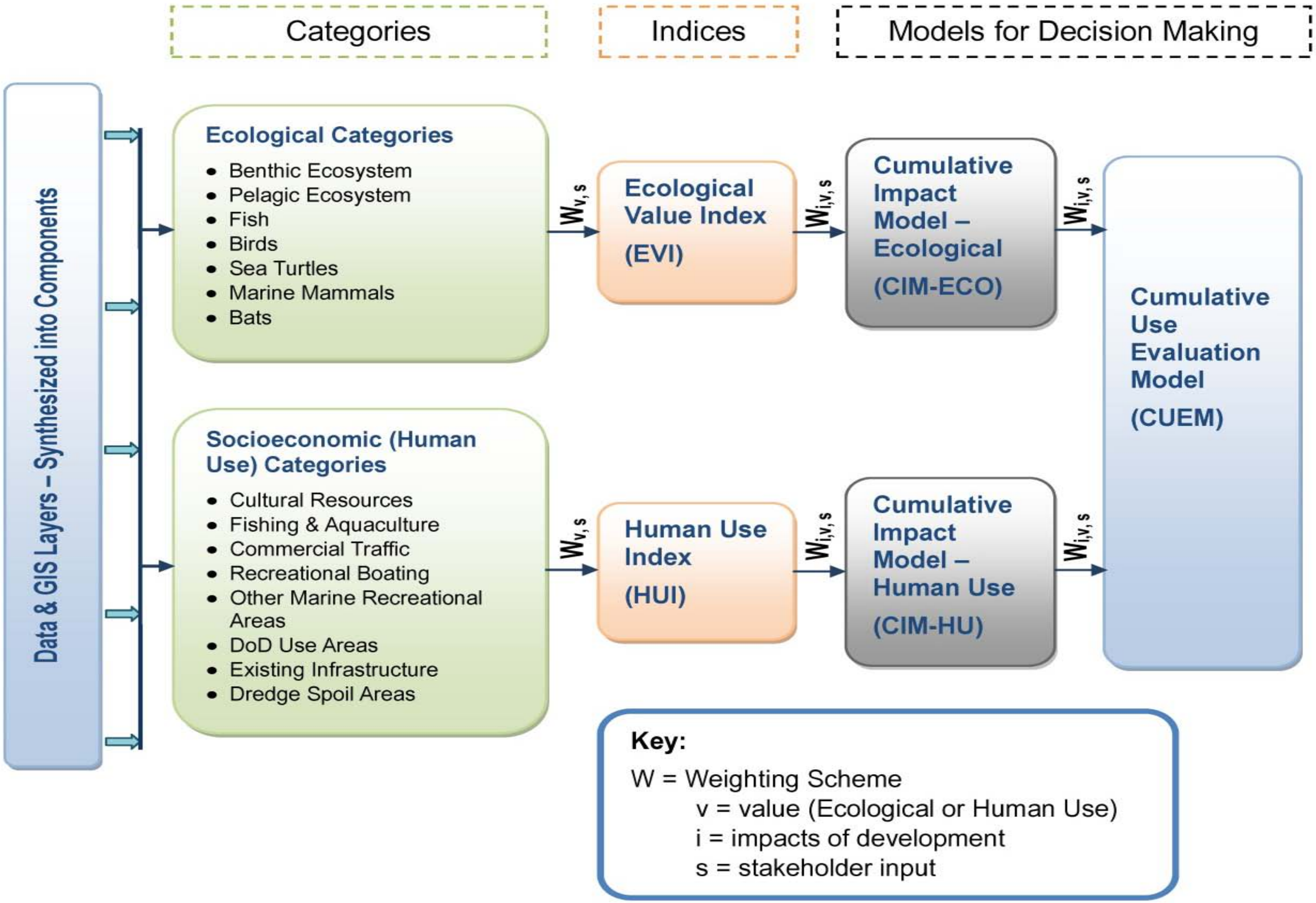
s = stakeholder input

Cumulative Use Evaluation Model (CUEM): Advantages and Challenges

- Advantages for Planning and NEPA:
  - Measure of resource/use value is on a relative scale, can use an index
  - Weightings implicitly made in any trade-off decision-making process are explicitly stated with a criteria-related basis
  - Inform stakeholders
  - Can incorporate stakeholder input to evaluate implications
  - Decision-making process transparent and documented
  - Analysis of alternatives pursuant to NEPA
  - Cumulative impacts on multiple resources and uses can be evaluated
  - Cumulative of multiple projects
  - Compare competing uses
- Challenge: Data – continuous topologies

Discussion

Cumulative Use Evaluation Model (CUEM)



Weighting Schemes: Ecosystem Component Productivity

- Productivity is evaluated based on three criteria:
  - What level of productivity results in the highest ecological value
  - What weighting (1-10) should be applied at the highest ecological value
  - What weighting (1-10) should be applied at maximum productivity
- Defining these two points establishes the shape of a weighting function, which is then applied to the data

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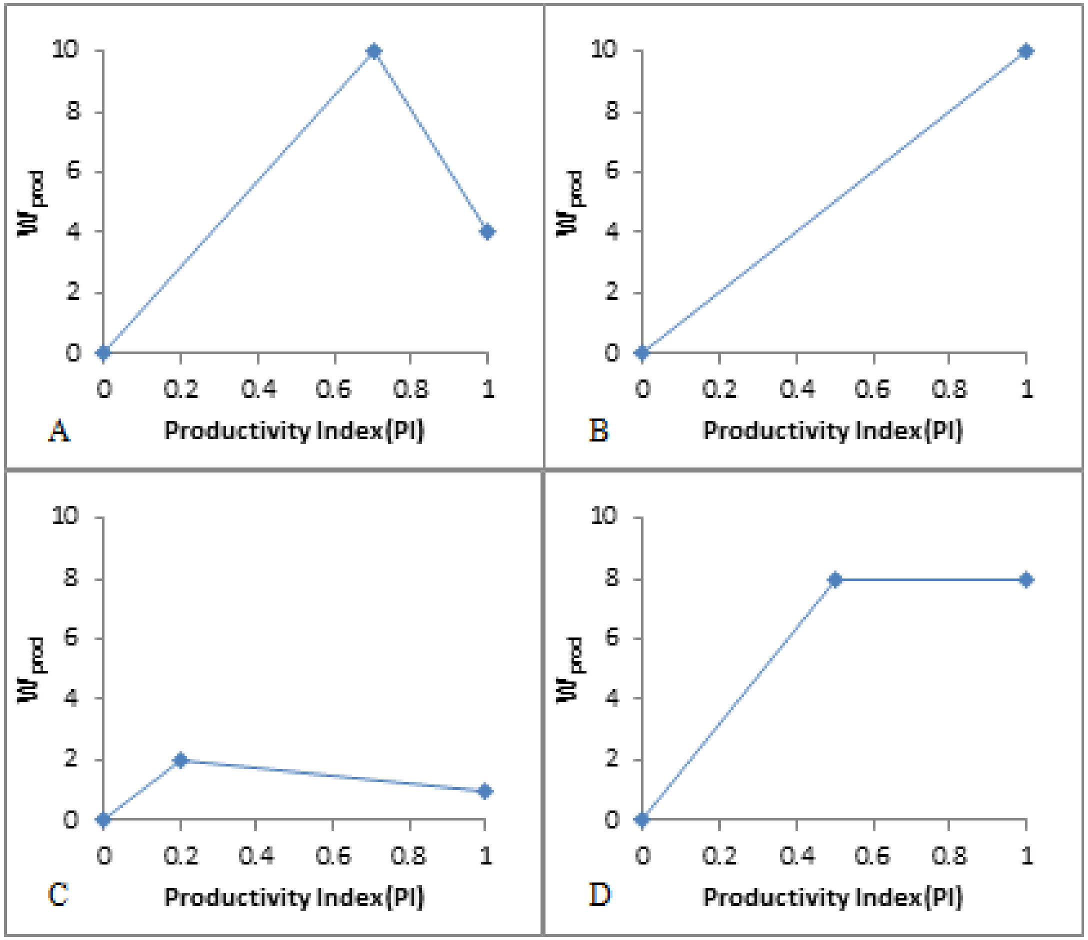
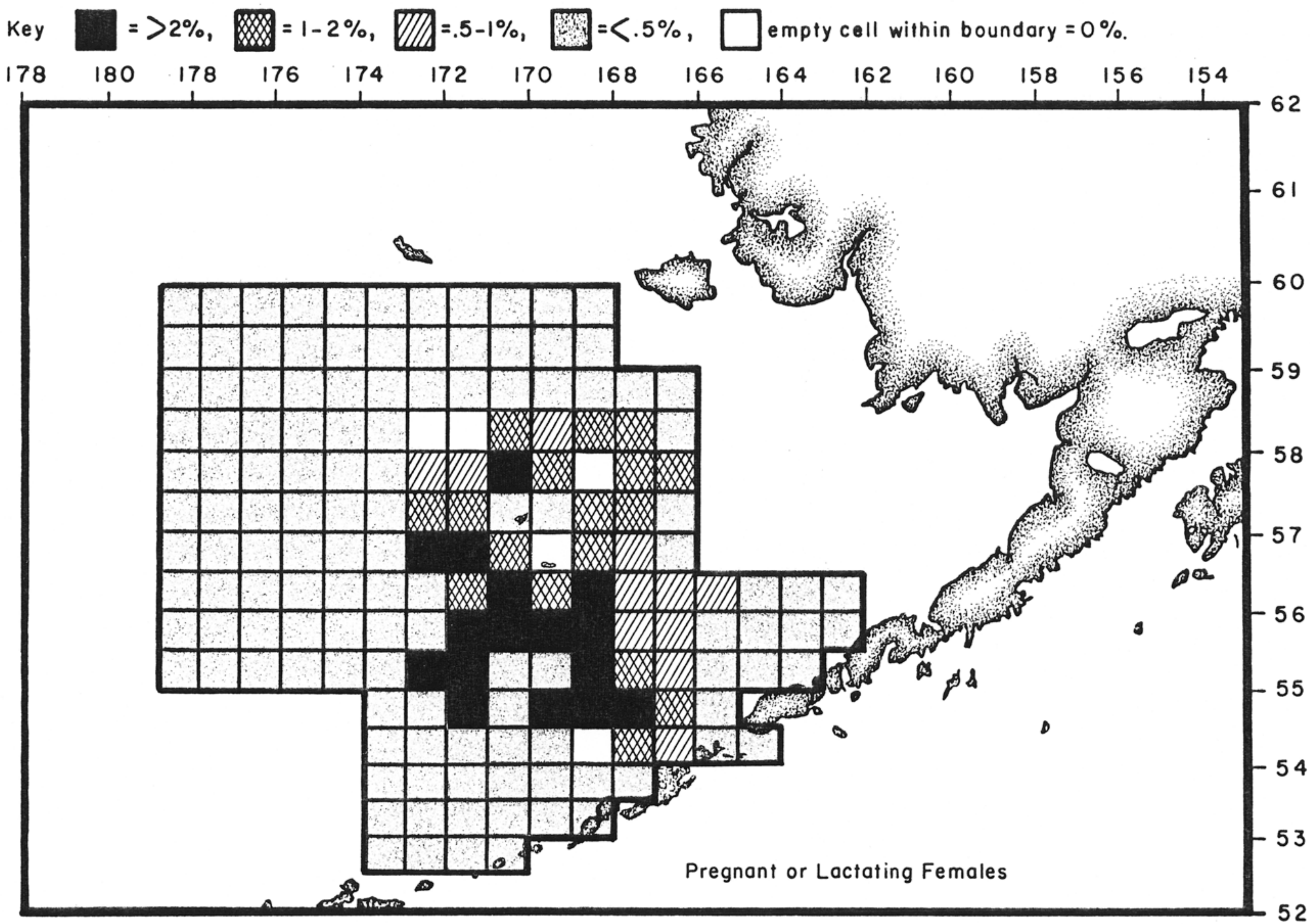
Weighting Schemes: Ecosystem Component Productivity



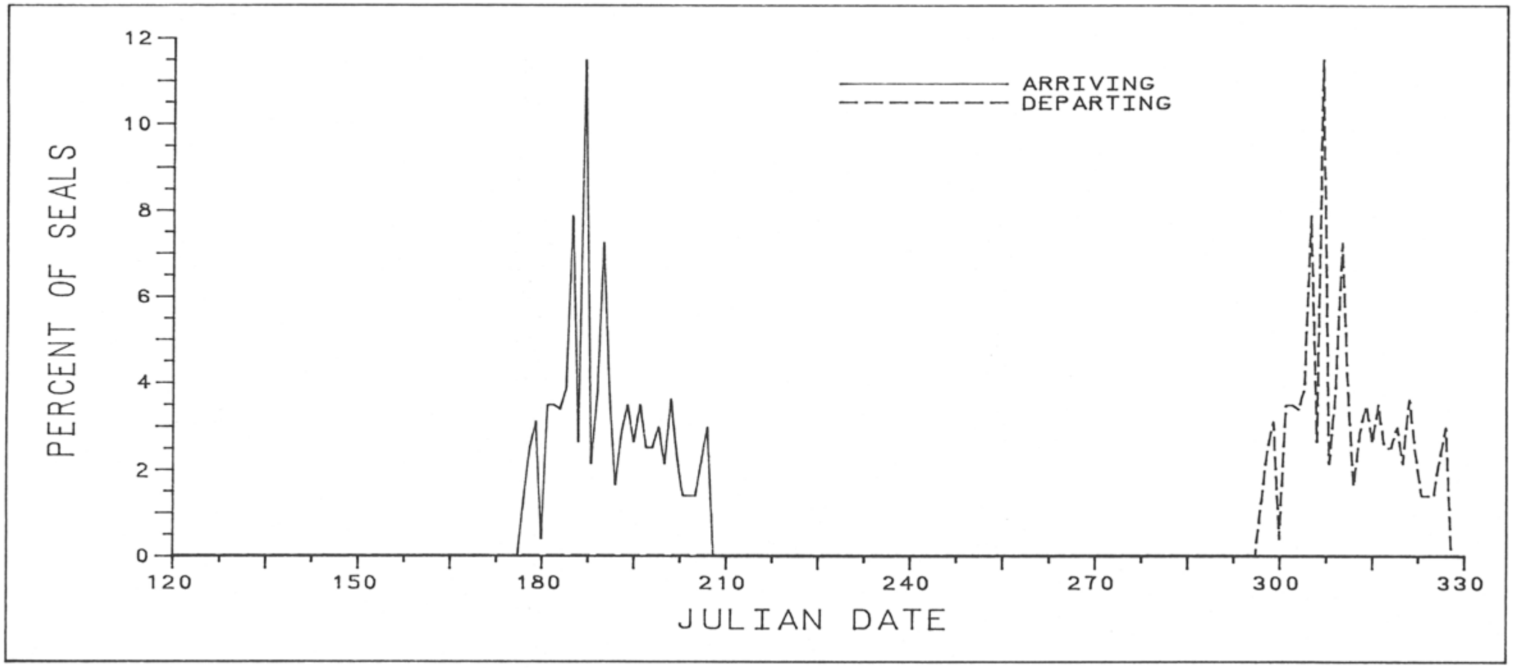
Example wildlife movement and mapping model:

- Fur seal population in the Bering Sea
- Based on life history information and behavior
- Developed spatial distributions over months in Bering Sea
- Reference:
  - French, D.P., M. Reed, J. Calambokidis and J. Cubbage, 1989. A simulation model of seasonal migration and daily movements of the northern fur seal, Callorhinus ursinus. Ecological Modelling 48:193 219.

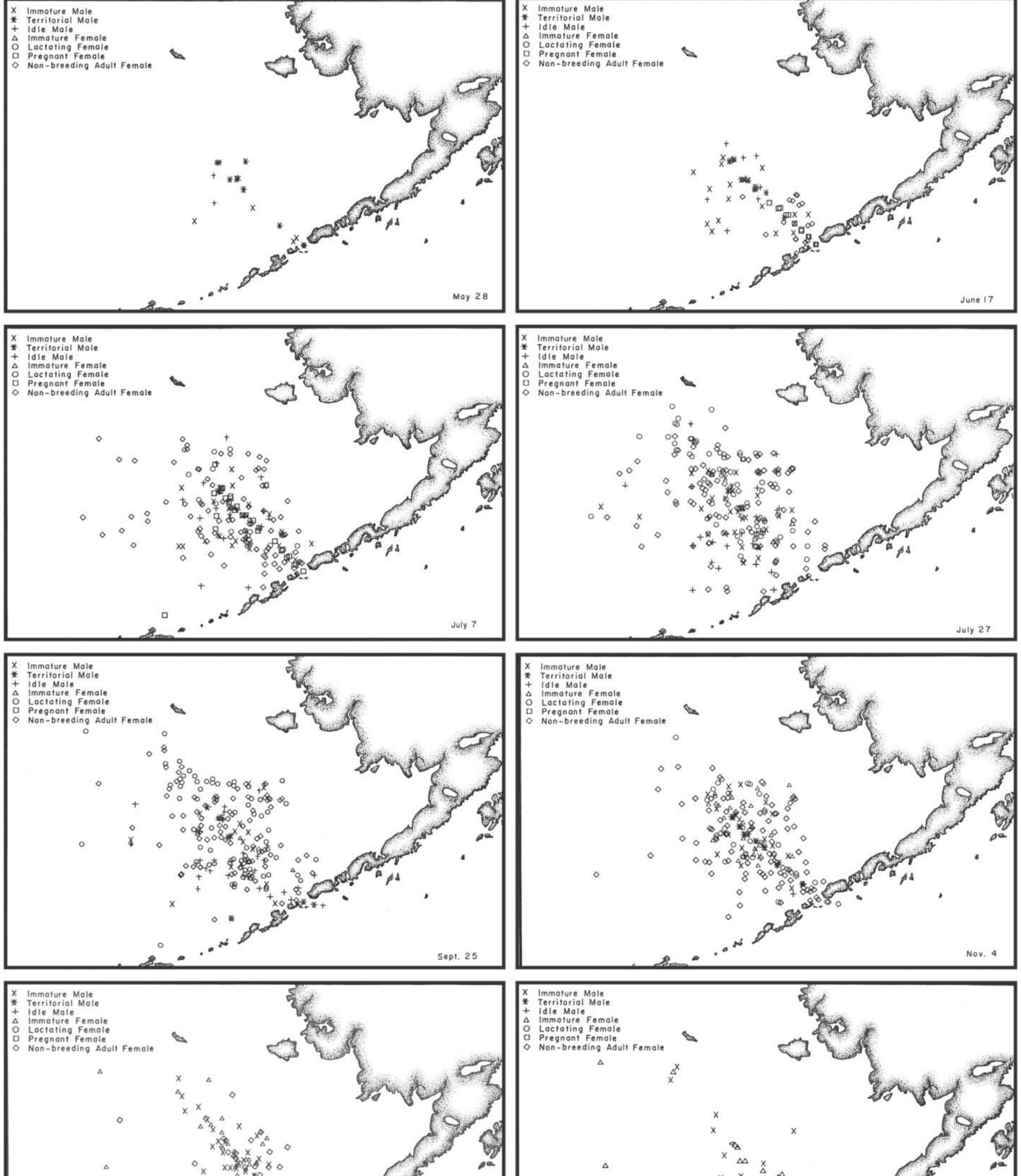

Key
= >2%,
= 1-2%,
=.5-1%,
=<.5%,
empty cell within boundary = 0%.
178
180
178
176
174
172
170
168
166
164
162
160
158
156
154
62
61
60
59
58
57
56
55
54
53
52
Pregnant or Lactating Females

RPS asa

ADULT FEMALES



RPS asa


X Immature Male
Territorial Male
+ Idle Male
Δ Immature Female
O Lactating Female
□ Pregnant Female
◇ Non-breeding Adult Female
May 28
June 17
July 7
July 27
Sept. 25
Nov. 4

Appendix D

Avian Breakout Session Presentations

APPENDIX TO SECTION 2.0

Biographies of European Invitees

Jan Blew, BioConsult SH

Jan Blew is a biologist focusing on ornithology, wildlife and databank management. He holds an MSc in Ecology, earned in 1985. From 1990 on he worked as freelancer in Germany on databank management and programming (resting and migrating birds, wildlife and ornithology field work). Since 2005 he has been with BioConsult SH, where he focuses on bird migration and applied environmental investigations, in particular daytime and nighttime censusing and observation methods and radar ornithology. From 2005 to 2007 he led a large research project at two Danish offshore windfarms to learn and report about bird and marine mammal reactions to those wind mills. From 2008 to 2011 they conducted an Environmental Impact Assessment on a very large European infrastructure project, the 20 km link between Germany and Denmark across the Baltic Sea, either tunnel or bridge. Jan leads the migrating bird investigations. Both large projects involved using various different radars for observing bird paths and measuring bird flux in different altitudes.

Philip Bloor, Pelagica

Phil Bloor has over 25 years of ornithological experience and 9 years' experience with offshore wind farms as both a Government regulator and an environmental consultant for the industry. For 9 years Phil worked as a Senior Environmental Manager for the Department of Energy and Climate Change (DECC). A major function of the role was the review and determination of environmental submissions submitted by the offshore wind (and oil & gas) industry. From 2004 onwards Phil was significantly involved in all offshore wind farm projects in the UK and was responsible for undertaking assessments required under the EU Habitats Regulations and undertook all Appropriate Assessments for the consented offshore wind farms in the UK.

Sjoerd Dirksen, Bureau Waardenburg

Sjoerd Dirksen is an ecologist and ornithologist, working in applied research and consultancy since 1986 after graduating from Groningen University. He is vice director of Bureau Waardenburg. Within the board of directors, his main responsibilities are with project management, business development, external relations, HSE matters and innovation. His skills as project manager are used in a few large, more complicated projects, such as on effects of wind energy on birds (both inland and offshore) and in coaching and supporting colleagues in such projects. Also smaller specialist contributions to projects are a regular issue. His involvement in studies on effects of wind energy on birds started in the early 1990s, with projects on land and a large inland lake. As part of this research track, he became a specialist in radar ornithology as well. Following wind energy from land into the seas, he has been involved in the ecological aspects of offshore wind energy in The Netherlands from the very start – the first project on selecting a location in 1997, two consecutive EIAs for OWEZ, the baseline studies at sea 2003-2005 and effect studies in the wind farm 2007 - 2012. Also, he managed projects in other countries (Denmark, UK, Malta, Bulgaria). From 2010-2012 he was a member of the Crown Estate's steering group SOSS (Strategic Ornithological Support Services) in the UK.

Thomas Merck, German Federal Agency for Nature Conservation

Thomas Merck is a marine biologist and since 1993 senior scientific officer at the German Federal Agency for Nature Conservation (BfN) in the unit "Marine and Coastal Nature Conservation". The BfN is the competent authority with respect to nature conservation in the German EEZ. He is head of a BfN-working group on environmental impacts of human marine activities. Since the late 90's, he analyses the offshore wind energy development in German waters and is familiar with the approval procedure and its legal background. He takes an active part in the development of the German offshore Standards for the Environmental Impact Assessment. These standards lay down the requirements for field studies to be conducted by the applicants aiming at providing the data needed for an Environmental Impact Assessments (EIA). Part of his work is the evaluation of results from monitoring programs related to construction and operation of offshore wind farms as well as giving advice on and initiating of research projects on possible ecological impacts and respective mitigation measures.

Ib Krag Petersen, Aarhus University

Ib Krag Petersen is a senior biologist and project manager at Department of Bioscience, Aarhus University in Denmark. He is in charge of the national waterbird census, and has been closely involved in avian programmes in relation to environmental assessments of offshore wind farms in Denmark and neighboring countries. He has particularly been involved in waterbird habitat utilization in and around offshore wind farms. Bird distributions have been sampled from aircraft by the line transect method, allowing for density calculations. Spatial models have been developed to estimate surface covering density surfaces. In close collaboration with the CREEM group at the University of St. Andrews, Scotland, a method to evaluate changes in bird distribution between pre- and post-wind farm construction was developed. A combination of GAM and GEE analyses was used to evaluate pre- and post-construction distribution of Long-tailed Ducks. For the last two years Ib has been in charge of monitoring marine birds in offshore wind farms in the UK, using a super high-resolution Vexcel Ultracam XP camera to create digital orthophotos with a ground resolution of 3x3 cm. Ib and Chris Topping have developed a landscape-based individual-based model for wintering Red-throated Divers in the Baltic. The aim was to evaluate the effect on the population from different planning scenarios for offshore wind farms in the region and at the same time to suggest a method to evaluate cumulative effects.

BOEM Workshop: Offshore Wind Energy Development Site Assessment and Characterization:
Evaluation of the current status and European experience.

Jan Blew, BioConsult SH

Bio Consult SH

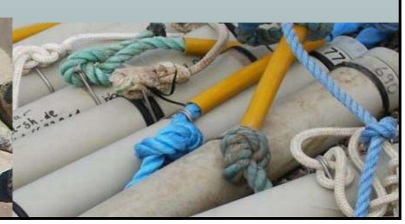
BioConsult (Georg Nehls); 20 employees, Germany

- Offshore and onshore wind energy EIAs
- Research and development of methods
- Wadden Sea and wildlife projects

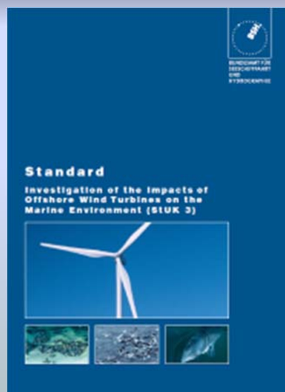
Consulting

- single farmers (e.g. Montagu's Harrier and wind mills),
- small, medium and large businesses (e.g. energy providers),
- regional, national and international institutions (e.g. EU)

Bio Consult SH



Rules and regulations



A: Conceptual and technical framework

B: Technical instructions…

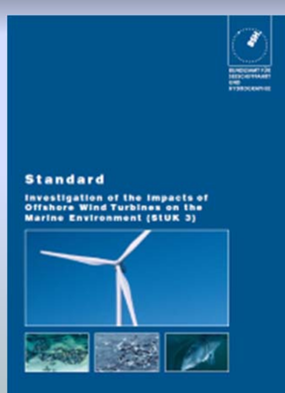
3. Avifauna
3.1. Resting and migratory birds

3.2. Bird migration and other bird movements in the survey area

C: Annex – further specifications of equipment

Bio Consult SH

Rules and regulations



"… to provide as complete as is possible description of the existing environment…"

Investigation design
- **2 (3) years pre-construction**
- **3 (5) years post-construction**
- **project level, regional level**

Non-breeding birds:
- **aerial surveys**
- **12 per year, ~2000 km², more, if e.g. divers**
- **boat surveys**
- **24 per year, ~400 km²**

Migrating (flying) birds
- **on site surveys (boat, platform)**
- **50 days per year**
- **visual, acoustic, radar**

Bio Consult SH

Aerial surveys - resting birds and sea mammals

- two-engine plane
- bubble windows

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Aerial surveys - resting birds and sea mammals

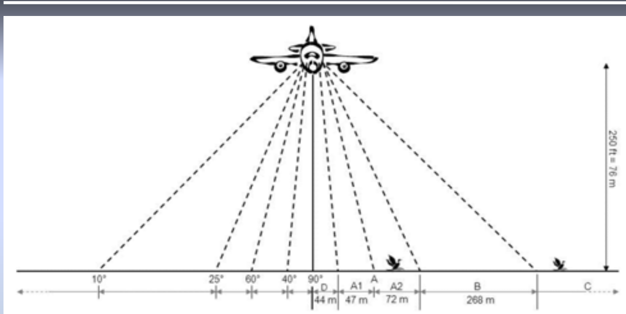


Abb. 2.2 Schematische (nicht winkelgetreue) Darstellung der verwendeten Transektbänder bei den Flugtransekt-Erfassungen.

•	Band D:	0 – 44 m (90° – 60°)
•	Band A1:	44 – 91 m (60° – 40°)
•	Band A2:	91 – 163 m (40° – 25°)
•	Band B:	163 – 431 m (25° – 10°)
•	Band C:	ab 431 m (<10°)

Aerial surveys

- **Flight altitude (250 ft = 76 m),**
- **two persons, third person in back**
- **counts per band, recording, GPS, time**
- **apply DISTANCE**

Bio Consult SH

Boat surveys - resting birds and sea mammals

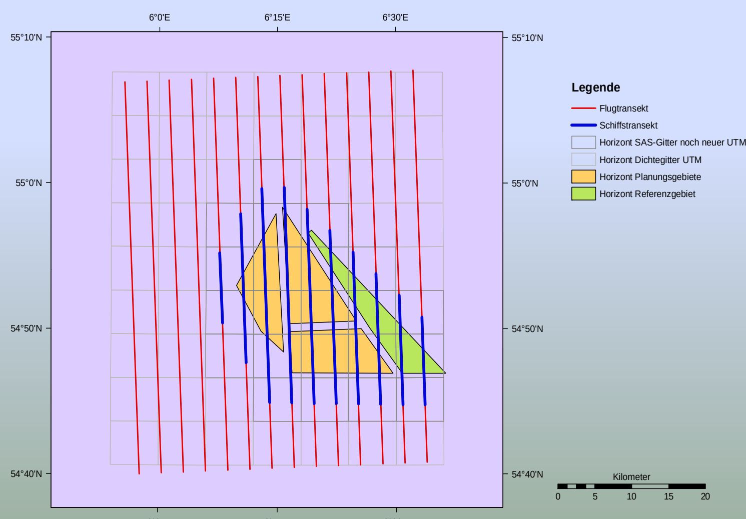
Boat surveys

- observer platform, radar equipment, living comfort
- transect counts (seabirds-at-sea)

Bio Consult SH

Aerial and boat surveys

Resting birds: Transect-design aerial and ship surveys



Bio Consult SH

Aerial and boat surveys

Resting birds: spatial analyses aerial and ship surveys

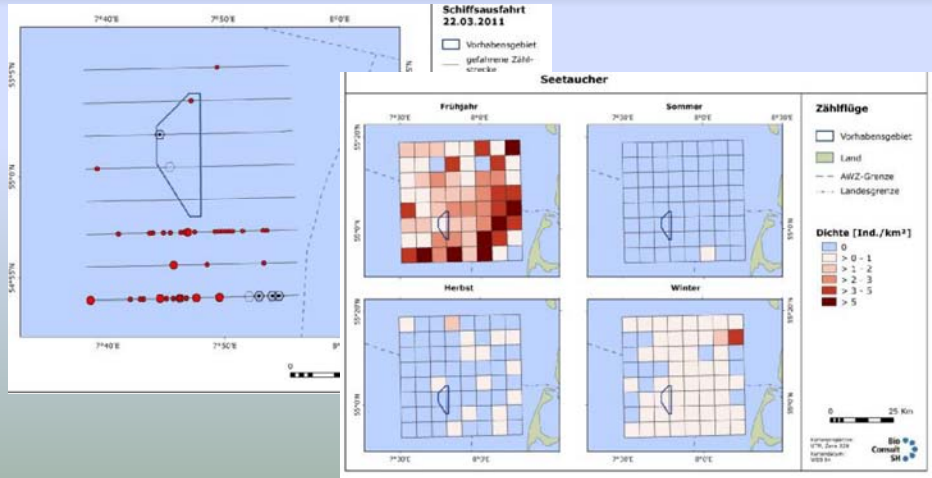


Abb. 5.3 Saisonale Verteilung von Seetauchern (Stern- und Prachttaucher) im Untersuchungsgebiet Butendiek. Dargestellt sind die mittleren saisonalen Dichten pro Rasterzelle; saisonale Zuordnung nach GARTHE et al. (2007).

Bio Consult SH

On site surveys

Migrating birds (flying birds)

- **radar surveys**
- **visual daytime observations (migration, foraging)**
- **acoustic night-time observations**

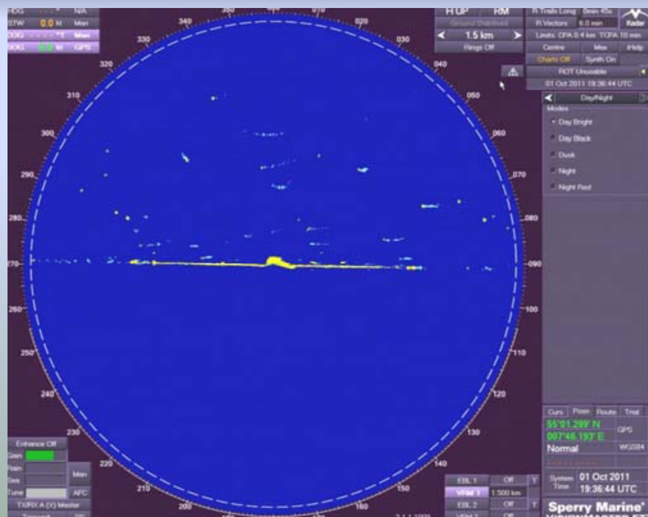
Platform ship
- **ship surveillance radars**
- **horizontal and vertical**

Platform platform
- **more options, e.g. use of scopes, pencil beam radar etc.**

Bio Consult SH

On site surveys

Birds fly at night, many, all altitudes.



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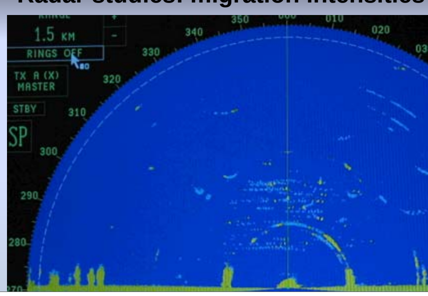
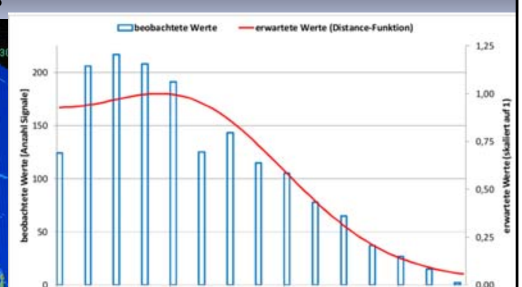
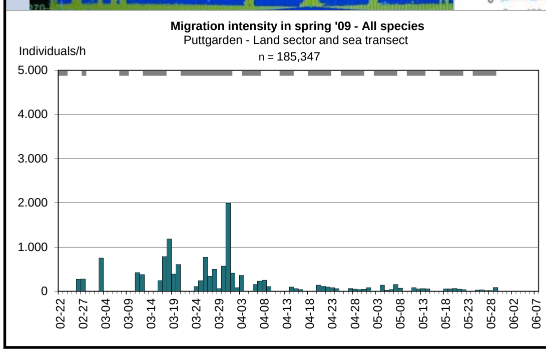
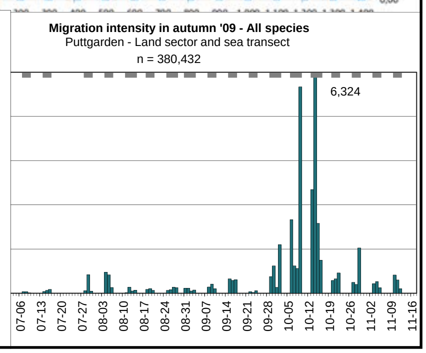
On site surveys

Radar studies: migration intensities



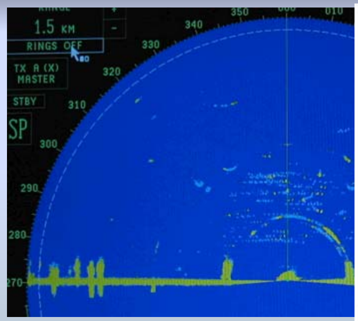


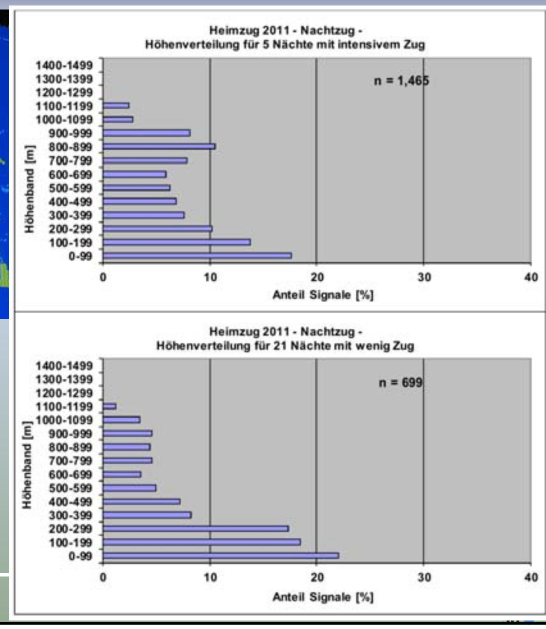




On site surveys

Radar studies: corrections of data, presentation of data

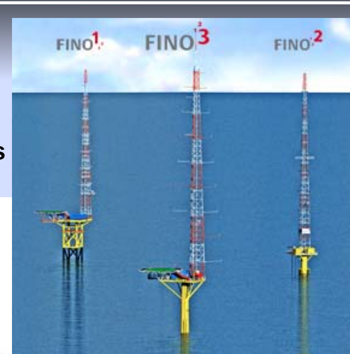




Research platforms FINO 1, 2 and 3

German initiatives (Ministry of Environment)

- **Research platforms**
- **test offshore wind-farm alpha-ventus**
- **Program RAVE - <u>R</u>esearch at <u>A</u>lpha-<u>VE</u>ntus**



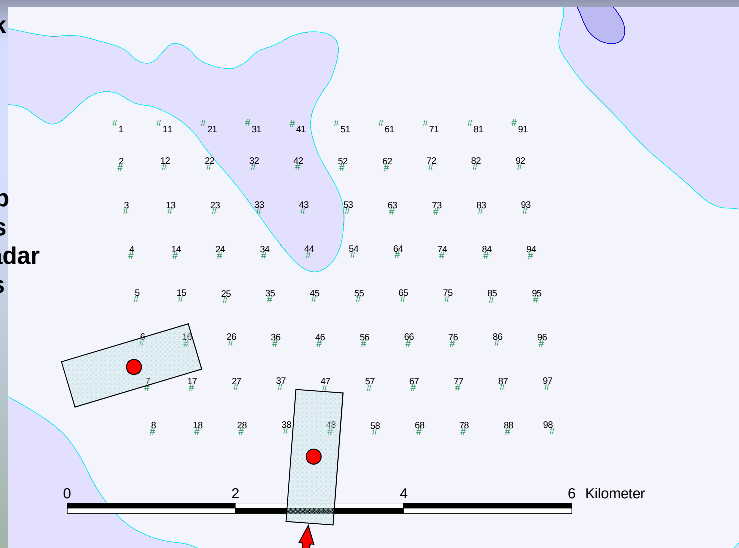
- **radar**
- **video**
- **acoustics**

Post-construction studies

e.g. Denmark Horns Rev

Denmark North Sea

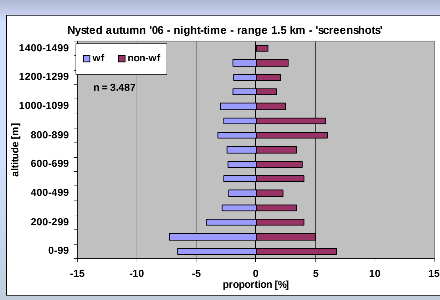
Platform ship synchronous visual and radar observations

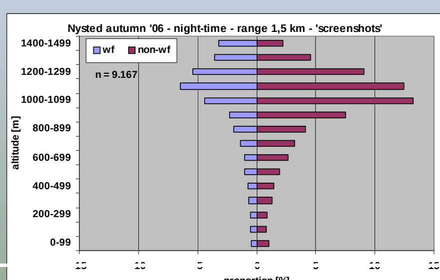


Bio Consult SH

Post-construction studies

Altitude distribution < 1,500 m at night; low vs. intense migration

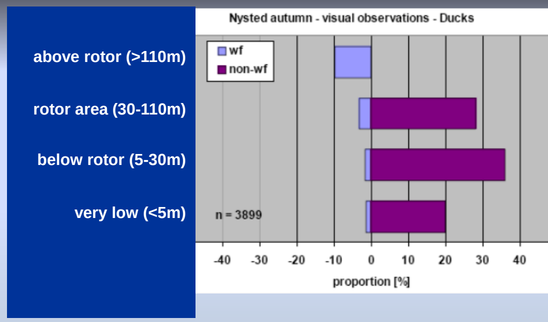


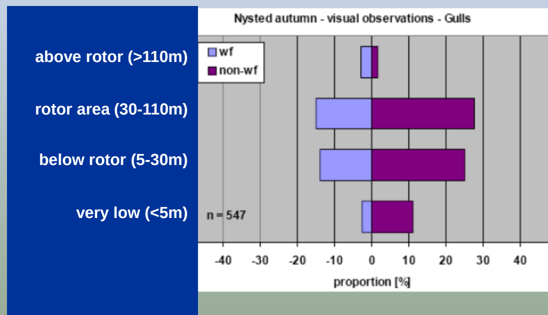


Proportions of birds in altitude bands		
low migration		
	wf	non-wf
< 200 m	13,8	11,8
< 500 m	23,1	21,6
intensive migration		
	wf	non-wf
< 200 m	1,0	1,8
< 500 m	2,9	5,4

Bio Consult SH

Post-construction studies





Altitude distributions (+/- 1000 m)

Ducks –

avoid the wind farm area within rotor area

Gulls –

use wind farm area within rotor area

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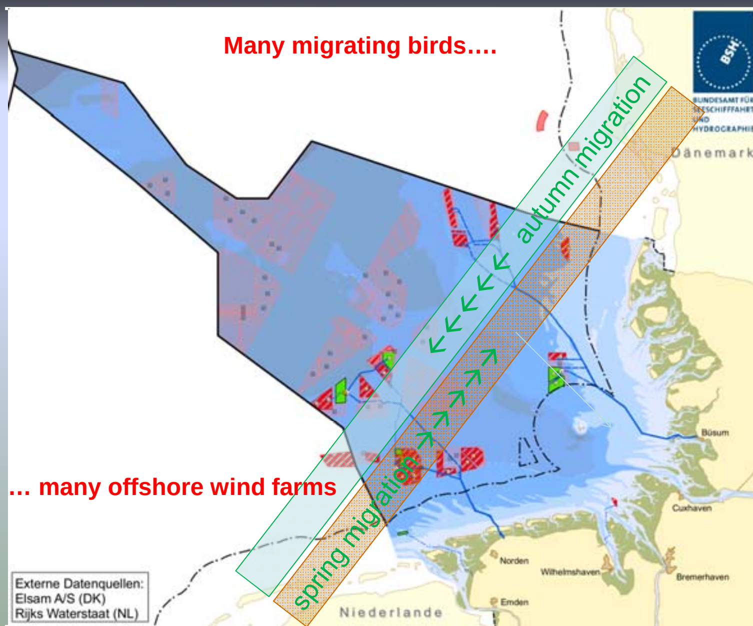
Bio Consult SH

Reference – methods – post-construction



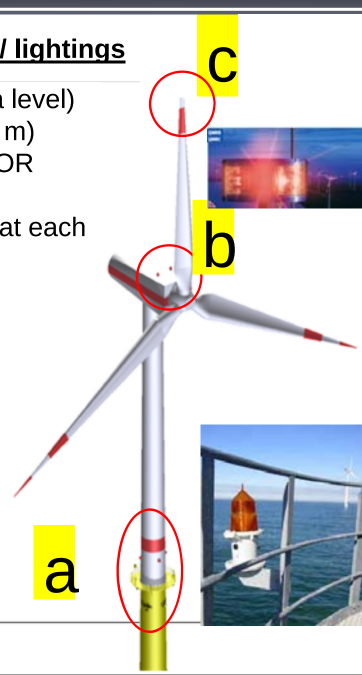
Bio Consult SH

Reference – methods – post-construction

Offshore wind mill with potential markings / lightings

Ship safety (a):
- yellow shaft (15 m above sea level)
- 3 x ID markings (letter size 1 m)
- illumination of ID markings OR illuminated ID
- 5 nm lights (yellow, blinking) at each peripheral wind mill

Air safety:
b) 2 x red blinking on nacelle
a) 4 x obstruction lights (red, permanent) on the mast
c) 3 x blade tip red lights, illuminated 60° before to 60° after the top height



SSC Montage SSC Windenergy Service

BOEM

February 26 – 28 2013

Pre –construction surveys

Strategic Environmental Assessment surveys.

Wide scale aerial surveys - DECC

Round 3 aerial surveys - The Crown Estate

PELAGICA environmental consultancy

Pre –construction surveys

2 years of monthly baseline surveys as a minimum.

Boat-based or aerial (or both),

2 km buffer as a minimum,

BACI or BAG methods.

PELAGICA environmental consultancy

Pre and Post-construction monitoring

Additional surveys can include:

Radio tracking breeding seabirds,

Radar studies for migrating species,

Land-based Vantage Point counts.

PELAGICA environmental consultancy

Post-construction monitoring

Post-construction monitoring is site specific but has often be ‘more of the same’.

Monitoring requirements are specified in the licence,

Three years of post-construction monitoring,

PELAGICA environmental consultancy

Post-construction monitoring

Specific studies have included:

Radar tracking studies on geese,

Migration studies,

PELAGICA environmental consultancy

What has been learned

Importance of:

Robust survey design,

Clearly defined monitoring conditions,

Publication of final reports.

What has been learned

Significant displacement of red-throated divers (loons),

Very high avoidance rate by migrating pink-footed geese,

Possible secondary impacts on Terns.

What has been learned

Barrier effects: Geese, gannets

Collision risk: Gulls and Terns
Geese, gannets

Displacement: Red-throated diver
Auks (?)

Secondary effects: Terns

BOEM

February 26 – 28 2013

Session 2

What would you do differently?

Robust survey designs

Enforced licence conditions

Published results

PELAGICA environmental consultancy

How have avian information needs changed over time

Good data on flight heights but poor data on avoidance behaviour

Improved understanding of displacement but poor understanding of effects.

PELAGICA environmental consultancy

How have avian information needs changed over time

Barrier effects appear not to be an issue

BUT

Cumulative impacts are becoming ever more critical.

PELAGICA environmental consultancy

Mitigation

Most effective mitigation is to identify sensitive sites and avoid them!

Raising turbine height (not been tried yet)

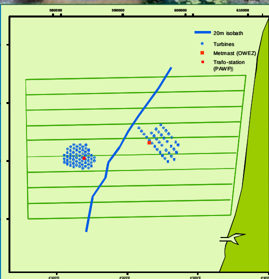
PELAGICA
environmental consultancy

Avian studies for offshore wind energy in The Netherlands

Sjoerd Dirksen

s.dirksen@buwa.nl @sjoerddirksen

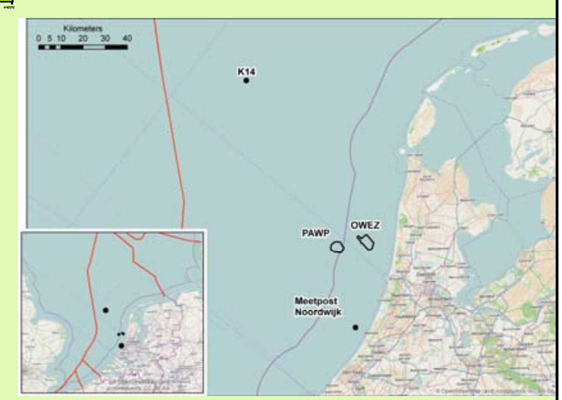
Bureau Waardenburg bv
Adviseurs voor ecologie & milieu



Two wind farms so far:

OWEZ (36, 108 MW), demonstration site

PAWP (60 120 MW)



Pre- and post construction studies

Pre:

• seabird at sea counts, ship-based (ESAS methodology) in wider area (X years, Y censuses)

• radar and observer studies on flying birds (local and migrating) from distant platform (X years)

Post:

• seabird at sea counts, ship-based (ESAS methodology) including second wind farm and anchoring area (X years, Y censuses)

• radar and observer studies on flying birds (local and migrating) from metmast (X years)

Not (yet) possible:

• collision victim monitoring

Lessons learned

- disturbance / habitat use / displacement
  good evidence for a range of species
- barrier effect / avoidance flying birds
  good evidence for a range of species
- patterns in fluxes and flight altitudes
  good measurements and description
- collisions
  no measurements, only flight behaviour/avoidance observations and modelling
- using population models, first steps on assessing cumulative impacts

Progress made, questions left

- collision rate and collision chance

  not an immediate worry, but uncertainty too big for current North Sea plans

  initiatives like UK JIP by The Crown Estate needed - this is bigger than individual windfarms
- cumulative impacts

  'the holy grail of offshore wind energy - bird research'

  North Sea wide cooperation needed

Species Protection and Offshore Wind Energy
The German Approach

- Introduction
- Prohibition of injury and/or killing of “specially protected species”
  - harbour porpoise and pile driving
  - **migrating birds (bats) and collision risk**
- Prohibition of significant disturbance of “strictly protected species”
  - **sea birds and offshore wind farms**
  - harbour porpoise and pile driving
- Research needs
- Conclusions

Legal framework
“Special Protection of Species”

German Federal Nature Conservation Act (2010)
Article 44:
Provisions on specially protected and certain animal and plant species

(1) It is prohibited,

1. … to injure or kill wild living specimens of the *specially* protected species …,
2. to significantly disturb specimens of *strictly* protected species and of the European bird species during the period of breeding, rearing, moulting, hibernation and migration; a disturbance becomes significant in case it impairs the conservation status of the local population of the species concerned,
3. … to deteriorate or to destroy breeding sites or resting places of wild living specimens of the specially protected species,
4. …

(1) *Specially* Protected Species

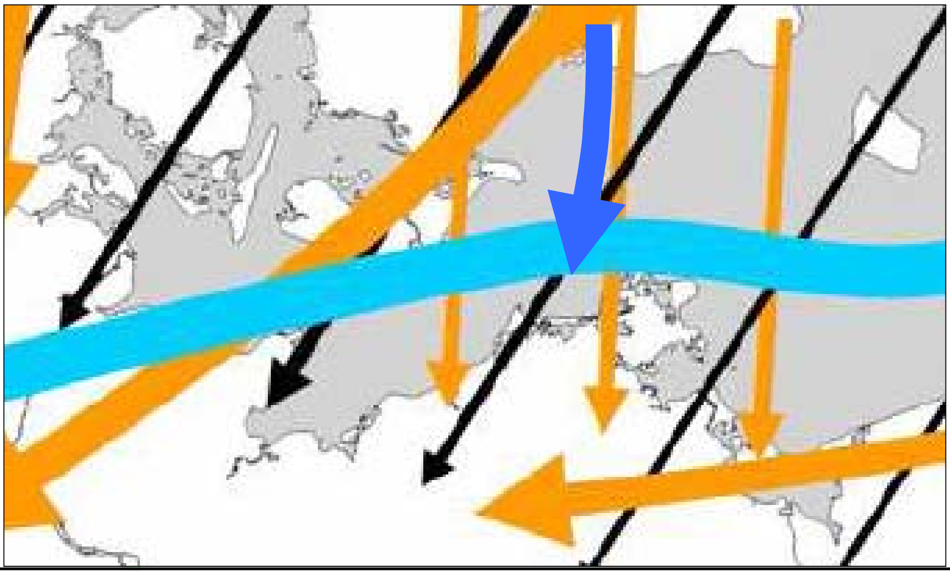
e. g, cetaceans, seals, bats, European bird species, some fish species (lampreys, sturgeon, eel etc.), some invertebrates (lobster, sun star, edible sea urchin etc.)

(2) *Strictly* Protected Species

e. g., cetaceans, bats, European bird species, sturgeon, houting, sun star

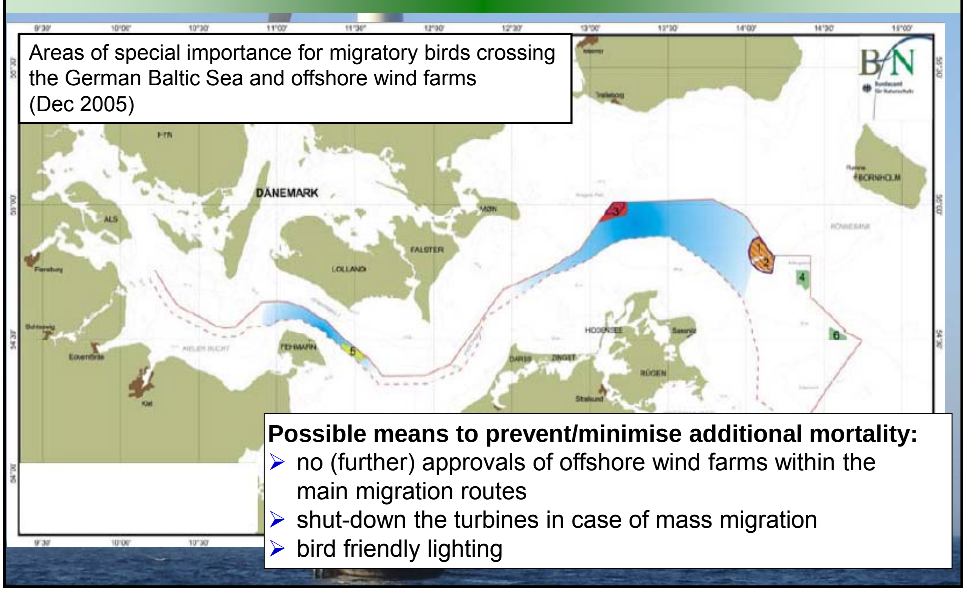
Prohibition of injury/killing

Migrating birds and offshore wind farms



Prohibition of injury/killing

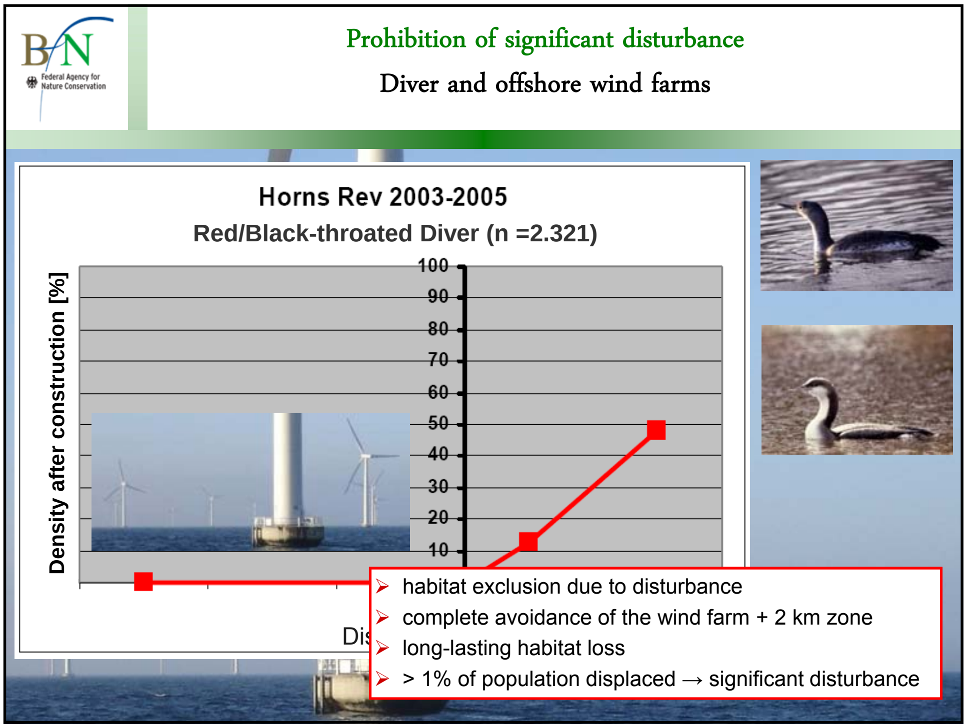
Migrating birds and offshore wind farms

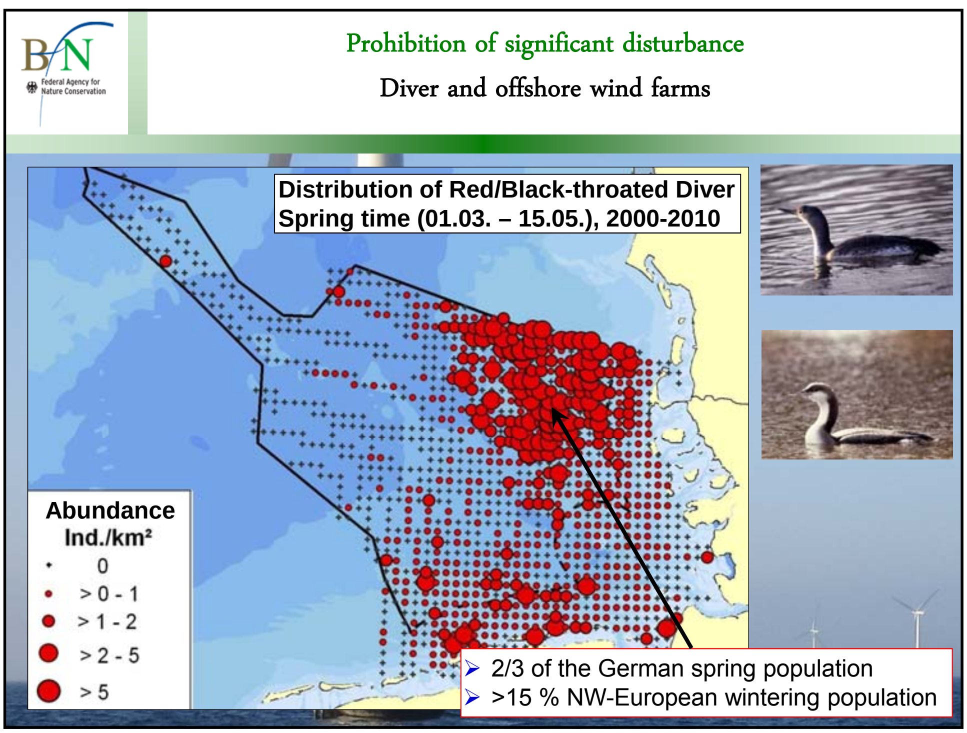


Areas of special importance for migratory birds crossing the German Baltic Sea and offshore wind farms (Dec 2005)

Possible means to prevent/minimise additional mortality:

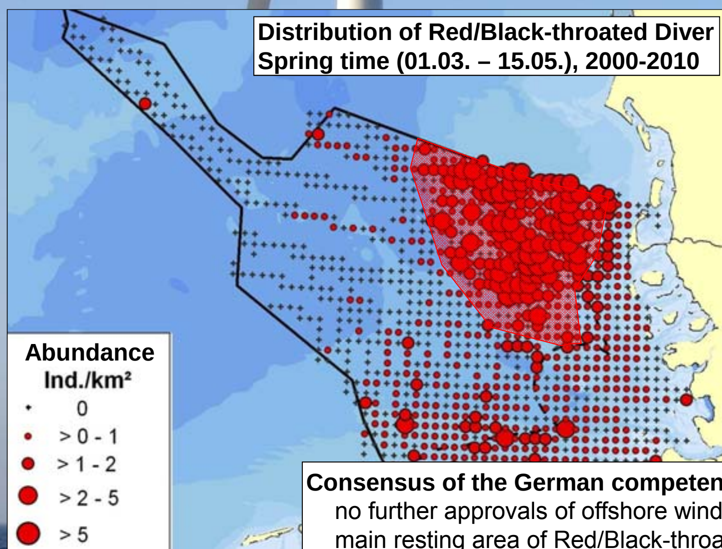
- no (further) approvals of offshore wind farms within the main migration routes
- shut-down the turbines in case of mass migration
- bird friendly lighting

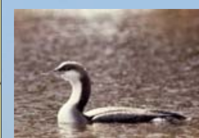

BfN
Federal Agency for Nature Conservation
Prohibition of significant disturbance
Diver and offshore wind farms
Horns Rev 2003-2005
Red/Black-throated Diver (n =2.321)
Density after construction [%]
100
90
80
70
60
50
40
30
20
10
habitat exclusion due to disturbance
complete avoidance of the wind farm + 2 km zone
long-lasting habitat loss
> 1% of population displaced → significant disturbance


BfN
Federal Agency for Nature Conservation
Prohibition of significant disturbance
Diver and offshore wind farms
Distribution of Red/Black-throated Diver
Spring time (01.03. – 15.05.), 2000-2010
Abundance
Ind./km²
0
> 0 - 1
> 1 - 2
> 2 - 5
> 5
2/3 of the German spring population
>15 % NW-European wintering population

Prohibition of significant disturbance

Diver and offshore wind farms

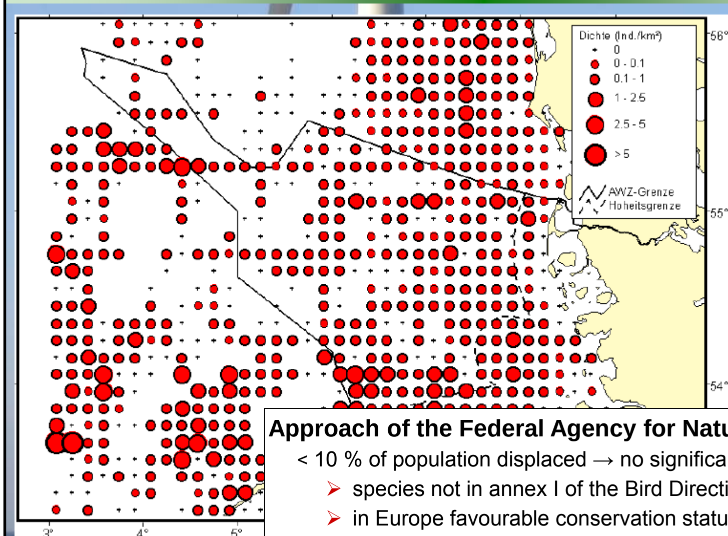


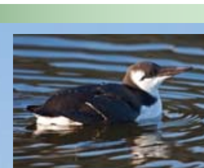


Consensus of the German competent authorities:
no further approvals of offshore wind farms within this main resting area of Red/Black-throated Diver

Prohibition of significant disturbance

Common Guillemot





Approach of the Federal Agency for Nature Conservation:

< 10 % of population displaced → no significant disturbance:

- species not in annex I of the Bird Directive
- in Europe favourable conservation status (Non-SPEC)
- in German North Sea < 1 % of the bio-geographic population

BfN Federal Agency for Nature Conservation

Research Needs

- spatial und temporal distribution marine species
- bird migration: routes and features
- impact of under water noise on marine mammals, fishes
- resting seabirds and species specific avoiding behaviour
- migrating birds (bats) and collision risk
- effects on population level
- under water noise (propagation, attenuation)
- cumulative and long-term impacts
- development technical mitigation measures

BfN Federal Agency for Nature Conservation

Conclusions

Protection of species has to be species specific as well as pressure specific.

To implement threshold for pressure levels, acceptable habitat loss etc. should be assigned.

Suitable mitigation measures should be applied:

- avoiding areas with high abundances of sensitive species;
- avoiding areas of special importance for *e.g.,* feeding, reproduction, migration corridors;
- excluding disturbing activities in sensitive times (*e.g.*, reproduction, lactation, spawning, high seasonal densities);
- application of technical mitigation measures (*e.g.,* noise reducing, switch off turning rotors, design of wind farm, bird friendly lightening);
- … .

Offshore Wind Energy Development Site Assessment and Characterization: Evaluation of the Current Status and European Experience

February 26-28, 2013, Herndorn, Virginia, USA

Development of Offshore Wind Energy and its Management in German Waters

Thomas Merck

German Federal Agency for Nature Conservation

Timeline for the Offshore Wind Energy Realisation in Germany

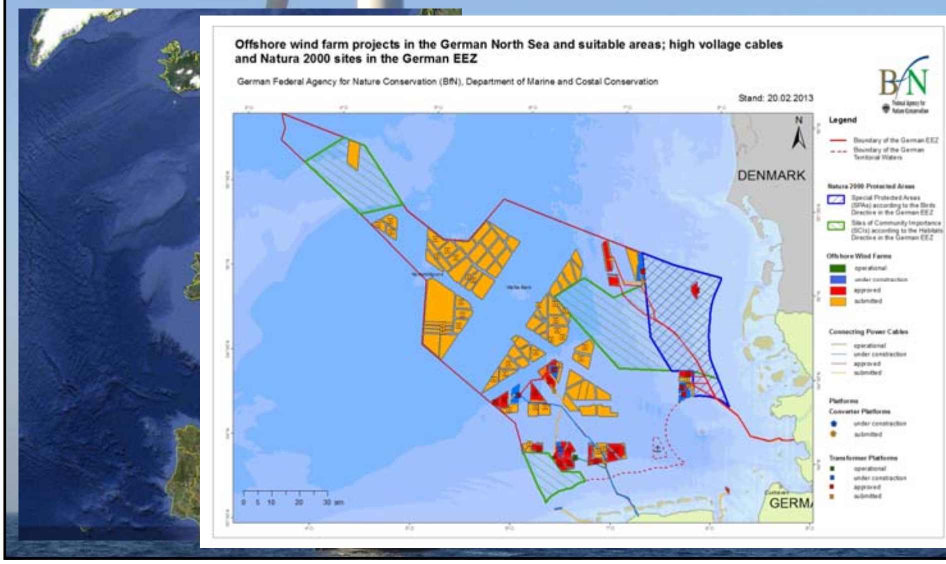
The German Government wants to expand the installed capacity up to **25 GW until 2030.**

Guiding principles (2002):

- Offshore wind energy should be used in an environmentally sound way.
- Therefor, the development should be accompanied by research on the environmental impacts.
- The development should follow a step-wise approach to enable the usage of growing environmental knowledge.

Phases	Period	Expected Capacity	Potential Power Yield
1. Preparational Phase	2001 - 2003	-- MW	-- TWh p.a.
2. Initial Phase (first construction phases)	2003/4 - 2006	at least 500 MW	ca. 1,5 TWh p.a.
3. First Expansion Phase	2007 - 2010	2.000 - 3.000 MW	ca. 7 - 10 TWh p.a.
4. Additional Expansion Phases	2011 - 2030	20.000 - 25.000 MW	ca. 70 - 85 TWh p.a.

Offshore Wind Development in Germany
North Sea



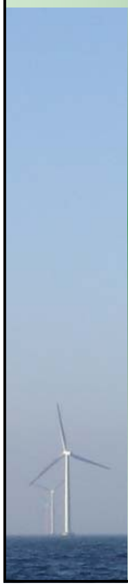
National Legal Framework for Wind Energy/German EEZ (I)

Marine Facilities Ordinance (SeeAnlV)

- Legal regulation for granting approvals
- An approval has to be granted unless the project:
  - is likely to impair the safety and efficiency of navigation
  - **poses a threat to the marine environment, in particular bird migration**
  - **is opposed to preconditions of spatial planning or to other overriding public interests**
- Competent authority:

  Federal Maritime and Hydrographic Agency (BSH)

National Legal Framework/ German EEZ (II)



Federal Nature Conservation Act (BNatSchG)

- **"Natura 2000" since 2002 national implementation EU-Habitat Directive**
- § 30 Protection of biotopes (since 2010)
- **§ 44 Protection of specific species (since 2010)**
- Impact regulation under nature protection law (with respect to Offshore Wind Energy only from 2017 on)
- Competent authorities:
  - Federal Agency of Nature Conservation (BfN) for species protection and protection of biotopes
  - Federal Maritime and Hydrographic Agency (BSH) for appropriate assessment report/habitat directive assessment, impact regulation under nature protection law

Legal framework "Special Protection of Species"

German Federal Nature Conservation Act (2010)
Article 44:
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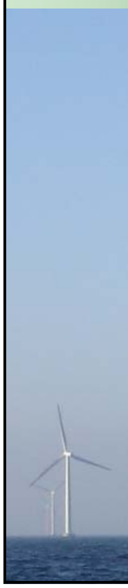
(2) Strictly Protected Species

e. g., cetaceans, bats, **European bird species**, sturgeon, houting, sun star

National Legal Framework/ German EEZ (III)



Renewable Energy Sources Act (EEG)

- aims at increasing the share of renewable energy sources in electricity supply
- defines *inter alia* the tariff paid for electricity gained from offshore installations
- **no tariffs paid for electricity from offshore projects licensed after December 2004 within designated Marine Protected Areas**

Regional Planning Act (ROG)

- purpose: resolving conflicts between different interests such as shipping, fishing, use of wind energy and marine environmental protection
- identifies suitable areas for the use of offshore wind energy
- **excludes via the Marine Facilities Ordinance offshore wind farms from marine protected areas**

National Legal Framework for Wind Energy/German EEZ (IV)

Environmental Impact Assessment Act (UVPG)

• requires EIA for wind farm projects comprising more than 20 turbines

Standards for the Environmental Impact Assessment (StUK)

- standardize the scientific basis of the EIA required by the approval authority
- providing information to applicants on the scope of environmental investigations:
  - investigation of the site specific abundance and distribution of various species groups and there temporal variability
  - monitoring the impact of the construction, operation and decommissioning on these species
  - forming the basis for assessing the suitability of the location and for identifying potential adverse impacts of the planned offshore project

BfN
Federal Agency for Nature Conservation

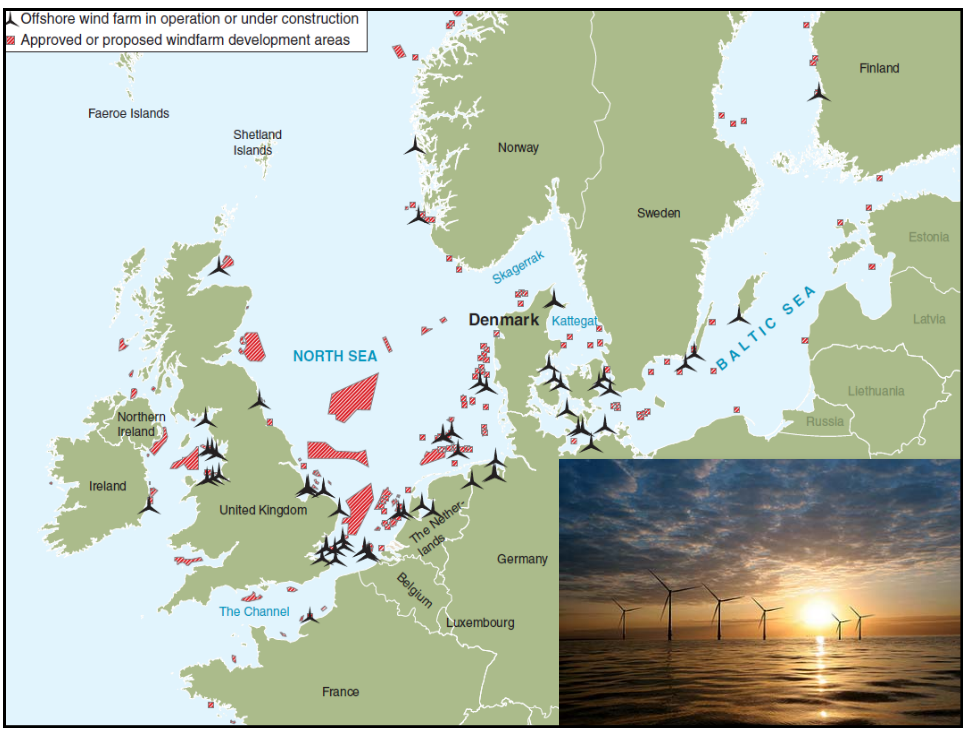
Offshore Wind Energy Development Site Assessment and Characterization: Evaluation of the Current Status and European Experience

February 26-28, 2013, Herndorn, Virginia, USA

Development of Offshore Wind Energy and its Management in German Waters

Thank you for your attention!


AARHUS
UNIVERSITY
DEPARTMENT OF BIOSCIENCE
BOEM 26. FEBRUARY 2013
Effects of offshore wind farms on birds
Ib Krag Petersen,
Anthony D. Fox,
Mark Desholm,
Johnny Kahlert and
Thomas K. Christensen
Department of Bioscience
Aarhus University
Denmark


Offshore wind farm in operation or under construction
Approved or proposed windfarm development areas
Faeroe Islands
Shetland Islands
Norway
Sweden
Finland
Estonia
Latvia
Lithuania
Russia
Skagerrak
Denmark
Kattegat
BALTIC SEA
NORTH SEA
Northern Ireland
Ireland
United Kingdom
The Netherlands
Germany
Belgium
Luxembourg
The Channel
France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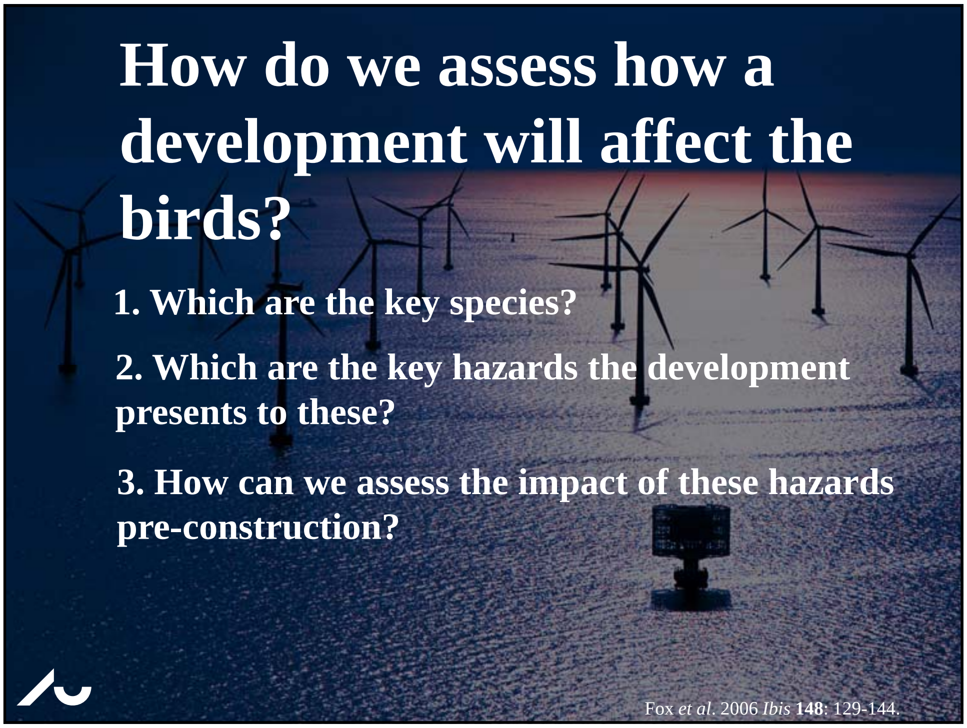
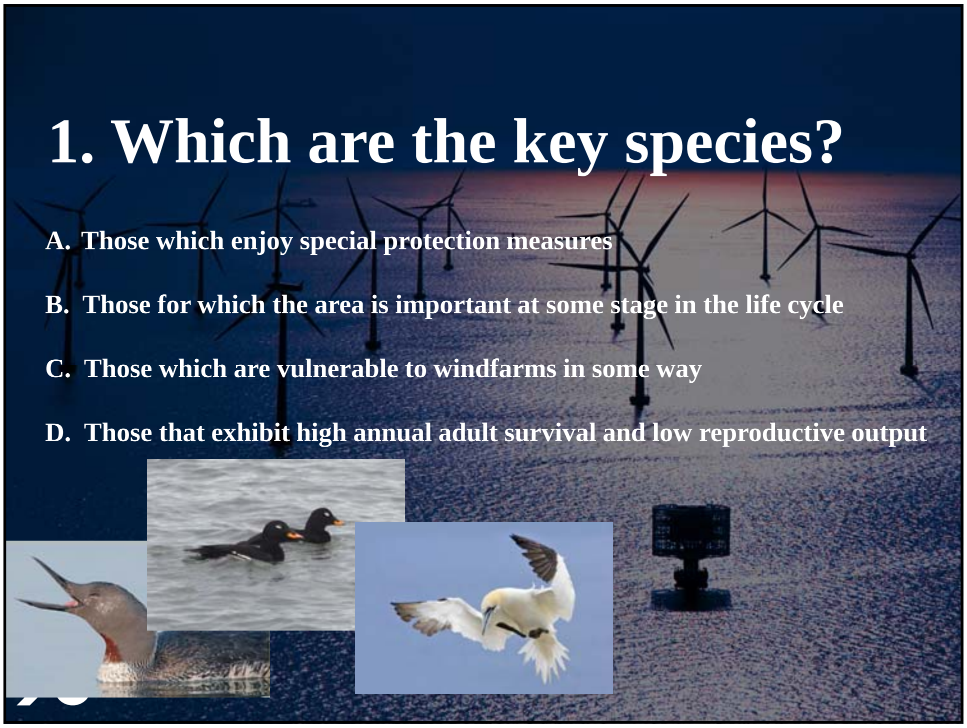
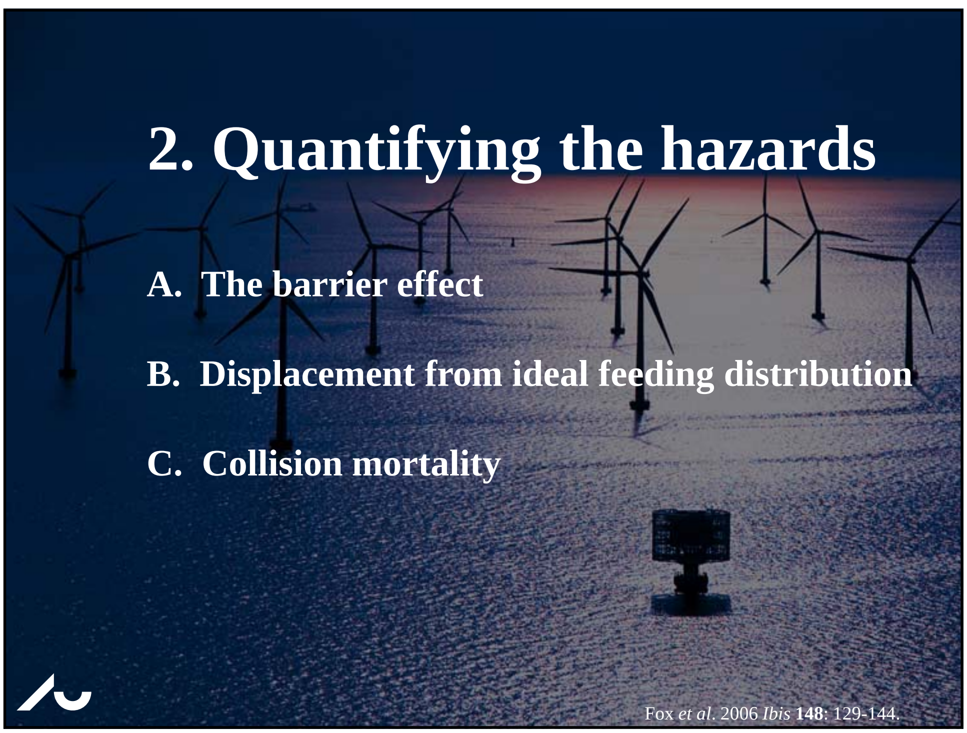
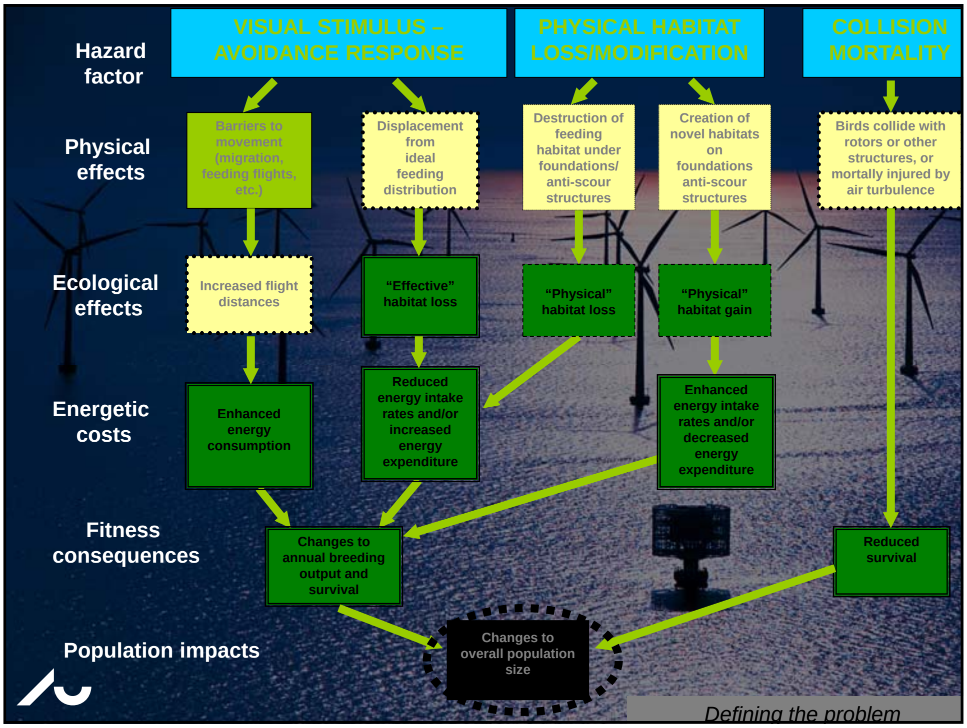
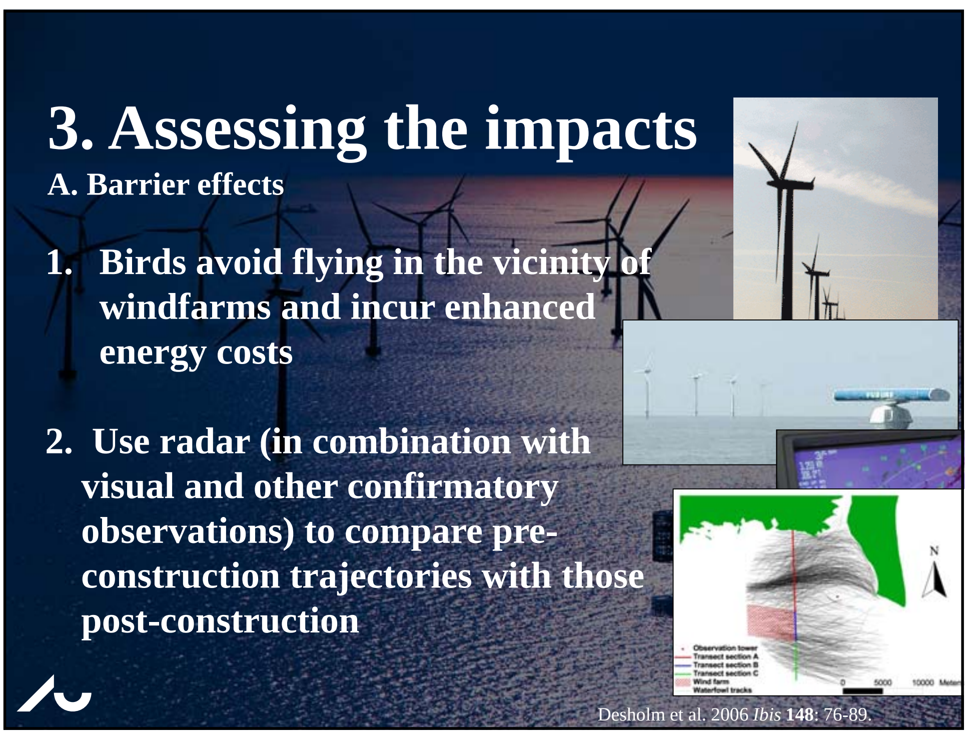
BOEM 26. FEBRUARY 2013
The legislative framework
European Union Directive (85/337/EEC) on Environmental Impact Assessments
(known as the EIA Directive)
applies to assessment of the environmental effects of major development projects.
European Union Directive (2001/42/EC) on Strategic Environmental Assessments
(known as the SEA Directive)
applies to environment impacts of implementation of major plans and programmes, including assessments of alternative solutions.

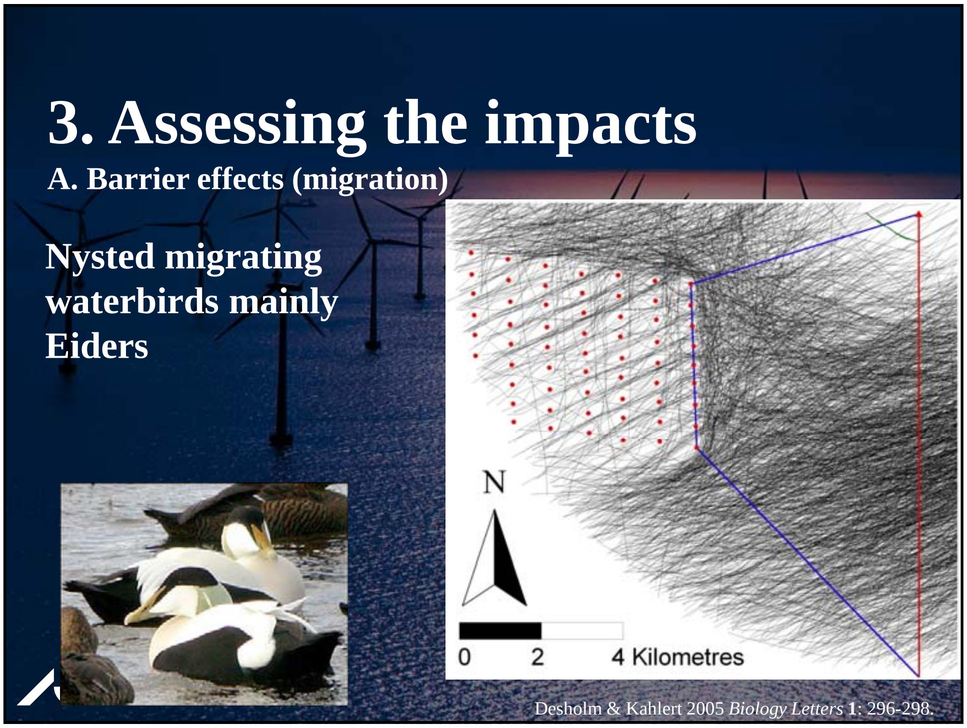

How do we assess how a development will affect the birds?
1. Which are the key species?
2. Which are the key hazards the development presents to these?
3. How can we assess the impact of these hazards pre-construction?
Fox et al. 2006 Ibis 148: 129-144.

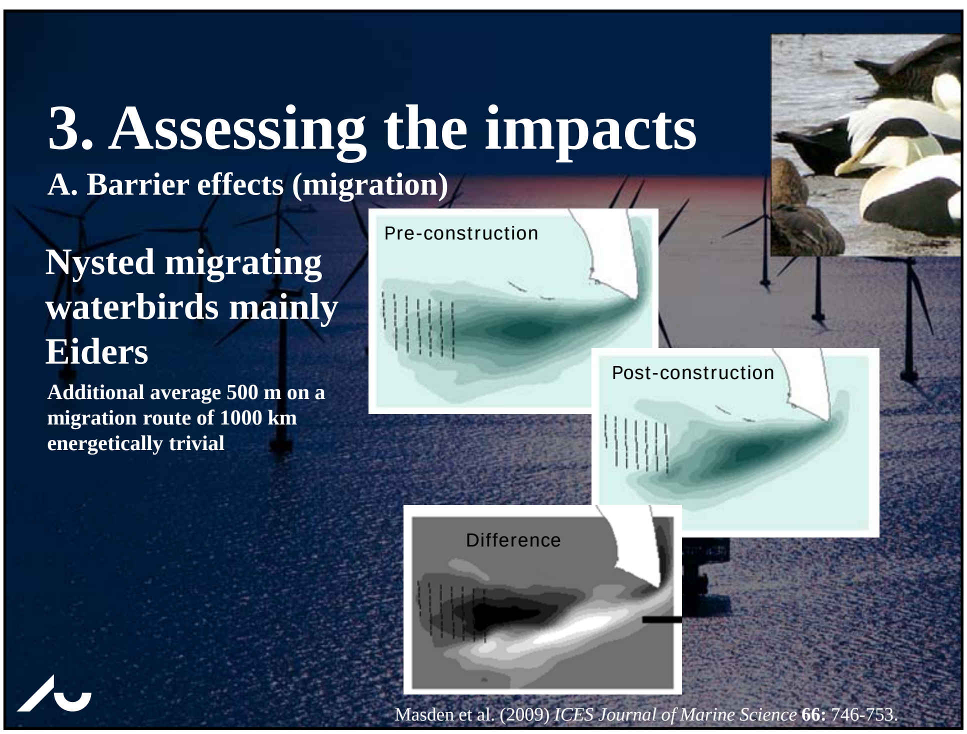

1. Which are the key species?
A. Those which enjoy special protection measures
B. Those for which the area is important at some stage in the life cycle
C. Those which are vulnerable to windfarms in some way
D. Those that exhibit high annual adult survival and low reproductive output


2. Quantifying the hazards
A. The barrier effect
B. Displacement from ideal feeding distribution
C. Collision mortality
Fox et al. 2006 Ibis 148: 129-144.


Hazard factor
VISUAL STIMULUS – AVOIDANCE RESPONSE
PHYSICAL HABITAT LOSS/MODIFICATION
COLLISION MORTALITY
Physical effects
Barriers to movement (migration, feeding flights, etc.)
Displacement from ideal feeding distribution
Destruction of feeding habitat under foundations/ anti-scour structures
Creation of novel habitats on foundations anti-scour structures
Birds collide with rotors or other structures, or mortally injured by air turbulence
Ecological effects
Increased flight distances
"Effective" habitat loss
"Physical" habitat loss
"Physical" habitat gain
Energetic costs
Enhanced energy consumption
Reduced energy intake rates and/or increased energy expenditure
Enhanced energy intake rates and/or decreased energy expenditure
Fitness consequences
Changes to annual breeding output and survival
Reduced survival
Population impacts
Changes to overall population size
Defining the problem


3. Assessing the impacts
A. Barrier effects
1. Birds avoid flying in the vicinity of windfarms and incur enhanced energy costs
2. Use radar (in combination with visual and other confirmatory observations) to compare pre-construction trajectories with those post-construction
N
Desholm et al. 2006 Ibis 148: 76-89.


3. Assessing the impacts
A. Barrier effects (migration)
Nysted migrating waterbirds mainly Eiders
N
0 2 4 Kilometres
Desholm & Kahlert 2005 *Biology Letters* **1**: 296-298.


3. Assessing the impacts
A. Barrier effects (migration)
Nysted migrating waterbirds mainly Eiders
Additional average 500 m on a migration route of 1000 km energetically trivial
Pre-construction
Post-construction
Difference
Masden et al. (2009) *ICES Journal of Marine Science* **66:** 746-753.

3. What were the impacts?

A. Barrier effects

- Responses highly species specific, but most species avoided wind farms
- Most showed gradual avoidance at long distance, others more dramatic deflections <1 km from outermost turbines
- c.75% of bird radar tracks heading for both wind farms at 1.5-2 km avoided going through them, at night birds flew at great heights
- Mean additional flight distance was 500 m, so energetically trivial for 1000 km migrants
- More of a problem for commuting birds, although effects differed greatly between species (due to foraging ecology, energetics etc.)
- Bayesian models can use avoidance data to inform upon wind farm design configurations to minimise effects

3. Assessing the impacts

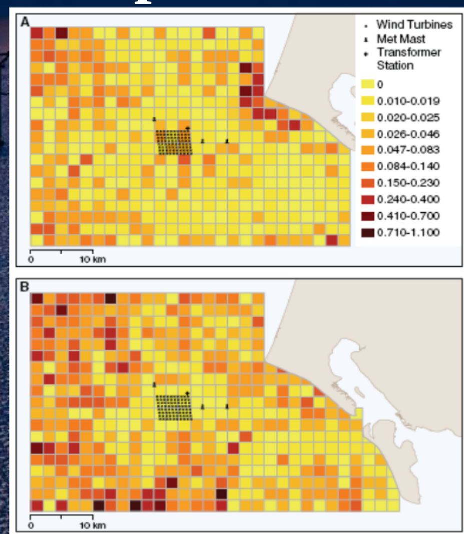
B. Displacement

3. Assessing the impacts

B. Displacement

Red-throated Divers have very rarely been seen between the turbines since construction

A. Pre-construction
B. Post-construction

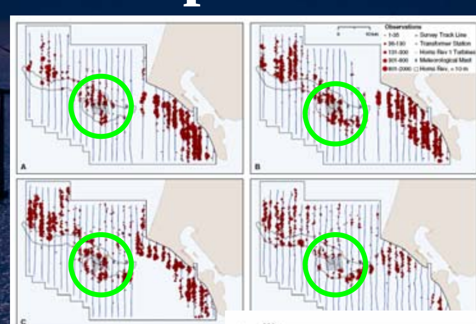


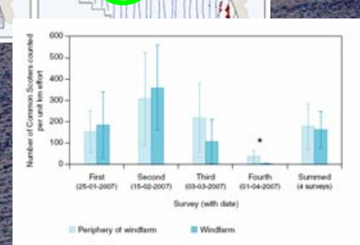
Petersen et al. (2006) available via http://www.ens.dk/sw42149.asp

3. Assessing the impacts

B. Displacement

Common Scoter avoided the vicinity of the wind farms for the first five years post construction, but subsequently occur between turbines at the same densities as outside



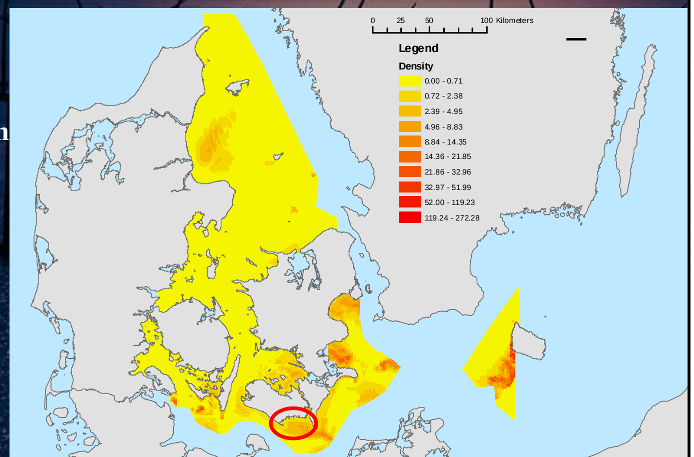


Petersen & Fox (2007) available at http://www.vattenfall.se/sv/file/Horns-Rev-Habitat-Changes_11336653.pdf

3. Assessing the impacts

B. Displacement

Long-tailed duck has a restricted distribution in Danish waters



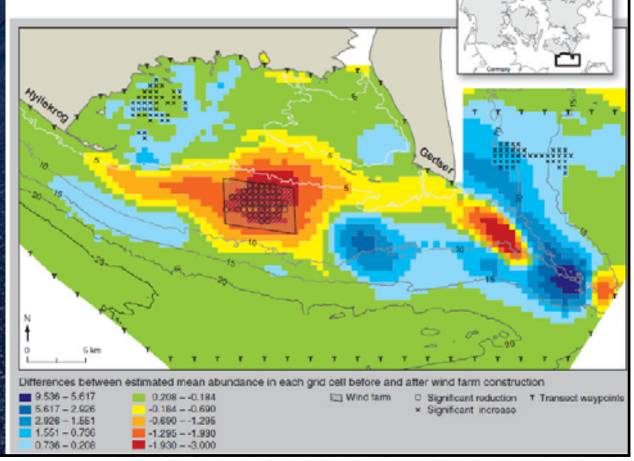
Petersen et al. (2006) available at http://www2.dmu.dk/Pub/FR606.pdf

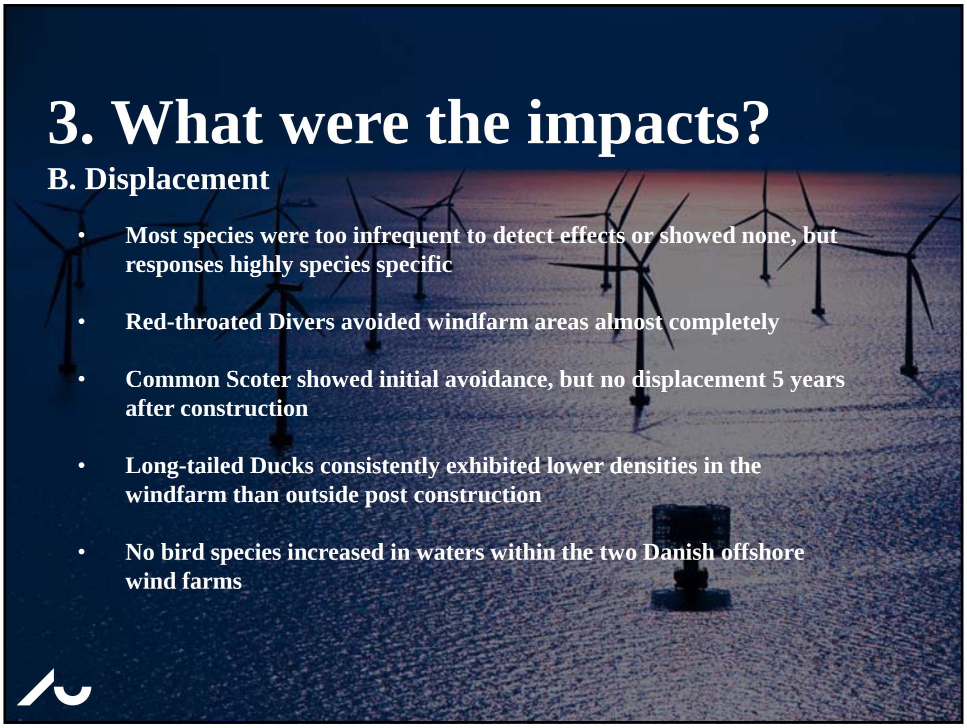
3. Assessing the impacts

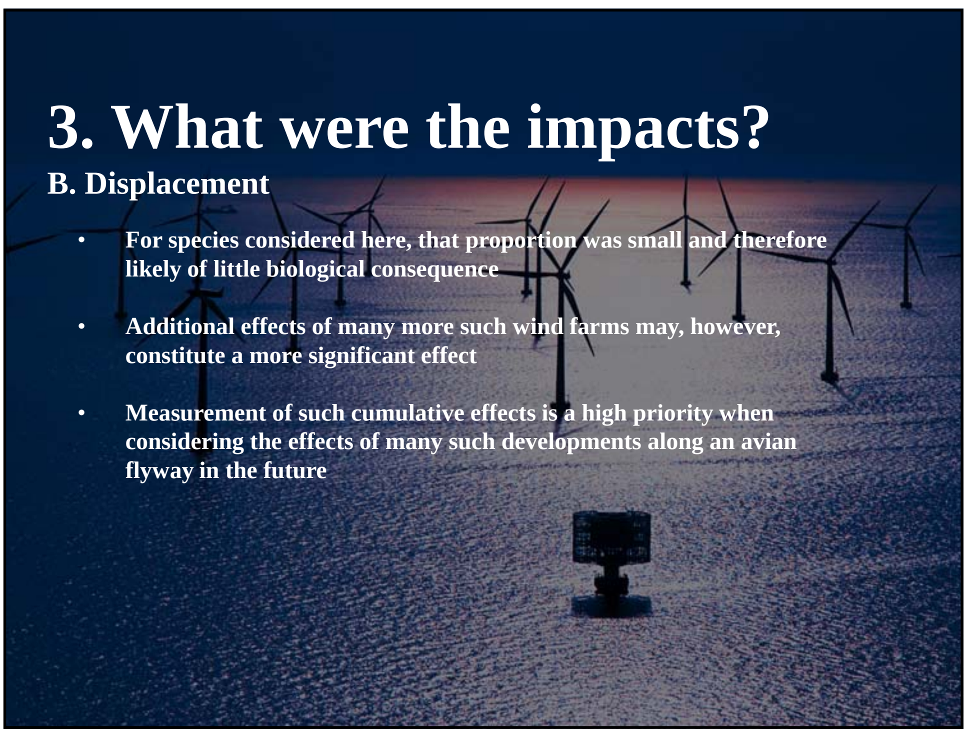
B. Displacement

… but at the Nysted site, Long-tailed duck showed significant reductions in density post construction compared to pre-construction

Petersen et al. (2011) available at http://research-repository.st-andrews.ac.uk/handle/10023/2008.




3. What were the impacts?
B. Displacement
• Most species were too infrequent to detect effects or showed none, but responses highly species specific
• Red-throated Divers avoided windfarm areas almost completely
• Common Scoter showed initial avoidance, but no displacement 5 years after construction
• Long-tailed Ducks consistently exhibited lower densities in the windfarm than outside post construction
• No bird species increased in waters within the two Danish offshore wind farms


3. What were the impacts?
B. Displacement
• For species considered here, that proportion was small and therefore likely of little biological consequence
• Additional effects of many more such wind farms may, however, constitute a more significant effect
• Measurement of such cumulative effects is a high priority when considering the effects of many such developments along an avian flyway in the future

3. Summing up

Effective habitat loss was caused by behavioural displacement, but at Horns Rev/Nysted was highly species specific and not biologically significant

Flying birds avoided both wind farms at a variety of levels; those entering between turbines showed clear behavioural changes minimised collision risk

Collision risk modelling suggested very low levels of collisions amongst the Common Eiders at Nysted, confirmed by direct observations

3. Summing up

More emphasis on Strategic Impact Assessment to zone developments to avoid early unnecessary conflicts and minimise impacts at individual project level

We need to invest in new modelling approaches to guide wind farm design (with regard to the geometric placing of individual turbines) to avoid barrier effects

All our reports, results and outputs can be accessed at:

http://www.ens.dk/da-DK/UndergrundOgForsyning/VedvarendeEnergi/Vindkraft/Havvindmoeller/Miljoepaavirkninger/Sider/Forside.aspx

BOEM's Avian Offshore Program

Avian Breakout Session

February 26, 2013

David Bigger, Ph.D.
Avian Biologist
Office of Renewable Energy Programs
Bureau of Ocean Energy Management

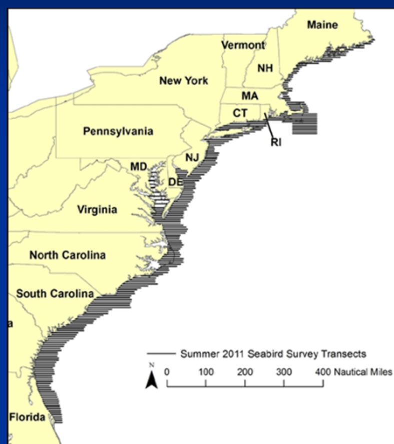
1

Research Efforts

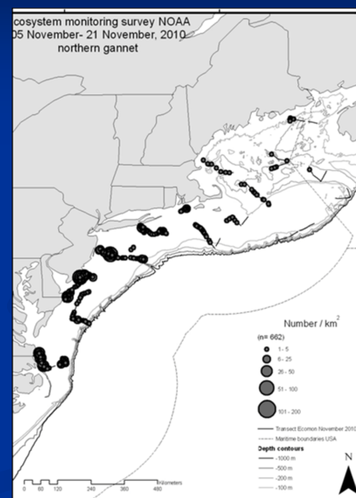
- Technology development
- Compiling survey information
- Identifying vulnerable avian species
- Mapping avian distribution and abundance
- Estimating number of surveys needed
- Identifying migration routes

2

Atlantic Marine Assessment Program for Protected Species



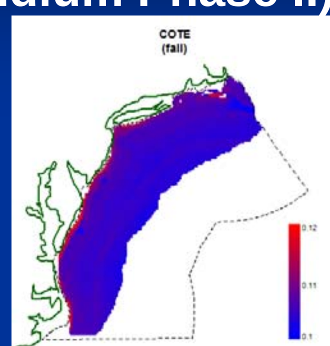
Surveying for Marine Birds in the Northwest Atlantic



3

Predictive Modeling of Seabirds in the Mid-Atlantic

(Avian Compendium Phase II)

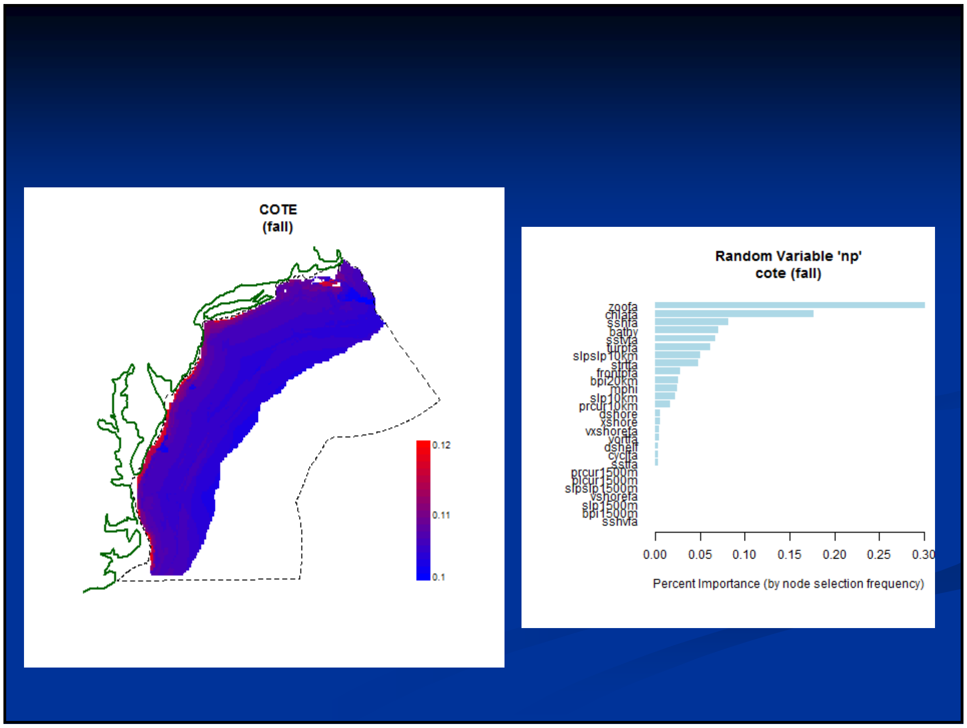


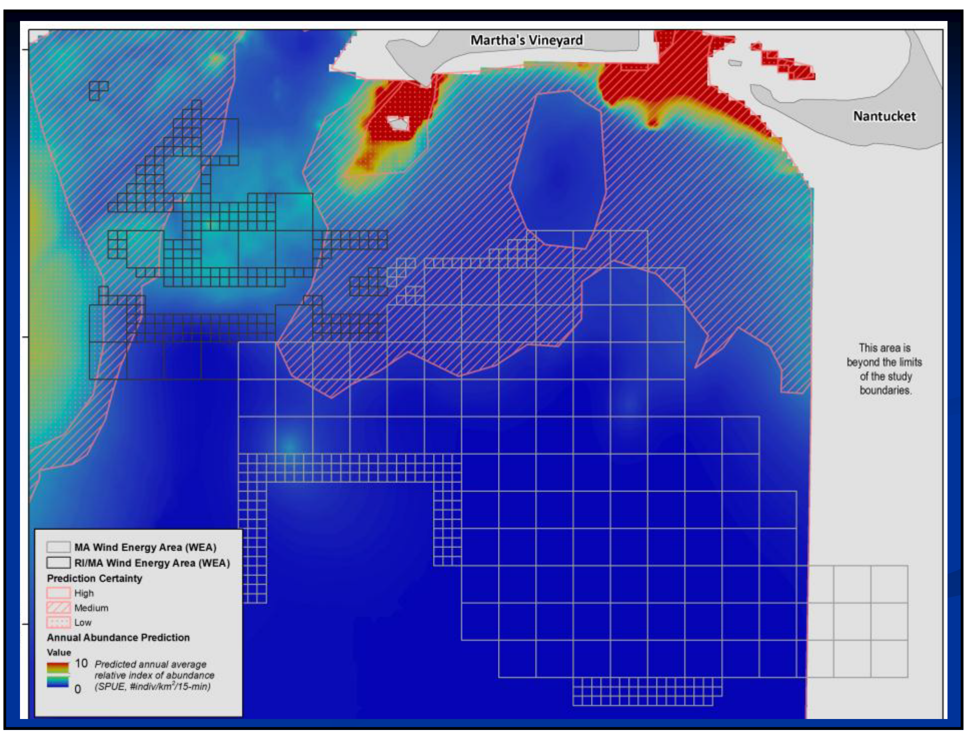
BOEM-funded collaboration between USGS Patuxent Wildlife Research Center and NOAA NCCOS. Goals:

- Develop predictive spatial models of long-term average patterns of seabird abundance and occurrence in the Mid-Atlantic Bight
- Validate products and characterize uncertainty
- Provide useful map products to support offshore wind siting and environmental assessment

Collaboration between USGS and NOAA: Brian Kinlan (NOAA), Chris Caldow (NOAA), Allan O'Connell (USGS), Mark Wimer (USGS)

Project started Fall 2011, maps available early 2013


COTE
(fall)
0.12
0.11
0.1
Random Variable 'np'
cote (fall)
zoofa
chlafa
sshfa
bathy
sstvfa
turpfa
slpslp10km
strtfa
frontpfa
bpi20km
mphi
slp10km
prcur10km
dshore
xshore
vxshorefa
vortfa
dshelf
cyclfa
sstfa
prcur1500m
plcur1500m
slpslp1500m
vshorefa
slp1500m
bpi1500m
sshvfa
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Percent Importance (by node selection frequency)


Martha's Vineyard
Nantucket
This area is beyond the limits of the study boundaries.
MA Wind Energy Area (WEA)
RI/MA Wind Energy Area (WEA)
Prediction Certainty
High
Medium
Low
Annual Abundance Prediction
Value
10
0
Predicted annual average relative index of abundance (SPUE, #indiv/km²/15-min)

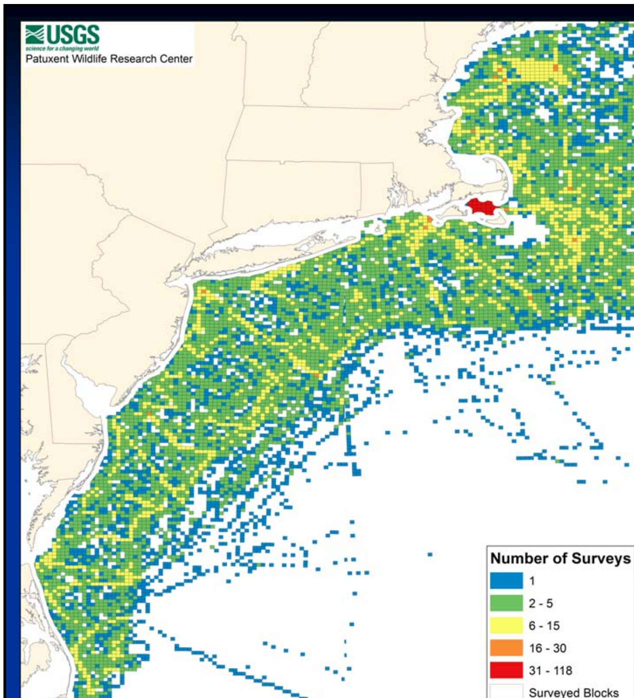
Statistical analyses to support guidelines for marine avian sampling

Brian Kinlan (NOAA)
Elise F. Zipkin (USGS)
Allan F. O'Connell (USGS)
Allison Sussman (USGS)
Mark Wimer (USGS)
Chris Caldow (NOAA)

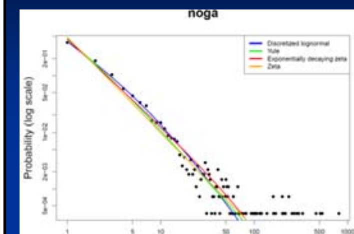
Special thanks to our NOAA Hollings Scholar,
Diana Rypkema (Cornell University)

NOAA/NOS National Centers
for Coastal Ocean Science (NCCOS)
USGS Patuxent Wildlife Research Center

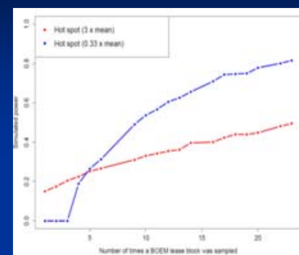
Report to BOEM—October 26, 2012



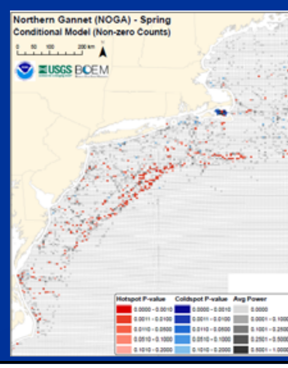
Model fit → Power Analysis



Model selection



Power curves



Power Maps & Significance tests

Guidelines for Avian Survey Information

- Survey plan should aim to:
  - Identify species using the project site
  - Establish a pre-construction baseline
  - Reduce uncertainty in the baseline
  - Develop an approach to quantify substantial changes in distribution and abundance
- Pre-survey meetings
- Reporting
- Survey methodologies

10

Learn from the European Experience

- Overview of studies conducted
- Experience and hindsight
- Planning and siting criteria
- Monitoring
- Data and data collection

11

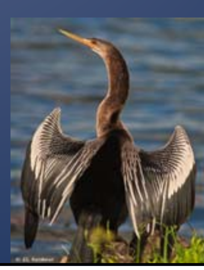
U.S. Fish and Wildlife Service

Conserving America's Trust Resources

Migratory Bird Program

Conserving America's Birds

The Migratory Bird Program is responsible for maintaining healthy migratory bird populations for the benefit of the American people



Migratory Bird Program

Migratory Bird Treaty Act

- Domestic statute that implements four international treaties for the protection of shared birds
- The take of 1 bird, *at any time, by any means, in any manner* is a violation of the law, without a permit
- Does not expressly authorize "unintentional take"
- It is important for project proponents to work with the Service to proactively find ways to avoid take

Migratory Bird Program

Conserving America's Birds

- Population Monitoring, Assessment and Management
- Habitat Conservation
- Permits and Regulations
- Consultation
- Communication and Outreach

Migratory Bird Program

Offshore Energy Interests

- Ensure the development of offshore energy in a manner that avoids or minimizes risk to birds
- Properly direct offshore energy siting in areas of low marine bird use
- Responsibility relates to Atlantic & Pacific Oceans, Gulf of Mexico, and Great Lakes

Challenges in the Face of Uncertainty

Assessing Effects

- Direct Effects
  - Collision risk – what makes a species vulnerable?
  - Effects of habitat modification/ "creation"
  - Effects of barriers on species movements
- Indirect Effects
  - Effects on behavior, including changes in energetics
  - Disturbance and displacement

Challenges in the Face of Uncertainty

Improving Baseline Data

- Species distribution and abundance
  - Through the entire annual-cycle
- Habitat relationships
  - Why are species found where they are?
- Assessing methods through new technology

Partnerships

The Power of Collaboration

- Offshore environment is challenging
- We know less about it – lack of baseline
- It is very dynamic – changes can be rapid
- Requires input from many
  - Federal Partners
  - State partners
  - Academic Institutions
  - Conservation Groups

Partnerships

Avian Information and GIS Database

- A database housing historic seabird data is being developed
  1. Collect, evaluate, standardize, and summarize existing data sets
  2. Use the seabird data to model seabird occurrence using physical, chemical, and biological variables
  3. Compile seabird data into spatial database

BOEM Bureau of Ocean Energy Management

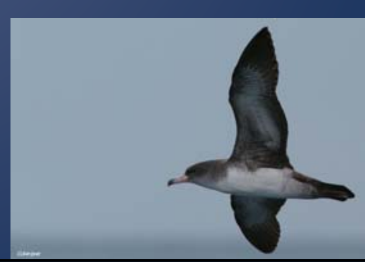
USGS science for a changing world

Partnerships

BOEM Bureau of Ocean Energy Management

Broad Scale Seabird Surveys Maine to North Carolina

- Five year project – (2009-2014)
- Use of “ships of opportunity” to study annual variability of seabird abundance
- Time-series methods to evaluate bird/plankton co-occurrence used



Partnerships

Diving Bird Study

- Two year study to assess fine-scale occurrence and local movement patterns
- Red-throated Loon, Surf Scoter, Northern Gannet
- Result in detailed maps of movement patterns and distribution of birds in winter

Partnerships

Sea Duck and AMAPPS Marine Bird Surveys

- 2008 – present – aerial offshore transects
  1. Provide estimates of wintering seabird abundance
  2. Information on regional distributions and critical areas for marine birds
- Covers Atlantic Coast – Florida to Maine
- Transects perpendicular to coast to 30 m contour

Lessons Learned from European Experience

What we hope to gain from this week

- Insight into pitfalls and panacea
  - What worked and what didn't?
- Ideas on how to create a consistent approach to offshore energy development
- Ways to ensure that pre- and post-construction assessments are linked together
- Technology that benefitted the process

Specific Questions

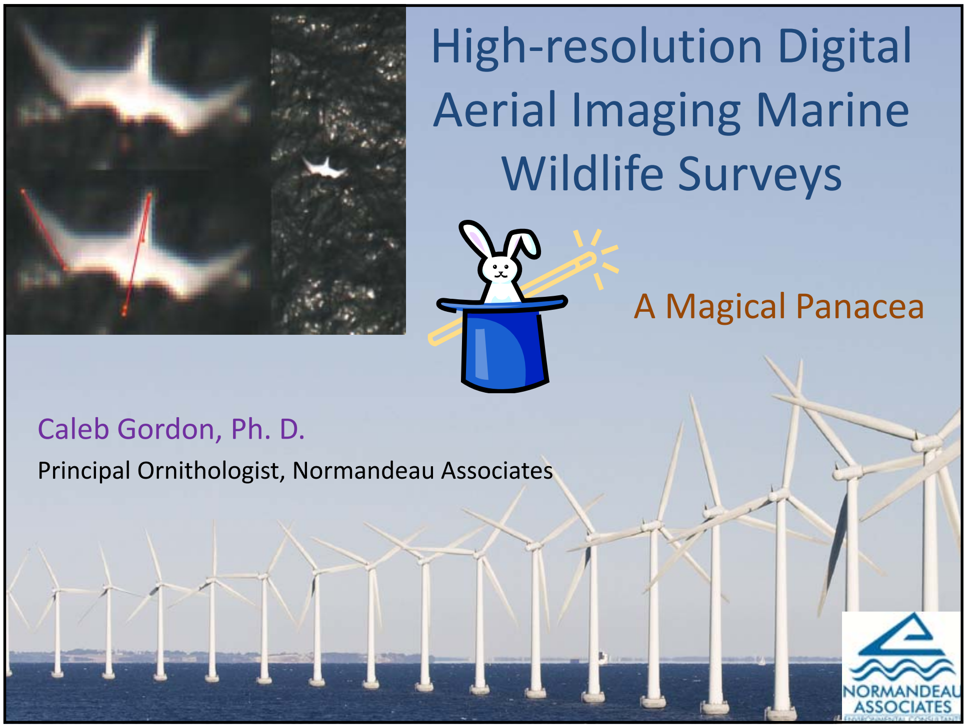
Based on what has been learned in Europe

- What effects are being documented?
  - What has the time frame for detecting effects? Timelag?
- What data are needed to evaluate these effects?
- What is the geographic scale we should be collecting baseline data?

Specific Questions

Based on what has been learned in Europe

- What data was *not* collected that should have been?
- What data *was* collected that you would not collect again?
- What is the value of post-construction monitoring?



High-resolution Digital Aerial Imaging Marine Wildlife Surveys
A Magical Panacea
Caleb Gordon, Ph. D.
Principal Ornithologist, Normandeau Associates
NORMANDEAU ASSOCIATES

A Technological Revolution Born in Europe…
Pioneering European Research on High Resolution Imaging Applications for Offshore Wind-Wildlife Studies
•Thaxter, C. B. and Burton, N. H. K. 2009. High Definition Imagery for Surveying Seabirds and Marine Mammals: A Review of Recent Trials and Development of Protocols. British Trust for Ornithology Report Commissioned by Cowrie Ltd.
•Burt, M. L., Rexstad, E. and S. T. Buckland. 2009. Comparison of visual and digital aerial survey results of avian abundance for Round 3, Norfolk Region. COWRIE Ltd.
•Rexstad, E. and Buckland, S. T. 2009. Comparison of aerial survey methods for estimating abundance of common scoters. CREEM technical report 2009-1.
•Buckland, S. T., Burt, M. L., Rexstad, E. A., Mellor, M., Williams, A. E. and Woodward, R. 2012. Aerial surveys of seabirds: the advent of digital methods. Journal of Applied Ecology doi: 10.1111/j.1365–2664.2012.02150.x
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…And Brought to the U.S. for Testing

- Aerial High-Resolution Imaging Pilot Study, BOEM contract M10PC00099 to Normandeau Associates
- Objective

  Determine optimal technology and methodology for conducting high-resolution aerial ocean wildlife surveys in the U.S.
  - Birds, marine mammals, and sea turtles
  - Evaluation criteria: Cost, Effectiveness, Safety
- Scope

  Conduct pilot studies, evaluate and make recommendations on technology and methodology, develop large area survey protocol
- Key Partners

Boulder Imaging	AIS observers
IA tech, Inc. (unmanned aircraft)	ECOES, inc.
Gemini Renewables	Pinnacle 1 Aviation
British Trust for Ornithology	

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Integration of the Imaging System, Raleigh, NC April, 2011

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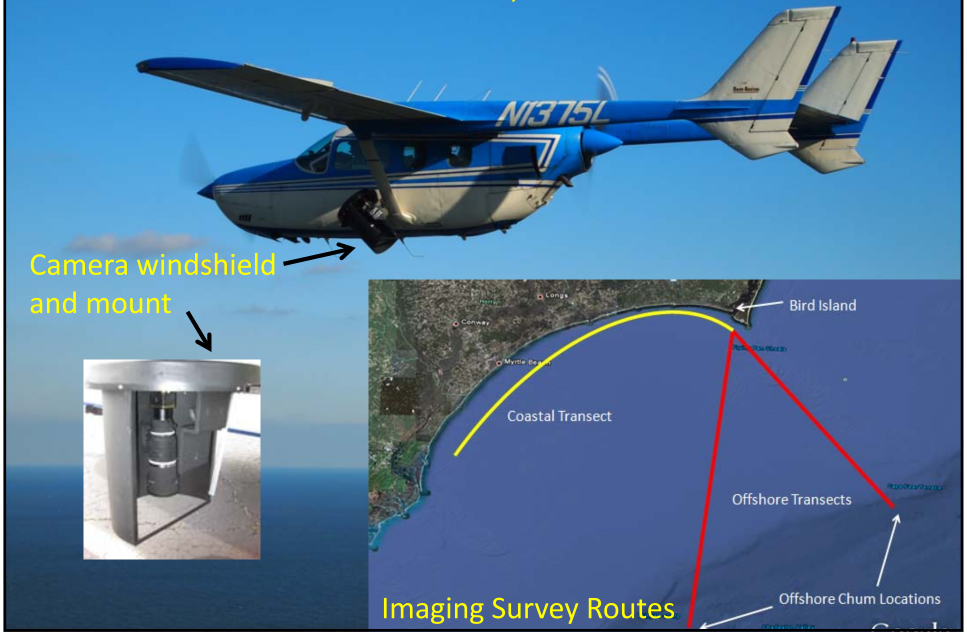
"Op house" Experiments, May 10-20, 2011 off of Oak Island, NC



Experimental Design

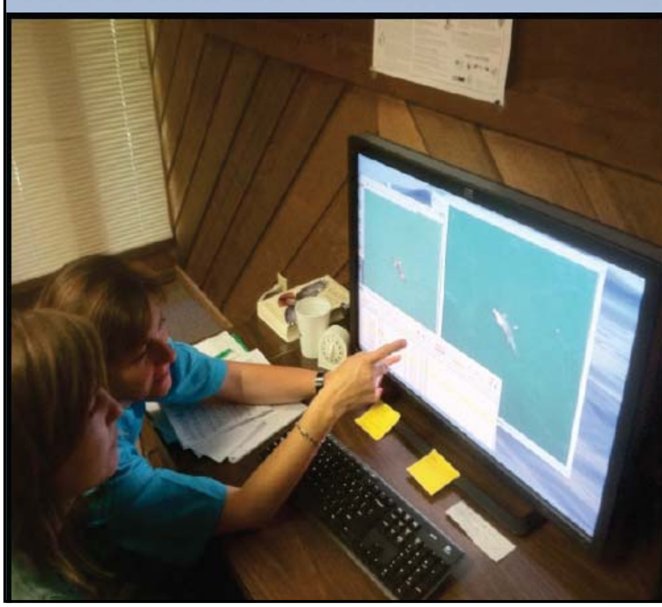
Treatment Factor	Treatments				
Aircraft	Twin-engine manned fixed wing	Unmanned Aerial Vehicle			
Resolution	1 cm	1.5 cm	2 cm	2.5 cm	3 cm
Camera Type	Area Scan	Line Scan			
Light Polarization	With	Without			
Angle	0^0	15^0	44^0		
Altitude	1200m	1000m	850m	600m	450m
Gyroscopic Stabilization	With	Without			

"Control" Surveys

- Visual Observer Plane (also Cessna 337)
  - Four observers on board (one bird, one mammal/turtle observer on each side)
  - 150 m flight altitude
  - 125 mph flight speed
  - trailed experimental imaging flights, same transects
  - gathered animal and met data

- Visual Observer Boat (40 ft fishing vessel)
  - Four observers on board (one bird, one mammal/turtle observer on each side)
  - ca 16 knots, depending on weather
  - gathered animal and met data
  - displaced transects plus chumming

Image Analysis



- 9 TB imagery reviewed
- 236,349 images
- 4,465 animals found
  - 3163 birds
  - 77 sea turtles
  - 37 marine mammals
  - 1188 fish
- 0 technicians blinded

NORMANDEAU ASSOCIATES


Loggerhead Sea Turtle, 600m height, 1.5 cm resolution


Royal Tern, 600m camera altitude, 1.5cm resolution

American Oystercatchers, 600m camera altitude, 1.5cm resolution

Immature Northern Gannet, 1000m camera altitude, 2.5cm resolution


Magnificent Frigatebird
433m camera altitude, 1.5cm resolution


Immature Brown Pelican
433m camera altitude, 1.5cm resolution


Probable Audubon’s Shearwater
425m camera altitude, 1.5cm resolution


Wilson’s Storm Petrel
450m camera altitude, 1.0cm resolution

Cost: Planes are cheaper than boats

Cost comparison of transect surveys of single commercial project-sized marine area with different survey vehicles (platforms). Data from BOEM contract M10PC00099 to Normandeau

Platform	Transect duration	No of days	Total cost incl. crew	Comments
boat	41 hrs 2 mins	7	$12,600	
plane	6 hrs 14 mins	7	$5,445	out and back time 0.5 hrs

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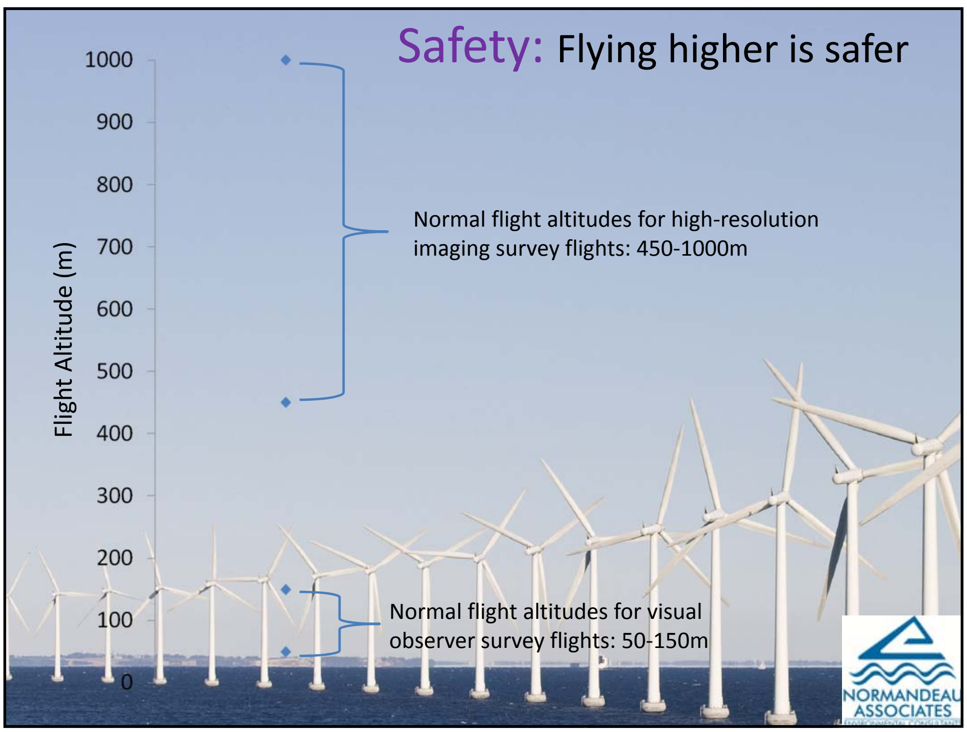
Safety: Flying higher is safer



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Effectiveness: Digital Surveys Generate Pre-observer Data

- Advantages of having a permanent, pre-observer data archive
  - Control/reduce observer effects
    - Control for variability among observers in
      - detection distances
      - ID skill
      - Search image (taxon-specific detection rates)
    - Eliminate Observer “swamping”
  - Enable post-hoc data qa/qc, cross checking and validation of results

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Effectiveness: Density Counts not Affected by Observer Swamping

Effectiveness: Density Counts not Affected by Attraction/Repulsion Effects

Mean estimated animal densities (animals/km^2) during "op house" transect surveys

Survey Type	Birds	Turtles	Cetaceans
Digital	0.383	0.182	0.018
Visual (plane)	0.143	0.043	0.004
Visual (boat)	0.948	0.019	0.933

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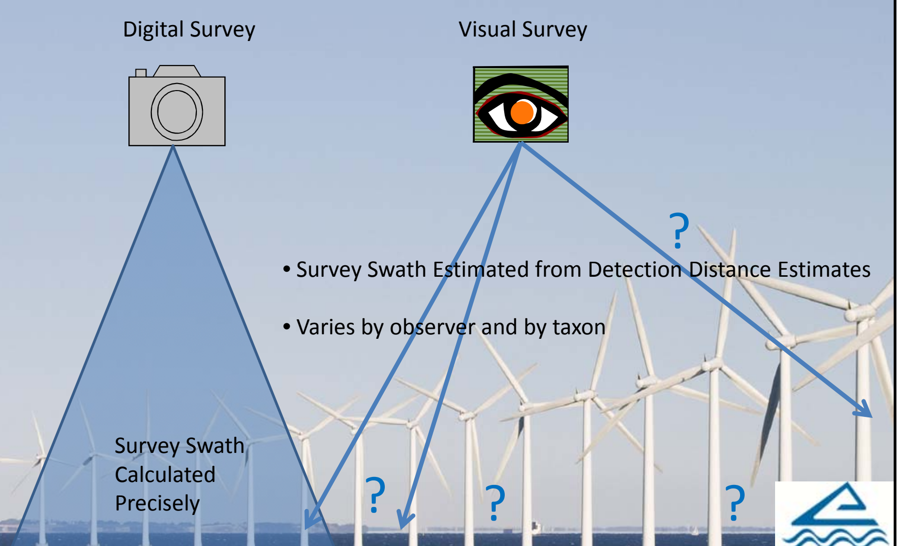
Effectiveness: Density Counts not Affected by Imprecise Distance Estimates



- Survey Swath Estimated from Detection Distance Estimates
- Varies by observer and by taxon

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Effectiveness: ID aided by morphometrics

	Wing Chord (cm)	Body Length (cm)	Tail Length (cm)	Bill Length (cm)
Royal Tern	35.7-38.2	45-50	14-17	6.2-6.5
Caspian Tern	37.4-43.3	48-56	12-15.2	6-7
Sandwich Tern	28.0-31.1	34-45	11.7-13.7	4.7-5.7
Common Tern	**26.2-27.1**	**31-37**	**14.8-15**	**3.6-3.8**
Forster's Tern	25.8-27.2	33-36	16-19.3	3.5-4.2
Roseate Tern	22.8-23.2	33-41	17.5-18.5	3-3.9
Arctic Tern	25.4-28.5	33-39	7.2-12.6	2.8-3.8
Least Tern	15.3-18.0	22-24	6-8	2.4-3.2
Bird in figure	***26***	***36***	***14.4***	***3.6***

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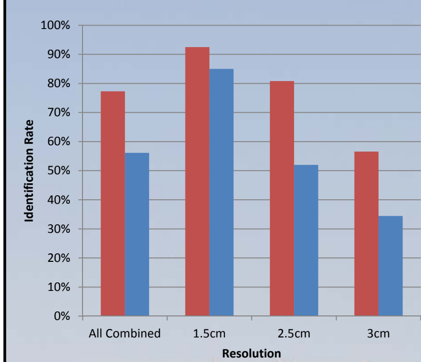
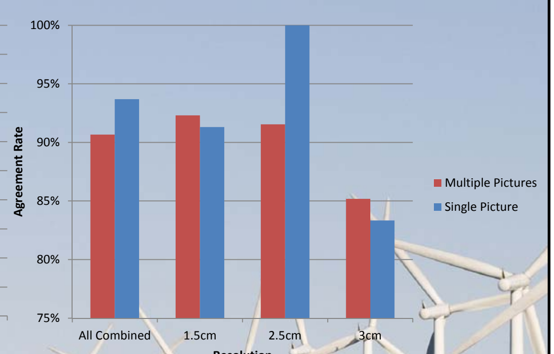
Effectiveness: ID strengthened by multi-observer cross-checking, validation





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Not a Panacea: Inherent Limitations of High Resolution Imaging

- Good coverage of space, bad coverage of time (like any survey technique)
    - Poor coverage of ephemeral, transitory phenomena, e.g. **Migrations**

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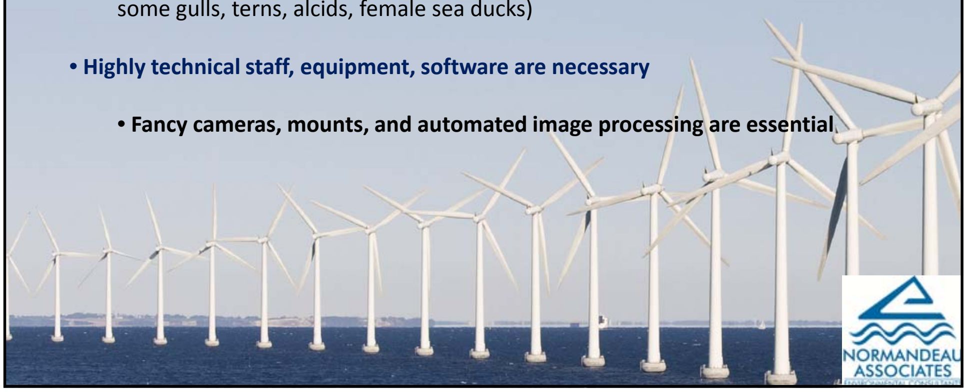
    - **Identification to species groups may be the only option for some taxa (e.g. some gulls, terns, alcids, female sea ducks)**



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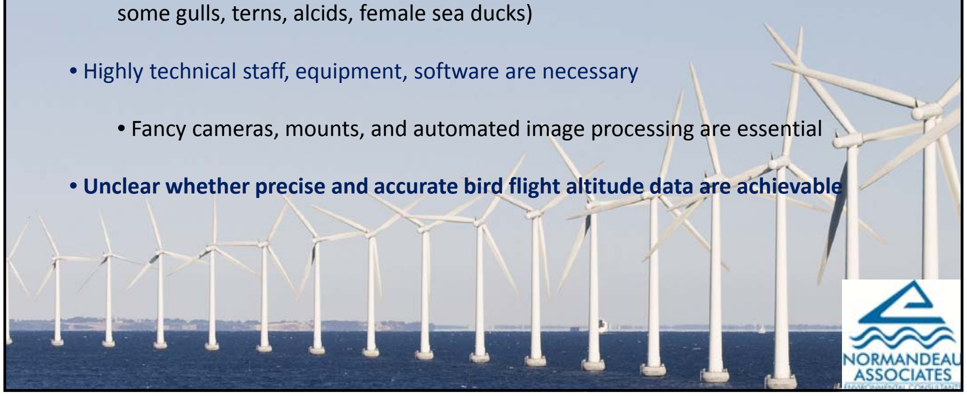
- **Highly technical staff, equipment, software are necessary**
  - **Fancy cameras, mounts, and automated image processing are essential**



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- **Unclear whether precise and accurate bird flight altitude data are achievable**

Summary: Not magical, but digital surveys likely to replace conventional

- Cost: Digital aerial survey cheaper than boat-based, comparable to other aerial surveys. Some expensive pieces are required.

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- Cost: Digital aerial survey cheaper than boat-based, comparable to other aerial surveys. Some expensive pieces are required.

- Safety: Digital surveys safer than conventional aerial surveys. Any marine survey carries some risk.

- Effectiveness: Digital survey data are generally superior to visual observer survey data

  - Pre-observer data archive to reduce and quantify observer effects, enable data qa/qc
  - No observer "swamping" effects
  - ID not instantaneous, based on measurements and reference materials
  - Animals not repelled from, or attracted to survey vehicle
  - Survey swath measured precisely, not visually estimated

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Thanks for your attention!

Osprey (*Pandion haliaetus*), 433m camera altitude, 1.5cm resolution

Appendix E

Benthic Breakout Session Presentations

APPENDIX TO SECTION 3.0

Biographies of European Invitees

Martin Attrill, PhD – Director of Marine Institute at Plymouth University

Professor Martin Attrill is a marine ecologist whose primary research interest is focused on the mechanisms behind long-term change and large-scale spatial patterns in marine assemblages and populations. He has been working with long-term data from marine fish and invertebrate populations within a range of habitats such as the Thames Estuary, Brazilian coral reefs and the open Atlantic Ocean, including investigating the role of climate variation on fish, corals and plankton. He has published over 100 papers in the prime literature, primarily on fish and benthic systems such as seagrass, and has also current projects investigating the roles of Marine Protected Areas, such as the new Defra designation in Lyme Bay; he coordinates the Lyme Bay Monitoring Programme. He has extended his interest in human impacts to large scale offshore renewable developments and how we can effectively and suitably monitor their interaction with the environment, coordinating biodiversity projects within the Peninsula Research Institute for Marine Renewable Energy. His team has published three leading reviews on the subject and he has been asked to provide overview presentations at a range of venues, including the United Nations. Since May 2009, Prof Attrill has been Director of the Marine Institute at Plymouth University, a multidisciplinary organisation comprising over 180 academic staff working in marine and maritime areas, 250 researchers and PhD students and 2600 students enrolled on marine and maritime courses.

Arjen Boon, PhD – Senior Researcher at Deltares

Arjen Boon Ph.D. is a senior researcher in the unit Marine and Coastal Systems of Deltares. He is a marine benthic/pelagic process and system ecologist with a 20 year professional background in fundamental (NIOZ) and applied marine ecological research (IMARES, Deltares) and consulting (Haskoning). He also has well-developed skills in consulting for marine policy, ecosystem impact and risk assessments, and especially in scientific integration and evaluation. In the past 10 years, he has been involved in impact assessments, spatial planning, research and scientific evaluation of offshore wind farms in the Netherlands. At Deltares he is scientific coordinator and evaluator of the Dutch research and monitoring program on the ecological effects of offshore wind farms. Within these projects, his main responsibility is as scientific coordinator and integrator, and his special focus is in the field of benthic and system ecology. He is also project manager of and a specialist in scientific integration and evaluation of a large (20 million m^3) experimental shoreface nourishment project on the Holland Coast. His main scientific interests revolve around connectivity issues (transport and recruitment) of meroplankton, and the macro-ecological aspects of (physical forcing of) benthic productivity and diversity. He works closely with the Netherland Institute for Sea Research.

Bryony Pearce – Director of Gardline Caledonia

Bryony Pearce, is a Director of Gardline Caledonia Ltd, and has been working as a marine environmental consultant for more than eleven years. Over the course of her career Bryony has carried out environmental impact assessment work for the marine aggregate extraction industry, major port developments and offshore renewable energy developments throughout the UK. Bryony has also been involved in broad spectrum of applied marine research including impact and recovery studies, marine mapping, fisheries sustainability, marine planning, design criteria for marine protected areas, goods and services provided by marine ecosystems, marine taxonomy and genetic barcoding. Bryony has secured funding for and led over 20 research projects and has an in-depth understanding of the UK marine environment and how it is influenced by anthropogenic activities. Bryony is currently writing up her PhD on the Ecology of *Sabellaria spinulos*a reefs with the University of Plymouth and Plymouth Marine Laboratories. Much of Bryony's PhD research has already been applied to the effective management of Sabellaria spinulosa reefs in the UK and she continues to work closely with the conservation agencies to ensure management decisions are based on the best available science.

Tom Wilding, PhD – Senior Scientist at Scottish Marine Institute

Tom is a marine ecologist, biometrician and diver with about 20 years of experience latterly specializing in offshore structures and aquaculture impacts. Tom managed the ground-breaking Loch Linnhe Artificial Reef project which required lengthy pre-deployment site characterization, stakeholder liaison, materials testing and negotiation with regulators /industry ahead of deploying Europe's largest artificial reef. The Lock Linnhe Artificial Reef contains 36 modules, 4000 concrete blocks (similar to scour protection in offshore developments), which allows for replication, and facilitates research into the impacts of offshore structures. Over the last five years Tom has developed novel methods for assessing the benthic impacts occurring around aquaculture operations and the societal/policy implications of offshore renewables. Tom is currently supervising two PhD students who are looking at productivity on offshore structures and the consequences of macroalgal biofuel extraction. Tom designed and oversaw benthic site-characterization surveys at a possible offshore wind site, in 2012, and is currently designing and running simulations to assess and optimize benthic sampling strategies.

Prof Martin J Attrill
Profile and Interests

Director, Marine Institute
Plymouth University UK
mattrill@plymouth.ac.uk; @mjattrill




Marine Institute
PLYMOUTH UNIVERSITY

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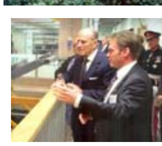
Background

* BSc, PhD Marine Biology (Univ Liverpool)
* 25 years practising marine ecologist since PhD (20 years Plymouth University)
* Director of Marine Institute since 2009
* Focus: patterns of marine biodiversity in time and space and how human activity influences those patterns
* Habitat: primarily benthic ecology and fish
* >100 peer review papers; 35 PhD students





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Plymouth University Marine Institute

- First and largest such university Institute in UK
- 180 academics; 250+ researchers; 2600 students
- Highly multidisciplinary: All Marine Sciences, Engineering, Technology, Navigation, Policy, Shipping, Business, Law, Psychology, Sports, Arts
- Broadest Portfolio in Europe?
- Strong theme of Marine Renewable Energy
  - Peninsula Research Institute for Marine Renewable Energy (PRIMaRE) with University of Exeter

PRIMaRE

Marine Institute
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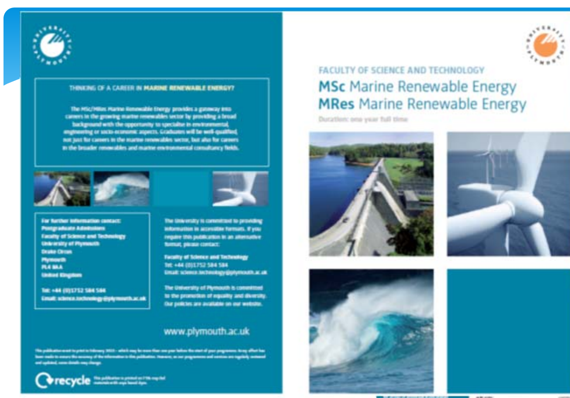
MSc Marine Renewable Energy



First Marine Renewables masters course in the UK

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Research Interests

- Impact of Marine Protected Areas and Renewable Energy developments on seabed communities
- Developed new High Definition Flying Array technology to allow cost-effective, non-destructive and robust sampling of seabed

OPEN ACCESS Freely available online PLOS one

A Quantitative, Non-Destructive Methodology for Habitat Characterisation and Benthic Monitoring at Offshore Renewable Energy Developments

Emma V. Sheehan[1], Timothy F. Stevens[2], Martin J. Attrill[1*]

1 Peninsula Research Institute for Marine Renewable Energy (PRIMaRE), Marine Institute, University of Plymouth, Plymouth, United Kingdom, 2 Griffith School of Environment and Australian Rivers Institute - Coasts and Estuaries, Griffith University, Gold Coast, Queensland, Australia

(copies available)

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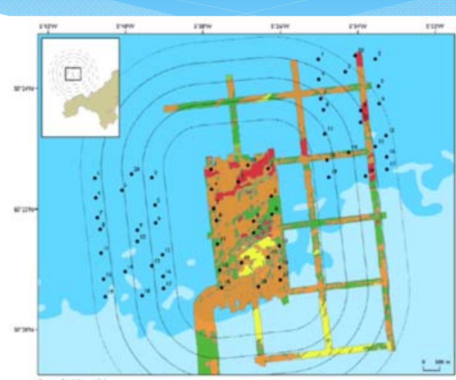
Marine Renewables Impact

- Used technology to characterise seabed at rocky/mixed sites
  - Wave Hub
  - Jersey Tidal Stream
- Assessing impact over range of diverse studies



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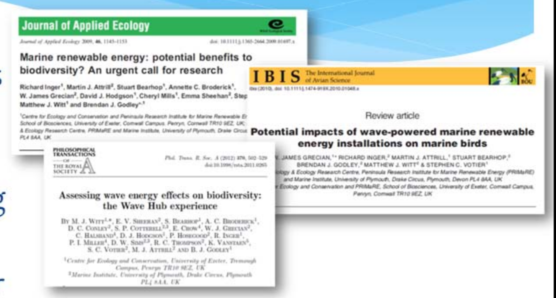
Wider interests in broad impact of MRE on biodiversity

- Lead biodiversity impacts team within PRIMaRE
- Three major published reviews, one mainly using offshore wind evidence
- Produced key briefing for Friends of the Earth


Journal of Applied Ecology

Marine renewable energy: potential benefits to biodiversity? An urgent call for research

IBIS

Review article

Potential impacts of wave-powered marine renewable energy installations on marine birds

Assessing wave energy effects on biodiversity: the Wave Hub experience


November 2012

Briefing

Marine Renewable Energy: necessary for safeguarding the marine environment?

(copies available)

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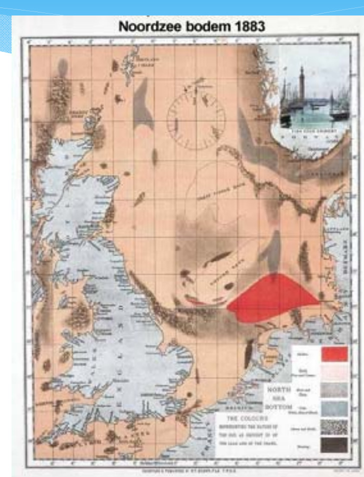
Main interest: costs/benefits of adding hard structure to the marine environment

- Historic loss of hard substratum due to commercial fishing
  - 20,000 km² native oyster bed in southern North Sea
  - Last harvested 1936
  - No oysters present by 1970
  - Lost ecosystem function
- Much soft sediment bottom is not natural?



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Main interest: costs/benefits of adding hard structure to the marine environment

- *Underwater piles/anchoring provides artificial reef habitat*
- Increases production and diversity of locality
  - Horns Rev – 60x increase in available food biomass in wind farm area
  - Increase in fish populations at Wind Farm (Wilhelmsson et al 2006)

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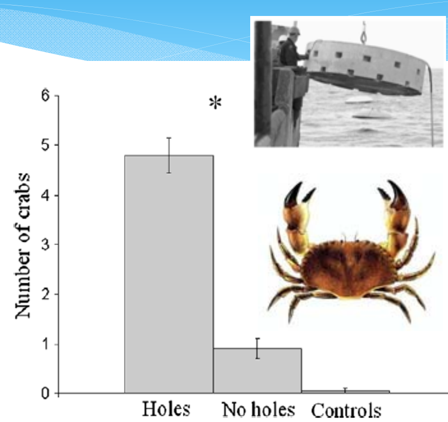
Provision of physical habitat – fishery boost?

- Physical structure can boost fisheries populations
- Langhamer & Wilhelmsson (2009) – wave energy foundations
  - Edible crabs boosted if holes provided
- Can environmentally enhance engineering structures for fishery gain



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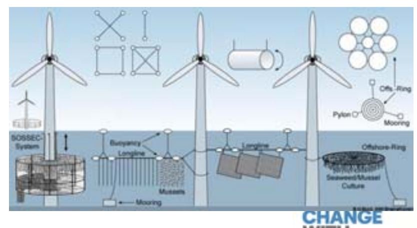
Can MRE developments act as *de facto* Marine Protected Areas?

* Other maritime activity, esp. towed fishing, difficult or impossible within renewable energy arrays
* Some evidence energy farms boosting, or concentrating, biodiversity
* Shift in emphasis of "impact" of renewable energy developments (*Punt et al 2009*)



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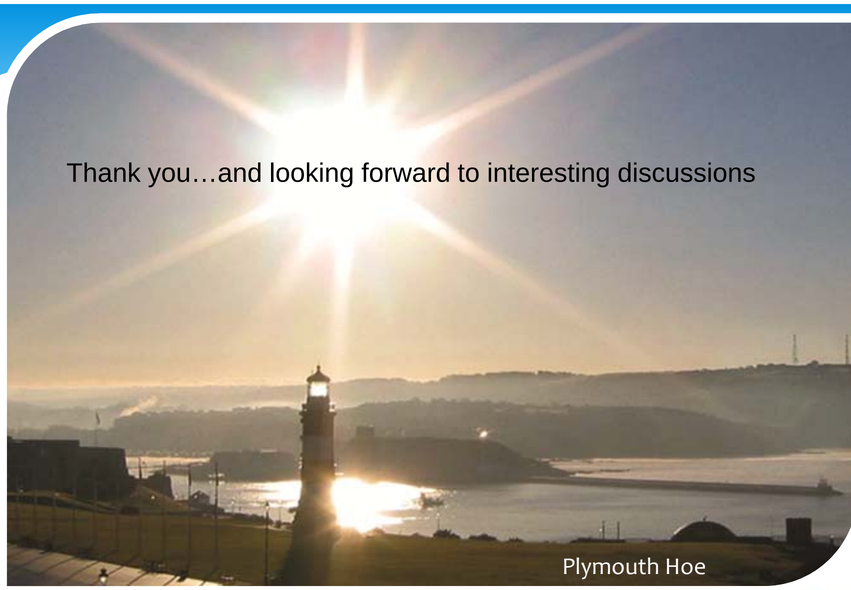

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Deltares

Enabling Delta Life

Offshore wind farms in the southern North Sea – Habtitat mapping and effects on macrozoobenthos

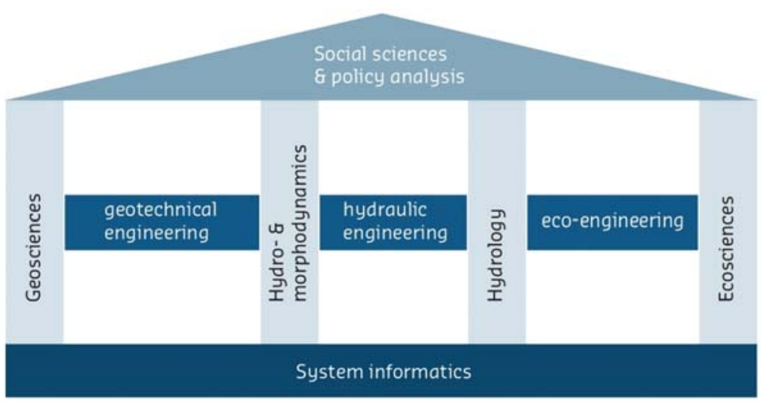
Dr. Arjen Boon

Special thanks to

Drs. Gerard Duineveld & Magda Bergman, Royal Netherlands Institute for Sea Research, The Netherlands

NIOZ

DELTARES – discipline clusters



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Arjen Boon – research experience and interests

- Ph.D. in process ecology (benthic-pelagic coupling)
- Experience in fish(eries) biology
- 10 – 15 years EIA, Appropriate Assessments OWF
- Project leader monitoring and research programs coastal zone nourishment, restoration projects
- Scientific and policy integration national and EU projects
- Setting up, co-ordinating and evaluating research and monitoring plans North Sea

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Sand Engine

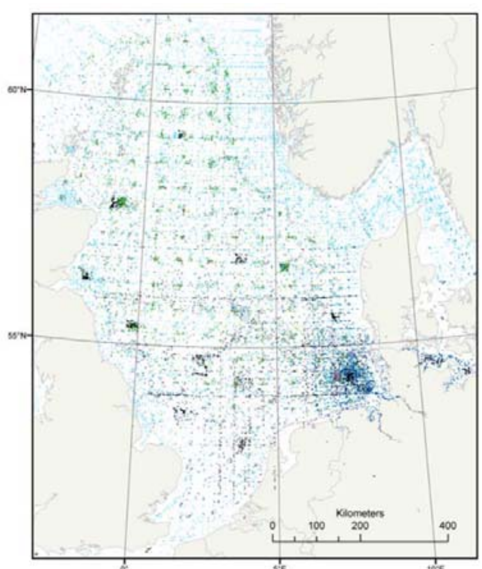
Hydro- & morphodynamics, Ecology

Deltares

Offshore Wind Farm Egmond aan Zee

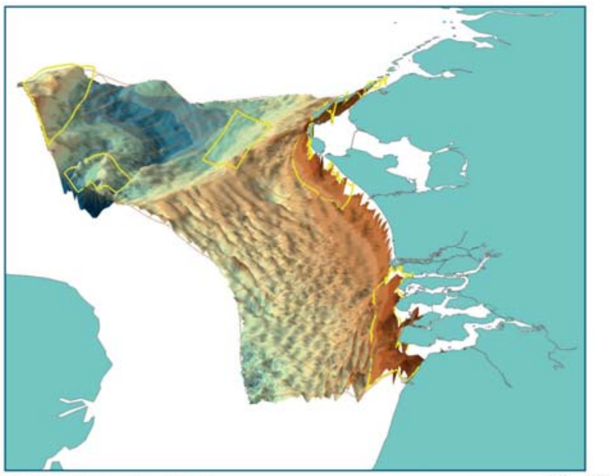
Masterplan Research Ecological Effects Offshore Wind
Review and Knowledge Advancement
Scour effects
Benthos effects

North Sea system



Overview of data sets on bathymetry, chemistry, biology

North Sea system – benthic mapping



3-D Dieptekaart Noordzee (Bron: TNO-RWS)

Benthic mapping with multibeam sonar – high resolution

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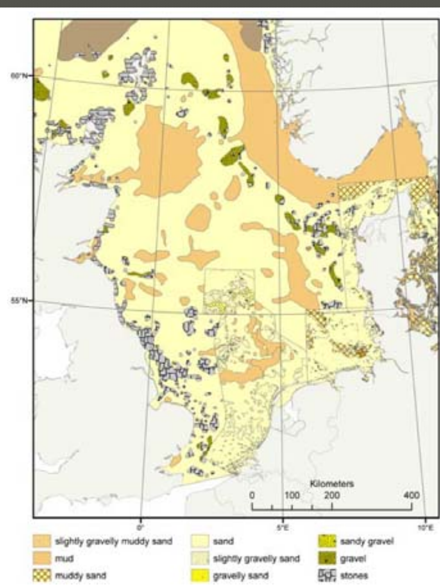
North Sea system – Sediment map



Aggregated sediment map North Sea - based on modified Wentworth classification

EUNIS – level 3 classification Marine habitats

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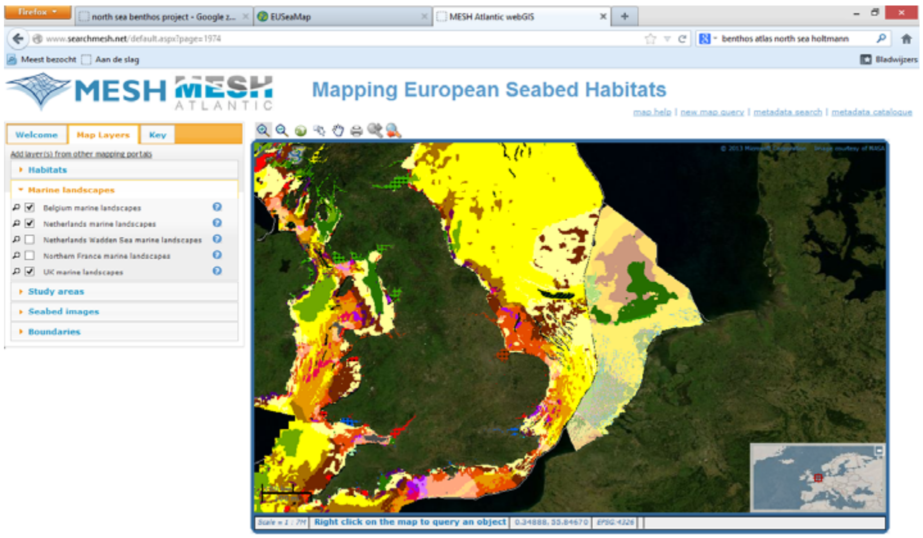
North Sea system – Habitat characterization in MESH



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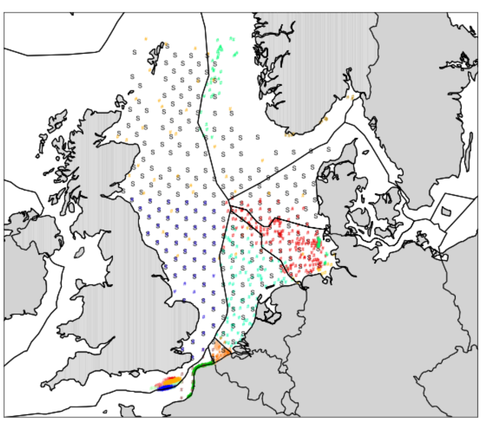
North Sea system – benthic mapping



Sampling stations benthos (Reiss et al. 2007)

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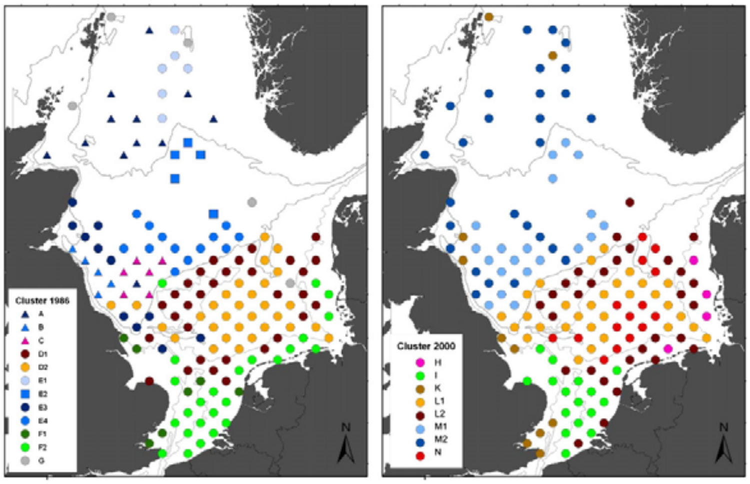
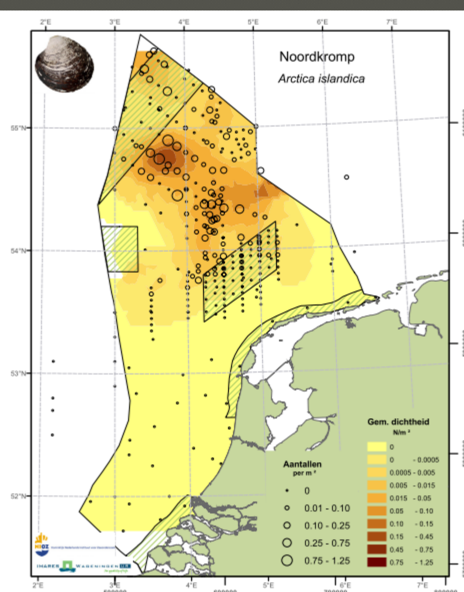
North Sea system – benthic mapping



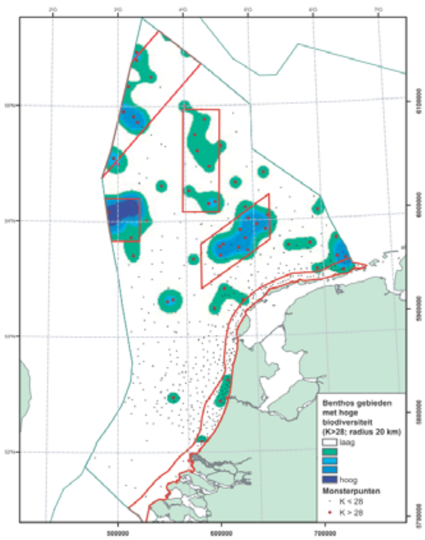
Clusters macrobenthos 1986 (left) and 2000 (right). Kröncke et al. 2011

North Sea system – valuation – Natura2000



Distribution of Ocean quahog – long lived species (>100 y) (Lindeboom et al. 2008)

North Sea system – valuation – Natura2000



Areas with high benthic diversity (Lavaleye 2000)

Areas under protection EU Habitat Directive and national law

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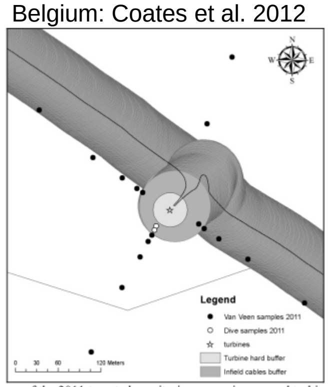
North Sea system – OWF effect studies

Belgium: Coates et al. 2012



- increasing key macrobenthic species in this area.
- community is evolving away from the original Nephtys cirrosa community
- far from reaching a stable equilibrium
- decreasing median grain size and increasing macrobenthic abundance and diversity
- the community might possibly be moving towards a variant of the rich Abra alba – Mysella bidentata community

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North Sea system – OWF effect studies

Netherlands – Bergman et al. 2012

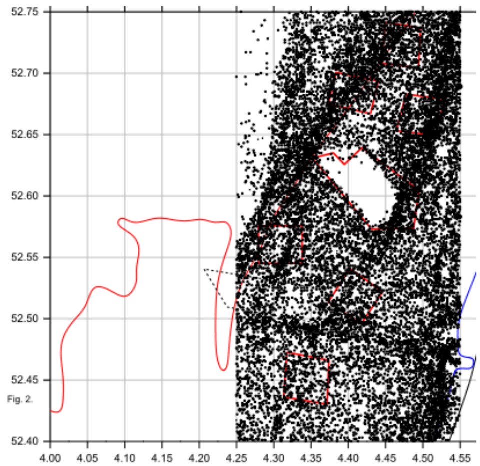

Fig. 2.

High level of beam trawl fishing

OWF would release benthos from fishing pressure

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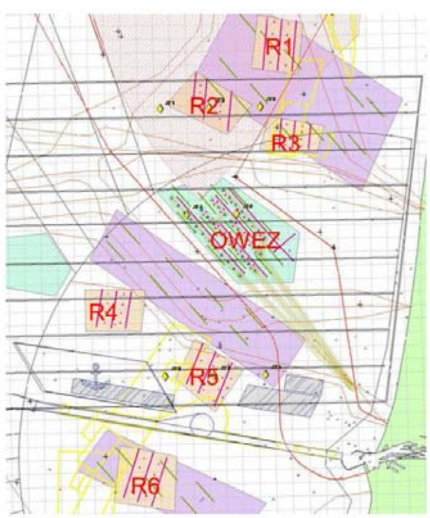
North Sea system – OWF effect studies



Sampling design 2007 and 2011. R1 and R6 were sampled in T0

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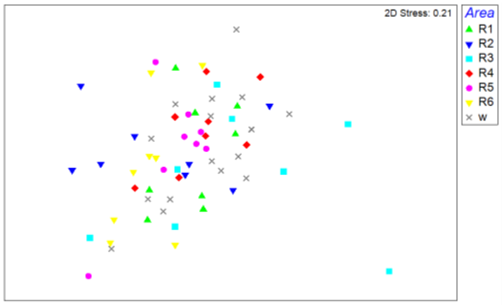
North Sea system – OWF effect studies



MDS plot abundance (n/m2) Macrobenthos boxcore data 2011

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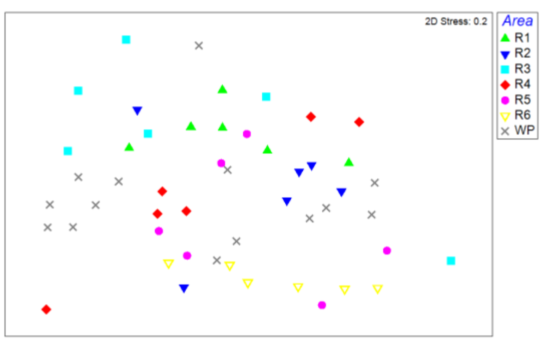
North Sea system – OWF effect studies



MDS plot abundance (n/m2) Macrobenthos sledge data 2011

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North Sea system – Assessment Framework

- Regulatory framework – know what to measure and why to measure it: spatial planning, site screening & selection
- Ecological indicators and goals – thresholds to separate the “good” from the “bad”
- Adopt an evidence-based approach, avoid unrealistic worst-cases, accept risks, but identify them!
- Adopt a system approach – try to understand in stead of simply monitor
- Prepare for cumulative impacts, multiple use from the start on

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North Sea system – Offshore wind farms present

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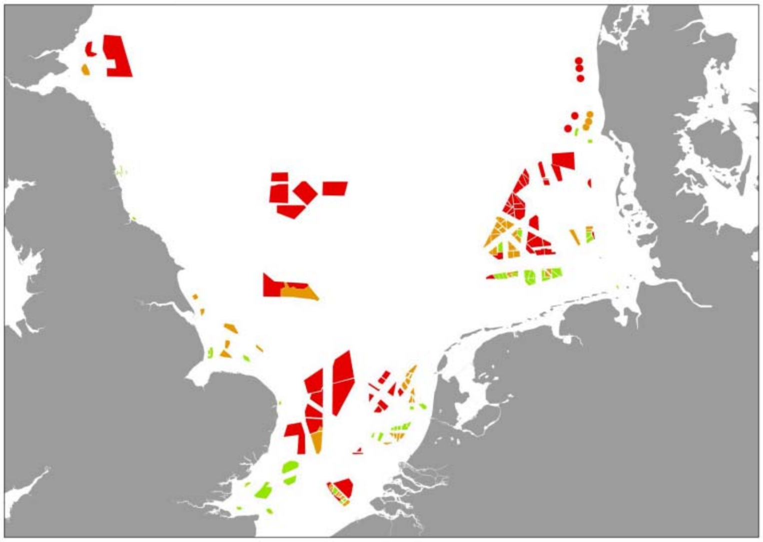
North Sea system – Offshore wind farms planned – high end scenario



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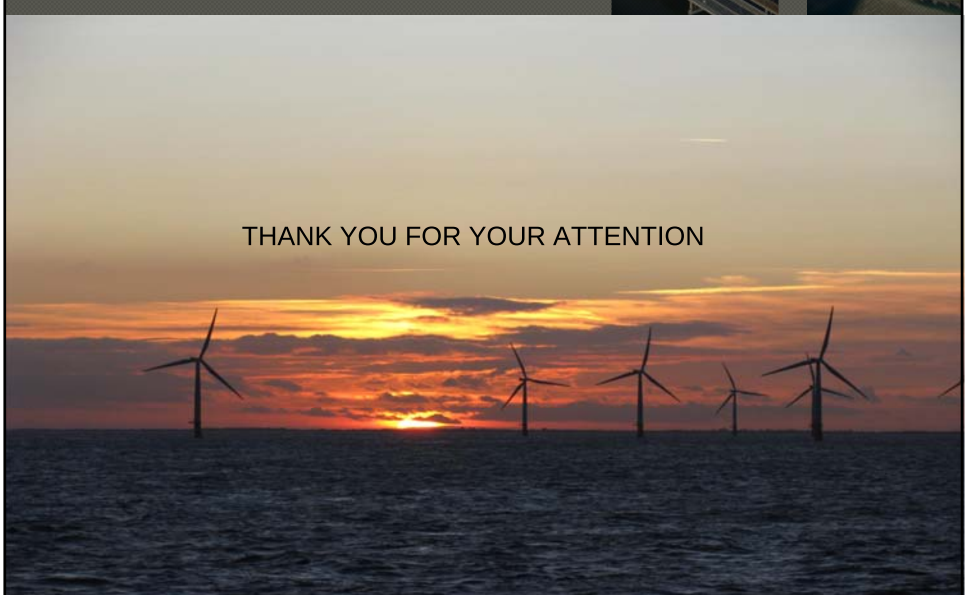
North Sea system OWF effects on benthos



BOEM Offshore Wind Energy Development Site Assessment and Characterisation - a UK Perspective

Bryony Pearce, Gardline Caledonia

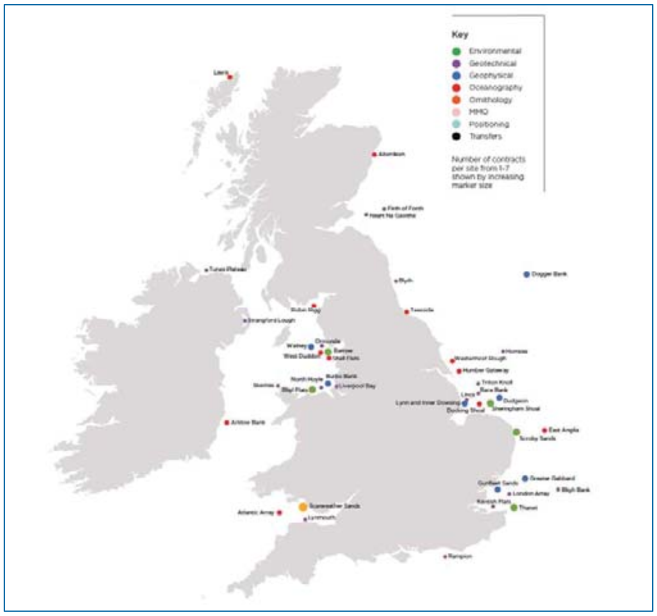
The Gardline Group

- The largest independently owned marine survey group
- Global Group with companies in Australia, Singapore, Brazil and the US (Alpine)
- Offshore renewables services include;
  - Environmental
  - Geotechnical
  - Geophysical
  - Oceanographic
  - Hydrographic
  - Crew Transfer and Training

More information can be downloaded from http://www.gardlinemarinesciences.com/services/sector-4/

UK Renewables Experience

Gardline

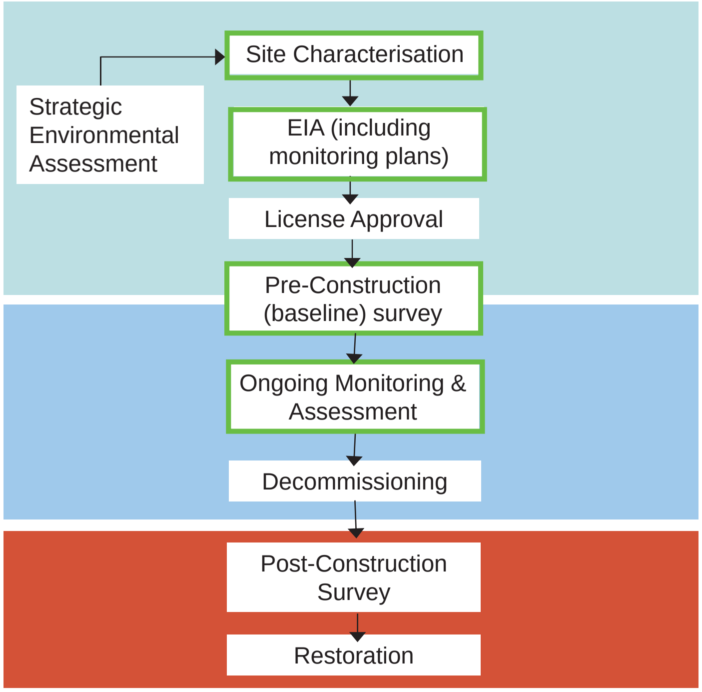


- Completed in excess of 150 contracts for offshore wind developers across the UK and Europe
- Provided EIA services for 9 of the 7 Round III wind farm sites in the UK

Gardline

Background & Research Interests

- Degree in Marine Biology from the University of Plymouth
- Part-time PhD on The Ecology of *Sabellaria spinulosa* Reefs
- Over eleven years' experience working as Marine Environmental Consultant
  - Environmental Impact Assessment work including baseline surveys and monitoring programmes for a variety of offshore developments
  - Applied marine research
    - *Impacts of aggregate extraction on benthic communities*
    - *Food-web interactions*
    - *Seabed mapping and classification*
    - *Marine planning and conservation*
    - *Fisheries sustainability*



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Environmental Impact Assessment & Monitoring Framework (UK)

Gardline

Thanet Offshore Windfarm

www.gardlinemarinesciences.com

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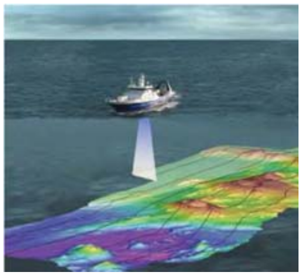
Site Characterisation / Baseline 2005
Pre-Construction 2007
Post-Construction Monitoring 2012



Remote Observations

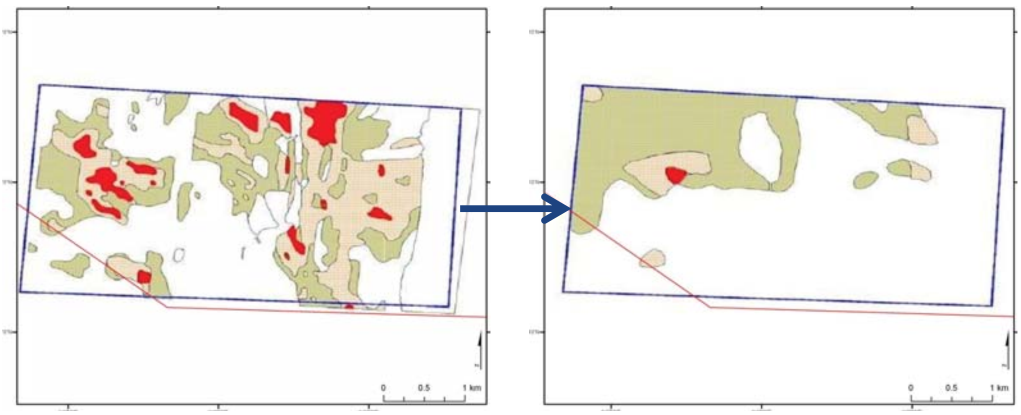
+

Ground Truthing Samples

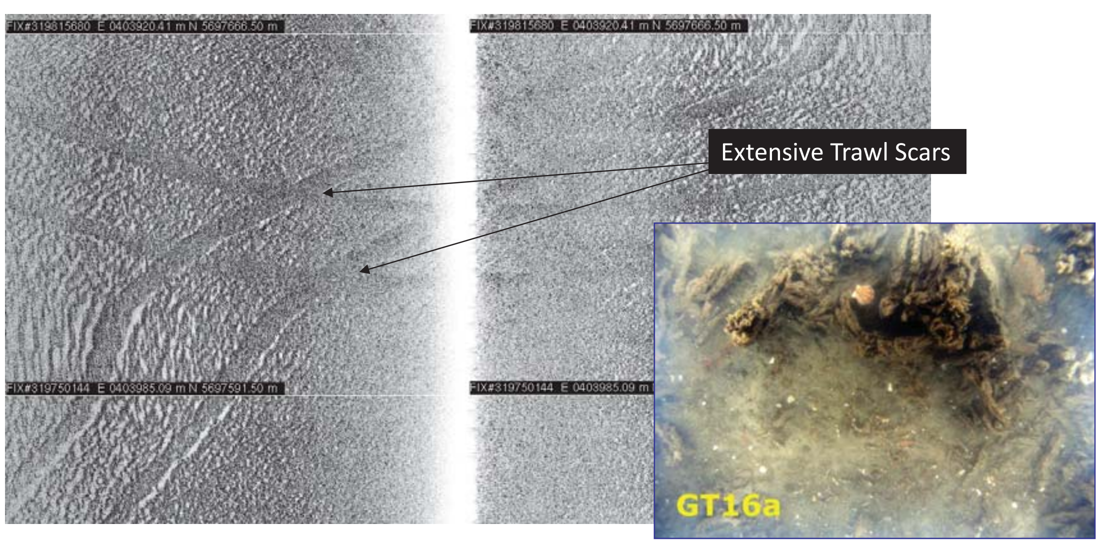
www.gardlinemarinesciences.com

Ground truthing revealed *Sabellaria spinulosa* reef

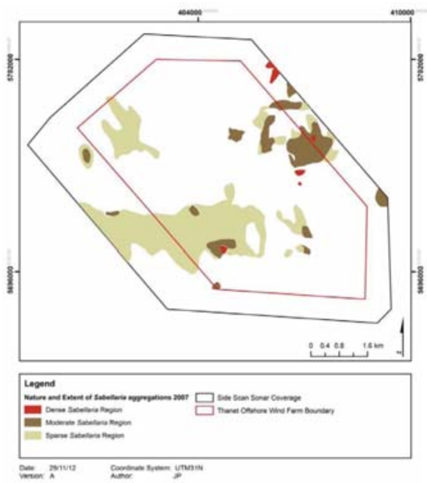
Shifting Baselines 2005-2007

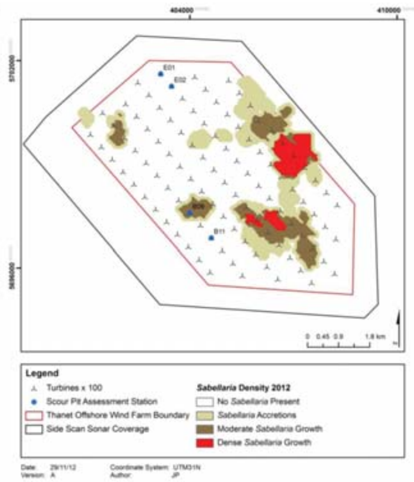


Trawl Damage

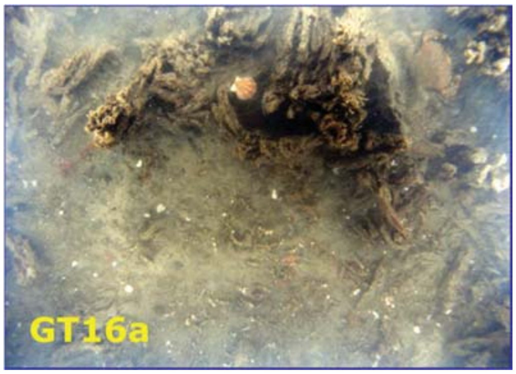


Reef Effect
2007-2012

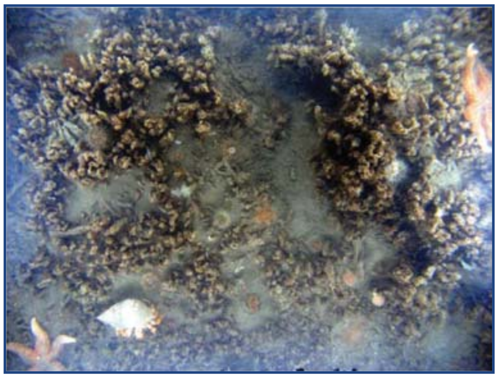




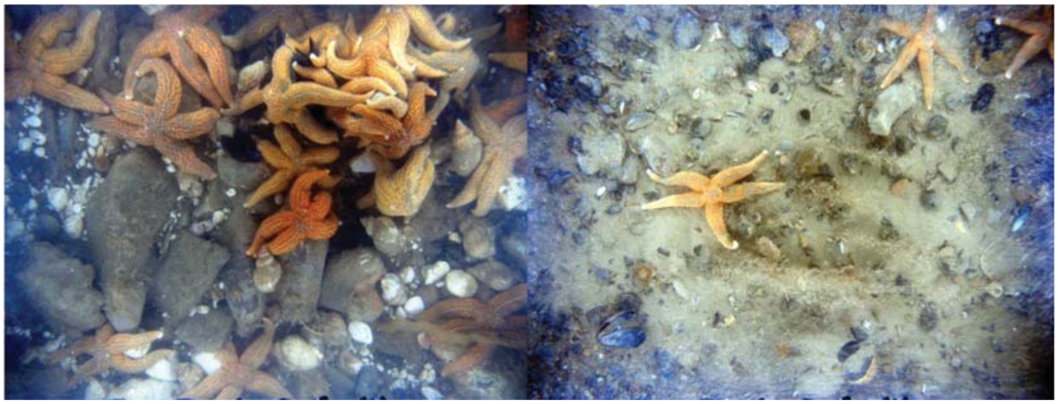
2007



2012

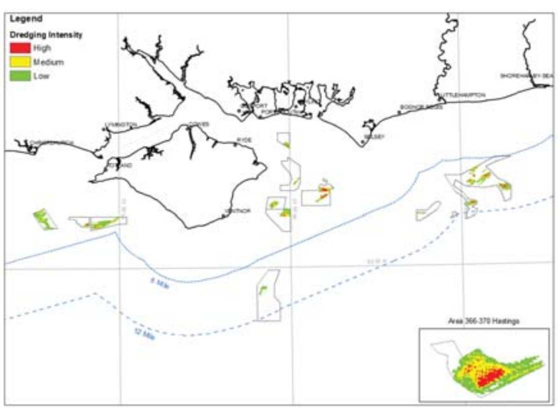


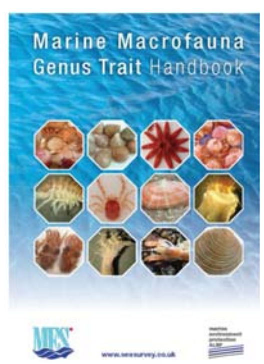
Impact of Scour

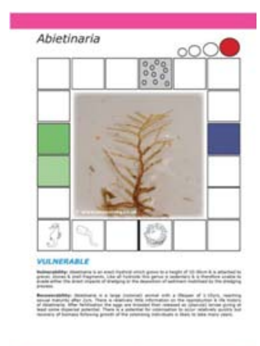


Applied Marine Research

Impacts & Recovery







http://www.genustraithandbook.org.uk/

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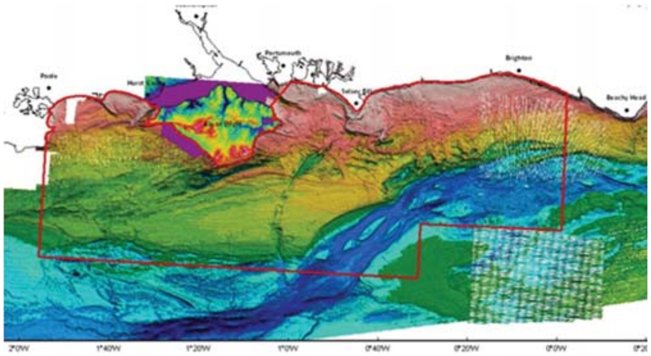
Applied Marine Research

Seabed Mapping



- Regional Environmental Characterisation (RECs) http://www.cefas.defra.gov.uk/alsf/projects/rec-projects.aspx
- Habitat Suitability Modeling
- Biotope Classification Schemes

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Applied Marine Research

Biodiversity Offsetting

- Habitat Restoration
  - *Transplanting biogenic reefs*
- Habitat Re-creation
  - *Shellfish bed restoration*
- Habitat Creation
  - *Artificial reef*
- Averted Risk
  - *Exclusion of fishing*
  - *Eradication of introduced species*
- Preservation
  - *Seal colony / seabird protection schemes*

www.gardlinemarinesciences.com

Bryony Pearce

Director

Gardline Caledonia Ltd

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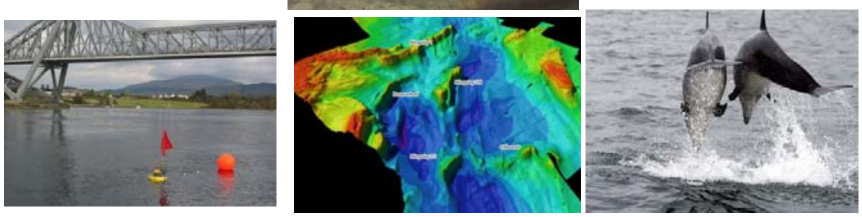
Scottish Association for Marine Science

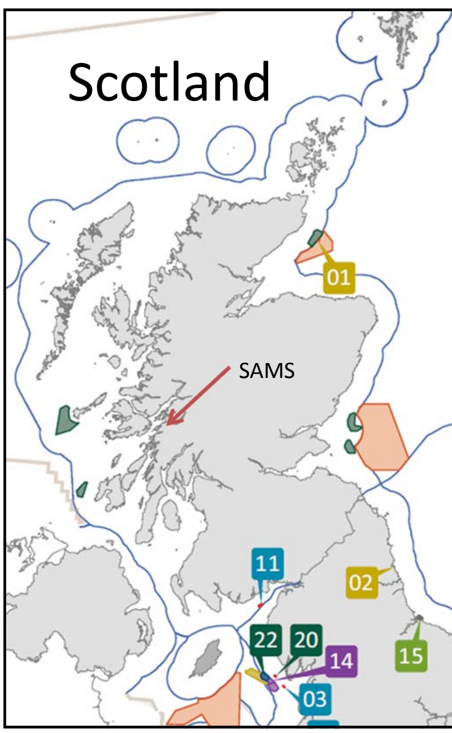
- SAMS is an independent research facility
- Delivers the ‘Marine Science’ degree as part of the UHI
- ~130 staff
- Some core funding, mostly PI grant capture
- SAMS is an academic institution (metric = research papers)
- SAMS Research Services Limited (SRSL) – commercial ‘wing’ (metric = commercial contracts)
- SRSL deliver baseline surveys for offshore renewables

SAMS/SRSL and offshore renewables

- Drop-down video survey
- Mammal surveys
- Diver surveys
- Underwater experimentation
- Acoustic imaging
- Soundscapes



Scotland



- Major offshore wind (and wave/tide) resource
- Tiree and Islay developments in planning stage
  - baseline characterisation,
  - stakeholder consultation
- SAMS involved (including wave/tide)
  - Mammals, fish, intertidal
  - **Benthos and**
  - **Social /policy implications**
- SAMS = hosts the Loch Linnhe Artificial Reef facility

Personal interests regards offshore renewables

- Reef effects
- Survey optimisation (monitoring methodologies)
- Logical questions
- Power analysis

Not necessarily in that order. These issues are largely inter-related.

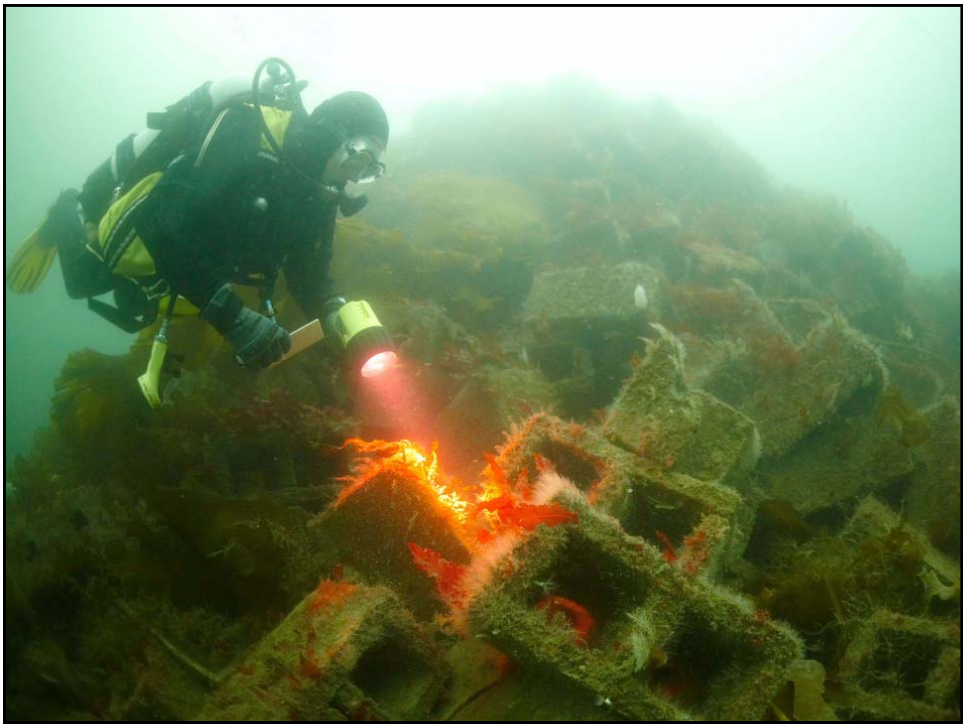
Loch Linnhe Reef

The Loch Linnhe Artificial Reef

- Europe’s largest experimental reef (at construction)
- 36 modules, each of > 4000 concrete blocks
- Structure similar to scour protection

Purpose: to facilitate research into the impacts of offshore structures

- Formed the basis of numerous research-theses and papers (Google Scholar ‘Loch Linnhe Artificial Reef’).



Reef-research synopsis

- Measuring habitat complexity underwater [1]
- Assessing macrobenthic near-reef impacts [2]
- Interactions with current regime [3,4]
- Productivity on offshore structures (PhD student, on-going)
- Stakeholder perceptions of offshore renewables [5-7]
- Currently advising on a amenity (diving) reef (4000 tonne frigate in the Sound of Mull)

Monitoring methodologies

- Develop cost-effective ‘drop-and-drift’ video technology (including statistical analysis) appropriate for ‘point’ impacts (used around fish- and mussel-farms)[8,9]
- Key is to ask logical questions.

On asking fundamental questions…

Often regulator asks questions like:
- Is there an impact?
- How far does it extend?

Easy to ask and answer – but relatively meaningless

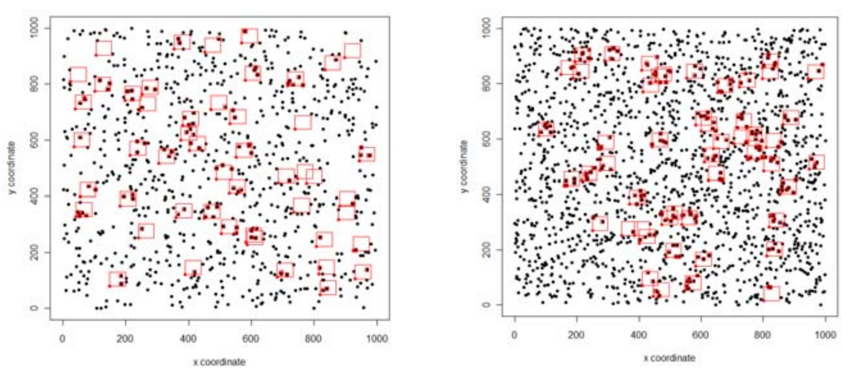
More useful questions could include:
- Who cares, about what, and how much?
- How much change is OK? (id thresholds)
- How confident do you want to be in assessing change in X?
- What are you going to do if change in X is deemed unacceptable?

Difficult to formulate question, but meaningful if answered

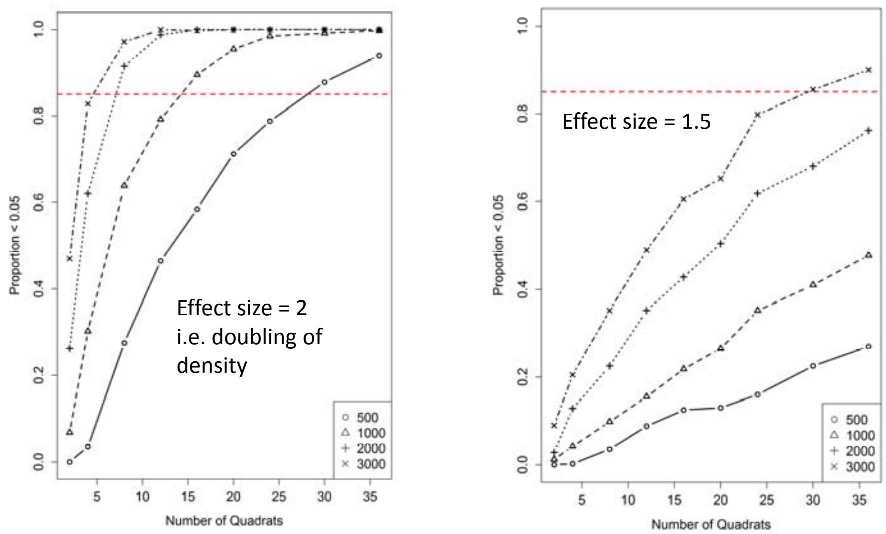
Investigating change – numerical simulations

Sampling simulations

- Estimating this difference is a function of sampling effort, initial density and effect size



Power analysis



Scottish experience (so far)

- Developers wish to minimise expenditure
- Benthic impacts are viewed as ‘low-risk’ = low priority by regulators (or their advisors)
- Baseline monitoring programme is developed/negotiated between regulator, developer and surveyor.
- Main focus on ‘priority marine features’ & red-list species
- Thresholds (effect sizes) are not specified
- But sampling effort is specified (based on ‘reasonable’ costs to the industry)
- Little known about the effect size that the imposed sampling regime could find
- No mandatory remedial action in terms of benthos (no threshold definition)

References

1. Wilding TA, Rose CA, Downie MJ (2007) A novel approach to measuring subtidal habitat complexity. Journal of Experimental Marine Biology and Ecology 353: 279-286.
2. Wilding TA (2006) The benthic impacts of the Loch Linnhe artificial reef. Hydrobiologia 555: 345 - 353.
3. Mills FS (2009) Sedimentation patterns around Loch Linnhe Artificial Reef. Heriot-Watt University, MSc Thesis.
4. Aston Z (2006) Modelling and Measuring Water Motion on the Loch Linnhe Artificial Reef - (i) Potential Biological Effects and (ii) Implications for Coastal Hydrodynamics [MRes thesis]: University of Newcastle. 109 p.
5. Alexander KA, Janssen R, Arciniegas G, O'Higgins TG, Eikelboom T, and Wilding, TA. (2012) Interactive Marine Spatial Planning: Siting Tidal Energy Arrays around the Mull of Kintyre. Plos One 7: e30031.
6. Alexander KA, Potts T, Wilding TA (In press) Marine renewable energy and Scottish west coast fishers: exploring impacts, opportunities and potential mitigation. Ocean & Coastal Management.
7. Alexander KA, Wilding TA, Heymans JSS (2013) Attitudes of Scottish fishers' towards marine renewable energy. Marine Policy 37: 239 - 244.
8. Wilding TA, Nickell TDN (Accepted) Changes in benthos associated with Mussel (*Mytilus edulis* L.) Farms on the West-Coast of Scotland. PLOS ONE.
9. Wilding TA, Cromey CJ, Nickell TD, Hughes DJ (2012) Salmon farm impacts on muddy-sediment megabenthic assemblages on the west coast of Scotland. Aquaculture Environment Interactions 2: 145-156.

Bureau of Ocean Energy Management
Offshore Wind Workshop 2013
Benthic Habitat Track

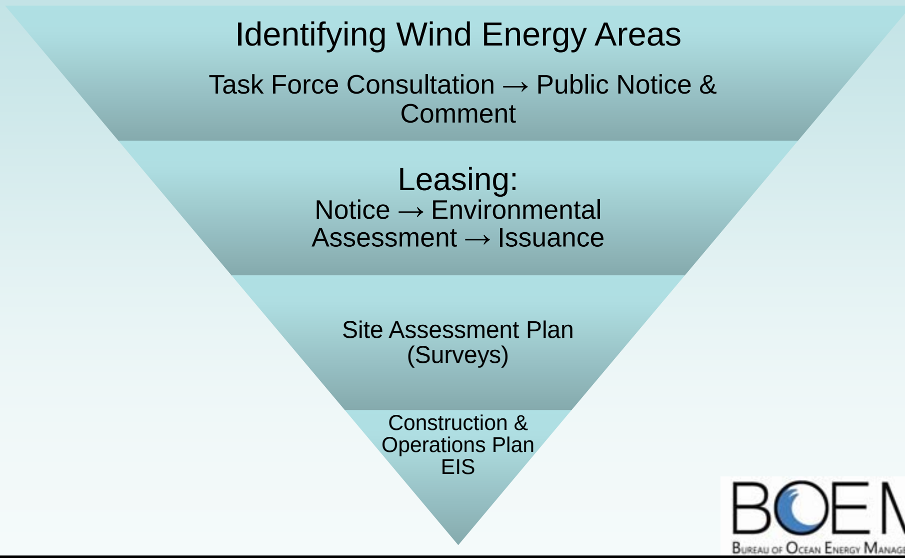
Brian Hooker
Biologist, BOEM

February 26, 2013

Overview

- BOEM and Environmental Impacts
- BOEM's Goals for Workshop
- Status of Benthic Studies to Date
- BOEM's Benthic Habitat Survey Guidelines
- Comments and Questions

Stages of Development



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BOEM's Obligations

- BOEM has statutory obligations to "protect the environment." – Energy Policy Act of 2005 and consult with NMFS regarding impacts to essential fish habitat.
- BOEM thus requires geophysical and biological data in order to approve a lessee's plan. Including:
  - Identification of sensitive bottom habitats
  - Fish and shellfish populations

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BOEM's Objectives

- Learn about the vulnerability of various habitat types to change from offshore wind turbine foundations.
- Learn about successful habitat classification systems and how that data is collected.
- Learn about model-based approaches to predicting habitat types and vulnerability to change from turbine foundations.

BOEM
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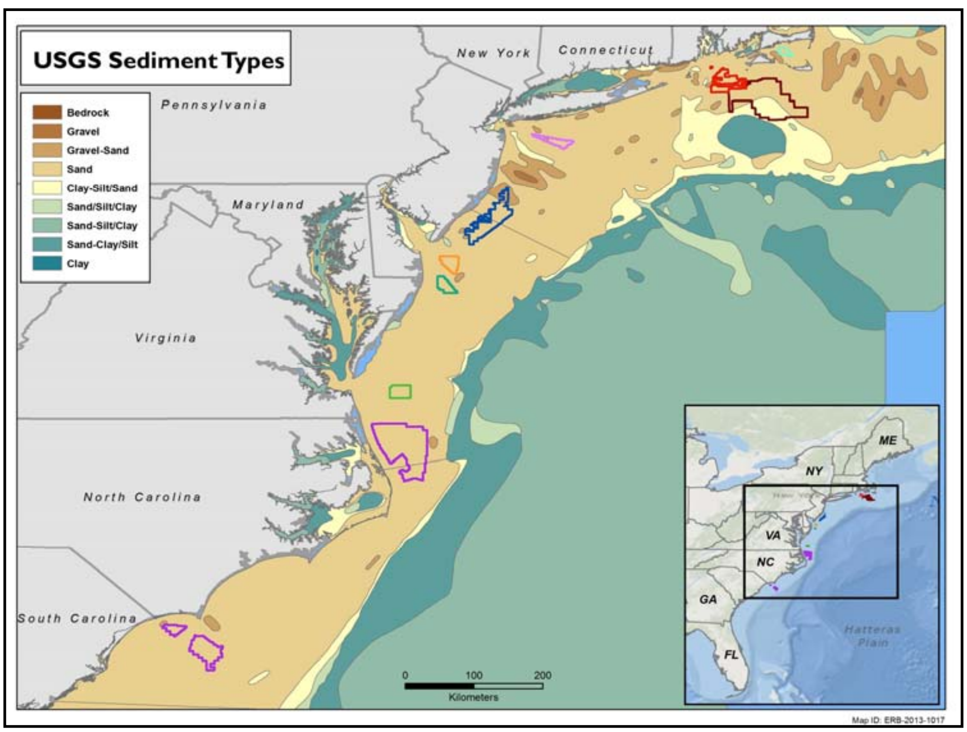
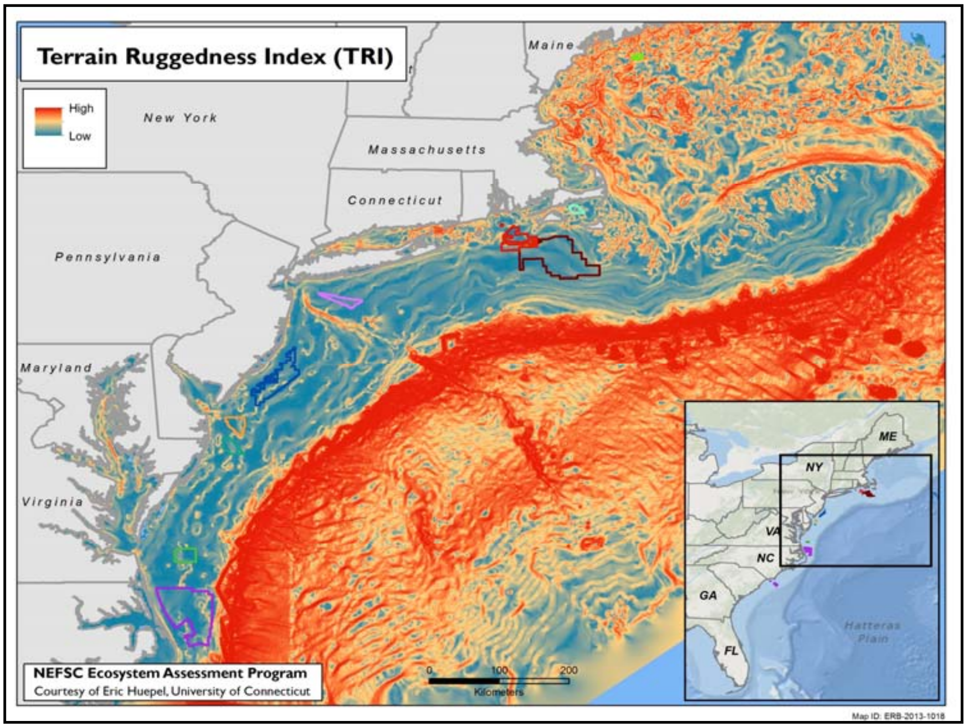
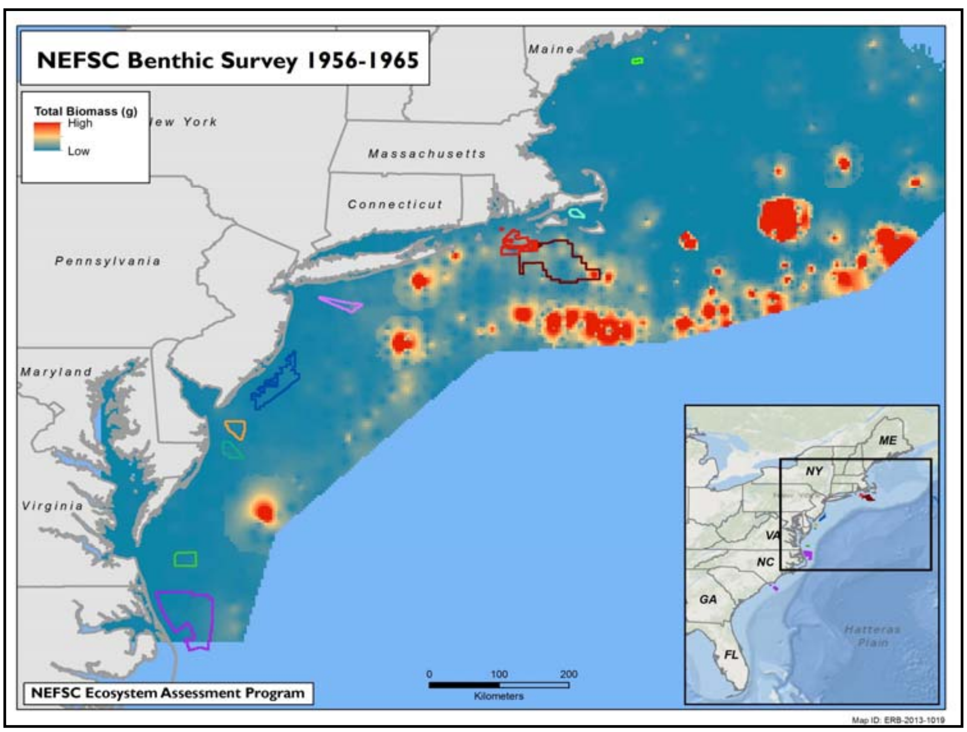
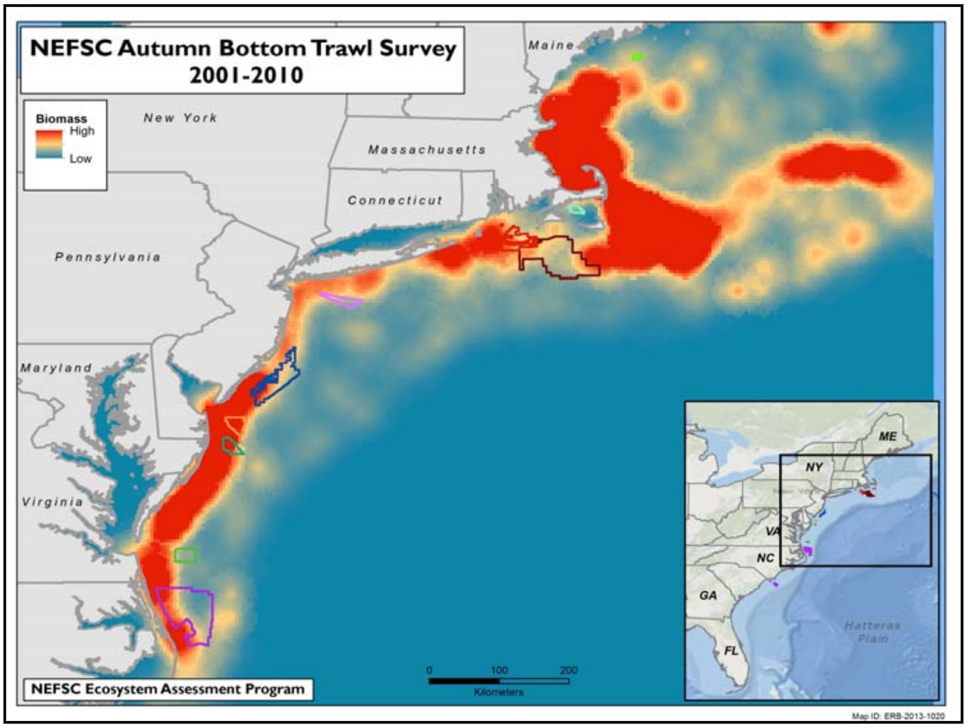
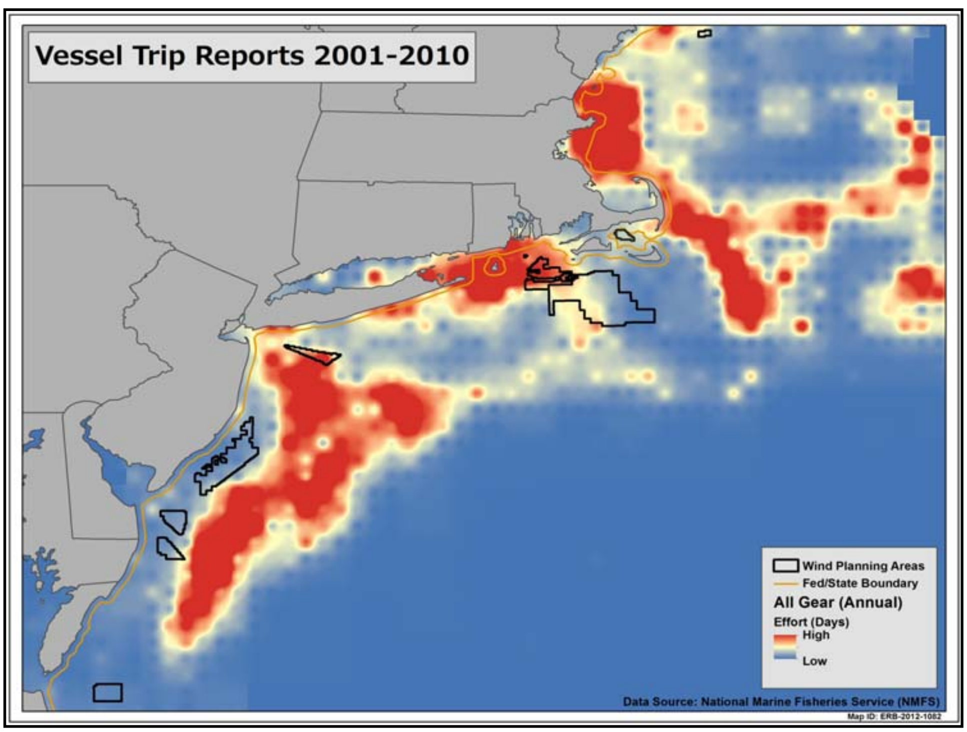



Terrain Ruggedness Index (TRI)
High
Low
Maine
New York
Massachusetts
Connecticut
Pennsylvania
Maryland
Virginia
ME
NY
VA
NC
GA
FL
Hatteras
Plain
0
100
200
Kilometers
NEFSC Ecosystem Assessment Program
Courtesy of Eric Huepel, University of Connecticut
Map ID: ERB-2013-1018


NEFSC Benthic Survey 1956-1965
Total Biomass (g)
High
Low
Maine
New York
Massachusetts
Connecticut
Pennsylvania
Maryland
Virginia
ME
NY
VA
NC
GA
FL
Hatteras
Plain
0
100
200
Kilometers
NEFSC Ecosystem Assessment Program
Map ID: ERB-2013-1019


NEFSC Autumn Bottom Trawl Survey
2001-2010
Biomass
High
Low
Maine
New York
Massachusetts
Connecticut
Pennsylvania
Maryland
Virginia
ME
NY
VA
NC
GA
FL
Hatteras Plain
0
100
200
Kilometers
NEFSC Ecosystem Assessment Program
Map ID: ERB-2013-1020


Vessel Trip Reports 2001-2010
Wind Planning Areas
Fed/State Boundary
All Gear (Annual)
Effort (Days)
High
Low
Data Source: National Marine Fisheries Service (NMFS)
Map ID: ERB-2012-1082

Studies: Biological

- Most biological studies to date have concentrated on endangered species surveys
- Large scale benthic studies of the middle shelf have not been done in earnest in decades.
- BOEM has completed data synthesis reports and recently completed studies to identify environmental survey and monitoring protocols as well as modeling recommendations.
- BOEM has just released benthic survey guidelines
- BOEM is looking forward now to doing WEA-scale benthic habitat surveys

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Questions? Comments?

BOEM
Bureau of Ocean Energy Management

Appendix F

Archaeology

APPENDIX TO SECTION 4.0

Biographies of European Invitees

Paul Baggaley, Wessex Archaeology

Dr Paul Baggaley is the Head of GeoServices at Wessex Archaeology where he leads the geophysics, geoarchaeology and geomatics teams. Paul has a B.Sc., M.Sc. and Ph.D. in Geophysics (Edinburgh, Birmingham and KeeleUniversities, respectively) and joined Wessex Archaeology in 2003. After leaving academia Paul worked as a geophysicist for a marine survey company and was based in both the UK and the US before undertaking his role at Wessex. Over the last ten years Paul has worked as a specialist in marine cultural heritage on over 100 offshore developments. His portfolio includes over 30 offshore wind farm schemes, multiple marine aggregate dredging applications and port developments, as well as various cable installations and research projects investigating both submerged landscapes and historic wreck sites. Through these projects Paul has been involved in various stages of works ranging from the acquisition and interpretation of marine geophysical data (including that acquired by marine survey companies) for environmental assessments and as part of monitoring mitigation strategies. Paul has contributed to the *Historic Environment Guidance for the Offshore Renewable Energy Sector*, the *Offshore Geotechnical Investigations and Historic Environment Analysis* and the forthcoming *Marine Geophysics Data Acquisition, Processing and Interpretation Guidance Notes*. Paul is also a committee member for the European branch of the Offshore Site Investigation Group of the Society of Underwater Technology which provides a technical forum for the offshore industry.

Jonathan Benjamin, Wessex Archaeology

Dr Jonathan Benjamin is the *International & Research Partnerships Manager* at WA Coastal & Marine (Wessex Archaeology's Scottish Branch Office). Jonathan has a B.A. in Anthropology from the University of California, Los Angeles and a Ph.D. in Archaeology from the University of Edinburgh. His research has focused on coastal and underwater archaeology, early prehistory and the study of submerged landscapes. As an experienced archaeological diver Jonathan has worked on submerged sites the UK, Denmark, Slovenia, Croatia, Cyprus, and Israel. He was the principal editor and co-author of *Submerged Prehistory* (2011) and has published in a number of leading international journals. He is also a member of the SPLASHCOS community, funded through the European Cooperation in Science and Technology. Jonathan joined Wessex Archaeology in 2010 and has a leading role in the WA Coastal & Marine Team in Scotland. He is the Principal Investigator on Project SAMPHIRE, working collaboratively with the Royal Commission on the Ancient and HistoricMonuments of Scotland to conduct underwater and aerial surveys of Scotland's coasts and seas. Jonathan also advises commercial clients and his portfolio includes the management of archaeological Environmental Impact Assessments for UK Round 3 Wind, European and UK Offshore wind test facility sites. Jonathan remains an honorary member of staff in History, Classics and Archaeology at the University of Edinburgh.

JørgenDencker, The VikingShipMuseum

JørgenDencker has been working with the location and excavation of submerged Stone Age settlements for the past 36 years and has since the early 1990s been involved in the developing field of marine archaeology and off shore wind farms (most of them being the biggest in the world at the time they were built) as well as all other kinds of off shore construction work. He has played a significant role in the negotiations with the construction companies involved as well as the Cultural Heritage Agency always pushing for and optimizing the demands for geophysical survey of the total area being affected, the choice of geophysical instruments to be used and a sufficiently small line spacing to get enough data for reconstruction of paleo landscapes and pin pointing the most potential areas for submerged Stone Age settlements. The many years of experience in this field and cooperation between marine archaeologists and the off shore industry have resulted in the location of the deepest as well as the oldest submerged Stone Age settlements in Denmark.

Michael Faught, Panamerican Consultants Maritime Division

Michael Faught is a Senior Maritime Archaeologist with Panamerican Consultants Maritime Division and a notorious, practiced, and published proponent of submerged pre-contact sites underwater archaeology. Faught's dissertation from the University of Arizona described successful predictive modeling, survey, and excavation experiences in the Big Bend of Florida, after finding submerged Paleoindian, Early Archaic, and Middle Archaic sites offshore. After an assistant professor experience at FSU teaching and conducting historic shipwreck and pre-contact underwater archaeology projects, Faught turned to the private sector where he has for a long time considered the cutting edge of this kind of research would take place. Faught has been principle investigator on several CRM reports with submerged pre-contact components from Florida to New Jersey; he is familiar with the recent Atlantic OCS study produced by BOEM, and he has written a book chapter out soon on protocols for background predictive modeling (qualitative), survey and remote sensing methods for site discovery and target identification, and testing for submerged pre-contact sites. Faught is looking forward to listening to and learning from our European colleagues on issues of Cultural Resources and wind energy infrastructure construction and monitoring.

Antony Firth, Fjordr Ltd.

Dr. Antony Firth, MIfA, is the Director of Fjordr Ltd., which is a company specialising in marine and historic environment consultancy. Early in his career, Antony combined academic training in political science, sea-use law and management with practical diving-based fieldwork on both submerged prehistoric sites and shipwrecks. Antony subsequently worked for Wessex Archaeology initially as a Project Manager and then as Head of Coastal and Marine, building one of the most capable specialist teams in this sector. From 2001 onwards, Antony was able to bring to the emerging offshore wind sector his experience from work on the environmental assessment of other forms of major marine development, especially ports and marine aggregate dredging, and from land-based archaeology. With his team he was involved in the majority of offshore wind farm developments in the UK, including several of the major 'Round 3' developments. Antony carried out much of the drafting of *Historic Environment Guidance for the Offshore Renewable Energy Sector* (Jan 2007) and initiated the *Offshore Renewable Protocol for Archaeological Discoveries* (ORPAD) and the *Model Clauses for Archaeological Written*

Schemes of Investigation (Dec 2010). He is currently preparing *Historic Environment Guidance for Wave and Tidal Energy*.

Christopher Pater, English Heritage

Christopher Pater joined English Heritage (an independent public body) in 2005 and provides advice about how the historic environment might be affected by coastal and seabed development projects as required by UK and European law. Our advice to inform major developments such as offshore wind farms, port infrastructure and marine minerals dredging has enabled him to work with UK government departments, industry and others on the development of guidance and to commission research projects to examine possible impacts. Chris now also works closely on the delivery of UK legislation and published policy that enables the preparation of marine plans and reforms procedures for consenting seabed development. He has a Master's degree in Marine Resource Management from Heriot-WattUniversity (Edinburgh) and his Doctoral research was conducted at the University of Nottingham. Chris is also a Fellow of the Royal Geographical Society.

Kieran Westley, University of Ulster

Kieran Westley is a Research Associate at the Centre for Maritime Archaeology, University of Ulster (UK) and has over 10 years' experience in the field of maritime archaeology. His current research focuses on the investigation and reconstruction of submerged prehistoric landscapes using geophysical, geotechnical and archaeological techniques. He also has wider interest in the use of geophysical techniques for mapping and identifying shipwrecks. In addition to academic work, he has previously undertaken archaeological impact assessments (on both shipwrecks and submerged landscapes) for offshore developments. As part of his present role, he is consulted by the Northern Ireland government's Department of Environment on the cultural/archaeological impacts of proposed coastal and marine projects (including offshore renewable energy) submitted under Marine Licensing legislation.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.