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Is Marine Spatial Planning Enough to Overcome Biological Data Deficiencies?

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The United States only accounts for 0.2% of the global offshore wind installed capacity despite a potential technical resource four orders of magnitude greater. A cumbersome permitting process is one of the challenges in implementing new projects. Part of this process requires biological data in order to inform assessments of environmental impacts; yet these data may be lacking for particular taxa at the required scale. Marine spatial planning (MSP) is a process that often includes data identification, collection, collation and analyses components. In this paper, we conduct a collective case study of three areas with offshore wind projects located in waters managed by marine spatial plans, focusing on how data efforts inform MSP and offshore wind development. Our study finds that MSP can facilitate data efforts during the permitting phase of offshore wind projects, but that other initiatives, particularly renewable energy policies and zoning, appear critical towards establishing offshore wind.

Keywords: Offshore wind energy; environmental impact assessment; renewable energy; ecosystem-based management.

Introduction

Despite accounting for over 17% of global energy consumption (BP, 2016), United States' installed offshore wind capacity contributes fractions of a percent to

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the 14,384 MW of global installed capacity (GWEC, 2016). A suite of benefits compels pursuing offshore wind technologies including environmental (e.g. low carbon emissions over the life cycle and negligible emissions of mercury, nitrous oxides and sulphur oxides) and economic (e.g. not subject to volatility in fuel costs and siting possibilities close to population centres; Snyder and Kaiser, 2009). Factors attributed to slow growth of the offshore wind sector in the U.S. include high capital costs, uncertain federal policy support, stakeholder resistance, lack of manufacturing and supply chains and a cumbersome permitting process (Van Cleve and Copping, 2010; Musial and Ram, 2010; Tierney and Carpenter, 2013; Navigant Consulting, 2014; USDOE, 2015). Improved data access for addressing uncertainties in ecological impacts would likely aid the permitting process and improve the speed and likelihood of development.

The permitting process for offshore wind projects in U.S. federal waters includes development of environmental impact assessments (EIAs) as required by the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. §§ 4321–4370). Two phases in the planning process of offshore wind projects require NEPA documentation: the site assessment/leasing of outer continental shelf lease blocks and approval of construction/operation plans (30 C.F.R. § 285). NEPA assessments require technical, social, physical and biological data to inform analyses of potential effects on natural resources that may result from offshore wind activities. Details of the spatiotemporal presence of resources, characteristics of stressors and effects of interactions are necessary to describe potential impacts to individuals and populations. However, uncertainty about or lack of fundamental data, including species presences in the study area, may eventually lead to more effort in the assessments of impact levels contributing to a cumbrous permitting process. Thus, any effort to streamline data access, such as online data portals (www.emodnet.eu or marinecadastre.gov), could help improve the permitting process and project outcomes, although this remains untested.

Examination of factors associated with operational offshore wind projects may provide insights into the U.S. federal system for permitting and approval. Marine spatial planning (MSP)[1] has become the leading framework to integrate offshore wind energy with existing marine uses. It is often defined as the process of analysing and designating the marine space for specific uses to achieve ecological, economic and social objectives (Ehler and Douvere, 2009). MSP arose out of a need to address potentially competing demands placed on the marine environment by fishing, oil and gas exploration, renewable energy projects, marine-protected

[1] MSP is referred to as maritime spatial planning in Europe.

areas, navigation channels, anchorages, military exercise areas, unexploded ordnance grounds, dredge and fill areas and recreation areas (Collie *et al.*, 2013). In addition, it provides a transparent decision-making process to encourage stakeholder coordination and collaboration through a common operating picture based on data compilation, decision support tools and data visualisation to achieve specified objectives and goals. Types of data typically incorporated into MSP include:

(i) jurisdictional and regulatory such as boundaries or outer continental shelf lease blocks;
(ii) human use such as utility assets, military exercise areas, navigation channels and commercial fishing areas;
(iii) ecological such as habitats, locations of shellfish, presence of marine mammals and migratory bird routes;
(iv) physical oceanographic such as wind energy potential, current velocity, seabed geology and bathymetry;
(v) demographic such as human population distribution, economically valued areas and locations of historical interest.

Data are required to inform four parts of the 10-step approach to MSP: analyse existing conditions, define future conditions, monitor and evaluate the performance of marine spatial plans (Ehler and Douvere, 2009). Data collection, analyses and management are key to support the place-based characteristic of MSP (Shucksmith and Kelly, 2014) and thus viewed as an important component of operationalising ecosystem-based management (Young *et al.*, 2007). Despite the significant role MSP could play in an ecosystem-based approach, and in reducing conflicts in the ocean (Crowder and Norse, 2008), its application and structural characteristics have not been uniform (Gopnik, 2015). Due to political, cultural and historical differences, MSP in practice in the U.S. has evolved away from the theoretical framework first presented in Europe (Gopnik, 2015). Despite these changes, the central role of data is similar in both frameworks, and the ultimate goal to minimise conflicts over space through data centralisation leads us to hypothesise that application of MSP would facilitate offshore wind development.

A collective case study approach was used to examine how biological data was collected, analysed and presented in relation to MSP processes and offshore wind development in Germany, Scotland and Rhode Island. We focused on the following questions: whether these data supported the needs of the offshore wind industry and whether data compiled through the MSP process facilitated the implementation of offshore wind energy projects.

Case Studies

Germany and Scotland lead the world in offshore wind installed capacity and technological innovation; Rhode Island is the only U.S. state to successfully install an offshore wind project. All three areas incorporate MSP into their regulatory processes and were thus selected for analyses.

Scotland

Overview and governance

Marine Scotland, a directorate within the Scottish Government, is responsible for the integrated management of Scotland's territorial waters, those from the high water mark to 12 nm offshore (Scottish Government, 2015a). However, inside the Scottish territorial waters, the seabed is property of The UK Crown Estate, an independent commercial business that was created by an act of parliament and that manages land and property for the Crown (Marine Scotland, 2011). The Crown Estate is responsible for allocating the rights to renewable energy from shore to 200 nm offshore, the exclusive economic zone (EEZ; Baxter *et al.*, 2011). A lease from The Crown Estate Commissioners, the commercial managers of the seabed, is required in order to construct an offshore wind project anywhere in the U.K. (Marine Scotland, 2011).

Offshore wind energy

Scotland has 25% of the offshore wind resource of Europe (Scottish Government, 2015b). The Scottish Government is committed to developing this sector due to potential jobs and increase in revenues that will benefit the Scottish economy (Marine Scotland, 2011). Currently, 66 turbines with an installed capacity of 221 MW are installed offshore in territorial waters (Marine Scotland, 2017). The Crown Estate initiated Round 3 in 2010, resulting in exclusivity agreements to offshore wind energy developers for nine areas, including two zones in the Scottish EEZ, Moray Firth and Firth of Forth, that have a combined generating capacity of 4,800 MW (Fig. 1; Baxter *et al.*, 2011; Marine Scotland, 2011, 2017).

The 'Blue Seas Green Energy — A Sectoral Marine Plan for Offshore Wind in Scottish Territorial Waters' guides regional development of offshore wind in Scottish territorial waters (Marine Scotland, 2011). The plan outlines 10 potential sites for development in the short term (defined as 2020), supporting approximately 5 GW of installed capacity, and 25 additional sites in the medium term (defined as 2030; Marine Scotland, 2011).

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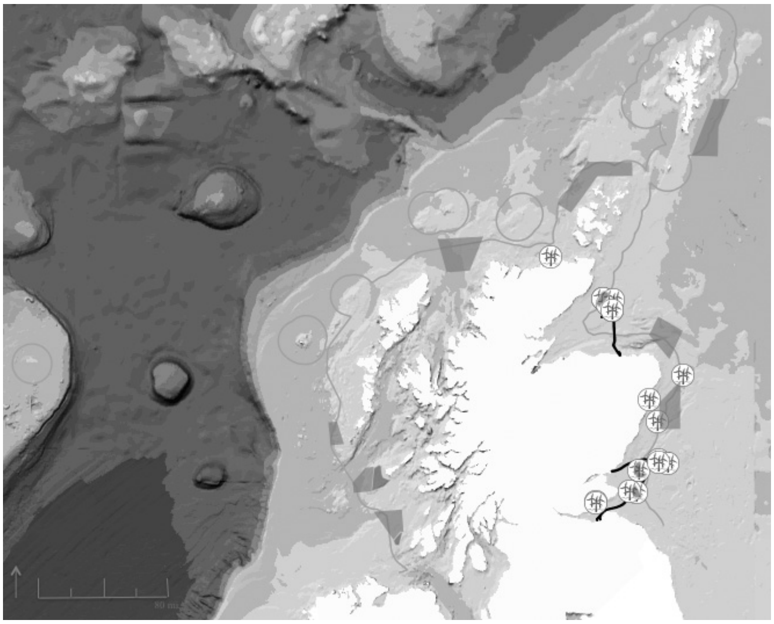

Fig. 1. Potential and operational offshore wind sites in Scotland. Windmill icons represent regions where agreements are in place between the Crown Estate Scotland and developers for offshore renewables and associated cables. Light grey shaded regions were identified in the Draft Sectoral Marine Plans for Offshore Wind as potential sites for future offshore wind energy. Dark grey shaded regions were identified in Blue Seas Green Energy — A Sectoral Marine Plan for Offshore Wind Energy in Scottish Territorial Waters as options for offshore wind development up to 2020.

MSP

Oil, gas, aquaculture, marine renewable energies, commercial fishing, recreation, tourism, shipping, ports, carbon capture and storage, telecommunications and defence have different spatial and temporal needs within the Scottish territorial waters and EEZ. The UK Marine and Coastal Access Act of 2009 and the Marine Scotland Act of 2010 provide the foundation for deconflicting these users through MSP (Marine Scotland, 2011). The national act appoints Marine Scotland to oversee a new statutory marine planning system that outlines 11 regional planning efforts focusing on local stakeholders and smaller habitat units (Scottish Government, 2015a). At the national level, Scotland published a National Marine Plan (NMP), a lofty, national scale, anthropogenic-centric document that focuses on encouraging economic development of marine industries while incorporating environmental protection into marine decision-making (Scottish Government, 2015a). The plan spatially includes both the territorial waters (under devolved functions) and the EEZ (under reserved functions). The offshore wind section includes recommended 'Plan Options', strategic development zones in which commercial scale offshore wind projects should be sited. These zones were identified through a multi-stage process involving a sustainability appraisal, a strategic environmental assessment (SEA), a habitats regulation appraisal and a socio-economic assessment. SEAs are impact assessments conducted at the policy, planning or programme level, as opposed to EIAs that are conducted at the project level. The comprehensive NMP was a successor to the sector-specific Offshore Wind Plan of 2011.

Data

Data management related to the offshore wind sector and MSP process in Scotland began in the early 2000s. The Robin Rigg Offshore Wind Farm Environmental Statement was one of the first notable data consolidation efforts for offshore wind (Natural Power, 2002). Surveys in various topic areas were conducted and combined with existing studies to establish a baseline status of environmental, social and physical aspects. Direct and indirect effects of the project were determined, and mitigation measures were incorporated into the design. Monitoring programmes, such as marine mammal surveys to compare use of the project area before and after construction, were implemented during the construction period and continued for three years post-construction (Natural Power, 2002).

A broader, more strategic approach to data management was undertaken in the Scottish Marine Renewables SEA (Faber Maunsell and Metoc PLC, 2007) and the SEA of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters (Offshore Wind SEA; Marine Scotland, 2010). The purpose of an SEA is to evaluate and describe the likely significant environmental effects, both positive and negative, of implementing a broad policy or programme. The Scottish Marine Renewables SEA assessed the potential effects of wave and tidal energy, but excluded wind in selected areas of the territorial waters of Scotland. The Offshore Wind SEA focused exclusively on the effects of offshore wind. Existing social and environmental data informed the assessments, but additional surveys were not conducted for either SEA. Data gaps, such as cetacean, seal and seabird distributions, were noted and viewed as limitations of the assessments (Faber Maunsell and Metoc PLC, 2007). Surveys to fill these gaps were identified, prioritised and recommended for future work. Other recommendations included requiring all developers to make publically available data collected on the existing environment in their area of development and development of data management protocols to ensure consistency and compatibility of datasets.

Marine Atlas was the most comprehensive national effort to collate data about aquaculture, fishing, oil and gas, undersea cables, renewable energy, ports, shipping, waste, water abstraction, recreation and defence in the Scottish territorial waters and EEZ (Baxter *et al.*, 2011). Collaborative monitoring programmes (e.g. Scottish Environment Protection Agency), government reports and previous EIAs informed the effort. Existing data sets were compiled, readjusted for scale and displayed spatially to inform the NMP. No systematic review process of the Marine Atlas is defined; however, the Marine Scotland information data portal includes current information organised by theme, metadata and maps as well as the content that informed the study.

Germany

Overview and governance

The democratic Federal Republic of Germany consists of a central federal government and 16 states (Länder). Individual Länder govern their adjacent territorial seas that are waters within 12 nm of the coast, whereas the federal government utilises and regulates the EEZ from 12 nm out to international limits. The EEZ of Germany spans approximately 33,100 km^2, of which 28,600 km^2 is in the North Sea and 4,500 km^2 in the Baltic Sea (Strehlow *et al.*, 2012).

Within the federal government, several ministries and agencies are involved in the management of activities in the EEZ. The Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie — BSH) provides oversight to ensure sustainable use of the oceans, approves offshore wind development projects and conducts MSP in the German EEZ. Within the territorial sea, the Länder conduct licensing of offshore wind projects upon receipt of stakeholder inputs and EIAs (Kannen, 2005; Köller *et al.*, 2006; Thomsen, 2014).

Offshore wind energy

Currently, Germany has 793 turbines installed representing 3.3 GW of installed capacity (Fig. 2; South Baltic Offshore Wind Energy Regions, 2017; German Offshore Wind Energy Foundation, 2017). Current and proposed locations of offshore wind projects are limited to the German EEZ instead of its territorial sea due to the significant number of national parks that prohibit development and the numerous navigation channels in the territorial sea (Kannen, 2005; Köller *et al.*, 2006). In addition, Germany's comparatively short coastline and socio-political concerns contribute to the preferential siting of offshore wind in the EEZ, where potential sites are located almost exclusively in significant water depth far away from the coast (Köller *et al.*, 2006).

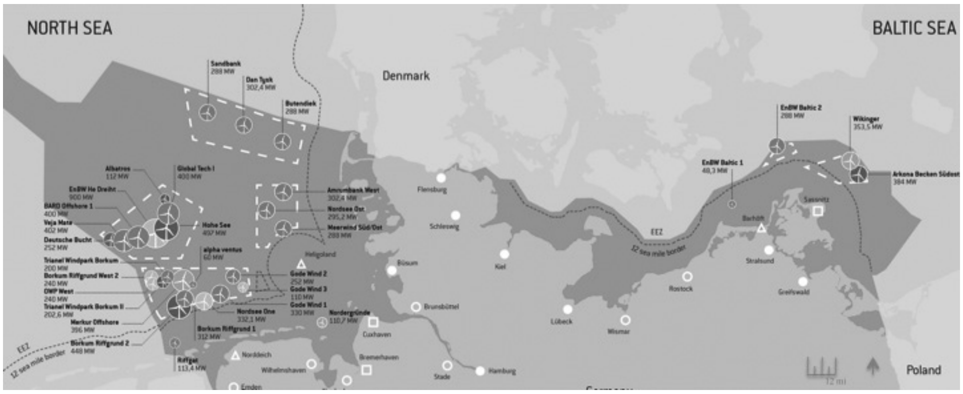

Fig. 2. German offshore wind projects in the North Sea and Baltic Sea.

In 2014, renewables were Germany's number-one source of electricity, with wind power leading generation (BMWi, 2015). However, as building land-based sites reached capacity, Germany began to look to offshore wind to fulfil its national renewable energy goals (Portman *et al.*, 2009). Key to meeting this goal was phased expansion, founded in the precautionary principle, whereby progression from phase to phase was dependent upon positive results with regard to environmental impacts (Lüdeke, 2017).

MSP

Projected conflicts among marine shipping, nature conservation and proposed offshore wind projects prompted MSP in Germany. The Federal Spatial Planning Act (Raumordnungsgesetz — ROG) established the legal foundation for MSP in Germany by extending existing planning guidance on land out to the EEZ and as amended appointed BSH as the lead-planning agency for federal MSP (Köller *et al.*, 2006; Douvere and Ehler, 2009; ROG, 2008). In 2005, planning efforts began with data collation and a questionnaire on uses and interests in the marine space (Blake, 2013). Shipping routes, pipeline locations and cable sites were included in the planning process; however, fishing grounds were notably absent (Blake, 2013). The planning process concluded in 2009 with the approval of the Marine Spatial Plan for the German EEZ in the North Sea (BSH, 2009a) and the Marine Spatial Plan for the German EEZ in the Baltic Sea (BSH, 2009b).

An SEA was performed as part of the MSP process in order to evaluate the state of the marine environment and to assess projected impacts caused by the implementation of the plans. It concluded that no significant effects on the marine environment would result from the adoption of the North Sea and Baltic Sea spatial plans. However, the environmental report of the SEA did recognise that given substantial environmental information gaps, a lack of criteria existed for evaluating the effects of anthropogenic activities on the living marine environment (BSH, 2009c).

A notable aspect of the final marine spatial plans was the designation of three spatial zones (BSH, 2009a,b): priority areas in which one use was given priority, reservation areas in which one use is given special consideration and marine-protected areas in which measures must be taken to reduce impacts on the marine environment. Within this framework, five priority areas for wind power were designated in the North Sea and two priority areas were designated in the Baltic Sea (BSH, 2009a,b).

Smaller, regional MSP occurred separately from the national plans in three Länder. Mecklenburg-Vorpommern, bordering the Baltic Sea, developed a plan in 2005 to prevent conflict among new technologies (i.e. offshore wind), tourism, nature protection, shipping and fishing (Douvere and Ehler, 2009). Also motivated by the development of offshore wind, Lower Saxony, bordering the North Sea, developed a marine spatial plan in 2006 by extending their existing terrestrial spatial plans into the territorial sea (Portman *et al.*, 2009; Drankier, 2012). Schleswig-Holstein developed an integrated terrestrial and marine use plan in 2010 to guide the sustainable development of the coastal zone (European Commission and European MSP Platform, 2017). In addition, Germany participates in broad-scale, cross-sectoral MSP in the Baltic Sea through membership in the joint Baltic Sea MSP Working Group (European Commission and European MSP Platform, 2017).

Data

Data that inform assessments of offshore wind projects and marine spatial plans come from a variety of sources. In 2001, the federal German government recognised the possible environmental impacts from offshore wind and initiated the research project Accompanying Ecological Research on Offshore Wind Energy Deployment (AERO; Köller *et al.*, 2006). The 2002 Strategy of the German Government on the Use of Offshore Wind Energy reinforced AERO, calling for ecological research and environmental monitoring in conjunction with the expansion of the offshore wind sector. At the conclusion of AERO in 2005, offshore wind power was still in its infancy in Germany with only a 4.5 MW pilot turbine installed. The initiation of focused ecological research so early in the development of a new industry was unique to their plan (Köller *et al.*, 2006).

Regional scale investigations were also performed for the SEA for the Utilisation of Offshore Wind Energy and its associated environmental report, sponsored by BMU, the German Ministry for the Environment (Schomerus *et al.*, 2006). Detailed baseline data were collected over a four-year period from a series of monitoring platforms (Phylip-Jones and Fischer, 2015). This SEA and its environmental report investigated potentially substantial environmental impacts (positive and negative), reasonable alternatives, proposed monitoring measures and the concerns of the affected public. It was broad in temporal scope, assessing potential impacts from inception of the programme through the anticipated life span of individual projects.

Offshore wind EIAs and associated environmental impact studies that focused on the immediate geographic area of individual projects were also conducted. EIAs are required by German law (German regulation § 3 Abs. 1 Nr. 1 UVPG i.V.m. Anlage 1, Nr. 1.6), initiated and funded by the developer and submitted to BSH as part of the authorisation process (Portman *et al.*, 2009). BSH provides explicit guidelines for developers, including a mandatory two-year baseline study period, and post-construction and operational monitoring for three to five years, all funded by the developer (BSH, 2013).

Rhode Island, United States

Overview and governance

Rhode Island is the smallest state in the U.S.; yet has the third most water as percentage of total state territory (United States Census Bureau, 2010). Numerous uses reflect the importance of the marine environment including commercial and recreational fishing, shipping, recreational boating and sailing, military, whale watching and offshore wind energy. The Coastal Resources Management Council, a state agency within the Rhode Island government, manages the coastal areas and state waters of Rhode Island, designated as those from the shore to 3 nm (of both mainland and any islands). U.S. federal laws are still applicable within this area including Section 10 of the Rivers and Harbours Act (33 U.S.C. 403) and Section 404 of the Clean Water Act (33 U.S.C. 1344). The U.S. federal government manages the EEZ from three-200 nm from shore.

Offshore wind energy

In 2016, the Block Island Wind Farm became the first offshore wind project installed in the U.S. The project is comprised of five-6 MW turbines located in state waters, less than three miles from the coast of Block Island (Fig. 3; Tetra-Tech, 2012; Marine Cadastre, 2017). The Block Island Wind Farm was motivated by the Rhode Island legislation for Renewable Energy Standards (RIGL §§ 39-26) of 2004 and amended in subsequent years. Its provisions included a requirement

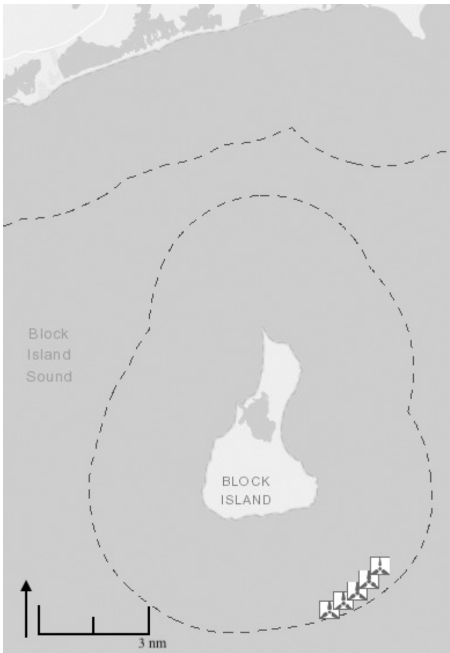

Fig. 3. Block Island Wind Farm location in state waters of Rhode Island, United States.

that 3% of retail electricity sold in 2007 comes from renewable energy resources, incrementally increasing up to 1.5% per year until 2035 (RIGL §§ 39-26-4). The Rhode Island Winds Programme (RIWINDS), initiated in 2006 to study the potential of wind energy to supply electricity, propelled offshore wind development further. The goal of RIWINDS was to find wind resource to supply 15% of Rhode Island's energy needs, or 400 MW of installed capacity, by 2012 (TetraTech, 2012). A subsequent siting study assessed that achieving this goal would only be feasible with the inclusion of offshore wind resources (TetraTech, 2012). A request for proposal for development of an offshore wind farm was initiated in 2008 and by January 2009, the State of Rhode Island and Deepwater Wind Rhode Island, LLC entered into a joint development agreement to develop the Block Island Wind Farm.

MSP

Rhode Island was one of the first U.S. states to develop a marine spatial plan. The Ocean Special Area Management Plan (OSAMP) is a planning tool, based on research, public engagement and policy making that provides a framework for studying, monitoring and planning in the OSAMP area in order to produce enforceable policies (CRMC, 2010; McCann *et al.*, 2013). The OSAMP study area includes approximately 1,467 sq. mi. of portions of Block Island Sound, Rhode Island Sound and the Atlantic Ocean, starting 500 feet from the coastline in state waters out to three nautical miles, and all federal waters within the boundary (CRMC, 2010).

Although the goals of the plan included comprehensive management of the marine space, offshore wind development was the primary issue (CRMC, 2010; RIGL §§ 39-26-1). Practical outcomes of the OSAMP included an offshore development regulatory framework, policies that protect natural resources and manage existing and potential future uses, new scientific research of the study area and a rigorous stakeholder process (CRMC, 2010). An example of the offshore regulatory framework was the designation of the Rhode Island Renewable Energy Zone, an area approximately 68 sq. km just east and south of Block Island. Development proposals within this zone that were received within two years of OSAMP completion could use data from OSAMP to complete the permitting for development, thus expediting the permitting process (CRMC, 2010).

Data

The OSAMP process included a dedicated two-year effort to collect and collate data about human and environmental resources in Rhode Island waters. A team of scientists, federal and state agencies, environmental organisations and users of the OSAMP area helped develop a research agenda to identify data gaps, research priorities, potential partners and available funding sources. Over 100 scientists then implemented this research agenda, collecting and analysing data with the assistance of local stakeholders. Concurrent data collection efforts by developers also took place at a finer spatial resolution to the analysis in OSAMP (TetraTech, 2012). These outcomes were combined with previously conducted studies regarding species, habitats, economics, archaeology and social issues to populate databases, inform stakeholders and develop policy.

Discussion

Biological data collection, collation and analysis conducted as part of MSP supported the needs of the offshore wind industry to varying degrees among the three case studies examined. Specifically, MSP in Scotland and Germany did not influence initial development of the offshore wind sector as the MSP processes happened after offshore wind was already formally a part of the blue economy

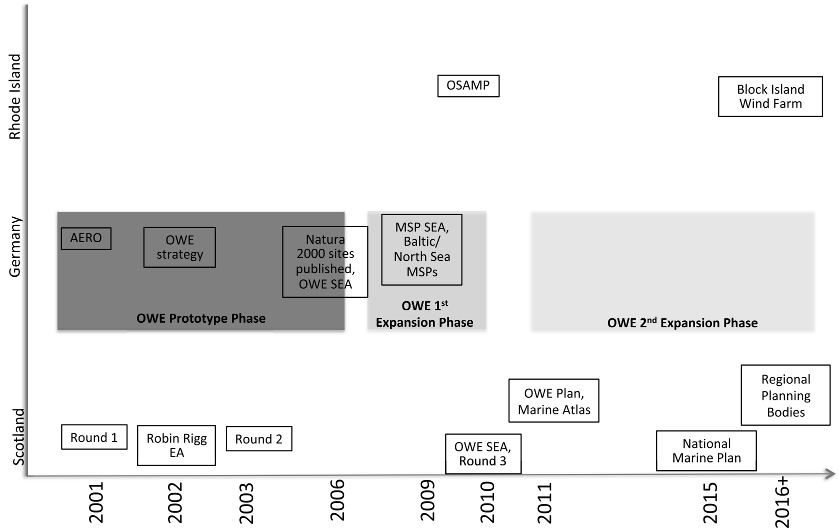

Fig. 4. Timeline of significant events related to offshore wind energy development and MSP in Scotland, Germany and Rhode Island.

(Fig. 4). The aim of 'plan-led marine management', where marine spatial plans would inform siting decisions, is not achieved since a majority of the decisions were already made prior to approval of the plans (Scaff *et al.*, 2015).

Similarly, Marine Atlas, the national data initiative in Scotland, was initiated too late to influence offshore wind development. It was published in 2011, one year after the Round 3 leases, and in the same year as the publication of the sectoral offshore wind plan. Offshore wind siting decisions were thus already made and informed the NMP, rather than being informed by the NMP. However, the Marine Atlas succeeded in its main objective to collate and spatially map data and uses of the marine environment in order to inform the NMP. Comprehensive supporting data are essential for assessments of impacts to inform decision-making during the regulatory approval process (CEQ, 1986; Council Directive 2001/42/EC). Thus, future offshore wind siting decisions may thus benefit from this effort and the resulting marine spatial plan.

Germany focused intensive data efforts early in the process that streamlined implementation of the offshore wind sector. National research projects focused directly on the needs of the offshore wind industry, specifically collecting data with the intent of assessing possible impacts from offshore wind and establishing a baseline understanding of important environmental variables. Furthermore, although offshore wind development in Germany was not accelerated by MSP, it ultimately benefited from MSP. The plans increased the number of delineated sites available for development, reduced stakeholder conflict and managed competing interests, which had previously stunted the industry (Drankier, 2012).

Despite the lack of synergy among national data efforts, national MSP processes and offshore wind siting, the offshore wind sector still established itself as part of the blue economies in Scotland and Germany. Several factors seemed to enable this progress. First, the sector was guided by offshore wind spatial plans or strategies that were informed by SEAs and included assessed stakeholder concerns, socio-economic conflicts and habitat appraisals. While the plans were not integrated, a key element of MSP, they did fulfil other theoretical aspects of MSP (Ehler and Douvere, 2009). The plans were: ecosystem-based in that they took into consideration the potential environmental impacts in the SEAs; place-based by allocating offshore wind energy zones (Table 1); strategic and anticipatory by mapping out long-term development; participatory by consulting stakeholders and adaptive through reviews to include monitoring results and research updates. Secondly, success of the offshore wind sector may be attributed to the existence of national energy policies (e.g. Federal Renewable Energies Act of 2004) and renewable energy targets supported by public sentiment (Zucco *et al.*, 2006). Finally, both these areas allocated spatial zones for offshore wind energy (BSH, 2009a,b; CRMC, 2010; Scottish Government, 2015a). Delineated areas give assurance to developers that they will be able to construct projects without contention from other marine users.

In Rhode Island, data efforts as part of the MSP process directly correlated to development of the first offshore wind project in the United States. OSAMP is

Table 1. Spatial allocations for offshore wind energy development identified in three case study locations: Scotland, Germany and Rhode Island.

Location	Zoning framework
Scotland	UK leasing rounds
	Plan options — strategic development zones
Germany	Priority areas
	Reservation areas
	Marine-protected areas
Rhode Island	Renewable energy zone

credited with saving two to three years of time in the planning and regulatory process of the Block Island Wind Farm due to the ability of developers to draw from existing data for use in the environmental reviews, knowing the methodologies were sound having participated in the planning process (Schumann *et al.*, 2016). Jeff Grybowski, CEO of Deepwater Wind, echoed this statement in his keynote address at the 2015 International Marine Spatial Planning Symposium: Sharing Practical Solutions. 'Rhode Island's pioneering MSP work has helped to pave the way for America's first offshore wind energy project, the Block Island Wind Farm. Smart, transparent, and inclusive planning is essential to the offshore wind energy industry', Grybowski said. Rhode Island's process followed a progressive path: data gaps categorically identified, data needs fulfilled through new surveys and existing sources, data incorporated into policy in a spatial planning process and ultimately development of an offshore wind farm.

However, the participants in the MSP process were emphatic that the OSAMP was not a renewable energy-siting plan, but rather a comprehensive ecosystem-based marine spatial plan (Schumann *et al.*, 2016). Drankier (2012) echoed this sentiment stating that it is a mistake to presume that a management plan is similar to a spatial plan. Management plans are frequently used for oversight of single sectors, such as fisheries or maritime transport, and are implemented through a top-down approach. MSP is ecosystem-based, area-based, integrated across sectors and participatory. The OSAMP process and final plan adhered to these principles, balancing the needs of new users with existing ones.

Some believe that offshore wind development may have proceeded in Rhode Island without a marine spatial plan (Schumann *et al.*, 2016). State-mandated legislation and renewable energy targets supporting the development of offshore wind could have been enough. However, the MSP process filled fundamental gaps regarding biological and geological data and public uses of the marine space. In addition, it allowed a forum for public input, deemed critical at a time when public opposition was high to an offshore wind project in the neighbouring state of Massachusetts.

Conclusions

Lack of biological data to inform EIAs may contribute to the perceived cumbersome permitting process resulting in delays to offshore wind development in U.S. federal waters. MSP, a process that includes identifying and fulfilling data needs of marine users, may help to streamline the federal NEPA process. In this case study, three areas with offshore wind energy development and implemented marine spatial plans, Scotland, Germany and Rhode Island, were examined to determine whether data management in MSP aided offshore wind development. We found that early development of offshore wind was not directly informed by data efforts for MSP in all cases. In Rhode Island, a focused data effort during MSP, conducted prior to siting of offshore wind, directly informed NEPA and accelerated implementation. Impact assessments of future offshore wind projects ~~in all areas~~ may benefit from a similar comprehensive data effort.

Common to ~~all areas in~~ these collective case studies were renewable energy policies with targets and designation of spatial zones for offshore wind. Despite 71% public support for alternative energy as a solution to solve the nation's energy problems (Gallup, 2017), the U.S. does not have a federal renewable energy policy with mandated targets to support the development of renewable technologies. However, 29 states, three territories and the District of Colombia do have renewable portfolio standards including a regulatory mandate to increase production of energy from renewable sources (Zhou, 2015). These standards are credited with the advancement of the terrestrial wind energy sector (AWWI, 2016) and could do the same for the offshore sector.

Apportionment of space or identification of zones for specific uses is absent from U.S. policy and U.S. regional MSP processes. Neither the National Ocean Policy Implementation Plan (National Ocean Council, 2013a) nor the Marine Planning Handbook (National Ocean Council, 2013b) includes the term 'marine *spatial* planning'. An earlier draft of the implementation plan defined *Coastal and Marine Spatial Planning* as a primary objective and referred to an allocation-planning tool (National Ocean Council, 2012), but these references were removed in the final version. At the state level, planners in Rhode Island, Massachusetts and Oregon have designated specific zones for renewable energies. Despite the lack of political will at the federal level, proponents of zoning argue that such a framework would facilitate alignment of ocean interests and attainment of healthy ecosystems (Eagle *et al.*, 2008; Yates *et al.*, 2015), and the results of our analyses support this assertion.

For offshore wind resources to significantly contribute to the U.S. Department of Energy's goal for wind to deliver 35% of U.S. electricity by 2050 (USDOE and USDOI, 2016), regional and state marine incentives should be codified into law and employed to inform spatial plans in areas where wind is being considered, such as the West Coast region and Hawaii. Data efforts during MSP have the potential to facilitate this growing industry and reduce time required during permitting. But, even with an effective MSP process, broader initiatives such as renewable energy policies and zoning appear to be critical to establishing the offshore wind sector.

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