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Assessing the impact of a new approach to ocean management: Evidence to date from five ocean plans ☆

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ABSTRACT

Previous studies have helped define what good ocean planning (also known as maritime or marine spatial planning) looks like, effective stakeholder engagement, possible conservation and community benefits, and how ocean plans could theoretically cut costs and create economic value. But little evidence has yet been compiled showing the actual results of ocean plans, and whether or not they have delivered on their promise to balance competing interests through a collaborative process that considers environmental concerns. This paper presents an empirical study of five government-approved ocean plans, all of which resulted in broadly shared net benefits. Economically, these five ocean plans delivered on average $60 million per year in value from new industries and retained value in existing industries, although some stakeholders bore losses and government spending did not decrease. Environmentally, planning increased marine protection, ensured industrial uses avoided sensitive habitat, cut carbon emissions, and reduced the risk of oil spills. Socially, marine planning increased broad stakeholder engagement (thus improving design and administration of plans), while building trust that will likely improve sustainable future use of ocean space.

1. Introduction

Ocean planning, also called marine or maritime spatial planning, is a public process of analyzing and allocating ocean uses over space and time to achieve economic, ecological, and social objectives [1].[1]

A rich body of literature has, to date, focused on defining the essential elements of ocean planning, elucidating its potential benefits, and documenting the early progress of planning efforts. For example, the seminal work of Ehler and Douvere provides a step-by-step guide and framework for ocean planning [2]. Later work by the Monitoring and Evaluation of Spatially Managed Areas (MESMA) project in Europe created a generic framework for monitoring and evaluating ocean planning efforts and evaluated planning efforts (though not plan results) against the framework [3,4]. Ehler's latest UNESCO guide on evaluating marine spatial plans addresses the evaluation of plan results [5]. Administrators and academics have expanded this body of literature to include other planning guides and tools, as well as process lessons and suggestions gleaned from past planning efforts [6–10].

Building on the planning literature, other studies have suggested the kinds of benefits ocean planning could theoretically provide. At its broadest level, ocean planning resolves the governance mismatches that stymie efforts to manage ocean ecosystems and uses holistically [11]. Economic overviews have described the theory by which ocean planning can lower government regulatory costs, speed approval of projects, and increase the total economic value of the ocean [12,13]. Ecological overviews have helped define what good conservation would look like in ocean planning, including codifying desirable environmental conditions in the European Union [14], describing ways ocean planning could go further than simply protecting defined areas [15,16], and integrating ecosystem resilience into broad-based plans [17]. Social overviews have shown how ocean planning can create management actions that are accepted and sustained over time by engaging a complex set of stakeholders, their interests, and expectations [18].

Recent literature has advanced the theory on ocean planning's economic impact by grounding it in real-world data. Ecologists have modeled the tradeoffs ocean planning considers and shown how planning can increase total economic value and expand conservation efforts, potentially at the same time. A model of the Massachusetts Bay suggests ocean planning could unlock over $10 billion in wind

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[1] Many academics and practitioners use the term marine spatial planning or MSP. This paper uses the term ocean planning to describe the same idea.

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energy development while still conserving commercial fisheries [19]. Similar models have projected the impact of planning on fisheries off the California coast and wave energy production in Oregon [20].

As countries around the world have turned to ocean planning, the evidence base for its benefits has grown as well. Initial planning efforts in England sped up the wind energy approval process, providing greater certainty to developers and saving government $210,000 in staff costs in just six months [21]. In Massachusetts Bay in 2007, stakeholders worked with the International Maritime Organization to shift shipping lanes in and out of Boston Harbor to avoid high concentrations of endangered whales. The shift cut the risk of colliding with endangered right whales by an estimated 58 percent, provided a safer environment for ships, and increased travel times by only 10–22 min [22].

To date though, analysis of economic, environmental, and social outcomes from the implementation of ocean plans has been lacking. These outcomes largely remain hypotheses to be tested. This paper uses a case study approach to test these hypotheses, drawing on qualitative and quantitative data from plans around the world, with a focus on cases relevant to North America.

2. Methodology

This study undertook five case studies of ocean plans in Massachusetts, Rhode Island, the Great Barrier Reef Marine Park, Norway, and Belgium. The study gathered information from and analyzed over 50 semi-structured confidential interviews with experts and stakeholders on the case studies. Interviewees included agency personnel, conservation groups, the wind industry, fishermen, other ocean users, and academics. The interviews were supplemented with additional research and original analysis, and information from other plans was collected to supplement the case studies where possible. Case studies and expert interviews were used since most ocean plans are relatively new, the lack of existing empirical studies, and the difficulty of assessing new public policy.

The study considered the 59 different ocean plans, broadly defined, completed or in process by the summer of 2014 [5]. Of these 59 plans around the world, only 26 have been completed and are in force. The others are still being developed, have yet to secure political approval, or lack any binding regulations. Of those 26, 15 are in North America, Europe, or Australia. The remaining 11 are all in China and therefore less applicable to the North American context.

To choose five geographically diverse plans for in-depth study, experts were asked in structured interviews about the recognition of the plans as exemplars of ocean planning and data availability (Table 1). Ultimately, Massachusetts and Rhode Island from North America, the Belgian North Sea and Norwegian Barents Sea from Europe, and the Great Barrier Reef from Australia were selected.

Of the North America plans, the Massachusetts and Rhode Island plans are recognized within the ocean planning community for balancing multiple uses effectively, and both have been in place for at least three years. The Oregon plan pre-dates the others, but was developed piece-meal so there are few cross-sector tradeoffs to analyze. The Florida Keys National Marine Sanctuary includes ocean planning, but is a less balanced multi-use plan since environmental protection trumps all other uses. While perfect balance is not a strict requirement to using it as a model, the Massachusetts and Rhode Island plans provide superior options given their multi-use character.

Of the ten European plans, the Belgian North Sea and Norwegian Barents Sea plans are the longest established and have collected the most impact data. The Netherlands completed its North Sea Plan in 2005, but there is less data available on the plan's impacts. Germany completed plans for the North Sea, the Baltic Sea, and the three states on its northern coast in 2009, but less impact data are available than for the Belgian and Norwegian plans.

In Australia, the modern Great Barrier Reef plan dates to 2004 (building off of legislation in 1975 and original plans completed in 1988 and is the only Australian plan with full regulatory force. While it has been criticized for relying more on zoning than on strategic management [23], and preferences conservation over other uses, it demonstrates most of the qualities associated with ocean planning (e.g., considered multiple uses, was derived through an extensive planning process with considerable stakeholder input, and includes monitoring and enforcement).

3. Results

3.1. Economic results

3.1.1. New economic value created

The five plans studied in-depth likely created approximately $310 million in new economic value, mainly through offshore wind developments in Rhode Island and Belgium (Fig. 1).

Belgium's new offshore wind farms provide approximately $230 million in annual gross revenues [24]. Before the plan, offshore wind was opposed by local communities and a proposed project was supposedly derailed because it blocked coastal views. This not only created additional carbon emissions but also cost developers: up to $13 million for environmental assessments, site surveys, piloting, and more each time a permitting process failed [25]. In 2004, by contrast, Belgium's Master Plan successfully declared a wind energy development zone far from the coast, away from sensitive seafloors. When fully developed, the zone is expected to support 2400–3800 MW of installed wind capacity. Three of the zone's seven granted leases have already been developed [26].

Rhode Island's experience was similar. The 2010 Rhode Island plan pre-approved renewable energy zones, enabling two wind projects with expected annual gross revenues of $5–10 million and $50–100 million respectively [27]. Deepwater Wind, the developer of both projects, has now secured all the approvals for a five-turbine wind farm in state waters off Block Island. It plans to install up to 100 turbines (a project called Deepwater One) in federal waters covered by the Rhode Island plan. Rhode Island approved this project in under one year, cutting its permitting process down from nearly five years. According to multiple interviewees, it is quite likely these projects would not have happened without the plan, which simplified the regulatory process and included stakeholder outreach to all major parties likely to be affected. A very different scenario played out in federal waters near Cape Cod, where Cape Wind has attempted for fifteen years to build 130 turbines. While there are no public figures available, Cape Wind estimates it has spent more than $65 million so far working through the regulatory and legal challenges [28].

Although their economic impact on wind development is not yet clear, European plans have made permitting easier. In the Netherlands, the North Sea ocean plan cut the cost of offshore wind permits by two-thirds [29]. In Germany, the North Sea plan helped resolve conflicts between wind developers and other users, and wind farms are reported to now have an easier time during permitting [30].

Industries other than wind, such as seafloor cable developers, also saw value from ocean plans. For example, Comcast and NSTAR credit the Massachusetts ocean plan with helping their project to lay a new cable from Falmouth to Martha's Vineyard getting approved 12–24 months faster than expected [31]. Comcast received approval to file a single Environmental Impact Report in July, 2011, saving at least six months assuming it would have crossed the impact threshold regardless, according to experts with detailed knowledge

Table 1
Case study selection among the 15 relevant plans.

Region	Plan	Experts view it as a model	Data on impacts
North America	**Massachusetts Ocean Management Plan**	Very high	Medium
	Rhode Island Ocean SAMP	Very high	Medium
	Oregon Territorial Sea Plan	Medium	Lower
	Florida Keys National Marine Seashore	Lower	Medium
Europe	**Belgian North Sea**	Very high	Very high
	Norway Barents Sea	Very high	Higher
	Norway Norwegian Sea	Very high	Medium
	Netherlands North Sea	Very high	Medium
	German North Sea MSP	Higher	Medium
	German Baltic Sea MSP	Higher	Medium
	Germany - Lower Saxony Länd	Higher	Lower
	Germany - Mecklenburg-Vorpommern Länd	Higher	Lower
	Germany - Schleswig-Holstein Länd	Higher	Lower
	UK - East Planning Regions	Higher	Lower
Australia	**Great Barrier Reef Marine Park**	Medium	Very high

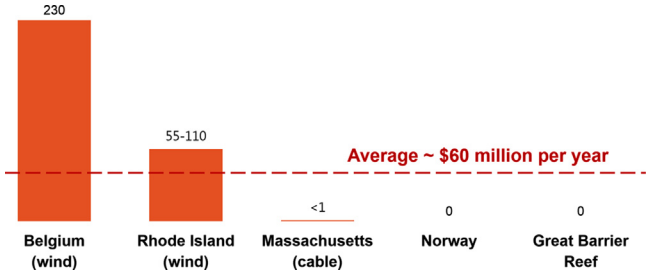

Fig. 1.

- Title: New economic value created.
- Subtitle: $ million per year.

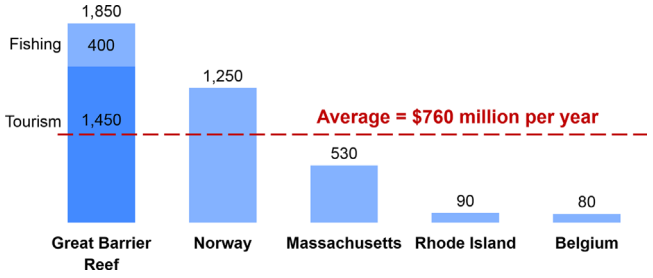

Fig. 2.

- Title: Existing economic value retainted.
- Subtitle: $ million per year.

of Massachusetts environmental regulations. The project received its permit in June, 2012. The permit used data collected for the ocean plan, and Comcast talked in advance with an inter-agency regulatory team the Massachusetts plan created. Comcast did not hire outside counsel given the lack of likely roadblocks, saving the company hundreds of thousands of dollars in legal fees according to an expert in environmental engineering [32].

3.1.2. *Existing economic value retained*

Each of the five plans studied in detail sought to retain the value of incumbent industries, providing some protection to tourism and fishing (Fig. 2) [26,33–38]. To some extent these industries were already protected through existing policies and customs, but most ocean plans added specific measures further protecting them.

Tourism is the largest economic driver in the Great Barrier Reef, making protecting that industry the greatest economic benefit that could result from the plan. The Great Barrier Reef plan protected tourism by ensuring access for tourists to a third of the Park covered by no-take zones. It also prevented the risk of degradation from trawling, enabled the Reef to be marketed as a sustainably managed World Heritage Area, and continued using tourism-specific regulations to prevent overcrowding. These measures protected nearly $1.5 billion in revenues, based on total tourist spending [33] and an estimate that half of all tourists would avoid visiting the Reef if its coral and ecosystems were permanently damaged [34].

The fishing industry benefited as a direct result of now having its interests represented in decision-making. For example previously when sand and gravel projects were proposed in spawning grounds off Winthrop and Nantucket, the Massachusetts Division of Marine Fishing had no jurisdiction. The ocean plan extended fisheries management closures to other industries, providing full protection against development in plan-defined Important Fish Resource Areas, including inner Massachusetts Bay (where Winthrop is located), Nantucket Sound, and others [39].

The result in Rhode Island was similar, where fishermen secured the removal of Cox's Ledge from a federal wind leasing area. Cox's Ledge is believed to be one of the most productive spawning areas in the mid-Atlantic, and fishermen are estimated to earn $500,000–750,000 in profit each year by fishing there [40,41]. While fishermen would have preferred to see a larger area excluded from development, they preserved over half of the area's historical catch value while reducing the area to be leased by just 25 percent. The wind farm will likely still cost fishermen $175,000–425,000, but compensation payments are expected to cover this lost revenue [40,42].

Norwegian and Belgian fishermen similarly saw nearly all their fishing grounds protected in ocean plans, which is particularly important in Norway since the Barents Sea fishery lands $1.25 billion annually in fish – over half of Norway's total fishing revenues – and employs 11,000 people [36]. Neither country closed economically significant areas to fishing nor substantively increased fishing regulations. Rather, Norway restricted seismic exploration during key fishing times, a measure achieved through greater cooperation between fishermen and petroleum developers.

3.1.3. *Economic losses*

Fishing in Australia, Rhode Island, the Netherlands, and Germany: These plans imposed some losses on fishermen by limiting access to current fishing grounds. Specifically, Australia expanded no-take zones. Rhode Island, the Netherlands, and Germany

facilitated offshore wind development that will close wind farm areas to fishing: in Rhode Island the fishing closure applies only during construction but in the Netherlands and Germany throughout the life of the wind farm.

However, the Australian and Rhode Island plans compensated fishermen for their expected losses. In Rhode Island, fishermen negotiated a compensation package worth $285,000 per year from the smaller Block Island wind farm according to one participant in the confidential negotiations (negotiations on the larger project are ongoing). The Australian government provided $210 million to fishermen [43]. In the Netherlands and Germany, interviewed planners expect losses to be negligible as fishing revenue is more constrained by overfishing than by lack of space.

Sand and gravel extraction in Massachusetts and Belgium: In the two plans where sand and gravel extraction was a known industrial use, planners included new regulations that limited short-run profits in the interest of conservation and long-term sustainability. To protect spawning grounds, the Massachusetts plan closed areas in which developers had expressed interest. In Belgium, the 2004 plan increased extraction fees and the 2014 plan will gradually decrease the total amount of extraction permitted [26].

Some possible development projects in Massachusetts and Rhode Island: Both US plans constrained where developers could build large infrastructure projects, including wind energy and liquid natural gas terminals. To the extent that these projects would have gone forward in their absence, the plans caused economic losses. However, developers may have gained from the certainty of a quick rejection. For example, a Rhode Island planner interviewed noted that an Italian wave energy company withdrew its application for a project near Block Island once they saw the fishery data the ocean plan had collected.

The Australian government: The $210 million-plus fishery compensation program in the Great Barrier Reef exceeded independent analysis of commercial fishermen's economic losses and did not reduce capacity as intended [43]. The compensation program may have accomplished social or political aims, but represented an economic loss for government.

3.1.4. Government spending

Ocean planning does not appear to have had a significant net impact on government agency spending, with minor increases and decreases likely canceling each other out. Agencies generally spent slightly more staff time and money on research and stakeholder outreach than they had before the plans. At the same time, agency staff expect to benefit from a reduced risk of appeals and litigation, particularly in the US. Consistently, at time of publication, no projects pursued under US ocean plans have been appealed.

In most cases, agencies established ocean plans using existing staff. The budgetary cost of these plans was therefore relatively low – no agency interviewees reported receiving additional funding from appropriators. Higher non-staff costs were typically due to plans taking on additional stakeholder engagement and unique research.

In both Massachusetts and Rhode Island, additional activities were pursued to make the plans or planning processes more robust, and in both cases supplementary grants helped fund these efforts. In Massachusetts, the government provided agency staff time (valued at $2.7 million) and private philanthropy provided approximately $8 million for stakeholder support and additional research. Rhode Island commissioned approximately $3.2 million in wind-specific research that was later reimbursed by the wind farm developer. It also secured in-kind assistance and grants from the University of Rhode Island and the federal government.

In all case studies outside the US, governments have shouldered any additional costs within agency budgets. The European Union also made funding available for ocean plans through the European Maritime and Fisheries Fund and the European Regional Development Fund and has spent $6 million on cross-national plans so far. Governmental financial support for ocean planning not only obviates the need for private funding, but may make plans more likely to achieve their goals [44].

3.2. Environmental results

Each of the plans led to marine ecosystem protection. Certain plans also enabled wind farms and reduced the risk of oil spills (Fig. 3) [45–48].

3.2.1. Marine protection

Each of the plans expanded marine protection and/or modified sector-specific regulations to benefit the environment.

The Great Barrier Reef plan banned infrastructure development throughout the entire 130,000 square-mile area, extending protection against oil drilling and limestone mining dating back to the park's creation in 1974. In addition to the no-take zones discussed earlier, the 2004 plan banned trawling in an additional 28 percent (more than 35,000 square miles) of the Reef.

In Norway, the 2006 Barents Sea plan placed a moratorium on oil and gas exploration in the Lofoten Islands area. Lofoten and the coastal Barents Sea are the most important spawning and habitat areas for capelin, herring, and Northeast Arctic cod in the region, and the only spot for wintering herring [36]. 70 percent of Norway's fish stocks spawn in the Lofoten Islands, [49] and the area provides nearly all of Norway's cod and haddock catch [50]. Protecting this area from industrialization was therefore the highest value conservation outcome that could have been expected from the plan.

The Massachusetts plan extended protection over 1565 of its 2145 sq miles of state waters (over 70 percent) as Special, Sensitive, or Unique areas and therefore excluded from infrastructure development. These areas include habitats for endangered species like roseate terns and North Atlantic right whales; fish spawning and stock habitats; and sensitive ecosystems like intertidal flats, eelgrass, and hard or complex seafloors. It also maintained existing protected areas (e.g., Cape Cod National Seashore).

These protected areas have already influenced economic activity in Vineyard Sound. Comcast's cable project was designed to avoid hard and complex seafloor areas, in contrast to previous cable projects that ran directly through them. In addition, while NSTAR had previously proposed its own cable, the plan made it more economical for the two projects to co-locate, reducing disturbance.

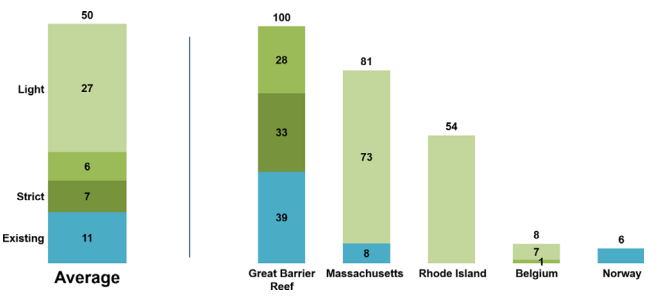

Fig. 3.
–Title: Increases in marine protection.
–Subtitle: Percentage of area protected; Strict: IUCN IA-V, Medium: IUCN VI, Light: No new industrial use.

Rhode Island extended protection over 792 sq miles, 54 percent of the 1467 sq-mile planning area [47]. Like Massachusetts, Rhode Island did not prohibit all uses in these areas, but excluded major development like wind farms and liquefied natural gas terminals that would have had a multi-season negative impact on fishery and ecological resources [38]. Unlike in Massachusetts, this protection extends into federal waters. Rhode Island ensured consistency with federal planning requirements, and then negotiated for most plan elements to be included in jointly-agreed policies.

Rhode Island's work to ensure consistency between federal and state policies has already benefited marine ecosystems. In 2013, the federal Bureau of Ocean Energy Management modified its offshore wind lease zone in Cox's Ledge to accommodate concerns that wind development would harm important fish spawning areas (Fig. 4). The federal government removed over 80 sq miles from leasing, approximately a quarter of the final lease area.

3.2.2. Marine protected areas

The 2004 re-zoning of the Great Barrier Reef declared 38,000 sq miles of new no-take marine protected areas (MPAs) to create a network spanning nearly 45,000 sq miles. The no-take zones, while defined with sensitivity to the requests of fishermen, were designed to meet a series of specific ecological goals, such as covering at least 20 percent of each of the 70 bioregions of the Great Barrier Reef. Planners also protected 926 sq miles in 51 special ecological and heritage sites, growing the area off-limits to fishing from 15.4 percent to 38.4 percent [51]. The re-zoning also increased protection for dugong habitat by 250 percent (to 40 percent of the total habitat) and sea turtle nesting and foraging habitat by 375 percent (to 31 percent of the total habitat) [52].

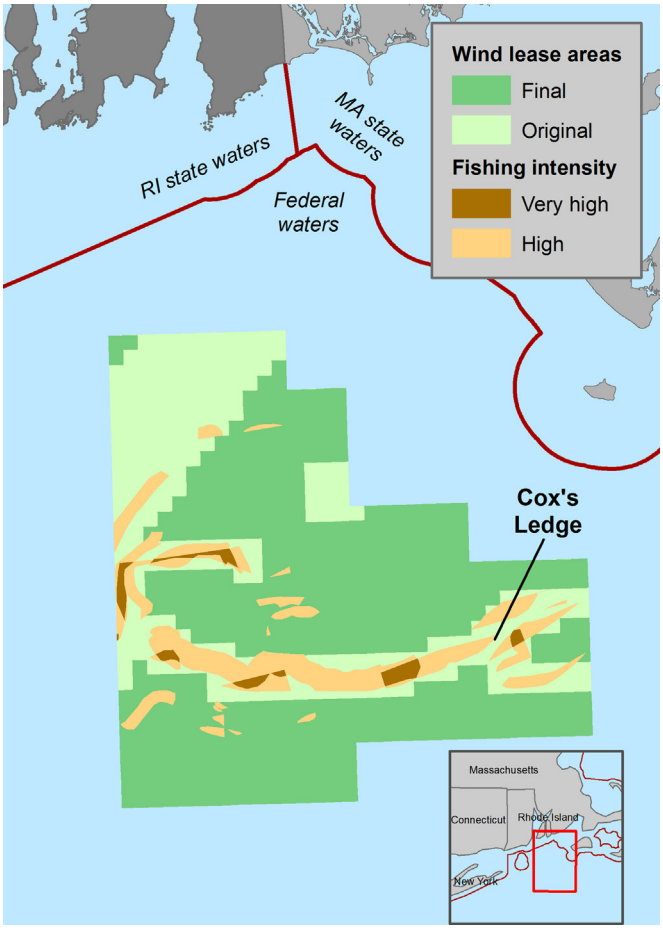

Fig. 4. –Title: Cox's Ledge exclusion.
–Subtitle: [None].

The no-take zones led to significant environmental gains. Commercially fished coral trout stocks increased from 57 to 75 percent in a few years [53]. The benefits have extended beyond the no-take zones. The no-take zones contribute "approximately half of all juvenile recruitment to both reserve and fished reefs within 30 km," far more than would be expected from their geographic coverage [54]. Further, there is evidence the no-take zones have decreased outbreaks of coral-eating crown-of-thorns starfish—a cause of coral degradation—by nearly 80 percent [55].A review of marine protection worldwide found the 2004 plan to be "exemplary," although recognizing that some ecoregions are better protected than others [56].

The planning approach of the Great Barrier Reef Marine Park (GBRMP) also, however, demonstrates the limitations of ocean zoning. The re-zoning has not counteracted three of the biggest challenges the Reef faces: climate change, water pollution, and the expansion of bulk export ports [35]—all threats from outside the boundaries of the GBRMP and its zones. Ports are a recent challenge and were excluded from the GBRMP's initial authorizing legislation along with most other coastal activities. Dredging of the ports and disposal of dredge spoils within the GBRMP are expected to negatively affect the Reef, although the exact extent will depend on political choices regarding the scale of port development.

3.2.3. Carbon

Due to Belgium's Master Plan, the Belgian North Sea is now home to 706 MW of offshore wind capacity, and the plan includes space for another two to three gigawatts. Wind power from the Belgian North Sea, enough to power 184,000 homes, likely displaces more than two megatons of carbon dioxide emissions each year [57].

In Rhode Island, the Block Island Wind Farm is fully permitted. Its five turbines are expected to provide 30 MW of power as soon as 2016. The project will end Block Island's reliance on generators that run on diesel shipped to the island, and provide wind power to the mainland [57].

The Deepwater One project could provide a further 200–500 MW of wind capacity in federal waters, out of a total potential of approximately 1000 MW. The developer has not yet secured agreements from utilities to purchase the power, meaning the project's ultimate size and success remain uncertain. However, if Deepwater One's power replaces that from coal-fired power plants, this initiative could save up to one megaton of carbon dioxide equivalent each year – equivalent to taking every other car in Rhode Island off the streets [5–58].

Massachusetts has struggled in siting wind farms. The plan set aside two Wind Energy Areas that could accommodate approximately 150 turbines. While these sites may be the best available within Massachusetts state waters, experts do not believe they are economically viable for wind development. The German and Dutch plans facilitated wind development as well, but the effect on total wind capacity is not clear.

3.2.4. Oil spills

In Norway, the Barents Sea plan laid the groundwork for moving the international shipping lane around Norway's northern coast to 30 km offshore and separating northbound and southbound traffic. Norway successfully petitioned the International Maritime Organization using data that originated in the ocean plan. By reducing the risk of tankers running aground, the shift should "reduce accidents by over 20 percent and give 15 percent reduction in oil spill volumes" given current shipping patterns,

and by 30 percent given the likely volume of oil shipping by 2025 [59], all without increasing expected fuel consumption [60].

In Australia, the Great Barrier Reef Marine Park planning process contributed to the establishment of safe routes through the reef, new vessel tracking systems, and specific anchoring points. The new regulations have reduced ship groundings by 90 percent, with only one grounding since 2004 [61].

3.3. Social results

Ocean planning in the US, Australia, and the Netherlands has brought together stakeholders who have often been at odds in the past. The Great Barrier Reef, Massachusetts, and Rhode Island plans emphasized proactive outreach, stakeholder input, and incorporating that input into the eventual plans. European ocean plans generally included less public input, in line with European planning efforts generally.

3.3.1. Stakeholder engagement

Massachusetts and Rhode Island increased fishermen participation in planning, reducing tension with developers. In Rhode Island, after outreach and trust-building, commercial fishermen shared their closely-held fishing data to preserve fishing grounds. This led to planners excluding Cox's Ledge from wind energy development. Fishermen now have a seat at the table and can engage early in regulatory processes. For example, commercial fishermen in Rhode Island argued successfully for modifying the wind turbine siting surveys so the resulting data could also be used in fishery management [42]. Deepwater Wind largely chose to work with potential opponents, agreeing to millions of dollars in mitigation and signing a separate environmental mitigation agreement with conservationists to avoid legal challenges. At the hearing for the Block Island wind farm, fishermen testified in favor of the project [62].

In Australia, the Great Barrier Reef plan underwent the most intensive stakeholder engagement process in Australian history, receiving more than 10,000 submissions in the first round of public comment and more than 20,000 in the second round. This likely increased support for the plan. Recreational fishermen were "significantly more likely to support the plan if they believed that […] the consultation programme was adequate" (along with believing in the necessity of the plan) [63]. Social support for the plan is also believed to increase compliance, as "the public shame as well as the private guilt of being reputed as a noncompliant free-rider can pose a strong dissuasive effect," at far less cost than formal enforcement [64].

Norway's Barents Sea plan also shows how ocean planning can encourage engagement and social cohesion. It took up whether petroleum exploration should be allowed in the Lofoten Islands region, potentially endangering its spawning grounds. The plan improved data and clarified the tradeoffs, and even though "the conflict is at its base a value-based question which is impossible to resolve by empirical knowledge alone […the plan] increased the legitimacy of the complex decisions [65]." The Netherlands' experience was similar – the emergence of the offshore wind industry created conflict with every major existing ocean user, but wind development has proceeded without major controversy since. In Belgium, stakeholder input resolved various smaller conflicts over use of the North Sea and resulted in limited modifications.

3.3.2. Native peoples

Aboriginal Australian peoples and Native American tribes were also included in planning efforts. The Great Barrier Reef plan called for the full inclusion of Traditional Owners in managing the park. Communities can draft Traditional Use of Marine Resources Agreements (TUMRAs) that lay out their vision for their traditional ocean area and restrict use of sacred sites. TUMRAs also provide a framework under which the Marine Park Authority can contract with them for management activities, such as research, monitoring, and compliance. Traditional Owners who participated in the program felt that TUMRAs had "made a significant contribution to reconciliation between indigenous and non-indigenous stakeholders […] through an increase in respect for Traditional Owners and a strengthening of Traditional Owners' voice in sea country management [66]."

Tribes in the US also may have benefited from the plans. In Massachusetts, the Mashpee Wampanoag Tribe and the Wampanoag Tribe of Gay Head both participated in developing plans. The Narragansett Indian Tribe in Rhode Island went further and added their traditional knowledge to the planning process. Tribal elders helped planners identify culturally important sites, which were then removed from potential development. Federal funding secured by the University of Rhode Island allowed younger tribe members to participate in primary research and add their own experiences and methods to the process.

3.3.3. Marine research

One of the first outcomes of Norway's Barents Sea plan was that government recognized that a more robust research base would allow more sustainable use of its ocean space. Accordingly, the state made an unprecedented public commitment to map Norway's seabed. Norway has dedicated approximately $85 million to this project since 2006 and is investing $15 million annually. This research aims to improve Norwegian ocean governance by identifying cold-water coral reefs, showing where trawling is damaging habitats, and informing international marine ecosystem governance in the north Atlantic [65].

Norway's experience is not unique. Massachusetts filled research gaps identified in its plan. Rhode Island drew on the federal government, University of Rhode Island, and private developers to research aspects of its plan. The Belgian plan funded research into restoring reef, seal, and oyster habitats.

4. Discussion

The five plans differ in their contexts and goals, resulting in varied economic, environmental and social impacts. The two North American plans were developed with a likely goal of introducing a new industry (wind power) into a well-used marine environment under regulatory and political structures that strongly favor incumbent users. The two European plans attempted to balance all—although primarily economic—competing uses. In Australia, given the Reef's status as a global icon and the economic importance of the Reef's tourism industry, the plan's primary goal was to preserve the heritage values of the Reef.

As a result, not all economic benefits were shared equally. Major capital-intensive projects like wind farms have reaped the biggest economic benefits, mainly arising from greater certainty and speed of regulatory processes. While planning has typically not brought major economic benefits to incumbent industries such as commercial and recreational fishing, tourism, and shipping, a case can be made that they could have lost greater economic value without the plans (e.g., if wind farms were sited in spawning areas or shipping lanes).

Another important finding has been that the net impact on the government cost of ocean management is likely small. In the US, projects did not appear to require substantially less agency staff time to review, since the plans did not change existing approval processes (e.g., state environmental reviews). In addition, the paucity of project

proposals submitted under the new plans means most agencies' workload is largely unchanged. Outside the US, the relevant agencies typically did not see major cost savings as they are tasked with ocean management regardless of the particulars of zoning.

Environmentally, ocean plans have provided environmental protection to varying degrees, consistent with the varying goals and contexts of the plans. The Great Barrier Reef plan expanded no-take areas (IUCN levels IA and II) by over 650 percent. However, Norway did not designate new protection, and Belgium's protection was limited to modifying trawling regulations on 111 sq miles and revising sand and gravel extraction regulations. The US plans were in between these extremes.

Ocean planning has had a secondary environmental benefit, however, which is to spur development of renewable energy, reducing dependence on fossil fuels. In Rhode Island, the plan secured a wind farm lease for 200–500 MW of offshore wind capacity, the first time a major offshore wind development had been approved in the US. And since passing its 2004 plan, Belgium has sited, permitted, financed, and installed 706 MW of offshore wind capacity, and has leased territory for another two to three gigawatts clustered in its small corner of the North Sea. In the Netherlands and Germany, ocean plans designated wind development zones and smoothed their permitting processes, although it is too soon to know whether more development is occurring as a result.

Socially, ocean planning in the US, Australia, and the Netherlands has brought together stakeholders who have often been at odds in the past, likely leading to better outcomes for ocean management. The trust built through joint planning is not only important in its own right, but eases the regulatory process, reduces the likelihood of legal challenges, and facilitates other community-based planning processes.

There is less evidence that other European plans have produced many social benefits. Public comments resulted in small changes to the Belgian plan, and Norway, after receiving very few submissions on its first plan, did not solicit public input on its later ocean plans. Germany drafted its plans without public input, and comments on draft plans typically resulted in no changes to the final plan, although a political decision expanded potential wind lease areas separate from the bureaucratic process. This appears to be consistent with other planning processes in Europe, where public engagement is a considerably smaller element of the process, and where government is tasked with striking appropriate balances on the parts of all stakeholders. It nevertheless appears these European plans have somewhat reduced inter-sector conflict by providing certainty as to which industries have priority in which areas.

The implication is that, if done well, ocean planning can produce net benefits at relatively modest upfront costs, and no net increase in ongoing costs. The distribution of these benefits, however, depends on the context, politics, and goals underlying the plan.

5. Conclusions

This paper examined five case studies in depth and surveyed others to see whether ocean plans have delivered on their promises of economic development, environmental stewardship, and social cohesion. The preliminary evidence suggests that they all have done so.

However, ocean planning is still in its early days; there is not yet a robust dataset that allows for a rigorous, comprehensive study of the full impacts. Of the 59 possible case study plans, fewer than half have been approved and implemented, and the vast majority of those that have only have a few years of results.

As a result, data that allows for systematic and rigorous comparison of the impacts of these plans is scarce. What does exist is first-level results, such as square miles of marine protected areas or direct economic impacts. As existing plans are in place for more time and new plans are implemented, close monitoring could provide a better understanding of the full effects of ocean planning. With an expanded dataset and longer time lapse, future studies could assess the full suite of economic, environmental, and social impacts, and the efficiencies gained through better multi-use planning (e.g., ocean ecosystem health, coastal economic strength).

Ideally, this data would be captured in a global database of ocean planning and its impacts. This will only be possible, however, if this type of monitoring and baseline data are valued by those entities responsible for ocean planning, and therefore built into ocean planning processes going forward.

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References

[1] Ehler C, Douvere F. Visions for a sea change: report of the first international workshop on marine spatial planning. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. Paris: UNESCO; 2007. ⟨http://www.unesco-ioc-marinesp.be/uploads/documentenbank/322a25f624fcb940dc70d0b3b510de24.pdf⟩.

[2] Ehler C, Douvere F. Marine spatial planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission Manual and Guides No. 53, ICAM Dossier no. 6. Paris: UNESCO; 2009. ⟨http://unesdoc.unesco.org/images/0018/001865/186559e.pdf⟩.

[3] Stelzenmuller S et al. Generic framework for monitoring and evaluation of spatially managed areas (Monitoring and Evaluation of Spatially Managed Areas) Grant Agreement 226661, Deliverable 2.1. IJmuiden, the Netherlands: European Community; 2010. ⟨http://www.mesma.org/default.asp?ZNT=S0T1O-1P121⟩.

[4] Breen P et al. Protocol for application of generic framework (Monitoring and Evaluation of Spatially Managed Areas) Grant Agreement 226661, Deliverable 2.2. IJmuiden, the Netherlands: European Community; 2010. ⟨http://www.mesma.org/default.asp?ZNT=S0T1O-1P122⟩.

[5] Ehler C. A guide to evaluating marine spatial plans. Intergovernmental Oceanographic Commission Manual and Guides no. 70, ICAM Dossier no. 8. Paris: UNESCO; 2014. ⟨http://unesdoc.unesco.org/images/0022/002277/227779e.pdf⟩.

[6] Douvere F, Maes F, Vanhulle A, Schrijvers J. The role of marine spatial planning in sea use management: the Belgian case. Mar Pol 2007;31:182–91. http://dx.doi.org/10.1016/j.marpol.2006.07.003.

[7] Fang Q, Zhang R, Zhang L, Hong H. Marine functional zoning in China: experience and prospects. Coast Manag 2011;39(6):656–67. http://dx.doi.org/10.1080/08920753.2011.616678.

[8] Maes F. Towards a spatial structure plan for sustainable management of the sea. Brussels: Belgian Science Policy; 2005. ⟨http://www.belspo.be/belspo/organisation/publ/pub_ostc/MA/MA02A_en.pdf⟩ (coordinator).

[9] Villa F, Tunesi L, Agardy T. Zoning marine protected areas through spatial multiple-criteria analysis: the case of the Asinara Island national marine reserve of Italy. Conserv Biol 2002(16):515–26. http://dx.doi.org/10.1046/j.1523-1739.2002.00425.x.

[10] Walmsley J. Developing objectives and indicators for marine ecosystem-based management: international review of marine ecosystem-based management: international review of marine ecosystem-based management initiatives throughout the world (Eastern Scotian Shelf Integrated Management Initiative). Dartmouth, Nova Scotia: Fisheries and Oceans Canada; 2005. ⟨http://www.dfo-mpo.gc.ca/Library/318539.pdf⟩.

[11] Crowder LB, et al. Resolving mismatches in U.S. ocean governance. Science 2006;313(5787):617–8. http://dx.doi.org/10.1126/science.1129706.

[12] GHK Consulting, Wilson S. Potential benefits of marine spatial planning to economic activity in the UK. Sandy, United Kingdom: Royal Society for the Protection of Birds; 2004. ⟨http://www.rspb.org.uk/Images/MSPUK_tcm9-132923.pdf⟩.

[13] Policy Research Corporation. Study on the economic effects of maritime spatial planning. Brussels, Belgium: European Commission Directorate-General for Maritime Affairs and Fisheries; 2010. ⟨http://ec.europa.eu/maritimeaffairs/documentation/studies/documents/economic_effects_maritime_spatial_planning_en.pdf⟩.

[14] European Commission. Commission decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters. Off J Eur Union 2010;53:14–24. http://dx.doi.org/10.3000/17252555.L_2010.232.eng.

[15] Agardy T, Notarbartolo di Sciara G, Christie P. Mind the gap: addressing the shortcomings of marine protected areas through large scale marine spatial planning. Mar Pol 2011;35:226–32. http://dx.doi.org/10.1016/j.marpol.2010.10.006.

[16] Gubbay S. Marine protected areas in the context of marine spatial planning: discussing the links. WWF-UK; 2004. ⟨http://www.unesco-ioc-marinesp.be/uploads/documentenbank/e866573526258ca0f9ab582b2bd8bc4a.pdf⟩.
[17] Crowder L, Norse E. Essential ecological insights for marine ecosystem-based management and marine spatial planning. Mar Pol 2008;32(5):772–8. http://dx.doi.org/10.1016/j.marpol.2008.03.012.
[18] Pomeroy R, Douvere F. The engagement of stakeholders in the marine spatial planning process. Mar Pol 2008;32(5):816–22. http://dx.doi.org/10.1016/j.marpol.2008.03.017.
[19] White C, Halpern BS, Kappel CV. Ecosystem service tradeoff analysis reveals the value of marine spatial planning for multiple ocean uses. Proc Natl Acad Sci 2012;109(12):4696–701. http://dx.doi.org/10.1073/pnas.1114215109.
[20] Lester S, Costello C, Halpern BS, Gaines SD, White C, Barth JA. Evaluating tradeoffs among ecosystem services to inform marine spatial planning. Mar Pol 2013;38:80–9. http://dx.doi.org/10.1016/j.marpol.2012.05.022.
[21] How marine spatial planning can lower costs for management and industry: interview with Tim Norman of the Crown Estate. Mar Ecosyst Manag 2010;4(1):6–7.
[22] National Oceanic and Atmospheric Administration (NOAA) National Ocean Service. Setting a new course: shipping lane shift helps mariners steer clear of whales. Sanctuary Watch; 2014. ⟨http://sanctuaries.noaa.gov/news/pdfs/sanctuarywatch/sw_1209.pdf⟩.
[23] Ehler C, Agardy T. Online debate: does marine spatial planning need to involve ocean zoning to be effective? OpenChannels 2013. ⟨http://openchannels.org/chat/online-debate-does-marine-spatial-planning-need-involve-ocean-zoning-be-effective-bud-ehler-and⟩.
[24] 3E. Benchmarking study on offshore wind incentives: comparison of the systems in six neighboring countries; 2013. ⟨http://www.belgianoffshoreplatform.be/upload/attach-image/benchmarkingstudyoffshorewind20130326.pdf⟩.
[25] Anon. Regulatory expert in North Sea wind energy; pers. comm; 2014.
[26] Belgium Ministry for the North Sea. Marine spatial plan: annexes to the royal decree establishing the marine spatial plan. Brussels, Belgium: Belgium Ministry for the North Sea; 2014. ⟨http://www.health.belgium.be/filestore/19086906/Bijlage%201%20Ruimtelijke%20Analyse%20van%20de%20zeegebieden.pdf⟩.
[27] Deepwater Wind. RI supreme court upholds Block Island Wind Farm power contract; 2011. ⟨http://dwwind.com/news/ri-supreme-court-upholds-block-island-wind-farm-power-contract⟩.
[28] Zeller T. Cape wind: regulation, litigation, and the struggle develop offshore wind power in the US. Renewable Energy World, 28/2/13. ⟨http://www.renewableenergyworld.com/rea/news/article/2013/02/cape-wind-regulation-litigation-and-the-struggle-to-develop-offshore-wind-power-in-the-u-s⟩.
[29] Anon. The Netherlands Sea and Delta Water Agency, Ministry for Infrastructure and the Environment; pers. comm; 2014.
[30] Anon. The Federal Maritime and Hydrographic Agency of Germany; pers. comm; 2014.
[31] Moura S, Siebenlist P. Massachusetts ocean plan improves review and permitting for hybrid submarine cable project. Eco. p. 46–49; 2014, May. ⟨http://digital.eco-tsc.com/publication/?i=205327⟩.
[32] Anon. An environmental engineering and consulting company with knowledge of the project; pers. comm; 2014.
[33] Deloitte Access Economics. Economic contribution of the Great Barrier Reef. Townsville, QLD, Australia: Great Barrier Reef Marine Park Authority; 2013. ⟨http://www.gbrmpa.gov.au/__data/assets/pdf_file/0006/66417/Economic-contribution-of-the-Great-Barrier-Reef-2013.pdf⟩.
[34] Oxford Economics. Valuing the effects of Great Barrier Reef bleaching. Sydney, NSW, Australia: Oxford Economics; 2009. ⟨http://www.oxfordeconomics.com/samples/gbrfoxford.pdf⟩.
[35] Great Barrier Reef Marine Park Authority. Strategic assessment report. Townsville, QLD, Australia: Great Barrier Reef Marine Park Authority; 2014. ⟨http://elibrary.gbrmpa.gov.au/jspui/bitstream/11017/2861/1/GBR%20Region%20SA_Strategic%20Assessment%20Report_FINAL.pdf⟩.
[36] Norwegian Ministry of the Environment. First update of the integrated management plan for the marine environment of the Barents Sea-Lofoten area. Report to the Storting 2010–2011 10. Oslo, Norway: Norwegian Ministry of the Environment; 2010. ⟨http://www.regjeringen.no/Upload/MD/Vedlegg/Svalbard%20og%20polarområdene/Forvaltningsplan%20Barentshavet/PDF0080506_engelsk-TS.pdf⟩.
[37] National Marine Fisheries Service. Commercial fisheries statistics: annual commercial landing statistics; 2014. ⟨http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index⟩.
[38] Rhode Island Coastal Resources Management Council. Road Island ocean special area management plan, volume 1. Wakefield, RI, USA: Rhode Island Coastal Resources Management Council; 2010. ⟨http://seagrant.gso.uri.edu/oceansamp/pdf/samp_crmc_revised/RI_Ocean_SAMP.pdf⟩.
[39] Massachusetts Executive Office of Energy and Environmental Affairs. Massachusetts ocean management plan: volume 2, baseline assessment and science framework. Boston, MA, USA: Massachusetts Executive Office of Energy and Environmental Affairs; 2009. ⟨http://www.env.state.ma.us/eea/mop/final-v2/v2-text.pdf⟩.
[40] Jin D, Hoagland P, Wikgren B. An empirical analysis of the economic value of ocean space associated with commercial fishing. Mar Pol 2013;42:74–84. http://dx.doi.org/10.1016/j.marpol.2013.01.014.
[41] Dwyer J, Dalton T. Economic impacts to fishing from offshore wind farms in Massachusetts and Rhode Island's AMI 2014 (unpublished). ⟨http://csc.noaa.gov/socialcoastforum/2014AbstractsandPPTs/Dwyer.pdf⟩.
[42] Anon. Fishermen's Advisory Board to the Rhode Island Plan member; pers. comm; 2014.
[43] Macintosh A, Bonyhady T, Wilkinson D. Dealing with interests displaced by marine protected areas: a case study on the Great Barrier Reef Marine Park structural adjustment package. Ocean Coast Manag 2010;53:581–8. http://dx.doi.org/10.1016/j.ocecoaman.2010.06.012.
[44] Olsen E, Fluharty D, Håkon Hoel A, Hostens K, Maes F, Pecceu E. Integration at the round table: marine spatial planning in multi-stakeholder settings. PLoS One 2014. http://dx.doi.org/10.1371/journal.pone.0109964.
[45] Great Barrier Reef Marine Park Authority. Zoning, permits, and plans: interpreting zoning; 2014. ⟨http://www.gbrmpa.gov.au/zoning-permits-and-plans/zoning/zoning-guide-to-using-the-marine-park/interpreting-zones⟩.
[46] Massachusetts Office of Coastal Zone Management, Executive Office of Energy and Environmental Affairs. Massachusetts ocean resource information system (MORIS); 2014. ⟨http://maps.massgis.state.ma.us/map_ol/moris.php⟩.
[47] John Torgan. Director of Ocean and Coastal Conservation, The Nature Conservancy Rhode Island; pers. comm.; 2014.
[48] Belgium Ministry for the North Sea. Marine spatial plan for the Belgian part of the North Sea. Brussels, Belgium: Belgium Ministry for the North Sea; 2014. ⟨http://www.health.belgium.be/filestore/19094275/Summary%20Marine%20Spatial%20Plan.pdf⟩.
[49] Fredrik Myhre. Fisheries and Marine Conservation Director, WWF-Norway; pers. comm.; 2014.
[50] Klaveness G. Ecosystem approach: marine integrated management plans. Oslo, Norway: Norwegian Ministry of the Environment; 2014 (presentation).
[51] Fernandes L, Dobbs K, Day J, Slegers S. Identifying biologically and physically special or unique sites for inclusion in the protected area design for the Great Barrier Reef Marine Park. Ocean Coast Manag 2010;53(2):80–8. http://dx.doi.org/10.1016/j.ocecoaman.2009.12.003.
[52] Dobbs K, Fernandes L, Slegers S, Jago B, Thompson L, Hall J, et al. Incorporating dugong habitats into the marine protected area design for the Great Barrier Reef Marine Park, Queensland, Australia. Ocean Coast Manag 2008;51(4):368–75. http://dx.doi.org/10.1016/j.ocecoaman.2007.08.001.
[53] Russ G, Cheal AJ, Dolman AM, Emslie MJ, Evans RD, Miller I, et al. Rapid increase in fish numbers follows creation of world's largest marine reserve network. Curr Biol 2008;18(12):R514–5. http://dx.doi.org/10.1016/j.cub.2008.04.016.
[54] Harrison HB, Williamson DH, Evans RD, Almany GR, Thorrold SR, Russ GR, et al. Larval export from marine reserves and the recruitment benefit for fish and fisheries. Curr Biol 2012;22(11):1023–8. http://dx.doi.org/10.1016/j.cub.2012.04.008.
[55] Sweatman H. No-take reserves protect coral reefs from predatory starfish. Curr Biol 2008;18(14):R598–9. http://dx.doi.org/10.1016/j.cub.2008.05.033.
[56] Devillers R, Pressey RL, Grech A, Kittinger JN, Edgar GJ, Ward T, et al. Reinventing residual reserves in the sea: are we favouring ease of establishment over need for protection? Aquat Conserv: Mar Freshw Ecosyst 2015. http://dx.doi.org/10.1002/aqc.2445 (in press).
[57] United States Environmental Protection Agency. Greenhouse gas equivalencies calculator; 2014. ⟨http://www.epa.gov/cleanenergy/energy-resources/calculator.html⟩.
[58] United States Federal Highway Administration. Highway statistics 2012: state motor-vehicle registrations. Washington, DC: United States Federal Highway Administration; 2014. ⟨http://www.fhwa.dot.gov/policyinformation/statistics/2012/mv1.cfm⟩.
[59] International Maritime Organization. New traffic separation schemes off the coast of western Norway. NAV 56/3/3. London, UK: International Maritime Organization; 2010.
[60] International Maritime Organization. New mandatory traffic separation scheme off the coast of Norway from Vardø to Røst. NAV 52/3/6. London, UK: International Maritime Organization; 2006. ⟨http://www.sjofartsverket.se/pages/7434/52-3-6.pdf⟩.
[61] Mick Bishop. Manager, Great Barrier Reef Vessel Traffic Service, Australian Maritime Safety Authority; pers. comm.; 2014.
[62] Kuffner A. Opponents of proposed Block Island wind farm in the minority. Providence Journal, 27/2/14.⟨http://www.providencejournal.com/business/content/20140227-opponents-of-proposed-block-island-wind-farm-in-the-minority.ece⟩.
[63] Sutton SG, Tobin RC. Recreational fishers' attitudes towards the 2004 rezoning of the Great Barrier Reef Marine Park. Environ Conserv 2009;36(3):245–52. http://dx.doi.org/10.1017/S0376892909990270.
[64] Arias A, Sutton SG. Understanding recreational fishers' compliance with no-take zones in the Great Barrier Reef Marine Park. Ecol Soc 2013;18(4):18. http://dx.doi.org/10.5751/ES-05872-180418.
[65] Buhl-Mortensen L, Olsen E, Røttingen I, Buhl-Morentsen P, Håkon Hoel A, Lid Ringheim S, et al. Application of the MESMA framework case study: the Barents Sea and Lofoten area. Ijmuiden, the Netherlands: Monitoring and evaluation of spatially managed areas – MESMA; 2012. ⟨http://www.mesma.org/default.asp?ZNT=S0T1O-1P42⟩.
[66] Butler S. Most significant change project report: reef rescue land and sea country indigenous partnership program. Townsville, QLD, Australia: Great Barrier Reef Marine Park Authority; 2014 (unpublished).