1.0 Introduction and Background

In developed areas of the world, the ocean is becoming more industrialized and competition among marine spatial users is increasing (Buck 2004). Increased spatial competition can lead to conflict between ocean users themselves, and to conflict that also spills over to include other stakeholders and the general public (McGrath 2004). Such conflict can wind up in litigation, which is costly and can distract from other important priorities. To break free of a reactive cycle of conflict, agencies, stakeholders and developers need ways to avoid or mitigate marine space use conflicts.

Marine spatial conflict is distinct from terrestrial environmental conflict that involves well-defined ownership rights. Marine spatial conflict plays out against a background of public ownership of natural resources, remoteness, and difficulty of monitoring and enforcement (Portman 2009). In the United States and many other nations, the sovereign (represented by government agencies) manages the resources of the seabed and offshore waters for the public's benefit. As ocean uses and the potential for conflict both increase, often so does the number of possible parties to (and thus the complexity of) the conflict. Parties can include any entity with an interest in the coastal and marine areas under consideration, including government agencies with coastal and marine jurisdiction. Although the facts of, and parties to, each environmental conflict and its resolution are context dependent, successful strategies do exist to arrive at durable, collaborative solutions to ocean space conflicts.

1.1 Objectives and Deliverables

Coastal and offshore marine waters make a valuable contribution to our nation's social and cultural wellbeing and to our economic prosperity. Increasingly, traditional marine industries such as shipping and fishing have to share an already crowded ocean with emerging uses such as marine renewable energy. Identifying both the potential for conflict between ocean uses and ways of mitigating conflicts is key to the balanced decision-making needed for effective marine spatial planning that meets the needs of our economy and society while safeguarding the environment. Although the need is clear, there is no comprehensive documentation of the spatial uses, values, or potential economic contributions of the coastal and ocean waters, making the identification of potential space conflicts and the design of mitigation methods exceedingly challenging.

This literature review completes the first of four research tasks that make up the research project "Identification of Outer Continental Shelf Renewable Energy Space-Use Conflicts and Analysis of Potential Mitigation Measures. The four tasks are:

- *Access to and understanding of relevant literature*. The foundation for the development of recommendations for mitigation strategies will be lessons learned from previous relevant experience in the U.S. and internationally.
- *Ethnographic research and stakeholder outreach*. Central to the research is a series of stakeholder meetings and interviews with a range of fishing and boating interests as well as other stakeholders in key East and West Coast ports.
- *Creation of geospatial databases and geographic information systems*. The

organization and communication of information collected throughout the project will be enhanced by the mapping and visualization techniques enabled by these tools.

- *Data synthesis and final report preparation*. Beyond simply organizing the results of the literature review, stakeholder meetings, and interviews, the final report from this research effort will serve as the basis for decision making that furthers renewable energy development while respecting and accommodating the competing uses of ocean resources.

The literature review synthesis has three objectives:

1. It identifies and characterizes potential space use conflicts that could result from renewable energy activities in the Atlantic and Pacific regions.
2. It summarizes key underlying causes of coastal and marine space conflicts.
3. It describes strategies and specific measures for avoiding or resolving these conflicts, including coastal and marine spatial planning and mechanisms for improved communication and cooperation among stakeholders.

Three products are delivered:

1. A synthesis report of key findings from the literature review.
2. An annotated bibliography and full list of citations (Appendix II and Appendix III).
3. A searchable and updatable electronic data base compatible with Endnote and Zotero bibliographic software programs.

Outside the terms of reference for this study are the biophysical impacts of marine renewable energy development except in so far as they impact competing human uses for coastal and marine space. For example, the impact of a wave energy array on whales is not addressed but the impact of wave energy arrays on whale watching as a tourism activity is.

1.2 Literature Review Method

Three teams searched the available published literature on the topic of spatial conflicts and their resolution/mitigation. The searches focused on the marine environment with two teams exploring the professional/grey literature (IEc and Urban Harbors Institute) and the third team (Oregon State University) the peer-reviewed literature. Some effort was spent examining analogous conflicts and mitigation in the onshore environment as well as general best practices in conflict management. The results, although not necessarily comprehensive given the nature of the current information landscape, are clearly representative of the breadth of authorship, contexts and perspectives on marine spatial conflict associated with marine renewable energy development.

All researchers used similar search strategies that included the broad topic of conflict, the ocean regime, and the conceptual areas of interest such as planning, management, resource use, or zoning and sea/ocean/marine conflict.

Given the variety of sources searched, flexibility in search strategies was needed. For example, the structured databases accommodate structured searches in ways that GoogleScholar does not. The resources searched were varied, some proprietary or commercial products, and others openly accessible. They included the following:

- Databases:
    - LexisNexis
    - Aquatic Science and Fisheries Abstracts
    - Web of Science
    - GeoRef
    - Sociological Abstracts
    - Environmental Sciences and Pollution Management
    - Army Corps of Engineers' PONDS database http://ff.cecer.army.mil/ponds/home.htm
- Web and Open Repository Resources
    - Science.Gov
    - FedWorld.gov
- Web Search Engines
    - GoogleScholar
    - Bing

Care was taken to utilize past work by the Mineral Management Service and other projects.

Once references were identified, each was entered into a bibliographic database maintained by each team. The record was tagged with keywords that included the following elements.

- Use (based on taxonomy developed by UNESCO for marine spatial planning).
- Geographic region(s).
- Jurisdiction (near-shore, territorial sea, outer continental shelf, etc).
- Designation of the source as "Project/case study" or "General". This addressed whether the reference discussed an actual project, such as a wind farm, or a more general issue, such as the siting of offshore wind farms.
- Aspect of conflict and resolution mechanisms.

Merging the three teams' databases resulted in over 300 unique references. Of these, 165 were considered highly, moderately or somewhat relevant to this study. We deselected many that did not address marine environment or renewable energy, as well as those that did not address the topics with any depth. We choose to include 88 of the 165 in this literature synthesis. These and other moderately relevant references are included in Appendix II with annotations. All 165 are listed in Appendix III as citations only with an accessible URL where available.

1.3 Literature Characterization

Overall, the literature points to a field that is not well developed in terms of conflict description and resolution. In fact of the 165 citations, only 69 directly address offshore renewable energy uses. Much of the discussion is general and describes potential conflicts rather than specific instances with productive resolutions. Even so, there appears to be consistency between offshore renewable energy development and past experience with offshore oil and gas exploration and development as well as sand and gravel operations. The context, scale and severity of conflicts differ on a case-by-case basis and cannot be divorced from underlying causes and human values.

Table 1.1 lists the numbers of citations found for each of the uses, geographic areas, conflict types and resolution strategies. As not every reference discussed all the aspects, there are gaps and overlaps. Wind energy has been in planning stages longer than any other type of offshore marine renewable energy, so has more developed literature including planning documents, siting guidelines, and resolution measures. Wave, current and tidal energy lag.

The literature has a bias towards the eastern Atlantic that is not surprising given the European history of marine renewable energy development. Much of the Pacific literature addresses conflicts other than marine renewable energy including the work associated with offshore oil and gas and commercial fishing. Most is either very site specific or very general (e.g., policy and planning).

Resolution methodologies are difficult to categorize because the literature does not consistently express strategies and many current conflicts remain unresolved. The citations listed reveal strategies from other areas of marine spatial conflict and not particularly offshore renewable energy. This is to be expected given the young nature of the field.

Table 1.1 Characterization of the Literature

	Number Citations	Percent Citations		Number Citations	Percent Citations
Uses Marine Space			**Type of study**		
Cables, Pipelines, Transmission Lines	18	11%	Case Study	37	22%
Commercial Fishing	38	23%	Environmental Assessment	6	4%
Cultural and Historic Conservation	17	10%	General	75	45%
Marine Transportation	17	10%	Guidelines	11	7%
Military Operations	6	4%	**Aspects of Conflict**		
Offshore Aquaculture	7	4%	Cultural	17	10%
Offshore Minerals	3	2%	Economic	31	19%
Offshore Oil & Gas	16	10%	Environmental	28	17%
Port and Harbor Operations	2	1%	Historic	4	2%
Recreational Boating	9	5%	Institutional	30	18%
Recreational Fishing	10	6%	Legal	23	14%
Sand and Gravel Mining	4	2%	Political	23	14%
Strictly Protected Marine Reserves	9	5%	Social	11	7%
Wildlife Watching	1	1%	**Resolution Methodologies**		
Types of Marine Renewable Energy			Conflict identification and avoidance	9	5%
Wave	21	13%	Mapping	9	5%
Wind	59	36%	Mediation	1	1%
Tidal & Current	14	8%	Marine spatial planning	31	19%
Geographic Areas			Stakeholder involvement	18	11%
Atlantic Ocean Basin (eastern)	61	37%	Technical/ Engineering	14	8%
Atlantic Ocean Basin (western)	24	15%	Voluntary agreement	9	5%
Pacific Ocean Basin (eastern)	26	16%			
Pacific Ocean Basin (western)	10	6%			
Gulf of Mexico	7	4%			
Indian Ocean	3	2%			
Terrestrial	10	6%			

2.0 An Overview of Marine Renewable Energy Technologies

Three type of marine renewable energy device are described in the literature: Wind, wave and tidal/current (see for example, Elcock 2006; Michel et al. 2007; U.S. Department of the Interior 2006a; 2006b, 2006c, 2006d; U.K. Maritime and Coastguard Agency 2008a). This section provides a brief overview of each type of technology.

Wind Turbine Generators (WTG) can be 150 meters high or more and use wind to generate electricity. At the top of the turbine tower is the nacelle, housing the generator. Attached to the nacelle are the turbine blades. Each turbine blade can be more than 60m in length. Turbines within a wind farm are generally spaced 500 meters or more apart depending on the size of the turbine. Turbine spacing is proportional to the rotor size and the down-wind wake effect created. The proposed Cape Wind development in Nantucket Sound off of Cape Cod in Massachusetts is designed to comprise 130 turbines with an overall footprint of some 62 km^2 **(**U.S. Department of the Interior 2009). The Long Island Offshore Wind Park project would consist of 40 wind turbines in a cluster design and cover 21 km^2 of ocean space (Michel et al. 2007). The London Array project, planned for the Kent and Essex coasts of England, would be the largest wind park constructed to date. The park would consist of 270 turbines over an area of 245 km^2 (Michel et al. 2007).

Wave Energy Convertors (WECs) capture kinetic energy carried by waves. Wave energy convertors are likely to be located at or near the surface. They are usually attached to a mooring point on the seabed. WECs may be visible or semi-submerged. Unlike wind turbines the technology used to harness wave energy is varied and still experimental. No full scale-wave projects are operational. The following types of WEC are currently under development:

- Attenuator: An attenuator is a floating device that works in parallel to the wave direction. Movement along its length can be selectively constrained to produce energy.
- Point absorber: A point absorber is a floating structure that absorbs energy in all directions through its movement at or near the water surface.
- Oscillating Wave Surge Converter: An arm oscillates in response to the movement of the waves.
- Oscillating water column: An oscillating water column device is a partially submerged, hollow structure. Waves cause the water column to rise and fall allowing trapped air to drive a turbine.
- Overtopping device: This type of device captures water from waves that is then returned to the sea through turbines that generates power. An overtopping device can use collectors to concentrate the wave energy.
- Submerged pressure differential: These devices are attached to the seabed. The motion of the waves causes the sea level to rise and fall above the device. The pressure differential created is used to generate electricity.

See http://www.emec.org.uk/wave_energy_devices.asp for animations of each of these devices.

The size, spacing and footprint of these devices vary considerably depending on technology (Minerals Management Service 2006b) but it is anticipated that operational wave energy parks will occupy significant areas of marine space.

Tidal energy convertors (TECs) capture potential energy as the tides ebb and flow. Similar devices use ocean currents in open waters. TEC devices may be surface or sub surface structures. Though tidal power has been harnessed commercially in a few estuaries, TECs using ocean currents or tidal currents outside of estuaries remain experimental. Types of devices under development include:

- Horizontal axis turbine: This type of device extracts energy from moving water using a vertical rotor in much the same manner as a wind turbine.
- Horizontal and vertical axis turbines (enclosed blade tips): A funnel-like collecting device, sits submerged in the tidal or ocean current. The flow of water drives a turbine directly or the pressure differential in the system can drive an air-turbine. In a vertical axis turbine the turbine is mounted on a vertical axis.
- Oscillating hydrofoil. A hydrofoil is attached to a moving arm and the motion caused by the tidal current flowing either side of a wing results in lift.

See http://www.emec.org.uk/tidal_devices.asp for animations of these devices.

Both WEC and TEC devices can be anchored to the seabed in a variety of ways including:

- Seabed mounted: Physically sitting on the seabed due to the weight of the combined device/foundation. In some cases there may be additional tethering to the seabed.
- Pile Mounted: Similar to the anchoring for wind turbines, with the device attached to a pile buried in the sea floor.
- Floating Flexible Mooring: The device is tethered via a cable/chain to the seabed with freedom of movement so the device can swing as the tidal current direction changes with the tide.
- Floating Rigid Mooring: The device is secured into position using a fixed mooring system, with minimal movement allowed.

Supporting infrastructure: WTG, WEC and TEC arrays may also have a transformer station or hub that contains power conversion equipment either within or outside the array. A hub may be a separate fixed or floating platform. Wind, wave or tidal devices are connected to the hub via array cables that may be placed on the seabed, suspended above the seabed or buried beneath it. A submarine cable transfers the power ashore from the hub where it is connected to the main transmission grid. These offshore electricity transmission cable systems are nearly always buried some one to two meters under the seabed and can traverse tens of kilometers of seabed before making landfall.

3.0 Identification and Characterization of Conflicts

This section outlines likely conflicts between marine renewable energy and other ocean uses such as shipping and navigation, military exercises, existing subsea pipelines and cables, fishing grounds, tourism etc.

It should be noted that the scale and severity of potential conflicts are heavily dependent on both the type of marine renewable device deployed and the physical location of a development and therefore it is only possible to give a generic description of conflicts. Moreover, the relatively sparse literature on use conflicts with renewable energy, combined with few actual case studies, especially for WEC and TEC devices, means that the summary presented is based:

- On a small sample size and/or
- On inference from marine space conflicts associated with oil and gas development, offshore aquaculture and other uses of the marine environment.

Several reports proved the most useful in compiling a description of potential conflicts:

- OSPAR Commission (2008) "Guidance on Environmental Considerations for Offshore Wind Farm Development". This report assists OSPAR European nations, developers, consultants, regulators etc in the identification and consideration of some of the issues associated with determining the environmental effects of offshore wind farm developments. The potential impacts discussed within this document are not an exhaustive list and guidance has been structured to consider the main stages of the life history of an offshore wind farm.
- Halcrow Group Limited Group Limited (2006) "Wave Hub Environmental Statement." The Wave Hub is a renewable energy project to create the UK's first offshore facility to demonstrate the operation of WEC devices. The South West of England Regional Development Agency developed the Wave Hub project to provide the electrical infrastructure necessary to support and encourage developers of WECs to generate electricity from wave energy. The Wave Hub environmental statement provides a comprehensive list of potential conflicts with other ocean uses.
- Sørensen, et al. (2003) "Social Planning and Environmental Impact." This report collates information on barriers to large-scale development of wave energy arising from competing uses of marine resources. The information presented has been collated through interviews with developers and regulators and review of the available literature.
- Michel et al. (2007) "Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf." The objectives of this study were to identify, collect, evaluate, and synthesize existing information about alternative energy uses; the study includes sections addressing space-use conflicts.

A useful US case study of offshore wind development is the recently released report:

- U.S. Department of the Interior, Minerals Management Service (2009) "Cape Wind Energy Project: Final Environmental Impact Statement." This identifies potential use conflicts during the operational phase of the Cape Wind Project. Conflicts examined include commercial fishing, other submarine cables, navigation dredging, vessel anchoring, sand mining, marine radar, recreational fishing and boating, air navigation, shipping, and ferries.

3.1 Characterizing Conflicts

Siting conflicts over the use of marine and coastal space fall into two broad categories (Sørensen et al. 2003):

- Areas with existing regulated, restricted or prohibited access such as:
  - Major shipping routes.
  - Military exercise grounds.
  - Major coastal or offshore structures (bridges, harbors, oilrigs).
  - Sub-sea cables or pipelines.
  - Marine protected areas for fisheries management or marine conservation.
- Areas with conflicting uses such as:
  - Commercial and recreational fishing grounds.
  - Resource extraction areas (aggregate extraction, etc.).
  - Tourism and non-consumptive recreational areas.
  - Archaeological interest such a shipwrecks.
  - Cultural significance, for example because of customary use or tribal history.

Areas with existing regulations, restrictions and prohibitions are site-limiting and suitability, if any, for marine renewable energy facilities can be quickly determined (Michel et al. 2007; Sørensen et al. 2003). Areas with conflicting uses are more complicated and the nature and significance of the conflict will be site specific. State and federal agencies have in place public processes for determining whether or not marine energy development is appropriate in these circumstances. Environmental impact assessment/statement processes and related consultation form the basis for this deliberation.

Potential conflicts can also be classified by whether they occur or vary during different phases of site development and operation including:

- Construction.
- Operation.
- Decommissioning.

Unless otherwise noted in this document, there appear to be few significant differences in the nature or magnitude of space-use conflicts during the construction, operation and decommissioning phases of a marine renewable energy project.

3.2 Space Use Conflicts: An Overview

Table 3.1 summarizes potential conflicts.

Table 3.1 Overview of potential conflicts from Marine Renewable Energy Development

Issue	Potential conflict
Conflicts with areas with existing regulated, restricted or prohibited access	
Marine Protected Areas such as Marine Reserves, National Monuments, Marine Sanctuaries.	• Loss of area or function of area, or disturbance of biota or ecosystem services in the protected areas.
Listed areas of biological or ecological interest or value (e.g. habitats of rare or threatened species, Essential Fish Habitat)	• Loss of area or function of area, or disturbance of biota in the sensitive or ecologically valuable area.
Military exercise areas (ships, submarines, aircraft)	• Loss or restriction of exercise areas.
Submarine gas and oil pipelines	• Loss or restriction of areas available for routes. • Obstruction of maintenance and repairs. • Damage to existing pipelines.
Submarine power and communication cables	• Loss or restriction of areas available for shipping routes. • Obstruction of maintenance and repairs. • Damage to existing cables.
Disposal sites for munitions	• Disturbance of past disposal sites (risk of detonation and remobilization).
Disposal sites for dredged material	• Loss of disposal sites. • Obstruction of disposal activities.
Navigation/shipping lanes	• Loss, restriction, rerouting of recognized sea-lanes through restriction zones and Areas To Be Avoided.
Conflicts with existing or potential activities	
Areas of archaeological interest	• Loss of areas of archaeological interest. • Destruction of or damage to archaeological sites.
Cultural	• Loss of access to customary food gathering areas; • Loss of cultural identity. • Disturbance of cultural traditions.
Commercial and recreational vessel navigation	• Vessel restrictions on innocent navigation, freedom of navigation and anchoring. • Collisions between devices and powered and unpowered (drifting) vessels; vessel to vessel collisions.
Search and Rescue	• Obstacle to air navigation in particular for low flying aircraft (e.g., helicopters).

Issue	Potential conflict
	• Obstacle to SAR vessel navigation. • Radar interference.
Civil air traffic	• Obstacle to air navigation in particular for low flying aircraft (e.g., helicopters)
Recreational and Commercial Fisheries	• Construction: Noise from construction may cause temporary changes in local fish abundance, distribution and behavior. • Operation: Loss of fishing grounds. Snagging of gear, Increased steaming time. Increased costs to fishermen. Loss of income. • EMF may cause localized changes in fish abundance, distribution and behavior affecting local catch per unit effort.
Sediment extraction	• Temporary loss or restriction of areas; disturbance of extraction.
Offshore oil and gas activities	• Temporary exclusion or restriction of exploitation or exploration activities.
Seascape	• Visual impact during day and at night.
Tourism and recreation activities	• Restrictions to on-water recreation activities. • Changes in visitation rates and participation rates. • Changes to wave form impacting surfing and beach form.
Scientific research	• Restrictions for scientific research. • Disruption to research transects. • Changes in marine community structure. • Changes in local ocean currents. • Changes in the abundance, distribution and behavior of marine life.

Adapted from OSPAR Commission 2008.

3.3 Major Conflicts Noted in the Literature

It is assumed that marine renewable energy developments will generally avoid locating in areas with existing regulated, restricted or prohibited access (Sørensen et al 2003; Michel et al. 2007). The literature on the remaining category of conflicts between marine renewable energy and other uses of ocean space identifies only a few conflicts of major significance. These are with:

- Vessel navigation (commercial and recreational).
- Commercial fisheries.
- Cultural activities.
- Tourism and recreation.

As noted in Table 2.1 and Appendix I, numerous other use conflicts can occur but the four listed above receive by far the most attention in the literature and are therefore documented in more detail here.

3.3.1 Navigation

Navigation conflicts can occur during the construction, operation and decommissioning of marine renewable energy facilities (OSPAR Commission 2008; Michel et al. 2007; Halcrow Group Limited Group Limited 2006; Sørensen et al. 2003; Tomson 2009; UK Maritime and Coastguard Agency 2008a, 2008b).

Anticipated conflicts include:

- With designated shipping lanes especially in areas of high vessel traffic or restricted navigation such as entry and exit to harbors.
- With freedom of navigation and innocent navigation outside of designated shipping zones.
- Prevention of anchoring within an array or within or near transmission cables.
- Increase vessel traffic due to maintenance needs.
- Risk of collision between service vessels and other vessel traffic.
- Risk of collision between renewable energy devices and shipping and aircraft in the case of WTGs. Collision may involve powered or drifting vessels (Halcrow Group Limited 2006).
- Effects of WTG, WEC and TEC on wind and currents creating navigation hazards (UK Maritime and Coast Guard Agency 2008).
- WEC or WTG devices drifting into shipping lanes or creating other collision hazard if mooring lines break (Sørensen et al. 2003).
- Effects of WTG, WEC, and WTGs on navigational devices such as radar, communication systems, and positioning systems (Howard 2004; MARICO 2007; US Coast Guard 2009; US Department of Interior 2009).
- Physical interference from WTG, WEC or WTG devices with airborne or vessel based search and rescue operation and interference with search and rescue radar and other equipment (Brown and Stanley 2005; US Department of Interior 2009).

3.3.2 Commercial Fisheries

Together with navigational impacts, potential restrictions to fishing rights from marine renewable energy developments are the best-documented ocean space conflicts (Berkenhagen et al. 2010; Gray et al. 2005; Mackinson et al. 2006). The conflicts described are similar in nature to the conflicts documented between the oil and gas industry and commercial fisheries (see for example Centaur Associates 1981; Impact Assessment Inc 2004) or other competing uses such as marine reserves, recreational only fishing zones, and aquaculture (Raynes et al. 2009; Bess and Rallapudi 2007). Key conflicts noted in the literature include:

- Prevention of fishing activity within any exclusion zone that may be established around marine renewable energy facilities and associated cable corridors (Berkenhagen et al. 2010; Halcrow Group Limited 2006; Raynes et al. 2009).
- Increased fishing pressure on adjacent fishing grounds due to displacement of fishing from the deployment area (Raynes et al. 2009; Halcrow Group Limited 2006; Mackinson et al. 2006).
- Commercial fishing vessels will be affected by navigation restrictions and in heavy traffic areas could see increased space conflict between fishing vessels and commercial vessels as a result of navigation restrictions (Halcrow Group Limited 2006; Sørensen et al. 2003).
- Snagged and loss of fishing gear from operator error or exposed cables, moorings and other subsurface structures if fishing is allowed within marine renewable

energy production areas (Raynes et al. 2009; Impact Assessments Inc 2004).

Gray et al. (2005) note that there is often little supporting evidence for claims of economic losses in fisheries from offshore wind energy developments in the UK creating further tension between energy developers and fishing groups. In contrast, Berkenhagen et al. (2010) found that fishing opportunities in Germany's North Sea EEZ could be reduced by 20 to 53 percent for some flatfish species as a result of WTG development.

3.3.3 Cultural Heritage

Many coastal communities and tribes have close cultural affinities with the marine environment. Several reports discuss impacts of marine renewable energy developments on cultural heritage including:

- Cultural identity.
- Tribal traditional use of the marine environment.
- Religious beliefs.

(Halcrow Group Limited 2006; Shull 2010; OEER 2008; US Department of Interior 2009)

In some communities, the perception of competing uses that are local versus nonlocal and old versus new plays a critical role in perceptions that can set up conflict (Buck 2004). Even more fundamentally developments may impact religious beliefs. For example the Wampanoag Tribe of Gay Head/Aquinnah is concerned about the impact that the Cape Wind project could have on their ceremonies and religious practices that are dependent on maintaining the ability to view the first light, eastern horizon and viewshed (Shull 2010; US Department of Interior 2009). This issue and several related ones led to the determination that Nantucket Sound is eligible for listing in the National Register as a traditional cultural property (Shull 2010).

3.3.4 Recreation and Tourism

The coastal and marine areas are a major vacation and leisure resource. Recreational areas and values can be a significant barrier to major near-shore construction projects (Michel et al. 2007 Sørensen 2003).

The major conflict concerns the visual intrusion of the technology into the viewscape. In general, conflicts and opposition lessen when facilities are deployed 'out of sight.' Ladenburg and Dubgaard (2009) found that specific users and frequent visitors of the coastal zone in Denmark are willing to pay approximately twice as much to have future offshore wind farms moved further away from the coast, when compared to less frequent users and visitors. They conclude that the recreational value of the coastal use is potentially jeopardized by visual impacts from offshore wind farms. As such the optimal location, offshore wind farms might be closer to the coast in areas with fewer recreational activities compared to coastal areas with greater levels of recreational activities.

Compared to wind power, where significant local opposition to large-scale farms is found in several countries, viewscapes conflict is likely to be less severe for WEC and TEC compared to WTG since they are less visible from a distance. Nevertheless WEC and TEC devices in coastal areas with relatively little offshore vessel traffic and/or infrastructure may be especially visible at night due to navigation lighting and thus impact amenity values (Halcrow Group Limited 2006).

Other possible recreational conflicts include:

- Recreational and charter boating due to navigation restrictions (Tomson 2004; UK Maritime and Coast Guard Agency 2008b).
- Recreational and charter fishing due to potential access restriction and changes (positive and negative) in fish distribution and abundance (Michel et al. 2007; Halcrow Group Limited 2006; US Department of Interior 2009).
- Beach replenishment/nourishment both natural and engineered due to changes in coastal processes from presence of device arrays (Michel et al. 2007; US Department of Interior 2009).
- Surfing due to changes in wave energy and form (Michel et al. 2007; Halcrow Group Limited 2006). Halcrow Group Limited (2006) conducted numerical modeling in conjunction with the UK Wave Hub project and estimated between 3 and 13 percent reduction in wave heights depending on the wave conditions. AquaEnergy Ltd. (2006) suggested that there would be no impact on the local wave climate for the Makah Bay project in Washington State, but did not reference any quantitative estimation approaches.

3.4 Underlying Legal, Institutional and Economic Causes of Conflict

Mitigating marine space use conflicts, while a necessary and pragmatic aspect of marine renewable energy development, can be akin to treating the symptoms of an illness rather than addressing the underlying cause of the disease. Over the course of this literature review several reoccurring underlying challenges to conflict mitigation have emerged. These are:

- The legal system creating the framework for the governance of our coasts and oceans.
- The institutional system for ocean and coastal management.
- The economic characteristics of coastal and marine resources.

3.4.1. Legal

By law, the natural resources in, on, and beneath the ocean within the U.S. EEZ belong to the public and are managed on their behalf by the United States (Kalo et al. 2007; Christie and Hildreth 2007; Salcido 2009). This legal framework is based in both common law and statutory U.S. law. Therefore, any natural resource use or extraction needs to receive government approval by one or more agencies by means of permits. Uses of public resources are open to public scrutiny, including through formal notice and public comment on the environmental impact of each use before a permit can be issued. Natural resource extractions or uses on public land, including ocean uses, must also provide a fair return to the public (for example, fees generated by offshore oil, gas or mineral leases and royalties on resources extracted offshore).

There are some 140 federal ocean-related statues reflecting the prevailing approach of sector-by-sector management (fishing, energy, shipping, etc.) (Crowder et al. 2006; Salcido 2009). Many authors suggest this sector by sector "silo" approach is the source of many conflicts (Crowder et al. 2006; Masalu 2000; Kearney 2007). Within and between each sector, there are multiple users representing sometimes competing and/or conflicting interests. Some authors have pointed out that when new uses are proposed or become viable technologically, in the rush to usher them in there is a lack of consideration of the potential interaction of new uses with existing uses (Buck 2004; Salcido 2009).

Existing laws or ordinances may be rigid and incapable of the flexibility needed to adapt to change. The ability of laws to clearly indicate rights between parties or priorities between uses is compromised by weak or vague regulations concerning some uses (Buck 2004), or when several agencies are involved but there is no designated lead for final decision-making (Buck 2004; Pew Ocean Commission 2004; US Commission on Ocean Policy 2004). At best, regulatory frameworks are inconsistent and incongruent across boundaries (Buck 2004; CEQ 2009; Pew Ocean Commission 2004; US Commission on Ocean Policy 2004). This situation is exacerbated when innovative new uses require laws and regulations to be cobbled together that are often patterned on those that were written for other uses (Salcido 2009).

3.4.2 Institutional

No single U.S. agency is in charge of ocean and coastal management. Instead this arena is characterized by multiple agencies with competing, conflicting, and often inconsistent directives and policies (Crowder et al. 2006; Interagency Ocean Policy Task Force 2009b; Pew Ocean Commission 2004; Salcido 2009; US Commission on Ocean Policy 2004). This situation creates fundamental space use conflict when activities that would be otherwise considered incompatible are approved or even promoted by different agencies. In order to carry out contemporary practices of ecosystem-based management and "integrated" coastal and ocean management, agencies at both the state and federal levels have been challenged to grow beyond the old "silo" paradigm and work together (Interagency Ocean Policy Task Force 2009b). In response to the requirements for interdisciplinary and complex problem solving for complex ecosystems, increased cross-agency consultation is beginning to be evident (Salcido 2009). Integrated management requires the former silos to cooperate not just across the divisions within each agency, but across federal, state, and local governing levels. This dissolution of communication barriers is similar to the need to break down the management barriers between sectors (CEQ 2009; Crowder et al. 2006).

3.4.3 Economic

Space use conflicts are further exacerbated by economic factors (Barbier 2009; National Research Council (NRC) 2005; Wainger and Boyd 2009):

- Marine areas within national jurisdiction feature few or poorly defined private rights and few regulations devoted to private rights (Buck 2004; Portman 2009). Tenure, use privileges and property rights in the marine environment are therefore often incompatible (Hanna 1999; Bess and Rallapudi, 2007). Multiple use rights can be issued for the same area of the ocean even though these uses may be incompatible or competing. For example a harvest privilege to fish in a location is a separate entitlement from the lease right to occupy the seabed in the same place. Occupying the seabed may well prevent the exercise of the harvest privilege. This leads to conflict in several ways:

    - A change in ocean use results in an economic loss to one or more parties holding rights to use that area (Cicin-Sain and Tiddens 1989; OEER, 2008).
    - There may be no formal mechanism to compensate the losers for their loss and gainers are not required to compensate the losers. In some instances there are explicit agency mandates against compensation that can further exacerbate conflict (Bess and Rallapudi, 2007).
- Economic markets do not exist for some types of consumptive and non-consumptive marine activities even though they are important for people and communities (Pendleton et al. 2007). These marine uses or activities may be unvalued or undervalued in subsequent planning processes and permitting deliberations (Lynam et al. 2007).

New in the marine economics literature is the concept of ecosystem services (Fisher et al. 2009; Crowder and Norse 2008). These can be defined as "aspects of ecosystems utilized (actively or passively) to produce human well-being" (Fisher et al. 2009, p. 645). Ecosystem services have become an important focus in natural resource management as a way of integrating economic and ecological considerations into ecosystem-based decision-making systems (Fisher et al. 2009; Millennium Ecosystem Assessment 2005; NRC 2005).

Ecosystem services associated with marine systems include (Beaumont et al. 2007; Millennium Ecosystem Assessment 2005):
- Provisioning services that are the direct products obtained from the ecosystem, such as fish taken for food.
- Regulating services, such as the role that extensive kelp beds can play in preventing shoreline erosion.
- Cultural services providing nonmaterial benefits to humans, such as the identity a community and its population have as a fishing community or a center for whale watching.
- Supporting services that are necessary for the production of other ecosystem services, but do not directly benefit humans, such as the habitat structure provided by a rocky reef.

The concept of ecosystem services has highlighted a number of issues that challenge our ability to efficiently allocate resources of any type between competing uses (Boyd and Banzhaf 2007; Cowling et al. 2008; Fisher et al. 2009; Limburg et al. 2002). Any of these issues singly or cumulatively can heighten space-use conflict in marine systems. For example:
- The high degree of ecological complexity and the non-linearity in marine ecosystems mean that ecosystems services can be heterogeneous in space and time. Tradeoffs between services are non-linear and dynamic creating uncertainty and complexity in decision making over the allocation of marine resources including space.
- A single ecosystem service can produce multiple benefits. This is called joint production and it can further complicate resource use and conflict. For example, a wave can provide recreational benefits to surfers, energy for electricity generation, and aesthetic beauty to beach goers. When all these uses can be supplied without a change in the quantity or quality of services conflict is

unlikely. Where there is a real or perceived change in the quantity or quality of these services then conflict is likely.

- Many traditional uses and the apparently unlimited supply of marine resources gave the impression that marine ecosystem services were by and large non-rival (use by one person does not reduce the amount available for another person) and/or non-excludable (one person cannot prevent another person from using the ecosystem service) and consequently have been managed as public goods for the benefit of all. As demand for marine ecosystem services increases and new uses emerge, marine activities are increasingly taking on rival and excludable characteristics that are more commonly associated with private goods and services, yet laws and management institutions are still geared to the management of these services as public goods.

4. Mechanisms for Resolving Marine Spatial Conflict

This section outlines likely mechanisms, identified in the literature, for resolving conflicts between marine renewable energy and other ocean uses such as shipping and navigation, military exercises, existing subsea pipelines and cables, fishing grounds, tourism, etc. We begin with an overview of marine renewable energy space use conflicts and potential mitigation methods before turning to a discussion of mitigation methods for the two major conflicts noted in the literature -navigation and fishing. The section concludes with a more detailed thematic discussion of coastal and marine spatial planning and stakeholder engagement as effective proactive conflict mitigation approaches.

4.1 Mitigation of Ocean Space Conflicts: An Overview

Table 4.1 summarizes mechanisms for resolving conflicts between marine renewable energy and other ocean uses.

Table 4.1 Overview of Conflicts from Marine Renewable Energy Development and Approaches to Conflict Mitigation

Issue	Approaches Used to Mitigate Conflict
Conflicts with areas with existing regulated, restricted or prohibited access	
Marine Protected Areas such as Marine Reserves, National Monuments, Marine Sanctuaries.	• Avoid protected areas or ensure that the project complies with the relevant protection and conservation targets.
Listed areas of biological or ecological interest or value (e.g. habitats of rare or threatened species, Essential Fish Habitat)	• Avoid sensitive and ecologically valuable areas or ensure that project does not negatively affect the respective area and its biodiversity
Military exercise areas (ships, submarines, aircraft)	• Avoid locating in or near military exercise areas. • Negotiate use priorities at political level.
Submarine gas and oil pipelines	• Avoid pipeline routes. • Provide space for maintenance and repair vessels.
Submarine power and communication cables	• Avoid cable routes. • Provide space for maintenance and repair vessels. • Plan for crossings of new and existing cables.
Disposal sites for munitions	• Avoid known disposal sites. • Carry out appropriate consultation and surveys during project planning.
Disposal sites for dredged material	• Avoid known disposal sites. • Carry out appropriate consultation and surveys during project planning.
Navigation/shipping lanes	• Avoid established shipping lanes and anchoring locations.
Conflicts with existing or potential activities	

Issue	Approaches Used to Mitigate Conflict
Areas of archaeological interest	• Adjust planned locations of moorings, foundations and cables. • Hydroacoustic/seismic surveys and evaluation of historical records in the planning phase.
Cultural	• Community and ethnographic surveys in the planning phase • Consultation with communities, indigenous peoples representatives and tribal authorities.
Commercial and recreational vessel navigation	• Risk assessment and mitigation during planning phase. • Education of mariners (recreational and commercial) about potential navigation hazards and avoidance measures. • Marking and placement of appropriate navigation devices. • Consideration of exclusion zones and Area To Be Avoided Designation.
Search and Rescue (SAR)	• Consultation with SAR organizations. • Marking of devices and where appropriate provide marking and engineering design elements to assist SAR.
Civil air traffic	• As necessary avoid flight lanes, particularly near airports. • Maintain appropriate marking and navigation signals suitable for aircraft navigation.
Recreational and Commercial Fisheries	• Avoid or minimize overlap with valuable fishing grounds dependent on the use of bottom trawls or bottom contact gear such as pots. • Consult with recreational and commercial organizations on location and siting of devices and associated intra array cables. • Promote formation and ongoing consultation with port and fishing industry liaison committees • Develop contingency plans for addressing potential loss of gear around devices and cables. • Consider industry assistance where loss of fishing opportunities is unavoidable.
Sediment extraction	• Avoid licensed extraction areas.
Offshore oil and gas activities	• Avoid licensed areas. • Provide for space for exploitation or exploration activities.
Seascape	• Select location sufficient distances from shore. • Avoid sensitive vistas. • Engineer devices to minimize visual intrusion during day and light pollution at night.
Tourism & recreation activities	• Consult with local tourism board during planning phase.

Issue	Approaches Used to Mitigate Conflict
	• Avoid or limit interaction with areas of high recreation use. • Create fund to mitigate, to the maximum extent feasible, impacts to coastal recreation, aesthetics, tourism, and/or sensitive environmental resources.
Scientific research	• Consult with local research institutions during the planning phase. • Partner with local researchers on long-term monitoring and evaluation. • Avoid disruption to long-term research projects.

Adapted from OSPAR Commission 2008.

Appendix I notes the literature relevant to each of these potential space use conflicts.

4.2 Mitigating Impacts of Marine Renewable Energy on Commercial Fishing and Navigation

Marine renewable energy projects appear to have the greatest degree of conflict with commercial fishing interests and the navigation of commercial and recreation vessels. The literature has indicated a number of best management practices for mitigating these impacts.

4.2.1 Commercial Fishing

4.2.1.1 Industry Liaison: Adoption of formal consultation with the fishing industry early in the marine energy planning process is crucial (Berkenhagen et al. 2010; U.K. Department for Business Enterprise and Regulatory Reform 2008a; Halcrow Group Limited; Mackinson et al. 2006). Working with formal liaison groups is encouraged (British Wind Energy Association (BWEA) 2002; Mackinson et al. 2006). The advantage of such groups is that ideas can be tested and concerns identified before they become public. Liaison groups can also maintain communication with wider groups of stakeholders and offer recommendations on controversial issues to help mitigate conflict.

For example, the Fishing Liaison with Offshore Wind and Wet Renewables (FLOWW) was established by the UK Department for Business, Enterprise and Regulatory Reform (formerly DTI) in 2002 to help foster cooperation between the fishing industry, marine renewable energy developers and government agencies. It is the UK focal point for all fishing and fisheries matters related to the offshore renewable energy sector. It is a forum:

- To discuss issues arising from the interaction of fishing and offshore activities.
- To share best practice.
- To agree on standards under which compensation may be considered for any direct disruption to work and loss of income.

The report "Recommendations for Fisheries Liaison Best Practice Guidance for Renewables Developers" (BERR 2008) is a particularly valuable guide produced by

FLOWW that is equally applicable for working with the fisheries sector in the UK or U.S.

Examples of similar organizations exist in relation to:

- The oil/gas and fisheries interactions. According to Impact Assessment Inc (2004) these include:
    - The Joint Oil/Fisheries Committee to address space use conflicts in federal waters off California.
    - The Oil/Fisheries Group organized and since disbanded in Alaska.
    - One Ocean group in Canada (http://www.oneocean.ca/), a liaison organization established by the fishing and petroleum industries of Newfoundland and Labrador.
- Communication Cable Committees. This includes including guidance to fishermen produced by the International Cable Protection Commission (Drew & Hopper 2009) and the Oregon Fishermen's Cable Committee (http://www.ofcc.com/). The Oregon Fishermen's Cable Committee is a regional organization that facilitates communication, coordination and cooperation between the fishing industry and the submarine cable industry and informs the fishing fleet of procedures to follow when operating near submarine cables.
- Oregon Wave Energy Industry. The Oregon Wave Energy Trust (www.oregonwave.org) with members from fishing and environmental groups, industry and government is a nonprofit public-private partnership funded by the Oregon Innovation Council in 2007. It connects stakeholders involved in the responsible development of wave energy projects.

<u>4.2.1.2 Mapping Fishing Effort</u>. Researchers and agencies are mapping fishing effort to better represent the potential for conflict between fishing and other uses of marine spaces. For example, St Martin and Hall-Arber (2008) developed a participatory method to map the at-sea presence of fishing communities in the U.S. Northeast. Fishing effort data is being collected and mapped in support of Oregon's Territorial Sea Plan revision (Ecotrust 2009). The project will compile a series of maps illustrating the commercial and recreational fishing use patterns and values along the Oregon coast. A similar project has been completed for the north central coast of California. (Scholz et al. 2008).

<u>4.2.1.3 Compensatory Payments</u>. Concern over livelihoods and impacts on coastal communities may give rise to the issue of 'industry support' or compensation in discussions about potential conflicts between commercial fishers and marine renewable resources (Mackinson 2006). FLOWW offers advice on how the value of fisheries can be assessed and on approaches to the consideration of compensation (BERR 2008; BWEA 2006). The guidelines (BERR 2008, p. 26) state: "…fishing interests should be neither advantaged nor disadvantaged by the development of a wind farm project." BERR (2008) identify three potential approaches to compensation:

- Individual site-by-site negotiations and discussions between developers and fishermen. This has the advantage of being site- and fishermen-specific but also can lack transparency.
- A multi-site subregional approach involving two or more sites. This can reduce the transaction costs associated with negotiations between multiple developers and multiple fishermen. However, this approach can be insensitive to individual

circumstances or to different fishing sectors and may not readily produce a single agreement between multiple fishermen and developers.
- The community fund approach is often viewed as transparent and fair since it benefits a whole fishery or community and can be flexible in its application, addressing potential losses to both harvesters and processors. However, it requires a legal entity to be created to receive and distribute funds and it does not necessarily result in individuals receiving compensation in proportion to the harm incurred by them.

The County of Santa Barbara California has two compensation-type arrangements between fisheries and the oil and gas industry in place (County of Santa Barbara. Planning & Development Department 2008; Impact Assessment Inc 2004). These were negotiated to lessen the effects of offshore activity on local fishermen since it was determined the local fleets were being displaced from historic fishing grounds and otherwise affected by offshore activities such as platforms, pipelines, and piers:
- Local Fishermen's Contingency Fund. A portion of oil and gas revenues is required to be set side in this contingency fund. Funds are specifically used to aid commercial fishermen whose gear is damaged or lost due to offshore oil or gas development.
- Fisheries Enhancement Fund. This fund is similar to the Contingency Fund but targets the improvement of commercial fisheries. Projects eligible for funds from this program include: protection of certain spawning grounds; pier, dock, and harbor improvements for commercial fishermen; and various types of fishery enhancement programs.

4.2.2 Navigation

Marine renewable energy installations present challenges to safe navigation by both commercial and recreational vessels. However, these risks can be mitigated by the appropriate use of:
- Risk assessment methods during project scoping and planning.
- Voyage planning by vessels transiting through areas where marine energy devices are present and providing access to relevant safety information.

UK agencies with maritime navigation and safety responsibilities have produced a number of operational guides addressing these measures.

<u>4.2.2.1 Risk Assessment</u>. The UK Department of Trade and Industry (2005) in its report “Guidance on the Assessment of the Impact of Offshore Wind Farms: Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms” provides a template for developers to help prepare navigation risk assessments, and guidance for agencies in the assessment of these. The assessment requires:
- A Formal Safety Assessment (FSA) using numerical modeling and/or other techniques of risk assessment.
- Estimating a “base case” level of risk based on existing densities and types of traffic and the local marine environment.
- Predicting a “future case” level of risk based on expected growth in future densities and types of traffic.
- Production of a “hazard log” listing the hazards caused or changed by the introduction of the marine renewable energy facility, the risk associated with the

hazard, the controls put in place and the tolerability of the residual risk.
- Predicting a "base case" marine renewable energy facility level of risk based on existing densities and types of traffic with the development in place.
- Predicting a "future case" marine renewable energy development level of risk based on expected growth in future densities and types of traffic.
- Report whether the risks associated with the proposed facility are "Broadly Acceptable" or "Tolerable" on the basis of "As Low As Reasonably Practicable" declarations.

This advice is supplemented by guidance from the UK Maritime and Coast Guard Agency (MCA) (2008a) report "Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues." This guidance addresses:
- Site position, structures and safety zones around developments.
- Navigation, collision avoidance and communications.
- A wind farm shipping template for assessing wind farm boundary distances from shipping routes.
- Safety and mitigation measures recommended for installations during construction, operation and decommissioning.
- Standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around an installation.

4.2.2.2 Voyage Planning

The UK Maritime and Coast Guard Agency (2008b) report "Offshore Renewable Energy Installations (OREIs): Guidance to Mariners Operating in the Vicinity of UK OREIs" helps masters and skippers to make an informed risk assessment for the voyages in the vicinity of marine renewable energy installations. The report describes:
- The characteristics of wave, wind and tidal installations.
- The markings and navigation devices associated with installations.
- Physical effects of installations on routing options.
- Effects on communication and navigation systems.
- Safety zone provisions, which for WTGs will likely be 500 meters during construction and decommissioning and 50 meters during a WTG's operational life. The MCA notes that safety zones around and WEC and TEC installations will likely be more prohibitive than around WTG. This is because they (p.10) "…may not be fixed in position, may extend horizontally for considerable distances on or below the sea surface, and may have potentially dangerous moving parts. Their low profiles may make them difficult to detect visually or by radar."

Depending on a vessel's characteristics (type, tonnage, draught, maneuverability), prevailing weather and sea conditions, navigators are given the options:
- To avoid the installation area completely,
- To navigate around the edge of the installation area, or
- In the case of a wind farm, navigate, with caution, through the wind farm array.

4.3 Cross Cutting Innovative Approaches for Resolving Marine Space Use Conflicts

The term "upstream" describes conflict and avoidance strategies in the planning and policy realm. The term "downstream" describes conflict and avoidance strategies that are place-based and site-specific once a development has been proposed (Dukes 2004).. In this section we discuss two thematic approaches to mitigation of marine space use conflict:

- Coastal and Marine Spatial Planning as an example of upstream conflict avoidance.
- Stakeholder engagement and conflict resolution as an example of an approach that has both upstream and downstream applicability.

4.3.1 Coastal and Marine Spatial Planning

Technology advances in the marine wind and hydrokinetic energy industry and increased clarity about the leasing and licensing process have fostered proposals around the U.S. in both state and federal waters. As these proposals are evaluated, too often decision-makers lack the tools and information to properly account for cumulative effects and the tradeoffs associated with alternative human uses of the ocean (CEQ 2009). Coastal and Marine Spatial Planning (CMSP) is an adaptive, science-based approach that addresses these deficiencies by analyzing current and future uses of marine and coastal areas, assessing tradeoffs between uses and allocating space to different uses in a way that maximizes societal benefits (Ehler 2008).

Siting ocean renewable energy facilities in the context of CMSP requires that information on the physical environment, ecosystems and human use patterns be integrated to evaluate:

- The cumulative impacts of proposed offshore renewable energy projects relative to stewardship objectives for the specific location for which they are proposed.
- The suitability of coastal and marine areas for different types of human activity, including offshore renewable energy development, thereby assisting state and federal agencies with ocean zoning activities.

Several comprehensive guides to CMSP have been developed including:

- A UNESCO report "Marine Spatial Planning – A Step-by-Step Approach" by Ehler and Douvere (2009) presents a step-by-step approach to CMSP. It provides:
    - An understanding of what CMSP is about, what benefits it can have, and what results can be expected.
    - Insight into the process of setting up a successful CMSP program.
    - Examples of what has worked and what has not in MSP practice around the world.
- A US report by The Nature Conservancy "Best Practices for Marine Spatial Planning" by Beck et al. (2009) provides advice on best practices for CMSP. It addresses:
    - Choosing geographic planning boundaries.
    - Appropriate planning scales and resolution.
    - Data collection and management for CMSP.
    - Multi-objective planning including advice on aims and outcomes
    - Interactive decision support tools to assist CMSP.

Identifying, mapping and quantifying the cumulative impact of human activities on coastal and ecosystems are key elements in the practice of CMSP. However, estimating and mapping human impacts in the marine environment is a very recent activity (Ban et al. 2010). An effective cumulative effects analysis allows anticipated project effects to be understood in a broader context. Knowing that an ocean renewable energy project will have an impact is important, but it does not tell us much about the actual significance of that impact. Considering potential impacts in a manner that is more sensitive to this broader context can provide the basis for improved programmatic approaches, pre-negotiated performance standards, adaptive management and streamlined ocean renewable energy permitting processes.

European states are well advanced in their CMSP efforts (Ekebom 2008; Blæsbjerg et al. 2009; Douvere 2008; Gilliland and Laffoley 2008). Belgium was among the first countries in Europe to adopt comprehensive CMSP in 2003. Germany has three spatial management plans for its region of the Baltic Sea covering the Exclusive Economic Zone and state waters out to 12 statute miles from shore. Portman et al. (2009) suggest that CMSP has been a catalyst for offshore wind power development in Germany and a similar pattern may be occurring in state waters in the U.S. A particular feature of CMSP in Europe is that it is focused on managing the conflicting demands of new technologies, such as offshore wind and wave energy sites, tourism, nature protection, and traditional sectors like shipping, fishing, and defense. Blæsbjerg et al. (2009) provide a comprehensive review of marine spatial planning in Europe, with particular focus on the experience of Nordic countries.

In the United States some 12 coastal states are undertaking marine spatial planning of state waters (Portman et al. 2009). For example, in late 2009, Massachusetts released its Ocean Management Plan. The plan (available at http://bit.ly/8ZidO3):

- Sets out the Massachusetts goals, siting priorities and standards to promote the stewardship of coastal and marine waters.
- Identifies and protects critical marine resources.
- Supports the development of sustainable uses, renewable energy, and necessary infrastructure.
- Establishes measures that minimize conflict between existing uses and new uses.
- Provides a foundation for ongoing study and evolving management of the ocean environment.

Rhode Island's Office of Energy Resources (OER) determined that offshore wind farms would be necessary for achieving the state's 15 percent renewable energy resources goal by 2011. The Rhode Island Coastal Resources Management Council (CRMC), proposed an Ocean Special Area Management Plan (SAMP) to guide development of energy facilities while protecting existing uses and ecological values. The SAMP (available at http://seagrant.gso.uri.edu/oceansamp/) is expected to be finalized by mid 2010. Its goals are to:

- Maintain the ecology of the ocean resource.
- Promote and enhance existing commercial and recreational fisheries activities.
- Maintain a healthy marine transportation network.
- Promote and enhance existing recreational activities.
- Determine appropriate and compatible roles for future activities within the study area, including offshore renewable energy infrastructure.

- Build a framework for coordinated decision-making between state and federal management agencies.

Oregon also used CMSP to respond to proposals for ocean wave energy development. The Department of Land Conservation and Development developed a plan for ocean alternative energy as a new chapter in the Territorial Sea Plan to guide wave energy development while protecting habitat and ocean fisheries (http://www.oregon.gov/LCD/OCMP/docs/Ocean/otsp_5.pdf). Part 5A of the Territorial Sea Plan describes the process for making decisions concerning the development of renewable energy facilities in the state territorial sea, and specifies the areas where that development could occur. The requirements of Part Five are intended to protect areas important to renewable marine resources (living marine organisms), ecosystem integrity, marine habitat and areas important to fisheries from the potential adverse effects of renewable energy facility siting, development, operation, and decommissioning.

Some examples of CMSP at the regional level are also emerging (Salcido 2009). For example, the 2006 West Coast Governors Agreement on Ocean Health (WCGA) expanded the geographic and political context for ocean management (available at http://westcoastoceans.gov/). Regional ocean "governance" entities such as the WCGA are key elements of a national ocean policy framework recommended by the Interagency Task Force on Ocean Policy (Interagency Ocean Policy Task Force 2009a). The WCGA created ten Action Teams (ACTs) to help implement the Agreement's 2008 Action Plan. The Renewable Ocean Energy Action Coordination Team released a draft plan in mid 2009 intended to explore the feasibility for offshore alternative ocean energy development and evaluate the potential environmental impacts of these technologies. The ACT's highest priority is to produce a first version of a coastal siting report for offshore renewable energy by December 2010 based on available data.

At the federal level, the United States Marine Cadastre is a well-established ocean mapping effort, and a CMSP initiative is evolving under the National Ocean Policy Task Force's Interim Framework for Effective Coastal and Marine Spatial Planning (Interagency Ocean Policy Task Force 2009a). Within the interim framework, the second national guiding principle states that multiple uses should be managed "in a manner that reduces conflict, enhances compatibility among uses and with sustained ecosystem functions and services, and increases certainty and predictability for economic investments" (Interagency Ocean Policy Task Force 2009a, p.7).

4.3.2 Stakeholder Engagement in Conflict Identification, Avoidance and Mediation

Stakeholder engagement in marine renewable energy conflict resolution can take two forms:

- Upstream, occurring as part of the CMSP or preliminary site investigations.
- Downstream when part of mediation around planned or operational energy facilities.

Engaging stakeholders in the upstream assessment and evaluation of ocean renewable energy proposals allows group deliberation to inform knowledge about cumulative impacts, societal relationships with those impacts and the value of benefits and costs associated with the impacts (Portman 2009). It also has wider benefits including

(Cowling et al. 2008; Inger et al. 2009; Kumar and Kumar 2008; Lynam et al. 2007; Pomeroy and Douvere 2008):

- Understanding potential for conflict over multiple objectives for the use and management of coastal and marine ecosystems.
- Better specification of existing interactions between marine ecosystems and the communities that depend on them.
- Disseminating knowledge about costs and benefits of alternative uses of marine systems, such as renewable energy development, to coastal communities, decision makers and stakeholders.
- Fostering community participation in CMSP.

Lyman et al. (2007), writing in the context of their experience with forest communities, review a wide range of tools for incorporating community knowledge, preferences, and values into decision making in natural resources management. These tools are less about stakeholder engagement and more about the translation of stakeholder input into information for decision-making. The tools assessed are:

- Bayesian belief networks and system dynamic modeling tools that simplify complex systems through key variables and their relationships.
- Discourse-based valuation that develops a common and group representation of importance.
- The 4R framework that assesses stakeholder roles and resilience in natural resource management.
- Participatory mapping representing spatial relationships between people and natural resources.
- Scoring or the Pebble Distribution Method that rates alternatives and explores the underlying reasons for these ratings.
- Scenarios that describe several possible future outcomes (negative or positive) based on current trends and uncertainties.
- Spidergrams representing causal or categorical relationships among variables related to a central resource management question or issue.
- Venn diagrams that represent social relationships and power differences between stakeholders.
- Who Counts Matrices that use different criteria to assess stakeholder links to the management of a natural resource.

They conclude that given the complexity of natural resources and their management, picking the right tool does not guarantee that the data desired will be produced, but selecting the wrong tool does make success less likely.

Geographic Information Systems (GIS) are increasingly being used to support upstream stakeholder engagement (Ramsey 2009). GIS are used to inform, engage and include stakeholders and their knowledge in management of coastal and marine resources. For example, St Martin and Hall-Arber (2008) describe a participatory method to map the at sea presence of fishing communities in the U.S. Northeast. The lessons learned concerning the spatial representation of communities can inform sectors such as marine renewable energy striving to incorporate human dimensions in site assessment and planning. Brody et al. (2004) used GIS to map potentially competing stakeholder values associated with establishing protected areas in Matagorda Bay, Texas. By overlaying multiple values associated with a range of stakeholders across space, they were able to identify hotspots of potential conflict as well as areas of opportunity for maximizing joint gains.

Despite some progress, incorporation of stakeholders in marine renewable energy planning remains challenging. Gray et al. (2005) explore the divide between developers of offshore wind farms and the fishing industry in the UK. Their research highlights conflict arising from:

- The inadequacy of stakeholder consultation processes;
- The right to compensation for loss of livelihood;
- The lack of adequate scientific data.

They conclude that offshore wind farm development would be better managed if stakeholder consultation was more extensive, compensation claims were standardized, and scientific data were more readily available.

Portman (2009) reviews public participation in environmental impact assessments (EIA) for offshore renewable energy projects in the US and Europe and calls for a planning framework consisting of five main elements:

- Effective communication where developers or agencies administering the EIA process communicate clearly, fully, and on a level that is understood by participants.
- Broad-based inclusion where special attention is paid to how stakeholders and the public are included in scoping.
- Prioritization addressing the effectiveness of decision-making, definition of boundaries, and the consideration of cumulative impacts.
- Three-way learning involving local (stakeholder) knowledge, expert knowledge, and knowledge from previous or parallel EIA experience.
- Analysis of alternatives as part of an iterative process.

Portman (2009, p.337) considers that:

> *Public involvement in decision-making through EIA is especially important in the coastal zone and the marine environment because the inter-dependency of activities raises the potential for contradicting uses, for conflicts with environmental protection, and for the loss of public trust rights.*

The British Wind Power Association (now RenewableUK) in its 2002 report "Best Practice Guidelines: Consultation for Offshore Wind Energy Developments" states that the purpose of consultation is to: "enable all stakeholders to make known their views and to work together to ensure they are addressed." (p. 8). According to the guidelines consultation needs to:

- Be inclusive.
- Treat people equally.
- Ensure responsibility for the process and feedback needs to be shared.
- Use independent professional facilitators as appropriate.
- Be transparent, especially about uncertainties.

If up stream engagement of stakeholders fails to mitigate conflict once a marine renewable energy development is proposed then dispute resolution comes into play. The Minerals Management Service (MMS) has a history of successful conflict resolution (United States Department of the Interior 1996). Examples include:

- A process targeted at settling outstanding and contentious mineral royalty claims that has reduced appeals and litigation and increased royalty collections.
- A tradition of conflict resolution training for offshore minerals management personnel and establishment and conduct of a joint review panel for constituent review of environmental documents.

Environmental Conflict Resolution (ECR) has three features (Orr et al. 2008):

- A focus on environmental, natural resource, or public resource issues and conflicts.
- Involvement of an independent, third party facilitator or mediator.
- A process that shows intent to seek agreement.

McCreary et al. (2001) undertook an examination of environmental conflict and alternative dispute resolution literature to determine what practices could be best applied to conflicts in the coastal zone. The authors found that many disputes are best addressed by using a structured mediation model that involves face-to-face negotiation with a broad range of stakeholders to build consensus- based agreements for coastal zone management.

It is important to really understand each party's preconceptions, prejudices, complaints, and desires, because if an agreement is reached too quickly without really forcing these issues out into the open the issues will smolder and ignite later and can derail an agreement (Buck 2004; Capitini 2004). The common interest(s) identified for purposes of the present objective might not be strong enough to endure if difficulties arise in the future. On the other hand, McCreary (2001) notes that during one three-year stakeholder process, the participants bonded so well that the group was able to quickly and effectively deal with unexpected circumstances that threatened the negotiated agreement.

In 2004, the United States Institute for Environmental Conflict Resolution (ECR) undertook a survey on behalf of the Interagency ECR Initiative to determine which agencies were using ECR and which barriers existed to the technique's use (USIECR 2004). The Interagency Initiative defined ECR to mean: "assisted multi-party negotiations in the context of environmental, public lands, or natural resources issues or conflicts, including matters related to energy, transportation, and land use." The United States Department of the Interior (DOI) was among the agencies that responded to the 2004 survey. Notably, the DOI has an office devoted to alternative dispute resolution (the Office of Collaborative Action and Dispute Resolution or CADR, http://www.doi.gov/cadr/).

The DOI response to the USIECR survey pointed out barriers or disincentives in the Department to using ECR. These include:

- Difficulty in finding funds, staff time and senior commitment to support long-term projects.
- Continuing resistance from some attorneys and some managers to use of the process.
- Lack of resources available to support capacity building both for government employees and for other parties.
- Lack of understanding of value/benefits of appropriate use.
- Insufficient collection of data and evaluation of ECR processes to demonstrate

value.
- The budget process does not provide rewards or incentives for choosing to work with ECR.

The Environmental/Public Disputes Sector and the Consortium on Negotiation and Conflict Resolution of the Society for Professionals in Dispute Resolution have created a compendium of “guidelines for best practice” for agencies in the United States and Canada (SPIDR 1997). Its recommendations include

- An agency should first consider whether a collaborative agreement-seeking approach is appropriate.
- Stakeholders should be supportive of the process and willing and able to participate.
- Agency leaders should support the process and ensure sufficient resources to convene the process.
- Ground rules should be mutually agreed upon by all participants, and not established solely by the sponsoring agency.
- The sponsoring agency should ensure the facilitator's neutrality and accountability to all participants.
- Agency and participants should plan for implementation of the agreement from the beginning of the process
- Policies governing these processes should not be overly prescriptive.

The theory behind assessing and identifying “best practices” is continually evolving (U.S. Institute for Environmental Conflict Resolution 2005; Orr 2008; Orr 2006). Which tools and practices in ECR are best depends a good deal on the context or setting of the specific conflict and the unique composition of its participants (Bean 2007). Foley (2007) observes that no ECR process may be judged a success unless it fully takes environmental conditions and the transformation of stakeholders into account. Participants must be allowed in the beginning to honestly articulate their positions and the bases for their beliefs or concerns before an agenda for settling the conflict is established (Sagarin 2008). Allowing stakeholders to communicate their positions safely and openly enhances respect, fairness, and active listening, but it also allows the structure of their various positions to emerge in terms of how they “frame” their ideas about the conflict.

5.0 Summary

This literature synthesis:

- Identified and characterized potential space use conflicts that could result from renewable energy activities in the Atlantic and Pacific regions.
- Summarized key underlying causes of coastal and marine space conflicts.
- Described strategies and specific measures for avoiding or resolving key conflicts, including coastal and marine spatial planning and mechanisms for improved communication and cooperation among stakeholders.

The available literature on potential conflicts between marine renewable energy installations and other uses of marine space is limited and general. Literature on the mitigation of space use conflicts is even sparser. What literature is available is:

- European focused given the more advance nature of marine renewable energy planning and development.
- Biased towards offshore wind developments.
- Oriented towards the mitigation of impacts on commercial fishing and navigation by commercial and recreational vessels.

Although European "best practices" are transferable to U.S. state and federal waters, different legal and institutional contexts mean that considerable adaptation of this material is required before an equivalent level of guidance on space conflicts and their mitigation is available in the U.S.

In U.S. federal waters, and to a lesser extent in state waters, some similarities are apparent with existing approaches used to mitigate space use conflicts with the oil and gas and sand and gravel extraction industries. Nevertheless, even this literature is limited. Moreover, the potential size of marine renewable energy installations, proximity to the coast and heavily populated areas, shipping lanes, valued seascapes and the uncertainty associated the impacts of emerging WEC and TEC technology suggests that actual and perceived conflicts may be orders of magnitude greater than MMS has experienced previously.

Coastal and marine spatial planning appears to have done much to promote the resolution of space use conflicts in European waters. Although there has been limited progress in this regard in U.S. federal waters, coastal states are quickly adopting CMSP. Each state appears to be taking a different approach to CMSP and this may create uncertainty for developers and barriers to national standards for the deployment of marine renewable energy installations. Marine spatial planning in Europe has also tended to emphasize the minimization of conflicts between existing and emerging marine uses while CMSP in the US appears to be more focused on protecting marine ecological processes and functions. Whether this makes a difference to the space use conflict mitigation in the U.S. remains to be seen.

APPENDICES