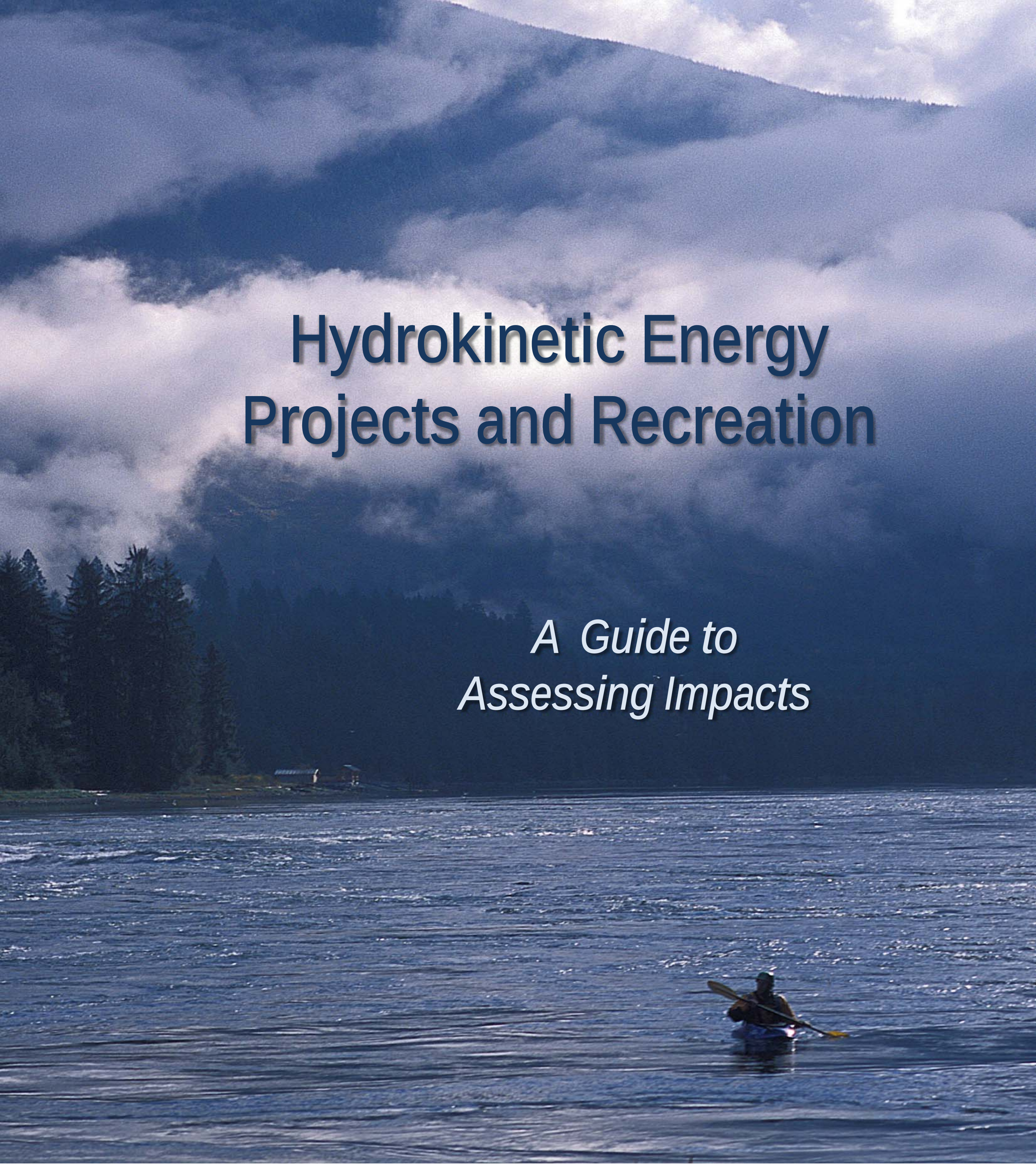

Hydrokinetic Energy Projects and Recreation

A Guide to Assessing Impacts

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Hydrokinetic Energy Projects and Recreation: A Guide to Assessing Impacts

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Note and Disclaimer:

Several federal agency officials involved in hydrokinetic energy technology regulatory processes or assessing recreation impacts reviewed draft versions of this document and provided feedback on its accuracy, completeness, and clarity. Feedback provided by reviewers helped guide revisions, but final content is the responsibility of the authors and editors. The document provides general information about hydrokinetic devices, permitting processes, potential recreation impacts, and ways to study and mitigate those impacts, but applications of this information will vary for specific projects and situations. In addition, changes in statutes, rules, regulations, technologies, or understanding of recreation effect issues may occur after publication, thus requiring revisions or new interpretations of the document's content.

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Chapter Authorship and Acknowledgements

Lead chapter authors have been identified below to allow readers to follow-up on particular topics. The list includes authors of In Focus sections when those were written by someone other than lead chapter authors.

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Chapter 3: Types of Recreation in Hydrokinetic Settings	Rich Bowers and Randy Thoreson
In Focus: What If Area Recreation Uses Are Unknown?	Susan Rosebrough
Chapter 4: Applying Recreation Concepts	Doug Whittaker and Bo Shelby
Chapter 5: Potential Impacts on Recreation Opportunities	Doug Whittaker and Bo Shelby
In Focus: Assessing Cumulative Impacts on Recreation	Susan Rosebrough
Chapter 6: Types of Studies for Recreation Impacts	Doug Whittaker and Bo Shelby
In Focus: Recreation studies for the Mississippi River projects	Randy Thoreson
Chapter 7: Protection Strategies and Adaptive Management	Susan Rosebrough
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Executive Summary

Introduction

"Hydrokinetic Energy Projects" refers to technologies that generate electricity from waves, tides, and ocean or river currents. These emerging technologies may become an important energy source, but like any technology they may affect other public resources such as fisheries, wildlife, and recreation. This paper provides guidance on how to study recreation impacts and consider ways to minimize adverse ones. It is designed for staff from utilities/developers and state and federal agencies involved in assessing hydrokinetic impacts, as well as interested stakeholders who want to be "critical consumers" of studies.

Types of hydrokinetic development

Over a hundred conceptual designs of hydrokinetic devices have been developed worldwide, but only a few have been tested at full-scale. The report summarizes broad categories of wave and current technologies and provides examples that give a sense of their size, generating capacity, working principles, place in the water column, or distance from shore. The major distinction between devices is whether they harness 1) wave or 2) current energy (current technologies can be in river, tidal, or ocean current settings). When considering potential impacts on recreation, it is helpful to further divide categories by 1) location relative to shore; 2) location in the water column; and 3) type of technology.

The diversity of hydrokinetic devices makes it challenging to illustrate the range of device characteristics. Additional information needs for recreation impact assessments include: 1) clearance distance for submerged devices; 2) size, shape, appearance, and lighting of visible development; 3) the type and extent of mooring systems; 4) size and shape of anchors and pilings; 5) size, number, and spacing of arrays; 6) specific siting relative to shore; 7) speed and motion of moving parts; 8) initial installation characteristics; 9) routine maintenance activity characteristics; 10) noise levels; 11) transmission facilities; and 12) appearance and location of proposed security features, including a description of potential exclusion zones and activity restrictions.

Types of recreation

The report provides a checklist of recreation activities that occur in river or marine areas with potential hydrokinetic development. Descriptions include setting conditions and attributes that may be affected by hydrokinetic development. Activities include: boat- and shore-based fishing, powerboating, swimming, diving, kayaking, surfing, general recreation on beaches and shorelines, and wildlife viewing.

Concepts for assessing impacts

The report reviews several recreation management and impact assessment concepts, including: 1) providing opportunities for people to have recreation experiences through management of social, biophysical, and managerial setting conditions; 2) distinctions between descriptive and evaluative information; 3) the importance of assessing trade-offs between potential alternative projects; 4) distinctions between direct and indirect effects; and 5) a "progressive approach" of analysis that matches the amount of study, monitoring, and mitigation proportional to a project's likely impact.

Impacts

The paper reviews a range of potential impacts from hydrokinetic projects on recreation, including:

- ***Access restrictions.*** Restrictions could include full "exclusions" or "activity restrictions." The amount of impact depends on the type of restriction; size and shape of the "restriction zone"; importance of the restricted zone to that type of recreation; and availability of substitute recreation opportunities.
- ***Changes in aesthetics.*** Hydrokinetic projects can change the visual quality of an area by introducing structures, cables, power-substations, lights, moorings, or barges. They may also produce sounds during construction, maintenance, or normal operation that some people will find objectionable. The extent of aesthetic or noise impacts from hydrokinetic development depends on the specific project (size, shape, and number of devices; restriction zone buoys; sub-stations; and lighting, etc.), the setting where it will be located, and the types of uses, including recreation, that occur in the area.
- ***Changes in wave or hydraulic characteristics.*** A hydrokinetic project designed to capture energy from waves or currents may affect their characteristics. Surf-related recreation in marine settings may be the most sensitive, but kayakers and others may also seek out areas with dynamic current or wave conditions.
- ***Wreckage and salvage impacts***. Impacts from a wrecked device may damage habitat or create pollution, which may have longer-term implications on plants and animals that in turn affect recreation. Devices that cannot be salvaged may also become navigation hazards, entanglement hazards, or eyesores.
- ***Displacement to other recreation areas.*** Access restrictions may displace recreation users to other areas, which in turn may increase crowding at those areas.
- ***Effects on recreation-relevant fish and wildlife.*** Hydrokinetic facilities may alter fish and wildlife habitat or behavior, with implications for recreation dependent on those species (especially fishing and wildlife viewing). Hydrokinetic development may also increase the abundance of certain fish or wildlife species by creating new habitat or other more favorable conditions.
- ***Cumulative impacts.*** While an individual hydrokinetic project's adverse impacts may be minor, the long-term success of hydrokinetic development relies on many projects over broad areas. The cumulative effect of multiple projects is likely to exceed direct effects on any single project.

Types of studies

The paper reviews several types of studies (organized by three levels of study intensity), describes general study objectives and approaches, and suggests some "keys to success" or other issues, including:

- Overview from existing information
- Hydrology, current, and wave summary
- Interviews with key experienced users
- Expert analyses of potential impacts
- Extensive user interviews & focus groups
- Observations of recreation use
- Limited fieldwork and "expert" assessments
- User surveys
- Economic impact and valuation studies
- Supply and demand assessments
- Computer and physical modeling
- Post-installation monitoring

Many studies focus on indicators/standards-based measures of quality or natural resource health. Choosing recreation indicators for monitoring hydrokinetic development can be challenging, depending on the type of development, type of recreation, site characteristics, and impacts of concern. Indicators are more useful when they are specific, measurable, responsive, sensitive, integrated, relatively few in number, and reflect important conditions.

Protection strategies

There are three general approaches to protect, mitigate, and enhance recreational resources from hydrokinetic projects: 1) identify sensitive and less sensitive areas (a focus on choosing best sites); 2) minimize or reduce impacts through project design modifications; and 3) develop off-site mitigation for impacts that can't be reduced to acceptable levels.

As a new technology, there is limited scientific or historic basis for assessing impacts. This increases the importance of applying adaptive management principles: ensuring there is a structured process for long-term monitoring, evaluation of potential impacts, and adaptation (or removal) of projects to keep impacts to acceptable levels.

Getting involved in licensing processes

A final chapter briefly reviews authorities and processes required to develop hydrokinetic projects, including BOEMRE leases (for projects on the Outer Continental Shelf) and FERC pilot and conventional licenses. It also highlights key information requirements and opportunities for addressing recreation issues. There are many opportunities for stakeholders to participate in the licensing process including: 1) helping identify issues of concern; 2) proposing studies and negotiating study plans; 3) commenting on licensee proposals; 4) recommending operations and protection, mitigation, and enhancement measures; and 5) challenging FERC decisions through administrative and legal appeals.

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Contents

1. Introduction

"Hydrokinetic Energy Projects" (hereafter labeled "hydrokinetics") refers to a class of devices that generate electricity from waves, tides, and ocean or river currents.[1] Interest in these technologies has grown in recent years; at the end of 2010, there were more than 160 projects on file at Federal Energy Regulatory Commission (FERC), the primary federal agency with jurisdiction over hydrokinetic projects.

These emerging technologies may become an important energy source, but like any energy technology they may affect other public resources such as fisheries, wildlife, and recreation. Few technologies have been tested in a marine or river environment in this country, although several prototypes have been developed in Europe and Australia. At the end of 2010, there was only one licensed hydrokinetic project in the United States (through an amendment to an existing conventional hydropower project) and there had been limited in-water testing (and no larger-scale projects). However, a regularly updated summary of projects showed FERC issued preliminary permits for 143 projects (17 tidal, 10 wave, and 116 in rivers) and 22 preliminary permits were pending (13 tidal, 1 wave, and 8 inland rivers); two license applications are pending (1 tidal, 1 wave); and another project had tested devices without a license (because it did not transmit power into the national energy grid). Most of these projects are being developed under FERC's "pilot license" option, a much shorter than normal license term to allow developers to test equipment on-site and study potential impacts. Pilot projects also allow stakeholders to help identify potential environmental impacts and request reasonable studies that will help developers determine the scope of project impacts.

The Department of Energy (DOE) recently completed a review of potential biological and physical impacts from hydrokinetic projects (DOE 2009b) as directed by Congress in the Energy Independence and Security Act of 2007 (EISA). However, that report does not address potential recreation impacts. To help fill that information need, this paper reviews potential impacts[2] to recreation and suggests ways those impacts can be studied, minimized, or mitigated. Potential recreation impacts may include:

- Recreation access exclusions or activity restrictions for safety or security reasons.
- Aesthetic impacts, including visual and aural impacts from the devices or the cables, power-substations, lights, moorings, or barges associated with them.
- Impacts on "hydrodynamics," including waves or hydraulics in river, tidal, or ocean currents that affect surfing, kayaking, fishing or other activities.
- Wreckage/salvage impacts that create boating hazards, damage habitat, or change aesthetics.
- Changes to fish or wildlife populations, behaviors, or habitat that in turn affect fishing and wildlife viewing opportunities.
- Potential for hydrokinetic development to become an "attractive nuisance" that encourages recreation use in hazardous areas.

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[1] Several labels have or could be used to identify these technologies (or categories of technologies), including "wave energy technologies," "current energy technologies," "marine and hydrokinetic technologies," or "marine and river hydrokinetic technologies" (each with separate acronyms). We encourage use of the general term "hydrokinetics" to cover the full range, all of which involve some method of generating energy from the movement of water. Ocean Thermal Energy Technology (OTEC) is a related technology that is sometimes included in this group. However, this report does not explicitly cover recreation impacts from OTEC because that technology falls under a different regulatory framework (even as many principles discussed are applicable).

[2] "Impacts" may refer to positive or negative impacts.

The National Park Service (NPS, which has consulting responsibilities concerning recreation issues in FERC hydropower licensing proceedings, and the Hydropower Reform Coalition (HRC, which includes organizations with an interest in water-based recreation) collaborated to review the potential impacts of hydrokinetic projects on recreation in a 2008 workshop in Seattle. From that session, participants recognized the need to develop a document that would help FERC, agencies, stakeholders, and project developers understand and address the issues. Similar guides have been developed to help assess recreation impacts from traditional hydropower projects (Whittaker et al., 1993; Whittaker et al., 2007), but hydrokinetic projects are likely to be developed in different environments and have different impacts. This document applies recreation management concepts and study options to the distinct issues presented by hydrokinetic development.

Paper goals and objectives

The overall goal of the paper is to provide guidance on how to study recreation impacts and minimize (or mitigate) adverse impacts from hydrokinetic projects on recreation in river and marine settings. Specific objectives include:

- ***Review concepts*** that help assess impacts of hydrokinetic projects on recreation.
- ***Develop common terminology*** for types of projects, impacts, and studies and provide links for stakeholders and professionals interested in further information.
- ***Identify types of hydrokinetic projects*** and the recreation-relevant characteristics that distinguish them, with links to a Department of Energy database with more information.
- ***Identify the range of potential project impacts*** on specific types of recreational opportunities.
- ***Identify types of studies*** that can be used to assess impacts on recreation from hydrokinetic development and describe issues in conducting studies well.
- ***Discuss challenges integrating recreation*** study results with other resources (e.g., studies on impacts to fish, wildlife, or ecological resources).
- ***Briefly describe existing FERC licensing*** processes for hydrokinetic development and the opportunities they provide agencies and stakeholders to assess recreation impacts.
- ***Educate project developers, agencies, and stakeholders*** about recreation issues and provide links to existing documents that can help.

The guide is designed for staff from utilities/developers and state and federal agencies involved in assessing hydrokinetic impacts, as well as interested stakeholders who want to be “critical consumers” of studies and become involved in hydrokinetic project licensing processes. The guide is not intended to provide detailed information about specific technologies, their recreation impacts, or instructions on how to conduct specific studies; the EISA report likewise does not assess impacts from specific devices on ecological resources or describe ecological study protocols. However, the intent is to provide a sufficient overview that allows readers to become meaningfully involved in licensing or study processes.

The guide describes processes for 1) determining appropriate levels of study, and 2) conducting and documenting those studies; the goal is the same regardless of the size, complexity, or level of impact from the project. We recognize that hydrokinetic energy development is in its early stages, and some developers are testing pilot devices that are likely to have small impacts, while others have larger designs. A good process matches the study effort (including cost, time, etc.) to the type, location, or extent of likely impacts.

The guide focuses on site impacts from hydrokinetic development. Comparing impacts from hydrokinetics with other energy alternatives (such as coal, natural gas, oil, traditional hydropower, nuclear, wind, or solar) is an important task, as is consideration of impacts such as climate change that are not site-specific. We recognize the importance of these larger comparisons, but our focus in this guide is narrower.

Finally, the guide does not compare legal or administrative requirements for hydrokinetic studies with requirements for alternative energy technologies. The applicable licensing/permitting regulations were developed independently, so the "rules" and study processes for assessing impacts on recreation may be different. Addressing potential inequities in those rules or processes is beyond the scope of the guide.

Paper organization

The paper is organized into eight chapters. In several chapters there are "In Focus" sections (identified by shading and different font type), which provide additional information or detailed examples for topics in that chapter. We have collected the In Focus sections at the back of each chapter to improve the flow of broader concepts in the main text.

- Chapter 2 provides an overview of ***different types of hydrokinetic projects***, with representative examples for each. The goal is to suggest the range of hydrokinetic project characteristics (e.g., size, location, and generation capacity).
- Chapter 3 provides a summary of different ***types of recreation*** that may occur in hydrokinetic development areas. The goal is to provide a preliminary "check list" of activities (and their key attributes) which may be affected by hydrokinetic development.
- Chapter 4 reviews several ***principles for assessing impacts on recreation***, providing a conceptual framework for other sections of the report.
- Chapter 5 is a major focus of the document and reviews ***potential impacts of hydrokinetic projects on recreation***. The goal is to provide a "check list" of impacts for study consideration, as well as provide examples that illustrate the issues involved in each.
- Chapter 6 is the other major focus of the document. It reviews ***types of studies for assessing impacts*** of hydrokinetic projects on recreation, organized by level of effort. For each type of study, we provide descriptions of study objectives, approaches, and keys to success.
- Chapter 7 provides an overview of ***protection strategies and adaptive management,*** exploring how study information might be used to minimize or mitigate impacts on recreation.
- Chapter 8 provides an overview of ***getting involved in hydrokinetic licensing***, with brief reviews of authorities, information requirements, and licensing processes.

Appendices include references and website links, a glossary of terms, a list of interviewees, and a list of hyperlinks for readers with non-electronic versions of the document.

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2. Types of Hydrokinetic Projects

This chapter reviews general classes of river and ocean hydrokinetic projects and provides links to the DOE database and the FERC eLibrary for more information about specific projects. The use of specific projects as illustrations does not imply the project is more likely to be developed or that its impacts apply to other technologies (illustrative examples were provided by DOE for each type).

Over a hundred conceptual designs of hydrokinetic devices have been developed worldwide, but only a few have been built and tested at full-scale (and most of those have been in Europe). The following broad categories are intended to be general and to illustrate hydrokinetic technologies. DOE (2009a) has developed an extensive device database and categorized different types by technology or other attributes.

More detailed descriptions and taxonomies of potential devices are also available:
- Wave and Current Energy Generating Devices Criteria and Standards (MMS, 2009).
- Marine and Hydrokinetics (MHK) Knowledge Base (Pacific Energy Ventures, 2009).

For this document, we have summarized broad categories of wave and current technologies (see outline below) and provided examples (see tables that follow) to provide a sense of their size, generating capacity, working principles, where they may be deployed in the water column, or their distance from shore. We have also provided links to example projects or other background material, with example photos for each type of device. (Note: We have tried to provide examples from the United States, but when those don't exist, we use examples or photos from other countries).

Categorizing technologies

The major distinction between types of devices is whether they harness 1) wave or 2) current energy (current technologies can be in river, tidal, or ocean current settings). Within those categories, it is possible to divide types by:
- Location relative to shore (on-shore, near-shore, or off-shore).
- Location within the water column (e.g., fully submerged vs. some components above the surface).
- Type of technology (e.g., oscillating water column, pitching/surging/heaving/swaying, point absorber, turbine).

With our focus on recreation impacts, we primarily organize examples by their location relative to the shore and to the amount of visible development above the water surface. Once project siting has been determined, location relative to recreation access points, attractions, and routes will also be important. We also illustrate the major technologies used within these categories. Note that some technology types are repeated because they can be placed in different settings and locations within the water column. Also, some types include more than one example (to cover prominent U.S. projects; these were suggested by DOE as representative of each type).

Wave Energy Technologies

A. Shore-based
B. Fixed with above-water components
C. Fixed with all components submerged
D. Floating

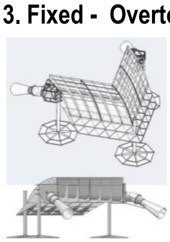
Current Energy Technologies

A. Floating
B. Submerged

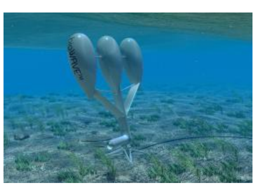
Wave Energy Technologies

Wave energy devices use surface wave motion or pressure changes beneath passing waves to generate power. With surface devices, the vertical rise and fall of the water surface is converted into rotary motion to run a generator, while devices located below the surface exploit the vertical head created by passing waves, just as conventional hydro turbines harness the potential energy of falling water.

Table 1. Examples of Wave Energy Technologies.

Type of Technology	Description	Examples[3]
A. Shore-based These devices are typically attached to shore, with generating facilities contained in a watertight concrete or steel chamber. There are typically components above and below the water surface.		
1. Shore-based Oscillating Water Column 	The pneumatic pressure from long swell waves pushes an internal water column back and forth, which turns a generator. Existing prototypes are embedded in cliffs; others are proposed to be incorporated into jetties. It may be possible to hang device from a floating or other fixed structure. Devices typically designed for 6 to 30 meter depths. Dimensions vary, but one prototype is 20 meters wide. The developers project capacity for a single unit: 500 KW; scalable to 1.5 MW.	Wavegen Project Islay, Scotland Douglas County Wave Energy Project Winchester Bay, OR FERC Preliminary Permit No. P-12743 issued 4/6/2007.
B. Fixed with above-water components These devices are typically in nearshore settings. They are fixed to the shore or ocean floor, but have substantial components above the water surface.		
2. Fixed - Oscillating Wave Surge Converter 	As waves pass the device, the rising peak pushes an oscillating water column from underneath (not visible in photo at left) which pushes air through a generator. When the water passes, the water column drops, air is decompressed and pulled through the generator from the other direction. Dimensions vary, but one prototype appears to have an above surface "pipe" radius of about 4.5 to 6 meters and a length of 23 to 30 meters. The developers project capacity for a single unit: 1.5 to 2.5 MW.	Potential projects in Australia, Hawaii, Mexico, and Spain. To date, no FERC preliminary permit for USA. Prototypes developed in Port Kembla, Australia.
3. Fixed - Overtopping 	Device is anchored with the head up against the incoming waves and guides the water into a tube which then drains through a generator. Mounted on the sea floor or man-made beach. Dimensions vary depending on device. Full scale prototype being tested in Hanstholm, Denmark. The developers project capacity for a single unit: .0.2 MW	Waveplane Prototype 1.

[3] We encourage hydrokinetic projects to be identified by their geographical location and type of technology (e.g. "Hastings current project") rather than by their developer's corporate name (which may change, is not descriptive, and which could apply to several sites if the technology becomes popular). However, readers should note that many others may use developer names.

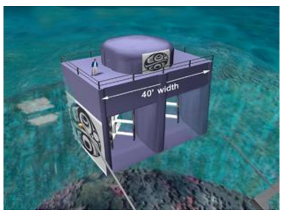
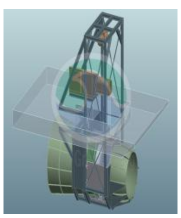
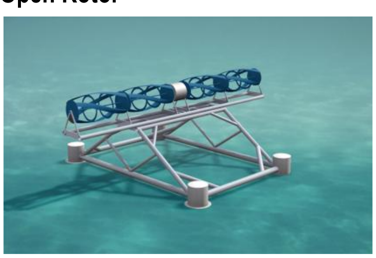
Type of Technology	Description	Examples
4. Fixed - Oscillating Wave Surge Converter  	Captures wave surge energy directly by using relative motion between a flap and a fixed reaction point; the flap oscillates along a given axis dependent on the device; energy is extracted from the relative motion of the body part relative to its fixed reference. The tops of most devices are just above the water surface. Devices typically designed for 10 to 12 meter water depth. Dimensions vary depending on device. One prototype is about 18 meters wide. Devices are likely to be developed in arrays; example spacing is about 18 meters between devices. Single Unit wave-shore prototype is being tested at EMEC (European Marine Energy Centers) The developers project capacity for a single unit: 0.3 to 0.6 MW	Aquamarine Power EMEC-1 project "The Oyster", Scotland
C. Fixed and submerged These devices are typically in near-shore settings (but may be located off-shore). They are fixed to the shore or ocean floor (both pile supported and tethered/moored devices) and have no components above the water surface.		
5. Submerged - Point Absorber 	This converter is fully-submerged and uses the power of waves to deliver high pressure seawater ashore to produce either electricity or freshwater from desalination. It requires no high voltage transmission. Devices are permanently anchored to the seafloor and can operate in water deeper than 15 meters in areas where there are no breaking waves. Prototype is approximately 2 meters wide by 5 meters in height. Formal launch January 2010 in Fremantle, Western Australia. The commercial demonstration project will have a peak installed capacity of 5MW.	CETO Wave Energy Technology
6. Submerged - Oscillating Wave Surge Converter 	This device captures energy from the swaying motion of buoyant blades with the oscillating flow field. Devices sit on seafloor. Prototype is approximately 2 meters wide by 5 meters in height. 0.25 MW prototypes being deployed in Port Fairy, Victoria, Australia. The developers project capacity for a single unit: .25 MW, scalable to 1 MW per unit.	BioWave Technology

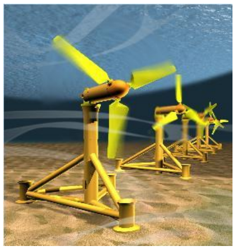
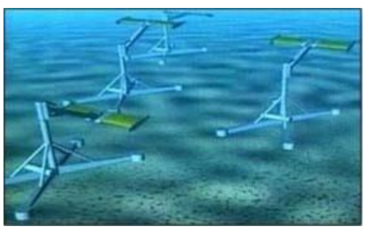
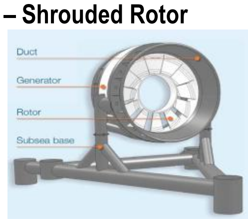
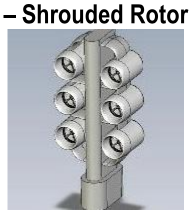
Type of Technology	Description	Examples
D. Floating These devices are moored to shore or the ocean floor, but they float and have substantial components above the water surface.		
7. Floating - Oscillating Wave Surge Converter 	Waves enter this large floating powerplant, causing flaps hung below the floats to heave or sway. Prototypes deployed Lolland in Denmark in 2008. A recent prototype was 37 meters wide, 25 meters long, 6 meters high (to deck) and weighed approximately 350 tons. A full scale project may be up to 450 meters wide. The developers project capacity for a single unit: 10 MW.	"Poseidon" Floating Power Plant
7. Floating - Point Absorber (power buoys) 	Most work by "bobbing" and capturing the energy from the "up and down" motion of waves. These are partially submerged (e.g., rising 1.8 meters above the surface), but also tend to be relatively long and have substantial components below the surface (e.g., extending 45 meters). "PowerBuoy" technology is expected to be deployed in depths of 50 meters. The developers project capacity for a single unit: scalable to 2 MW.	Reedsport OPT Wave Park Project Reedsport, OR FERC Preliminary Permit No. P-12713 issued 2/16/2007 and application filed with FERC on 1/27/2009. Coos Bay OPT Wave Park Project Coos Bay, OR. FERC Preliminary Permit No. 12749, issued 3/9/2007.
8. Floating - Attenuator – Rotational Joint 	Device is oriented parallel to the direction of the incoming wave and converts the energy due to the relative motion of the parts of the device as the wave passes along it. They look somewhat like semi-submerged "train cars" and are typically moored to the ocean floor. An example device may be 120 meter long and 3.5 meter wide, with about 2 meter above the water surface. The developers project capacity for a single unit: 750 kW	Orcadian Wave Farm Profile, Scotland
9. Floating - Overtopping 	Large devices that capture water in a reservoir from the tops of waves, then allows water to drain through a traditional low-head hydropower turbine in the device. Pilot / testing since 2004. May be scalable as large as 170 meters by 300 meters. The developers project capacity for a single unit: 11 MW	WaveDragon, Denmark

Current Energy Technologies

These often submerged devices operate in rivers, tidal areas, or ocean currents, generally using the energy of horizontal currents to spin turbines that power generators.

Table 2. Examples of Current Energy Technologies.

Type of Technology	Description	Examples
A. **Floating or with above-water surface components**		
1. Floating - Cross Flow Turbine – Shrouded Rotor 	Four fixed hydrofoil blades of the turbine are connected to a rotor that drives an integrated gearbox and electrical generator assembly. The hydrofoil blades employ a hydrodynamic lift principal that causes the turbine foils to move proportionately faster than the speed of the surrounding water. Dimensions vary by device. The developers project capacity for a single unit: .25 MW.	Turnagain Arm Tidal Generation Project, AK (Blue Energy Ocean Turbine) FERC Preliminary Permit No. P-13509, Preliminary Permit issued 9/3/2009
2. Floating - Axial Turbine Flow – Shrouded Rotor 	Typically has two or three blades mounted on a horizontal shaft (wind turbine design) to form a rotor; the kinetic motion of the water current creates lift on the blades causing the rotor to turn driving a mechanical generator. Rotors on these projects are designed to operate over a wide range of flow speeds. Hastings Project is mounted to a 20 by 12 meter barge located in the tailrace of an existing dam, 2-units with total capacity of .07 MW; (Sole license issued in the United States to date).	Hastings Project, Minnesota FERC Project No. P-4306, license issued 12/13/2008
3. Floating - Cross Flow Turbine – Open Rotor 	Typically has two or three helical blades mounted along a shaft (egg beater) to form a rotor; the kinetic motion of the water current creates lift on the blades causing the rotor to turn, driving a mechanical generator. The OCGen prototype can be barge-mounted and unidirectional regardless of current flow direction and is 11 by 32 meters long, 2 to 5 meters in length. The device can be stacked either horizontally or vertically to form arrays. Project capacity for a single unit is 158 kW; 80 to 120 units proposed for Western Passage Project (total capacity between 12.6 and 19 MW).	Western Passage OCGen Power Project, Maine FERC Preliminary Permit No. P-12689, issued 7/23/2007.

Type of Technology	Description	Examples
B. Submerged devices These devices are typically attached to fixed pilings or moorings with no substantial development above the surface.		
4. Submerged - Axial Turbine Flow – Open Rotor 	Typically has two or three blades mounted on a horizontal shaft (wind turbine design) to form a rotor; the kinetic motion of the water current creates lift on the blades causing the rotor to turn driving a mechanical generator. Rotors on these projects are designed to operate over a wide range of flow speeds. An example device may have 5-11meter rotor diameters for each unit. Six units with a project capacity of .175 MW.	Roosevelt Island Profile (RITE), New York FERC Preliminary Permit No. P-12611 issued 12/13/2005 with pilot license application submitted 11/25/08.
5. Submerged - Oscillating Hydrofoil – Reciprocating Device (Flow Flutter) 	Similar to an airplane wing but in water; yaw control systems adjusts their angle relative to the water stream, creating lift and drag forces that cause device oscillation; mechanical energy from this oscillation feeds into a power conversion system. Fifteen meter wide hydroplane The developers project capacity for a single unit: 1.5 MW.	Shetland Islands Profile , United Kingdom
6. Submerged - Axial Turbine Flow – Shrouded Rotor 	Submerged device similar to #2 above, but using ocean currents located in an inland marine waterway and sitting directly on the sea floor. The turbine is bi-directional to capture ebbing and flowing tidal currents. Admiralty pilot project to include two units with a combined installed project capacity of 1 MW. Projected build-out 450 units.	Admiralty Inlet Project, Washington FERC Pilot License application P-12690 issued 12/28/2009. Yukon River at Eagle, AK
7. Submerged - Axial Turbine Flow – Shrouded Rotor 	Submerged device similar to #2 above, fixed to the river bottom, with several turbine units per mount structure. Example units have 7-10 blades, and a diameter of either 1.4 m or 3m. Turbines designed for river applications are not bi-directional. Devices are likely to be developed in arrays; example proposal is for 3850 units, generating 77 MW. The developers project capacity for a single unit: 10 kW – 40 kW.	Ste. Genevieve Bend Project, Missouri FERC Preliminary Permit No. P-12917, issued 2/1/2008.

Additional technology information needs

The diversity of hydrokinetic devices makes it challenging to illustrate the range of device sizes, extent of development above the water surface, or design features, even within the broad categories above. Accordingly, we have developed an initial, non-exclusive list of additional information needed to adequately assess impacts for recreation:

- For submerged devices, it is important to know the "subsurface clearance distance" (vertical distance between the top of device and the water surface), and whether that distance changes with flow or tidal fluctuations. The issue here is what size recreation vessels could navigate over the device.
- For submerged or floating devices, it may be important to describe a "lateral clearance distance" (horizontal distance from the sides of the device) that vessels need to maintain to avoid colliding with the device.
- For floating devices or those with above-water components, another issue relates to the size, shape, and appearance of visible development, which may have potential aesthetic impacts as well as indirect impacts on skimming/diving birds, waterfowl, and sea mammals.
- For all floating devices (or submerged devices that are not fixed to the sea or river floor), the type and extent of mooring systems will be important. The depth and extent of cables or anchors could affect whether recreation users can fish or anchor in an area, some mooring systems may present navigation hazards, and there may also be indirect impacts on fish and wildlife. To date, few conceptual device descriptions provide extensive detail about their mooring systems.
- For devices that are fixed to pilings or otherwise anchored to the ocean or river bottom, developers should provide detailed information about the size and shape of anchors and pilings. These may become "channel" structure that may affect fish and wildlife populations or behavior, current or wave characteristics, or influence potential access restrictions for recreation.
- Pilot projects typically have only one or two devices, but commercial projects may involve arrays of tens or hundreds. The size and shape of an array (footprint, exclusion zones, and impacts on navigation) is a major issue for recreation analyses, and most projects have not provided detailed information that will allow adequate analysis of commercial project impacts.
- Distance from shore is a potentially important issue for recreation impacts. Several impacts depend upon the specific site characteristics where devices will be deployed. Many projects focus on water column depths rather than distance from shore, but both variables are important for recreation.
- The speed and "range of motion" of moving parts in hydrokinetic devices may be important. They are likely to vary by type of device and setting characteristics (e.g., a turbine will move faster in stronger currents, a wave device may sway more dramatically or with greater force in large waves), and may affect safety of boats or other recreation uses in the vicinity (which may affect the need for access restrictions). Key information may include average, typical, and maximum velocity estimates for moving parts.
- Initial construction or deployment may involve greater amounts of activity, support vessels, noise (especially for piling-based development), access restrictions, or other impacts. Estimates of the length and level of activity during deployment are an important part of the project description. Time of year for initial deployment may be a factor, allowing impacts to be concentrated in low recreation use seasons, or less critical times for fish and wildlife.
- Estimates of the frequency and length of maintenance periods and associated levels of activity could also be important. Maintenance activities may involve support vessels, increased noise impacts, risks of leakage or salvage, increased aesthetic impact due to greater activity at the site, or larger or

different access restrictions. Descriptions should include whether maintenance can be conducted underwater or whether they require components brought to the surface, which may take longer or create greater aesthetic impacts. Scheduled maintenance may be able to be scheduled during lower use seasons or when fish and wildlife populations are less vulnerable, but unexpected maintenance needs might occur at less opportune times (e.g., fish migrations or spawning, peak recreation seasons).

- Information about under or above water noise levels during deployment, maintenance, or regular operations could be important. The primary potential effects are likely to focus on fish and wildlife behavior, but in some "quiet" settings, the buzz or hum of development may affect human aesthetic evaluations.
- Some technologies may alter circulation in river channels or near-shore environments, affecting impacting navigation and changing the distribution or abundance of aquatic and marine organisms important for wildlife watching, fishing, and shell fishing.
- All technologies must connect to a land-based grid. The type of connection (subsea/underground v. overhead) and associated facilities needed (e.g. substations) should be described because these may affect recreation access, aesthetics, or shore-based fish and wildlife.
- Most wave and current development is unlikely to change ocean or river temperatures, but ocean thermal energy conversion (OTEC) development is a related technology that generates energy from temperature differentials between warm surface water and cold deep ocean water. Although OTEC devices are not a focus of this guide, temperature changes are a critical variable for that technology.
- It would also be beneficial to have estimates of "project footprint" (both area of actual development and area of access restrictions) to compare with projected generation (in terms of kilowatts). This will allow comparisons with other alternative energy projects (e.g., wind, solar, nuclear, micro-hydro, etc.), which also occupy a certain amount of space to produce a certain amount of energy, each with recreation repercussions. .

3. Types of Recreation in Hydrokinetic Settings

This chapter provides a general list of recreation activities that occur in areas with potential hydrokinetic development. The goal is to provide a "checklist" for potential developers, agencies, or stakeholders to review as a project is proposed, as well as briefly describe the activity and its key biophysical, social, and managerial setting attributes. The list should not be considered exhaustive, but we have tried to identify the most common recreation activities and important attributes. Chapter 4 discusses the importance of setting attributes for specifying recreation opportunities, which is the foundation for assessing impacts as discussed in Chapter 5.

Hydrokinetic projects may be located in river and marine settings, including estuaries, coastal marine and near-shore zones, and open-ocean, deep-sea regions, where a diversity of recreation opportunities occur. While it is challenging to develop a comprehensive list of recreation for each setting, it is possible to identify the most common recreation opportunities and the key characteristics or setting attributes that may become issues during hydrokinetic – recreation analyses.

The following recreation opportunity list is organized by type of setting (river and marine) and then by type of opportunity, with some opportunities grouped to avoid repetition. For each, we provide basic information about how the opportunity "works" and describe attributes that define high quality. Opportunity descriptions are necessarily general, and may need to be more carefully described for particular projects. For example, descriptions generally do not distinguish between opportunities related to experience settings (e.g., whether an area is more primitive or more developed, or has higher vs. lower use levels), size or type of boat craft (e.g., jetboats vs. other motorized craft on a river, larger vs. smaller sailboats), or technique or target species fishing (e.g., top-casting vs. bottom-fishing in a surf fishery, trout vs. salmon in a river fishery).

The great variety of outdoor recreation pursuits in the United States, including in river and marine environments, plays an important role in the lives of most Americans in terms of quality of life, the importance of public resources, and the state of our overall economy and health. For example, a 2006 Active Outdoor Recreation Economy Report found that outdoor recreation contributes $730 billion to the US Economy, and supports nearly 6.5 million jobs.

River settings

Boat-based fishing

Taken together, fishing from boats or the shore is one of the most popular water-based recreation activities, with 44 percent participating (National Survey on Recreation and the Environment (NSRE), 2004; see 2004 report and 2005 summary PowerPoint). Anglers fish from boats in cold and warm water for a variety of different species using different techniques (usually categorized by type of "terminal tackle:" bait, spinning or other artificial lures, or flies). The details of these differences may be important when assessing potential impacts from hydrokinetic development, depending on where it is located in the water column. For example, anglers may fish the bottom of the river with bait for catfish, walleye, or sturgeon, while targeting other species closer to the surface with lures or flies (e.g., trout, steelhead trout, salmon, or bass). On the Lower Mississippi, bottom-fishing anglers sometimes attach weighted tackle to floating jugs and set out several at a time (when they see them bobbing, indicating a strike, they retrieve the jug, tackle and hooked fish). By comparison, top-casting techniques (with spinning or fly gear) are generally at much lower risk of becoming entangled in hydrokinetic development.

River anglers may fish from both drift or power boats. A drift boat is more flow-dependent (has less ability to travel long distances or deal with strong currents), so hydrokinetic project locations, navigational lanes, and access restrictions may have greater impact, especially regarding devices that are not completely submerged. In contrast, powerboat anglers may have more ability to travel around hydrokinetic development or restriction zones.

Many fishing techniques occur from stationary or slow-moving boats (drifting with the current, or trolling with a small motor or oars), which may depend upon certain flows and current velocities. Most anglers fish from their own boats, but others may rent or charter boats with a guide, which may have different economic impacts for a local community.

The density of boat-based fishing varies greatly. A high potential harvest area may experience seasonal crowding (Columbia and Kenai salmon fisheries are some examples), though many fisheries have high success rates and lower densities. The spacing between boats can also be important (e.g., in order to avoid entanglements, or competition for fishing locations, boats may be widely dispersed). All of these factors may interact with hydrokinetic development in such a way that reduces access to fishing.

Shore-based fishing

Many anglers fish from shore rather than boats, for both warm and cold water species. Target areas and techniques for shore-based fishing vary greatly (and include those who wade from shore while they fish). Similar to boat-based fishing, shore anglers may be interested in bottom fish (catfish, sturgeon, or carp) or those targeted in the middle of the water column or closer to the surface (trout, salmon, various species of bass). Spin, bait, and fly fishing are three general categories of shore-based fishing techniques, which may interact with species targets to determine which parts of the water column they use. Techniques that fish deeper waters are more likely to be affected by sub-surface hydrokinetic development.

Angler specialization may be an important consideration when assessing fishing opportunities. The angling specialization concept was proposed by Bryan (1977, 1979) to partially explain differences between anglers that use different equipment and seek different species, settings, and experiences (see Dawson, 2010 for a recent review). Specialized anglers may have invested more time and money in a chosen activity, and may be more sensitive to conditions at their setting.

Shore-based anglers may also be distinguished by their interest in a specific harvest, as well as other characteristics, such as membership in fishing clubs, interest in tournaments and competitions, and affiliation with a socio-economic class. Both shore- and boat-based anglers tend to have higher proportions of men than women, and tend to have older participants than the general population.

Swimming

Swimming in natural waters (identified as lakes, streams, rivers, etc.) is one of the most popular recreation activities in the country, with 42 percent participating (NSFE 2005). There are different types of swimming based on skill level and/or preference for specific conditions (e.g., currents, waves, calm water, proximity of rocks to diving, etc.), which may interact with potential hydrokinetic development. Many swimming activities are associated with periods of relaxation or other activities (e.g., picnicking or sunbathing), and occur in environments that offer pleasant scenery or facilities for these activities. Also, fish watching is becoming more popular on rivers and can include snorkeling and diving.

Recreational boating (non-fishing)

Recreational boating includes both motorized and non-motorized water craft. Most recreational boating requires launch areas, parking, and associated facilities. More than 42 percent of the national population participates in motor boating, sailing, jet skiing, canoeing, kayaking and rafting (NSFE 2005).

Motorized boats include dinghies, bass boats, bow riders, runabouts, wakeboard/water skiing boats, and personal water craft (PWCs). Most boats are privately owned, but some boaters also use rentals and charters. Motorized boating use may be focused in areas with marinas, boat launch facilities, and gas or maintenance services; they may also be associated with large group events such as competitions and rallies. Motorized boating may be associated with several other diverse activities, including access to beaches or similar areas for swimming, picnicking, camping, or relaxation and "water sports" such as water skiing and wake-boarding. These activities may have different navigation and access needs, which can interact with hydrokinetic development.

Non-motorized river boats include canoes, kayaks, sculls, rafts, and sailboats (discussed separately below), and may be used in conjunction with several other activities such as racing, relaxing, or access to areas swimming, relaxing, or camping. Whitewater river recreation is a distinct form of non-motorized boating with a focus on currents, waves, and rapids. Whitewater recreation may occur on long segments of a river (downriver trips) or at specific whitewater features (sometimes known as "park and play" or locational playboating areas). Trips may be offered through commercial outfitters or organized through competitions, club outings, or by private users. About one percent of the population participates in whitewater kayaking but higher proportions (as much as five percent) may take whitewater rafting trips (Shelby and Whittaker 2004).

Multi-day float trips (such as on Idaho's Middle Fork Salmon, Alaska's Tatshenshini, and West Virginia's Gauley River) are another potential distinction within river boating. These often focus on camping, whitewater, and fishing, and require increased logistical planning compared to day trips. Many also require permits (because demand exceeds capacity to maintain high quality trips). Multi-day trips can also include coastal, wilderness lake, river route and urban artery water trails. Water trails are located in almost every state (see American Canoe Association Water Trails Database).

Marine settings

Boat-based fishing

About 10 percent of national population participates in boat and shore-based saltwater fishing (NSFE 2005). Boat-based recreational fishing in marine settings (commercial fishing and crabbing are not a focus of this report) may focus on different species in off or near-shore locations (i.e., less than 30 meters depth and within sight of land); some typical target species may include tarpon, bonefish, blue fish, salmon, striped bass, halibut, white seabass and rock fish (as well as crab, lobster or other non-fish species). Offshore (aka deep sea or open water) fishing generally occurs in deeper water from larger boats and may target species such as tuna, shark, and marlin.

Both types of boat-based fishing may seek existing "structure" in the marine setting topography, which may be created by natural features (e.g., reefs or drop-offs) or artificial features (e.g., artificial reefs, wrecks, or even oil drilling platforms). As a general rule, structure creates more physical habitat diversity, attracting ecological communities, including game fish.

Boat-based fishing techniques in marine settings include simple topcasting (see the section on "Boat based fishing" under "River settings" above), trolling techniques (slowly pulling tackle through an area with the boat's motor), setting traps (especially for crab), and even harpooning. Artificial and natural baits are used. Larger species require larger and heavier tackle, including sea rods with lines of 30 to 50 pounds and conventional rods and reels (multiplier or fixed spool). It is important to distinguish techniques because they can use different parts of the water column, and may conflict with different hydrokinetic technologies.

Boats used for marine fishing include sea kayaks, small dinghies, PWCs, runabouts, cruisers, large multi-hulled powerboats, cabin cruisers, and sailboats. Different crafts employ different techniques and may interact differentially with hydrokinetic development.[4]

Shore-based fishing

Shore-based fishing in marine settings (including surf casting and jetty fishing) is very popular in some parts of the country, with anglers typically targeting striped bass, blue fish, fluke, black fish, red fish, shark, halibut, haddock and mackerel or using traps to catch crabs. As with river shore fishing, anglers may use different techniques or exhibit specialization levels that vary by location and season. Anglers often fish from jetties and docks (usually with spinning tackle or bait), cast into surf from the beach or tidewater banks, or set single pots for crab. Shore based fishing can be highly seasonal depending on migratory patterns of different species (more often in spring, fall and winter), and which may affect the best locations for fishing. All these variables may differentially interact with hydrokinetic development.

Access is critical to shore based fishing as many anglers like to fish from or near their vehicles, and permits are often required to drive on beaches or along shore. In some cases, docks and jetties have beed developed to provide ADA accessibility. Considerable private land and potential conflict between anglers and other beach users in some marine settings have reduced shore-based fishing access over the years. Although many shore-based anglers fish at night (which may reduce these conflicts), access restrictions are a major issue with this activity, which has implications for hydrokinetic development.

Swimming

Ocean swimming is an important recreation activity in many locations, often in association with beach settings. Most people swim from sand beaches during warm water months, but some good swimming may be available in areas with steeper topography (cliffs and rocks). Swimming opportunities may vary from family wading to wave surfing (see below) to open water swimming, with different skill levels required for each. Use levels may depend on the swimming characteristics (e.g., size of waves, strength of currents, water temperatures) as well as adjacent setting features (e.g., quality of sand, availability of shade, scenery) and facilities (e.g., parking, restrooms, picnic tables and shelters, concessions, restaurants, and hotels). Swimming opportunities may differentially interact with hydrokinetic development.

[4] In both river and shore based settings, traditional subsistence fishing (which is not recreation, but is sometimes assessed with it) may use boats and different techniques, including rod and tackle, arrows and harpoons, throw nets, set nets, drag nets, weirs and fish wheels.

Recreational boating (non fishing) including sailing

Marine recreational boating can be either motorized or non-motorized, ranging from sea kayaks, surf skis, drift boats, power or sailing boats, PWCs, to large cruising vessels. Larger cruisers, either sailing or motorized, participate in both day and multi-day trips, often along well known navigation lanes, including navigation lanes in channels and harbors. Boat sizes and required depths vary greatly, affecting where boats go to avoid natural and man-made hazards, including rocks, rips, shoals, buoys, pots and lines (and potential hydrokinetic projects). Large boats may be over 100 feet long and require (draw) 10 to 12 feet of depth. Larger racers (35 to 50 feet) draw 6 to 10 feet. Most cruisers from 20 to 50 feet in length draw 3 to 6 feet.

Geographic use patterns vary by type of craft and activity goals. Some recreational boating focuses on exploring a marine setting, making it difficult to identify high or low use areas. Weather patterns may affect the ability of small boats and kayaks, often without navigational aids or motors, to avoid restricted areas.

Marine sailing may be differentiated by racing and cruising, although other distinctions might include length of trip (e.g., day sailing vs. long-distance, also known as "blue-water" or "offshore," sailing). For cruising sailors, both anchorage and storm refuge locations are important. Sailboats include dinghies (usually under 16 feet), day sailors (about 14 to 25 feet) and larger craft (usually 25 to 65 feet). Craft over 20 feet often have auxiliary motors. Approximately five percent of the population participates in sailing activities (NSRE 2005). Kite boarding and sailboarding/windsurfing are related recreation boating activities that combine sailing and surfing techniques, and may occur in distinct recreation settings or differentially interact with hydrokinetic development.

There are distinct recreational boating areas in the United States; some coasts have much higher use levels than others for a diversity of reasons. Major locations include the North Atlantic coast from Rhode Island to Maine; Long Island Sound; Chesapeake Bay to the Outer Banks in Maryland, Virginia, and North Carolina; Florida Keys; San Diego, San Francisco, and Catalina Island, in California; Salish Sea[5] and San Juan and Gulf Islands in Washington and British Columbia; the Intracoastal Waterway extending along the Gulf of Mexico and Atlantic Coast; and the Inside Passage along Washington, British Columbia, and Southeast Alaska.

Sea Kayaking

Sea kayaking occurs year-round in fresh and marine water bodies. Inland waterways often provide outstanding locations due to protection from weather and heavy motorized use, good aesthetics, and an abundance of biodiversity and marine life. For these reasons, prime sea kayaking areas include Prince William Sound and Glacier Bay in Alaska, the San Juan and Gulf Islands in British Columbia and Washington, the Down East Islands in Maine, and Pictured Rocks Lakeshore in Michigan.

Paddling can cover simple day to multi-day long distance paddling trips, and appropriate camping and landing locations are necessary for multi-day trips. Salt water kayaking can involve the use of a sail, and like whitewater kayaking, can involve play boating on waves and in currents. Some outstanding play and surf areas for sea kayaks or surf skis include Deception Pass, Washington, Santa Cruz, California, and Cape Hatteras, North Carolina. Sea kayaking occurs in all weather and navigation conditions, and is affected by fog, open ocean crossings, marine shipping lanes, tides, currents, wind, and waves. Many of these situations require advanced skill levels.

[5] "Salish Sea" refers to the Strait of Georgia, Puget Sound and Strait of Juan de Fuca (US Board of Geographical Names, 2009).

Diving and Snorkeling

Nearly 10 percent of the national population enjoys diving (using SCUBA equipment) and snorkeling (NSFE 2005). Most recreation and technical diving occurs where existing structures (e.g., artificial reefs, drop-offs, wrecks, platforms, and artificial dive parks) attract biodiversity and visually interesting vistas. Known locations also provide increased safety (from well-documented tides and currents), specific species for viewing, and predictable social interaction with other participants.

Tides, waves, surf and surge, currents and rip tides affect diving and snorkeling. Except for divers with special certifications (e.g., technical divers who conduct salvage, research, search and rescue, night and deep water dives), few divers seek water with velocities greater than a few knots. However, divers sometimes time their activities to take advantage of lower currents during slack tides, or to test their skills in challenging areas (e.g., Puget Sound's Deception Pass, tides and surge along the Oregon coast). These higher velocity current areas may also be good locations for hydrokinetic development.

The depth limit for recreational SCUBA diving is about 100 feet, with most divers limiting their dives to the 30 to 50 foot range. More skilled divers may go to 150 to 160 feet, and trained deep, "big-wall," divers can descend deeper. Recreational dives rarely exceed about an hour or cover more than a half-mile in length. However, multiple dives may occur per outing and boat-accompanied dives can greatly increase the range. Free-diving refers to diving without SCUBA equipment and may be associated with snorkeling. Some forms of fish or invertebrate harvest or collecting (for abalone, sponge, and coral, pearl) are not permitted except on free dives, but other forms of harvest (e.g., spear fishing) may occur with or without SCUBA gear). Diving or snorkeling may occur from beach and shore locations or from boats. Access and parking may contribute to the popularity of dive sites.

Existing cables or lines for mooring and/or electrical transmission are sometimes used by some divers as a route-finding tool. Hydrokinetic development, which includes such cables or lines, may attract some divers, particularly if development also produces reef structure that increase biodiversity (without increasing substantial safety hazards).

Surfing and other wave-sports

Approximately three percent of the national population participates in surf-related activities (NSFE 2005). Surfing refers to any water sport in which a person moves along the face of a breaking wave. Surfing waves are formed by prevailing winds, fetch (distance over which the wind blows), and local characteristics such as beach or reef breaks. Surfing traditionally occurs on longboards, mid-size funboards, or shortboards (where participants stand while surfing) but variations include boogie boarding (where participants lay prone), body surfing (no board is used), surf and sea kayaking (where participants use boats and paddles), wave skiing, and kite boarding and wind surfing (where participants use sails or kites to catch or jump waves), and stand up paddle boards (use of a paddle in conjunction with a surf board). Surfing is not restricted to ocean currents, and sometimes occurs on standing waves in rivers. Kite and board sailing could be classified under sailing, but are listed here because they are usually located in high surf zones, especially for highly skilled users.

Skill level is a major variable with surfing recreation. Beginners usually surf close to shore on smaller, glassy waves, while experts can utilize a greater variety of wave conditions but may prefer large, fast, and dynamic storm swell (and sometimes even employ motorized PWC to match wave speeds and allow them to tackle very large waves). Different types of surfing may also work better in specific wave/wind conditions that further interact with skill levels.

Weather, including water and air temperature, affects surfing, although new technology and equipment, (e.g., higher quality wet and dry suits), have expanded the waters that surfers are willing to use. Initially developed in warm water locales such as Santa Cruz, California; Oahu, Hawaii; or Daytona Beach, Florida, surfers today seek out good conditions in locations such as Yakutat, Alaska; China Beach, British Columbia; Coos Bay, Oregon; and La Push, Washington.

In addition to certain sized waves, good surfing locations require good take-off points and breaks – which are created by specific bathymetric features (similar to the way river rapids accelerate within channels framed by large rocks). The presence of usable rip tides, wind protection (from a jetty or headland), and proximity to a headland that refracts waves, can all be important for creating specific wave characteristics that facilitate a certain type of surfing.

As with all recreational use, beach access and parking are important, and facilities can play an important role in the popularity of some sites. As with other recreational areas, good surfing locations are relatively rare, may not be well known, and may have limited space, often leading to crowding and territorial behavior. This can lead to unwillingness to reveal preferred locations.

Recreation opportunities in both marine and river settings

General recreation

Active and passive recreation activities such as wildlife viewing, picnicking, walking, hiking, rock hopping, biking, shell collecting, wading, tubing, tanning, and relaxing, can occur in both river and marine settings. These can be day or multi-day trips. For example, approximately 60 percent of the population has participated in a visit to a beach or waterfront site (NSFE 2005).

Ancillary facilities at these sites are important, and may include campsites (both formal as well as backcountry sites for multi-day trips), shelters, bathrooms, and parking. Ancillary facilities should be included in a recreation review and analysis of a hydrokinetic project. Key issues to consider are impacts to access, wildlife viewing, and general aesthetics. Access is a good indicator for general recreation that is planned and/or currently occurring.

Wildlife viewing

Wildlife viewing is one of the top ten most popular recreation activities, and one of the fastest growing with more than 31 percent of the national population participating (NFRE 2005). In addition, wildlife viewing may enhance other activities. For example, eagle watching along the Lower Snake in Idaho, and the Skagit and Nooksack Rivers in Washington include both land- and water-based viewing; the latter facilitated by commercial or private kayak or raft trips. Whale watching trips can also be land- and water-based (e.g., commercial trips are available along the Northeast Coast and throughout the Salish Sea in British Columbia and Washington). Birding, including observing mass migrations of shorebirds and waterfowl from shore, is a particularly popular form of wildlife viewing.

In Focus: What If Area Recreation Uses Are Unknown?

This chapter outlines the many recreational activities that occur in river and marine environments that could be affected by hydrokinetic projects. For some hydrokinetic projects, the existing recreational use of the area is well-established and documented by users and agencies. For other projects in more remote or unfamiliar areas, existing and potential recreation use may be unknown, presenting additional challenges for impact assessments. For projects where use is not well understood, even initial "desk top" research can be helpful (see additional discussion in Chapters 4 and 6), and might include:

- ***Review aerial photographs.*** New internet tools like Google Earth provide a quick, easily accessible way to initiate desktop analysis. Current and historical high quality aerial photographs can be viewed for evidence of how humans have used a shoreline over time. Flat open areas and social trails that provide, or have the potential to provide water access, are often visible. In addition, other information (e.g., recreation activities, water features, land ownership, other uses nearby, etc.) is often provided and can help indicate recreation opportunities. Panoramio, a photo sharing site that is linked with Google Earth, is related tool that can help researchers visualize the area and assess recreation possibilities.

- ***Literature/internet search and review.*** Review relevant information describing recreation opportunities in the area from books, reports, and internet web pages. If information cannot be found about a specific area, review regional information for clues about potential recreation uses.

- ***Interview key users and resource specialists*** who know the area. Although information is likely anecdotal, it can be accurate and indicative of the type and magnitude of use, especially if additional networking confirms the narrative of initial contacts. Finding initial interviewees can be challenging, but contacts with user clubs for potential activities or local parks and recreation staff may help. These contacts may also provide perspectives on the national, regional, or local recreation importance of the area.

- ***Create base maps using Geographic Information Systems (GIS).*** This step can help summarize spatial characteristics of the project area and identify discovered recreation use features (e.g., travel corridors, rapids if in a river, access facilities, shoreline use, potential recreation use sites). These data can then be integrated with other mapping data that exists for coastal activities and marine spatial planning efforts. Mapping tools can also be used as a forum for public participation.

- ***Public engagement.*** Reach out to nearby communities, resource specialists, and user groups to help identify historic, current, and potential future recreation uses.

The goal of these analyses is to help prioritize recreation opportunities and important impacts. In some cases, a hydrokinetic project could have substantial direct impacts to recreation use (e.g., a commercial-scale project that excludes recreation from a nationally significant surfing area). In other cases, impacts may be negligible (e.g., a pilot-scale project with one submerged turbine in an industrial area where the nearest recreational use is beach combing). There are a full range of possible impacts, depending upon the types and significance of the recreation opportunities, and how the hydrokinetic project will affect those. Activities with low use, low importance, or low probability of being impacted by hydrokinetic projects could be eliminated from further consideration, while attention could be devoted to areas with extensive recreational use, significance, or high probability of being impacted by hydrokinetic projects.

Key questions to consider in such an analysis include:

- Is recreation use occurring?
- What types of activities and experiences are being provided?
- Are the opportunities nationally, regionally, or locally significant?
- How will the proposed project change use of and access to the area?
- What are the recreation use participation trends?
- What are potential future recreation uses?
- What are the expected direct, indirect, and cumulative impacts on these opportunities? Are impacts adverse or beneficial? What are the spatial and temporal boundaries of the impacts? What is the expected intensity of the impact (e.g., major, moderate, minor or negligible)?

In addition to identifying existing use, potential future recreation use needs to be considered. Consideration of potential future recreation use is required under FERC regulation (18 CFR 4.41.7(iv)); see Chapter 8 for more information. Recreation uses may also change over the 30 to 50 year length of a traditional license. For example, remote areas with limited access historically may have had little past recreation use, but an increase could occur if a hydrokinetic project makes the area more accessible (through changes in access, amenities, or other facilities). This requires some forecasting of suitable types of and potential demand for new recreation.

If increased use is forecast, it may also be important to document how a more solitude/primitive experience may be replaced by a higher density recreation opportunity. In these cases, an assessment of the trade-offs between the type and quality of recreation experiences may be needed. Adequately predicting future recreation demand and how hydrokinetic projects will change recreation use for an area can be challenging. New activities and equipment can change opportunities available in an area. As an example, only one-percent of the national population in 1960 participated in downhill skiing; today 15% of a much larger population ski or snowboard. This has affected local economies of small towns like Vail, Colorado which largely developed in response to the growth of the skiing industry (Whittaker and Shelby, 2005). Similar recreation-driven booms may occur in river and marine settings.

Long-term monitoring of recreation use is critical to capturing changes near the project. The initial baseline studies that are conducted pre-construction can help inform monitoring plans for recreation to be conducted periodically over the life of the license. The time interval and level of monitoring will vary by project depending on the activities and experiences provided, significance, and degree of impacts expected.

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4. Concepts for Assessing Impacts

This chapter describes conceptual principles used for understanding how a hydrokinetic device may affect recreation. It reviews basic recreation management concepts, applying those concepts in hydrokinetic impact assessments, distinctions between direct vs. indirect impacts, "level of effort" and a progression of study options.

Note: Discussion in this and remaining chapters focus on project-specific impacts to local or regional recreation. It is beyond the scope of this document to compare larger-scale impacts of hydrokinetic generation options with status quo energy generation (e.g., gas, coal, oil, nuclear, or traditional hydropower) or other alternative energy generation (e.g., wind, solar), and doe. This is important, but out of our scope. All about trade-offs at a different scale. Same rules apply for other energy siting….

Basic recreation management concepts

Assessing hydrokinetic impacts on recreation requires a definition of "recreation," and criteria to determine when high quality recreation is being provided. Recreation is not defined simply by types and numbers of recreation facilities (e.g., parking areas, rest rooms, campgrounds, marinas, etc.) or the types and numbers of people that use them. While facility inventories and use-level statistics describe important dimensions of outdoor recreation, they do not describe the nature or quality of outdoor recreation opportunities.

A better definition also considers outdoor recreation in terms of recreational experiences – psychological outcomes that people obtain by participating in certain activities in certain settings (Driver & Brown, 1978; Driver et al., 1987). ***The overarching goal of recreation management is to provide opportunities for people to have these experiences.*** An important goal of recreation research is to identify and understand how resource or setting conditions and management decisions affect those opportunities (Manning, 1985; Shelby and Heberlein, 1986).

Two fundamental principles follow from this definition and guide recreation management and research. First, because people demand a diversity of recreation experiences, management should ensure a diversity of opportunities is provided. This idea has been institutionalized in many resource management agencies (e.g., Forest Service and Bureau of Land Management) through planning frameworks such as the Recreation Opportunity Spectrum (ROS; Brown et al., 1978; Clark & Stankey, 1979), which define types of recreation along a setting continuum defined by biophysical, social, and managerial conditions.

Second, recreation opportunities are provided by specific combinations of these biophysical, social, and managerial conditions. For example, an opportunity for wilderness sea kayaking is provided by a biophysical marine setting with an unmodified natural environment; a social setting that provides relatively few contacts with other users; and a managerial setting that encourages the preservation of wilderness values. The "wilderness sea kayaking" experience is derived from this opportunity as users participate in the activity and respond to the conditions.

Recreation management analyzes how conditions provide high quality opportunities, which thus allow people to have high quality experiences. Hydrokinetic development may affect elements of the biophysical setting (e.g., wave or current characteristics, fish or wildlife populations and behavior), managerial setting (e.g., access or activity restrictions), or social setting (e.g., displacing users or increasing crowding at other locations because of access restrictions). Providing high quality river or marine recreation opportunities requires information about these impacts in relation to specific opportunities.

As this information is collected and organized, it is important to distinguish whether it is descriptive or evaluative (Shelby & Heberlein, 1986). ***Descriptive information*** shows how the recreation system works and explores specific changes to recreation from development: Who is recreating in the area and when? What facilities do they use? How will development change recreation use patterns? What components of development will be visible to recreation users? How will development change flows, waves, or currents that recreation users enjoy? How will development affect the population size or behavior of watchable wildlife, etc.? Descriptive information does not evaluate whether an impact (or effect) is positive or negative – it simply describes the changes to setting conditions.

In contrast, ***evaluative information*** identifies important recreation opportunities or attributes, the acceptability of impacts, and the acceptability of management actions that might reduce negative impacts: Which areas are most important for different types of recreation? How important are setting attributes or facilities? Will users tolerate some access or activity restrictions? What aesthetic changes are acceptable? What is the value of lost recreation opportunities due to biological or physical changes? Many controversial recreation management decisions revolve around evaluative rather than descriptive issues – and separation is needed to clearly understand what is being debated.

Applying recreation concepts to hydrokinetic impact assessments

Applying these concepts to hydrokinetic impact assessments requires clear distinction between resource condition changes (which require descriptive information) and the acceptability of those changes or alternative ways the project could be developed (which require evaluative information). The ultimate goal is a transparent accounting of the trade-offs between different project alternatives with different recreation impacts. Considering trade-offs may provide feedback which could change the hydrokinetic project's technology type (less likely) or its size, location, or other characteristics (more likely). Monitoring and adaptive management provides additional feedback to address longer-term changes to conditions.

Proposed hydrokinetic project

The attributes of a hydrokinetic project are the starting point in the analysis. For example, the type of device, location, and size/number/spacing are critical variables that drive biophysical impacts or potential access restrictions (see categories of devices in Chapter 2). Descriptive information about the device also needs to account for the type of setting where it will be located (e.g., is it an urban, rural, or wilderness-like setting?), because that is the context for assessing impacts. Developers usually provide the initial project proposal, but there may be opportunities for stakeholders and agencies to work with developers to consider project modifications that minimize recreation (or other) impacts during licensing.

Changes in "resource conditions"

Changes in "resource conditions" refer to the specific ways a hydrokinetic project affects biological, physical, or social/experiential resources that collectively provide recreation opportunities. For example, a specific device may directly change recreation access, viewshed aesthetics, wave characteristics, river or tidal hydraulics, channel characteristics, or fish and wildlife abundance or behavior in an area. The need for transmission lines, powerhouses, and access roads can also alter conditions. All these factors are at the center of an impact assessment and they are typically analyzed separately. However, these impacts may be complex and inter-connected, and sometimes collectively produce an overall impact that is greater than the sum of their parts. Potential impacts on resource conditions and attributes are discussed in Chapter 5, while Chapter 6 outlines various ways to study them.

"Resource outputs" and the importance of assessing trade-offs

Once resource condition impacts have been specified, it is useful to summarize broader implications of the project. Different combinations of specific resource conditions produce different "resource outputs" that favor different recreation opportunities, fish and wildlife communities, or produce different levels of power generation. At this point, the analysis begins to move from the technical arena (where scientists and resource specialists assess impacts of different configurations on conditions and subsequent outputs) to the decision-making arena (where resource managers, interest groups, and developers evaluate and possibly negotiate the desirability of different outputs).

The focus here is assessing trade-offs between potential alternative projects (including "no project"). This process involves evaluation and "balancing," integrating technical (usually descriptive) information with value judgments about what is "better" or "worse," "acceptable" or "unacceptable," and considering uncertainties. For example, is it better to maximize power generation but lose access to a popular fishing and surfing jetty, or develop at a different site that may generate slightly less power but displace less recreation use? What is the appropriate balance between lost recreational crabbing opportunities and the size of an array of wave devices? Assessing specific impacts of the proposed project is the starting point for alternative -development, but it is also important to consider alternatives that offer other realistic combinations development and recreation outputs. In traditional hydropower licensing processes, negotiations among developers and stakeholders, particularly after studies have been completed, often produce settlements that substantively change the project scale or other characteristics to provide better environmental outcomes. Chapter 7 explores some of the issues in developing protection and mitigation strategies for recreation; Chapter 8 provides an overview of licensing processes and how developers, agencies, and stakeholders can become involved in these evaluations and crafting balanced settlements.

Monitoring and adaptive management

Finally, it is important to integrate monitoring and adaptive management into the assessment process. Adaptive management is a system of structured decision-making that periodically reviews potential impacts and considers new actions to reduce impacts. Any new technology may have impacts that are long-term or unforeseen; this step allows agencies, stakeholders, and developers to respond to problems as they become known. Long-term monitoring checks whether actual impacts are the same as those predicted. If not, adaptive management prescribes a systematic approach to assess the magnitude of unanticipated impacts, and consider whether changes to the hydrokinetic project (including potential removal) are necessary.

Distinguishing direct and indirect impacts

As impacts are assessed, it is helpful to distinguish direct versus indirect impacts. Direct impacts tend to be immediate and obviously caused by a hydrokinetic device. For example, an "exclusion zone" that prohibits recreation use within 100 meters of a river-based hydrokinetic device immediately and unambiguously reduces the area where recreation can occur. Likewise, a visible device that changes an area's aesthetics or scenic quality does so immediately and directly.

In contrast, indirect impacts may affect other recreation resources over the long-term or less directly, and sometimes causation may be less obvious. For example, a device might change hydrodynamics (the current or wave energy) of an area, which could alter sediment transport or related ecological characteristics, which might change wildlife viewing opportunities or sport fishing populations and harvest success. At each "stage" in this "chain of impacts," the impacts may be delayed in time or mediated by other variables unrelated to the hydrokinetic device, and so a direct accounting of the recreation impacts may be more challenging.

It is beyond the scope of this document to review research on the wide range of potential long term ecological or physical (hereafter shortened to "biophysical") impacts from hydrokinetic devices; each scientific area has a well-developed literature and research protocols. Biophysical impacts are the focus of a major report to Congress on the Potential Environmental Impacts of Marine and Hydrokinetic Energy Technologies (EISA; DOE, 2009b), and they are likely to receive considerable attention during licensing of hydrokinetic devices. However, the recreation implications from biophysical changes may also be important and deserve explicit consideration and integration into the overall decision-making about project licensing.

For many indirect impacts, there may be greater uncertainty about potential changes, particularly for new technologies that have not been "in the water" in many places (DOE, 2009b). Initial assessments for these biophysical impacts may be speculative and require systematic monitoring, so evaluations of related recreation impacts will mirror this uncertainty, complicating recreation evaluations. Recreation studies can identify important biophysical resources for certain activities (e.g., fish, wildlife, or plant/reef communities) or assess trade-offs between different choices (e.g., different types of fisheries), but not until biophysical scientists can specify alternative "futures" with different devices or site locations. In traditional hydropower relicensing, it has been challenging to produce consensus on biophysical outcomes from alternative flow regimes, so "early and often" discussions between recreation and biophysical scientists will be needed.

For both direct and indirect impacts, it is important to identify baseline conditions for a potential site to compare with post-development monitoring. Baseline information includes existing uses and types of opportunities, and the key attributes that make those high quality opportunities.

Level of effort and "a progression of study options"

Deciding the appropriate amount of effort for studying or mitigating impacts is a major issue in hydrokinetic development. Some settings have extensive recreation use that would clearly be affected by hydrokinetic development and deserve more intensive or detailed efforts. In other settings, the potential for recreation use may be less well-known, or will likely be minimally affected (e.g., a submerged turbine situated in a powerhouse outflow, where boating and fishing is already prohibited). Given the potential diversity of situations, it is challenging to specify a single "standard" for a sufficient study. We recommend a "progressive approach" with phased efforts of increasing focus and precision as needed. This applies a "sliding scale" of analysis to the issues, with the amount of study, monitoring, and mitigation proportionate to a project's likely impact. The following provides an overview of this approach; Chapter 6 provides more detailed examples of the kinds of studies that fit with each level.

All projects are required to provide basic information about recreation opportunities in the affected area and review the range of potential direct and indirect impacts (see Chapter 8, In Focus – FERC Recreation and Aesthetic Information Requirements). However, more intensive or detailed studies need only be prescribed in situations that merit them. To be effective, a phased approach needs 1) a clear sequential framework; 2) standardized terminology for various study options; 3) agreement about which study options provide which degree of resolution; and 4) explicit decision criteria to help determine whether the study needs to continue to the "next level." The following suggests three general "levels of resolution or precision," with distinct study options identified for each level:

Level 1 – "Desk-top" options. This first level focuses on basic information collection and integration. This phase usually focuses on "desk-top" methods using existing information in contrast to new field work, or limited interviews with experienced recreation users for each identified recreation opportunity. This is the sort of information included in a "Preliminary Application Document" (PAD) for a FERC license, but may sometimes exceed the technical requirements for that document. In general, we believe that any hydrokinetic development proposed for waters that have existing or potential recreation uses should conduct a Level 1 analysis (with findings in early components of that effort to determine if additional Level 1 options are needed too).

Level 2 – Limited reconnaissance and structured interview options. This level increases the resolution and precision of information through limited reconnaissance-based studies, more intensive analysis of existing information, more systematic, numerous, and structured interviews (possibly including targeted focus groups), or on-site observational studies. This level will probably be necessary but sufficient when hydrokinetic development will affect recreation, but impacts are not expected to be substantial (based on determinations in Level 1 studies).

Level 3 – Intensive studies. This level further increases the resolution and precision of information through more intensive studies, which may include large-scale use or observational assessments, representative surveys of users, aesthetic evaluation studies, monitoring recreation impacts during a pilot project, or laboratory modeling (physical or computer-based models to predict specific impacts). Intensive studies like these will probably be necessary when hydrokinetic development will affect recreation, those recreation opportunities are regionally significant, and impacts are likely to be substantial.

Advantages of the progressive study approach

The progressive study approach has been applied successfully in FERC licensing proceedings for traditional hydropower projects, and improves recreational impacts analyses in several ways. First, efforts are focused on those river and marine settings with greater interest to the recreation community or with greater impacts from potential projects, rather than less important opportunities and minor impacts. Although NEPA and CEQ regulations require a comprehensive review of impacts, there is a clear need to apply a "filter" that directs attention toward significant impacts during environmental review, and this is accomplished in the NEPA scoping process (see Chapter 8)

Second, the approach provides a transparent and defensible record for all parties (e.g., potential Licensees, stakeholder groups, and agencies) regarding the "sufficiency" of effort, and should lead to more efficient licensing proceedings with fewer challenges. Developers would ideally prefer clear "rules" about how much effort is needed to assess potential recreation impacts, but lessons learned from conventional hydropower licensing suggests this is a consensus decision that emerges from the process (FERC, 2006). Developers, stakeholders, and agencies with conditioning authority ideally arrive at these decisions through on-going discussions during the preparation of the PAD and study plans, with FERC generally acting as a waiting "referee" if various sides can't agree. FERC is ultimately responsible for deciding which studies need to be conducted, but applicants get to propose initial studies after considering stakeholder and agency study requests, and all parties are encouraged to comment on others' proposals and participate in study plan meetings to informally resolve study issues prior to FERC Study Plan determination. In addition, conditioning agencies can invoke a formal study dispute resolution process (18 CFR § 5.9-5.15) if they disagree with a determination; for stakeholders or other agencies, alternatives to an adverse determination may include a rehearing of FERC's determination and court challenges.

Third, the approach helps standardize study methodologies and improve comparability across situations. It has taken many years and projects in conventional hydropower licensing to develop well-accepted labels and protocols for many types of recreation impact studies. With hydrokinetic technologies being so new, there is an opportunity to develop "best practice" recreation impact assessment methods from the start.

Fourth, the approach increases transparency and allows information to be shared earlier in the process, particularly across resource disciplines, and among stakeholders and agencies who are addressing issues in the licensing process. This allows an earlier discussion addressing potential conflicts between impacts or outputs for different resources, which may help researchers design studies that address solutions to those conflicts. Integrating information across resources is a major challenge in licensing new technologies; the sooner issues are articulated, the more likely researchers can study them, provide information about trade-offs, or develop ways to mitigate them.

Integrating concepts into project licensing

The previous discussion refers to general concepts that should be integrated into general licensing processes, but does not describe specific authorities, processes, or integration steps. Chapter 8 provides an overview of how hydrokinetic projects are licensed in the United States, with reference to specific applicant responsibilities related to recreation, as well as opportunities for agencies and stakeholders to become involved. This includes links to specific MMS leasing processes (for hydrokinetic projects on the Outer Continental Shelf) and FERC licensing processes (for all projects), each with steps where applicants and stakeholders may consider, develop, conduct, or review findings from recreation studies.

5. Potential Impacts on Recreation Opportunities

This chapter reviews a range of potential direct and indirect impacts from hydrokinetic projects on recreation. The impacts are generally ordered by their importance to recreation interests, recognizing that these may vary by type of device, location, and type of recreation. For each effect, we describe concerns and impacts to provide a "brainstorming checklist" for study plan consideration. The chapter includes four In Focus sections on example access restrictions (one organized by type of device, one by type of recreation), aesthetic impacts, recreation impacts related to ecological changes, as well as a sidebar on cumulative impacts. In all cases, discussions of impacts and device-effect relationships are illustrative rather than exhaustive. In addition, readers should note that the list is of ***potential*** *impacts, and that not all will be applicable or inevitable.*

Access restrictions and public safety

The most obvious direct impacts on recreation from hydrokinetic development are access restrictions or other use alterations designed to enhance public safety. Access restrictions have spatial and temporal components, and "exclusions" (no recreation use allowed) should be distinguished from alterations such as "activity restrictions" (e.g., where access is allowed, but regulations may limit vessel types, vessel speed, or specific activities such as swimming, surfing, or fishing). It is also important to distinguish device-specific exclusions (which prevent recreation use within a certain distance of an individual device but allows use between devices) from array-specific exclusions (which do not allow use between devices) and transmission facilities (where the power comes to shore). Finally, some access restrictions may apply continuously throughout the life of the project, while others may apply for shorter periods during construction/deployment or maintenance only.

The amount of impact from an access restriction depends on the type of restriction; size and shape of the "restriction zone"; importance of the restricted zone to a given type of recreation; and availability of substitute recreation use areas. The type, size, and shape of a restriction, however, also depend on the type, number, and spacing of hydrokinetic devices; attributes of the location (its physical configuration, depths, currents, or other navigational hazards); and the type and amount of recreation use, all of which give rise to the reasons for developing restrictions. In general, it appears that reasons for restrictions include (1) device security (e.g., preventing intentional damage from any source); (2) device damage risks (e.g., collisions or unintentional interference from recreation such as anchor lines or fishing tackle); and (3) recreation user safety (e.g., preventing harm from collisions or interactions with hydrokinetic devices).

It is beyond the scope of this document to identify specific access restrictions that might be adopted for different hydrokinetic devices. However, an In Focus section on ***example restrictions for hydrokinetic devices*** provides some examples, suggesting that restrictions will be greater for development with:

- Larger and more expensive devices (greater security concerns).
- More devices or less spacing in an array (increased chances for collisions).
- More "fragile" devices (more vulnerable to damage).
- Challenging navigation conditions (e.g., stronger currents, larger waves, or extreme weather).
- Multiple recreation uses in the area (increased chances for collisions).
- Recreation uses where larger vessels are common (increased damage from collisions).
- Recreation uses that utilize the same part of the water column occupied by the hydrokinetic device (e.g., bottom-fishing and submerged turbines).

A second In Focus section examines ***example impacts of access restrictions by specific types of recreation.*** These examples illustrate how certain activities occupy specific "recreation habitats" and how different types of hydrokinetic devices may affect those areas differently.

Potential access restrictions will also need to be consistent with existing navigation-related programs and regulations of the Coast Guard (USCG; largely in maritime waters) and/or Army Corps of Engineers (COE; largely in inland waters). These agencies are responsible for assessing and marking navigation hazards, establishing navigable channels (e.g., into harbor areas, along inter-coastal waterways, across estuary bars, or along rivers), and otherwise supporting public use of navigable waterways. The Coast Guard considers itself a cooperating agency in FERC licensing processes, with its primary role to "provide…expertise in the areas of navigation safety and maritime security" that may lead to "recommended terms and conditions which may include mitigation measures such as restricted areas," regardless of whether they are "inside/outside or very near designated channels" (Detweiler, 2010).

The USCG has created "security" exclusion zones around military installations, shipyards, vessels, presidential residences, and some coast-accessible utility plants (particularly nuclear power plants). It also has created "safety" exclusion zones around some (but not all) oil drilling platforms, but these generally do not apply to boats under 100 feet (most recreation craft), so potential damage from larger vessels appears to be the primary concern. By contrast, the USCG does not generally apply access restrictions at aquaculture sites.

In addition to federal input regarding access restrictions, state agencies may also provide input. Some state constitutions (e.g., California, Oregon, Alaska) appear to reserve public fishing or other access rights that might preempt or at least influence siting and access restriction choices.

FERC often adopts access restrictions at traditional hydropower projects. For both security and recreation safety reasons, boating exclusion zones near dams and powerhouses are common. Powerhouses, penstocks, and canals are also sometimes restricted from land-based recreation uses, although many new licenses provide more recreation opportunities than in the past. Similar safety-related recreation exclusions occur at COE and Bureau of Reclamation dams or hydropower projects.

Even considering the above information, it is difficult to predict the specific access restrictions that might be requested by hydrokinetic developers, or whether FERC (or other agencies) will change these requests when issuing permits or licenses. To minimize recreation impacts, hydrokinetic developers may prefer few restrictions or smaller restriction zones that are device- or array- specific, or to choose to develop in areas with existing restrictions (e.g., a Hastings, Minnesota project located in the tailrace of an existing dam). But from a maintenance and liability perspective, applicants may propose more restrictions or larger restriction zones, particularly for devices with high replacement costs, challenging maintenance, or substantial hazards for recreation users. From a public agency perspective, the goal is to balance the tradeoffs between increased safety and lost recreation or navigation access.

Aesthetics and noise

Changes in aesthetics (landscape/visual beauty or related sensory issues) are another potential direct effect from hydrokinetic development. There is growing evidence that people increasingly value aesthetics in their daily life and environment (Postrel, 2003). Hydrokinetic projects can change the visual quality of an area by introducing structures, cables, power-substations, lights, moorings, or barges. They may also produce sounds during construction, maintenance, or normal operation that some people will find objectionable ("noise") in recreation settings (Miller, 2002) or that is extraneous to the environment (Morfey, 2001).

Sound from normal hydrokinetic project operations could include terrestrial transformer hum and power line corona discharge (buzz) or above/underwater noise from the hydrokinetic generator systems. Potential hydrokinetic generator noise could result from turbulence around turbine blades and hydrofoils or from other moving parts such as rotor/gearbox systems and the actual electrical power generators. Fog horns or buoy bells warning of a surface or subsurface project's location may be necessary; associated sounds may be perceived negatively or positively by different recreational users. Sound, especially low frequency sound, travels much farther and with much less attenuation under water than through air, so sensitive receptors for underwater noise could include recreational divers. Aesthetic and noise impacts also go beyond recreation to include local residents or others concerned about an area's scenic or related natural values (Thayer & Freman, 1987).

Several studies in National Parks suggest that large majorities consider enjoyment of natural quiet and the sounds of nature as compelling reasons to visit (McDonald, Baumgartner, & Iachan, 1995), and that anthropogenic noise can detract from experiences or decrease scenic evaluations (Mace, Bell & Loomis, 2004; Benfield et al. 2009, 2010). Although speculative, findings would probably generalize to similar high value recreation areas (especially those with low development levels).

Evaluations of aesthetic and noise impacts from human-built environments are a complex topic (Arbogast, 2005; Dickinson, 2002; Orr, 2002). Such impacts have been a component of environmental effect analysis for many similar developments, including traditional hydropower in river settings (mostly focused on visual aesthetics) and wind energy projects in offshore and upland settings (both visual and noise impacts).

Well-established principles and methods of studying and managing visual resources have been developed by federal land managing agencies and can be applied to hydrokinetic projects (BLM, 2009; USDA Forest Service, 1995). Methods generally involve visual resource inventories and preference evaluations of project alternatives by experts (usually agency staff or consultants with landscape architecture backgrounds). Evaluations by recreation users are less commonly used, although they may provide different findings than "expert" judgments (Daniel, 1990; Manning & Friemund, 2004; Whitmore et al., 1995), a topic that may deserve greater research attention.

Similar research and planning literature is available for noise impacts, particularly related to airport, highway, and railroad siting, and noise abatement structures (Federal Highway Administration, 2006; Airport Noise Law, 2009). However, transportation noise impact assessments typically focus on impacts to land use in community settings, so impact thresholds are typically too high for noise sensitive areas. Understanding and preserving natural soundscapes (e.g., waves crashing, water flowing, leaves rustling, birds chirping, etc.) and natural lightscapes (particularly night sky views) are growing areas of interest and research focus (NPS, 2010; Smith, 2009).

The extent of aesthetic or noise impacts from hydrokinetic development depends on the specific project (size, shape, and number of devices; restriction buoys; sub-stations; and lighting, etc.), the setting where it will be located (e.g., primitive vs. rural vs. urban), and the types of uses, including recreation, that occur in the area. It is beyond the scope of this report to provide a comprehensive review of aesthetic issues associated with specific hydrokinetic development in different settings, but an In Focus section at the end of the chapter lists some example concerns and hypothesized relationships that deserve attention as projects are planned and developed.

Impacts on waves or hydraulic characteristics

A hydrokinetic project can directly affect and alter wave or hydraulic characteristics. By design, hydrokinetic devices absorb and convert wave or current energy, which may slow currents or decrease wave height or strength. These changes in turn may affect sediment transport, bathymetry, substrate type, shoreline profiles, or the ecological characteristics of plants and animals (DOE, 2009b; commonly known as the "EISA report"), which in turn affect other wave or current characteristics (a longer-term indirect effect). Collectively, these changes may alter opportunities for recreation users, some of whom seek higher energy waves or currents, while others avoid them.

Surf-related recreation activities may be the most sensitive to wave characteristic changes (although effects on diving or snorkeling are also conceivable). The size and shape of waves determine types of surfing (e.g., body surfing vs. board surfing), skill level needed, types of maneuvers possible, and the overall quality of the experience. There is developing research literature on the dynamics of high quality surfing waves, which are created by specific combinations of wave characteristics and ocean floor topography (Scarfe et al., 2003). Some research and subsequent projects are aimed at controlling erosion in high value beach areas by creating artificial surf reefs (ASRs), while other projects have focused explicitly on creating new surfable breaks (Jackson & Corbett, 2007; Hearin, 2006). Related work has occurred for artificial wave pools (e.g., human-built water parks), producing data describing the wave energies and bathymetry necessary to create surfing conditions for different skill levels and techniques.

The surfing community has debated whether artificial reefs are appropriate in natural settings, can perform as well as designed, will attract considerable surfing use, or will induce substantial economic benefits (Surfermag.com, 2008; Marine Consulting Research, 2008). One review suggests that better designs have created surfing improvements and provided coastal protection, but early ASR projects in Australia, New Zealand, and California have not produced outstanding recreation opportunities, and most hope that proposed projects in Florida, Indonesia, India, and South Africa will improve the "state of the art" (Marine Consulting Research, 2008). Given that human activities in coastal areas (e.g., jetties, beach nourishment, or dredging) have sometimes inadvertently produced high-quality surfing breaks (Corne, 2009), advocates of artificial reefs argue that designed reefs should be able to do as well or better (Marcus, 2009).

Regardless of one's position on artificial reefs or artificial surfing facilities, the science advancements have identified the variables that create high-quality surfing, and this knowledge may help determine hydrokinetic impacts on surfing. Although early work suggests that hydrokinetic impacts on wave height and power are likely to be small, longer-term changes to sediment patterns that affect reef bathymetry and wave characteristics may be important (Michel et al. 2007; Nelson et al. 2008; DOE, 2009b). Reduced wave energy may also affect beach profiles (making their slopes more shallow) and possibly reduce the average particle size of cobbles, gravels, sands and silt in the swash zone, or create new shoals and sandbars, with potentially important impacts on swimming, boating, surf-casting, etc.

A similar science has helped determine how currents and channel features in rivers interact to produce whitewater rapids, which may have applicability to hydraulic features in tidal channels (Whitewater Courses and Parks, 2009). In the past decade, dozens of "whitewater parks" (some in natural channels and some in artificial rivers) have been developed for racing or "playboating," and many have produced high-quality whitewater opportunities. Applying this science to hydrokinetic concerns may help assess impacts on whitewater features. We speculate that impacts from river hydrokinetic devices are likely to be lower than wave devices in surfing settings, because river hydrokinetic devices are more likely to be located in deeper water with strong but steady currents (less likely areas for rapids).

Wreckage and salvage impacts

"Wreckage and salvage impacts" refers to direct and indirect impacts if hydrokinetic devices sink or break up, or are otherwise abandoned. Hydrokinetic devices may need to withstand corrosive salt water, sediment-laden rivers, large temperature fluctuations, the physical forces of high energy waves, sustained currents, and debris. It seems likely that some development will fail, particularly as developers seek to build sufficiently "hardy" devices that can survive challenging environments while also controlling costs. In addition, even if complete device loss does not occur, any construction in water-based settings could produce partial losses (e.g., tools or materials that sink, buoys or anchors that break free). It is important to contemplate these potential losses and calculate how they might affect other resources, including any mitigation or salvage efforts.

Impacts from a wrecked device may include damaged habitat and pollution, which may have longer-term implications on plants and animals that in turn affect recreation (see below). Devices that cannot be salvaged may also become navigation hazards, entanglement hazards (for diving birds, marine mammals, anglers or anchoring vessels), or eyesores (debris on beaches or coasts). Salvage efforts may require temporary access restrictions (because the device has moved) and aesthetic impacts related to recovery (e.g., vessels and divers at the site for extended periods).

In all these cases, predicting impacts will be difficult. However, it is possible to develop hypothetical wreckage and/or salvage scenarios, which can be analyzed for likely recreation implications. Wreckage or salvage experiences from other ocean development may help estimate the proportion of development that may become wreckage in extreme weather events or how long it generally takes to salvage them (for example, the Minerals Management Service (2006) estimates that Hurricane Katrina destroyed 113 oil platforms, set 20 adrift, and damaged 457 undersea pipelines). Damage to undersea cables from storms, fishing trawlers, or landslides are also possible, even as new technologies tend to bury cables to minimize these risks (Connected Earth, 2009).

Displacement that leads to crowding at substitute areas

Displacement that leads to crowding at a substitute area (or areas) can be an indirect effect. Access restrictions displace recreation users to other areas, which in turn may increase crowding or conflict at those areas. This effect is related to the extent of access restrictions, but may be abated by recreation use trends, demand factors, and available substitutes in a region.

The effect of displacement and crowding at an alternative area is likely to be more acute when access restrictions block opportunities that are relatively rare. For example, a hydrokinetic device that eliminated shore-based fishing from one of two jetties in a town would probably increase use at the remaining jetty. Whether crowding or conflict will occur depends on the initial use level at each site, the number of users that are likely to be displaced, and user sensitivity to crowding. Displacement and crowding is also more likely to be an issue if hydrokinetic access restrictions divide a river or marine channel into segments, eliminating thru-travel or access to launch sites.

Fish, wildlife, and related ecological impacts

Direct impacts on fish and wildlife are important for ecological reasons, but these impacts can also have indirect effects on fish or wildlife-dependent recreation. Hydrokinetic development that changes the number or behavior of game fish species or "watchable" fish and wildlife could have substantial consequences on the number and quality of recreation opportunities (e.g., divers or snorkelers often target certain species or communities; sea kayakers may plan trips for areas with greater likelihood of marine mammal or bird species). Similarly, many recreation opportunities depend on "being in a natural place" or "observing natural processes," and may be affected by a change in the presence of viewable fish and wildlife (Manfredo, 2002).

The abundance of certain species is particularly important for "consumptive" recreation opportunities (harvest-based fishing or hunting), which are completely foregone if the target species is unavailable or regulations close the fishery. Many non-consumptive recreation opportunities are enhanced by rather than dependent on watchable fish and wildlife. But activities such as birding, whale-watching, and some types of diving/snorkeling are comparable to consumptive recreation activities in their narrow focus on a single species. Satisfaction levels for these activities drop substantially when species are not viewable (Manfredo & Driver, 2002; Gill, 2002; Orams, 2000).

Hydrokinetic facilities may alter ecosystems, fishery habitat and the capacity of habitat to maintain historic fish population levels. It may also increase the abundance of certain fish or wildlife species by creating new habitat or other more favorable conditions. To effectively assess recreation impacts, one must translate ecological effect findings into meaningful "scenarios" (e.g., number or sizes of certain species; fishing success rates) for recreation stakeholders and agencies to evaluate.

It is beyond the scope of this document to review a comprehensive list of potential environmental impacts with fish and wildlife implications, which are summarized in the EISA report (DOE, 2009b). The EISA report notes that few studies have specifically targeted fish and wildlife impacts from hydrokinetic projects (because few hydrokinetic projects have even been developed), but literature for related technologies (e.g., impacts from marine construction, electro-magnetic fields, submarine cables, offshore wind farms, and fish passage injuries for conventional hydropower turbines) provides a useful starting point. In the EISA report, impacts are summarized in a matrix of issues and potential environmental impacts (see below):

Issues

- Altered currents and waves
- Altered bottom substrates, sediment transport, or sediment deposition
- Altered benthic habitats
- Noise
- Electromagnetic fields
- Chemical toxicity from anti-fouling treatments and/or releases of lubricants, hydraulic fluids, and electrical insulating fluids
- Interference with animal movement/migrations
- "Strike" (animal-device contact)

Potential environmental impacts

- Physical environmental changes
- Animal behavior changes
- Individual injury or mortality
- Population-level impacts
- Community and ecosystem-wide impacts

For each cell in the matrix, the EISA report suggests the likelihood (low, medium, high) that additional investigation will be needed to understand potential impacts. For cells identified as “medium” and “high,” impacts may be more “serious” and characteristics of the site or device are likely to be critical, requiring additional research or monitoring as hydrokinetic projects are developed. The EISA report also notes that information about fish and wildlife population, community, or ecosystem-level impacts (particularly cumulative impacts) are generally insufficient at this time and need further research.

A review of these issues and available literature in light of their recreation implications may prove instructive. As with the EISA report (DOE, 2009b), we caution that current research may be insufficient to identify whether an effect is likely or important. But given finite resources for research and monitoring, we have identified example environmental impacts in an In Focus section on “Example ecological impacts with recreation implications” (see below) with potentially large indirect impacts on recreation.

In most of these examples, conservation concerns about various species, habitats, or natural behaviors is likely to “trump” recreation implications. Nonetheless, it is important to recognize the interrelationships between recreation, fish and wildlife resources, and potential hydrokinetic development. Although existing science may offer limited information and make it difficult to assess fish and wildlife population, community, or ecosystem-level impacts, it is important for biologists to ascertain general magnitudes of hydrokinetic project impacts, which necessitates a comprehensive look at other “threats” (which may include recreation users themselves). Fishery and marine mammal agencies are frequently asked to make these types of decisions about resources they manage (e.g., estimating and managing numbers to determine harvest levels; or assessing the impacts from creating marine sanctuaries). Similar efforts will be needed to assess hydrokinetic development scenarios so stakeholders and agencies can weigh potential outcomes.

Local recreation economic impacts

It is possible that some hydrokinetic devices may attract some visitation for the purpose of simply viewing the technology. Particularly noteworthy conventional hydroelectric projects (e.g., Bonneville Dam on the Columbia River, Hoover Dam on the Colorado) can attract considerable recreation and produce significant local economic impacts, while FERC has often required (or at least encouraged) utilities operating smaller projects to provide sufficient interpretive information to explain projects and encourage visitation. It is unclear whether hydrokinetic projects will be sufficiently dramatic (like large dams or wind farms) to attract substantial visitation of this sort (particularly if they become more commonplace), but this effect may be worth monitoring.

A related topic concerns whether some devices will become “attractive nuisances” – objects that draw recreation users out of curiosity but which may then create safety or liability problems. Access restrictions are probably the most direct way to address this issue

In Focus: Example Access Restrictions for Different Types of Devices

There are few existing hydrokinetic projects or agency track records regarding hydrokinetic access restrictions. In spite of this, it is instructive to consider example restrictions for different types of devices. The examples are based on USCG restrictions for in-water safety zones at oil platforms, FERC restrictions at traditional hydropower facilities, hydrokinetic developer requests in license applications or information in the hydrokinetic device database (see DOE 2009a), safety recommendations from a "wave hub" research area in Europe (Halcrow Group Limited, 2008), and a general understanding of hydrokinetic devices, site characteristics, and recreation uses. The resulting range of potential restrictions should not be considered definitive. We have organized the discussion into categories distinguished by the variables most likely to affect restrictions, including: whether the device is on the surface, submerged, or land-based, and whether it utilizes current or wave energy.

Access restrictions should also not be assumed to be "inevitable" near all hydrokinetic development. In conventional hydropower projects, safety concerns sometimes led to extensive restrictions (e.g., no boating use in a long bypass reach because flows might fluctuate from project operation). However, recreation stakeholders have worked with agencies and developers in many of these cases to remove such restrictions without compromising safety.

Surface-based river, tidal, or ocean current devices

These devices are likely to be turbines suspended from a barge in river or tidal currents, creating navigation hazards with safety and damage risks. As a result, these devices are likely candidates for ***exclusion zones*** that might extend several hundred feet, even when adjacent "navigation lanes" are provided. These exclusions also reduce chances of anchor lines or fishing gear becoming entangled in the moving parts of turbines or their mooring systems. In cases where adjacent navigation lanes are provided, speed limits or anchoring, fishing, and diving ***activity restrictions*** might also apply.

A hydrokinetic project on the Upper Mississippi River near Hastings, Minnesota (FERC P-4306-017), developed as an amendment to a traditional hydropower license at the same site, offers an example. The project has two turbines suspended below a barge moored just downstream of a run-of-river hydropower dam. The hydrokinetic access restrictions are part of an existing recreation exclusion zone that extends 300 feet downstream and 600 feet upstream of the existing dam. The asymmetric shape of the exclusion zone (larger restriction upstream, smaller downstream) makes sense because the river current affects the ability of recreation users to avoid the device. In tidal currents where the "upstream" and "downstream" locations change with each tide, zones should conceptually be symmetric, but local bathymetry and shoreline geometry could create complex currents that require other shapes.

Exclusion zone size and shape are major variables in determining lost access. In a river (or narrow marine channel) setting, a "wide" array of devices may encompass the entire channel, blocking navigation and dividing a recreation area into discontinuous segments. In the Hastings example, hydrokinetic devices do not reduce "pass-through" access because the dam has a navigation lane through an adjacent lock. But the issue is well-known and was a major issue in a proposed (and later retracted) Illinois dam safety regulation that would have created 350-foot exclusion zones (300 feet upstream, 50 feet downstream) at every run-of-river dam in the state. As boating stakeholders noted, this "one-size-fits-all" approach does not account for different hazards for different dams and devices. Ultimately, Illinois decided to review dam exclusion zones on a case-by-case basis (Illinois Paddling Council, 2008). Until there is a longer history for specific types of hydrokinetic devices, we expect a case-by-case approach will be necessary.

If hydrokinetic devices are arranged in a "long" array parallel to the current (e.g., a series of barges with turbines connected longitudinally), other access issues may emerge. A long exclusion zone (e.g., thousands of feet or even several miles) can limit navigation options, particularly in channels with shifting features such as sand bars, or cut off use to attraction areas (e.g., a slough, fishing area, diving area, or rapids used by kayakers). Even if navigation lanes physically allow access, travel may be inconvenient enough to displace some use.

Submerged river or tidal current-based devices

Submerged hydrokinetic devices in rivers or tidal currents are attached to pilings or moored in the water column without any development above the surface. Although these may require ***exclusion zones*** similar in size and shape to those for surface-based devices, less intrusive ***activity restrictions*** may be adequate (e.g., to prevent fishing gear or anchor lines from interfering with the hydrokinetic device's moving parts) may be sufficient. The deciding factor is the depth from the surface to the top of the device (the clearance depth"), which could vary due to tide or flow levels. If the clearance depth can accommodate vessels, there is little safety rationale for excluding boats. However, if problems associated with diving, fishing, or anchoring remain in these areas, activity restrictions could still be required.

A hydrokinetic project in the East Channel of the East River in New York City (Verdant Power, 2008; FERC Preliminary Permit No. P-12611) offers an example of exclusion zones for a fully submerged but shallow array of devices. In this case, a small exclusion zone was established for two turbines during a testing phase, and a larger one is now proposed for a 30-turbine build-out (a narrow but long array of 3 turbines by 10 rows). The entire size of the proposed exclusion zone is about 12 acres (roughly 250 feet by 0.4 miles). The location avoids some shore-based fishing locations and allows commercial and recreation boat passage through the channel even though most traffic uses the another channel of the river (the navigation lane is 21 feet deep by 140 feet wide). The project requires an exclusion zone, rather than activity restrictions, because the project's clearance depth is only 6 to 10 feet at low tide (and vessels that use the East River often require larger depths).

Floating or semi-submerged wave devices

Floating or semi-submerged devices designed to tap wave energy in marine environments are likely to have access restrictions similar to surface-based river or tidal current devices. The difference is the setting in open ocean, which may make some device designs easier for vessels to avoid compared to a constrained river or tidal channel. Depending on height and weather, distance-to-horizon calculations suggest a structure about 15 feet above the water surface is likely to be visible to recreation craft at a distance of 4 miles (Boatsafe, 2009). Devices may be even more visible or noticeable if they are outfitted with appropriate navigation aids (e.g., lights, foghorns, or bells) to reduce the chance of collisions. If devices are outside commonly used navigation lanes, they may not require exclusions. Smaller activity restrictions may be sufficient to address recreation safety issues (for example, one might restrict fishing, anchoring, or swimming and diving within 50 feet).

Other situations may require exclusions. Some devices are individually large (e.g., overtopping devices may exceed 1,000 feet and floating attenuator/rotational devices may exceed 500 feet) and supported by substantial investments, so developers are more likely to request greater protection. Some oil companies have received 500 meter Coast Guard exclusion zones around active oil drilling platforms. Similar security measures may be requested for hydrokinetic projects.

Safety risks increase when devices cover larger areas. Proposed arrays of 10 wave-train devices could occupy a 0.7-mile by 0.3-mile area, and twenty-three "power buoys" could occupy a 1.0-mile by 0.4-mile area. Even if small to moderate recreation craft (e.g., less than about 60 feet long) could easily navigate between these devices, there may be agency or developer interest in excluding recreation craft. If these devices attract sport fish or shellfish species and anglers (see previous discussion), exclusions or activity restrictions could create an enforcement challenge at the boundary of the exclusion zone as anglers concentrate at this location (a similar situation appears to occur near some Gulf of Mexico oil drilling platforms, which are known to attract some anglers).

As with previous examples, the size, shape, and location of restriction zones are critical for assessing the impacts on recreation. Important variables include total device depth, the type and extent of mooring systems, and proximity to shore. Restrictions in shallow waters or within a few hundred feet of shore are more likely to disrupt shore- or boat-based fishing or affect vessel travel patterns. Although it depends on species and technique, many important fishing locations are close to shore (e.g., within a couple of hundred yards) and in shallower waters (e.g., less than 50 feet) with specific reefs or other topographic "structure" known to provide good fishing. Likewise, sea kayakers or other small vessels generally travel close to shore except during crossings, and require access to specific areas along coasts for landings, anchorages, and refuge from storms. To the extent that attractive recreation areas conflict with an exclusion zone, the effect will be larger. In contrast, devices in deeper waters or farther out to sea are less likely to occupy locations critical for a specific recreation use. If there is relatively low overall use in the area and there are adequate substitute areas to fish or dive, the loss from a specific project may be less consequential (and the focus will shift to cumulative impacts of many projects; see In Focus section below).

Submerged wave devices

Like submerged turbines in river or tidal current settings, submerged wave devices may not require complete exclusions if they are deep enough to provide a navigable channel. However, a review of existing designs suggests clearance depths generally do not allow larger vessels (e.g., larger sailing vessels or powerboats, which commonly draw 6 to 10 feet) to pass over them. Because these devices are not visible, but still represent a navigation hazard, there may be greater impetus for full exclusions or significant activity restrictions. In addition, these access restrictions will likely need to be identified with navigation aids such as buoys with lights and sound.

As with floating wave devices, the size, shape, and location of access restriction zones will be important. Some project designs propose multiple devices arranged parallel to a segment of coast, which could have substantial impacts on activities such as diving and sea kayaking. For example, an array of five 50-foot-wide submerged pitching/heaving/ swaying devices positioned every 50 feet could extend nearly 500 feet along a coastline. If poorly sited, this array could effectively close off access to attractions such as "take-off" points for surfing, good fishing grounds, or sailboat, powerboat, and/or kayak travel routes.

Shore-based wave devices

Shore-based wave-energy devices are sited at the end of a jetty, groin, or along a segment of coast. As with dams and powerhouses, land-based recreation users can expect some access closures (e.g., fencing around the facilities). Adjacent water-based use may also have restrictions (probably exclusions) if there are demonstrable safety hazards. Because jetties commonly provide important recreation features (e.g., access to deeper water for shore-based anglers; "rips" that surfers use to access "take-off" locations), such restrictions could represent significant recreation access losses.

A proposed jetty-based hydrokinetic project on Oregon's coast (FERC P-12743, Douglas County, at the mouth of the Umpqua River) offers an example. Utilizing an "oscillating water column" technology similar to the Land Installed Marine Powered Energy Transformer (LIMPET) project developed on the Scottish Coast, the Oregon project could occupy a substantial part of a jetty popular with anglers and surfers. In this case, a second jetty nearby offers an alternative site for the project, resulting in smaller recreation impacts, but possible lower energy outputs. Trade-offs continue to be studied and debated.

Transmission lines and associated development

Regardless of the type of device, cables that transmit energy to shore and connect to the grid will be necessary; these may include sub-stations or other associated shore-based development that may also require access restrictions for security and safety reasons. In some cases, restrictions could be minimal. For example, a hydrokinetic project in Wiscasset, Maine is considering developing on-shore development in a retired coal gasification plant that has a sub-surface water cooling tunnel that could accommodate transmission cables (and thus not require any recreation access restrictions). In other cases, typical sub-station sized facilities are likely to be fenced and restricted like many conventional hydroelectric powerhouses.

In Focus: Example Access Restriction Impacts for Recreation

This In Focus section provides examples of access restriction impacts organized by specific recreation activities. The goal is to highlight the most likely restriction concerns as a new hydrokinetic device and/or site is considered. Conclusions are illustrative rather than comprehensive. As noted previously in the chapter, access restrictions are not inevitable at hydrokinetic projects, and developers may be able to work with agencies and stakeholders to develop effective education programs that provide for public safety without restrictions (and potentially expensive enforcement).

Shore-based fishing

Shore-based saltwater fishing is probably the activity most at-risk from hydrokinetic-related access restrictions, particularly on the Atlantic coast. Bottom fishing, surf casting, and crabbing from jetties, groins, beaches, docks, or other shoreline areas, is already limited to a small proportion of the coast due to fishing regulations, fish availability, and limited public access (or associated parking facilities). These activities are most likely to be affected by (1) shore-based wave devices, or (2) near-shore wave or current devices located within casting distances (about 50 to 150 feet). Jetties and groins are popular fishing or crabbing locations because they offer "structure" that attracts many game species such as striped bass and blue fish (see discussion under fish and wildlife impacts below), as well as opportunities to fish deeper water without a boat.

Even without full exclusions, shore-based fishing is unlikely to be allowed near any wave or current device with moving parts (due to interference with operations or safety hazards for anglers). This seems especially likely for recreational crabbing, which may involve small traps that rest on the bottom, but also includes shore-based surf fishing, where "getting tackle deep" is an important part of success. Diving-based spear fishing may also be affected because safety concerns are unlikely to allow these relatively limited mobility users to approach development.

Fishing from shore, in river settings, may also be affected by hydrokinetic development, particularly in cases with "long" arrays that limit access to a substantial length of river. Fishing will generally be incompatible with these turbine arrays, which may be located close to existing towns or landings, to facilitate transmission. The same areas are advantageous for hydrokinetic development because they are close to population centers and may have parks or other public lands used by shore-based fishing.

Boat-based fishing

Boat-based fishing will probably be affected by access restrictions near hydrokinetic development. The on-shore or near-shore fisheries described above also receive considerable boat-based use (particularly by those in small craft). Boat-based anglers may be attracted to hydrokinetic development farther off-shore (e.g., floating or semi-submerged wave devices), because a project may offer alternative fish habitat, attract fish, and offer good fishing opportunities. Many anglers are attracted to buoys and oil drilling development because they provide habitat for sport fish, and hydrokinetic development may offer similar opportunities if anglers are allowed to fish near them.

Similarly, devices may interfere with fishing in large rivers like the Columbia, Mississippi, or Ohio. Although many fishing techniques are used, common target species include catfish and other bottom feeders that are generally targeted by putting tackle on or close to the channel bottom, which could potentially conflict with moving turbines. Longitudinal arrays that cut off sloughs or coves that anglers use are another issue. As with shore-based anglers, hydrokinetic development might be sited close to existing towns or landings, which are often frequented by anglers in boats.

Powerboating

Recreational powerboating involves diverse craft, and activities that may include cruising, fishing, water skiing, and transporting to other locations for snorkeling, diving, camping, or relaxing. The diversity of opportunities makes it challenging to describe potential impacts from hydrokinetic access restrictions, but in general, powerboating opportunities are unlikely to be substantially affected unless device arrays are large (e.g., several square miles), they block narrow navigation channels, or they close off specific attraction sites. Recreation powerboats are generally smaller and more maneuverable than commercial vessels, and may be able to pass over submerged devices. However, powerboat safety is a major issue for many state and federal agencies and several factors are involved in risk assessments and recommendations for reducing risk (Washington Parks and Recreation Commission, 2004).

Surfing and related opportunities

Access restrictions from shore-based (or near-shore) wave devices are likely to affect surfing. These devices are likely to be located in high-energy locations where surfing is common, and may close off access to other important recreation features (e.g., a predictable rip-tide current along a jetty that allows surfers easy passage to "take-off" locations).

Near-shore wave devices may also affect surfing access, depending upon their proximity to surfing breaks. Surfable waves typically start to break in depths about 1.3 times the wave height, so if surfers are interested in waves between 4 to 15 feet high (a reasonable range for most skill levels), typical "take-off" depths are about 5 to 20 feet. The DOE (2009a) database shows that typical near-shore wave proposals target 20 to 30 feet depths, so an exclusion zone that extended very far from the device may impinge on surfing.

Wind surfing (also known as "board sailing") and kite-boarding are less often tied to specific wave break locations, so these recreational users can use a wider expanse of beach or surf. However, these activities still require good shore access and an adjacent area that is suitable for boarding or kiting. Changing conditions may make it difficult for wind surfers and kite boarders to avoid near-shore devices, necessitating large exclusion or activity restriction zones.

Kayak touring

Hydrokinetic development is unlikely to impinge on access for kayak touring, unless near-shore or shore-based devices prevent use of kayak navigation routes. Touring kayakers generally travel well-defined routes that avoid higher energy wave areas that are the likely sites for above-surface devices. If devices are submerged, paddling over them probably presents no problems. If devices are surface-based or semi-submerged, kayaks are sufficiently maneuverable to avoid contact. However, if development is in a high energy zone also used by kayakers, it is important to offer a route for safe passage that does not force paddlers into more challenging waters that they would otherwise avoid.

Kayak "playboating" in rivers or fast current tidal areas

River or tidal areas with higher energy hydraulics that attract playboating kayakers may likewise be desirable locations for hydrokinetic turbine development, because these areas have underwater topography and tidal patterns that accelerate currents (Fraenkel, 2006). Conflict in uses in these areas could be acute. Submerged devices may not require exclusions, but activity restrictions may be necessary if devices are close to the surface or affect current hydraulics, increasing hazards for kayakers "playing" on those features.

Sailing

Sailing is unlikely to be affected by most hydrokinetic access restrictions unless development and associated restrictions occur in narrow channels. In these passages, submerged development that allows navigation through defined lanes (or over the top of devices) would mitigate most problems. While most recreational sailing vessels draw less than about 6 feet, some racing vessels or larger yachts draw up to 12 feet.
In open ocean settings, hydrokinetic development is unlikely to have substantial impacts on sailing (unless array size is large). Sailors generally have multiple travel options once they reach open water and they can avoid above-surface devices or arrays. It is important for hydrokinetic development to be identified on navigational charts and by physical navigation aids (e.g., lights and bells).

Diving

Snorkeling typically occurs in shallow reefs, which have lower energy waves and currents and are typically unattractive for hydrokinetic development. In contrast, diving occurs in deeper water that may have some stronger tidal currents or surface waves. Unlike many surface water activities, divers may use parts of the water column occupied by submerged hydrokinetic devices (dive depths typically range from 20 to 110 feet).

The critical issue is whether hydrokinetic development will occupy specific places where divers go. Most "point to point" dives occur over short distances (usually well less than a mile) to view specific attractions (e.g., a big wall, wreck, or plant, invertebrate, or fish concentrations), which hydrokinetic development could probably avoid. In addition, most divers prefer velocities lower than about 4 to 5 knots, while hydrokinetic developers appear to seek stronger currents. However, some highly skilled divers seek "drift diving" opportunities in high current, shallow areas, which may present conflicts with hydrokinetic projects (Polagye, 2010).

In Focus: Example Aesthetic Impacts and Issues

This In Focus section provides example aesthetic effect concerns and hypotheses about the types of development likely to have larger impacts on different types of recreation. As with other examples, conclusions are intended to be illustrative rather than comprehensive.

Submerged vs. above-surface development

Submerged devices will generally produce fewer aesthetic impacts than those above the water surface because most recreation occurs on shore or the water surface, but sub-surface aesthetic impacts may be relevant for diving-related activities.

"Hiding" on-shore development

On-shore development which can be housed in buildings, buried, screened, or otherwise camouflaged or blended into the existing visual setting will produce fewer adverse aesthetic impacts (Pasqualetti et al., 2003). This is the primary protection or mitigation strategy for aesthetics impacts from traditional hydropower development (see discussion in Chapter 7).

Regular vs. irregular patterns of development

In some cases, large arrays with a discernible pattern may be perceived negatively, because they produce a human-built "order" in a more organic or "random" natural environment. However, wind power aesthetic evaluations have suggested that irregular patterns for these large structures (e.g., wind towers of different heights or variable spacing, turbines of different sizes) may be less acceptable than regularly-spaced and -sized development (Gipe, 1995; 2008).

Aesthetic evaluations may reflect broader attitudes

Some experts have hypothesized that aesthetic evaluations of a hydrokinetic development may be more reflective of general attitudes toward a setting, type of recreation, or type of hydrokinetic development than specific judgments about design elements of the project such as color, shape, contrast, or texture,(Carlson, 2009; Gobster, 1999). For example, some people may find wind and wave energy development attractive in part because of what they represent (alternative energy) or for what they might partially replace (e.g., coal or nuclear plants) rather than their specific physical attributes (Saito, 2003). In contrast, other people may find certain types of wind or hydrokinetic development unattractive because it represents an obstacle to places they would like to use (especially if development includes prominent restriction markers or fencing).

Aesthetic sensitivity may vary by types of recreation users

In general, people engaging in activities with a greater focus on being in, learning about, or interacting with a natural environment (activities such as wildlife viewing or beach walking) are likely to be more sensitive to visual impacts. Some consumptive recreation activities (e.g., harvest-oriented fishing) are likely to be less sensitive to aesthetics.

Aesthetic sensitivity may vary within activities

Aesthetic sensitivity may be higher for people engaged in longer (especially multi-day) trips and for more specialized users (those with higher skill levels, greater experience, or greater equipment and travel cost expenditures for their activity). There may also be differences between residents and tourists that need to be examined.

Context and setting affect aesthetic evaluations

Context and setting are important considerations for evaluating impacts to recreation (Schreyer and Beaulieu, 1986). New hydrokinetic development in remote and less developed areas is likely to be evaluated more negatively than development in an urban setting. For example, the buoys, restriction signs, and relatively small shore-based switching stations associated with the East River Project (FERC Preliminary Permit No P-12611) in mid-town Manhattan is unlikely to be considered "out of place." In contrast, similar development in a rural area with few structures (e.g., the west coast of Washington's San Juan Islands) or an area distinguished for its scenic beauty (e.g., Washington's Deception Pass) is likely to elicit more negative evaluations.

A useful recreation planning tool, called the Recreation Opportunity Spectrum (ROS), helps account for various settings based upon level of development, type and amount of use, and level of management. ROS concepts help agencies inventory and evaluate different geographic settings (usually within 6 institutionalized classifications) from "primitive" to "urban," and further encourages setting different standards for acceptable impact levels in different classes (Driver et al., 1987).

Aesthetic evaluations may change over time

User sensitivity to aesthetic impacts may change over time, as people become habituated or sensitized to development. Structures such as the Golden Gate Bridge and the Eiffel Tower, widely considered aesthetically pleasing today, were widely disparaged when first built (Saito, 2004), and judgments toward 19th century windmills in the Netherlands have similarly shifted over the years (Righter, 2002). On the other hand, large dams on the Columbia and Colorado Rivers were widely celebrated when first built, but may elicit more mixed reactions today (especially given the better understanding of ecological impacts associated with large dams). Aesthetic researchers have disputed fundamental aesthetic shifts of this nature (Boone, 2005). Initial impact assessments may not be able to predict such changes in aesthetic evaluations but monitoring might track them over time.

Night sky and lighting

There is growing recognition that natural darkness and night skies are important resources that are at risk in many developed settings (Smith, 2007). The increasing population and dependence on lights is causing "light pollution" that prevents people from seeing stars and planets, even in rural areas (National Geographic, 2008). Light impacts from development can affect night skies for a long distance; the National Park Service's "Night Sky Team" has detected impacts over 200 miles from a source and most NPS units that have been tested had some detectable light pollution (NPS, 2010). Fortunately, simple changes in design and installation (e.g. motion sensor lights, shielded lights, low wattage lights) can substantially reduce light pollution, and unlike many other types of pollution, trends can be reversed (NPS, 2010). If lights are needed for hydrokinetic projects, efficient products that limit light pollution are available (Dark Sky, 2010).

Noise and natural soundscapes

Hearing adds to the richness and is usually an integral part of a visitor's experience in a place (NPS, 2010). The acoustic environment is defined as the aggregate of all sounds at a location, together with the physical capacity for transmitting sounds, while the human perception of that acoustical environment is "more broadly included in the definition of soundscape" (NPS, 2010). The importance of natural soundscapes to visitors varies by location and setting. For example, visitors to protected areas (e.g., marine sanctuaries, parks, etc.) generally have higher expectations to hear natural sounds (e.g., wildlife noises, waves crashing). The National Park Service has developed a protocol for measuring the acoustic environment of National Park System units (NPS, 2008). Potential impacts of noise, including underwater noise, generated from hydrokinetic projects on visitors' experiences and wildlife should be considered.

In Focus: Example Ecological Impacts with Recreation Implications

This section provides ecological effect concerns with recreation implications. As with other "example" sidebars, conclusions are intended to be illustrative rather than comprehensive.

Creating "structure" that changes fish abundance

Hydrokinetic development may alter channel bottoms, sediment deposition patterns, and create artificial reefs or similar "structure" that may change the abundance of game fish species, whether increasing some species or decreasing others. For example, anecdotal information from Gulf of Mexico and Atlantic Ocean sport fish anglers notes that buoys and oil drilling platforms tend to increase benthic and bait fish habitats that attract game species, including striped bass, red snapper, mahi mahi, yellow fin tuna, flounder, and grouper.

There is a substantial literature about the positive and negative impacts of "fish attraction devices" (FADs) and "artificial reefs" (Carr & Hixon, 1997; Dauterive, 2000; Caselle et al., 2003; Schroeder & Love, 2004). But applicability to hydrokinetic development will likely depend on specific species, extent and location of devices, device design and maintenance, and the characteristics of local ecosystems. Potential game fish increases will also need to be considered in light of access restrictions, because anglers will not benefit from more fish if they cannot effectively target them. Conversely, structure created from extensive mooring systems in otherwise sandy bottom habitats may reduce some crab populations (e.g., Dungeness crab). These species may be concentrated in particular areas (especially estuaries or near the mouths of large rivers), and lend themselves to specific harvesting techniques, which may be disrupted by hydrokinetic development.

Creating "no fishing" sanctuaries that change fishing population levels

Hydrokinetic access restrictions could reduce recreation or commercial harvest in an area, which in turn may protect some species, similar to marine sanctuaries. Marine sanctuaries are a major ocean spatial planning topic, with many proponents, critics, and mixed research findings (Halpern et al., 2004; Klein et al, 2008; Marine Renewable Energy and Spatial Planning Workshop, 2009). Sanctuaries may increase biodiversity and are likely to increase some fishery population levels, but it is unclear whether sanctuaries simply shift harvest to other areas or have other unwanted consequences. There is also considerable controversy over specific sanctuary boundaries and impacts on local recreational fisheries, commercial fisheries, or local economies (Klein et al., 2008).

Creating attractive habitat for watchable wildlife

Game fish may not be the only animal species that may be attracted to hydrokinetic development. Plant, invertebrate, and fish species may attract divers or snorkelers to mooring structures or the devices themselves, while above-surface development may provide habitat for watchable bird species and marine mammals such as seals and sea lions. Many buoys or other floating development appear to attract watchable wildlife, but not much research is available that documents population or ecosystem impacts, or responses of recreation users. Divers interviewed for this report noted that submerged structures in marine settings are quickly colonized by diverse sea life to become attractive dive sites. A good example is a popular "underwater park" developed in Edmonds, Washington, with artificial reefs created from a sunken vessel and other materials (Emerald Diving, 2009a).

Construction, operations and maintenance impacts on fish and marine mammals

Marine mammals and some fish species may be particularly sensitive to noise impacts (e.g., seismic exploration or construction involving submarine pilings), which may damage their hearing or change their behavior by masking communications or echolocation abilities, or in rare cases cause death (DOE, 2009b; Southall et al, 2009; Hastings and Popper, 2005). The likelihood of these impacts will depend on location and device characteristics, and many other variables (e.g., pollution, marine food sources, or recreation impacts from whale watching).

Some marine mammals (e.g., humpback, grey, and orca whales; and sea lions) receive considerable research attention in part because they are “charismatic megafauna” (large animals with popular appeal). There are many challenges to integrating the impacts of human activities (with hydrokinetic development being just one of many) into a coherent overall management strategy (NMFS, 2009). From a recreation perspective, specific species tend to travel or concentrate in specific locations that attract associated viewing activities (Koski, 2009). If hydrokinetic development is proposed for wildlife viewing areas, the species frequenting these areas may deserve particular research and management attention (DOE, 2009b).

Electromagnetic field impacts on fish and wildlife

A final example focuses on electromagnetic fields (EMF) produced by submarine cables that deliver hydrokinetic energy to shore (Gill et al., 2005; Center for Marine and Coastal Studies, 2003). These cables produce a direct electric field (that can largely be contained by insulation), and an induced magnetic field (which cannot be controlled through insulation), which in turn induces a second electric field. Several fish species (e.g., sharks and rays) are known to sense electric fields that attract or repel them (depending on species and underwater characteristics). Other species are thought to depend on magnetic fields for navigation during complex migration patterns (including sea turtles, salmon, and benthic marine species, such as mussels, prawns, and crabs). However, research about EMF impacts on all of these species from submarine power cables is “variable and inconclusive” (DOE, 2009b), and does not specifically demonstrate substantive impacts from EMFs. Surfing and diving occur in areas where sharks may be present, so even a perceived increase in aggressive shark behavior could raise the profile of these potential EMF impacts. Research on these impacts, especially long-term monitoring, is needed. Potential mitigation (e.g., burying cables, asymmetric cables, etc.) may be able to be identified during the planning stages of the project, with adaptive management informing better mitigation strategies/options.

In Focus: Assessing Cumulative Impacts on Recreation

Cumulative impacts, or the combined impacts of human activity on a resource over time (EPA, 1999), are a critical concern with hydrokinetic development. While an individual hydrokinetic project's adverse impacts may be minor, they may combine with impacts from other projects to cumulatively affect important resources (e.g., "the straw that breaks the camel's back"). Timber harvest impacts provide an illustrative analogy: Individual small clear-cuts in a forest may not substantially affect wildlife populations, scenic values, or overall ecological function. However, a patchwork of clear-cuts combined with housing developments in the area could have these impacts, and planners need to account for them during environmental impact analysis.

A relevant example applicable to hydrokinetic development concerns fishing access. Shore-based fishing opportunities may have decreased in recent years because of management changes (creel limits, catch and release regulations, etc.), fishery declines, increasingly limited access (e.g., vehicle restrictions or private land 'no trespassing' enforcement), and increased crowding due to population increases. Any single issue may account for a small portion of the lost opportunity, but taken together, losses may be severe (and access restrictions caused by hydrokinetic development could intensify the losses).

Since hydrokinetic projects will require review and approval by at least one federal agency, they fall within the purview and requirements of National Environmental Protection Act (NEPA). NEPA requires consideration of cumulative impacts. "Cumulative impact" is defined by the Council for Environmental Quality (CEQ) regulations implementing NEPA as the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions..." (40 CFR 1508.7). "Considering cumulative impacts under NEPA" (CEQ, 1997) and "Consideration of cumulative impacts in EPA review of NEPA documents" (EPA, 1999) provide further guidance on analyzing cumulative impacts. The EPA report states "cumulative impacts result when the impacts of an action are added to or interact with other impacts in a particular place and within a particular time...cumulative impacts of an action can be viewed as the total impacts on a resource, ecosystem, or human community of that action and all other activities affecting that resource no matter what entity is taking the action (EPA, 1999)."

The spatial and temporal boundaries for cumulative impacts need to be broad enough to include all potentially significant impacts on the resources, which typically are larger than the geographical and time-period boundaries used in the direct and indirect impact analysis (CEQ, 1997). In general, the time period of the cumulative impacts analysis should equal the length of the proposed license period.

EPA guidance provides that all NEPA documents need to consider whether cumulative impacts are a significant issue that should be addressed. EPA recommends consideration of the following when determining cumulative impacts (EPA, 1999):

- Is the resource especially vulnerable to incremental impacts?
- Is the proposed action one of several similar actions in the same geographic area?
- Will other activities in the area have similar impacts on the resource?
- Have these impacts been historically significant for this resource?
- Have other analyses in the area identified a cumulative impacts concern?

Scoping and input from recreational users and agencies can help project proponents define those resources that should be considered in the cumulative impacts analysis. For each case, the expected adverse and beneficial project impacts will vary based on a number of factors, including, but not limited to, the hydrokinetic device (e.g., whether the device is submerged or visible above the surface, whether drilling into seafloor is required to install or whether device is anchored, and whether transmission cable is bored through the near-shore seafloor or lays on top of the seafloor, etc.), project footprint, and location of the project (e.g., whether it is in a high recreational use area, whether the setting is urban or primitive, whether it is at an adequate depth to allow surface uses, etc.). The national, regional, or local significance of the recreational opportunity(s) will also help inform the degree of expected impacts. For many areas, recreation opportunities are particularly vulnerable to incremental impacts of a number of past, on-going, and likely future projects.

Cumulative impacts analysis should cover past, present, and "reasonably foreseeable future" projects regardless of which entity has taken or proposes to take an action. As mentioned above, past and ongoing activities by public and private entities impacting the same resources in the same geographical area and time period should be considered. Trends for activities in an area should also factor into the analysis (EPA, 1999). Regarding future actions, CEQ guidance warns against consideration of only those projects that are funded or completing the NEPA analysis. However, considering all potential projects that may be included in long-term plans likely overestimates future impacts, since some of these projects may not be constructed or implemented. Therefore, CEQ directs agencies to "use the best available information to develop scenarios that predict which future actions might reasonably be expected" (CEQ, 1997). Scoping and feedback from stakeholders can further help identify and refine relevant past, present, and reasonably foreseeable actions.

Fully assessing cumulative impacts is especially critical to hydrokinetic projects. Because hydrokinetic technology is a new and developing industry, many initial proposals are small pilot projects consisting of only a few devices resulting in relatively small impacts. However, it is likely that many developers proposing a pilot project intend to construct larger projects with many more devices that occupy larger areas. For example, at the end of 2010, over 40 hydrokinetic projects were proposed along the Mississippi River from St. Louis to New Orleans, with an estimated total of over 100,000 devices. Further adding to the complexity is the fact that in some cases there will be multiple entities implementing different projects in the same river or marine environment. As stated earlier in this chapter, one of the greatest concerns of recreational users is loss of access to existing or potential future recreational resources. A small exclusion zone for one or two devices may not have much impact, but if a larger-scale project or several smaller exclusion zones are implemented in a region, the cumulative impacts could be substantial.

Clearly, more research is needed to improve cumulative impacts analyses of hydrokinetic projects. Ensuring that project development moves at an appropriate pace and uses adaptive management to monitor pilot- and commercial-level projects will be vital to understanding and addressing potential impacts of this new technology. Cumulative impacts to recreational resources are a significant concern. Many recreational opportunities have already been restricted or lost by other development. Since cumulative impacts analysis addresses more than an individual project, monitoring recreational resources on a project-by-project basis may not be adequate to prevent degradation of important resources. To address this issue, new institutional mechanisms may be needed to facilitate collaboration among developers of individual projects to research and review recreational impacts on a broader, watershed-scale. Conducting comprehensive planning that would delineate the most appropriate places for development and monitor impacts would further ensure hydrokinetic energy development occurs in an environmentally and recreationally-friendly manner. Some concepts for developing mitigation and protection strategies are discussed in Chapter 7.

6. Types of Studies for Recreation Impacts of Hydrokinetic Projects

This chapter describes different types of studies that can be used to examine hydrokinetic impacts on recreation. For each, we describe study objectives, approaches, products, responsibilities, and additional issues or keys to success. Types of studies are illustrative rather than comprehensive, and descriptions do not provide detailed instructions for conducting them (ample technical literature is available on recreation studies). Methods are organized by the three levels of study intensity discussed in Chapter 4.

Level 1 methods

Recreation overview from existing information

Objective: Review and summarize existing documents with information about recreation opportunities or the characteristics of the river/marine setting that attract specific types of recreation.

Typical approach: Literature searches on the Internet, in libraries, or in agency collections, with systematic documentation of sources and findings. Literature may include summaries or basic analysis of recreation use information collected by management agencies.

Product: Report summarizing recreation opportunities, facilities, use, and recreation-related setting characteristics (including regional and local maps).

Responsibilities: Hydrokinetic developers (or their consultants) have primary responsibility, but agencies and stakeholders may provide documents or access to files.

Additional issues:

A brainstorming session among agencies and stakeholders may help identify documents; searches of agency files sometimes produce useful “gray literature” or use statistics.

A major brainstorming goal is identifying “recreation opportunities of interest.” At this stage, all potential opportunities should be listed (when in doubt, “split” rather than “lump” potentially distinct opportunities). The intention is to identify substantial opportunities that may be affected by hydrokinetic development. The document should prioritize opportunities for further attention.

For river segments, important setting characteristics include length, gradient, channel type, access, attraction sites, and facilities.

For marine environments, important setting characteristics include channel widths and depths, tidal ranges, current velocities, wave characteristics (size and direction by season), access, attraction sites, and facilities.

Extensive analysis of recreation use data is seldom necessary at this stage, but even approximate estimates of typical and peak levels can be helpful. Qualitative assessments of seasonal or weekly use patterns may be important and identifiable at this early stage.

The report should be systematic and comprehensive, organized by recreation opportunities and identify physical characteristics or use information with each category.

The report should provide spatial information on maps. Regional scale maps identify population centers, recreation attractions, and potential substitute recreation areas. More localized maps identify access points (e.g., public and private boat launches, parking lots for anglers, surfers, or other shore-based recreation), recreation facilities (e.g., campgrounds, picnic areas, rest rooms, etc.), recreation travel corridors (e.g., navigation lanes), and recreation attractions (e.g., rapids, wildlife viewing areas, and surfing breaks, anchorages).

Guidebooks and website information often provide a good "first source" for a river or marine area's physical characteristics and types of uses. However, hydraulic, wave, or tidal information contained in these sources should be used with caution. The level of accuracy and rigor varies considerably, and evaluations often represent the opinion of the author(s) only.

Recreation-relevant hydrology, current, and wave summary

Objective: Summarize recreation-relevant hydrology, current, or wave information as an initial step for assessing potential impacts that may have recreation implications.

Typical approach: Search for hydrology, current, or wave data, usually available from the U.S. Geological Survey (USGS) for river settings and National Oceanic and Atmospheric Administration (NOAA) for marine settings, but such information may also be available from state water resource departments, academia (particularly for oceanographic data), or other resource agencies. Assemble and summarize recreation-relevant findings, including graphs and tables for typical/example recreation seasons.

Product: Report (or appendix to the "recreation overview" report) with summary information.

Responsibilities: Hydrokinetic developers (or their consultants) have primary responsibility, but agencies provide access to data or summaries to make this effort efficient (and non-duplicative).

Additional issues:

The amount of analysis and reporting in this task depends on the resolution needed. For a Level 1 report, summaries of existing or example information for an average year or season may be adequate; more intensive analyses and presentations are usually necessary to reach the higher degree of precision common for a Level 2 or 3 effort.

River hydrology information focuses on flows or depths, which help recreation users assess navigation hazards or best conditions for fishing, boating, whitewater, etc.

Tidal current information focuses on average and peak velocities and depths at different tides, all of which may affect recreation and navigation. Information should be specific to geographic areas (e.g., navigation lanes in constrained channels, primary shore or boat-based fishing areas).

Wave information focuses on direction, height, duration, plus wind speeds and direction, all of which may affect conditions for surfing, angling, sailing, powerboat cruising, kayaking, or swimming.

In most cases, summary information for one key gauge (on a river) or wave/current buoy (in marine settings) will **not** be sufficient. Raw data, gauge or buoy statistics, project operational constraints, and similar information commonly need to be "re-packaged" to focus on recreation-relevant flows or seasons. The goal is a concise summary through a typical year of the "baseline condition."

Interviews with key experienced users

Objective: Improve recreation overview information by adding local knowledge from recreation users and resource experts about the river/marine setting, recreation opportunities, and potential impacts from hydrokinetic development.

Typical approach: Identify a list of experienced recreation users or resource experts, usually through networking. Develop questions to learn about recreation opportunities, use patterns, opportunity attributes, and potential impacts from hydrokinetic development. Conduct and document interviews, analyze responses, and summarize findings.

Product: Companion report (or additional sections) for the "Recreation Overview." This should include importance of recreation opportunities, geographic locations for them, and potential hydrokinetic impacts on those opportunities. Lists of interviewees and notes from interviews are in appendices.

Responsibilities: Hydrokinetic developers (or their consultants) have primary responsibility, but agencies and stakeholders can help develop the interview panel or review questions and findings. Recreation groups can be particularly helpful for identifying people who use the study area for recreation.

Additional issues:

There are inherent challenges in determining the appropriate number and type of users to interview. In general, these decisions are made collaboratively during study plan development by developers, stakeholders, and agencies. The goal is to ensure panels of interviewees adequately represent important recreation groups, including potentially displaced users.

The number of interviews and level of analysis depends in part on the resolution needed. For a Level 1 report, a few interviews per type of recreation opportunity, limited summaries of interview results, and occasional "personal communication" citations may be adequate. For a Level 2 or 3 report, more interviews (e.g., three to ten per opportunity), quantified analysis, and summary statistics or graphs may be more appropriate.

Some recreation users may be reticent to disclose favorite locations or attractions because publicity may contribute to crowding or competition. Others may not trust developers or agencies to use such information appropriately. Researchers/planners need to work with trust issues and explain the importance of spatial information for assessing whether and where hydrokinetic development may be appropriate (i.e., planners cannot protect a place if they do not know where it is).

Interview panels may be small in a Level 1 effort, limiting the ability to characterize group evaluations statistically. Interview information is best for learning about setting characteristics, past use patterns, and critical recreation use areas (attraction and access sites). This knowledge can then applied in more detailed reviews of potential hydrokinetic impacts.

"Representativeness" of panels is a potential issue, especially when developed through "self-selection" techniques. Active networking designed to reach different parts of a recreation community can help overcome this limitation.

"Expert analyses" of potential impacts

Objective: Assess potential hydrokinetic impacts on recreation opportunities through logic-based analyses using existing studies from other locations, basic scientific principles, general knowledge of recreation opportunities, and available information from other Level 1 efforts (described above).

Typical approach: Assemble expert researchers and a small number of stakeholders/users with knowledge of recreation opportunities to evaluate Level 1 information. Systematically review device specifications and recreation opportunities, and discuss potential impacts. Identify whether additional information quantifying impacts is necessary, and brainstorm mitigation or protection options that might be applied. A single site visit/field reconnaissance, if possible, may be helpful.

Product: Companion report to the "Recreation Overview." The report provides logic-based analyses of potential impacts for relevant recreation opportunities, with appropriate links to previous studies and other Level 1 information (recreation overview, summary of hydrologic or wave conditions, and interviews with expert users). Includes prioritization of effect issues and potential mitigation and protection measures.

Responsibilities: Hydrokinetic developers (or their consultants) have primary responsibility, but agencies and stakeholders may participate.

Additional issues:

Stakeholder/user participants may not know about studies from other locations, so education about previous work may be important. Success depends on integrating research and logic-based concepts with local information about the area and its recreation opportunities, so all participants need to become familiar with existing literature and concepts.

Specifically defining target opportunities is important to keep discussion focused, but one needs to avoid pre-judging which opportunities and impacts should be considered.

Choosing the right mix of local users, stakeholders, "outside" researchers-planners, and hydrokinetic developers to participate is important. Small groups increase opportunities for interaction and collaboration, but larger groups can provide diversity. In general, working groups of 6 to 10 are optimal, with about two-thirds representing local experts. If multiple recreation opportunities require larger groups, it may be best to conduct separate efforts for different groups of opportunities.

Good facilitation is critical because analyses depend on systematic consideration of issues and collaborative interaction among participants. These sessions have elements of "focus groups," but they are "analysis-oriented" and require more active participation by researcher-planners.

A major goal is to winnow the number of opportunities and impacts that require additional study. This can help "check off" items that are not major issues or can be easily addressed, allowing more attention on challenging or unknown impacts.

Site visits may be important for many reasons. However, there may be logistical challenges to site visits that address multiple opportunities, particularly if these occur during different times or locations.

Even with more extensive efforts to develop larger and more representative panels, these efforts still rely on purposive rather than random samples.

Identifying representative locations for particular recreation activities may increase efficiency, but assumes homogeneity among locations.

Expert judgment assessments are likely to identify magnitudes of impacts on recreation opportunities and potential mitigation or protection measures. But they are unlikely to provide precise quantitative estimates, particularly given the short history of hydrokinetic development. The report helps guide additional studies at higher levels but may represent the "stopping point" for issues not requiring further attention.

Level 2 methods

More extensive user interviews or focus groups

Objective: Build on Level 1 interview information with a larger and more representative panel of users, which may include quantitative or "group consensus" evaluations of important recreation opportunities, attributes, acceptable levels of effect, or acceptable management actions to reduce/mitigate impacts.

Typical approach: Similar to Level 1, this effort would identify experienced recreation users or resource experts through networking and conduct structured interviews or focus groups. The difference is that panel sizes are larger and preliminary findings (from Level 1 work) will provide the foundation for more detailed information collection about recreation opportunities, use patterns, impacts from hydrokinetic development, and potential mitigation options. Results will provide more quantifiable data and may include "consensus" recommendations.

Product: Report with quantified or consensus information about opportunities, use, impacts, and mitigation options. Appendices include information about interview/focus group panels and quantifiable data.

Responsibilities: Hydrokinetic developers (or their consultants) conduct the studies with agency and stakeholder input and participation.

Additional issues:

Representativeness of the panel becomes more important than Level 1 and an even greater issue as interview data are quantified. Developing larger networking lists coupled with random selection help ensure that panels are representative, not just "cliques" of users (a potential problem with "snowball" or "networking" techniques).

Choices between interviews and more collaborative focus groups may depend upon logistics and geography. Focus groups collect information more efficiently if participants are centrally located, while interviews may require longer data collection periods. Focus groups may also create better synergies, as panelists learn from and build on each other's ideas. Good facilitation is important to make sure "stronger voices" in a focus group do not prevent others from providing useful information. Offering panelists opportunities to write individual responses can help with this problem.

"Reticence" issues (discussed with Level 1 interview methods) will remain, particularly in focus group settings where information is shared "publicly." In an interview setting, researchers can assure confidentiality by explaining that individual information will be integrated with other data before public presentation.

Observations of recreation use

Objective: Develop quantified information about recreation use levels, patterns, or responses to certain types of impacts.

Typical approach: Develop observation and counting protocols to assess the types, amounts, and timing of recreation use at a specific site or area. Techniques may include a mix of mechanical (e.g., traffic counters or trail counters), photographic (e.g., remote or motion-activated cameras), or in-person observations. Information needs to be systematically collected and analyzed.

Product: Report with summaries of quantified use information. Appendices should include detailed descriptions of observation methods to allow comparability across years and observers.

Responsibilities: Hydrokinetic developers (or their consultants) conduct the studies with agency and stakeholder input and participation. Information may need to be integrated or collected from recreation resource managers (e.g., federal, state or local) or private service providers (e.g., outfitters, boat taxi operators, or boat rental companies).

Additional issues:

Collecting and summarizing use data is a fundamental recreation management activity that helps guide and support agency priorities and budgets. Use data may explain recreation use impacts, offering possible ways to control use in order to maintain high quality experiences or protect cultural or natural resources. But there are many types of use data that serve distinct purposes, requiring careful decisions about the units of use (e.g., boats, groups, or people), classes of activities (e.g., types of anglers or sizes and types of vessels), location (e.g., at facilities like campgrounds, parking areas, or attraction sites vs. larger geographic areas) and time scale (e.g., at one time, per day, per week, per season, or per year).

In general, larger geographic and time scales are more helpful for assessing the "importance" of a particular activity (and might help assess overall impacts of access restrictions). However, smaller geographic and time frames may be more relevant for understanding peak recreation use impacts or specific responses to hydrokinetic devices.

Modern vehicle counters can be very accurate for vehicles using a road or parking areas that lead to river or marine access sites, but it is often important to "ground truth" raw data with periods of direct observation. For example, some parking areas receive non-recreation use, or repeated "in-and-out" use by the same vehicles, which substantially affect use estimates. Counters also cannot distinguish different types, or the number of people per vehicle, which may be important.

Remote cameras with motion detectors can be effective ways to collect boating information, especially in rivers, narrow marine channels, or at specific attraction sites such as reefs. They also may be able to distinguish types of vessels and recreation activities, and could assess how closely boats approach a pilot device (a major access restriction question). However, such cameras have logistical challenges (e.g., mounting systems, weather proofing, vandalism-proofing, and data retrieval), can be costly, and may intrude on visitor privacy. It is also time-intensive to review and code raw footage.

Remote cameras are unlikely to be effective in open ocean settings, where logistical and technological hurdles can be very high. Visual counts over wide expanses like open ocean are problematic in general, although "route counts" (i.e., an observation boat travels a set route on a periodic basis) may prove helpful if use levels are moderate to high levels. For most open ocean settings, use information collected from marinas and other access points may be the appropriate focus, especially when combined with survey information with questions about where users traveled on their trips).

Designing efficient and replicable observation protocols (for cameras or observers) can be challenging, especially in backcountry or remote settings. Monitoring that is difficult to accomplish will not be conducted consistently. Documented protocols and thorough training can help ensure comparability and consistency across observers and years.

Automatic information system (AIS) receivers can help count and monitor boat traffic (Polagye, 2010). AIS transponders are required on vessels over 300 tonnes grosse weight or those which carry passengers, but some recreation vessels also employ them.

Observation data can go beyond "counting" to assess visitor behaviors in response to new hydrokinetic devices, or document recreation activity patterns. For example, observations could be used to identify travel paths and attraction sites used by surfers, kayakers, swimmers, or anglers. Technology such as GPS units or range finders may help improve accuracy and repeatability by recording observation locations or estimating distances. More intensive efforts may qualify as a Level 3 study.

Observer logistics and safety may be challenging and can require substantial oversight, especially if boat use is involved. Enlisting the aid of volunteers (e.g., campground hosts, park rangers, or even recreation users themselves) to conduct counts and observations may be initially appealing, but making such programs sufficiently rigorous is challenging.

Limited reconnaissance and "expert" assessments

Objective: Use field work to develop improved information about recreation opportunities, attributes, potential impacts from hydrokinetic development, or options to reduce or mitigate impacts.

Typical approach: Coordinate fieldwork with experienced recreation users (e.g., surfers or anglers) to examine locations, activities, or potential or existing hydrokinetic development. Fieldwork may need to be scheduled at multiple times (e.g., different days, tide levels, and seasons) to assess the range of conditions.

Product: Report with a summary of methods, participants, and findings.

Responsibilities: Hydrokinetic developers (or their consultants) conduct the studies with agency and stakeholder input. Participants for target opportunities may be required; "non-local" recreation experts may also be recruited (offering alternative views of opportunities and features).

Additional issues:

Many recreation opportunities develop in specific locations, requiring onsite assessments to understand them. For example, access to and use of specific surfing breaks or angling locations can be illustrated on a map or discussed at a meeting, but on-site demonstrations are likely to be more instructive. Joint fieldwork including researchers, agency personnel, recreation stakeholders, and hydrokinetic developers can stimulate brainstorming about development impacts or "win-win" solutions. In many cases, people making decisions have little personal experience with an "at risk" recreation activity; similarly, recreation stakeholders may not understand the scale or "footprint" of hydrokinetic development. Visiting sites together facilitates such exchanges.

Fieldwork can be combined with focus groups or on-site evaluations of attributes, and may enhance "expert analysis" (see above) for devices that have not been developed before. For example, scenic evaluations using standardized visual resource surveys may clarify existing visual attributes and show how hydrokinetic development might change them. Similarly, onsite evaluations of recreation opportunity classes (e.g., a water-based version of the Recreation Opportunity Spectrum; Haas et al., 2000) can help develop consensus about recreation resources and build working relationships among stakeholders.

Inviting a non-local participant with a particular recreation expertise may broaden perspectives and link local assessments to wider knowledge of similar recreation opportunities. For example, international rating systems provide some comparability across rivers for whitewater features, but it is difficult to understand the importance or quality of recreation opportunities without contrasting them with other regional or national locations and placing them in the proper context.

Protocols for onsite fieldwork depend on specific activities and resource features, and they are identified in advance of fieldwork. In river settings, field activities are usually scheduled to target specific flows, fishing seasons, or locations. In marine settings, identifying target tides, weather, or surf conditions may also be important. Weather is probably the primary factor affecting recreation use levels, and studies need to occur for sufficient duration to capture expected variation in weather conditions. Fieldwork logistics can be challenging, particularly if there is extensive travel by boat or the number of participants increase. Some hydrokinetic development locations may have strong currents or higher energy waves, which are not necessarily easy environments for group discussions, taking careful notes, or making considered evaluations.

Level 3 methods ("intensive studies")

User surveys

Objective: Quantify recreation user opinions or behavior to develop more robust information about recreation opportunities and potential impacts. Surveys can help identify the importance of specific recreation attributes and sites; evaluate potential access restrictions, aesthetic or noise impacts, or other consequences of hydrokinetic development; or gauge the acceptability of management actions. Surveys can also quantify user characteristics, trip characteristics, and spatial or temporal use patterns.

Typical approach: Identify a sampling frame for target opportunity(ies). Develop survey instrument focusing on important objectives (see above). Administer survey (choices include onsite, mail, phone, email/web) and code responses. Analyze data and summarize responses, disaggregating dissimilar types of users. Summarize findings in a report.

Product: Report methods and findings. Methods should include sample and instrument development, as well as potential sources of error. Findings typically include tables and graphs appropriate to the analysis.

Responsibilities: Hydrokinetic developers (or their consultants) have primary responsibility, but agencies and stakeholders can review the sampling frame, survey instrument, and analysis plans. Agencies often possess information about commercial service providers (e.g., outfitters, guides, shuttle, water taxis) or other knowledgeable users to help with sample development.

Additional issues:

Survey research and analysis is a complex topic beyond the scope of this document. However, several recreation survey issues are listed below, along with a few specific concerns related to hydrokinetic development. More detailed information about survey research in recreation settings is available in Vaske (2008).

Survey mode. Surveys can by conducted on-site, by mail, phone, electronically (through emails or websites), or with a combination of types. Each type has advantages and disadvantages that depend on the characteristics of the population and survey objectives. Many recreation studies are conducted on-site, an effective strategy when use levels are high enough to collect appropriate sample sizes in a short period of time. For lower use recreation, mail, phone, or email methods may be more efficient.

Sampling approach. Sample issues usually trade off "representativeness" against cost or logistical complexity. Larger samples improve precision, but numbers may be less important than a representative sampling frame. Probability sampling is often considered the "gold standard," but can be inefficient when a target population is small or challenging to reach (e.g., shore-based anglers who fish from multiple access sites).

Researchers may choose "purposive sampling," usually developed through stakeholder contacts, advertisements in newspapers or internet message boards, and networking with other contacts (e.g., through outfitters, recreation retailers, activity clubs, etc.). While these samples suffer from "coverage error," they are often the only practical choice, and effective samples can be developed through multiple channels.

Sample size and stratification. Sufficient sample sizes are important for statistical purposes, but the "minimum" number depends on the homogeneity of users and their evaluations. Similarly, stratified sampling (e.g., for weekend vs. weekday users, anglers pursuing different target species) could be important if sub-groups differ on variables of interest.

Survey development. Survey question construction is important and requires expertise. Although some issues are straightforward, evaluations of hydrokinetic development impacts will probably require careful development and pretesting of questions. While draft survey instruments are often developed during study plan development, researchers ideally will revise instruments after pretesting that may include use of focus groups or additional agency and stakeholder reviews.

Other sources of error. Non-response bias is an issue if the people that complete a survey are different from those who are in the sample frame but cannot be reached (or refuse to participate). Strategic bias refers to respondents that deliberately provide an inaccurate response in an attempt to influence results in a certain direction. It may be helpful to conduct surveys of users before hydrokinetic development has received substantial publicity to minimize strategic bias. Although surveys are typically conducted after a project has been announced via a PAD and "Notice of Intent," controversial recreation issues related to development tend to receive publicity much later in the process (when decisions about development are closer to being made). The concept here is to conduct survey research on such issues as early as possible in the process.

Surveys assessing use and trip characteristics. Surveys can be effective for discovering and documenting use levels, recreation activities, and recreation locations in marine or riverine environments. For example, an extensive observation and survey study (Shelby & Tokarczyk, 2002) provided information on primary user activities, perceptions of crowding and conflict, and methods of beach access on the entire Oregon coast.

Surveys assessing access closures. Addressing access restrictions from hydrokinetic development is likely to be challenging. How does one ask users about how much access they are willing to lose?

Surveys can help assess the relative importance of different areas, or provide information about activity or vessel characteristics that may help mitigate restrictions. A side bar at the end of this chapter provides more information about mapping the relative importance of recreation areas.

Surveys assessing aesthetic impacts. Surveys may be used to assess aesthetic impacts from hydrokinetic development, particularly if realistic portrayals of devices or other infrastructure are developed. This level of study may be necessary when hydrokinetic projects are expected to have substantial aesthetic impacts (a larger visible footprint) in areas with important scenic resources (e.g., off a coastal reach known for its scenery). Methodological issues for assessing aesthetic impacts in survey efforts include:

- Developers often provide artist's renderings to depict devices. This is a starting point for how they will appear in a landscape, but may be very different than what recreation users would experience.
- Illustrations should be realistic. If buoys, mooring systems, or other development will be visible, they should be in the illustration. If the device includes visible moving parts, those should be illustrated (possibly with video rather than pictures).
- Illustrations should depict development from multiple viewpoints that represent recreation use areas (e.g., from boats at likely viewing distances, from multiple shore locations such as beaches, bluffs, or jetties). Views of off-shore development in marine settings is a critical issue with much taller offshore wind power projects (e.g., Cape Wind off the Massachusetts coast), and studies have explored precise distances from which such development can be seen (Environmental Design & Research, P.C. 2006).
- Illustrations from different perspectives should match the user group that would experience that view.
- Alternative device sizes or array spacing and patterns should be included in evaluations if options are under consideration.
- Evaluations can include qualitative and quantitative components; providing both offers richer information about impacts.
- Survey samples should represent the diversity of groups that will see devices, potentially including local residents (e.g., homeowners with views of the river or marine setting).
- Studies might measure preferences as well as tolerances for various types of development.
- There are multiple formats for comparing evaluations, including ranking, scales, and paired comparisons.

Projects that are just being developed (have not settled on a device or its final characteristics) may not be able to provide this sort of information for study. Until they can, it will be challenging to accurately assess aesthetic impacts.

Surveys assessing noise impacts. If noise evaluations are important, simulations or on-site evaluations of pilot devices may be helpful. This is a "psychological" approach that focuses on visitor evaluations rather than measurements of physical sound in decibels (Gramann, 1999). Considerations in conducting such studies (many of which were developed from research assessing loud noise sources such as aircraft and highways) include:

- Noise impacts vary substantially by location because of several factors, including wind patterns, terrain, vegetation, and existence of other ambient sounds. Complex noise propagation models developed to estimate noise levels from airports and highways might be applicable to other types of sound.
- NPS management policies define natural ambient as the baseline condition and standard against which noise impacts will be evaluated. Natural ambient is defined as background sound that exists in the absence of human-caused noise. Some audible mechanized sound may be considered acceptable in certain settings. In some circumstances, survey information may help provide data on visitor impacts.
- Visitor characteristics may affect evaluations of noise. There is greater sensitivity to aircraft noise by backcountry vs. frontcountry users, repeat vs. first-time users, small vs. larger groups, and motorized vs. non-motorized users (HBRS/HMMR 1993, Anderson et al., 1994).

- Contextual factors almost certainly affect noise evaluations. Noise levels may be more objectionable at specific locations (e.g., scenic places such as canyons, placid locations of a lake or river without rapids, or other places with low ambient sound) and at different times of the day (e.g., at night, in early morning).
- Recent NPS guidance suggests noise should be evaluated independently for different sources and relative to baseline ambient sound (if known). NPS (2008) has also developed data collection protocols.
- Noise can occur underwater, and has become a major issue for biologists studying impacts on marine mammals or other species (NMFS, 2009). This has implications for recreation as sound may affect the abundance of fish or watchable wildlife species. Sound travels faster in water than air because water has a significantly greater measure of stiffness than air. Divers may also have concerns about underwater sound, although noise from diving equipment may mask noise impacts in some cases.

Surveys assessing wave or current characteristics. Concerns about hydrokinetic development impacts on channel bathymetry, substrate, and/or the hydraulics of waves and currents may be a relevant survey topic for surfers, whitewater kayakers, or anglers. In traditional hydropower settings, intensive "controlled flow studies" are often used to develop field-based evaluations of different flows (which can sometimes be manipulated in a short period of time). In hydrokinetic development, wave or current changes are more likely to occur over the long-term, but survey research might focus on hypothesized impacts (from physical or computer modeling). Changes in wave or current characteristics need to be described in ways that recreation users can understand, although more experienced users may be "calibrated" to other variables. For example, some surfers evaluate wave heights as "knee high, waist high, or shoulder high" rather than in feet, even as others may be able to discuss important variables such as "peel angles," wave period, or type of break (Scarfe et al., 2003 Jackson and Corbett, 2007).

Economic impact and valuation studies

Objective: Quantify economic impacts or determine the economic value of recreation opportunities that may be affected by hydrokinetic development. Economic effect studies estimate recreation expenditures and apply information about the local economy to suggest the amount of money and jobs supported by recreation. Economic valuation studies estimate value of a user-day of some activity; it is the value of recreation to the person recreating, and is the appropriate input to cost-benefit analyses.

Typical approaches: There are distinct methods for assessing recreation economic impacts and recreation valuation. In most cases, however, surveys of users are an important component.

Economic effect studies (also known as input-output analyses) survey users about their expenditures while participating in an activity (e.g., food, lodging, gas, equipment, shuttles, etc.), then multiply by estimates of use. They also apply analyses to the proportion of money spent in the community based on county-by-county data of commercial activity. A recent example of expenditure data related to impacts on surfing from a hydrokinetic project is available (Matsler, 2009).

Valuation studies use one of two basic techniques. The "travel cost method" (TCM) estimates the proportion of visitors recreating from different distances (usually from surveys), developing a "demand curve" that relates visits to travel costs. The curve allows calculations of the value of the recreation opportunity at any given cost. The "contingent valuation method" (CVM; also known as "willingness to pay" or WTP) creates a hypothetical market by asking participants what they would be willing to pay in addition to their actual costs.

Product: Summary of methods and findings. Methods should include descriptions of the sample and instrument, as well as potential sources of error. Findings typically include tables and graphs appropriate to the analysis.

Responsibilities: Hydrokinetic developers (or their consultants) have primary responsibility, but agencies and stakeholders can review the sampling frame, survey instrument, and analysis plans.

Additional issues:

Economic impacts from recreation in a small region or local area can be significant if use levels are high and alternative recreation opportunities in the area are few (Loomis & Walsh, 1997). From a national or larger regional perspective, however, expenditures associated with a single river or marine setting are often negligible because users are likely to spend similar amounts of money doing another activity in the same region. The scale of recreation economic effect information is always a major issue, and needs to be carefully defined as studies are developed. A town that is substantially dependent on recreation-based tourism will probably have a strong interest in economic impact information, but this will be less important in larger, more diverse economies.

Valuation of recreation opportunities and larger benefit-cost analyses are more likely to be more helpful in hydrokinetic decision-making. This information helps assess the value of particular recreation opportunities relative to the value of energy provided from hydrokinetic development. This is similar to cost-benefit analysis used in traditional hydropower projects.

There are several complex methodological issues involved in conducting TCM or CVM studies well, but researchers suggest that well-designed studies produce valid results that appear consistent when study findings are compared (Loomis & Walsh, 1997; Mitchell & Carson, 1989).

CVM studies typically focus on the "use value" of a recreation opportunity (the value of taking the trip). But some recreation opportunities may also have value for those who 1) want to use it in the future (option value); 2) want future generations to be able to use it (bequest value); or 3) appreciate their existence even if they will never use them (existence value). Values may be difficult to quantify, but in some cases exceed use values (Johnson & Johnson, 1990; Loomis & Walsh, 1997). A similar case has been made for "place identity" and the closely related concept of "place attachment," which focus on how local resources and recreation opportunities associated with them provide benefits and help explain attitudes of local residents or recreation users toward development or other community changes (Williams, Patterson, Roggenbuck, & Watson, 1992; Devine-Wright, 2009; Kyle, 2010).

Supply and demand assessments

Objective: Describe regional availability (supply) of potentially affected recreation opportunities, regional demand for opportunities, or likely use levels if new opportunities were to be created by project enhancements or mitigation. Regional supply and demand information can help decide the need for or scale of potential enhancements.

Typical approach: Level 1 and 2 efforts commonly list regional recreation opportunities to provide context for more focused recreation studies. Similarly, information from interviews, focus groups, and surveys can help identify "substitute" opportunities, demand for certain types of opportunities, comparative ratings among different locations, or likelihood of use. This Level 3 effort involves more comprehensive assessments of supply and demand that integrate multiple sources of information.

Supply studies develop a database of regional river or marine settings and characteristics; analyses can describe or quantify the areas that meet specific criteria (e.g., Class IV boating segments or shore-based fishing areas within 3 hours of city X).

Demand studies also integrate multiple sources (e.g., national, state, or regional participation surveys; regional equipment sales; estimates from recreation leaders) to predict participation and trends. This information may be used to help estimate use levels for specific recreation opportunities. Surveys of regional groups (e.g., local anglers) are another option that may make sense if potential project impacts include a new resource (e.g., an enhanced reef fishery from hydrokinetic development).

Product: Summary report of supply, existing or projected demand, and estimates of use. The report includes descriptions of methods, sources and their limitations, and findings.

Responsibilities: These studies are led by hydrokinetic developers or their consultants. Agencies and stakeholders participate through study requests by reviewing supply database variables, suggesting demand assessment sources, reviewing surveys, or reviewing draft reports.

Additional issues:

These studies require integrating several sources of information, each with limitations or assumptions. It is important to clearly identify sources, limitations, assumptions, and how information is combined to form conclusions.

Assessments of existing regional opportunities (supply) can be quite accurate. For example, analyzing basic guidebook information can provide useful summaries of opportunities and help assess how a proposed enhancement might increase regional supply. However, simple lists of opportunities usually do not provide sufficient information about the relative value of these opportunities. There are complexities in how recreation users consider and compare substitute resources and activities (Brunson and Shelby, 1993).

Assessments of demand or estimates of use are also challenging, particularly when they are intended to apply thirty to fifty years into the future. Recreation participation is not always stable or predictable, and new activities develop over time. Other factors such as population growth and demographic trends, economic trends, new technologies, and the nature of an activity's "participation cycle" (i.e., individuals have a short activity participation "career" with distinct stages) also affect participation and confound easy predictions. These complexities don't invalidate assessments, but limits should be acknowledged.

Demand or supply assessments provide context for utilities, agencies, and stakeholders to consider the relative value of existing or potential recreation opportunities. However, their limitations can be substantial, and supply and demand are not the only criteria for protecting or enhancing recreation opportunities.

Computer and physical modeling

Objective: Computer and physical modeling is designed to predict how device installations will affect physical characteristics associated with waves, currents, sediment transport, or geomorphology. These changes can then be utilized in scenarios that users can evaluate though surveys or other stakeholder collaboration.

Typical approach: Computer models utilize data from existing features or conditions to estimate how changes may affect wave, current, and tidal range characteristics. This science has developed rapidly in the past decade as engineers have helped design artificial multi-purpose reefs for erosion control and surfing. Physical modeling occurs in laboratory settings (e.g. wave labs), which are commonly used to test hydrokinetic devices for energy output and seaworthiness. Scale models may be used for similar assessments.

Product: Summary report of methods and findings from modeling experiments.

Responsibilities: These studies are led by hydrokinetic developers or their consultants. Agencies and stakeholders may participate through study requests and reviewing developers' study plans and findings.

Additional issues:

Computer and physical modeling is quantitative and probably replicable, an obvious advantage of these studies. For devices that have yet to be installed in real environments, computer and physical modeling may be prerequisites. Computer modeling is often the most cost-effective way of analyzing potential impacts across a long period of weather and hydraulic records, allowing researchers to assess different types of devices, more vs. less of them, or siting and spacing.

However, modeling is only as good as the way it represents "reality," so "ground-truthing" is critical. Most importantly, computer and physical modeling do not allow recreation users to assess conditions produced by hydrokinetic development, and descriptions of characteristics may not be an adequate substitute. Modeling-based outputs need to be monitored as devices are installed and impacts occur.

Post-installation monitoring

A recurring theme in this document is the lack of existing information about recreation impacts from hydrokinetic development. With few projects "in the water," it is challenging to estimate lost access, aesthetic diminishment, or user responses to these or other impacts. This situation will change as devices are installed and systematic monitoring occurs. "Post-installation monitoring" refers to this work, which may replicate many of the techniques described in earlier "types of studies." The difference is that assessments will examine realistic conditions and responses to them, which contrasts with studies of "what could occur."

With multiple assessments over time, monitoring might be conceived as "experiments" that explore impacts and responses. The following are considerations for future monitoring:

- Accurate description of baseline conditions is fundamental to effective monitoring. Monitoring plans identify baseline conditions for key indicator variables, and should conduct future measurements in comparable ways.
- A monitoring plan may be more effective if it accurately covers a smaller number of key indicators (see In Focus: Effective and efficient monitoring: Choosing appropriate indicators later in this chapter).
- Recreation user responses to devices or access restrictions are likely to be a major monitoring focus. Will recreation users be attracted to some types of devices? Will they respect access restrictions?
- Interference and safety hazards associated with hydrokinetic development are likely to become one monitoring focus. This information can then be used to improve appropriate types and sizes of access restrictions.
- If monitoring focuses on changes in current or wave characteristics, data will need to cover sufficient periods (possibly several years) to "control for" weather or other factors.

In Focus: Hydrokinetic – Recreation Studies on the Lower Mississippi River

Several hydrokinetic developments have been proposed on the Lower Mississippi River. Initial proposals from Free Flow Power (FFP) envisioned 55 sites from Illinois to New Orleans with as many as 188,000 turbines, although recent submittals suggests the developer has surrendered 9 sites, has reduced the number of total estimated turbines to about 100,000, and is focusing on five lead projects: Greenville Bend FERC P-12829, Scotlandville Bend FERC p-12861, Kemp Bend FERC P-12921, Ashley Point FERC P-12930, Hope Field Point FERC P-12938).

A PAD covering all sites submitted in January 2009 elicited several comments from NPS, the Missouri Department of Conservation, and the U.S. Army Corps of Engineers about many environmental issues, including recreation. FERC released a Study Plan Determination for the five lead sites in January 2010, offering insight into the kinds of studies the agency will require for hydrokinetic projects. The eight recreation study elements include:

- ***Study Goals and Objectives.*** Ensure recreation studies provide adequate information regarding existing recreational and fishing opportunities within the study areas and assess potential effects of the proposed projects on these opportunities.
- ***Study Area.*** Define study area boundaries to include use areas farther than the developer-proposed quarter-mile radius from hydrokinetic facilities. FERC stated, "the study area should include the proposed turbine deployment areas, and areas encompassing the river and river banks above and alongside the defined deployment area." It also included review of aesthetic effects within the foreground and mid-ground view from public use areas, which could also be farther than a quarter-mile from development.
- ***Recreational Facility and Use Inventory.*** FERC accepted an FFP proposal for an inventory of facilities, but added five additional components that require more detailed information.
- ***Recreational Use Survey.*** FERC required surveys to be conducted in all seasons, and requested more detailed information about the methodology (to be developed in collaboration with stakeholders and agencies such as NPS) to ensure that it covers a range of use and impact issues.
- ***Recreational Use and Needs Assessment.*** FERC requested studies to address project impacts on aesthetics and possible noise effects from construction and operational phases, and explicitly noted the need for information about cumulative effects on recreation.
- Assessment of Recreational Safety Issues and Potential Effects of Closures. This requirement highlights the need for analysis of recreation safety impacts and exclusion zones issues.
- ***Potential Protection, Mitigation, and Enhancement (PME) Measures.*** FERC reiterated the need for ongoing consultation with local, state, regional, and federal entities including agencies, non-governmental organizations, user groups, and other interested stakeholders in the development and implementation of study plans, as well as the development of PME measures that might be used to address adverse impacts, even as these are not required to be finalized until license applications are prepared.
- ***Schedule.*** FERC required work to begin on these studies (in conjunction with related commercial fishing studies) as soon as the study plan determination had been made. FFP has started this work, focusing on overall study plan refinement and survey(s) methodologies.

In Focus: Evaluating Recreation Implications of Biological Changes: The Example of Fishability Studies in Traditional Hydropower Relicensing

High quality fishing opportunities cannot occur without functioning habitat and a healthy fishery, but these attributes alone are not sufficient. For some anglers, catching fish may be less important than experiential benefits such as “exploration,” “experiencing natural environments” or “the challenge of fishing” (Knopf et al. 1973; Fedler and Ditton 1994). A “blue ribbon” fly-fishing stream, for example, has a good fishery ***and*** good water to fish (e.g. wadeable access to riffles and pocket water, sufficient casting space away from riparian vegetation, and clear water). Likewise, shore-based fishing from beaches or jetties may be enhanced by certain tide or wave conditions, or access to parts of the shore. While anglers can adapt to different situations, they often have preferences for specific locations, conditions, and fishing techniques (Whittaker et al. 1993), which may be affected by hydrokinetic development.

In traditional hydropower licensing, “fishability” studies assess the impacts of development on flows and related fishing conditions. Although biological and physical scientists may be needed to assess how development will change biophysical resources, there is often a need to include angler or stakeholder evaluations.

In conducting these studies, separating evaluations of “angler habitat” from “fish habitat” is important. Flows that optimize high quality angler habitat may sacrifice fish habitat, just as flows that maximize numbers of fish may sacrifice important elements of anglers’ experiences. For example, would wading-based fly anglers prefer higher catch rates if it required fishing from a boat or using spinning gear? Would anglers prefer “easier” fishing conditions (e.g. wadeable low flows where fish are concentrated), even if harder conditions increase the number of fish?

Fishability studies address immediate impacts on fishing that anglers can evaluate; they do not provide information about immediate or long-term biophysical impacts. Anglers in fishability studies consistently express concerns about flow impacts on fish populations, feeding behavior, spawning success, and the overall health of the fishery. However, anglers generally are not the appropriate “experts” to assess these impacts. The best way to prevent these biophysical concerns from confounding fishability evaluations is to discuss them in a pre-evaluation focus group. This gets the issues “out on the table” and allows anglers to voice their opinions, but then narrows the focus to attributes anglers are best equipped to evaluate: access to fishable water (wading, from the bank, or by boat) and use of fishable water (tackle and technique considerations).

Fishability studies carefully specify the type of fishing opportunity under consideration. Even on the same river, for example, boat-based fishing for salmon may have flow needs substantially different from wading-based fly fishing for trout. New flows may change the type of fishing, and anglers may not want to “lose” the old opportunity. Well-designed fishability studies can address these different opportunities and evaluations, but require considerable care in developing evaluation panels and focusing on appropriate variables.

Social scientists have begun developing models for assessing complex tradeoffs inherent in fisheries management decisions (Aas et al. 2000; Gillis and Ditton 2002). Social science can help determine anglers’ preferences for different types of fishing opportunities affected by flows. However, the opportunities must be carefully specified with both social and biophysical information. Preferences will probably shift depending upon 1) the abundance, size, and distribution of the current versus “new” fishery; 2) whether the new fishery will include new species (e.g. salmon and/or steelhead); 3) how new species might affect existing species; 4) relationships between development and fishing success; and 5) how development would affect the way anglers fish (technique and tackle, and whether it was boat, shore, or wading-based). To assess angler preferences, biophysical scientists need to specify how flow regimes affect the fishery and social scientists need to develop data from anglers to consider the trade-offs. This is an area for interdisciplinary work.

In Focus: Mapping the Relative Importance of Recreation Areas

The relative importance of different recreation areas cuts across many hydrokinetic effect issues. The ultimate impacts of access restrictions, aesthetic impacts, or changes in fish and wildlife all depend on the importance of a river or marine area to recreationists. Many may not want to identify their preferred locations. Interviews with knowledgeable users, focus groups, or surveys all explore this issue with various levels of specificity, but useful quantifiable information requires more systematic protocols and greater care with representative samples.

EcoTrust, a Northwest environmental NGO focused on a range of fisheries and forestry resource issues, has developed a GIS-based project to map the importance of resource areas used by commercial and recreational fishermen for a marine life protection initiative (EcoTrust, 2009a; Scholz et al., 2006). The project asked a purposive sample of fishing vessel owners and captains to identify important fishing grounds by drawing polygons on computerized marine charts, then assigning weights to specific polygons by distributing a hypothetical "bag of 100 pennies." The technique forces participants to carefully specify spatial boundaries and relative values. They can view output from the project after completion, and may have additional opportunities to revise their weightings.

Conducted on computer programs that assure confidentiality of individual data (which fishermen may want to keep private), the program also allows researchers to assign more weight to participants that catch more fish (coded through landings data). The result is an aggregate gradient map showing more vs. less important areas. The information is intended to help assess economic impacts of large-scale ocean planning, which includes suitable areas for hydrokinetic development or marine sanctuaries.

A review of the project is available (EcoTrust, 2009b), as is a peer review of the technique and applications to commercial fisheries (McCay et al, 2006). Recreation fishery applications are being developed and should be available in summer 2010. Issues raised by reviewers include the representativeness of samples, clarity of criteria participants use when identifying "important" polygons, appropriate groupings of target species, and links between overall importance findings and impacts for specific ports. Reviews also identify concerns about confidentiality, use of information to exclude fishing, and strategic bias.

We agree with reviewers that this technique is a "thoughtful attempt" to identify important fishing grounds without disclosing specific "hot spots" that some fishermen consider proprietary. The maps capture local knowledge and they are particularly helpful at a larger regional scale. The "100 pennies" concept also standardizes and quantifies evaluations. However, there are legitimate concerns about sample representation and whether recreational anglers can identify and value important locations as well as commercial fishermen.

In Focus: Effective & Efficient Monitoring: Choosing Appropriate Indicators

The concept of "indicators and standards" is commonly used in many fields, including business, medical research, health, and education; they are designed to reflect the "health" of a system. In general, indicators identify what conditions will be monitored, while standards define when those conditions become acceptable or unacceptable.

Indicators and standards help focus on future conditions, articulate management responses to conditions, establish management priorities, and allow managers to be proactive. In recreation applications, they also connect on-the-ground conditions with more intangible experiences (Whittaker & Shelby, 1993).

Choosing recreation indicators for monitoring as hydrokinetic project development can be challenging, depending on the type of development, type of recreation, site characteristics, and impacts of concern. Several criteria can help narrow the choices (Whittaker, 1992):

- ***Specific.*** Indicators should be precise and clearly related to conditions of concern. For example, an aesthetic indicator should focus on visual resource ratings for a defined viewshed from a specific location.
- ***Measurable.*** Indicators should be efficiently calculable in the field (e.g., counts of surfers or creel data), or efficiently developed to evaluate several conditions). The choice of an appropriate level of measurement will depend on such factors as availability of funding and staffing, number of sites that must be evaluated, and frequency of measurement and evaluation.
- ***Responsive.*** Indicators should be related to hydrokinetic-caused changes in conditions. Scientists recognize that many important indicators (e.g., number of viewable whales, fishing success for a certain species) may be affected by other variables (e.g., fishery management, climate change, etc.) and disentangling sources of impacts is complex. Factors that limit understanding include lack of baseline data, spatial and temporal discontinuities between cause and effect, and the general challenge of isolating individual components of complex ecosystem interactions. If it is unclear whether human development is causing a condition change, that condition may not be a good indicator.
- ***Sensitive.*** Indicators should detect meaningful change at an appropriate level of precision. The indicator needs to be sensitive to changes in conditions during relatively short time periods. Such changes may be reflected in biological conditions (e.g., the presence or absence of particular wildlife species) or the human experience (e.g., the frequency of encounters with others at an attraction site). If the indicator only changes after impacts are substantial, the variable lacks the early warning signs that allow managers to be proactive.
- ***Integrated and relatively few in number.*** The most useful indicators reflect multiple impact conditions. Because developers and agencies typically have small monitoring budgets, indicators that can be used to represent several different impacts allow managers to focus their attention and efforts while being reasonably assured that the overall quality of a given experience is maintained.
- ***Important.*** Finally, indicators should represent important impacts. If managers and visitors do not care about an impact, other indicators make more sense (Whittaker, 1993). For example, harvest-oriented jetty anglers may not consider aesthetic impacts from a ashore-based device to be particularly important (especially if they fish mostly at night), but may be very concerned about potential loss of access to fishing locations on the jetty.

In Focus: Integrating Information Across Disciplines

In traditional relicensing, integrating findings from recreation, fisheries, and other biophysical resources is challenging even with well-defined processes and increasingly well-informed agencies and stakeholders and researchers. There will be even greater needs to integrate findings in hydrokinetic – where many impacts are unknown and may be indirect (e.g., impacts on fish and wildlife that in turn affect fish- and wildlife-dependent recreation).

Current hydropower licensing processes generally become more time constrained as studies are completed, the precise time when integration is crucially important. In order to address this fact of the process, successful efforts have sometimes avoided a "rushed" integration effort by coordinating early and often cross-discipline meetings between researchers and agencies. This helps prepare for the settlement period when time is often short. As a hydrokinetic process and timeline are developed, particularly with pilot projects, we encourage a deliberate effort to encourage cross-discipline study development and exchanges of preliminary findings, as well as a slower pace after study results become available, so better integration can occur.

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7. Protection Strategies and Adaptive Management

This chapter outlines potential strategies to protect, mitigate, and enhance recreational resources from hydrokinetic projects. It describes the relevant laws and regulations that can be applied. It also outlines the adaptive management framework and the need for flexible and sound decisions to preserve recreational resources while further developing hydrokinetic technology.

There are numerous laws and regulations that apply to hydrokinetic projects; *Siting Methodologies for Hydrokinetics: Navigating the Regulatory Framework* Handbook (PVE, December 2009) provides a good review. Significantly, the Federal Power Act, as amended, and the National Environmental Policy Act (NEPA) create the overarching framework for protecting and enhancing environmental and recreational resources (see Chapter 8). The Federal Power Act and related FERC guidelines require "equal consideration" of the public's interest in recreation and power generation; they also require that FERC judge the project which will best able to protect, mitigate, and enhance beneficial public uses, including recreation. Since hydrokinetic projects require actions (i.e. permits, leases, license, etc.) by at least one federal agency, they also need to comply with NEPA. Depending on the lands and waters where a project is located, there may also be other requirements.

Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 C.F.R. § 1508.2.) define mitigation as:

- Avoiding the impact altogether by not taking a certain action or parts of an action.
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing or providing substitute resources or environments.

The FERC process provides a framework for developers and stakeholders to work together to develop protection, mitigation, and enhancement (PME) measures. The parties use the information learned through studying potential impacts to develop PME measures. The type and amount of PME measures is negotiated on a case-by-case basis depending on the extent of the impacts involved. FERC is the ultimate decision maker on which measures will be carried forward in the license to operate the project. If the negotiated PME measures do not fit within the scope of FERC's jurisdiction, settlement agreements and side-agreements are effective tools for stakeholders and developers to use.

Protection strategies

Using the CEQ regulations, three main protection strategies/ best practices are outlined below for addressing recreation impacts from hydrokinetic projects:

1. Identify sensitive and non-sensitive areas of recreational and natural resources. This strategy falls under the "avoid" and "minimize" impact categories defined by CEQ guidelines. This strategy should be used first, as it provides the greatest potential for preservation of recreational resources. Setting and location are highly important factors in determining what types of impacts could occur. Identifying sensitive and less-sensitive areas for recreational and natural resources could help facilitate environmentally sound development.

Less-sensitive areas:
- near existing dams and hydropower facilities
- in highly developed areas
- low existing and/or potential recreation use
- low quality of recreational experiences

Sensitive areas:
- designated protected areas (e.g. parks, marine sanctuaries, etc.)
- locations public access locations
- sites sensitive to changes in wave or hydraulic characteristics (e.g. surfing areas, whitewater rapids)
- key navigation routes, passage ways, and water trails
- high existing or potential recreation use
- areas with high quality recreational opportunities
- remote and/or scenic settings
- regionally or nationally significant or unique recreation areas for particular uses (e.g. fishing grounds, wildlife watching areas, diving, etc.)

Some recreational users may be reluctant to provide information about their favorite spots unless the area is already well-known. Establishing trust and a process where individual user-provided information remains confidential while aggregated information is shared with the public (a standard social science practice) is important. Once collected, recreation data can then be compiled with environmental data to identify appropriate locations for hydrokinetic development. This strategy is being employed in Oregon, where Ecotrust is interviewing commercial and recreational fishermen to identify and map fishing grounds in order to define good locations for hydrokinetic projects (See *In Focus: Mapping the Relative Importance of Recreation Areas* in Chapter 6.)

Within potential project boundaries, there could be ways to select sites that avoid or minimize impacts. For example, Snohomish County Public Utility District avoided locating devices near the popular S.S. Governor Ship Wreck Diving site to minimize impacts to divers from its Admiralty Inlet Hydrokinetics project (FERC # p-12690). When assessing project siting, recreation access issues are also important. If exclusion zones are proposed, ensuring boat passage to high quality recreation areas is critical.

CEQ recently finalized recommendations Interagency Ocean Task Force (CEQ, 2010) for developing a regionally-based coastal and marine spatial planning system (CMSP); a concept supported by several advocacy organizations (e.g., FISH, 2009) that is also examined in a website developed by NOAA. CMSP is a comprehensive, integrated, science-based, spatial planning process that will analyze existing and anticipated ocean uses and define areas most suitable for various types of activities. CMSP will help facilitate reaching long-term goals of protecting ecosystems and recreation resources, while also optimizing sustainable development.

The CEQ framework identifies guidelines and essential elements of the CMSP process, but the actual planning will be carried out by regional officials in nine geographic areas. Like municipal zoning, the ocean could be divided into zones where some uses have priority over the others. For example there could be a hydrokinetic zone, a recreation area, an ecosystem protection zone, a wind power area, etc. While some marine areas already have protected area designations (e.g. National Marine Sanctuaries, National Parks or Sea Shores, or State Parks), CMSP represents a significant shift in the way the ocean is managed, allowing more opportunities to comprehensively review biophysical, recreational, and economical goals for ocean settings. This could benefit hydrokinetic developers since it would help identify acceptable places for this new energy development. With CMSP still on the horizon, the default existing approach is a more reactive, case-by-case permitting system. Where feasible though, smaller-scale comprehensive reviews of regional issues and resources could be conducted.

The state of Oregon is actively applying this approach through an update of their Territorial Sea Plan, (OregonOcean.info, 2010), which includes sections on hydrokinetic opportunities and marine spatial planning. This includes a non-consumptive recreation study completed by Surf Rider on recreation opportunities and economic data, as well as results from a survey of anglers, which inform scenario development.

2. **Identify ways to reduce impacts.** This strategy falls under the "minimize," "rectify," and "reduce or eliminate" impact categories defined by CEQ guidelines. If one can't avoid impacts by siting projects in less sensitive areas, the goal shifts to finding ways to reduce or mitigate potential impacts. This strategy should be implemented where the benefits of the project outweigh the environmental and recreational costs, including cumulative impacts, and the project is slated to move forward. While benefits from multiple hydrokinetic projects can potentially provide important sources of "green" rather than fossil fuel-based energy, the goal is to design energy systems with the least impact possible. This may add some costs to the project, which must be weighed against the energy they would generate, but some recreation impacts may be reducible with forethought and good planning.

Within project boundaries, there may still be opportunities to modify locations, technologies, and/or operations to reduce or mitigate impacts. Alternatives should explore ways to reduce the footprint of recreation access restrictions to ensure they do not impede passage and connections to other resources. In many cases, designated boat passage channels through exclusion zones may be effective. In others, full exclusion zones may not be necessary and could be replaced with specific activity restrictions (e.g. no anchoring, no fishing, etc.) that protect development from recreation use and reduce safety concerns while still letting some recreation use occur. Limiting exclusions and restrictions to off-peak times and seasons could also help minimize impacts. Increased user education and patrolling may be other ways to meet safety and security goals without exclusions or activity restrictions.

If any access restrictions are implemented, impact analysis and mitigation should consider what happens to the recreation users who were using these areas. Where will they go? Will these displaced users have unintended consequences for use or impacts at other places? Possible mitigation could include enhancing other areas where recreation users are likely to go.

To address aesthetics concerns, several design and technology choices may reduce adverse impacts. Choosing devices that are mostly submerged probably provides the greatest benefit, but even simple color choices may be effective at reducing aesthetic problems. Similarly, project designs can limit light pollution at facilities by employing motion sensors or shielded lights that shine downward.

3. Develop "off-site" mitigation. In general, this strategy should be considered only when "impact avoidance" or "impact minimization" are judged to be insufficient – an evaluation that must consider the full range of costs and benefits of the project. Depending upon the nature of the impacts and the site, off-site mitigation may not even be compatible with some federal agencies' guidelines or authorities. But in other cases, mitigation may enhance the overall acceptability of a project to local communities and user groups. The concept is to enhance recreation away from the project to "make up" for what was lost at a project; it falls under "compensating for the impact" category defined by the CEQ guidelines. Some projects may have substantial impacts on recreation, but will still be built because their power generation benefits outweigh those or other impacts. In these cases, developers and agencies may be able to redress recreation losses.

Examples of potential off-mitigation include:

- Secure and develop public access for recreation at another location through acquisition of property or easements.
- Enhance recreation amenities at locations already being used for recreation (i.e., build additional boat docks, new trails along the river, or improve existing facilities, etc.).
- Provide one-time compensation payments to relevant agencies, and possibly non-profits, which could be used to secure new access sites or enhance recreation resources.

Off-site mitigation proposals should provide benefits for recreation opportunities similar to those affected by the hydrokinetic project. When feasible, mitigation should apply to recreation in similar settings, types of activities, levels of use, and types of experiences. Off-site mitigation sites should be located as close to the existing site as possible, and linked to the degree of expected impact. For example, a project that only restricts recreation access during construction/installation of the devices would require less mitigation than a project that proposes recreation access restriction continuously through the life of the license.

With any of these strategies, there is a need for good information about existing conditions; a site's local, regional, or national importance; and the opportunities for onsite enhancements or nearby mitigation. Similarly, any strategy is likely to be more successful if developed in collaboration with recreation users, stakeholders, and agencies, which can help prioritize potential benefits and costs of different approaches.

Adaptive management framework

Given the early state of hydrokinetic technology, there is limited scientific or historic basis for assessing impacts of even one hydrokinetic device, let alone hundreds that may be developed in a given marine or river environment. This increases the importance of applying adaptive management to hydrokinetic development, a structured process of iterative decision-making that includes systematic monitoring. Adaptive management sets up a framework to plan, monitor, evaluate, and adapt project activities based on the results.

The key to successful adaptive management is to develop clear monitoring plans that outline desired conditions, the indicators and standards that will be used to quantify them, and define when management actions will be taken. Monitoring should also help assess cumulative impacts to recreation, as these may exceed the direct impacts of single projects (especially pilot projects). The Department of Interior's guidance provides further information on developing and implementing adaptive management approaches.

As discussed previously, it may be important to develop collaborative recreation research and monitoring across a broader watershed-scale with hydrokinetic development, at least until a body of knowledge about the impacts to recreation is developed. After several projects have become operational, there will be much greater opportunity to understand impacts to recreational, natural, visual, and acoustical resources or account for previously unforeseen impacts. While each technology and site is different and impacts will vary, wide dissemination of information collected for these early projects will help facilitate future environmentally-sound development.

With such a new technology, unexpected and unwanted consequences may occur, and in some cases development might even be considered for removal. FERC currently has protocols in pilot licenses for quick "decommissioning" if adverse outcomes occur. Monitoring and adaptive management are the tools that allow those assessments, and they need to be applied with sufficient rigor to ensure that hydrokinetic technology moves forward in an environmentally-responsible and recreationally-acceptable way.

8. Getting Involved: Authorities, information requirements, and Licensing Processes

This final chapter provides a brief overview of the authorities and processes required to develop hydrokinetic projects, then highlights key information requirements and opportunities for addressing recreation issues. The chapter includes three In Focus sections on recreation and aesthetic information requirements, study requests and settlements, and consultation requirements with the National Park Service. More detailed information about specific steps and roles for applicants and stakeholders are available from FERC and the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE). *Additional resources to help navigate the authorization processes include materials available from* DOE *and the* Hydropower Reform Coalition.

Authorities and information requirements

The authorization process for hydrokinetic projects is complex and it is beyond the scope of this document to provide detailed information. For the latest information on various requirements, consult with the relevant agencies. However, the basic authorization paths are shown in Figure 8-1 and briefly described below.

A hydrokinetic project requires federal authorizations to operate. Although the types of required authorizations may vary depending on the project location, most will need a license from FERC and those located on the Outer Continental Shelf [6] (OCS) also require a lease from BOEMRE. Each agency uses its own basic authorities and follows NEPA during its environmental review. Both agencies provide for public involvement.

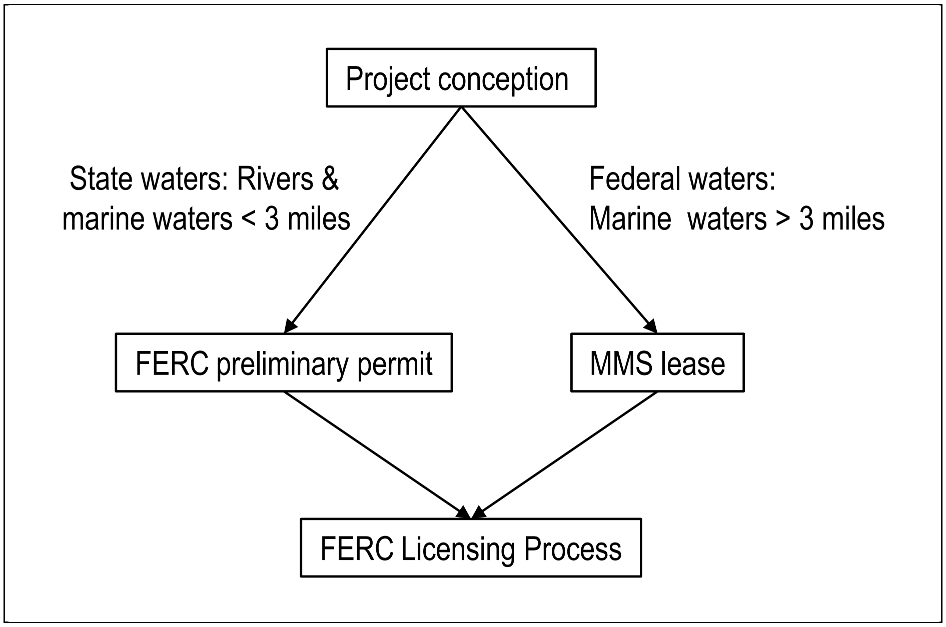

Figure 8-1. Federal authorizations for hydrokinetic projects.

[6] The OCS includes all submerged lands, subsoil, and seabed lying between the seaward extent of the States' jurisdiction (approximately 3 nautical miles from shore, or 3 marine leagues for Texas and the Gulf coast of Florida) and the seaward extent of federal jurisdiction (approximately 200 nautical miles or more from shore).

The intent of NEPA is to help public officials understand the environmental consequences of potential federal actions and review alternative ways to protect, restore, and enhance the environment in conjunction with those decisions. While NEPA processes are sometimes implemented differently by federal agencies, both FERC and BOEMRE are required to prepare either an Environmental Assessment (EA) or Environmental Impact Statement (EIS), depending upon the nature of the action and the significance of potential impacts. Both agencies involve the public in preparing and implementing NEPA procedures, so stakeholders have opportunities to provide comments before any final action. FERC provides guidelines for public participation. Additional NEPA resources include: Preparing Environmental Documents and the Council on Environmental Quality (CEQ) website to guide the public "A Citizen's Guide to the NEPA – Having Your Voice Heard."

The siting handbook for wave and hydrokinetics projects prepared on behalf of the Department of Energy (Pacific Ventures, 2009) provides an excellent overview of the various authorizations required at the State and Federal level, including consultations under various laws such as: the Clean Water Act section 401(a), the Endangered Species Act, Coastal Zone Management Act, National Historic Preservation Act,[7] and with federal land managers that are integrated with licensing/leasing authorities of FERC and BOEMRE. The NEPA process provides a mechanism for additional agencies and others to provide expertise and make recommendations. For example, the U.S. Coast Guard may make recommendations about navigation safety and maritime security. More guidance about FERC hydropower licensing is available from Citizen's Toolkit for Effective Participation in Hydropower Licensing (Hydropower Reform Coalition, 2005).

BOEMRE Lease

Projects located on the OCS require a lease (or an easement/right of way) from the BOEMRE, in addition to a license from FERC. The basic authority is the 2005 Energy Policy Act (EPAct), Section 388, as codified in subsection 8(p) of the Outer Continental Shelf Lands Act (OCSLA).

The BOEMRE will convey the property right (lease or grant) on the OCS for hydrokinetic projects, and FERC will license and regulate the construction and operation of the generating facility. A FERC license can only be obtained after securing a lease from the BOEMRE.

Additional information is available from the BOEMRE, the Programmatic Environmental Impact Statement on the leasing process, and the Final Renewable Energy Framework . BOEMRE provides public participation guidelines at Environmental Comment – Public Review.

FERC Preliminary Permit

A FERC preliminary permit provides the exclusive right to apply for a license for a particular site for a period of 36 months. It does not authorize construction or guarantee the issuance of a project license and grants no land-disturbing or other property rights. The basic authority is the 1935 Federal Power Act (FPA) and associated amendments.

Preliminary permits are available, but optional, for in-river and marine projects in state waters. It is not necessary to obtain a permit in order to apply for or receive a license. Preliminary permits are not

[7] Additional laws with consultation requirements include: Magnuson-Stevens Fishery Conservation and Management Act, Pacific Northwest Power Planning and Conservation Act, Wild and Scenic Rivers Act, Wilderness Act, and Marine Mammal Protection Act.

available for projects located on the OCS.

FERC has adopted a "strict scrutiny" approach for evaluating applications for preliminary permits. Under this approach, FERC states that it will review preliminary permit applications for hydrokinetic projects to limit the boundaries of permits to prevent site banking and to promote competition. Further, to ensure that permit holders are actively pursuing project exploration, FERC intends to carefully scrutinize semi-annual applicant reports and consider canceling permits that do not show sufficient progress. For additional information on the Commission's "strict scrutiny" approach, see the Order Issuing Preliminary Permit for the Reedsport OPT Wave Park, LLC (FERC Project No. 12713-000).

We recommend that applicants interested in obtaining a preliminary permit consult with recreation stakeholders early in the process, especially to identify locations that might adversely affect significant recreational and aesthetic resources and identify issues that may need additional evaluation.

FERC License

A FERC license is the primary regulatory document that authorizes the use of public waters for electricity generation, and is required for projects located in state and off-shore federal waters. It specifies the conditions and legal responsibilities for construction, operation, and maintenance of the project (including a schedule). When final, a license is enforceable by FERC, who may issue fines or revoke a license in the event of systematic non-compliance. Licenses often require mitigation for environmental and recreational impacts, as well as monitoring to assure compliance and (in some recent licenses) to evaluate whether the measures have the intended results. Specific content for draft applications is described in FERC's checklist.

Under the FPA, any applicant must consult with appropriate federal, state, and local resource agencies, Indian tribes, non-governmental agencies, and members of the public (all of these are considered as "stakeholders" for the purpose of this report).[8] For projects located in the United States, individuals and organizations with recreation interests have the right to participate as a stakeholder.

Applicants for a FERC license must address information about recreation (18 CFR § 5.6(viii)), aesthetics (18 CFR § 5.6(ix)), and wildlife information related to recreation (18 CFR § 5.6(v)(b)) as part of their draft license application (see In Focus section on Recreation and Aesthetic Information Requirements for FERC Hydropower Licenses below). We encourage applicants to contact and involve potential recreation stakeholders in developing this information because they may be knowledgeable sources of information and can help identify issues of concern and study needs. Input helps assure that licenses protect and enhance fish and wildlife resources, recreation, and water quality. There is both a process and a goal to accomplish this; under the Electric Consumers Protection Act (ECPA, 1996) FERC is required to give "equal consideration to power and non-power values" when issuing licenses. Recreation qualifies as "non-power" values.

Although the FERC licensing processes allow comment at many stages, early involvement offers more opportunities to learn concerns and address them, and is recommended as a best practice in guidance available from FERC. We recommend applicants to reach out early and often to stakeholders in order to understand and address recreational, aesthetic, and other potential impacts. Stakeholders should contact the developer directly, seek assistance from federal or state agencies, talk with local environmental and recreational nonprofits, and formally participate in the process for licensing any new hydroelectric

[8] The consultation role of the National Park Service goes beyond addressing impacts to National Parks and is confusing to many applicants. (See In Focus: Hydropower Proposals and the National Park Service).

project. Early involvement is even more important for new technologies that require authorizations from multiple agencies and jurisdictions (e.g., projects sited on the OCS require FERC licenses and an BOEMRE leases). While FERC's pilot process (small, short-term, removable, and carefully monitored projects intended to test technologies, sites, or both) is intended to reduce the time required to receive a pilot license to as few as six months, the typical permitting and licensing process is expected to require more than five years before a final license is issued and construction can begin. This process is more analogous to a marathon than a sprint, and both applicants and stakeholders should be prepared for several years of involvement. Again, experience shows that success for developers, agencies, and stakeholders is higher when the range of stakeholder input is broad and available early in the process.

There are many opportunities for stakeholders to participate in the licensing process including:

- Helping identify issues of concern.
- Proposing studies and negotiating study plans.
- Commenting on licensee proposals, including:
    - issue identification
    - studies
    - proposed project operations
- Making recommendations about operations and protection, mitigation, and enhancement measures.
- Challenging FERC decisions through administrative and legal appeals.

The study process is particularly relevant to this guide. The study plan describes how new information will be collected to prepare license applications. Information is needed to characterize the environmental baseline affected by the project and to assess potential project impacts and alternatives to protect, mitigate, and enhance environmental quality.

This is an iterative process that includes the applicant developing a study plan in consultation with agencies, tribes, and other participants; opportunities for stakeholders to comment and request studies; meetings to informally clarify the plan and resolve outstanding issues; a formal study dispute process available to Federal agencies with mandatory conditioning authorities; and ultimately, FERC approving the revised study plan with any modifications after considering all information in the record.

Study requests must meet strict criteria. (See "In Focus: Making Study or Information Requests and Settlements").

FERC Licensing Processes

There are two general types of licenses that can be obtained from FERC for hydrokinetic projects: 1) pilot license or 2) conventional license, briefly described below. Additional information on hydrokinetic licensing processes is available from FERC. One key difference between these types is when study information is collected.

FERC Pilot Hydrokinetic Licenses

The purposes of licensing hydrokinetic pilot projects are to test new, hydrokinetic technology devices; to determine the appropriate sites for hydrokinetic projects; and to gather information on environmental and other impacts of the devices. Most impact studies will occur during the pilot license term (about 5 years), rather than during the application process for a conventional license. The process includes opportunities for input from federal, state, and local resource agencies, Indian tribes, non-governmental organizations, and members of the public. The process allows applicants to collect information to determine whether or not to progress to a full-scale project. If not, then the licensee has responsibility to remove the pilot project. Expansion beyond the pilot project will require a new application (usually through the Conventional Hydropower License Process; see below).

Additional information about pilot license criteria and requirements is available from FERC. To qualify, a project must meet the following criteria:

- Projects will be small in capacity (equal to or less than 5 MW) and occupy the minimum area commensurate with the technology to be employed;
- the license will be short term;
- Project site avoids sensitive locations;
- Project applications will contain strict safeguard plans to protect the public and environmental resources
- Projects will be removable and able to shut down on short notice, and will be removed, with site restored, before the end of the license term (unless a new license is granted); and
- the draft application must be in a form sufficient to support environmental analysis and include proposed monitoring plans

FERC Conventional Hydropower Licenses

Hydrokinetic projects are not limited to the Pilot Licensing process. Developers can initially choose to use FERC's conventional hydropower licensing processes, or use a conventional process to transition from a successful pilot process to full build-out. Conventional licenses are issued for 30 to 50 years. The licensing process provides multiple opportunities for stakeholder input and requires studies during the application process. Key elements of licensing are listed below. Detailed information about these elements is beyond the scope of this report. In addition to guidance available from FERC, stakeholders are encouraged to review guidance available from DOE and the Hydropower Reform Coalition.

Key Elements of FERC Hydrokinetic Licensing Processes

- Preliminary Application Document (PAD)
- NEPA scoping and stakeholder comment
- Develop study plans
- Conduct studies
- Preliminary license proposal
- Final License Application (FLA)
- FERC-conducted NEPA
- FERC License Order
- Project development and monitoring

In Focus: FERC Recreation and Aesthetic Information Requirements

The following information is ***required*** by FERC as part of both pilot and conventional licensing, as listed below and described in (***18 CFR § 5.6***).

Recreation and land use (18 CFR § 5.6(viii). A description of the existing recreational and land uses and opportunities within the project boundary. The components of this description include:

- Text description illustrated by maps of existing recreational facilities, type of activity supported, location, capacity, ownership and management;
- Current recreational use of project lands and waters compared to facility or resource capacity;
- Existing shoreline buffer zones within the project boundary;
- Current and future recreation needs identified in current State Comprehensive Outdoor Recreation Plans, other applicable plans on file with the Commission, or other relevant local, state, or regional conservation and recreation plans;
- If the potential applicant is an existing licensee, its current shoreline management plan or policy, if any, with regard to permitting development of piers, boat docks and landings, bulkheads, and other shoreline facilities on project lands and waters;
- A discussion of whether the project is located within or adjacent to a:
  - River segment that is designated as part of, or under study for inclusion in, the National Wild and Scenic River System; or
  - State-protected river segment;
- Whether any project lands are under study for inclusion in the National Trails System or designated as, or under study for inclusion as, a Wilderness Area.
- Any regionally or nationally important recreation areas in the project vicinity;
- Non-recreational land use and management within the project boundary; and
- Recreational and non-recreational land use and management adjacent to the project boundary.
- Aesthetic resources (18 CFR § 5.6(ix). A description of the visual characteristics of the lands and waters affected by the project. Components of this description include a description of the dam, natural water features, and other scenic attractions of the project and surrounding vicinity. Potential applicants are encouraged to supplement the text description with visual aids.
- Wildlife information related to recreation - Temporal or spatial distribution of species considered important because of their commercial, recreational, or cultural value (18 CFR § 5.6(v)(b)).

In Focus: Making Study Requests and Settlements

The results from studies and the project study plan provide key information in the record on which FERC will make its decision in a typical proceeding. Commenting on and requesting studies is a good way for public and agency stakeholders to start working directly with the applicant to provide early and substantive input in the process, and to influence FERC on including conditions to protect sensitive recreational and other resources. Early collaboration can also reduce controversy and uncertainty concerning the outcome of a licensing proceeding. Additional guidance about studies is available from FERC and the Hydropower Reform Coalition.

The study plan must: (1) identify each study to be completed by the licensee to characterize existing conditions of resources affected by the project; (2) identify corresponding management goals and objectives; and (3) and propose analytical methods (generally, field studies) to determine the nature and scope of the project's existing or potential impacts and alternatives to mitigate such impacts. As specified by CFR 18, §5.9(b) of FERC's regulations under the Integrated Licensing Process (ILP), study requests must address the following seven criteria:

- Subject and purpose of the request (e.g., "this study will assist in our understanding of project impacts on the following resource...");
- Relevant management goals of any agency or tribe with jurisdiction over the resource to be studied;
- Relevant public interest considerations supporting the request, if the commenter is not an agency;
- Existing information concerning the subject and an explanation why additional information is needed;
- Nexus between the project and the resource to be studied, and how the study results will inform the development of the license articles;
- Proposed study methodology and explanations why they are consistent with generally accepted practice in the scientific community or, as appropriate, consider relevant tribal values and knowledge; and
- Level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

Settlements

One method for seeking early collaboration and reducing controversy is by seeking a settlement agreement among all or most of the project stakeholders: "The Commission looks with great favor on settlements in licensing cases. When parties are able to reach settlements, it can save time and money, avoid the need for protracted litigation, promote the development of positive relationships among entities who may be working together during the course of a license term, and give the Commission, as it acts on license applications, a clear sense as to the parties' views on the issues presented in each settled case" (See FERC Policy Statement on Settlements, 2006).

Settlement discussions can begin whenever the licensee and a critical mass of other participants believe there is a reasonable prospect of timely success, and early collaboration provides an opportunity to create agreement about studies and license provisions, including mitigation. Settlement also prevents or at least reduces the frequency or severity of disputes about the adequacy of the licensee's study plan, so early collaboration and involvement with study plans is often the earliest opportunity to reach agreement and a potential course towards settlement. FERC prefers settlement as the basis of any new license for a given project, no matter which of the licensing processes is used. Even though the three conventional licensing processes (i.e., ILP, TLP, ALP) differ in their emphasis on collaboration, Practice and Procedure Rule 601 establishes settlement as an accepted method to resolve disputed issues in any proceeding before FERC (18 CFR § 385.601 *et seq*.).

In Focus: Hydropower Proposals and the National Park Service

The National Park Service (NPS) may become involved in hydropower proceedings for a variety of reasons including:

- Potential impact on recreation opportunities;
- Potential impact on the National Park System resources; and
- Potential impact on areas where NPS has oversight or management responsibilities.

NPS Hydropower Recreation Assistance

Consultation with the National Park Service is required in FERC hydropower licensing proceedings, regardless of whether a park unit is affected (18 C.F.R. § 4.38(a), 18 C.F.R. § 5.1(d), and 18 C.F.R. § 16.8(b)(4)). This broad responsibility stems from the NPS Organic Act (16 U.S.C. § 1 *et seq.*) and the technical assistance provisions of the Outdoor Recreation Act (16 U.S.C. § 4601-1), the Wild and Scenic Rivers Act of 1968 (PL 90-542), and the National Trail System Act of 1968 (16 U.S.C. § 1246(a)).

When evaluating proposals for technical assistance, NPS may select projects that do not impact the Park System or places where NPS has oversight (see below). NPS *Policy and Guidelines for Recreational Technical Assistance in Hydropower Licensing* (Federal Register 57 FR 61915, December 29, 1992) provides a framework and criteria for project selection. Priority is given to projects in areas with high natural, cultural and/or recreational resource values and where there is a significant opportunity to create or improve recreation opportunities. In addition, NPS seeks to provide assistance for a diverse mix of recreation experiences, settings, and geographic locations, particularly if multiple projects are involved. NPS also gives priority to requests from groups that have little or no access to professional sources of planning assistance and analysis. For more information about the NPS Hydropower Assistance Program see http://www.nps.gov/hydro

Hydropower and Units of the National Park System

The Federal Power Act generally prohibits FERC from licensing or exempting hydropower projects within National Parks and Monuments 16 U.S.C. §§ 797a (2006). The Federal Power Act also prohibits FERC from licensing hydropower projects within the boundaries of other units of the National Park System if those projects "would have a direct adverse impact to federal lands within any such unit" 16 U.S.C. § 797c (2006).

When project boundaries overlap with federal lands managed by NPS, NPS may require developers to obtain an NPS issued right-of-way permit 16 U.S.C. §§ 5, 79 (2006). In these situations, NPS may also develop conditions to ensure the adequate protection and utilization of the federal lands managed by NPS, which FERC must include in the project license 16 U.S.C. § 797(e) (2006). In situations where a project would be sited in a unit of the national park system, but where the project boundary does not overlap NPS lands, it may recommend terms and conditions to FERC that would best adapt the project to a comprehensive management plan for that unit 16 U.S.C. § 803(a)(2) (2006). In addition to the authorities described above, enabling legislation for any national park system unit potentially affected by a project must be reviewed to identify additional protections or authorizations that may apply.

BOEMRE is also prohibited from leasing projects in any unit of the National Park System, or similar protected conservation units such as National Marine Sanctuaries, National Wildlife Refuges, and National Monuments on the OCS 43 U.S.C. § 1337(p)(10); Pub. L. 109–58, § 388(a)(2005).

NPS Oversight Responsibilities

NPS has several oversight responsibilities relevant to recreation areas protected under many federal laws. Local, tribal, and state government lands that have received grants through the Land and Water Conservation Fund (LWCF) are protected under Section 6(f) of the LWCF Act for public outdoor recreation use. Any conversions from outdoor recreation use require NPS approval and replacement property (equal to current market value, in a similar location, and with reasonably equivalent usefulness). Similarly, local government lands with recreation sites that were rehabilitated through the Urban Park and Recreation Recovery (UPARR) program are protected under Section 1010 of the Urban Park and Recreation Recovery Act of 1978, as amended. Local government and state lands that have been donated through the Federal Lands to Parks program are also restricted to public recreation use only; conversion of lands to non-park use triggers a reversion of title to the federal government. *See* 16 USC §460*l*-8; 16 USC §2501-14; 36 CFR §59; 40 USC § 550 (b), (e); 41 CFR § 102-75.625 through 75.690.

In addition, NPS has special oversight responsibilities, along with the other river administering agencies, for the National Wild and Scenic Rivers System. FERC is prohibited from licensing new construction of hydropower projects within the boundaries of Wild and Scenic Rivers and rivers that have been designated for potential inclusion into the Wild and Scenic Rivers System. 16 U.S.C. § 1278(a)-(b) (2006). FERC is subject to the river-administering agency's finding relating to hydropower projects located below/above, or on a tributary to, a designated Wild and Scenic River or a congressionally authorized study river. 16 U.S.C. § 1278(a)-(b) (2006). For designated rivers, a downstream/upstream project may not invade the area or unreasonably diminish the scenic, recreational, and fish and wildlife values present at the date of designation. For congressionally authorized study rivers, greater protection is provided. The project must not invade the area or diminish the area's values.

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10. Glossary

Adaptive Management. A process that acknowledges the imperfect and evolving understanding of environmental dynamics. Adaptive management includes monitoring conditions, testing hypotheses, evaluating results, and using the conclusions to improve management decisions.

Aesthetics. The study or evaluation of the beauty of some object or setting. It is typically associated with visual quality, but could be extended to concern about impacts to other senses (sound, touch/vibration, taste, or smell).

ALP. Alternative Licensing Process.

Attenuator. Wave energy capture device with principal axis oriented parallel to the direction of the incoming wave and converts the energy due to the relative motion of the parts of the device as the wave passes along it. (From DOE, 2009).

Baseline (or Environmental Baseline). The environmental conditions that are the starting point for analyzing the impacts of a proposed licensing action (such as approval of a license application) and any alternative.

BLM. Bureau of Land Management, an agency within the US Department of Interior

BOEMRE. Bureau of Ocean Energy Management, Regulation, and Enforcement. An agency in the US Department of Interior (formerly the Minerals Management Service; it was changed in the wake of the 2010 Gulf of Mexico oil spill).

Call. Call for Information and Nominations, a process during MMS leasing where MMS solicits information from stakeholders to assist the MMS in determining the area to be offered for lease.

CEQ. Council on Environmental Quality.

C.F.R. Code of Federal Regulations.

CMSP. Coastal and Marine Spatial Planning system.

Comprehensive Plan. A plan for the development of generation or other beneficial uses of a river recognized under FPA Act section 10(a)(2)(a).

Consultation. Under FPA Part I, consultation is a cooperative effort of the licensee and other participants to prepare and implement a study plan and subsequently a license application to minimize unresolved disputes of fact and law. Under ESA Section 7, consultation is a cooperative effort of FERC, licensee, and FWS or NMFS, to analyze the impacts of a licensing action on listed species or critical habitats.

Consumptive Recreation. Recreation opportunities that involve "harvest" or some other "consumption" of a natural resource. This label is typically applied to fishing and hunting where wildlife are specifically targeted and are killed, but could include berry, mushroom, or plant collecting.

CWA. Clean Water Act.

CZMA. Coastal Zone Management Act.

Draft License Application (DLA). A preliminary license application that provides a project description, existing and proposed plan for project operation and maintenance, including environmental measures, and an analysis of existing and any impacts, taking into account the environmental measures.

Docket. A formal record of a proceeding on a given application for permit, license, or exemption.

ECPA. Electric Consumers Protection Act.

EMF. Electro-magnetic Field.

Endangered Species Act (ESA). The federal law, 16 U.S.C. §§ 1531-1544, that provides for protection and recovery of endangered or threatened species of fish, wildlife, or plant.

Endangered Species. Any species of fish, wildlife, or plant listed under the Endangered Species Act as in danger of extinction throughout all or a significant portion of its range.

Environmental Assessment (EA). A document prepared by FERC and any cooperating agency, pursuant to NEPA, to determine whether a licensing action may significantly affect environmental quality.

Environmental Impact Statement (EIS). a document prepared by FERC under NEPA to analyze a licensing action that, even after mitigation measures, may have significant adverse impacts on environmental quality.

EPA. U.S. Environmental Protection Agency.

ESA. Endangered Species Act.

Federal Lands. Lands which the U.S. holds in fee title.

FERC. Federal Energy Regulatory Commission.

Filing. Any document filed in a licensing proceeding.

FPA. Federal Power Act, 16 U.S.C. §§ 791-823 (Part I) and 16 U.S.C. §§ 824-824n (Part II).

FWS. Fish and Wildlife Service, a bureau under the Department of Interior with jurisdiction over fish and wildlife resources.

Groin. A structure similar to a jetty, but usually shorter and not associated with an inlet or harbor entrance. Groins interrupt lateral sand movement along a beach and may prevent erosion (or increase deposition) in some locations. However, they may also disrupt sediment transport to other locations (which may see increased erosion).

Horizontal Axis Turbine. Typically has two or three blades mounted on a horizontal shaft to form a rotor; the kinetic motion of the water current creates lift on the blades causing the rotor to turn driving a mechanical generator. (From DOE, 2009).

HRC. Hydropower Reform Coalition.

Hydraulics. The characteristics of moving water; typically focused on velocity, depth, and energy variables.

Hydrokinetics. General term that refers to a full range of energy technologies.

ILP. Integrated Licensing Process.

Installed Capacity. The instantaneous capacity of the project to generate electricity, expressed in kilowatts or megawatts.

Jetty. A barrier designed to control lateral sand movement at an inlet or harbor entrance, usually to improve navigation. In a natural inlet, sand transported along the shore by waves and currents creates inner bars on a flood tide and an outer bar on an ebb tide, both of which may shift and affect navigation.

Lease. A legal document executed between MMS and a developer which grants right to the developer to use a certain area in the OCS for energy production for a specific period of time.

Licensee. The entity which holds a license and thus is legally responsible for construction, operation, and maintenance of a project. For simplicity of reference, this Toolkit uses the term “licensee” to describe a license applicant, including an applicant for original license.

Mitigation. Avoidance or reduction in the potential impact of a license or exemption.

MMS. Minerals Management Service, an agency within the Department of the Interior that has recently been reorganized into BOEMRE.

MW. Megawatt.

NEPA. National Environmental Policy Act, 42 U.S.C. §§ 4321 - 4347.

NMFS. (formerly NOAA Fisheries) National Marine Fisheries Service, fisheries branch of the U.S. Department of Commerce.

NOAA. National Oceanic and Atmospheric Administration.

Notice of Intent (NOI). Document that the licensee files at least five years before expiration of a license, to state its intent whether it will seek a new license.

NPS. National Park Service, an agency within the U.S. Department of the Interior.

OCSLA. Outer Continental Shelf Lands Act.

OEP. Office of Energy Projects, a division within the FERC that regulates siting and operation of energy projects, including hydropower projects.

Oscillating Hydrofoil. Similar to an airplane wing but in water; yaw control systems adjusts their angle relative to the water stream, creating lift and drag forces that cause device oscillation; mechanical energy from this oscillation feeds into a power conversion system (from DOE, 2009). (From DOE, 2009).

Overtopping Device. Partially submerged structure; a collector funnels waves over the top of the structure into a reservoir; water runs back out to the sea from this reservoir through a turbine. (From DOE, 2009).

PAD. Pre-Application Document. A FERC term for a document that summarizes reasonably attainable existing information about a hydrokinetic project, an area’s characteristics, potential effects, and potential studies that might be needed to assess effects and mitigation options. They are prepared by the licensee early in the relicensing process.

PM&E. Protection, mitigation and enhancement. Acronym used to describe actions that may be included in License Articles to enhance positive and reduce or mitigate negative impacts from a hydropower project.

Pilot License. A five year license issued by FERC for experimental projects using new technology to test the technology and its impact on the environment.

Point Absorber. Wave energy capture device with principal dimension relatively small compared to the wave length and able to capture energy from a wave front greater than the physical dimension of the device. (From DOE, 2009).

Preliminary Permit. An authorization from FERC, valid for three years, that allows the permit holder to conduct initial technical and environmental assessments to determine the feasibility of developing a site.

Project Boundary. The boundary designated by FERC to identify the lands and structures included in a license or exemption.

NREA. Notice of Ready for Environmental Analysis. The notice issued by FERC that finds that the application is complete and ready for environmental review under NEPA. It is after the issuance of NREA that parties can formally intervene in the FERC process and resource agencies can submit their initial recommendations and conditions.

Recreation experience. The collection of psychological and physiological outcomes or benefits received by recreation users when they engage in a recreation activity.

Recreation opportunity. The combination of physical, biological, social, and managerial conditions that give value to a place, and allow users to pursue and receive a recreation experience.

Recreation opportunity spectrum. A concept from recreation research that suggests recreation settings range on a spectrum from "paved to primitive." In general, development and use levels drive these setting assessments, but the concept considers other variables as well.

Rehearing. An administrative procedure requesting reconsideration of FERC decisions, either at staff or Commission level.

SD. Scoping Document.

SD-1. Scoping Document 1.

SD-2. Scoping Document 2, as revised following public comment.

Settlement Agreement. Often a binding document, between signatories regarding operations of a hydropower project. While FERC is not a party to any settlements, it usually respects the decisions reached amongst stakeholders in a settlement and includes the provisions within the settlement as license conditions later on.

Study Plan Determination. The determination by the Director of Office of Energy Projects on what studies are required of the applicant to develop adequate record for environmental analysis.

Submerged Pressure Differential. Wave energy capture device, which can be considered a fully submerged point absorber; a pressure differential is induced within the device as the wave passes driving a fluid pump to create mechanical energy. (From DOE, 2009).

Swash zone. The zone of wave action on the beach, which moves as water levels vary, extending from the limit of run-down to the limit of run-up.

Threatened Species. Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, as listed under the Endangered Species Act, 16 U.S.C. § 1532(20).

TLP. Traditional Licensing Process.

USCG. United States Coast Guard.

USDA. United States Department of Agriculture.

USGS. United States Geological Survey.

Vertical Axis Turbine. Typically has two or three blades mounted along a vertical shaft to form a rotor; the kinetic motion of the water current creates lift on the blades causing the rotor to turn driving a mechanical generator. (From DOE, 2009).

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11. List of interviewees

Interviews were conducted in fall 2009; the goal was to discuss recreation and hydrokinetic development with people from a diverse range of recreation activities and geographic locations. Interviewees were suggested through a brainstorming process and additional networking. Interview questions generally focused on 1) information about various recreation activities; 2) a review of potential hydrokinetic impacts on the target recreation opportunity; and 3) opportunities for studying impacts (including networking options within a recreation community). A few interviewees offered expertise on licensing process issues rather than recreation issues, and interviews were structured differently. Brief notes below outline interviewees' expertise and the topics that received most attention during their interviews. While information from these experts on recreation provided a wealth of information for this document, they are not responsible for its content or conclusions (any errors are the responsibility of the authors).

Julie Anderson. Washington Water Trails Association. This is an non-profit organization with a focus on developing and protecting access for paddlers in the Puget Sound region and other areas in the Northwest. More information is available at wwta@wwta.org. Interview discussion focused on kayaking access issues, sea kayaking recreation opportunities, and networking options among sea kayakers.

Peter Arnold. Chewonki Foundation. Chewonki is a non-profit organization that offers environmental education programs to youth and others, primarily in Maine coastal and river/lake settings where sailing, sea kayaking, and river paddling are featured recreation activities. It also works on "sustainability" projects and has been assisting the city of Wiscasset with a potential hydrokinetic project. More information about Chewonki is available at www.chewonki.org. Interview discussion focused on potential recreation impacts from the Wiscasset project, recreation craft navigation issues in coastal Maine, recreation user networking, and aesthetic impacts from submerged devices.

Kris Arnold. Avid diver in the Pacific Northwest and Florida Keys. Interview focused on types of recreation and technical diving opportunities (including diving in high current areas), diving attractions in the Northwest, diver networking options, and potential diver responses to access and aesthetic impacts from hydrokinetic development.

Tom Babbitt. Yacht broker and sailor with a focus on the Maine coast (50+ years of experience). More information at Wayfarer Marine or East Coast Yacht Sales (www.ecys.com). Interview focused on sailing navigation needs, sail racing and cruising trip characteristics, networking options among sailors and other coastal recreation users, and potential impacts from hydrokinetic development (especially access restrictions or aesthetics).

Steve Bennett. Sound Rowers. Kayak and other paddle sport racing in Puget Sound. This non-profit organization is one of the primary organizers of paddle races in the region. More information available at soundrowers.org. Interview discussion focused on race routes, networking options among paddlers, and potential hydrokinetic impacts (particularly potential access restrictions and aesthetics).

John Beuttler. California Sportfishing Protection Alliance (CSPA). This is a non-profit organization dedicated to conservation of California's fisheries and their aquatic habitat. Interview discussion focused on networking options for fishing studies, and a review of potential impacts from hydrokinetic development on anglers. More information about CSPA is available at www.calsport.org.

Flaxon Conway. Oregon State University professor and researcher in Ocean Sciences. Her research program includes potential hydrokinetic impacts on recreational and commercial fishing, or related social impacts in communities. Interview discussion focused on challenges of finding and developing information from local and recreation users, several specific hydrokinetic developments on the Oregon coast, issues related to EcoTrust fishing grounds "importance" studies, and future recreation-hydrokinetic research needs.

Tom Christopher. New England FLOW. This is a non-profit organization focused on securing improved flow regimes on New England rivers for boating and other recreation, often through relicensing processes. He has been involved in hydropower issues since the late 1980's and pioneered recreation stakeholder involvement in traditional relicensing. Interview discussion focused on importance of cumulative ecosystem impacts, potential physical impacts on currents from hydrokinetic development, and the importance of setting in assessing aesthetic impacts.

Frank Daignault. Author and lecturer on east coast surf and shore-based salt water fishing (55 years experience). Titles include Fly Fishing the Striper Surf, Twenty Years on the Cape, The Trophy Striper, and Striper Surf. More information is available at www.stripersurf.com/daignault.html. Interview discussion focused on access issues (including cumulative impacts of access degradation for multiple reasons) and aesthetic issues (including differences in sensitivity among different types of anglers).

Bob D'Amico. Author, lecturer, and website developer on east coast surf and shore-based salt water fishing (over 50 years experience). More information available at www.stripersurf.com. Interview discussion focused on boat and shore-based techniques for different species; potential impacts from hydrokinetic development on access, fishing success, and aesthetics; cumulative impacts from other access restrictions; and networking options for developing local information.

Sherrie Duncan. Private kayaker and fisheries biologist with extensive experience in Alaskan and Pacific Northwest waters. Interview discussion focused on potential hydrokinetic development impacts on recreation (especially access restrictions and aesthetics) and local resident or recreation user networking options.

Bob Eder. Commercial fisherman, member of Fishermen Involved in Natural Energy (FINE), and board member of Oregon Wave Energy Trust. Interview discussion focused on process issues and stakeholder involvement associated with licensing of hydrokinetic development.

Jordan Fields. Board member of Florida Oceanographic Society and avid surfer with extensive (42 years) east coast and international experience. Interview discussion focused on Atlantic coast surfing opportunities, networking options among surfers, potential impacts from hydrokinetic development on wave characteristics, access restrictions, noise, and aesthetics.

Shawna Franklin. Sea kayak instructor and co-owner of Body Boat Blade International (instruction and retail store) in Washington's San Juan Islands. With over 20 years of kayaking experience and an instruction focus, she provided general information on sea kayaking in Puget Sound and the San Juans, sea kayaker networks, and concerns over recent proposed "no boat" areas to protect Orcas in the San Juans (potential lost sea kayak access that has parallels to potential hydrokinetic development access restrictions). She also provided specific information about Deception Pass use levels and safety concerns (which could interact with potential hydrokinetic development in the area).

Paul Hartfield. US Fish and Wildlife Service biologist and Lower Mississippi canoeist and angler; he is based in Jackson, Mississippi. He provided background information on several recreation opportunities on the river, with specific information about biodiversity, fisheries, local fishing techniques (e.g., "jug fishing"), interactions between recreation users and barge traffic, navigation issues, and potential hydrokinetic development proposals in the Lower Mississippi.

Kaety Hildenbrand. Marine fisheries educator for Oregon Sea Grant (Oregon State University). Oregon Sea Grant develops and supports research, outreach, and education related to marine and coastal resources. She has participated in some outreach meetings related to recreation or fishing impacts from hydrokinetic projects. Interview discussion focused on recreation user networking options, community involvement issues (including "trust" issues in developing information about priority recreation uses or fishing grounds), and aesthetic impact assessments.

Tim Holschlag. Fly angling guide, author, and lecturer in Upper Mississippi basin (primarily Wisconsin, Minnesota, and Iowa). Interview focused on upper Midwest angling opportunities (including vessel types and fishing techniques), use levels, ecological concerns from hydrokinetic development, networking options among anglers, and aesthetics needs for different types of anglers. More information about his trips is available at www.smallmouth**flyangler**.com.

Don Hudson. Chewonki Foundation. Chewonki is a non-profit organization that offers environmental education programs to youth and others, primarily in Maine coastal and river/lake settings where sailing, sea kayaking, and river paddling are featured recreation activities.

Brian Jacobson. Avid near and off-shore fisherman off Virginia and North Carolina Coast; he has pioneered off shore fishing from Personal Watercraft and operates a website on the topic at www.jetskibrian.com). Interview discussion focused on boat-based fishing opportunities on the central Atlantic coast and potential hydrokinetic development impacts (access restrictions, aesthetics, line entanglement issues).

Jeremy Jones. Avid diver, diving instructor, and owner of Washington Divers (Bellingham dive shop; since 2001). Instructs all levels of diving, including open water and technical (mixed gas) courses. He provided background on recreational and technical diving in the Northwest, including informal diver networks, artificial reefs, diving attractions, and potential aesthetic and noise issues related to hydrokinetic development.

Ken Kimball. Director of research for Appalachian Mountain Club. Extensive experience with traditional hydropower relicensing, wind power projects, and river recreation. He discussed "lessons learned" from other power licensing efforts, including specific discussions of wildlife impacts, aesthetics assessments, and the need to include natural resource planners in siting and design decisions.

Bill King. Private marina operator on the Upper Mississippi near Hastings, Minnesota (site of first licensed hydrokinetics devices in the country). Interview discussion focused on types of uses in the Upper Mississippi, responses to the Hastings project, and potential recreation impacts if additional similar units were to be developed in other areas.

Alberto Knie. Avid salt water angler, author, and charter boat captain; affiliated with Recreation Fishing Alliance and NY Sport Fishing Federation. Interview discussion focused on salt water fishing opportunities on the Atlantic coast, eroded access from multiple causes over the past several decades, angler networking options, and likely angler responses to hydrokinetic-caused access restrictions.

Curtis Knight. California Trout, Northern Representative. Avid fly angler with hydropower relicensing experience. Interview discussion focused on potential hydrokinetic impacts on river-based fishing, particularly on larger rivers (e.g., Sacramento) where these technologies may be more likely.

Jan Konigsberg. Hydropower Reform Coalition staff in Alaska who works on Yukon River fisheries projects and several traditional hydropower projects in Southeast and Southcentral Alaska. Interview discussion focused on proposed Yukon hydrokinetic development, potential recreation impacts, and local residents and recreation user networking options.

Brian Lockwood. Avid salt water and estuary angler, often using personal watercraft. Has developed a web blog on the topic; more information at www.jetskibrian.com. Interview discussion focused on fishing opportunity attributes, navigation requirements for different craft, and potential impacts from hydrokinetic development (especially entanglement issues, aesthetics).

Jim Martin. West Coast Director for Recreational Fishing Alliance (RFA). RFA is a non-profit lobbying organization focused on recreational fishing rights in marine fisheries issues. It supports litigation requiring comprehensive planning prior to site by site licensing of hydrokinetic projects. He provided extensive background information on sport and commercial fisheries along the California coast (including abalone diving), fishing vessel navigation capabilities (ability to avoid potential me development), and issues related to compensating commercial or recreation fishermen affected by such development.

Steven Medeiros. President of Rhode Island Saltwater Anglers Association and avid salt water angler. RISAA is a non-profit organization focused on education, sportsmanship, support for marine conservation, and a "unified voice preserve and protect the rights, traditions and the future of recreational fishing in Rhode Island." Interview discussion focused on shore-based fishing opportunities, networking options among anglers, and a range of potential hydrokinetic development impacts (e.g., especially access concerns, but also fish abundance changes and aesthetics).

Kate Miller. Legal analyst for Trout Unlimited with a focus on hydropower impacts on fresh water fisheries issues. Interview focused on potential hydrokinetic affects on fish and fishing in river-based settings, but also addressed access restriction and aesthetic impacts.

Beth Mitchell. Attorney for Fishermen Interested in Safe Hydrokinetics (FISH). Lead in developing litigation requiring comprehensive planning prior to site by site licensing of hydrokinetic projects. Interview discussion focused on state and federal agency processes for licensing or permitting hydrokinetic development, advocacy for broader scale marine planning, specific recreation opportunities off the California coast, and a range of potential impacts from hydrokinetic development (including access and aesthetic impacts on charter fishing operators, abalone diving, whale watching, and fishing).

Mark Perry. Executive Director, Florida Oceanographic Society (a non-profit that advocates for marine resources, conducts research and monitoring of marine life, and operates the 60 acre Florida Oceangraphic Coastal Center). Interview discussion focused on the diversity of coastal recreation in Florida (including scuba, snorkeling, boating, and fishing) and potential impacts from hydrokinetic development. Additional information focused on artificial reefs and fish attraction devices. Additional information about FOS is available at www.floridaoceanographic.org.

John Pfeiffer. Columbia Basin Flycasters (fly angler group based in tri-cities area in central Washington). Interview discussion focused on potential hydrokinetic development impacts on fishing opportunities in Pacific Northwest, including boat and shore based fishing.

John Ruskey. Avid canoeist/kayaker and owner of Quapaw Canoe Company in Clarksville, Mississippi. He has been taking multi-day canoe/kayak trips on the Mississippi (from St. Louis to the Gulf of Mexico) most from for nearly 30 years and has guided similar trips since 1998. He provided extensive information about recreation values on the river, non-motorized trip options, use estimates for other types of recreation trips (e.g., anglers, powerboats), development levels, access issues, barge-recreation use interactions, and potential responses to hydrokinetic development or potential access restrictions.

Margie Simpson. Avid cruising sailor, with most experience in Puget Sound and the Pacific Northwest. Interview discussion focused on types of sailing opportunities, navigation requirements for different craft, access restrictions, sailor networking options, potential aesthetics impacts, and salvage concerns.

Brandi Smith. Clemson University researcher with expertise on night sky / light pollution issues. Interview discussion focused on potential aesthetic impacts.

Rem Smith. President of Hole in the Wall Kayaking Club (sea kayakers in San Juan Islands). Interview discussion focused on networking options among kayakers, safety and navigation issues, and potential access restrictions or aesthetic impacts from hydrokinetic development.

Glenn Spain. Pacific Coast Federation of Fishermen's Association (trade organization focused on CA/OR coastal fishing issues). Interview discussion focused on potential impacts (especially access restrictions) from hydrokinetic development on commercial and recreation fishing on the CA coast.

Ray Spillman. Avid (20+ years) salt water angler, with most experience off the North Carolina coast and in Lower Chesapeake Bay. Interview focused on near shore boat-based fishing opportunities, including networking options among private and charter fishing users.

Peter Stauffer. Avid surfer and Policy Coordinator for Oregon Surfrider Foundation; has been involved in Douglas County, Oregon hydrokinetic development proposals and recreation study requests. More information is available at www.surfrider.org/oregon. Interview discussion focused on a full range of potential hydrokinetic development impacts on recreation (particularly surfing), including wave characteristic issues, access restrictions, aesthetics, ecological impacts, networking options among surfers, and recreation research needs in licensing efforts.

Dave Steindorf. Avid whitewater kayaker, fly angler, and Stewardship Director for American Whitewater with primary focus on California rivers (particularly thorough traditional relicensing processes). Interview discussion focused on potential hydrokinetic impacts on whitewater in river settings, including navigation concerns, impacts on rapid features, and assessing aesthetic impacts.

Bobbi Walker. Executive Director of National Association of Charterboat Operators. This national trade organization has 3,400 members nationwide; she is based out of Orange Beach, Alabama (more information available at www.nacocharters.org). Interview discussion focused on charter fishing opportunities, navigation needs for different vessels, networking options among charter captains, and the range of potential impacts from hydrokinetic development (especially fish abundance changes, access restrictions, and aesthetics).

Doug Welch. Executive director of Maine Water Trail Association. This is a non-profit organization that has developed a 375-mile chain of over 180 coastal islands and sites along the coast of Maine for boaters and paddlers (among the first water trails in the country). Interview discussion focused on North Atlantic coast recreation opportunities (sailing, powerboating, and sea kayaking), access issues, and other potential hydrokinetic development impacts (e.g., aesthetics, noise, navigation impacts).

Karl Wickstrom. Avid salt water angler, Founder/Editor-in-chief of Florida Sportsman, and a leader in the Florida-based Rivers Coalition (focused on St. Lucie River and Everglades restoration). Interview discussion focused on Atlantic and Gulf of Mexico sportfishing opportunities, angler networking options, artificial reefs, potential impacts from hydrokinetic development (e.g., access restrictions, aesthetics), and other alternative energy development (e.g. wind).

12. List of hyperlinks

For readers with an electronic version of this document, hyperlinks direct them to several references or other information on the internet. For readers with a printed copy of the document, we have assembled a list of hyperlinks by chapter (type these into your browser to access the document or internet webpage).

Chapter 1 - Types of Hydrokinetic Projects		
Page	**Reference**	**URL Link**
1	Summary of FERC hydrokinetic projects.	http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics.asp

Chapter 2 - Types of Hydrokinetic Projects		
Page	**Reference**	**URL Link**
5	Device database	http://www1.eere.energy.gov/windandhydro/hydrokinetic/default.aspx
5	Wave and Current Energy Generating Devices Criteria and Standards	http://www.boemre.gov/tarprojects/629/AA.pdf
5	Marine and Hydrokinetics (MHK) Knowledge Base	http://www.advancedh2opower.com/default.aspx
6	Wavegen Project	Technology Link - LIMPET OWC fixed Near shore http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=67c3f110-f817-430e-a8d8-4dfd416a4689&type=tech
6	Douglas County Wave Energy Project	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=d8aa4649-eb39-4aeb-bac8-2c3cb5cdcf8e&type=project Technology Link - LIMPET OWC fixed Near shore http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=67c3f110-f817-430e-a8d8-4dfd416a4689&type=tech FERC Preliminary Permit No. P-12743, Accession No. 20070406-3006 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=11304163
6	Fixed - Oscillating Wave Surge Converter	Technology link – http://www.oceanlinx.com/index.php/our-products/bluewave
6	Waveplane Prototype 1.	Technology Link - http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?type=tech&id=aee84186-d695-424e-a998-73d7eda238f3
7	Aquamarine Power EMEC-1 project	Technology Link – Oyster http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=53268cd8-74be-4a4c-bc7a-851e93bc0d06&type=tech
7	CETO Wave Energy Technology	Technology Link - http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=eb5a9403-c038-487b-9d3a-47f37a8de04b&type=tech
7	bioWAVE Technology	Technology Link - http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=5ee7ba85-cc10-43fe-8173-61b48854cc19&type=tech
8	"Poseidon" Floating Power Plant	Technology Link - Poseidon 37 http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?type=project&id=e3496965-54b5-4892-a259-0c6ecf25245f

Page	Reference	URL Link
8	Reedsport OPT Wave Park Project	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?type=project&id=4e120708-c79c-464d-9a29-c72fb5c6eae5 Technology Link – PowerBuoy http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=1812f3ca-a8cb-4f70-b306-41166d8a2b7f&type=tech FERC Preliminary Permit No. P-12713, Accession No. 20070216-4004 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=11264469
8	Coos Bay OPT Wave Park Project	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=fd56bf77-c21e-4bab-b7f9-3177df0d5688&type=project Technology Link – PowerBuoy http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=1812f3ca-a8cb-4f70-b306-41166d8a2b7f&type=tech FERC Preliminary Permit No. 12749, Accession No. 20070309-3018 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=11283961
8	Orcadian Wave Farm Profile	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?type=project&id=72c5c76b-b8c0-4219-a783-46cb2a380dc3 Technology Link – Pelamis http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?type=tech&id=c403e422-7feb-43e1-8f6c-3eeb273f614a
8	WaveDragon	Technology Link - Wave Dragon http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=93b2490c-ea38-4cbd-92ee-ab0b71ccd53d&type=tech
9	Turnagain Arm Tidal Generation Project	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=7ed9f7de-4e8d-4a92-be05-addb0ead9d1f&type=project Technology Link - The Davis Hydro Turbine http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=9a476308-97db-4690-98ec-e50c193b404f&type=tech FERC Preliminary Permit No. P-13509, Accession No. 20090903-3027 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=12132192
9	Hastings Project	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=a939cf33-fa5e-4b17-96ca-4df07cc479ea&type=project Technology Link – Kensington http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=16bbeb8d-7469-49fd-b273-fd0225e9499f&type=tech FERC Project No. P-4306, Accession No. 20081213-4000 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=11876400
9	Western Passage OCGen Power Project	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=68296cf6-730d-43cb-8a9b-79ee358c02a1&type=project Technology Link - OCGen turbine-generator unit http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=7862e0f2-29e0-4fb4-a71d-a74dc801784d&type=tech FERC Preliminary Permit No. P-12689, Accession No. 20070723-3013 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=11403669

Page	Reference	URL Link
10	Roosevelt Island Project	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=1bc140b2-dd50-416f-ae56-02f2acf6822c&type=project Technology Link – Free Flow Kinetic Hydropower System http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=f90cd770-4761-402d-bd62-8cfdfa4ca73e&type=tech FERC Preliminary Permit No. P-12611, Accession No. 20051213-3017 http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=f90cd770-4761-402d-bd62-8cfdfa4ca73e&type=tech
10*	Shetland Islands Profile , United Kingdom	Technology Link - Stingray http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?type=tech&id=6962aadb-26bb-47c5-9338-e3e0aa45a990
10	Admiralty Inlet Project, Washington	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=7e266960-e13b-4eb1-8c5f-a79d61feecf3&type=project Technology Link - Open-Centre Turbine http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=f53233db-2fe5-4435-bc41-59d0e2acb310&type=tech FERC Pilot License application P-12690, Accession No. 20091228-5046 http://elibrary.ferc.gov/idmws/search/intermediate.asp?link_file=yes&doclist=13780893
10	Yukon River Project at Eagle, Alaska	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=349250fd-b4ce-435b-aa65-328e0677c665&type=project No Pilot License Application
10	Ste. Genevieve Bend Project, Missouri	Project Profile http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=6e926193-539a-430f-b561-493cf851280b&type=project Technology Link – SmarTurbine http://www1.eere.energy.gov/windandhydro/hydrokinetic/information.aspx?ID=9421b1ce-cd78-4f2a-855e-62629760c0b5&type=tech FERC Preliminary Permit No. P-12917, Accession No. 20080201-3048 http://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=11575978

Chapter 3 - Types of Recreation		
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13	Active Outdoor Recreation Economy Report	http://www.outdoorindustry.org/images/researchfiles/RecEconomy_Statefinal403.pdf?52
13	National Survey on Recreation and the Environment	Report: http://www.srs.fs.usda.gov/trends/Nsre/nsre2.html PowerPoint: http://www.srs.fs.usda.gov/trends/Nsre/NSRE200562303.pdf
14	Dawson, 2010	http://www.nrs.fs.fed.us/pubs/gtr/gtr_ne198/gtr_ne198_039.pdf
15	American Canoe trails database	http://www.americancanoe.org/site/c.lvIZIkNZJuE/b.4850753/k.3403/The_ACAs_Water_Trails_Database.htm

Chapter 4 – Concepts for Assessing Impacts		
27	FERC licensing review	http://www.ferc.gov/industries/hydropower/gen-info/licensing/ilp/eff-eva/ideas.pdf

Chapter 5 – Potential Impacts on Recreation Opportunities		
Page	**Reference**	**URL Link**
30	Coast Guard regulations	http://www.law.cornell.edu/cfr/cfr.php?title=33&type=chapter&value=1
30	Army Corps of Engineers regulations	http://www.iwr.usace.army.mil/NDC/navchart/navregs.htm
36	Review of Illinois low head dam access restriction issues	http://www.illinoispaddling.org/access_project
37	Angler attraction to oil drilling platforms in Gulf of Mexico	http://www.rodnreel.com/gps/DeepWater.asp
44	National Geographic article about night sky issues	http://ngm.nationalgeographic.com/2008/11/light-pollution/klinkenborg-text
44	NPS study about light pollution	http://www.nature.nps.gov/air/lightscapes/mgmt.cfm
44	Organization with information about low-light pollution products and design techniques	http://www.darksky.org/

Chapter 6 – Types of Hydrokinetic Projects		
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63	Study plan determination for Mississippi projects	http://elibrary.ferc.gov/idmws/File_list.asp?document_id=13788453
65	EcoTrust fishing importance map	http://www.ecotrust.org/ocean/OpenOceanMap.html

Chapter 7 – Protection Strategies and Adaptive Management		
Page	**Reference**	**URL Link**
70	EcoTrust ocean mapping project	http://www.ecotrust.org/ocean/
70	Finalized recommendations of Interagency Ocean Task Force	http://www.whitehouse.gov/files/documents/OPTF_FinalRecs.pdf
70	Marine spatial planning	http://www.msp.noaa.gov/
71	Oregon territorial sea plan	http://www.oregonocean.info/index.php?option=com_content&view=article&id=66:territorial-sea-plan-amendment-process&catid=15:stay-up-to-date-on-ocean-alternative-energy&Itemid=12
72	Department of Interior adaptive management principles	http://www.doi.gov/initiatives/AdaptiveManagement/whatis.html

Chapter 8 – Getting Involved: Authorities, information requirements, and Licensing Processes		
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73	FERC hydrokinetics webpage	http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics.asp
73	BOEMRE renewable energy page	http://www.boemre.gov/offshore/RenewableEnergy/index.htm
73	DOE wind and hydrokinetics webpage	http://www1.eere.energy.gov/windandhydro/pdfs/siting_handbook_2009.pdf
73	Hydropower Reform Coalition webpage	http://www.hydroreform.org/hydroguide
74	FERC public participation information	http://www.ferc.gov/for-citizens/get-involved.asp
74	Preparing environmental documents	http://www.ferc.gov/industries/hydropower/gen-info/guidelines/eaguide.pdf#xml=http://search.atomz.com/search/pdfhelper.tk?sp_o=2,100000,0
74	CEQ guidelines on public participation	http://ceq.hss.doe.gov/nepa/Citizens_Guide_Dec07.pdf
74	Siting handbook	http://www.advancedh2opower.com/Resources/Regulatory Roadmaps/Siting Handbook_2009.pdf
74	Clean Water Act Section 401(a)	http://www.nwo.usace.army.mil/html/od-rwy/33USC1341.htm
74	Endangered Species Act	http://www.fws.gov/endangered/consultations/s7hndbk/s7hndbk.htm
74	Coastal Zone Management Act	http://coastalmanagement.noaa.gov/about/czma.html
74	National Historic Preservation Act	http://www.mms.gov/eppd/compliance/nhpa/index.htm
74	HRC Citizen's toolkit	http://www.hydroreform.org/hydroguide/hydropower-licensing/citizen-toolkit-for-effective-participation
74	Section 338 of Energy Policy Act	http://www.boemre.gov/ooc/PDFs/EnergyPolicyActof2005andMMS.pdf
74	Programmatic Environmental Impact Statement	http://www.ocsenergy.anl.gov/documents/docs/OCS_FPEIS_NOA.pdf
74	BOEMRE NEPA guidance	http://www.gomr.boemre.gov/homepg/regulate/environ/nepa/nepaprocess.html
74	FERC preliminary permits	http://www.ferc.gov/industries/hydropower/gen-info/licensing/pre-permits.asp
74	Federal Power Act	http://wildlifelaw.unm.edu/fedbook/fedpower.html
75	Reedsport FERC preliminary permit	http://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=11264469
75	FERC license checklist	http://www.ferc.gov/industries/hydropower/indusact/hydrokinetics/pdf/pilot_project.pdf
75	FERC guidance	http://www.ferc.gov/industries/hydropower/gen-info/licensing/ilp/eff-eva.asp
76	FERC hydrokinetics links	http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics.asp
77	FERC pilot license information	http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/energy-pilot.asp

Page	Reference	URL Link
78	FERC required information	http://edocket.access.gpo.gov/cfr_2006/aprqtr/18cfr5.18.htm
78	CFR regulations regarding FERC licenses	http://edocket.access.gpo.gov/cfr_2006/aprqtr/18cfr5.6.htm
79	FERC pre-filing steps (regarding studies)	http://www.ferc.gov/industries/hydropower/gen-info/licensing/ilp/pre-filing-steps.asp
79	HRC study plan development advice	http://www.hydroreform.org/hydroguide/hydropower-licensing/4-2-study-plan-development-and-nepa-scoping
79	FERC advice regarding potential settlements	http://www.ferc.gov/whats-new/comm-meet/092106/H-1.pdf
80	NPS webpage on hydropower assistance program	http://www.nps.gov/hydro
81	NPS webpage on National Wild and Scenic Rivers system	http://www.rivers.gov/