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Social and Economic Data Collection for Marine Renewable Energy

The social and economic effects of marine renewable energy (MRE) are a necessary consideration for the consenting/permitting (hereafter consenting) of projects (including planning, siting, and project design) and for strategic planning processes. Social and economic effects can include impacts on people, communities, jobs, wages, and revenues (Uihlein and Magagna 2016).

9.1. IMPORTANCE OF THE ISSUE

Fully understanding the effects of MRE developments includes addressing the social and economic aspects (e.g., coastal development, valuation of an area, population, services, cultures, and well-being). For the purpose of this chapter, the focus is on gathering and analyzing information strictly as it is needed for consenting MRE. This chapter does not include an exhaustive list of potential effects, indicators or data types, or assessment methods. Instead, it provides a general overview/description and some examples of social and economic effects and data collection in order to move toward both a better understanding of the effects of MRE and good practices for data collection. While some countries have provided common frameworks, such as the European Union (EU)'s Marine Strategy Framework Directive (Directive 2008/56/EC 2008), they are outside of the purview of this chapter. A large body of knowledge exists about social and economic effects, but not all of it is specific to MRE. As the industry advances and more MRE development occurs, understanding of the social and economics effects of MRE will increase and the information presented in this chapter can be expanded upon.

A number of studies have shown that the MRE sector has the potential to create significant social and economic benefits, including benefits for rural and coastal communities and economies that other sectors cannot reach (Regeneris Consulting Ltd. 2013; Smart and Noonan 2018). The social and economic benefits of MRE projects include low visual impacts (Bailey et al. 2011; Devine-Wright 2011), engagement of the local population (Devine-Wright et al. 2013), and an increase in employment opportunities (Lavidas 2019). Some MRE deployments have provided insight into potential effects and their extents, and indicated the importance of social and economic effects, especially as the industry scales up to array-sized deployments (see Section 9.6). However, because the MRE industry is in the early stages of development globally, some uncertainty regarding potential social and economic benefits or adverse effects of developments remains (Bonar et al. 2015).

Social and economic data and information are needed to support strategic planning for and the consenting of MRE developments, especially in relation to understanding the social and economic effects, dynamics, and values in a community and surrounding areas (Figure 9.1). Commonly, social and economic effects are assessed through cost-benefit analyses or social and economic impact analyses (Uihlein and Magagna 2016). In many countries, these analyses are required as part of consent applications and are often included in environmental impact assessments (EIAs) in Europe or environmental impact statements (EISs) in North America. Furthermore, many countries require the assessment of socioeconomic impacts in their strategic planning processes for marine energy (see Chapter 11, Marine Spatial Planning and Marine Renewable Energy).

To improve how these effects are assessed, there is a need for additional focus on and the development of standardized processes, best practice examples, and guidance for social and data collection and use in MRE consenting and strategic planning. Current practices are inconsistent and could be better developed (Copping et al. 2017). Further, the degree to which social and economic data and assessments have a substantial influence on the outcome of strategic planning or license determination processes is often unclear, even when they are required in support of applications or planning processes.

Ocean Energy Systems (OES)-Environmental has been involved in furthering understanding of the social and economic effects from the perspective of data collection, analysis, and application for consenting, which have been addressed at two international workshops. The first workshop (Copping et al. 2017), hosted at the 2017 European Wave and Tidal Energy Conference, examined frameworks and practical aspects for collecting data that define the social and economic risks and benefits of MRE development. The second workshop (Copping et al. 2018), held in conjunction with the Environmental Interactions of the Marine Renewables 2018 conference, built on the 2017 workshop and examined case studies for social and economic impacts. This chapter builds on the outcomes from both workshops, and much of the information in this chapter comes from discussion and feedback at these workshops. This chapter provides a general overview of the definitions of social and economic effects; requirements for collecting social and economic data in several OES countries, including the responsibility for data collection and stakeholder engagement; needs for data collection; and good practices for data collection, case studies to showcase lessons learned, and recommendations for future data collection improvements.

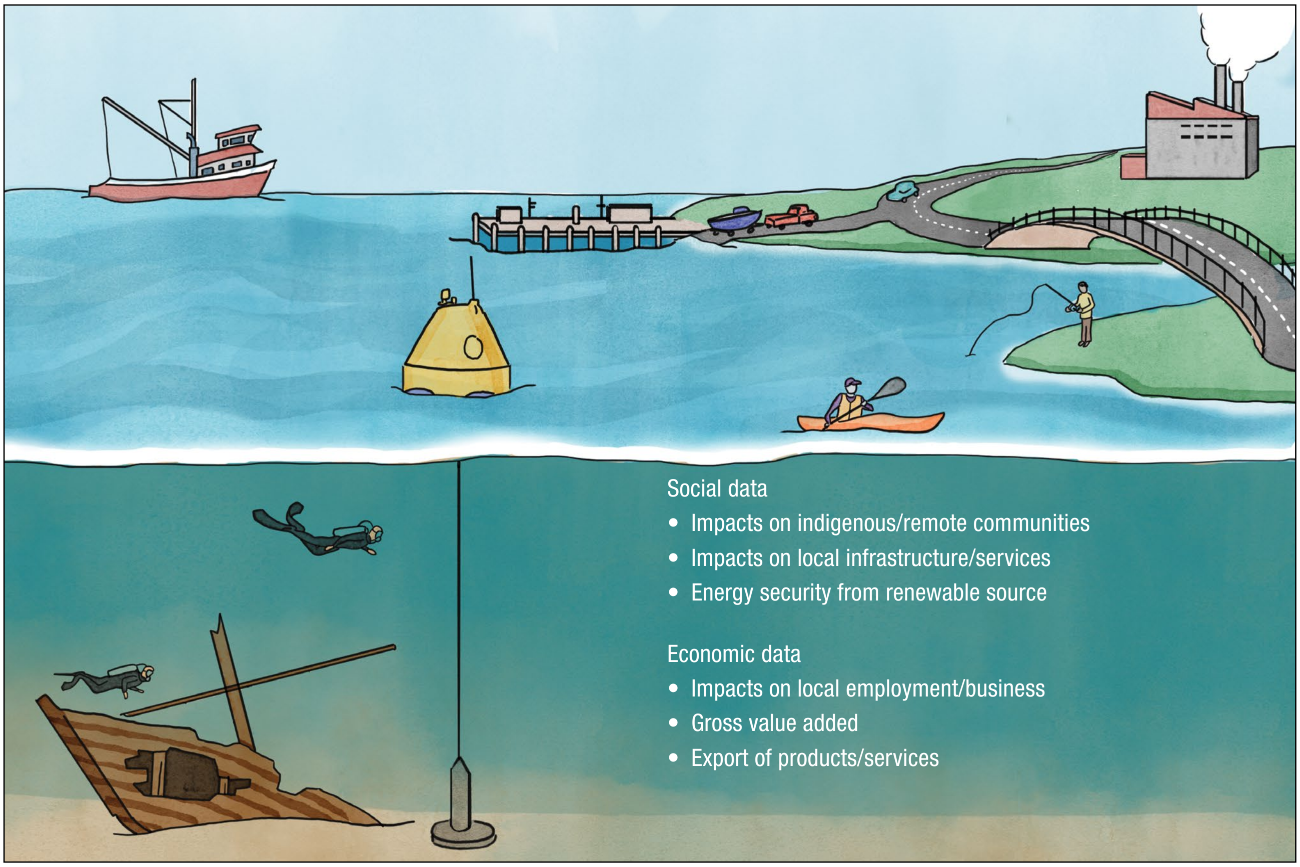


Figure 9.1. Examples of social and economic activities for which data should be collected for consenting and understanding of the potential benefits and adverse effects of marine renewable energy development. (Illustration by Rose Perry)

9.2. DEFINITION OF SOCIAL AND ECONOMIC EFFECTS

Social and economic effects can include benefits to or adverse effects on employment, local infrastructure and services, regional businesses, and communities. Additional examples of social and economic effects can be found in the supplementary material (online at: *https://tethys.pnnl.gov/state-of-the-science-2020-supplementary-socio-economics*). Social and economic issues are commonly considered together, but it is important to distinguish between the two because they differ in assessment methods, data types, and scales (both temporal and spatial); for instance, economic data are often quantitative while social data are often qualitative. Key economic indicators include the effects on gross value added[1], employment, wages, exports, businesses, and existing industries, while key social indicators include the effects on infrastructure and facilities, services, cost of living, health and well-being, culture, and populations (Kerr et al. 2014; Vanclay et al. 2015). It is important in any assessment of social and economic effects to include the effects on indigenous and remote communities, because they are often marginalized and may be affected differently than other communities (Kerr et al. 2015).

MRE developments have the potential to provide benefits to local, regional, and national communities. They can stimulate economic development and output, as well as generate revenue and employment opportunities, especially local job creation (including skilled jobs), throughout the different project stages, including manufacturing, transportation, installation, operation, and maintenance (Akar and Akdoğan 2016). MRE developments can provide opportunities for tourism, such as sightseeing and fishing experiences from project structures that serve as artificial reefs/fish-aggregating devices (see Chapter 6, Changes in Benthic and Pelagic Habitats Caused by Marine Renewable Energy Devices) (Leeney et al. 2014; van den Burg 2019). On the other

1. Gross value added is used to measure the contribution made by an industry or sector and is calculated by the output minus consumption (OECD 2001).

hand, if MRE developments are not carefully located and implemented, they could have adverse effects on communities, economies, and employment. For example, MRE developments may exclude other marine uses, such as reducing access for fisheries, if they are not sited sensitively. In addition, an MRE development could affect the perceived value of an area; for instance, visual components may be negatively perceived by a community or homeowners in the vicinity (Rand and Hoen 2017; Vanclay 2012). Furthermore, the economic effects of an MRE development can vary greatly depending on whether the installation and/or operation are staffed locally or by outside sources. For example, if an MRE development does not use the local supply chain it may fail to create much local benefit or provide direct employment.

Key economic data and information for measuring changes include data about local employment (e.g., job creation potential, employment multiplier, gross wages), inward investment potential, extent of the local and regional supply chain, gross value added, exports of products and services, existing sectors (e.g., commercial fishing, tourism and recreation, shipping and navigation), and economic impacts of MRE on local communities (Copping et al. 2017, 2018; Marine Energy Wales 2020; Smart and Noonan 2018). Some key social data and information to collect include social and cultural context (e.g., social dynamics, cultures and values, traditional activities), demographics and community structure, energy security and carbon offsets (Smart and Noonan 2018), protected or conservation areas, other marine uses (e.g., commercial fisheries, indigenous fisheries, leisure, and recreation), and impacts on local communities (Copping et al. 2017, 2018). Some key metrics for measuring change include business opportunities, net job gain or loss, improvements in existing infrastructure and services, social acceptance and awareness, impacts on local communities, and impacts on existing businesses and marine uses (Copping et al. 2017, 2018).

9.3. REQUIREMENTS FOR COLLECTING SOCIAL AND ECONOMIC DATA TO SUPPORT CONSENTING

Governmental/regulatory or statutory requirements for collecting social and economic data are limited and poorly defined, and regulations can vary from one country to the next as well as within countries, if they exist at all. Several countries and regulatory bodies have requirements for assessing social and economic factors when considering the development of new infrastructure projects. These requirements are primarily addressed in EIAs (also called EISs, environmental statements [ESs], impact assessments [IAs], social impact assessments [SIAs], or environment and social impact assessments [ESIAs], depending on the country). These planning documents are not unique to MRE developments; they are usually required for any full-scale infrastructure project, including device deployment, and few countries have requirements that are specific to the development of MRE projects.

9.3.1. COUNTRY-SPECIFIC SOCIAL AND ECONOMIC REQUIREMENTS FOR MRE

Requirements to consider when assessing social and economic factors are described below for several OES-Environmental countries:

- The EU updated the EIA Directive in 2014 to broaden its scope to include climate change, population and human health, biodiversity, landscape, and risk prevention (Directive 2014/52/EU 2014). Under EU law, these requirements are transposed into member state national EIA legislation by May 2017.
- **France** requires additional analysis of project impacts on cultural heritage that includes architecture and archaeology, impacts on the visual landscape, and the level of nuisance created for humans by project noise, vibration, or light (Environmental Code 2018).
- **Norway** has adopted some components of the EU EIA Directive (Directive 2014/52/EU 2014) to specifically include consideration of conflicts with cultural environments or monuments, traditional reindeer husbandry practices, and other tenets of outdoor life in environmental assessments (Regulations on Impact Assessments 2017).

- In the **United Kingdom** (UK) there is no UK-wide planning process for MRE; there are different systems for Scotland, Northern Ireland, England, and Wales. Consideration of social and economic factors is required in alignment with the EU EIA Directive[2] (Directive 2014/52/EU 2014), which is transposed into UK law (including at a devolved nation level[2]) through specific EIA Regulations. Each devolved administration within the UK has marine planning responsibility, which sits alongside the leasing responsibilities of The Crown Estate Scotland. Marine spatial plans produced within each of the UK devolved nations (see Chapter 11, Marine Spatial Planning and Marine Renewable Energy) generally also include policies related to socioeconomics, which must be taken into account in licensing decisions. Applicants must assure that they have provided sufficient information in support of their license applications for these policies to be considered and permitting authorities must be able to demonstrate that they have taken account of socio-economic policies in their decision-making. A description of impacts on populations and human health, cultural heritage, and the landscape is required across the UK. Where EIAs have been completed for MRE developments (such as at Pentland Firth and the Orkney Islands), they have included predictions of local job creation as well as possible impacts associated with port congestion, near neighbor issues, etc. However, the guidance provided by local and national governments and agencies about social and economic issues, such as local impacts, has been poorly defined and has not been adequately assessed.

  Some examples of the types of information provided in social and economic assessments are provided below:

  - The ES for the European Marine Energy Centre (EMEC) test center at Billia Croo in Scotland included a section on land use, fisheries, and socioeconomic issues, which required consideration of local economic benefits, traditional fishing regions and access, and harbor congestion (Carl Bro Group Ltd. 2002).
  - The ES for MeyGen in Scotland included a description of social and economic issues, including tourism and recreation, harbor and port facilities assessments, local jobs, and other sea uses. In addition, a full commercial fisheries navigational risk assessment and cultural heritage impact assessment were carried out (MeyGen 2012).
  - At SeaGen in Strangford Lough in Northern Ireland, the EIA included an assessment of cultural heritage, social and economic impacts, and a navigational risk assessment. The social and economic impacts included land use, commercial fisheries, and tourism.
- **India** has required consideration of socioeconomic factors since 2006, including anything that would "affect the welfare of people e.g., by changing living conditions", impacts on vulnerable groups of people, the generation of noise or light nuisance, disturbance of tourist routes or facilities, and impacts on "areas occupied by sensitive manmade land uses (hospitals, schools, places of worship…)" (Environmental Impact Assessment Notification 2006). In addition, India already has a specific procedure in place for monitoring and evaluating renewable energy infrastructure projects, including MRE. The ESIA for renewable energy requires analysis of population characteristics, community and educational structure, political and social resources, individual and family changes, and community resources relevant to any development (Dutta and Bandyopadhyay 2010). For example, a draft ESIA for a 200 MW wind project included an analysis of factors including poverty levels, demographic profile, literacy, cultural values, and religious distribution (Voyants Solutions Pvt. Ltd. 2016).
- SIAs have been included in projects in **China** for decades, but they have faced many implementation challenges (e.g., Ip 1990). The first Environmental Impact Assessment Act of the People's Republic of China, passed in 2003, did not explicitly address social issues (Tang et al. 2008). Over time, public participation and social impact assessment have been incorporated more informally into the EIA process (Ren 2013), and China began requiring social risk assessments for major development projects beginning in 2012 (Bradsher 2012; Price and Robinson 2015).

2. Devolution is the concept of delegating power from higher levels of government to lower levels. In the UK devolved nations include Scotland, Northern Ireland, England, and Wales, and while each has statutory powers transferred to them by the UK, some reserved powers remain with the UK. (*https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770709/DevolutionFactsheet.pdf*)

- In the **United States (U.S.)**, SIAs have been a part of the National Environmental Policy Act of 1969 legislation since its initial adoption in 1970 (Burdge and Taylor 2012). Several other pieces of legislation have also included requirements for an SIA, including the Magnuson-Stevens Fishery Conservation and Management Act 1976, the Outer Continental Shelf Lands Act 1978, and others (Burdge and Taylor 2012). In addition, there are coastal requirements that may vary from state to state throughout the U.S. and may be significant.
- **Canada** approved the Impact Assessment Act and the Canadian Energy Regulator Act in August 2019 that adds factors to reflect a more holistic assessment of environmental impacts, specifically in the energy sector. These acts include requirements for assessing the potential negative effects on gender issues in the workforce, exploitation of vulnerable groups, and an increase in cooperative indigenous partnerships and consultations in the development of new projects (Government of Canada 2018, 2019).

9.3.2. DATA COLLECTION RESPONSIBILITY

The responsibility for collecting social and economic data falls to different levels of government, planning authorities, or other responsible parties, such as project developers, depending on the intended purpose and application of the data. However, it is difficult to determine the specifics of who should be responsible for data collection and assessments and, often, any gaps become the burden of the project developer. It is especially challenging to determine the responsibility for long-term baseline data collection and continuing assessments to inform strategic planning for future developments, all of which can be costly. To collect data in a meaningful manner, it is important to come to a consensus on the expectations of the different levels of government (strategic-level data) versus the project developer (project-level data); hence, the two relevant levels of assessments and data collection to be considered are:

- strategic-level activities and measures that should be implemented to meet objectives in line with local, national, and regional policy by government, agencies, and other relevant organizations, and
- project-level activities and measures that should be implemented by the project developer to meet objectives on a local scale, such as within a municipality or community.

Strategic assessments of social and economic effects generally fall to governmental and marine planning entities that can assure that data collection and analysis are completed consistently using appropriate methods to define future effects (Figure 9.2). An advantage of public-sector-collected data is that any results, findings, or reports would be readily accessible. The disadvantage of public data is that results may be outdated, not regularly updated, or relevant data may not have been collected. While developer-collected data are often not shared with the public or easy to access, it may be more contemporary than data from alternative sources. Different levels of government can collaborate to provide information at a strategic level. For instance, higher levels of government could request or provide support for local authorities to collect relevant social and economic information, which could then be scaled up to regional or national levels. In addition, strategic-level assessments carried out by governments can be important to better understanding project-level impacts. For instance, the U.S. Bureau of Ocean Energy Management commissioned two economic impact assessments of wave energy deployments in Oregon, U.S. (Jimenez and Tegen 2014; Jimenez et al. 2015) that showed a significant impact, including an increase in jobs, and identified potential sources of economic development. Both reports are publicly available and can be used to inform future MRE developments and their project-level assessments.

Project-level information would more likely fall to the responsibility of MRE developers (Figure 9.2). Developers will need to collect data and information to support both site-identification and project design and regulatory requirements for consenting. Consulting with regulators is key to defining requirements and data needs from an early stage of project development. This can include discussions about the application of national or regional data to aid project-level assessments. For example, if data are not available at the project-level it may be necessary to downscale strategic-level data to fill in gaps and satisfy regulatory requirements. Developer-collected data are not extensive and can be difficult to track because such data are usually considered private and are often not publicly available. This absence of developer-collected data is likely due to a lack of funds available for data collection that is not based on a regulatory requirement. However, if such information is collated within environmental assess-

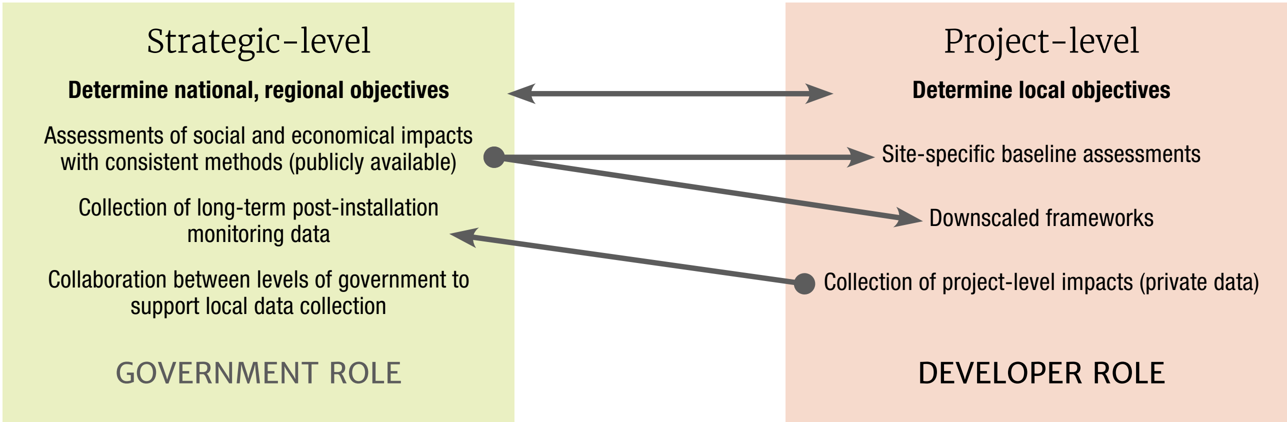


Figure 9.2. Responsibilities of governments and developers in collecting social and economic data, as recommended by expert workshops (Copping et al. 2017, 2018). The arrows indicate which direction data should flow (for example, assessments with consistent methods should inform site-specific baseline assessments and downscaled frameworks).

ments and consent/license applications, it may be made available in the public domain. Trade associations, data portals, test sites, or universities could play an important role as intermediaries that could collate such data and publish results that may not be available directly from developers. The MRE industry can also provide collated information to reveal the potential impacts of MRE, which can then be used by developers to present the likely effects of a project. Two examples include a state of the sector report detailing the economic benefits of MRE for Wales (Marine Energy Wales 2020) and a report about the cost reduction and industrial benefits of MRE for the UK (Smart and Noonan 2018). While these highlight potential impacts, the most effective option is to deploy devices and collect data as projects progress to understand the true social and economic effects of MRE and adapt or mitigate where necessary.

9.3.3. STAKEHOLDER OUTREACH AND ENGAGEMENT

To be successful at all stages of MRE project development, there must be a well-planned process for stakeholder outreach, engagement, and consultation (Equi-Mar 2011; Kerr et al. 2015) that begins early in project planning (Simas et al. 2013). This is especially important because there is relatively little public familiarity with, knowledge of, or awareness of MRE, including the different types of technologies and potential impacts of MRE developments (Dalton et al. 2015), and there may be misconceptions or misunderstandings of MRE and its impacts (Stokes et al. 2014). A study of local perceptions of the Wave Hub deployment in Cornwall, England, found that stakeholders had firm views (such as concern about the wave device affecting waves for surfing) based on intuitions that were generally not influenced by technical understanding or impact assessments (Stokes et al. 2014).

Communicating with stakeholders provides a range of benefits to developers. It is crucial to have the support of stakeholders and local communities, both for individual projects and for the long-term acceptance of the MRE industry. In this sense, stakeholders can include political leaders, local businesses, members of the supply chain, nongovernmental organizations, social program staff, and community members, and especially indigenous and local communities (Isaacman et al. 2012). MRE projects are often located in rural and sometimes remote areas where development pressures have not been previously experienced. MRE developments are relatively new and unproven commercially and therefore they can be seen as both pioneering or experimental. A partnership approach, with full communication (listening as well as information sharing), practical engagement (using local resources as a priority), and options for local participation (such as investment once risk levels are appropriate) can help align local community and project-related interests.

Stakeholders will differ between communities, regions, and countries, and, while it can be difficult to define the stakeholders, identifying main groups and involving local communities is crucial. Stakeholders (especially local knowledge-holders) can supply a wealth of knowledge and information, and help assure that the data collected and the metrics used are relevant to the project and the community. They can be important allies and supporters of MRE development if they are engaged early in the process through transparent and timely communication. Sharing success stories or positive case studies from other projects or analogous industries, such as offshore wind, can be an especially useful tool to aid outreach efforts and can provide insight into best approaches and lessons learned (Box 9.1). In addition, developer awareness of prior projects (both MRE or other industries) that have not been successful or failed to deliver on promises or commitments can aid in understanding community perceptions of a new MRE project. Building trust by engaging stakeholders early in the development process and being transparent throughout project development is key to successful stakeholder engagement efforts. Involving stakeholders can be challenging and often lengthens the process, especially because all stakeholders may not initially be in favor of MRE development. In circumstances where a project or particular development strategy may be irreconcilable with local interests, concerns, and aspirations, it may not be appropriate for a proposed development to proceed. While difficult, such successful engagement and participatory processes can lead to consensus building, help manage conflict and build trust, and gain better cooperation (Drake 2012).

9.4. DATA COLLECTION AND NEEDS

Social and economic information is needed to understand baseline and long-term assessments at all scales, economic changes (e.g., employment, wages, local supply chain, etc.), and social changes (e.g., social structures, schools, housing, services, etc.), as well as the success of projects that maximize benefits and limit adverse effects.

For social and economic data to be useful, they must be collected (by developers, researchers, industry, etc.) consistently and comparably over time (both before and after a project), to the extent possible, so that they can be comparable (Leeney et al. 2014) and put into context to demonstrate potential impacts. Qualitative data should be used in addition to quantitative data (Vanclay 2012). Providing a cultural context, history of events, and narratives from communities can help understand initial attitudes and expected responses to potential developments. These social characterizations must include spatial and temporal factors for any assessment.

Value maps (e.g., Figure 9.3) can also be a useful tool to represent the stakeholders, cultures, or jobs, and provide important context for assessments to help determine the best approach to MRE development.

9.4.1. DATA COLLECTION CONSISTENCY AND REGULATORY GUIDANCE

It can be difficult to predict or analyze the effects of MRE projects. For example, understanding local impacts is difficult for smaller projects because the associated number of jobs alone may be minimal, may not be truly indicative of the change, and will necessitate other data, information, or context to show the full effect (Copping et al. 2018), and in the end these impacts may still be small at the MRE prototype and demonstration scale. Gathering and analyzing social and economic data to capture and grasp the full spectrum of effects can be challenging because of a lack of

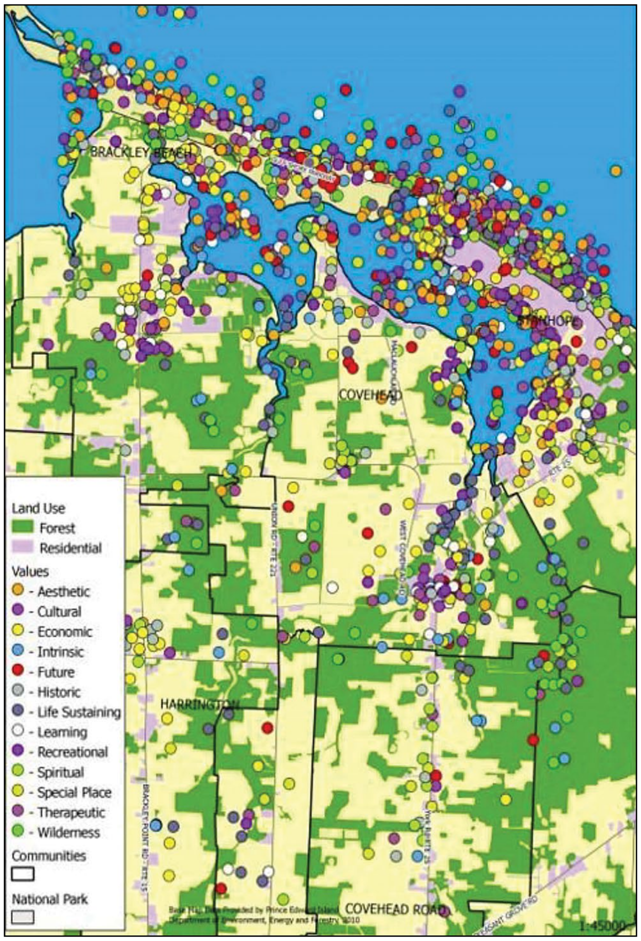
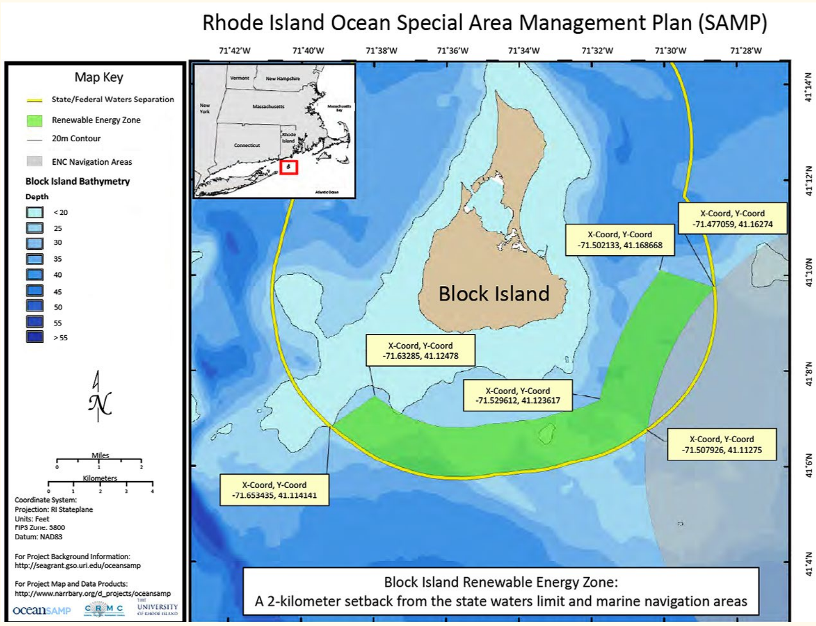


Figure 9.3. A value map created from a study of social and cultural values related to climate change adaptation on Prince Edward Island, Canada. Colored dots note areas where survey participants expressed interest based on the specific values. (From Novaczek et al. 2011)

BOX 9.1

EXAMPLES OF STAKEHOLDER ENGAGEMENT AND OUTREACH FROM THE MARINE RENEWABLE ENERGY (MRE) AND OFFSHORE WIND INDUSTRIES



MRE test centers – A review of environmental impact assessments from several MRE test centers showed that consulting stakeholders (e.g., fishers, surfers, navigation authorities, etc.) early (prior to test center design) introduced an opportunity for stakeholders to voice concerns and provide input. Through this engagement process, test centers were able to choose a location and design that addressed potential concerns, did not require further mitigation, and most important were agreed upon (Simas et al. 2013).

Offshore wind on the United States (U.S.) Atlantic Coast – As Rhode Island developed the Ocean Special Area Management Plan, they conducted a comprehensive stakeholder engagement process to give stakeholders an opportunity to have a say in the process. When an application for wind development came around, stakeholders (i.e., commercial fishery representatives, environmental advocates, and members of the Narragansett Indian Tribe) were able to support the application and encourage siting and consenting because of their early involvement (Smythe et al. 2016).

MRE in Orkney, United Kingdom – MRE development and its ramifications in Orkney involve many individuals and organizations such as Aquatera, European Marine Energy Centre, Heriot Watt University, Marine Scotland, and Xodus. The Orkney Renewable Energy Forum (OREF) provides an example of ongoing engagement efforts. Since 2000, OREF has brought stakeholders together and has become key to developing the industry in Orkney by focusing on the environmental, commercial, community, and research and development aspects of renewables. OREF has consistently advocated for the community, the MRE sector, and environmental interests of MRE, and has dealt with internal and external challenges to balance competing interests. OREF's approach has helped achieve

- more than 50 device deployments
- an investment of about £400 million in projects in (or linked to) Orkney MRE deployments
- an investment of about £150 million by the local community in MRE developments
- a direct supply chain of about 300 individuals
- support from the vast majority of the community and the local authorities for MRE development
- monitoring of ecological effects that have not yielded indications of harm to fish, marine mammals, or seabirds
- the management of leasing authority devolving from The Crown Estate to The Crown Estate Scotland, which is a new organization that has a more community-centric focus.

OREF continues to work with its partners and the community to further the MRE industry and appropriately address issues that arise (OREF 2020).

MRE in Oregon, U.S. – The Oregon Wave Energy Trust (OWET) started in 2007 as a non-profit, public-private partnership established by the Oregon State Legislature to "responsibly develop ocean energy by connecting stakeholders, supporting research and development, and engaging in public outreach and policy work. OWET works with stakeholders, industry, and local communities to explore the balance among existing ocean uses and ocean energy projects." OWET has funded wave and other technology developments, community outreach and engagement, and research studies to address concerns related to regulatory, environmental, education/outreach, market development, and applied research. About 10 of these studies have addressed social and economic issues, which are major concerns for the coastal community and state government, particularly with the emphasis on the importance of fishing to Oregon coastal communities. OWET has worked with stakeholders including fisheries representatives, the military, a nearby liquefied natural gas plant, and the logging industry. While potential and perceived conflicts between fishing and wave energy were not fully resolved, the care and understanding applied to dealing with fisheries issues specifically, and coastal planning issues in general, provided exemplary models that can be exported to other jurisdictions (OWET 2020). OWET became the Pacific Ocean Energy Trust (POET) in 2017.

guidance or standard approaches for collecting, analyzing, and presenting appropriate data or information (Copping et al. 2017). Having governments at the appropriate level provide guidance and standard approaches would lead to more consistent data collection (including methods and metrics) and the ability to compare results across projects. As data become increasingly available and are compared across projects, understanding of social and economic impacts can increase and benefit the industry as a whole. However, standardization of data is complicated because each project, context, region, and country can be unique in its culture, situation, history, demographics, and regulations, and regulatory guidance at an international level is unlikely. While such standardization can be provided through industry standards, to date the only guidance related to environmental or social and economic effects in the MRE industry is for measuring underwater noise (see Chapter 4, Risk to Marine Animals from Underwater Noise Generated by Marine Renewable Energy Devices).

This scarcity of guidance for conducting proper assessments can cause delays in consenting processes as regulators attempt to interpret impacts, which can hinder strategic planning and license applications. Clarification of how social and economic benefits and adverse effects substantially influence strategic- and project-level decision-making for MRE, and guidance on associated evidence requirements, are needed. Currently, regulatory requirements are driven by the need to respond to legislation and are often focused on numerical data, but numerical data may not be the best way to represent social effects and can involve value judgments. Economic effects may not always be straightforward to represent, but data are frequently collected to understand these effects. Social effects can be even more challenging to properly measure and analyze (Vanclay 2012), so much so that they are often dismissed, left out of assessments, or do not occur on timescales that allow for the effects to be easily understood. Defining success is difficult because there is no standard approach for assessing social and economic effects, regulatory guidance can be hard to provide, and there is not enough data to indicate whether previous efforts to maximize benefits and minimize adverse effects have been successful. To make progress in this area, clear assessment methods and metrics in all locations and the capacity to assess performance relative to those metrics are needed. The responsibility for standard methods and metrics may fall to the research community or industry to develop, while governments may be responsible for creating the impetus for, or requiring the use of, agreed-upon assessments and methods.

9.4.2. SCALES OF DATA COLLECTION

Data collection at all appropriate scales (both spatial and temporal) is important for providing a full picture of the benefits and adverse effects of MRE development. The scales at which data collection should be carried out will vary across projects and countries (and may include spatial scales ranging from the project, city, state, or regional level or temporal scales ranging from a monthly, yearly, or bi-annual basis) based on a variety of factors. Spatial effects are more likely to occur at smaller geographic scales or at the project level. As the MRE industry moves to larger arrays and/or multiple projects in a similar area, it will be important to assess social and economic effects over larger geographic scales. However, most spatial data are collected over a large geographic area or at a strategic level and are not specific to MRE developments. While such data can offer a useful starting point, MRE developers must downscale such data on a project-by-project basis or collect additional project-level data, which can be costly, to gain an understanding of the potential effects. For example, regional and national data are collected at larger geographic scales and will need to be downscaled to inform projects at smaller geographic scales.

Similarly, most assessments and research focus on the shorter-term impacts (Dalton et al. 2015). Having long-term data is equally important, especially as the industry develops. Because of a lack of well-established and coordinated efforts to track the social and economic effects of the MRE industry over time, the onus falls on the project developers, especially those first in the water, to show anticipated benefits and adverse effects. Another issue with temporal data is the lag between the time of data collection and actual implementation of an MRE project (Copping et al. 2018). Demonstrating the benefits of early MRE projects and collectively tracking efforts over time would help future projects plan for impacts, improve consenting processes, and aid in obtaining public acceptance of future MRE projects.

9.5. GOOD PRACTICES FOR COLLECTING DATA AND FOLLOWING TRENDS

Good practices for social and economic data collection for impact assessment and monitoring of MRE developments can contribute to planning and management that will maximize benefits and avoid or minimize adverse effects (Vanclay et al. 2015). However, there is lack of available frameworks or guidance related to good practices. Good practices can provide greater standardization in collecting and assessing baseline, installation, and operational data to be used in consenting MRE projects. Improving the consistency of data collection allows for benefits and adverse effects of projects on communities to be compared, and will foster a better understating of long-term impacts and changes.

OES-Environmental has developed a set of good practices for the collection of social and economic data (see Table 9.1). Because the industry is in the early stages of developing frameworks, guidance, and associated good (or best) practices, these good practices are based on qualitative experiences and will need to be improved as the industry advances.

Table 9.1. Good practices for the collection of marine renewable energy (MRE) social and economic data. (From Copping et al. 2019)

Practice 1:	Strategic-level data collection, analysis, and assessments should be carried out by the appropriate level of local, regional, or national government (or relevant agencies) in order to understand the benefits and adverse effects of MRE projects, and the data should be collected in relation to the size of the development (for example, larger projects may necessitate more data if strategic decisions are involved).	
Practice 2:	Specific questions should be developed by researchers and/or the MRE community and the answers to these questions should elucidate changes in social or economic conditions (either benefits or adverse effects) for the communities and regions in which MRE development is planned. These questions should drive the specific data collection efforts and analyses.	
Practice 3:	Baseline social and economic data should be collected that address the current social and economic attributes, at the appropriate scale, prior to MRE development. For this practice, it is important to differentiate between strategic-level (3A) and project-level (3B) baseline data and who may be responsible for the collection efforts.	
	Practice 3A: Baseline data for strategic assessments should be gathered by the appropriate level of local, regional, or national government, scaled to the closest possible geographic extent for the area of the MRE project, before development occurs.	**Practice 3B:** Project-level baseline data should be gathered by the project developer, assisted by existing supply chain companies and other local stakeholders as part of consenting processes, before development occurs. If multiple projects are occurring on similar time scales, the project developers should be encouraged to collaborate to help gather data to inform strategic assessments.
Practice 4:	Social and economic data should be collected once MRE development has occurred and the devices are operational. To the greatest extent possible, data should be collected using variables/methods similar to those used for baseline data to allow for direct before/after comparison. For this practice, it is important to differentiate who is responsible for such data collection (4A or 4B).	
	Practice 4A: Social and economic data should be collected at the same scales, using the same methodologies for strategic-level assessments, by the appropriate level of local, regional, or national government.[1]	**Practice 4B:** Social and economic data should be collected at the same scales, using the same methodologies for project-level assessment, by the project developer, with assistance from supply chain personnel and other local stakeholders, including local governments.
Practice 5:	Results from both social and economic assessments should be clearly communicated to the communities affected by MRE developments, with a focus on the transparency of methods, analyses, and purpose of the studies. Strategic-level assessment communication is the responsibility of the appropriate level of government, while project-level social and economic assessments should be jointly presented by the project developer and the appropriate level of government.	

1. It is important to note that for good practices that rely on government data collection, resources may not be available for collecting data for all, or in some cases any, MRE projects. This will vary by country, region, and locality.

9.6. CASE STUDIES

Analyzing case studies related to deployed MRE projects can help further the understanding of social and economic effects and provide lessons learned for future projects. The case studies can also be used as reference points for the effects of MRE developments and offer a reliable comparison upon which to base estimates for future projects. Box 9.2 highlights social and economic data that have been collected around three MRE developments and test centers.

9.7. RECOMMENDATIONS

To fully understand the effects of an MRE deployment, social and economic data must be collected and assessed. The good practice examples presented in this chapter provide guidance about collecting data consistently throughout the industry and enabling greater standardization of assessments to support strategic planning for and consenting of MRE projects. These practices will lead to an overall increase in the understanding of the social and economic benefits and adverse effects of MRE developments, improved social acceptance, and could be linked to more favorable regulatory outcomes for the MRE industry.

There are many ways in which data collection could be improved upon. Some recommendations are listed in the following sections.

9.7.1. REVIEW OR DEVELOP TOOLS AND DATABASES

Identifying potential social and economic indicators at both the project- and strategic-level will improve data collection efforts and be useful for developers or other stakeholders. Available tools and databases from MRE and other analogous industries (such as offshore wind, oil and gas, etc.) should be reviewed. If the necessary tools or databases do not exist, there may be a need to develop new tools or a database that could identify key indicators. Doing so would help to understand what data are relevant for a project and should be collected based on the size and potential impact of a project, and would show regulators and governments which data may be important. Reviewing or developing tools and databases can help standardize data collection and assessment as key indicators become agreed upon throughout the MRE industry and across governmental bodies. This recommendation is best carried out by researchers or the MRE community.

9.7.2. GUIDE DATA COLLECTION EFFORTS

Once key indicators of the social and economic impacts of MRE development are better understood, the next step would be to develop a template that establishes the questions that need to be asked and answered and the key data needed to understand impacts that may arise from a specific MRE development. Such a template would guide data collection efforts by developers as well as data collection requirements from governments and regulators (ABPMer 2012). This recommendation is best carried out by researchers or the MRE community.

9.7.3. CONDUCT MEANINGFUL STAKEHOLDER ENGAGEMENT

As described in Section 9.3.3, stakeholder engagement is necessary for successful MRE project development and operation. In addition, stakeholders and groups familiar with the area surrounding a project can provide a wealth of information on key social and economic data to collect. Stakeholders should be engaged in a meaningful manner by listening and learning from important groups to identify evidence needs and key sources of data. These groups will likely include local companies in the MRE supply chain, the fishing industry, the tourism industry, communities that are often marginalized especially indigenous or native populations, and representatives from local and regional groups that are likely to be impacted. This engagement is best carried out by MRE project developers.

9.7.4. PROVIDE AN INCENTIVE TO COLLECT AND PUBLICIZE MRE DATA

To move the industry forward, data and information should be shared between MRE projects so that lessons can be learned from past deployments (see Chapter 13, Risk Retirement and Data Transferability for Marine Renewable Energy). The collection of social and economic data should be included in funding and deployment conditions when possible. Government entities and/or investors who provide funding or test sites who provide funding or deployment opportunities can incentivize (or even require) developers to collect spe-

BOX 9.2

CASE STUDIES OF SOCIAL AND ECONOMIC DATA COLLECTION EFFORTS FROM MARINE RENEWABLE ENERGY (MRE) DEVELOPMENTS OR TEST CENTERS (COPPING ET AL. 2018)

MeyGen Prior to the MeyGen tidal energy deployment at Pentland Firth, United Kingdom (UK), an extensive assessment of social and economic impacts as part of the environmental statement (ES) was undertaken (MeyGen 2012). In addition, a comparison of economic development estimates and data was carried out. Metrics from the gross value added report were used and the information gathered is now regarded as the baseline. The ES included data collected about employment sectors, fisheries, cultural heritage, and shipping and navigation, as well as the mapping of constraints to development such as other marine uses (MeyGen 2012). Outreach to the fishing community resulted in comments and data collected that allowed for the ES to report that impacts on the fishing community would not be significant (MeyGen 2012). In addition, MeyGen took note of potential impacts and made a commitment to have a number of apprenticeships and to use a percentage of local workers (Copping et al. 2018). The developer, DP Energy, also collected social and economic information in two ways that should be noted. They tracked apprenticeships in anticipation of construction and monitoring and also talked to the fishing community in the area; both practices allowed them to gather data that could not have been gained otherwise (Copping et al. 2018).

European Marine Energy Centre (EMEC) Social and economic data have been collected around Orkney's EMEC (established in 2003), to elucidate the potential social and economic impacts of MRE development. One of the main tangible benefits of MRE development is the employment opportunities that EMEC and MRE developments bring to Orkney (Figure 9.4) and beyond. EMEC employs 22 staff, and the average equivalent of 119 jobs in Orkney and 262 jobs across the UK were supported by EMEC activity from 2003 to 2011 (Renewable UK 2014). The local government, understanding the opportunities present, funded the development of ports and additional infrastructure to support the MRE industry, which in turn benefited other marine industries and produced additional job opportunities (EMEC 2019). Orkney residents developed a greater understanding of MRE and how MRE can contribute to the community by investing in energy projects (Copping et al. 2018). It is worth noting that EMEC's development was shown to have boosted the UK economy by over £200M (EMEC 2019). On a local scale, population growth related to increased employment, the increase in average earnings, and job diversification have also been attributed to EMEC (EMEC 2019). An important lessons learned through data collection efforts related to EMEC was to assure that the metrics used are valid. For example, a comparison of jobs in London to jobs in Orkney was not meaningful for understanding the impacts in a small community such as Orkney. It is key to use the proper metrics so that useful data can be collected for meaningful assessments.

Date	Overall total jobs (number)	Annual income from jobs (£000s)	Monthly salary bill (£000s)	Cumulative jobs (job years)	Cumulative income from jobs (£000s)
2000	26	650	54	26	650
2001	27	675	56	53	1,325
2002	32	800	67	85	2,125
2003	40	1,000	83	125	3,125
2004	48	1,200	100	173	4,325
2005	57	1,425	119	230	5,750
2006	69	1,725	144	299	7,475
2007	77	1,925	160	376	9,400
2008	93	2,325	194	469	11,725
2009	124	3,100	258	593	14,825
2010	163	4,075	340	756	18,900
2011	189	4,725	394	945	23,625
2012	229	5,725	477	1,174	29,350
2013	286	7,150	596	1,460	36,500
2014	300	7,500	625	1760	44,000
2015	250	6,250	520	2010	50,250
2016	220	5,750	460	2240	56,000

Figure 9.4. This graph shows the MRE job trend in Orkney over time from 2000 to 2016. The first MRE deployment at EMEC was in 2004 and the number of deployments peaked at 14 in 2014. (From Copping et al. 2018)

Fundy Ocean Research Center for Energy (FORCE) Some social and economic data have also been collected in Nova Scotia (Canada), especially related to the construction of the Fundy Ocean Research Center for Energy (FORCE), which was established in 2009. A value proposition for tidal energy developed in the region showed the economic benefits to include 22000 new full-time equivalent jobs and more than $1.5 billion of additional gross domestic product (Gardner et al. 2015). These figures were due in part to the fact that much of the pre-construction, construction, installation, operation, and maintenance work was sourced locally and that more than 300 companies were involved in the supply chain. FORCE has also become a part of the tourism industry and attracts visitors to its Visitor Center from Nova Scotia and worldwide (Howell and Drake 2012). However, FORCE has run into pushback, mainly in the form of ongoing opposition from the fishing community and concerns about the cumulative effects and potential harm to marine life caused by tidal deployments (CBC News 2017). While it was ruled that FORCE has carefully monitored and is following the precautionary principle, this conflict speaks to the importance of social acceptance and the need for early and transparent outreach and engagement with key stakeholders to understand and address community concerns.

cific social and economic data following the good practices above. In addition, government entities, investors, and test sites can also incentivize or require that data, information, and analyses be shared and provided for public use. For example, the U.S. Department of Energy stipulates that MRE projects that have received government funding have to upload their data to an online data portal (Marine and Hydrokinetic Data Repository 2020). Not only does this help fund and create an impetus for data collection and sharing, but it allows these entities to ask for data collected about key indicators and impacts, thereby further adding to the ability to standardize methods and available data. This recommendation is best carried out by governments, investors, and/or MRE test sites.

9.7.5. USE A FLEXIBLE PLANNING APPROACH

With uncertainty around not only the environmental effects of MRE, but also its social and economic effects, it is important to allow for learning to develop over time and for adjustments to be made as a project is deployed. Considering a flexible approach to planning, such as a design envelope approach (also known as the "Rochdale Envelope") (The Planning Inspectorate 2018; Caine 2018), or an adaptive management approach (see Chapter 12, Adaptive Management Related to Marine Renewable Energy), is necessary. A design envelope approach gives developers flexibility during the consenting and development stages of projects because they can provide a range of project parameters (BOEM 2018). These approaches allow for uncertainty to be addressed and adjustments to be made as the project moves forward, and learning, including understanding of potential social and economic impacts, increases. This recommendation is best carried out by governments allowing a flexible approach to be used and developers using such approaches for their developments.

9.7.6. CORRELATE IMPACTS, DATA COLLECTION, AND PROCESSES TO APPROPRIATE SIZES

With many barriers for the MRE industry to overcome as it advances, one potential barrier is unnecessary requirements. In the case of social and economic data collection, the requirements may be overly burdensome. Instead, when collecting data, the associated impacts need to be strongly correlated to the sensitivity of the receptor. For example, if fishing jobs are lost because of an MRE deployment, the loss would have a smaller impact on a community that does not heavily rely on the fishing industry than it would have on a community that relies significantly on this industry. In addition, consenting processes can create challenges related to long timelines and associated costs. While consenting processes can help limit adverse effects, such processes and the associated evidence burden placed on developers should be proportional to the project size. For example, for a smaller MRE development, adversarial effects will be small and requirements for benefits to offset those should be proportionally smaller too. This recommendation is relevant for regulators who set requirements for data collection and governments who set requirements for consenting processes.

9.8. CONCLUSION

One of the most important areas for future MRE research is the social and economic effects, especially because the social effects are not well understood (Uihlein and Magagna 2016). Improving the collection, collation, and dissemination of data about social and economic effects would greatly aid this developing industry. As more information becomes available, producing social and economic assessments will become easier thanks to lessons learned from previous projects, more existing and accessible data to compare between projects, and data and information that may be used from one project for a future project (see Chapter 13, Risk Retirement and Data Transferability for Marine Renewable Energy).

9.9.
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REPORT AND MORE INFORMATION

OES-Environmental 2020 State of the Science full report and executive summary available at: *https://tethys.pnnl.gov/publications/state-of-the-science-2020*

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