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Knowledge Co-Production to Improve Information Uptake:
A Case Study in Downeast Maine

by Gabriella Marafino, Gayle Zydlewski, and Jessica Jansujwicz

Abstract

Scientific information is often not presented in a form that fits the specific needs and capacities of decision-makers. This mismatch results in the *loading dock* problem, where information remains unused or uptake is slow. Further exacerbating this gap is the challenge to integrate data from different disciplines. In response, we collaborated with stakeholders to co-produce knowledge in support of decision-making (e.g. related to siting, impacts on species, or local capacity) for sustainable tidal power development in Downeast Maine. Agency regulators, an industry developer, and a tribal environmental department were engaged in a series of workshops to discuss existing information, identify knowledge gaps, and co-produce data integration strategies. While this study was motivated by the need to make well-informed decisions related to tidal power development in Maine, the process is applicable to other coastal development contexts.

INTRODUCTION

Science and society are often not closely linked (Chevalier and Buckles 2013), which results in a research-implementation gap. This disconnect between the people producing information (e.g., research scientists) and people using that information (e.g., decision-makers) can be attributed to several factors. First, in the traditional scientific research process, scientists continuously generate new information, yet often without input from people who use this information to make management and policy decisions (Djenontin and Meadow 2018). Second, this information is frequently either not shared outside of academic research settings (Grygoruk and Rannow 2017) or is not shared in a way that is useful and accessible (Cash et al. 2006), often referred to as the loading dock problem. This general lack of usable information is a barrier to informed decision-making (Clark et al. 2016) and slows the uptake of information when decision-makers find it difficult to locate information that is relevant, accessible, and readily usable (Dilling and Lemos 2011). The research-implementation gap is further exacerbated by challenges compiling information from different disciplines (Moore et al. 2017), since information is often collected from different sources and scales. Integrating interdisciplinary information is increasingly required to inform holistic and sustainable natural resource decision-making (Lanier et al. 2018).

Here, we use a case of marine renewable energy development in Downeast Maine to explore innovative pathways to bridge the research-implementation gap for more informed decision-making. Decisions related to marine energy development are made in the midst of high uncertainty (due to missing information on cumulative impacts) and increasing complexity (due to multiple marine uses that span commercial, recreational, and cultural significance) (Cammen et al. 2021), making this an exemplary case for this work. While we focus on a specific case study, our research process and findings are applicable and transferable to decisions in other complex, multi-use coastal ecosystems where decision-makers are faced with making informed decisions in high uncertainty and complexity.

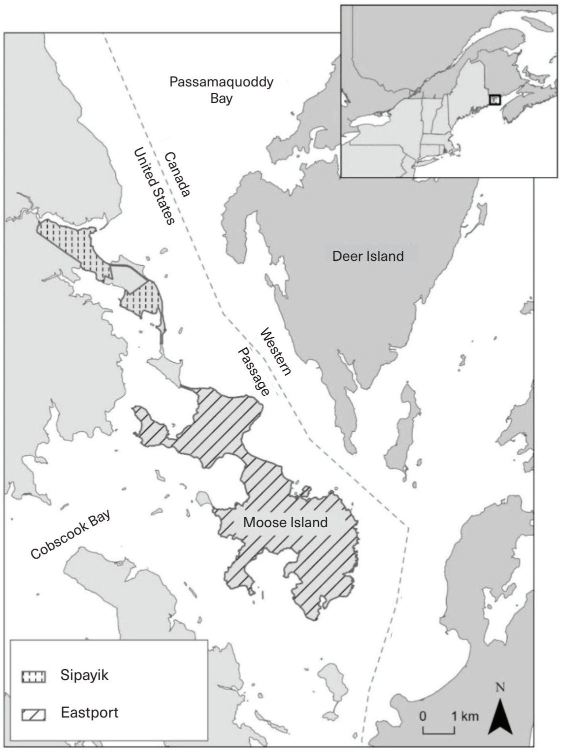
TIDAL POWER ENERGY IN MAINE

Downeast Maine historically has been an area of interest for coastal development projects, including proposed liquified natural gas, aquaculture, and, more recently, marine renewable energy. Sources of ocean energy are being explored for development globally, including offshore wind, wave, and tidal energy (Zydlewski et al. 2015), and the Gulf of Maine has been identified as one of the prime locations for tidal power development in the United States (Kilcher et al. 2016). Tidal power development was first attempted in Maine in the 1930s with the proposed Passamaquoddy Tidal Power Project that was never completed (Lowrie 1968;

Smith 1948). More recently, tidal power has been revisited through proposed development in Western Passage (Figure 1) by the Maine-based Ocean Renewable Power Company (ORPC). This case study builds upon ORPC's prior short-term pilot project in nearby Cobscook Bay (Johnson and Zydlewski 2012). Western Passage (Figure 1) is an international, tidally dynamic area in the Quoddy region that borders the state of Maine and southwestern New Brunswick, Canada. As part of the larger Bay of Fundy, this region is characterized by extreme tidal ranges and an ecosystem with diverse social and ecological components (Cammen et al. 2021).

There are often many stakeholder groups associated with marine renewable energy projects because sites are located in close proximity to coastal communities (Johnson et al. 2015). Neighboring the Western Passage are several coastal communities, including the city of Eastport and Sipayik, a Passamaquoddy community. Traditional Passamaquoddy land spanned the region between the Penobscot River watershed in Maine to the St. John River watershed in New Brunswick. A variety of marine mammals and fish in this region are important cultural and subsistence resources for the Passamaquoddy peoples (Bassett 2015). The city of Eastport is located on Moose Island and is connected to the mainland via a remnant tidal dam, which is now a causeway that runs through Sipayik and physically connects the two communities. Historically, Eastport's economy was driven by shipping, boat-building, lumber, and fishing activities. More recently, salmon aquaculture and harvesting scallops, sea urchins, and lobster sustain the seafood industry in this region (Hall-Arber et al. 2001).

FIGURE 1: **Western Passage Site Targeted for Tidal Power Development**



Note: Includes the City of Eastport and Sipayik, a Passamaquoddy community (also known as Pleasant Point), as well as the surrounding major water bodies (Western Passage, Cobscook Bay, and Passamaquoddy Bay).

PATHWAYS FOR KNOWLEDGE CO-PRODUCTION

Stakeholder Workshops

Our research team applied participatory action research approaches (Chevalier and Buckles 2013) to co-produce potential solutions to improve information production and use associated with proposed tidal power development in Downeast Maine. Knowledge co-production connects research with implementation by involving decision-makers in the research process to tackle questions, improve practice, and enhance information usability at the intersection of science and society (Djenontin and Meadow 2018). This research method involves collaboration between researchers and stakeholders to create outcomes together (Wall et al. 2017) that include the values, interests, and voices of all participating groups. We designed and implemented a series of three workshops to better understand stakeholder perceptions of information use and access, and to identify information needs, data gaps, and other challenges to information uptake by decision-makers. While this research was motivated by stakeholders' decision-making needs in the context of the proposed tidal power project, workshops addressed general decision priorities and information needs of the key stakeholder groups participating.

Participant Recruitment

Participants selected for this study included stakeholders in Downeast Maine with different roles and capacities within the regulatory and permitting process for proposed tidal power development. For this case study, we define key decision-makers as stakeholder groups who affect

TABLE 1: **Participation, Structure, and Data Collected to Understand Stakeholder Decision-Making Needs**

Stakeholder workshops and objectives	Date	Number of participants	Format	Data collected
Workshop 1	September 2018	8	Hybrid (In-person & virtual)	Audio recordings, handwritten notes
Workshop 2	March 2019	5	In-person	Audio recordings, handwritten flip-chart notes
Workshop 3	September 2019	7	Virtual	Audio recordings, handwritten notes

Note: The number of participants reflects a count of individuals who attended the workshops (not including our research team). Each of the four decision-maker groups and our research team were represented at all three workshops.

or could be affected by tidal power development. The involvement of these groups is important because they could be affected by or have the power to influence decision-making processes (Johnson et al. 2015). Four key decision-maker groups (federal government, state government, tribal, and industry) were purposefully selected for inclusion. Representatives from these four sectors agreed to participate in this research: federal regulator (National Oceanic and Atmospheric Administration, NOAA), state regulator (Maine Department of Environmental Protection, DEP), tribal (Passamaquoddy Tribe, Sipayik Environmental Department), and industry (ORPC). There were multiple representatives from NOAA and ORPC who participated in this study, and one representative each from Maine DEP and the Sipayik Environmental Department.

These decision-makers are connected through the Federal Energy Regulatory Commission (FERC) licensing process. FERC is the lead permitting authority for tidal power projects, but federal and state agencies have the opportunity to comment on proposed projects (Jansujwicz and Johnson 2015). Within this regulatory context, NOAA and DEP provide input to FERC related to ORPC's licensing and permitting applications. The Passamaquoddy Tribe is a sovereign entity that can intervene in the FERC decision-making process and would also be affected by the resulting decisions. Under the FERC pilot project license, ORPC was required to develop an adaptive management plan (FERC 2012), in which regulators address project uncertainty and knowledge gaps by working directly with stakeholders in a continual, iterative learning process (Jenkins et al. 2018). Prior to this case study, the federal, state, and industry participants were already interacting with each other and our research team through the formal FERC adaptive management process. However, the tribal participant was not involved in ORPC's adaptive management process or engaged with our research team or with other study participants in work related to the proposed tidal power project.

Three stakeholder workshops (Table 1) were held over the course of one year (September 2018–2019) at the University of Maine in Orono, which was a central location for all participating groups. Workshops were held both in-person and virtually in response to the scheduling needs of participants. With participant permission, the workshops were audio recorded. Data collected included audio recordings of the workshops and handwritten notes from large and small group discussions.

Knowledge Co-Production: Workshops 1 and 2

The objectives of the first workshop were threefold: (1) to understand what decisions participants were making in their role at their respective organization, (2) to document the types of information participants use most often in their decision-making, and (3) to identify existing knowledge gaps. Prior to the workshops, we created an inventory of existing data sources for the region, which included data collected and produced by different groups and presented in different forms (e.g., raw data on hard-copy datasheets) and stages of analysis (e.g., technical reports and peer-reviewed academic articles). Data were presented, provided in print copy, and then discussed in a large-group facilitated session. Then, small groups focused on (1) the types of decisions participants routinely make in their respective roles and (2) the types of information they seek to make these decisions. Participants were asked to write a typical decision they make in their role at their respective organization on one side of an index card and the information they use to make that decision on the other side. Participants were then split into breakout groups to discuss the decision types and information sources on their index cards, followed by a final

TABLE 2: **Data Types from the Data Café Activity at Workshop 2**

Table	Data type	Primary example	Secondary example
1	Raw data	Nautical charts with handwritten local ecological knowledge (LEK)	Citizen science fishing datasheet
2	Synthesized data	Peer-reviewed articles (e.g. Viehman et al. 2014; Johnson et al. 2015)	Pacific Northwest National Laboratory State of the Science research report on marine renewable energy (MRE)
3	Web-based data portals	Northeast Ocean Data Portal (https://www.northeastoceandata.org/)	Tethys Knowledge Base (https://tethys.pnnl.gov/)

Note: Raw data examples included nautical charts with handwritten local ecological knowledge from a 2017 community meeting in Eastport and citizen science fishing datasheets from 2018. Synthesized data examples included peer-reviewed articles by Viehman et al. (2014) and Johnson et al. (2015) and a *State of the Science* research report compiled by the Pacific Northwest National Laboratory (see Copping et al. 2016). Examples of web-based data portals included the Northeast Ocean Data Portal website and the marine renewable energy-specific Tethys Knowledge Base website (see links in table).

large-group discussion. Each breakout group was prompted to discuss the type of decisions they were making, the information source, and the format of information used.

The objective of the second workshop was to document stakeholder perspectives of the different data types identified in Workshop 1. We used a modified group facilitation technique, World Café (Brown and Isaacs 2005), to foster dialogue around a hypothetical decision scenario and develop a shared understanding of the usability of different data types. The World Café process for this workshop was renamed Data Café, and the following decision scenario was selected: *There is a proposed coastal development project in the Eastport area, and you are tasked with making a decision on appropriate siting.* The decision scenario was intentionally kept broad to investigate stakeholder perspectives on information utility and decision-making needs. Information presented to participants for feedback during the decision scenario represents different forms of knowledge.

Workshop participants were split into two groups purposefully selected to integrate different stakeholder groups, particularly those who do not often interact. Participants reviewed the data category examples, which included raw data, synthesized data, and web-based data portals (examples listed in Table 2). Participants were asked to comment on whether they could use the specific data examples at their table to address the hypothetical decision scenario and rotated to the next table until they visited all tables. A harvest session (i.e., large-group reflection) was used to come together and review themes. Data integration strategies were co-identified during the harvest session at the end of this workshop.

Weaving Next Steps: Identifying Decision-Making and Information Needs

Audio-recordings and handwritten notes from workshops 1 and 2 were transcribed verbatim and analyzed using NVivo (Version 12 Plus) qualitative analysis software. Using a deductive approach, we coded these data using a set of pre-identified categories (Table 3) (Schreier 2012), which were identified based on workshop observations and from literature on information usability and accessibility.

We found that decisions fell into three categories: (1) siting, permitting, and licensing, (2) impacts on protected species, and (3) local capacity and stakeholder outreach. The federal, state, and industry representatives stated that decisions related to siting, permitting, and licensing of proposed projects were primary decisions they often faced in their roles. The federal and state regulators and tribal representative noted that determining impacts on species was particularly important; however, regulators emphasized decisions on protected or endangered species, such as Atlantic salmon and right whales, whereas the tribal representative focused more on species of cultural significance to the Passamaquoddy Tribe, such as sea-run fish (i.e., alewives) and harbor porpoise. The industry representatives said they make decisions related to how to share relevant information with community stakeholders (e.g., fishermen), as well as decisions related to local capacity, which they referred to as the workforce, equipment, and infrastructure available at the site to allow for this development. Federal and state regulators also said they need to determine the cumulative impacts of a proposed project, particularly when scaling up from pilot projects to commercialization.

Participants noted that data collected at various scales are useful in different decision-making phases. For example,

TABLE 3: **Coding Schema for the Five Pre-Identified Categories to Analyze Workshop Data**

Coding Category	Description	Examples from Data
Decisions	Identification of priority decisions that need to be made	"siting"; "permitting and licensing"
Format	Key words or phrases that describe the form or layout of a data source	"raw data"; "synthesized data in reports"
Scale	Key words or phrases that describe the geographic focus	"regional"; "high-level" (i.e. coarser scale)
Source	Key words or phrases that describe where data originated or who it was collected by	"citizen science"; "academic science"
Content	Key words or phrases that describe what kind of information the data source contains	"socio-economics data"; "protected species data"
Accessibility	Key words or phrases that describe how easily data sources are able to be located and obtained	"challenging to get access to peer-reviewed articles"

hard-copy nautical charts and web-based data portals can help in the early phases of a project, particularly when making a decision for a project that has a broader geographic scale. However, the federal regulator noted that, as a project progresses, finer-scale site-specific information becomes more relevant and urgent. The industry and tribal representatives agreed that a community-level scale is more important for the smaller, site-specific project decisions that they often deal with, such as evaluating the tidal energy potential of a site (industry example) or assessing local streams for dam improvements to aid in fish migration (tribal example). The tribal representative noted that while knowing where projects are physically located is valuable information, the web-based data portal with a broader scale was missing community detail, such as fishing sites. Regulators noted that, depending on the decision, the information source does not necessarily need to be site-specific, and participants agreed that it would be useful to expand the data inventory list to also include datasets on nearby regions (e.g., Cobscook and Passamaquoddy Bays) to inform a broader understanding of the region.

All participants agreed that raw data (i.e., data that has not been analyzed or synthesized in any way) is not useful, whereas processed or synthesized information (e.g., technical reports, publications, and web-based data portals) were more useful for making decisions. Participants also noted a need for recent information and highlighted that the challenge of web-based data portals is finding when certain datasets were last updated. Easy access to metadata to determine when maps or other data portals were last updated was noted to be important to boost information credibility.

All participants said that they regularly use scientific information as a source of information. While scientific data was noted to be valuable and credible, several participants elaborated that using citizen science and local knowledge in conjunction with research data helps target further scientific data collection. An industry representative also noted that local ecological knowledge is valuable in helping to identify potential resources (i.e., areas of good flow for tidal power) and also to help avoid developing in areas with potential conflict of use (i.e., fishing spots or vessel traffic). Participants all noted that local ecological knowledge is an important source of historical, place-based information, but that it is challenging to compare the utility of scientific data with local forms of knowledge because of how the information is collected. Participants noted that citizen science is most useful when a standardized approach is applied to achieve longer-term data collection.

The industry and tribal representatives noted data accessibility was an issue because it can be challenging to get access to peer-reviewed articles and similar publications or reports. The tribal representative also noted that not many people in their community have a computer, but that most have a mobile phone. In addition, participants said that simply finding a database with relevant information can be difficult and that sorting through the data to find useful information is a further challenge that can be a barrier to information uptake.

Drawing on participant perspectives from workshops 1 and 2, our research team and participants co-identified data integration strategies. Participants identified two strategies at Workshop 2: (1) an interactive knowledge base and (2) a central data repository. Participants said that it would be helpful to see the spatial data for the Western Passage region represented on an interactive map to create a knowledge base for spatial information. ArcGIS Online was selected as the platform for the spatial knowledge base because it is accessible from any computer and can be enabled for use on mobile phones, which was identified as an accessible form of technology for the Passamaquoddy community. In addition, participants noted that it would be helpful to compile nonspatial information in a central data repository, with particular attention to peer-review publications and reports that are difficult for some groups to access. Google Drive was selected as the platform for the central data repository because participants were already familiar with using this platform and it can be easily accessed from any computer or phone using a link.

Knowledge Integration: Workshop 3

Workshop 3 was organized to share an overview and interactive demonstration of the knowledge base platforms that were developed in response to stakeholder's stated needs. The goal was to solicit feedback to improve the usefulness and accessibility of the knowledge base platforms. In advance of the workshop, participants were sent links to the two knowledge base platforms: (1) a public ArcGIS Online interactive map and (2) a Google Drive folder as a central data repository. Participants were encouraged to view these materials ahead of the workshop. Datasets included in these platforms reflected the data reviewed by participants at the Data Café in Workshop 2, including Western science (published peer-reviewed articles and reports), local ecological knowledge (from a 2017 community meeting in Eastport), and citizen science data sources (e.g., eBird data and local fishing data). This workshop was structured to demonstrate and discuss the two knowledge base platforms as strategies to share integrated datasets. A separate discussion was held after each knowledge base demonstration, and questions posed to participants by our research team included the following: Does the scale of this platform fit your decision-making needs? Is there anything that seems challenging or hard to manipulate? What can be improved to make navigation easier?

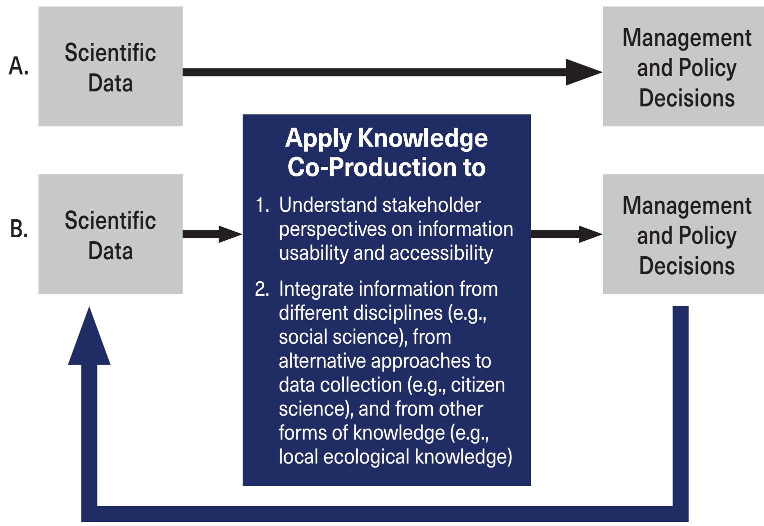
Feedback was solicited at Workshop 3 to make the knowledge base platforms more useful after preliminary data integration efforts. Our research team and participants agreed that this is an iterative process that will involve multiple reviews and edits to ensure these knowledge bases remain relevant and up-to-date for future decision-making needs. Feedback from participants on the interactive map knowledge base focused on simplifying access to and use of the information. This included adding pre-queried data layers that focus on temporal and species-specific trends to eliminate the extra step of learning how to query. Participants also noted that the central data repository could be improved by creating specific folders for information on surrounding regions (i.e., Passamaquoddy Bay) and to include a separate folder for marine hydrokinetic technology reports and publications. In addition, participants said that the metadata file would be more helpful if links were added to connect the user directly to the information resource by clicking on the name, again eliminating the need to search amongst folders. Overall, participants said that the amount of information and how it was organized into the two platforms was very useful and responsive to stakeholder needs. One participant commented that this participatory process of co-creating a knowledge base is a model that could be applicable in other areas with proposed coastal development projects.

PATHWAYS FOR BETTER DECISION-SUPPORT

The traditional scientific research process involves the production of scientific data that could be used for management and policy decision-making (Figure 2, panel a). We acknowledge that not all researchers are engaged in applied research or want their data to be used for decision-making. However, we identified a two-part intermediate step for researchers who want to make the scientific data they collect more useful and usable for decision-makers (Figure 2, panel b). This intermediate step focuses on researchers applying knowledge co-production to engage decision-makers throughout the information production and sharing process. This involves researchers (1) understanding stakeholder perspective on information utility and accessibility and (2) integrating information from other disciplines (e.g., social science), from alternative approaches to data collection (e.g., citizen science), and different forms of knowledge (e.g., local ecological knowledge).

The first piece of this two-pronged approach involves addressing the loading dock communication gap between researchers and decision-makers by applying knowledge co-production to actively collaborate and understand diverse stakeholder perspectives on information utility. This is similar to the stakeholder-driven approach to crafting usable knowledge described by Clark et al. (2016) and is the exact

FIGURE 2: **Traditional Scientific Research Process (Panel A) and Modified Process (Panel B) Including a Knowledge Co-Production Step**



type of information production that Cash et al. (2006) calls for to counter the loading dock approach. The second piece of our modified research-implementation process includes integrating information from different disciplines, from different data collection approaches, and from different forms of knowledge. This directly addresses previous studies that have identified the need for interdisciplinary approaches and data integration to support holistic natural resource decision-making (Lanier et al. 2018;). The arrow that leads from management and policy decisions back to scientific data (Figure 2, panel b) represents that this is an iterative process that should be informed by the people who use the information that research scientists produce.

CONCLUSION

While the emphasis of the traditional scientific research process is on producing new information, our study focused on improving the production and sharing process by working directly with the stakeholder groups who use the information being created. The most surprising finding for our research team was that participants did not find raw data very useful. This finding highlighted the importance of engaging with information users; without asking these questions, we would have provided access to raw data sources, which researchers most often use, but would have had limited usefulness for workshop participants. Using specific examples of data sources and formats during the Data Café allowed a more comprehensive investigation to better understand stakeholder information needs and barriers.

Benefits of this work included the development of products that were directly driven by stakeholder information and decision-making needs, creating space for dialogue that allowed us to be flexible and responsive to emerging needs and concerns, and forming new partnerships. Although our study was motivated by the proposed tidal power project in Maine, our co-produced products and processes are applicable and transferable to decisions in other complex, multi-use coastal ecosystems where managers are faced with making decisions in high uncertainty and complexity. Lessons learned about federal, state, industry, and local decision-making needs and information usability will help better inform the type of research output that interdisciplinary researchers generate in the future.

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REFERENCES

Bassett, Edward, 2015. *Cultural Importance of River Herring to the Passamaquoddy People.* Pleasant Point, Me: Sipayik Environmental Department.

Brown, Juanita, and David Isaacs. 2005. *The World Café: Shaping Our Futures Through Conversations That Matter.* San Francisco: Berrett-Koehler Publishers.

Cammen, Kristina, Gabriella Marafino, Sarah Burton, Jillian Dow, Emma Dullaert, Madalyn Jorge, Kate Macolini, et al. 2021. "Interdisciplinary Research Collaborative Trains Students to See Through Turbulent Systems." *Oceanography* 34(1): 256–267. https://doi.org/10.5670/oceanog.2021.102.

Cash, David W., Jonathan C. Borck, and Anthony G. Patt. 2006. "Countering the Loading-Dock Approach to Linking Science and Decision Making: Comparative Analysis of El Niño/Southern Oscillation (ENSO) Forecasting Systems. *Science, Technology, & Human Values* 31:465–494. https://doi.org/10.1177/0162243906287547.

Chevalier, Jacques M., and Daniel J. Buckles. 2013. *Participatory Action Research: Theory and Methods for Engaged Inquiry.* New York: Routledge.

Clark, William C., Lorrae van Kerkhoff, Louis Lebel, and Gilberto C. Gallopin. 2016. "Crafting Usable Knowledge for Sustainable Development." *Proceedings of the National Academy of Science* 113:4570–4578. https://doi.org/10.1073/pnas.1601266113.

Copping, Andrea, Nichole Sather, Luke Hanna, Jonathan Whiting, Gayle Zydlewski, Garrett Staines, Andrew Gill, et al. 2016. *Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World.* https://tethys.pnnl.gov/publications/state-of-the-science-2016.

Dilling, Lisa, and Maria Carmen Lemos. 2011. "Creating Usable Science: Opportunities and Constraints for Climate Knowledge Use and their Implications for Science Policy." *Global Environmental Change* 21:680–689. https://doi.org/10.1016/j.gloenvcha.2010.11.006

Djenontin, Ida Nadia S., and Alison M. Meadow. 2018. "The Art of Co-production of Knowledge in Environmental Sciences and Management: Lessons from International Practice." *Environmental Management* 61:885–903 https://doi.org/10.1007/s00267-018-1028-3.

FERC (Federal Energy Regulatory Commission). 2012. *Ocean Renewable Power Company: Order Issuing Pilot Project License Minor Project), Cobscook Bay Tidal Energy Project.* Project No. 12711–005.

Grygoruk, Mateusz, and Sven Rannow. 2017. "Mind the Gap! Lessons from Science-Based Stakeholder Dialogue in Climate-Adapted Management of Wetlands." *Journal of Environmental Management* 186:108–119. https://doi.org/10.1016/j.jenvman.2016.10.066.

Hall-Arber, Madeleine, Christopher L. Dyer, John J. Poggie, James McNally, and Renee Gagne. 2001. *New England's Fishing Communities.* MIT Sea Grant College Program.

Jansujwicz, Jessica S., and Teresa R. Johnson. 2015. "Understanding and Informing Permitting Decisions for Tidal Energy Development Using an Adaptive Management Framework." Estuaries and Coasts 38:253–265. https://doi.org/10.1007/s12237-013-9678-0.

Jenkins, Lekelia D., Stacia Jeanne Dreyer, Hillary Jacqueline Polis, Ezra Beaver, Adam A. Kowalski, Hannah L. Linder, Thomas Neal McMillin, et al. 2018. "Human Dimensions of Tidal Energy: A Review of Theories and Frameworks." *Renewable and Sustainable Energy Reviews* 97:323–337. https://doi.org/10.1016/j.rser.2018.08.036.

Johnson, Teresa, and Gayle B. Zydlewski. 2012. "Research for the Sustainable Development of Tidal Power in Maine." *Maine Policy Review* 21(1):58–65. https://doi.org/10.53558/BDFO2856.

Johnson, Teresa R., Jessica S. Jansujwicz, and Gayle Zydlewski. 2015. "Tidal Power Development in Maine: Stakeholder Identification and Perceptions of Engagement." *Estuaries and Coasts* 38:266–278. https://doi.org/10.1007/s12237-013-9703-3.

Kilcher, Levi, Robert Thresher, and Heidi Tinnesand. 2016. *Marine Hydrokinetic Energy Site Identification Ranking and Methodology. Part II: Tidal Energy.* NREL/TP-5000-66079. Golden, CO: National Renewable Energy Laboratory

Lanier, Alicia L., Jillian R. Drabik, Tanya Heikkila, Jessica Bolson, Michael C. Sukop, David W. Watkins, Jennifer Rehage, et al. 2018. Facilitating Integration in Interdisciplinary Research: Lessons from a South Florida Water, Sustainability, and Climate Project. *Environmental Management* 62:1025–1037. https://doi.org/10.1007/s00267-018-1099-1.

Lowrie, Walter E. 1968. "Roosevelt and the Passamaquoddy Bay Tidal Project." *The Historian* 31(1): 64–89.

Moore, Susan A., Greg Brown, Halina Kobryn, and Jennifer Strickland-Munro. 2017. "Identifying Conflict Potential in a Coastal and Marine Environment Using Participatory Mapping." *Journal of Environmental Management* 197:706–718. https://doi.org/10.1016/j.jenvman.2016.12.026.

Schreier, Margrit. 2012. *Qualitative Content Analysis in Practice.* London: Sage Publications.

Smith, Lincoln. 1948. "Tidal Power in Maine." *Land Economics* 24(3): 239–252.

Wall, Tamara U., Elizabeth McNie, and Gregg M. Garfin. 2017. "Use-Inspired Science: Making Science Usable by and Useful to Decision Makers." *Frontiers in Ecology and the Environment* 15:551–559. https://doi.org/10.1002/fee.1735.

Viehman, Haley A., Gayle Barbin Zydlewski, James D. McCleave, and Garrett J. Staines. 2014. "Using Hydroacoustics to Understand Fish Presence and Vertical Distribution in a Tidally Dynamic Region Targeted for Energy Extraction." *Estuaries and Coasts* 38: 215–226. https://doi.org/10.1007/s12237-014-9776-7.

Zydlewski, Gayle Barbin, Andrea E. Copping, and Anna M. Redden. 2015. "Special Issue: Renewable Ocean Energy Development and the Environment." *Estuaries and Coasts* 38:156–158. https://doi.org/10.1007/s12237-014-9922-2.

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