THE COMMUNICATION OF INFORMATION IN MULTI-SECTORAL NETWORKS: A CASE STUDY OF TIDAL POWER NETWORK(S) IN THE BAY OF FUNDY REGION OF ATLANTIC CANADA

by

Lee T. Wilson

Submitted in partial fulfilment of the
requirements for the degree of Master of
Library and Information Studies

at

Dalhousie University

Halifax, Nova Scotia

November 2015

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Natural resource developments, particularly those taking place in highly active, and often hotly contested, coastal areas involve a complex interplay among multiple stakeholders, sometimes with competing interests. In the Bay of Fundy region, a form of renewable energy that harnesses kinetic energy generated by tidal forces, known colloquially as "tidal power," is being explored. Tidal turbine implementation affects multiple stakeholders, e.g., municipal, provincial, and federal government agencies; non-governmental organizations (NGOs); environmental groups; industry both domestic and foreign; universities; and community groups, including First Nations communities. The literature suggests that the development of strong communication and information-sharing networks is essential to the success of such endeavors. Using a mixed-methods approach involving participant-led mapping of communication channels, semi-structured interviews, and Social Network Analysis (SNA), this research examines with whom and to what extent stakeholder organizations are communicating information about tidal power in the Bay of Fundy region.

The findings indicate that the tidal power communication network is comprised primarily of the government, industry, First Nations, NGO, and research sectors. Cross-sectoral communication is occurring, but some sectors, e.g., fishing and aquaculture and First Nations, are not well connected. Information is being shared strategically in the network to alleviate uncertainty and fill knowledge gaps in a nascent field that has many unknowns. Strategic communication is also used as a means to garner social license through stakeholder engagement and public education/awareness building about tidal power activities. The respondents highlighted a number of factors that act as either enablers or barriers to communication. Bridger organizations, predominantly from the NGO, government, and research sectors, were identified as instrumental to cross-sectoral communication. Committees, sub-committees, and working groups, as well as conferences and workshops, were emphasized as key communication mechanisms. Regulatory committees were also shown to be effective means for breaking down departmental silos in government, and ameliorating both internal and external channels of communication. Based on the results, several recommendations are outlined as a means of strengthening communication networks in the region.

LIST OF ABBREVIATIONS USED

ACOA	Atlantic Canada Opportunities Agency
ATEI	Acadia Tidal Energy Institute
BIO	Bedford Institute of Oceanography
COMFIT	Community Feed-In Tariff
CLC	Community Liaison Committee
DFO	Fisheries and Oceans Canada
EI Index	External-Internal Index
EIUI	Environmental Information: Use and Influence
EMAC	Environmental Monitoring Advisory Committee
FAST	Fundy Advanced Sensor Technology
FERN	Fundy Energy Research Network
FIT	Feed-In Tariff
FORCE	Fundy Ocean Research Centre for Energy
ICOM	Integrated coastal and ocean management
ICM	Integrated coastal management
ICZM	Integrated coastal zone management
IM	Integrated management
IOM	Integrated ocean management
KMKNO	Kwilmu’kw Maw-klusuaquan Negotiation Office
LFA	Lobster Fishing Area
MCG	Mi'kmaw Conservation Group
MEKS	Mi’kmaq Ecological Knowledge Study
MRC	Marine Renewables Canada
MRE	Marine renewable energy

MW	Megawatt
NGO	Non-governmental organization
NSDOE	Nova Scotia Department of Energy
NSPI	Nova Scotia Power Inc.
OEER	Offshore Energy Environmental Research
OERA	Offshore Energy Research Association
ORA	Organizational Risk Analyzer
R&D	Research and development
REB	Research Ethics Board
SEA	Strategic Environmental Assessment
SNA	Social Network Analysis
TISEC	Tidal in-stream energy conversion

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. Bertrum MacDonald (School of Information Management) for his guidance and support over the past two years, and especially during the course of this research. This project would not have succeeded without his invaluable insights and keen eye for detail. I also wish to acknowledge and sincerely thank the members of my Supervisory Committee – Dr. Peter Wells (Marine Affairs Program and the International Oceans Institute-Canada) and Dr. Claudio Aporta (Marine Affairs Program) – for lending their unique perspectives to this project. I would like to thank the members of the Environmental Information: Use and Influence (EIUI) team for continually challenging me to push the boundaries of my research and for pointing me towards new areas of inquiry. I am also grateful for the opportunity to have been employed as a research assistant with EIUI during my research. I would like to extend a sincere thank you to all of the individuals who took time out of their busy schedules to participate in this research. Finally, I would also like to thank my friends, family, and partner, Erica White, for their continued love and support.

CHAPTER 1. INTRODUCTION

1.1 Research Problem

Natural resource developments, particularly those taking place in the highly active, and often hotly contested, coastal zone involve a complex interplay among multiple stakeholders, sometimes with competing interests. The current literature suggests that the development of strong communication and information-sharing networks is essential to the success of such endeavors (Bastien-Daigle, Vanderlinden, & Chouinard, 2008; Bremer & Glavovic, 2013; Mitchell, Clark, & Cash, 2006; Sessa & Ricci, 2010; Wilson & Wiber, 2009). In Nova Scotia, marine renewable energies (MREs) are being considered as a means to help stimulate economic growth as well as to mitigate the effects of climate change through the production of "green" energy (Nova Scotia Department of Energy, 2012). In the Bay of Fundy region, a form of renewable energy that harnesses kinetic energy generated by tidal forces, known colloquially as "tidal power," is being explored due to its vast potential, which some estimates suggest could be as high as 2,500 MW (Nova Scotia Department of Energy, 2014; Offshore Energy Research Association, 2015).

Tidal power development in the region involves many stakeholder groups, e.g., municipal, provincial, and federal government agencies; non-governmental organizations (NGOs), e.g., the Fundy Ocean Research Center for Energy (FORCE) and Marine Renewables Canada (MRC); environmental groups; industry both foreign and domestic; universities; and community groups, including First Nations communities (Howell & Drake, 2012). Despite recent scoping studies examining cultural and socio-economic factors influencing tidal power implementation, research that actually engages with

stakeholders in the region is quite limited. Additionally, no studies have been conducted to date that look specifically at inter-organizational communication networks.

This study bridges that knowledge gap through a groundwork, qualitative Social Network Analysis (SNA) to gain contextual insights into why, how, with whom, and to what extent organizations are communicating about tidal power in the Bay of Fundy region. This study examined inter-organizational knowledge sharing practices, including barriers and enablers to communication. Network analysis was used to identify key network figures, possible “bridger” organizations, and which organizations are underrepresented or not at all represented in the network. Finally, recommendations are made where appropriate about how communication channels in the region could be strengthened.

1.2 Context

The effects of climate change and environmental degradation are increasingly being identified as one of the major challenges of our time. The United Nations Environmental Programme (UNEP) highlights devastating effects resulting from climate change such as shifting weather patterns threatening food production, and sea-level rise threatening increased coastal and inland flooding. The organization warns that “without drastic action today, adapting to these impacts in the future will be more difficult and costly” (United Nations Environmental Programme, 2010, p. 2). The development of sustainable and renewable energy resources is an action aimed at breaking our societal dependence on fossil fuels and thereby significantly reducing carbon emissions, considered to be the number one cause of climate change. In response to this need, the Nova Scotia Department of Energy (NSDOE) developed a renewable energy electricity plan that stipulated that 25% of the province’s energy production come from renewables by 2015, and 40% from renewables by 2020 (Nova Scotia Department of Energy, 2010a). Currently, Nova Scotia Power Inc. (NSPI) relies heavily on conventional, fossil-

based energy sources, e.g., coal, oil, and natural gas; however, renewable assets, e.g., wind, solar, biomass, and marine renewables, are also being developed (Nova Scotia Department of Energy, 2010a; Nova Scotia Power Inc., 2015). Marine renewables come in a variety of forms and can include, offshore wind, wave energy, and tidal (Nova Scotia Department of Energy, 2010b). Nova Scotia fell short of its 2015 goal; however, energy generation from renewable sources in the province stands at around 20% through the current renewable energy infrastructure, i.e., predominantly wind and solar (Nova Scotia Power Inc., 2015). Other developments will be needed to achieve the 40% mark in 2020 (Nova Scotia Department of Energy, 2010a). Given the significant resource potential, tidal power has emerged as a possible contender on the global renewable energy market.

The Bay of Fundy is home to some of the world's highest tides (Bay of Fundy Tourism Partnership, 2014; Percy, 2009). Estimates suggest that anywhere from 100 billion to 160 billion tonnes of seawater flow in and out of the bay each tidal cycle (Nova Scotia Department of Energy, 2008; 2014). Because of the unique tidal conditions, attempts were made as far back as 1607 in the form of tidal mills to harness the resource (Percy, 2009). In 1984, a tidal power plant opened in Annapolis Royal that currently generates up to 20 MWs of energy (Nova Scotia Department of Energy, 2014). In 2008, The Nova Scotia Department of Energy commissioned the Offshore Energy Environmental Research (OEER) association, now the Offshore Energy Research Association (OERA), to conduct a Strategic Environmental Assessment (SEA) aimed at providing advice on whether, when, and under what conditions tidal energy demonstration and commercial products should be allowed in the water (Offshore Energy Research Association, 2013a). The SEA process consisted of an environmental impact study, particularly focused on the Minas Passage, community engagement in the form of two rounds of

forums held in six locations in the Bay of Fundy region, a SEA update report in 2013, and a Mi'kmaq Ecological Knowledge Study (MEKS) conducted in 2009. As a result of these assessments, tidal energy development in the Bay of Fundy region has been permitted to move forward under certain conditions, one of which being the creation of multi-sector committees to advise tidal power proponents on environmental monitoring needs and to engage community stakeholders, i.e., the Environmental Monitoring Advisory Committee (EMAC) and the Community Liaison Committee (CLC) (Offshore Energy Research Association, 2013a).

The tidal energy sector in Canada is in its infancy, with current technology still at pre-commercial stages (Offshore Energy Research Association, 2015). Currently, the industry is moving towards increased development of tidal current, i.e., in-stream, energy as opposed to power based on tidal ranges, e.g., dams, barrages, and lagoons, similar to the Annapolis Royal installation. In Canada, tidal energy development is almost exclusively confined to Nova Scotia, with the majority of activity taking place in the Bay of Fundy. The Bras d'Or Lake in Cape Breton has also been identified has a possible site for tidal energy development and a SEA process for this area is being undertaken (Offshore Energy Research Association, 2013b). Development in the Bay of Fundy region can be further sub-divided into large scale and small scale operations. The former are currently being implemented within a test facility located in the Minas Passage area of the Bay of Fundy overseen by FORCE. FORCE is an NGO committed to working with tidal energy developers, regulators, and researchers to develop an understanding of the potential for tidal turbines to operate within the bay (Nova Scotia Department of Energy, 2014). The site, which has been deemed ideal for tidal energy production due to deep waters and high tidal currents (Nova Scotia Department of Energy, 2014), is home to four "proponents," also known as "berth holders," that plan to implement test devices

within the next three years. Estimations suggest that each of the test devices will produce between 2.5 – 4 MW of power per day for the electricity grid (Natural Resources Canada, 2015). Near the Municipality of Digby, smaller scale tidal projects are also being developed (Fundy Tidal Inc., 2014).

Although a recent value proposition study has suggested that the industry could generate 1.7 billion dollars for the Nova Scotia economy by 2040 (Gardner Pinfold Consultants Inc. & Acadia Tidal Energy Institute, 2015), the fledgling industry must overcome a number of barriers. The Bay of Fundy contains some of the harshest coastal conditions in the world for developers, giving rise to the dubious moniker of “The Fundy Standard” for devices capable of weathering the harsh currents of the bay (Fundy Ocean Research Centre for Energy, 2015b). In 2009, a joint project by OpenHydro, an Irish tidal energy developer, and NSPI proved unsuccessful when the turbine was destroyed after only three weeks of operation (“Bay of Fundy FORCE Study”, 2014). In addition to the challenging environment, the technology underpinning tidal energy extraction, which in the Bay of Fundy are predominantly tidal in-stream energy conversion (TISEC) devices, is not currently cost-competitive against other renewable energy sources (Gardner Pinfold Consultants Inc. & Acadia Tidal Energy Institute, 2015). Although this uncompetitive position is expected to change as the industry matures, standards are developed, supply chains are created, and mass-production of the technology becomes possible (Offshore Energy Research Association, 2015), the industry currently relies on government subsidies, e.g., the Feed-In Tariff (FIT) and Community Feed-In Tariff (COMFIT) programs. The current absence of a commercially viable industry creates risk that could act as a deterrent for would-be investors.

Another barrier is a lack in clear regulation and policy governing development of this industry. MRE development in the Bay of Fundy must operate alongside a number of

pre-existing sectors including fisheries, aquaculture, tourism, shipping, traditional use, and recreational activities (Nova Scotia Department of Energy, 2010b). As a consequence, regulations for development fall within a complex regulatory environment (see Nova Scotia Department of Energy, 2010b, p. 6, for a complete list). In response, the Nova Scotia provincial government, in tandem with the federal government, created the “One Window Committee” for tidal energy (Offshore Energy Research Association, n.d.). Essentially, the role of this committee is to provide a venue for interested developers to meet with all of the appropriate regulatory bodies as a whole rather than separately, effectively expediting the permitting process by deconstructing traditional inter-governmental silos (see Appendix A for a more detailed depiction of the current regulatory schema). Despite this committee, the need for a clear regulatory process has been consistently cited as requisite for industry advancement (Doelle, Russell, Saunders, VanderZwaag, & Wright, 2006; Nova Scotia Department of Energy, 2010b; Offshore Energy Research Association, 2015). In response, recently proposed legislation seeks to create a set of rules and regulations to help guide the industry as well as delineate “Marine Renewable Priority Areas,” or “safety zones,” that will prevent other activities, e.g., fishing and aquaculture, from occurring in areas identified as key tidal energy locations (Withers & LaRoche, 2015).

Recent advances in marine turbine technologies, coupled with a demand for renewable energy resources, have sparked a flurry of activity around the implementation of tidal power within the Bay. However, the geo-political, socio-economic, and cultural heterogeneity of the Bay of Fundy region complicates tidal power governance. The implementation of tidal power infrastructure within the Bay of Fundy is a complex, coastal zone issue involving many stakeholders, e.g., municipal, provincial, and federal government agencies; NGOs; environmental groups; community groups; the MRE

industry, both foreign and domestic; the fishing and aquaculture industries; universities, and First Nations communities, sometimes with competing interests (Howell & Drake, 2012). In addition, Maritime ocean and coastal zones are governed by “an intricate web of federal, provincial, regional and municipal regulations and policies” (Bastien-Daigle, et al., 2008). The predominance of certain sectors of interest, e.g., fisheries and tourism, further complicates coastal governance. In Canada, activities taking place in ocean and coastal areas are nominally governed by the integrated oceans management (IOM) policy framework of the *Oceans Act, S.C. 1996, c. 31* that strives to bring representation to affected constituents. As noted earlier, the current literature suggests that strong channels of communication and cooperation are vital to the success of complex, multi-stakeholder endeavours (Bastien-Daigle et al., 2008; Bremer & Glavovic, 2013; Mitchell, et al., 2006; Sessa & Ricci, 2010; Wilson & Wiber, 2009). Yet, as of the 2013 SEA update, an IM policy for the Bay of Fundy remains undeveloped (AECOM, 2014). With tidal turbine implementation becoming a reality, it is important to gain an understanding of how, and even if, stakeholder organizations are communicating with each other about tidal power.

For over a decade, researchers at the Environmental Information: Use and Influence (EIUI) research program have been exploring the complex science-policy interface. Simply put, the goal of the EIUI is to understand the processes by which information moves from producing bodies, i.e., scientific research groups, into the hands of decision and policy makers, while also seeking to comprehend the actual impact such information has on policy development. One of the conclusions drawn from this research suggests that “[t]he informational and social interplay at [the science-policy interface] is affected by many factors, and may be non-linear and unpredictable” (Environmental Information: Use and Influence, 2014). Such unpredictability arises, in part, from the fact that these

processes are comprised of human interactions and, therefore, do not always operate consistently or even logically. Social Network Analysis (SNA) represents an attempt to identify, measure, and visualize human social networks in order to gain a clearer understanding of information pathways and problems associated with the communication of information. Within the EIUI research program, SNA may offer a novel perspective on the operation of the science-policy interface.

This exploratory research study used qualitative SNA techniques to examine how, or even if, organizations affected by the use of tidal turbines for energy in the Bay of Fundy are communicating about the subject. SNA uses a mathematical approach to measure networks based on formal qualities (i.e., the strength, intensity, frequency, and direction of network relations) (Hanneman & Riddle, 2005). Since social networks, particularly those spanning organizational and sectorial boundaries, tend to be large, researchers often rely on either survey instruments (Easley & Kleinberg, 2010; Hartley, 2014; Parag, Hamilton, White, & Hogan, 2013), or publically available data, e.g., Twitter or Facebook records, that can be gathered automatically (Gruzd & Haythornthwaite, 2013). While both methods are effective at gaining a broad-view network perspective, contextual information is also required to achieve an understanding about how social relationships function (Edwards, 2010). Tidal power, unlike other energy sectors that are more mature, e.g., the hydroelectric or oil and gas industries, is still a nascent field. This results in an unstable climate lacking formalized structures where organizations are still emerging and whose roles are evolving. Due to a lack of formalized structures, contextual, secondary data are essential, yet scarce. Therefore, the network data collected in this research was derived primarily from “participatory mapping,” interviews whereby individuals representing key stakeholder groups identified their organization’s information sharing networks and provided a detailed account of each inter-

organizational relationship (Emmel, 2008). The mixed-method or comparative approach used in this study, combining quantitative SNA analysis with qualitative interview data, provides the basis for a strong groundwork study, the results of which can be tested in future studies involving larger sample sizes (see Chapter 3 for a full discussion of methods).

Some research has been pursued on the environmental, socio-economic, and political ramifications of tidal power implementation in the Bay of Fundy region (see Colton & Isaacman, 2013; Howell & Drake, 2012; MacDougall & Colton, 2013; Moore et al., 2009). A stakeholder analysis scoping study helped to identify affected constituents (Howell & Drake, 2012). A set of "toolkit" documents has created a suite of best practices for industry development (MacDougall & Colton, 2013) and community engagement (Colton & Isaacman, 2013). Research suggests that all stakeholder groups, including First Nations communities, need to be considered to ensure the success of multi-jurisdictional coastal zone endeavours (Alexander, Wilding, & Heymans, 2013; Baily, West, & Whitehead, 2011; Bastien-Daigle et al., 2008; Bremer & Glavovic, 2013; Coffey & O'Toole, 2012; de Groot, Campbell, Ashley, & Rodwell, 2014; Rice, 2005; Suskevics, Tillemann, & Kuelvik, 2013; Wilson & Wiber, 2009). Communication has been pinpointed as the means through which ideas and viewpoints "are made 'explicit' and mobilized in a state able to support deliberation and decision-making" (Bremer & Glavovic, 2013, p. 49). Yet, little research has been conducted that examines whether communication is actually occurring between affected parties, what types of information are being transmitted, and how such information is used to support organizational mandates and decision-making processes.

This study used qualitative SNA techniques to acquire rich contextual data about the working relationships between tidal power stakeholder organizations based on

interviews conducted with prominent figures (22 individuals) acting as representatives for their organizations. The methods included formal, semi-structured interviews that make use of “participatory mapping” (see Chapter 3) to probe inter-organizational relationships on the basis of variables, such as, frequency of communication, the perceived salience of information received, factors that act as barriers and enablers to communication, types of information received and transmitted, how received information is used to support organizational mandates, the means through which information passes between organizations, e.g., telephone, fax, and email, and also the mechanisms by which inter-organizational communication and collaboration occurs, e.g., multi-organizational committees, sub-committees, and working groups. Specifically, this research examined the following questions:

1. With which organizations and to what extent are stakeholder organizations communicating information about tidal power in the Bay of Fundy?
    a. Which stakeholder organizations are involved in tidal power in the Bay of Fundy?
    b. Which organizations communicate with other organization(s) in the network?
    c. Which sectors are more likely to communicate?
        i. Does type of sector contribute to information sharing propensity?
    d. Which sectors do not typically communicate?
2. What type(s) of information is/are shared among stakeholder organizations?
    a. What type(s) of information is/are being disseminated?
    b. What type(s) of information is/are being received?
3. How is the received information being used?
4. Does the information support the mandates of the organizations?
    a. If so, how?

5. What are the mechanisms for information sharing?
    a. What are the physical means of communication (e.g., telephone, email, face-to-face)?
    b. What structures, if any, exist to promote communication (e.g., conferences, multi-organizational sub-committees, shared projects, permitting and regulatory requirements)?
6. What factors affect communication in the network(s)?
7. Which organizations are key network figures?
8. Who is not represented in the network?

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

As the preceding chapter noted, this research examined the communication of information within a complex, multi-organizational, and multi-sector environment. Before an understanding of the mechanisms and processes by which information flows can be gained, it is first necessary to understand the context in which tidal power operates, as well as the academic background in which this research resides, including how other researchers have approached the question of information sharing within complex, multi-disciplinary environments. Chapter 1 provided a summative overview of the history of tidal power in the region, the current state of the industry, and the political, regulatory, and socio-economic landscape. Chapter 2 expands on some of these ideas, particularly the concept of integrated management (IM) in the coastal zone and the effect of integrated management on information sharing, as well as explores existing literature in a variety of related fields. Specifically, this review examines: 1) IM literature as it pertains to identifying potential barriers and enablers in inter-organizational communication, 2) selected literature on the use of information in decision-making at the science-policy interface, 3) social science research on marine renewable energy (MRE) developments, including a brief overview of the literature related to tidal power implementation in the Bay of Fundy, 4) research on interpersonal, inter – and intra – organizational information sharing, 5) selected literature on Social Network Analysis (SNA) with a particular focus on the use of SNA in an organizational context, and 6) research that applies a SNA approach to study inter-organizational communication networks in multi-stakeholder environmental resource management and governance issues. An examination of this literature suggests that few studies have 1) used a SNA approach to study inter-organizational communication networks in Canadian coastal zone environments; 2)

examined information sharing in emergent fields or complex, multi-sector networks; and 3) used empirical methods to determine what kinds, why, and how information is being shared within a diverse network where stakeholders possess a variety of differing roles.

2.2 Integrated Coastal Zone Management

The prevailing paradigm for the governance of coastal zone issues in Canada is a process known as integrated oceans management (IOM): a wholly integrated, participatory form of management that spans sectorial, organizational, and governmental boundaries (Bastien-Daigle, Vanderlinden, & Chouinard, 2008; Bruckmeier, 2005; Taljaard, Slinger, & Van Der Merwe, 2011; Wiber, Rudd, Pinkerton, Charles, & Bull, 2010; Wilson & Wiber, 2009). This type of management is purportedly accomplished through the creation of a participatory governance framework wherein all stakeholders are provided an equal opportunity to debate coastal issues (Bremer & Glavovic, 2013; Coffey & O'Toole, 2012). However, it should be noted that as of the 2013 Strategic Environmental Assessment (SEA) update, an IM policy for the Bay of Fundy remains undeveloped (AECOM, 2014).

Although defined as IOM under Canada's *Oceans Act, S.C. 1996, c. 31*, IM has several names, including integrated coastal and oceans management (ICOM), integrated coastal management (ICM), and integrated coastal zone management (ICZM). In the literature, ICZM is used most often to denote this concept (Bremer & Glavovic, 2013; Coffey & O'Toole, 2012; Ernoul & Wardell-Johnson, 2013; Taljaard et al., 2011). Hereafter, ICZM will be used exclusively to refer to integrated management initiatives.

Literature in this field is extensive, and is by no means homogenous. For the purposes of understanding the barriers and enablers to the communication of information in multi-stakeholder, coastal zone environments, relevant literature has been summarized into

four main themes: stakeholder responsibilities and power imbalances; communication, cooperation, and compromise; stakeholder representation; and reconciling separate knowledge systems.

2.2.1 Stakeholder Responsibilities and Power Imbalances

Research examining the perceived success of ICZM approaches in Atlantic Canada has cast some doubt on their effectiveness (Bastien-Daigle, et al., 2008; Wiber et al., 2010; Wilson & Wiber, 2009). A major barrier to ICZM appears to be a lack of clear roles and responsibilities of the different groups operating in coastal zones. Taljaard et al. (2011) suggest that clearly defined roles and responsibilities are needed to ensure cooperation across tiers of government and sectors. Bastien-Daigle et al. (2008) surveyed IM groups[1] and government entities engaged in ICZM in the Maritime provinces and found incongruities in their perceived roles. According to the findings, government entities saw ICZM as a tool for solving conflicts whereas IM groups saw it as a means for community empowerment. In another study, Wilson and Wiber (2009) surveyed community groups from the Maritime provinces and similarly found that these groups saw ICZM as a community-empowering governance framework. The survey data also suggested that community confidence in ICZM was contingent on a firm understanding of the role of the community and other local stakeholders within the process.

While the literature is in agreement about the need for clearly identified roles and responsibilities, the articulation of this ideal is inconsistent. Christie (2005) argues that while a participatory regime is still essential, large-scale ecological initiatives are not well handled by often short-sighted municipal governments. Conversely, Wilson and Wiber

[1] According to the study, IM groups were those that had multi-stakeholder and multi-criteria participative decision-making processes organized around definition and resolution of issues (Bastien-Daigle et al., 2008).

(2009) found that community groups felt disempowered by provincial and federal governmental interventions, and claimed that their local knowledge and vested interests would make for better long-term ecological management. Tensions over stakeholder roles relate to the more poignant issue of power imbalances within ICZM (Bastien-Daigle, et al., 2008; Bremer & Glavovic, 2013; Sessa & Ricci, 2010; Wilson & Wiber, 2009).

Power imbalances occur when some stakeholders are given preferential treatment or hold positions of greater influence over others (Bremer & Glavovic, 2013). For example, a case study examining intertidal clam fisheries in Digby Neck, Nova Scotia demonstrated how private corporations were being favoured over local interests (Wiber et al., 2010). The privatization of local beaches without public or stakeholder consultation damaged trust in the government's commitment to integrated management practices. Unequal representation severely reduces trust in a process that can only function when all stakeholders are prepared to communicate, cooperate, and compromise (Bremer & Glavovic, 2013; Taljaard et al., 2011).

2.2.2 Communication, Cooperation, and Compromises

The literature consistently highlighted the importance of integration by all stakeholders. The breakdown of communication channels and the unwillingness to cooperate and compromise were identified as key barriers to integration. Wiber et al. (2010) found that "siloing" among government departments hindered communication and damaged community perceptions of integrated management. The absence of strong communication channels among government bodies meant that community concerns voiced to local government might not have reached the higher tiers of government where decisions that directly impact local communities are made. In this way, poor communication channels can lead to decreased community confidence and an

unwillingness to cooperate with other stakeholders in ICZM initiatives (Bastien-Daigle et al., 2008; Sessa & Ricci, 2010; Wiber et al., 2010; Wilson & Wiber, 2009). Problems with inter-organizational and departmental communication also plague scientific and research entities.

Universities participating in integrated management frameworks require a commitment to interdisciplinarity and the ability to reach across institutional bounds. An interdisciplinary approach recognizes that complex problems often do not adhere to disciplinary boundaries (Bremer & Glavovic, 2013). Indeed, if coastal zones are to be studied holistically, cooperative effort between disciplines and institutions is needed, including the social and physical sciences, to ensure that problems are comprehensively addressed (Kerr et al., 2014). Another benefit to the interdisciplinary approach is that it forces academics to produce outputs in a form understandable to those outside of their own disciplines, a challenge that is echoed in the production of scientific information to be consumed by both the public and policy-makers (McNie, 2007; Smajgl & Ward, 2013). McNie (2007) highlights the role of the educational sector in facilitating the transfer of information between science, society, and decision-making bodies. How to translate scientific information into a form that can be easily digested by non-scientists is a prominent factor in the challenge of reconciling multiple knowledge systems discussed in the following sections.

For other types of non-governmental entities, e.g., private sector companies, NGOs, and community groups, a lack of homogeneity, sometimes competing interests, and differing organizational cultures confounds integrated management practices (Bremer & Glavovic, 2013). Information sharing and collaboration are not always advantageous in a competitive environment (MacDougall & Colton, 2013). Bastien-Daigle et al. (2008) found that the competition for limited financial resources acted as a barrier to inter-

organizational communication and cooperation. Competing interests mean that all parties must be willing to make compromises (Taljaard et al., 2011). Cooperation among non-governmental entities, and to a lesser extent between government bodies, is also contingent on the belief that other stakeholders are equally committed to the cooperative principles of ICZM (Bastien-Daigle et al., 2008; Taljaard et al., 2011; Wilson & Wiber, 2009). To this end, Bremer & Glavovic (2013) argue that clearly articulating the benefits of ICZM is an important step in gaining stakeholder support.

2.2.3 Stakeholder Representation

The literature consistently reported that ICZM initiatives cannot function well unless all relevant stakeholders are given fair representation (Bastien-Daigle et al, 2008; Bremer & Glavovic, 2013; Coffey & O'Toole, 2012; McNie, 2007; Sessa & Ricci, 2010; Taljaard et al., 2011; Wiber at al., 2010). Indeed, public perception, community engagement, and consensus building were all viewed as critical in creating sustainable ICZM (Sessa & Ricci, 2010; Taljaard et al., 2011). Among ICZM's core tenets is the recognition that no one group has access to the totality of all knowledge and that all forms of knowledge are to be considered legitimate (Bremer & Glavovic, 2013). Further, dialogue is the primary means through which ideas and viewpoints "are made 'explicit' and mobilized in a state able to support deliberation and decision-making" (49). Of course, stakeholders also require the creation of mechanisms, e.g., workshops, public consultation forums, and conferences, to ensure that they have a meaningful forum through which to represent concerns (Wilson & Wiber, 2009). Such mechanisms must also occur during the critical planning stages of a new coastal zone initiative so that stakeholders do not feel as though the proposal for integrated governance is merely a façade (Taljaard et al., 2011; Wilson & Wiber, 2009). However, it was also found that even when enabling conditions are established, stakeholder cooperation is not guaranteed (Bastien-Daigle et al., 2008).

In addition, creating a forum to represent stakeholders is only a first step, and does not address the larger issue of how to reconcile different “knowledge systems” (Bastien-Daigle et al., 2008; Bremer & Glavovic, 2013).

2.2.4 Reconciling Separate Knowledge Systems

In the literature, “knowledge systems” is a broad concept used to describe the perceptual lens through which individuals, institutions/organizations, and cultures view the world (Bremer & Glavovic, 2013; Coffey & O’Toole, 2012). The potential problems created by differing knowledge systems can be distilled into two areas. First, stakeholders may naturally have competing interests that often cannot be realized all at once, e.g., competition over land use with limited capacity for development (Bastien-Daigle et al, 2008). Second, opposing interests, as well as cultural differences, can mean that knowledge systems do not share similar values, or are valued differently (Bremer & Glavovic, 2013; Sessa & Ricci, 2010). For example, Wilson and Wiber (2009) found that local fishermen expressed concern that “community-based fisheries appear to be more focused on maximizing what can be extracted from the environment, rather than managing the resource for people who use it” (p. 566). In this scenario, two conflicting valuation schemas are clearly at odds. Similarly, “non-scientific” forms of knowledge, e.g., tacit, local, or indigenous, are often undervalued (Sessa & Ricci, 2010; Wilson & Wiber, 2009). Cultural value systems can be even more difficult to reconcile due to fundamentally different worldviews and language barriers (Bremer & Glavovic, 2013). The literature contains a number of recommendations for overcoming such difficulties. Individual stakeholders must be responsible for “translating” their knowledge system into a more generalizable form (Bremer & Glavovic, 2013). At the same time, all other stakeholders must be receptive to the novel forms of knowledge. The value of various forms of knowledge must be determined through an open discussion where all

stakeholder knowledge systems are represented (Wilson & Wiber, 2009). What constitutes "valuable" or "useful" information in decision-making processes is explored extensively in the literature pertaining to the science-policy interface.

2.3 The Use of Information in Decision-making

The science-policy interface describes the intersection between scientists who generate information and the policy-makers[2] who ultimately use it. McNie (2007) highlights the need for the production of more "useful" scientific information to support decision-making. For information to be considered useful, it requires what Mitchell, Clark, and Cash (2006) describe as salience, legitimacy, and credibility. Salience refers to the relevancy of the information disseminated to decision-makers, i.e., that it be fit for purpose for the concerned region and be current; legitimacy refers to the perception that information is free from bias; and credibility refers to the perceived accuracy of the information by its users (McNie, 2007; Mitchell et al., 2006). Legitimacy and credibility relate strongly to the themes of stakeholder representation and the acceptance of multiple knowledge systems discussed in the preceding section. The possible salience, legitimacy, and credibility of information is confounded by a wide array of factors as identified in the literature.

Scientists and policy-makers often operate on different timescales and with different aims. Scientists generally advocate for longitudinal studies wherein the long-term collection of environmental data can depict trends or patterns over time (Rice, 2005). Scientists are also considered to be more conservative in their interpretation of the data (Oreskes, 2015; Rice, 2005). Conversely, policy-makers rely on information that is useful in the short term to aid in decision-making, to help alleviate uncertainty, and to support

[2] Following the example of McNie (2007), this study will use the terms "policy-maker" and "decision-maker" interchangeably while acknowledging connotative and denotative distinctions.

the advocacy of a particular position or strategy (Hartley, 2014; NcNie, 2007; Smajgl & Ward, 2013). This need for scientific information to be interpreted into plain language can lead to a trade-off of complexity for simplicity in which important aspects of the information may be lost (Sarkki et al., 2014). Additionally, it is not clear who should be responsible for translating and/or communicating scientific information to policy-makers and the general public (McNie, 2007).

Another barrier to communication at the science-policy interface is the on-going debate on the role of scientists in contemporary society. One side of the debate maintains that scientists should avoid advocacy in favour of maintaining objectivity and keep the profession outside of partisan politics (Nielsen, 2001; Sarewitz, 2013). Others argue that scientist advocacy is necessary for the promotion of solutions to pressing environmental issues, particularly those relating to climate change (Gewin, 2014). In a recent study, Singh et al. (2014) found that despite polarization surrounding this debate, there exists a "prevailing belief among those in environmental science and policy that scientists should engage in science interpretation, integration, and even advocacy" (p. 164). The literature also points to the possibility of boundary-organizations acting as information brokers to help bridge the gap between science and policy sectors (Bremer & Glavovic, 2013; Coffey & O'Toole, 2012; Long, Cunningham, & Braithwaite, 2013; McNie, 2007). The communication of information and its use in decision-making processes is covered extensively in the literature, but few case studies explore how, or even if, communication is actually occurring in real-world contexts (McNie, 2007).

2.4 Marine Renewable Energy (MRE) Developments

This review has found that research focused more specifically on MRE developments, e.g., offshore wind, hydro-electric, and tidal, highlights areas similar to those discussed in broader coastal zone governance studies. Research conducted in Europe and the UK,

for example, has shown that the recent initiatives for MRE development have reignited a number of long-standing coastal zone debates, including the legal rights of individuals, and local and indigenous community groups with regard to coastal zone land use (Todd, 2012; Wright, 2015). In concert with ICZM studies conducted in Atlantic Canada, local communities and indigenous groups feel particularly disempowered in MRE issues (Bastien-Daigle et al., 2008; Kerr, Colton, Johnson, & Wright, 2015; Wiber et al., 2010). Kerr et al. (2015) found little evidence to suggest that current governance models, including ICZM frameworks, adequately address tensions between communities and government entities. Other studies have found that negative public perception surrounding MRE development is related to concerns about visual “pollution” created by MRE devices and possible environmental impacts (Appiott, Dhanju, & Cicin-Sain, 2014; Bailey, West, & Whitehead, 2011; West, Bailey, & Winter, 2010).

As an emerging industry, MRE relies heavily on financial investment from the private sector (Leete, Xu, & Wheeler, 2013). Appiott et al. (2014) found that a lack of funding, in addition to technological difficulties, represent a significant obstacle to MRE development in the UK. Long timescales, due in part to the length of time required to develop novel technologies and the subsequent unpredictability of costs, have been identified as possible barriers to private investment (Leete et al., 2013). In addition to commercial entities directly related to MRE activities, e.g., device manufacturers, private funding entities, and technology developers, other commercial sectors, e.g., fisheries and tourism, are also affected by coastal zone developments. Surveys and interviews conducted with UK fishermen found that while their perceptions of MRE development were mostly positive, acceptance hinged on being made aware of future development sites and being included in the consultation process (Alexander, Wilding, & Heymans, 2013; de Groot, Campbell, Ashley, & Rodwell, 2014). Despite such positive initial

findings, more social science research on MRE projects has been suggested (Kerr et al., 2014).

In 2008, the Government of Canada commissioned a Strategic Environmental Assessment (SEA) to explore the viability of tidal energy implementation in the Bay of Fundy. Recommendations arising from the SEA urged a cautious, iterative approach exploring all potential impacts, e.g., environmental, political, and socio-economic (Offshore Energy Environmental Research Association, 2008). As a result, considerable research has been pursued on the environmental, socio-economic, and political ramifications of tidal power implementation in the Bay of Fundy region (see Colton & Isaacman, 2013; Howell & Drake, 2012; MacDougall & Colton, 2013; Moore et al., 2009). A stakeholder analysis scoping study helped to identify affected constituents (Howell & Drake, 2012). A set of "toolkit" documents has created a suite of best practices for industry development (MacDougall & Colton, 2013) and community engagement (Colton & Isaacman, 2013). However, despite this research, no study yet examines stakeholder perceptions of inter-organizational communication and probes how, and indeed if, stakeholder communication actually occurs. Further, if stakeholder communication is occurring, no study has attempted to understand how information is used by organizations to support their decision-making.

2.5 Interpersonal, Inter – and Intra – Organizational Information Sharing

Information sharing describes the transmission of information from one party to another. While this research focuses primarily on inter-organizational information sharing, i.e., the movement of information between two distinct, often autonomous bodies, the concept is deeply intertwined with interpersonal and intra-organizational information sharing, i.e., the sharing of information between individuals and information sharing within an organization respectively. The literature can also be sub-divided into two main areas:

government and industry. In contrast to literature on the science-policy interface that looks at the processes or mechanisms by which information either moves or does not move among scientists, policy-makers, and the general public, studies focusing on information sharing in governmental contexts examine information flow between government entities, i.e., departments and agencies, and tiers, e.g., federal, provincial, and municipal (Wenjing, 2011; Willem & Buelens, 2007; Yang & Maxwell, 2011). Research looking at information sharing practices in industry tends to focus on the movement of information within a supply chain network, i.e., organizations whose relationship is predicated on the production or movement of a commodity (Cheng, 2011; Li & Lin, 2006; Li, Sikora, Shaw, & Tan, 2006; Samaddar, Nargundkar, & Daley, 2006).

Drawing on literature from all levels, i.e., interpersonal, intra-organizational, and inter-organizational, three areas are now discussed: 1) motivations for information sharing, 2) factors affecting information sharing, including a discussion of enablers and barriers, and 3) gaps in understanding.

2.5.1 Motivations for Information Sharing

Despite extensive research in the area, the reasons and motivations for information sharing are varied, complex, and not fully understood. Some argue that certain individuals are motivated to share information from an altruistic desire to share knowledge, i.e., sharing for sharing's sake (Jarvenpaa & Staples, 2001; Wang & Noe, 2010). Others suggest that information sharing comes from a desire to educate (Marshall & Bly, 2004, as cited in Yang & Maxwell, 2011) and research has shown that this is particularly true if the information holder has confidence in the accuracy or validity of the information (2011), and also believes that the information will be useful to the intended recipient (Chiu, Hsu, & Wang, 2006; Siemson, Balasubramanian, & Roth,

2007). However, the most common reason for why information is shared is simply because the act of sharing can be beneficial to all parties involved.

Organizations, intra-organizational working groups, and individuals are often unable to independently generate all of the resources necessary for a project's success (Samaddar et al., 2006). According to the literature reviewed, information sharing can provide a competitive advantage to both parties (Cheng, 2011; Li et al., 2006; Samaddar et al., 2006; Wang & Noe, 2011), strengthen existing relationships and network connections, as well as foster new connections (Cheng, 2011; Steinel, Utz, & Koning, 2010; Wang & Noe, 2010), increase efficiency, especially between government entities (Samadar et al., 2006; Wenjing, 2011), and help to address policy issues, e.g., in the public health sector (Yang & Maxwell, 2011). Of course, this overview does not suggest that information sharing is always beneficial. In certain contexts, e.g., when information is considered to be private, restricted, or personally sensitive, the withholding of information may be necessary from a legal standpoint (Wenjing, 2011). Additionally, certain kinds of information, e.g., proprietary information, or information relating to ongoing research and development projects within a competitive market, may also be considered more valuable if unshared (Cheng, 2011). Such tensions permeate research on information sharing practices, and are especially poignant in the factors that affect information sharing decisions, which can often possess the double-edged quality of being both enablers and barriers to information flow.

2.5.2 Factors Affecting Information Sharing

2.5.2.1 Organizational Culture and Structure

Studies show that organizational culture and even the structural composition of an organization can have an effect on information sharing. An organizational culture that promotes information sharing, especially when support for sharing comes from upper

management levels, has been shown to act as an enabler to information flow (Cabrera, Collins, & Salgado, 2006; Connelly & Kelloway, 2003; Li & Lin, 2006). Additionally, incentivizing employees towards information sharing practices can have a positive effect, insofar as the reward system encourages cooperation rather than competition (Ferrin & Dirks, 2003). In terms of structure, Wenjing (2011) found that stifling internal policies, regulations, and rigid bureaucratic structures can adversely affect information sharing tendencies. Similarly, de-emphasizing traditional hierarchies has been found to promote increased intra-organizational information sharing (Wang & Noe, 2010). It has also been noted that even robust, IT-based communication solutions cannot overcome poor organizational structure or culture (Cabrera et al., 2006; Yang & Maxwell, 2011).

2.5.2.3 Attitudes and Dispositions

Similar to organizational culture, the attitudes and dispositions of individuals within an organization have been shown to be a strong factor in information sharing. Individuals who withhold information either from an unwillingness to share or from a view of information as a strategic asset can act as a barrier to information sharing (Constant, Kiesler, & Sproull, 1994). In SNA, this is known as informational-gatekeeping or bottle-necking (Easley & Kleinberg, 2010). Steinel et al. (2010) found that some individuals who engage in informational-gatekeeping also employ deception, e.g., lying or "spinning" information, which has been shown to be an inhibitor to information sharing (Cheng, 2011). The concept of information ownership, i.e., whether an individual perceives personal ownership over information, can also affect one's propensity to share (Wang & Noe, 2010; Yang & Maxwell, 2011). Kolekofski and Heminger (2003) found that an individual was more likely to withhold information when there was a perception of ownership. In concert, Constant et al. (1994) noted that participants were more likely to share information that they believed to be owned by the organization. Cultural factors

have also been identified as a determinant in one's propensity to share information (Wang & Noe, 2010; Jiacheng, Liu, & Francesco, 2010). For example, Chow, Deng, and Ho (2000) performed a comparative study of Chinese and American organizations and found that general cultural trends towards collectivism (China) versus individualism (the USA) also played a role in whether information sharing occurred in the workplace. A more recent study by Jiacheng et al. (2010) produced similar findings, leading to their assertion that Americans are more likely to engage in information sharing practices only when they are seen as being personally advantageous.

2.5.2.4 Relationships and Trust

The existence of strong relationships, whether interpersonal or inter-organizational, have consistently been identified as essential to information sharing (Cheng, 2011; Hansen, 2002; Wang & Noe, 2010; Yang & Maxwell, 2011). The literature points to a variety of factors that can either strengthen or weaken relationships. Cheng (2011) contended that power symmetry, i.e., both parties within a relationship are of equal power, resulted in a more stable and therefore stronger relationship. This observation relates back to the literature on ICZM that points to power imbalance as a barrier to integrated management (Taljaard et al., 2011). Cheng (2011) also found that information sharing was strongest in relationships where the benefits are obvious and clearly defined, e.g., in a commercial partnership where both sides enjoy increased profits, and that clearly defined benefits can even outweigh communication barriers. In addition, the literature suggests that organizations that share a strategic vision or have complementary mandates are more likely to engage in information sharing (Yang & Maxwell, 2011). Conversely, organizations that have competing mandates, or are competitors, are unlikely to engage in information sharing (Fedorowicz, Gogan, & Culnan, 2010). Intertwined with the idea of strong relationships is trust. While trust has been seen to strengthen relationships,

thereby increasing information sharing (Li & Lin, 2006; Wang & Noe, 2010), a lack of trust between organizations has been shown to be a barrier to information sharing (Cheng, 2011). Research has found that individuals are more likely to share information when they trust that the other party will not try to use the information in an opportunistic or underhanded manner (Willem & Buelens, 2007).

In the same vein as a lack of trust, uncertainty has also been shown to possess deleterious effects on information sharing. Uncertainty in an industry context can relate to information quality and market, supplier, customer, and technological uncertainty (Li & Lin, 2006). Li et al. (2006) found that sharing of strategic information within networks could help to alleviate uncertainty, thus ultimately leading to increased information sharing. Information quality, e.g., the accuracy, timeliness, adequacy, and credibility of information (Li & Lin, 2006), is strongly similar to Mitchel et al.'s (2006) framework of information salience, legitimacy, and credibility discussed above. Indeed, many of the factors of informational uncertainty in an industrial context can be applied to uncertainty in information sharing more generally, particularly in the context of the science-policy interface (McNie, 2007).

2.5.3 Gaps in Understanding

Research in this field has focused more on the factors affecting information sharing than the types of information actually being shared, and/or the mechanisms through which exchange occurs. Samaddar et al. (2006) and Li et al. (2006) examined the types of information sharing in supply chain networks, but from a purely theoretical perspective. Samaddar et al. (2006) divided types of information sharing into two categories, strategic and operational, but did not offer a clear definition of what each would entail, perhaps assuming the categories to be self-evident. Li et al. (2006) separated types of information sharing into three categories: transactional information, e.g., order quantities,

prices, and sales; operational information, e.g., inventory levels, costs, and schedules; and strategic information, e.g., point of sale, real-time demands, and market trends. Both studies aimed to create a theoretical framework for future studies on information flow in supply chain networks, and therefore neither examined the kinds of information actually shared. Further, little research focuses explicitly on the mechanisms by which information is shared. Wenjing (2011) reviewed the legal frameworks for intra- and inter-governmental information sharing, including international arrangements, but not the means, i.e., mechanisms or processes, by which information is shared.

Yet, Li and Lin (2006) suggested that "while information sharing is important, the significance of its impact … depends on what information is shared, how it is shared, when and how it is shared, and with whom" (p. 1643). This research fills this gap by examining the types of information being shared, the mechanisms through which information sharing occurs, and the reasons for information sharing in tidal power networks, alongside factors affecting information sharing, e.g., possible enablers and barriers. Perhaps more so than in single-purpose contexts, e.g., industry-to-industry supply chain networks, the type of information shared and the reasons for information sharing are more important in complex, multi-stakeholder environments where factors such as the sector to which organizations belong must be taken into consideration. In addition, very few reported studies have examined information sharing in multi-jurisdictional environments where stakeholder organizations can have separate, and sometimes competing mandates.

Information sharing research often focused on either a single sector, such as the public sector (e.g., Yang & Maxwell, 2011; Wenjing, 2011; Willem & Buelens, 2007), or private industry (e.g., Cheng, 2011; Li & Lin, 2006; Li et al., 2006; Samaddar et al., 2006). Tidal power activities in the Bay of Fundy affect diverse stakeholder organizations with

different interests and roles. In their comprehensive literature review, Yang and Maxwell (2011) noted that a SNA approach could be used to discover “whether social networks could facilitate inter-organizational information sharing when participating organizations are diversified or have very different functions” (p. 173). Similarly, Wang and Noe (2010) posited that “social network theories such as structural holes and closeness of network theories are relatively underutilized and may improve our understanding of knowledge sharing in teams and communities of practice (p. 122). Indeed, Li et al. (2006) concluded that information sharing was largely context dependent and therefore required an understanding of the structure of the examined network. Attempting to understand how information moves within multi-sectorial networks, e.g., the tidal power sector in the Bay of Fundy, requires a framework that takes into account the complex interplay between network actors with regard to the diverse roles played by different sectors.

2.6 Social Network Analysis (SNA)

Emerging from graph theory, SNA is a social science research technique that examines the relationships between individuals within social settings (Cheliotis, 2010; Coffey & O’Toole, 2012; Easley & Kleinberg, 2010; Hanneman & Riddle, 2005). SNA visualizes individual “actors” as dots – or “nodes” – and then maps their interactions with other nodes through connecting lines – referred to as “ties” (Easley & Kleinberg, 2010; Hanneman & Riddle, 2005; Kilduff & Brass, 2010). SNA literature is extensive and diverse. For the purposes of this research, the following sections will examine literature pertaining to the role of bridgers in SNA theory and the use of SNA as a tool for examining ICZM initiatives.

2.6.1 Bridgers

Bridgers are network actors that facilitate the flow of information between at least two otherwise unconnected groups or actors (Hanneman & Riddle, 2005; Long et al., 2013). Many terms are used to describe this phenomenon. For example, Burt (1992) used the term “structural hole” to describe the intermediary position of an actor between groups of non-redundant, i.e., otherwise unconnected, actors. Bridgers are also sometimes referred to as information “gatekeepers” because they can choose to either enable the transmission of information, or act as information “bottlenecks” (Easley & Kleinberg, 2010); information “brokers” (Long et al., 2013); and “boundary spanners” (2013). Hereafter, the term “bridger” will be used exclusively to signify this concept.

The power of bridgers within a network is often related to the strength of weak tie connections and the presence of social capital (Easley & Kleinberg, 2010). In the context of a personal friendship network, strong ties would most likely be found among close friend groups, i.e., a cluster of actors that all share reciprocal ties. In contrast, a weak tie would be a connection to an actor who is outside of the closely-knit group. In SNA theory, weak ties are important because they provide access to new, i.e., non-redundant, connections, which can in turn facilitate the transmission of information, perspectives, or ideas (Burt, 1992; Granovetter, 1973). Weak ties are also responsible for linking separate actor groups. In this sense, actors possessing weak ties are the “bridges” that fill structural holes found in the network. Such bridgers conceivably have more access to and control over new information than their peers who only have strong, i.e., redundant, connections (Burt, 1992).

Social capital is the largely intangible measure of the influence held by actors within social networks (Hanneman & Riddle, 2005) and is often correlated with trust and perceived credibility (Cross, Borgatti, & Parker, 2002). Research has shown that bridgers

with a high degree of social capital are the most effective (Fernandez & Gould, 1994; Friedman & Podolny, 1992). Trust and credibility were also found to be integral to integrated management strategies and stakeholder cooperation (Bremer & Glavovic, 2013; Wiber et al., 2010).

Bridging theory is comprised of two predominant schools of thought, *tertius gaudens* and *tertius iungens*, both of which emerged out of the work of German theorist Georg Simmel (1902a; 1902b). The seminal work of Burt (1992) and Gould and Fernandez (1989) examined bridging from a structural perspective, characterizing bridgers as actors who retain an intermediary position between otherwise unconnected groups. This perspective is also known as *tertius gaudens*, or, “the third who laughs” (Burt, 1992). Under this definition, bridgers are empowered through the retention of an intermediary role since independent connections formed among unconnected network actors would weaken the advantages enjoyed by the bridging party, i.e., exclusive access to information and control over the transmission of information within a network.

Bridgers from the intermediary school of thought (*tertius gaudens*) can be categorized into five distinct roles based on actor attributes, e.g., the organization or sector to which an actor belongs. They are as follows: 1) coordinator, i.e., all three actors are from the same organization/sector; 2) representative, i.e., the bridging actor connects an actor from their organization/sector with an “outside” actor; 3) gatekeeper, i.e., the bridging actor connects an actor from an “outside” organization/sector to an actor within their own organization/sector; 4) consultant, i.e., a third-party bridging actor connects two actors from the same organization/sector; and 5) liaison, i.e., all three actors are from different organizations/sectors (Gould & Fernandez, 1989).

In contrast to *tertius gaudens* is an emerging view of bridgers as facilitators who benefit both themselves and the network as a whole by actively forging new connections among unconnected actors (Collins-Dogrul, 2012; Obstfeld, 2005; Snow, Miles, & Coleman, 2000). This model of information brokerage is popularly known as *tertius iungens*, or, "the third who joins," and is a reinterpretation of the bridging role by Obstfeld (2005) that highlights the advantages of closing structural holes rather than exploiting them. Research studying inter-organizational networks has identified bridgers-as-facilitators in the for-profit, government, and non-governmental organization (NGO) sectors. These bridgers specialize in brokering connections among multiple organizations across sectoral boundaries and may even have a formal mandate to perform this role (Collins-Dogrul, 2012). Snow et al. (2000) deconstruct the roles played by *tertius iungens* bridgers into two categories: the architect and the caretaker. The architect facilitates novel connections among actors to help grow the network, while the caretaker maintains and builds upon existing networks (2000).

2.6.2 SNA as a Tool for the Examination of Integrated Management

SNA research is highly varied, ranging from dining partner preferences in a girls' school dormitory (Moreno, 1960) to examining online communities of health care professionals formed over Twitter (Gruzd & Haythornthwaite, 2013). SNA has also been used more pragmatically in professional sectors as a means of examining inter- and intra-organizational communication or collaboration (Cross et al., 2002; Cross & Borgatti, 2004; Kleiner, 2002). Studies have shown that managerial perceptions of how an organization operates, e.g., who communicates vital operational information to whom, are fraught with inaccuracies (Cross et al., 2002; Rainie & Wellman, 2012). Often, formal structural hierarchies meant to govern work and information flow do not accurately represent real workflow processes because they present a narrow view of an

organization that cannot account for the complex social dynamics at play, e.g., informal communication networks that exist outside of the formal hierarchies. Cross and Borgatti (2004) contend that “mapping the pattern of information flow … across functional barriers can yield critical insight into where management should target efforts to promote collaboration that will provide strategic benefits” (p. 33). The idea of conceptualizing multi-stakeholder governance settings as social networks can be found throughout the ICZM literature (Bastien-Daigle et al., 2008; Coffey & O’Toole, 2012; McNie, 2007; Taljaard et al., 2011), however, actual research in this area is sparse.

In building an evaluation framework for knowledge mobilization in ICZM initiatives, Coffey and O’Toole (2012) include a SNA approach as one of four essential components in the evaluation of an ICZM schema. They argue that the value of a SNA perspective is its ability to discover “the influence of informal processes, the interplay across organizational boundaries, and the possibilities for intervening to improve the way in which knowledge systems may operate for a defined purpose” (p. 319). Indeed, Bastien-Daigle et al.’s (2008) examination of ICZM groups in the Atlantic Provinces found that the major success of ICZM was its capacity to foster an environment wherein organizations were “communicating, building new networks, and trust” (p. 96). Further, communication is consistently identified as an essential factor in multi-stakeholder environments; yet, only a handful of studies have attempted to probe how and if inter-organizational communication actually occurs. To date, no SNA study has been conducted in Atlantic Canada of inter-organizational communication in a complex, multi-stakeholder environment.

2.7 SNA on Inter-Organizational Communication in Multi-Stakeholder Environments

Studies conducted in the US and the UK have shown that a SNA approach can be effective in attempting to understand and, where necessary, improve inter-organizational communication networks. Parag, Hamilton, White, and Hogan (2013) used a SNA approach to study community environmental groups in the UK. Their research probed information flow and financial support within community group networks and found that boundary organizations were essential in connecting the closely knit community groups to larger state and non-state entities. A SNA conducted on “conservation practitioners” and stakeholders in Oregon, found network gaps between “business people” and conservation groups (Vance-Borland & Holley, 2011). In response, several qualitative approaches, including formal interviews and stakeholder workshops, were initiated to help enhance the network. In a study of fisheries and land use planning networks in the Chesapeake Bay, Hartley (2014) found substantial differences between “salience” networks and communication networks, e.g., necessary information networks versus actual communication patterns; a lack of network connectivity across jurisdictions and sectors hindered fisheries management in the region. The three studies used a predominantly quantitative SNA approach that captured a large volume of network data based on predetermined measures that were further supported by qualitative methods.

In the SNA field, debate between the merits of quantitative versus qualitative approaches is longstanding, with many studies opting for a mixed-methods or comparative approach (Edwards, 2010). Quantitative, also known as “formal,” SNA often aims to measure networks based on their formal properties, i.e., the strength, intensity, frequency, and direction of network relations (Heath, Fuller, & Johnston, 2009). This approach excels at examining network data from a big picture perspective that views

individuals as actors whose actions are determined by their social relationships and positions in relation to other actors (Hanneman & Riddle, 2005). Indeed, it is this perspective that forms the underpinning of the SNA perspective (Kilduff & Brass, 2010). However, gaining a deeper understanding about how networks function requires contextual, or secondary, data.

Qualitative approaches, e.g., network interviews (participatory mapping), can be used in the acquisition of secondary data (Edwards, 2010; Emmel, 2008). For example, Hartley's (2014) quantitatively identified networks showed that two operational networks, i.e., land use networks and fisheries networks, were only connected by a single individual. After conducting a formal interview, it was found that this individual would be leaving his/her post within six months, thereby potentially severing communication channels between the networks. Similarly, Vance-Borland and Holley (2011) had to conduct a series of interviews and stakeholder workshops to better understand network composition before they could forward recommendations to ameliorate communication channels. In other words, while quantitative data do a good job of showing the "what," qualitative approaches are essential in understanding the "why" of connections.

Although existing stakeholder scoping studies have facilitated the identification of organizations operating in the Bay of Fundy tidal power network, more contextual knowledge is needed before a purely quantitative SNA can be considered meaningful. Therefore, rather than attempting to capture only network data from a high volume of organizations, e.g., through a survey tool, this research used a qualitative approach to gain deeper insights about inter-organizational communications from the perceptions of prominent tidal power stakeholder organizations (Emmel, 2008). Future research beyond this study could use a larger participant sample to complement the qualitative findings.

2.8 Conclusions

Tidal power implementation in the Bay of Fundy is a complex coastal issue that involves many stakeholders across a variety of sectors. In Canada, coastal zone issues are ostensibly governed by the integrated management policy framework articulated in the *Oceans Act, S.C. 1996, c. 31*. The literature on ICZM accentuates the difficulties in bringing together a diverse set of stakeholders around a particular issue. The principal issues identified to date are: 1) the roles and responsibilities within integrated management processes are not always explicit, leading to decreased confidence in the management system; 2) departmental and organizational "siloing" act as barriers to communication; 3) competing interests impinge upon inter-organizational cooperation; 4) comprehensive stakeholder representation is difficult to achieve; 5) how to reconcile separate knowledge systems is unclear; and 6) power imbalances often deprive stakeholders of equal representation.

Literature on the use of information and decision-making at the science-policy interface mirrors many of these same themes, particularly in the discussion of what makes information "useful." In addition, understanding and possibly reconceptualising the role of the scientist as a transmitter of and advocate for scientific knowledge is offered as a way to facilitate the transfer of information across sectors. The promotion of information brokers, e.g., boundary-organizations, to facilitate information flow is also emphasized. Literature focusing specifically on MRE developments similarly reflects many of the ideas presented in ICZM literature, as well as the assertions made in the more theoretical literature examining the science-policy interface.

Literature on interpersonal, inter- and intra-organizational information sharing suggests that a primary driver of information sharing activities is that they are often seen as being mutually beneficial. Research in the area is predominantly focused on the factors that

affect information sharing, which can be categorized into three main themes: 1) organizational culture and structure, 2) attitude and dispositions, and 3) relationships and trust. Gaps in this field of study include a lack of research specifically on what kinds, why, and how information sharing occurs.

Many of these issues can be examined using a SNA approach that looks at the communication of information through a network perspective. While similar studies have been conducted on organizations involved in fisheries and environmental awareness groups, few SNA studies have been completed looking at stakeholders affected by MRE developments in coastal zones. Further, a general gap exists in SNA research conducted on coastal zone stakeholders in a Canadian context.

CHAPTER 3. METHODS

3.1 Introduction

Tidal power development operates in a complex regulatory, political, and socio-economic milieu that affects a diverse group of stakeholders from multiple sectors. Chapter 2 drew on literature from several fields to gain an understanding of how past research has explored information sharing in such environments. Specifically, the reviewed literature was drawn from research conducted on integrated coastal zone management (ICZM); the science-policy interface; marine renewable energy (MRE) developments, including an examination of work done on the Bay of Fundy; interpersonal, inter – and intra – organizational information sharing; Social Network Analysis (SNA), with a particular focus on bridgers; and SNA approaches to studying inter-organizational communication networks in multi-stakeholder environmental resource management and governance issues. Chapter 3 describes the methods used to address the research questions outlined in Chapter 1. This research was conducted in a series of iterative steps spanning several months. It involved: 1) preliminary stakeholder identification; 2) obtaining ethics approval; 3) semi-structured interviews and participatory mapping; 4) interview transcription, coding, and analysis; and 5) Social Network Analysis (SNA).

3.2 Preliminary Stakeholder Identification and Ethics Approval

In order to understand how, or even if, information flows in tidal power communication networks, it was first necessary to identify the relevant stakeholders. For this research, “stakeholder” was defined broadly as any group or organization that is affected by tidal power activities in the Bay of Fundy region. Previous scoping studies on the socio-economic impacts of tidal power implementation in the Bay of Fundy identified potential tidal power stakeholders (see Colton & Isaacman, 2013; Howell & Drake, 2012;

MacDougall & Colton, 2013). Among these were: municipal, provincial, and federal government departments and agencies; NGOs; environmental groups; industry both foreign and domestic; universities; First Nations organizations and communities; and community groups. Research into the existing MRE regulatory frameworks revealed which government entities had a mandate for promoting and overseeing tidal energy (Nova Scotia Department of Energy, n.d.). Internet searches identified several NGO and research groups. An examination of the NGOs' websites revealed additional stakeholders. In addition to internet research, stakeholder discovery was facilitated by informal conversations conducted with individuals involved in tidal power in the Bay of Fundy, and through attending the International Conference on Ocean Energy 2014 held in Halifax, Nova Scotia on 4-6 November 2014. The conference attendance roster was also used as a means of stakeholder identification.

The identified stakeholder organizations were categorized into eight broad sectors based on the contextual data gathered during the preliminary stakeholder identification. These were: government, i.e., all three tiers of government; industry, i.e., companies involved in the MRE industry; First Nations; research; fishers and aquaculture; NGOs; tourism; and community groups. Contextual and interview data revealed that the "community groups" involved in tidal power communication were predominantly local business collectives, e.g., district and area boards of trade, and so this category was folded into industry during analysis. See Chapter 4, Section 4.3 for a more detailed description of the composition of the sectors involved in tidal power communication networks. Additionally, in keeping with existing SNA research, initial interviews were used as a form of "snowball" sampling wherein organizations identified by participants were then contacted to be a part of the study (Prell, Hubacek, Quinn, & Reed, 2008; Prell, Hubacek, & Reed, 2009).

3.2.1 Ethics Approval

Ethics approval was required before the stakeholders identified in the initial discovery phase could be contacted. In satisfaction of the requirements laid out in the Dalhousie University Research Ethics Board (REB) ethics application, parameters of the research study including a detailed overview of the proposed research and a brief description of the research context were developed. This also included a protocol for the semi-structured interviews and a participant consent form (see Appendices B and C). The ethics application was approved on 24 February 2015 (see Appendix D for a copy of the Letter of Approval sent by the REB).

3.2.2 Recruitment

Once ethics approval was obtained, email invitations were sent out to prospective participant organizations explaining the nature of the research and participant requirements (Appendix E). A copy of the consent form was also attached to invitation emails. In all, 25 stakeholder organizations were identified and invited to participate. Of this group, representatives of 19 organizations agreed to participate in the study (see Appendix F for a list of the participant organizations with descriptions). Invitations were targeted towards representatives of the study population, i.e., tidal power stakeholder organizations, holding executive-level positons, or positions entailing active involvement with tidal power development.

An attempt was made to obtain representation from all of the sectors. However, organizations from the fishing and aquaculture, and tourism sectors were not represented in this research even though numerous invitations were extended to these groups. No response was received to the several invitations sent out to organizations in the tourism sector, possibly owing to the fact that data collection for this research occurred during the “off-season,” when many of these organizations were inactive for the

winter. Contact was made with representatives from fishing organizations; however, scheduling conflicts made participation within the timeframe of the data collection period impossible for these organizations. In addition, it should be noted that while fisher "organizations" do exist, such collectives are usually informal with fishers operating as individual entities. The informal composition of fishers adds an additional layer of complexity in finding participants to represent this diverse, non-uniform sector.

The participant organizations are predominantly regional, e.g., their primary operations are within Nova Scotia. Some groups, e.g., federal government and NGOs, operate nationally. However, the study's scope was limited to organizations represented by participants who are chiefly involved in and/or affected by tidal power developments in the Bay of Fundy region of Nova Scotia.

3.3 Semi-Structured Interviews and Participatory Mapping

The primary methods of data collection used in this research were semi-structured interviews and participatory mapping. These were pursued in tandem in single sessions with each participant. All of the interviews were conducted in person in various locations within Nova Scotia and were audio recorded after participants provided written consent. The physical nature of the mapping precluded the possibility of using technologically meditated forms of communication, e.g., telephone or Skype.

Of the 31 invitations sent to representatives from 25 stakeholder organizations, a total of 20 interviews were conducted, capturing network data from 19 organizations represented by 22 participants. Several invitees did not respond to invitations, whereas others stated that they had not communicated information about tidal power within the period of the study, i.e., the past six months. Some participant organizations, especially those for which tidal power is central to their operations, employ multiple personnel

fulfilling different roles, e.g., a regulator/industry coordinator and a community spokesperson. For such organizations, separate interviews were conducted and each participant produced separate network maps. Maps were collated after each interview to create a single map for each organization. In one case, a group interview consisted of three individuals representing two organizations, a municipality and a municipal partnership entity with a renewable energy mandate. This arrangement was deemed acceptable because the municipal partnership entity operates on behalf of the municipality with regard to tidal power initiatives. A single map was created for these two organisations because their communication networks for tidal power in the Bay of Fundy were the same. One interviewee from the government sector performed the participatory mapping, but did not wish for his/her organization to be identified as a study participant. In this case, the details about the organization's communication habits contributed to the network data and the qualitative interview data, but the participant was not quoted directly in this research and the name of the organization has not been included with the other participants (Appendix F). An additional interview was conducted, but the contents were not included in the analysis because the interviewee did not fit the parameters of the study, i.e., had not communicated information about tidal power in the last six months. The discussion with this individual helped provide context and some historical information about tidal power development in the region.

The interview sessions consisted of four phases: first demographical/contextual questions were asked followed by the participatory mapping, then probing questions, and concluding with whole network questions. Due to the semi-structured nature of the interviews, some participants elected to combine phases three and four, discussing relationships as they identified organizations. In the first phase, semi-structured questions were used primarily as a means to obtain demographic and contextual

information about participants, their organizations, and their self-identified role in tidal power networks. Participatory mapping requires participants to create a visual “map” of their social relationships by identifying actors and connections (Emmel, 2008). In the second phase, participants, acting as representatives for their organizations, were asked to identify organizations with which their organization had communicated information about tidal power activities in the Bay of Fundy region within the previous six months. Participants were instructed not to provide the names of the individuals within identified organizations. Names, along with any other personally identifiable information, were not included in the interview transcriptions. The mapping was recorded physically on 11” x 17” pieces of white Bristol board with felt-tipped markers. For purposes of readability and time, the names of the identified organizations were written on the board by the researcher. However, once the mapping phase was complete, participants were given a marker and encouraged to interact with the maps while they discussed the organizations in the network. The participants grouped organizations according to sector by placing organizations within the same sector next to one another on the map. In the third phase, questions were used to explore the relationships with organizations in greater depth. In response to these questions, the participants grouped organizations as appropriate, i.e., organizations were grouped together when the information sharing relationships were similar. The interview concluded with a series of open-ended questions about the perceived state of communication in the network generally. See Appendix B for the complete set of interview questions and description of the participatory mapping exercise.

3.4 Interview Transcription, Coding, and Analysis

In keeping with the methodology developed by Emmel (2008), this study required both the physical map as well as an audio recording of the interview (Aronson, 1994). Both

artefacts were analyzed in tandem since neither can act as independent data (Emmel, 2008). Audio recordings of the interviews were transcribed by the researcher. The names of identified organizations were then replaced with alpha-numeric codes based on sector and the alphabetical order of the names, e.g., the name of a provincial department might be changed to “government_1.” This was done to promote clarity during analysis and reporting because the sector to which an organization belonged was not always readily apparent from the name. Also, since this research is more concerned with examining the broader network of information exchange as opposed to individual organizations, organization names were deemed to be distracting and unnecessary. In addition, participants’ names were further obfuscated by another set of alpha-numeric codes based on the sector to which the participant belonged, e.g., “Participant #1 [research].” This was done to clarify which participant was speaking during quotations, since some organizations were represented by multiple participants, and also to increase the level of anonymity for participants. The qualitative interview transcripts were then analyzed using established qualitative data analysis techniques (Bradley, Curry, & Devers, 2007; Ryan & Bernard, 2003; Turner, 2010), with the aid of the NVivo qualitative data analysis software (Bazeley, 2007).

Thematic coding involved reading through interview transcriptions to identify and categorize themes across interviews. Rather than applying pre-set codes to the interview data, the codes were developed using a “grounded” or “open coding” thematic analysis approach that looks for identifiable patterns or themes emerging from an analysis of the transcriptions (Aronson, 1994; Bradley et al., 2007; Ryan & Bernard, 2003). Thematic codes were developed to understand what kinds and how information was being shared among tidal power stakeholders and included: types of information exchanged, i.e., the “product” of the communication, or, “what” was being shared; reasons for information

sharing, e.g., is information sharing between two organizations more operational and project-based, or high level strategic planning?; use of information, i.e., how exchanged information is used by organizations; role in the network, e.g., is an organization an industry regulator, or a project developer?; mechanisms of communication, i.e., the means by which information was communicated; and factors affecting information sharing, i.e., enablers and barriers to information sharing. Codes used to identify sector were also used to indicate which sectors were being discussed in relation to each theme. Multiple codes were applied to segments of the interview transcripts where appropriate.

NVivo's analytics were used to identify main themes which were then explored in greater depth. The main themes were identified by considering: 1) the percentage of participants who discussed a theme at least once during their interview, and 2) the frequency with which a theme appeared in the interviews. The themes were also cross-tabulated with "sector" codes to determine which sectors were sharing what kinds of information and how. Cross-tabulation counted the number of times each theme was coded along with a particular sector. Sections of the interview transcripts were often assigned multiple theme and sector codes, e.g., when a participant representing sector "A" discussed sharing information with an organization from sector "B," the interview was assigned both sector codes. By analysis of the codes, the results present an overview of how participants talked about information sharing activities within the network. Both approaches, i.e., examining the percentage of coding across participants and the frequency with which a theme appeared in the interviews, were used to uncover general patterns in the data which could be explored further. Main themes were also considered in relation to the literature on the field (Aronson, 1994), or by linking themes to existing theoretical models (Ryan & Bernard, 2003). Results for the qualitative analysis are given

in Chapter 5. Qualitative analysis of the interview transcriptions and participatory maps was applied alongside a SNA approach.

3.5 Social Network Analysis (SNA)

In addition to the qualitative analysis of the maps and the responses to the interview questions, all of the participant-generated maps were transcribed digitally into a Microsoft Excel spreadsheet. The organizations listed in these maps were verified by internet searches to obtain contextual information, and to ensure that they met the study criteria, e.g., that they were active within the last six months. Once verified, the data was put into a matrix format and the organizations were given a binary relationship value of either 1 or 0, i.e., they either communicated information about tidal power activities within the previous six month period or not. The matrix was then uploaded into the Organizational Risk Analyzer (ORA) SNA software (Carley, 2011) and labeled as the "participant network."

An additional "committee network" was created based on membership rosters obtained from websites, conversations with key individuals in the network, and the interview data. Committees were consistently identified by participants as a means through which communication, and particularly inter-organizational communication, occurred. Six committees with a sole focus on tidal power were identified and participants confirmed that membership information provided on the websites was accurate and that each committee had met at least once within the six month timeframe of the study. For this study, committee members were identified as representatives of their organizations rather than as independent individuals.

Since both the "participant network" and the "committee network" are evidence of inter-organizational communication about tidal power in the Bay of Fundy, they were

combined using ORA's "union" functionality and labeled as the "communication network." For the SNA, the concepts of "communication" and "information sharing" are both expressed by the network ties and are, therefore, comparable. Even after the networks were unionized, all connections are recognized by the software in a binary, i.e., yes or no, fashion. Connections between organizations present in both the "committee network" and the "participant network" are not given more weight, i.e., the links are not "counted" twice (Carley, Reminga, Storrick, & Columbus, 2010). In all cases, the network connections were considered to be reciprocal, e.g., all reported information sharing was mapped as bi-directional.

In ORA, network actors are represented by nodes, e.g., dots, and automatically given node identifiers and titles. For the purposes of visualization, node titles were replaced by the alpha-numerical coding scheme for organizations described above (see Section 3.4). Organizations in the tidal power networks were also assigned sector attributes, i.e., the sector to which an organization belongs, which reflected the categories discussed in Section 3.2.

To assess inter-organizational connectivity within the network, several network analyses were performed to test for: 1) network density, i.e., the number of network ties proportional to the total possibility of ties relative to the number of nodes in a network (Hanneman & Riddle, 2005); 2) average distance, i.e., the degree of separation between network actors; 3) network diameter, i.e., the maximum distance between any two actors in the network; 4) centrality measures, e.g., betweenness and degree centrality measures; 5) community clusters detected via cluster analysis (Girvan & Newman, 2002); and 6) the External-Internal (E-I) Index of the network, i.e., the proportion of external ties, e.g., ties occurring between organizations from different sectors, relative to the number of internal ties, e.g., ties occurring between organizations in the same sector

(Hanneman & Riddle, 2005). Centrality measures were used to find key network actors that are either: 1) highly connected within the network and therefore potentially influential, i.e., they possess a high degree centrality, or, 2) act as a conduit for bringing otherwise unconnected actors or clusters into the network, thereby exposing the network to outside ideas or perspectives, i.e., they demonstrate a high betweenness centrality (Hanneman & Riddle, 2005). The analyses were conducted using ORA's built-in analytic capabilities, e.g., "all measures" and "key entity" reports, and the UCINET (version 6.570) statistical analysis software (Borgatti, Everett, & Freeman, 2002).

The networks were visualized with the ORA visualizer. In the visualizations, node size was determined by both betweenness and in degree centrality measures, and node colour was identified by the sector attribute. Cluster analysis was used to segment the network into its constituent parts so that they could be analyzed. In this study, cluster analysis was calculated using the Girvan-Newman algorithm that removes network ties with the highest betweenness score, thereby "revealing" community clusters within a network (Girvan & Newman, 2002). Seven community clusters were identified before the algorithm ceased to have meaningful impact on the network.

The External-Internal Index (E-I) is a statistical analysis test devised to measure the proportion of external ties, e.g., ties occurring between organizations from different sectors, relative to the number of internal ties, e.g., ties occurring between organizations in the same sector (Hanneman & Riddle, 2005). The result, i.e., the "E-I value," provides an indication of whether network actors are communicating more often within their own sector, or if communication is occurring more often across sectoral lines (Cárcamo, Garay-Flühmann, & Gaymer, 2014; Vance-Borland & Holley, 2011). The E-I value is calculated by subtracting the number of external ties from the number of internal ties, and then dividing the result by the total number of ties (Hanneman & Riddle, 2005). The

highest possible result, 1, occurs when actors only possess external ties, while the lowest possible result, -1, is given for actors who only possess internal ties (2005). The test was conducted using UCINET (version 6.570) statistical analysis software (Borgatti, Everett, & Freeman, 2002). Following the recommendations of Legendre and Legendre (1998), 10,000 permutations, i.e., iterations, of the test were conducted to ensure “the stability of probability estimates” (p. 26). Results from the SNA are presented in Chapter 4.

CHAPTER 4. SOCIAL NETWORK ANALYSIS (SNA) RESULTS

4.1 Introduction

This chapter presents the results from the Social Network Analysis (SNA) conducted to develop an understanding of which organizations are communicating with other organizations about tidal power activities in the Bay of Fundy region of Nova Scotia. The results are outlined in several sections: 1) a description about how the networks were identified and measured; 2) an overview about the types of sectors operating in the networks; 3) results from the analysis of the "communication" network, including centrality measures and cluster analysis; and 4) results from the External-Internal (E-I) test. Discussion of these findings, along with the results from the interviews (see Chapter 5), is presented in Chapter 6.

4.2 Description of the Networks

The tidal power "communication network" examined in this research was comprised of two separate, but overlapping networks: the "participant network" and the "committee network." Tidal power development in the Bay of Fundy is a complex, multi-sectoral endeavour that affects a wide variety of stakeholders, e.g., all tiers of government; industry, both foreign and domestic; First Nations; research groups (e.g., universities and institutes); fishing and aquaculture and tourism. An examination of several sources was performed to discover potential stakeholder groups. This included: research papers, grey literature, technical documents, web-based promotional materials, e.g., organizations' websites, and consultation with industry members. Of the 25 stakeholder organizations identified by this process, representatives of 19 agreed to take part in the participatory mapping. Stakeholder representation was obtained from a majority of the sectors (five out of seven) (see Table 1); even though multiple attempts were made, representation from the fishing and tourism sectors was not obtained. Participants were

asked to draw a diagram identifying organizations with which their organization had communicated information about tidal power in the previous six months. After data collection, the participant diagrams were digitally transcribed, collated, and rendered using the Organizational Risk Analyzer (ORA) Social Network Analysis (SNA) software (Carley, 2011). This “participant network” is comprised of 218 distinct organizations with 633 ties.

Table 1. Research participants by sector.

Sector	Number of Organizations	Number of Participants
Government (Federal)	2	2
Government (Provincial)	2	3
Government (Municipal)	3	4
First Nations	1	1
Industry	5	5
Research	2	2
NGOs	4	5
Total	19	22

An analysis of the interview data revealed the prevalence of committees, subcommittees, and working groups as a means of inter-organizational communication. Committee membership was identified through the interview data and an examination of online materials, e.g., membership lists. The data was verified through conversations with participants who sat on the various committees to ensure that the lists were accurate and that the identified groups had met within the six month timeframe of the study. The “committee network” is comprised of six committees solely focused on tidal power as identified by participants and secondary sources. It contains 39 organizations from government (16), research (12), industry (7), NGOs (2), and First Nations (1). Only one organization present in the “committee network” was not also present in the

“participant network.” The “committee network” provided more information about inter-organizational communication than was possible to determine through the participant interviews alone. Since both networks are evidence of inter-organizational communication about tidal power in the Bay of Fundy, they were combined using ORA’s “union” functionality.

Some studies (see Hartley, 2014) use variables such as frequency of communication to “weigh” connections. While participants were asked about communication frequency, responses were either too varied or imprecise to provide an accurate assessment, e.g., many participants suggested that communication frequency was highly variable and often project-dependent. Therefore, all connections were recognized by the software in a binary fashion, i.e., organizations either are or are not communicating. Further, connections between organizations present in both the “committee network” and the “participant network” were not given more weight, i.e., the links were not “counted” twice. Hereafter, the “communication network” can be taken to mean the combination of the “committee” and “participant” networks (Figure 1). Participants often talked about communicating with other tidal power stakeholder organizations with regard to sector and responses revealed that the nature of information sharing was largely dependent on the sector to which an organization belongs. The following section provides contextual information about the various sectors present in tidal power communication networks.

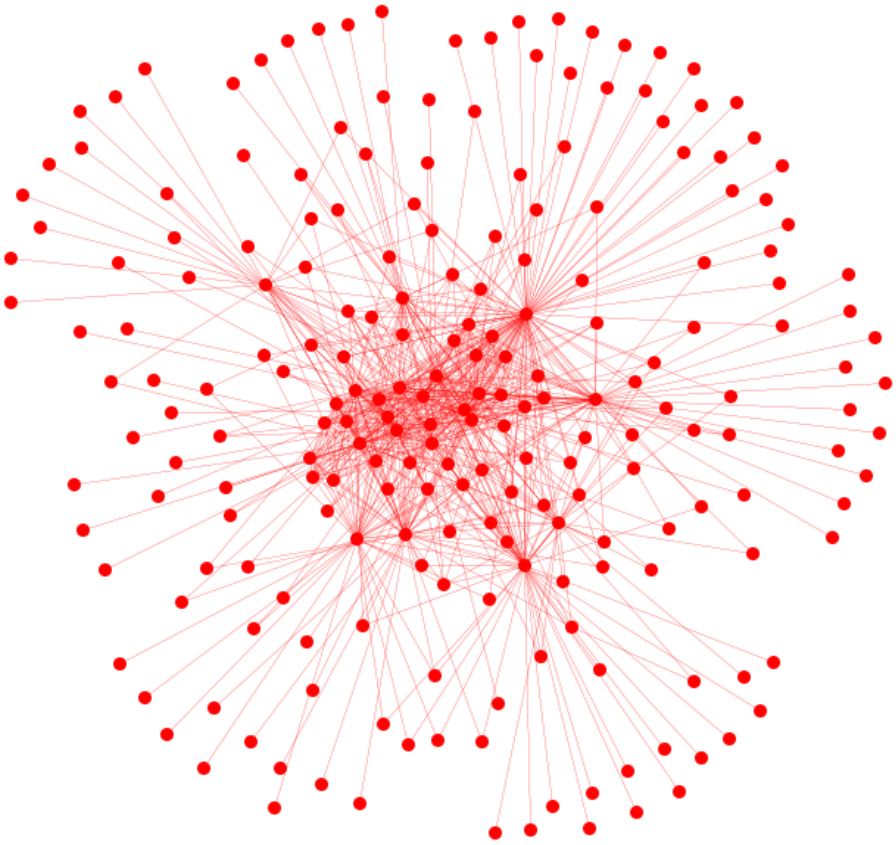


Figure 1. Tidal power communication network for the Bay of Fundy region of Nova Scotia. Organizations are represented by red dots, or "nodes," and connections are represented by red lines, or "ties."

4.3 Sectors

Previous Bay of Fundy tidal power scoping studies (see Colton & Isaacman, 2013; Howell & Drake, 2012; MacDougall & Colton, 2013) and demographic information gleaned from the qualitative interviews were used to categorize organizations into seven sectors: government, industry, First Nations, research, NGOs, fishing and aquaculture, and tourism. Table 2 lists the network distribution by sector. Out of the 219 organizations identified by participants, industry (36%), government (24%), and research (21%) contribute the largest number, while First Nations (10%), NGOs (4%), fishing and aquaculture (4%), and tourism (2%) contribute the least.

Table 2. Network distribution by sector.

Sector	Number of Organizations in the Network by Sector
Government	53
Industry	78
First Nations	22
Research	46
NGOs	8
Fishing and Aquaculture	8
Tourism	4
Total	219

However, it is important to note that a low number does not automatically mean that a sector is unimportant or not communicating within the network, e.g., NGOs are represented by eight highly active organizations. As noted in Table 1, participants were drawn from all tiers of government; First Nations; industry, including local business associations; research; and NGOs.

4.3.1 Government

Representatives from federal, provincial, and municipal levels of government participated in this research. Tidal power activities occurring in the coastal zone fall under the jurisdiction of multiple federal and provincial departments (see Nova Scotia Department of Energy, 2010b, p. 6, for a complete list). The role of government in this network is largely centered on regulation, policy creation, and stakeholder consultation. Although legislation governing marine renewable energy (MRE) has been introduced (Nova Scotia Department of Energy, 2015), no such approved legislation currently exists. Appendix A details the current regulatory process used for proposed tidal power projects. Municipal entities take part in the consultation process for tidal power projects, but their main role is focused on the impacts and possible economic benefits accrued from tidal power development in the region. Government agencies, such as the Atlantic

Canada Opportunities Agency (ACOA), similarly promote economic development in the region by connecting groups with complementary mandates and competencies.

4.3.2 Industry

Industry is a broad category comprised of organizations that fulfill a number of roles. Using a framework devised by CanmetENERGY (2011), this research divided the industry actors involved in MRE into eight sub-sections: technology developers, manufacturers and suppliers, project developers, development services, supporting technology providers, engineering and construction, operations and maintenance, and business services (see Appendix H for description of each category). Some companies may belong to multiple categories. In addition to the framework suggested above, a small number of community groups comprised of local business owners and entrepreneurs were identified. An interview conducted with a representative from a local board of trade determined that its roles and interests were best aligned with organizations from the industry sector, and so such groups were categorized accordingly. Other types of community groups, e.g., environmental advocacy groups, were not identified in the stakeholder discovery phase or by participants and so they are not represented in this research. This study directly interviewed representatives from four out of the five companies developing tidal energy projects in Nova Scotia. Project developers are also referred to as proponents, tidal energy developers, and/or berth holders for project developers operating at the Fundy Ocean Research Center for Energy (FORCE) berth site located in the Minas Passage area of the Bay of Fundy, Nova Scotia (Tethys, 2015).

4.3.3 Research

Research organizations involved in tidal power come in many forms, but are predominantly universities, e.g., Acadia University and Dalhousie University, research

groups hosted through universities, e.g., Acadia Tidal Energy Institute (ATEI), research networks, e.g., Fundy Energy Research Network (FERN), and private consulting firms conducting research and development (R&D) projects. Participants for this study were drawn from research groups and research networks. Research networks are organizational entities that seek to connect practitioners and experts across disciplines and institutional boundaries, usually through science and engineering-focused committees.

4.3.4 NGOs

Although limited in number, NGOs perform a varied and important industry support role. NGOs are not a homogenous group and can be difficult to categorize. As identified by participants, prominent NGOs include Marine Renewables Canada (MRC), FORCE, and the Offshore Energy Research Association (OERA). MRC is an MRE industry association that acts as an information hub for its extensive membership roster. It also plans industry-wide events aimed at connecting various stakeholder groups. FORCE hosts the tidal energy proponents operating in the Minas Passage area of the Bay of Fundy, but also plays a coordination, research, and oversight, or “watchdog” role. FORCE helped lay the undersea cables that will connect the berth sites to the provincial electric power grid and the FORCE test site provides shared infrastructure for the proponents. FORCE’s Fundy Advanced Sensor Technology (FAST) ocean monitoring platforms generate environmental ocean data, e.g., current speed, seafloor composition, and species monitoring (Fundy Ocean Research Centre for Energy, 2015a), while its visitor centre near Parrsboro, Nova Scotia provides the public with scientific and historical information about tidal energy development. OERA is closely connected to the Nova Scotia Department of Energy and supports industry development through the

solicitation, coordination, and funding of research projects. OERA coordinates with the industry, government, and research sectors to identify and fill knowledge gaps.

4.3.5 First Nations

Following a decision laid out by the Supreme Court of Canada in Taku River Tlingit First Nation v. British Columbia (Project Assessment Director), the Crown has a duty to consult First Nations on any decisions or activities that could impact established Aboriginal treaty rights (Government of Nova Scotia, 2015). Thus, present in the network map are: the 13 Mi'kmaq Bands of Nova Scotia; the Mi'kmaq Rights Initiative, an executive action arm of The Assembly of NS Mi'kmaq Chiefs and a part of the Kwilmu'kw Maw-klusuaquan Negotiation Office (KMKNO); and several organizations representing various aspects of First Nations' interests, e.g., the Mi'kmaw Conservation Group (MCG) and the Mi'kmaw Native Friendship Centre. In addition to participating in the legally mandated consultation process, First Nations groups are also involved in environmental research and public education about tidal power. A representative of the consultation process participated in this study.

4.3.6 Fishing and Aquaculture

Among the many industries operating in the Bay of Fundy is the fishing and aquaculture sector. This sector represents the variety of fishing activities operating in Lobster Fishing Area (LFA) 35 in the Minas Basin area of the Bay of Fundy (Fisheries and Oceans Canada, 2013). Activities in the area consist primarily of lobster and scallop harvesting, weir fishing, and long-line fishing. While fisher organizations do exist, many are informal with fishers operating more as individuals than as a collective. Contact was made with representatives from several fishing organizations; however, scheduling conflicts made participation within the timeframe of the data collection period impossible. While fishers were identified by participants as tidal power stakeholders, many participants were

unable to identify specific fisher organizations, or collectives, with which they were in communication. Instead, most participants suggested that communication with this sector occurred through individual fishers, if at all.

4.3.7 Tourism

The tourism sector in the Bay of Fundy represents a diverse set of organizations ranging from whale watching to events planning. No response was received to the several invitations sent out to organizations in the tourism sector, possibly owing to the fact that data collection for this research occurred during the "off-season," when many of these organizations were inactive for the winter. Additionally, very few participants identified tourism organizations in the participant mapping exercise.

4.4 Social Network Analysis (SNA)

Data collected for this research represents a snapshot in time that ranged from fall/winter 2014 to winter/spring 2015, e.g., about six months prior to the end of the data collection period. The network contains 219 organizations,[3] 762 ties, and has a density of 0.033, or roughly 3% (Table 3). See Appendix G for a complete list of the organizations in the tidal power communication network and the sector to which they belong.

Table 3. Tidal power "communication network" descriptive statistics.

Size	Ties	Density	Average Distance	Diameter
219	762	0.033	2.534	4

A "tie" refers to a connection between two network actors. Ties in the communication network are undirected, i.e., all identified connections are considered to be reciprocal, and binary, i.e., all ties are of equal value. Density is defined as the number of ties

[3] In accordance with standard SNA terminology, organizations may also be referred to simply as "actors," or "nodes."

present in a network proportional to the number of possible ties (Hanneman & Riddle, 2005). Vance-Borland & Holley (2011), conducted a similar study on a network of comparable size (344). They reported a “low” network density of 0.5%, suggesting that density in the tidal power communication network (3%) is also low. Distance refers to the degree of separation between network actors (Hanneman & Riddle, 2005). For example, if actors A and B and actors B and C are connected, but not actors A and C, then actors A and C are at a distance of two because in order for information to travel from A to C, it would first have to go from A to B (1 degree) and then from B to C (2 degrees). The average distance separating any two organizations in the network is 2.534. The network diameter, i.e., the maximum distance between any two actors in the network, is 4. Vance-Borland and Holley (2011) described a network diameter of 8 and average path length of 3.4, indicating that both measures for the tidal power network could be considered low. When examining information sharing, a low average distance and network diameter would be considered favourable, i.e., conducive to information sharing, because information only needs to travel a short path to potentially reach all organizations in the network (Borgatti & Parker, 2002; Long, Cunningham, & Braithwaite, 2013).

The communication network consists of a highly connected “core” surrounded by “periphery” organizations possessing few network ties (Figure 2). A black circle was added to the network image to distinguish the core (inside the circle) from the periphery (outside the circle). Note that the location of the circle was not generated through established core network measures (see Carley, Reminga, Storrick, & Columbus, 2010) and was added only to increase clarity. The core of the network is comprised of organizations in the industry (blue), government (red), First Nations (green), NGO (purple), and research (turquoise) sectors. In this figure, research organizations are

mostly clustered together, whereas the government and industry sectors are more intertwined. This composition suggests that industry and government communicate information more often, while researchers tend to communicate mainly with other researchers. In-degree and betweenness centrality measures, described below, provide further insight into network composition.

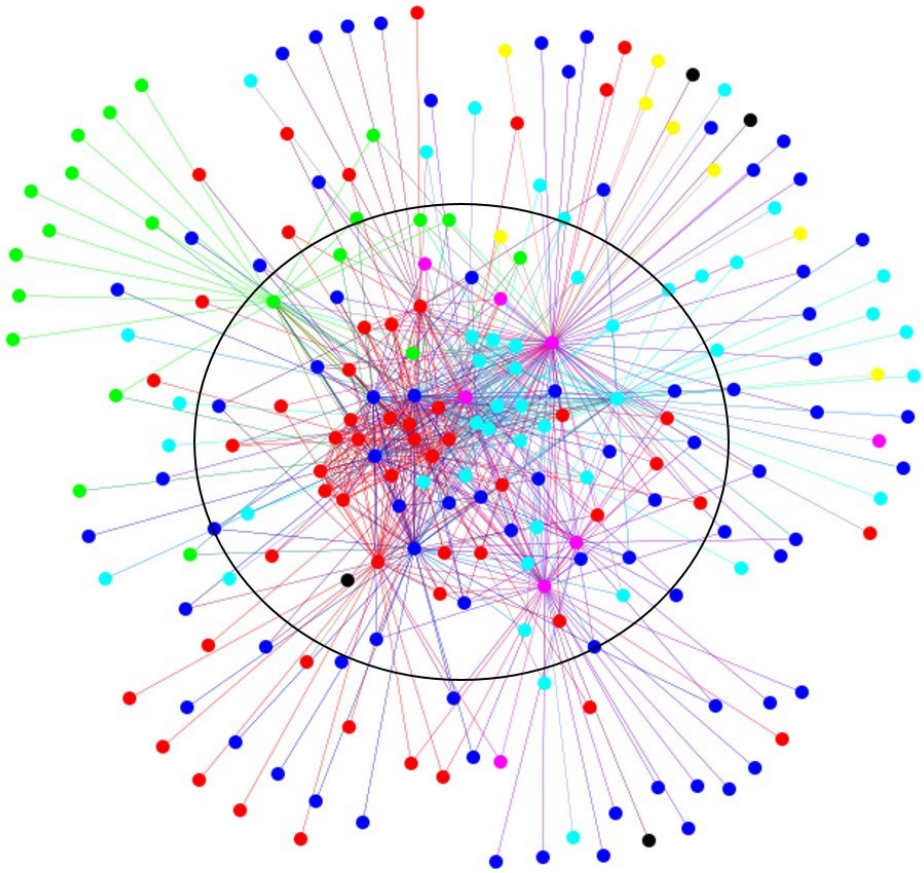


Figure 2. Tidal power communication network for the Bay of Fundy region of Nova Scotia with nodes coloured according to sector. The black circle distinguishes the "core" of the network from the "periphery." Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green=First Nations, Yellow=fishing and aquaculture, Black=tourism.

4.4.1 Degree Centrality Measurements

Degree centrality measures how well-connected an actor is within a network by calculating the number of ties the actor possesses (Hanneman & Riddle, 2005). Actors with more ties to other actors are in a stronger position within the network because they

will have access to more actors, knowledge, information, ideas, etc. (Hanneman & Riddle, 2005). Three common degree centrality measures are: in-degree, i.e., the number of incoming ties an actor receives from other actors in the network; out-degree, i.e., the number of outgoing ties an actor puts out to other actors in the network; and, total degree, i.e., the sum of an actor's incoming and outgoing ties. Since this network is undirected, in-degree and out-degree measure the same feature, i.e., any ties will be both incoming and outgoing. Even for undirected networks, ORA calculates total degree by adding the in-degree and out-degree values (Carley et al., 2010). Therefore, only in-degree was measured to avoid artificially inflating scores. Table 4 presents the top ten organizations according to in-degree centrality. Three of the top five are NGOs, despite the fact that there are only eight NGO organizations in the network. Indeed, NGO_1, the organization with the highest in-degree measure, has an in-degree centrality score that is nearly twice that of the second highest. Representatives from the government and research sectors, as well as four out of the five tidal energy developers are also within the top ten.

Table 4. Top 10 organizations by in-degree centrality. Measures are scaled; the highest possible in-degree score is 1 and the lowest is 0 (Carley et al., 2010).

Organization	In-degree Centrality
NGO_1	0.4611872
Research_2	0.26940638
NGO_4	0.26027396
NGO_2	0.25114155
Prov_1	0.23744293
Industry_3	0.23744293
Industry_2	0.23287672
Industry_5	0.23287672
Industry_1	0.20547946
Fed_2	0.20547946

In Figure 3, nodes are coloured by sector and sized according to in-degree centrality. As in Figure 2, a black circle was added to distinguish the core of the network from the periphery. The core of the network is visually expanded and presented in Figure 4. Four out of the five tidal energy developers in the Bay of Fundy region hold a central network position and a high in-degree centrality. A variety of government organizations with a primarily regulatory and policy development focus are clustered with the industry organizations. Also, several Nova Scotian universities connected to a tidal power research network (Research_1) are found in the center. NGO_2, an organization that works with government, industry, and research sectors to help fund tidal power research, is also close to the center and positioned between the research sector "cluster" and the industry-government "cluster."[4] Just outside of the center, i.e., closer to the black circle, are a government agency with a mandate for developing economic opportunities (Fed_2), a tidal power developer (Industry_5), a tidal power research group (Research_2), several NGOs (NGO_1, NGO_4, and NGO_3), a municipality (Muni_1), and a First Nations organization (First Nation_2). Their intermediary position indicates that these groups are connected with more periphery organizations. The "bridging" function, i.e., bringing otherwise disconnected organizations into the network, is more clearly represented by the betweenness centrality scores outlined in the next section.

[4] In SNA, a "cluster" refers to a collection of nodes positioned close together (Hanneman & Riddle, 2005). This is distinct from the "cluster analysis" discussed in Section 4.4.3.

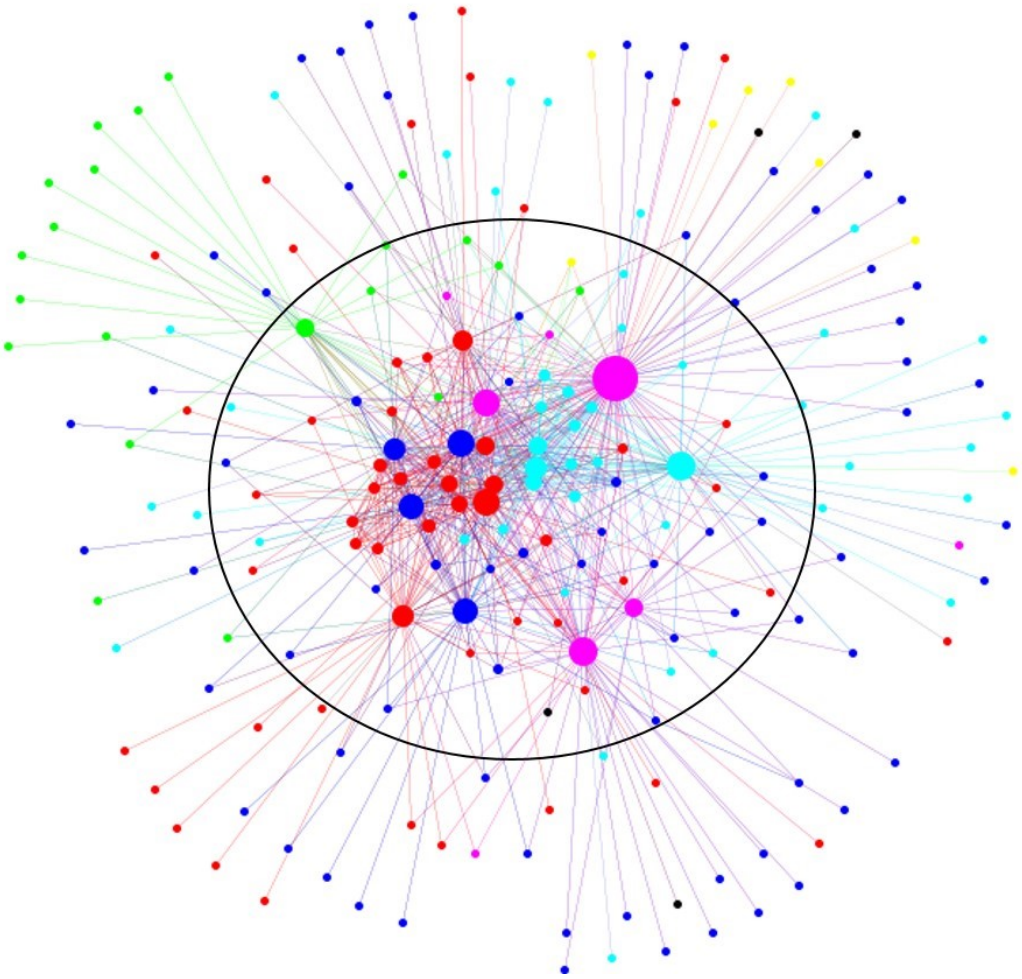


Figure 3. Tidal power communication network for the Bay of Fundy region of Nova Scotia with nodes sized by in-degree centrality. The black circle distinguishes the "core" of the network from the "periphery." Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green= First Nations, Yellow=fishing and aquaculture, Black=tourism.

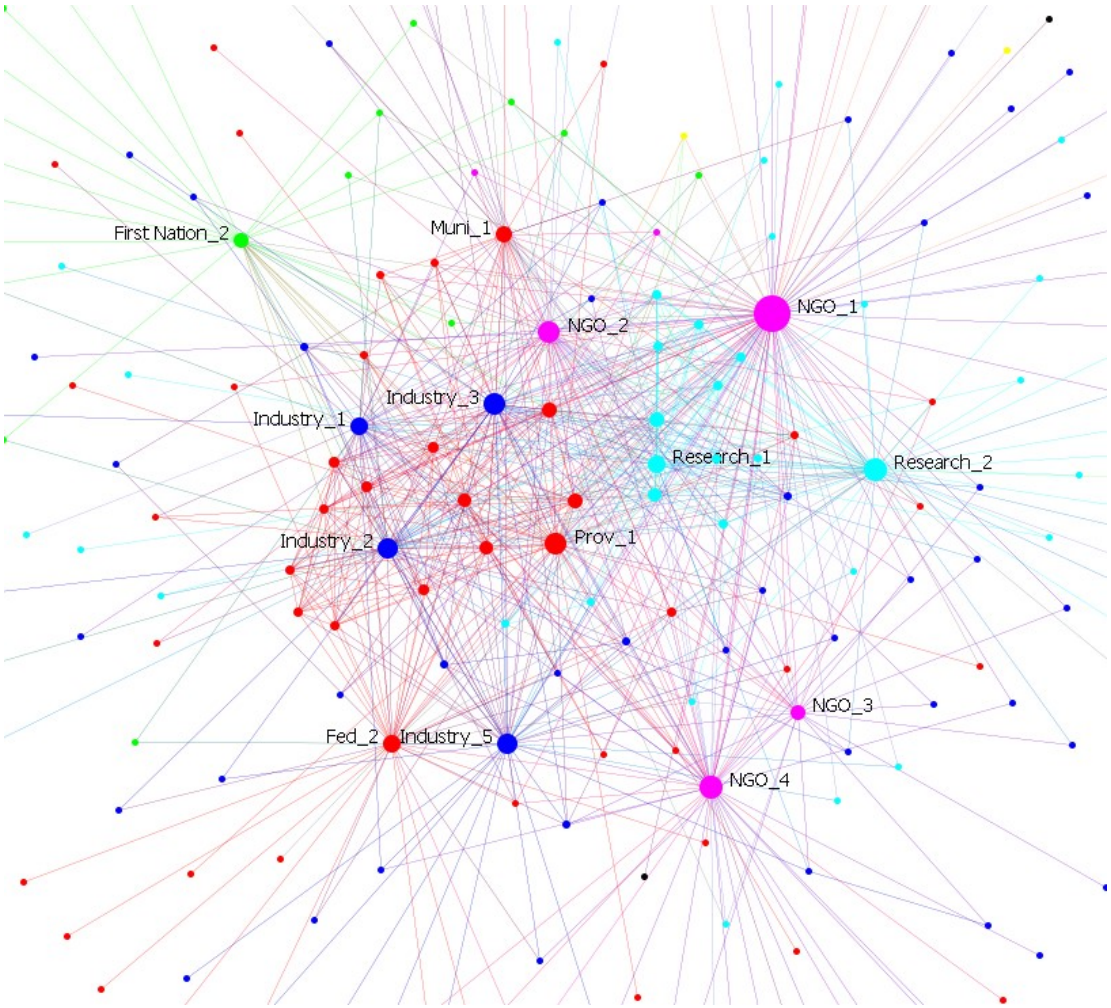


Figure 4. Core of the tidal power communication network for the Bay of Fundy region of Nova Scotia with nodes sized by in-degree centrality. Zoom is set to 4. Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green=First Nations, Yellow=fishing and aquaculture, Black=tourism.

4.4.2. Betweenness Centrality Measurements

Betweenness centrality measures how often a node connects to otherwise unconnected nodes or clusters (Hanneman & Riddle, 2005). Actors with a high betweenness centrality often act as a bridge, or a gatekeeper, for the flow of information, while also bringing potentially new information, ideas, and/or perspectives into the network (Easley & Kleinberg, 2010). Table 5 presents the organizations with the ten highest betweenness centrality scores. Except for the addition of a First Nations organization, the top five organizations are the same as those with the highest in-degree scores. As with the in-

degree centrality measures, NGO_1 possesses a much higher score than the others. Only one tidal power developer is figured in the top ten betweenness centrality scores. This indicates that organizations in the industry sector are not generally fulfilling bridging roles in the network.

Table 5. Top 10 organizations by betweenness centrality. Measures are scaled; the highest possible betweenness score is 1 and the lowest is 0 (Carley et al., 2010).

Organization	Betweenness Centrality
NGO_1	0.33690375
Research_2	0.15075593
NGO_4	0.14787172
NGO_2	0.13039015
First Nation_2	0.0908486
Prov_1	0.084686875
Industry_5	0.084131435
Fed_2	0.082285404
Muni_1	0.078431636
Research_1	0.06849143

In Figure 5, nodes are sized according to betweenness centrality and coloured by sector. A black circle is used to separate the core from the periphery. Figure 6 shows the same image with a greater zoom applied. Organizations with the ten highest betweenness centrality scores are labelled. In contrast with in-degree scores, organizations with the highest betweenness centrality are still positioned in the core, but further away from the center.

Organizations with a high betweenness centrality connect the myriad of periphery organizations, many of which possess no other network ties, to the network. It is possible that this effect is a by-product of the methods used in this research, i.e., a survey of the peripheral organizations might reveal additional connections. That said, the tidal power industry in Nova Scotia is a nascent industry with a tightly-knit community of

actors and organizations that is growing as the industry develops. In this pre-commercial stage, many “outside,” or periphery, organizations are brought in for one-off projects led mainly by the government, NGO, and research sectors. As the industry develops, some of the periphery organizations, particularly industry groups related to the supply chain, will likely move towards the centre of the network as they engage in contractual relationships with the industry sector. Cluster analysis, discussed below, reveals further characteristics of the role played by organizations with a high betweenness centrality.

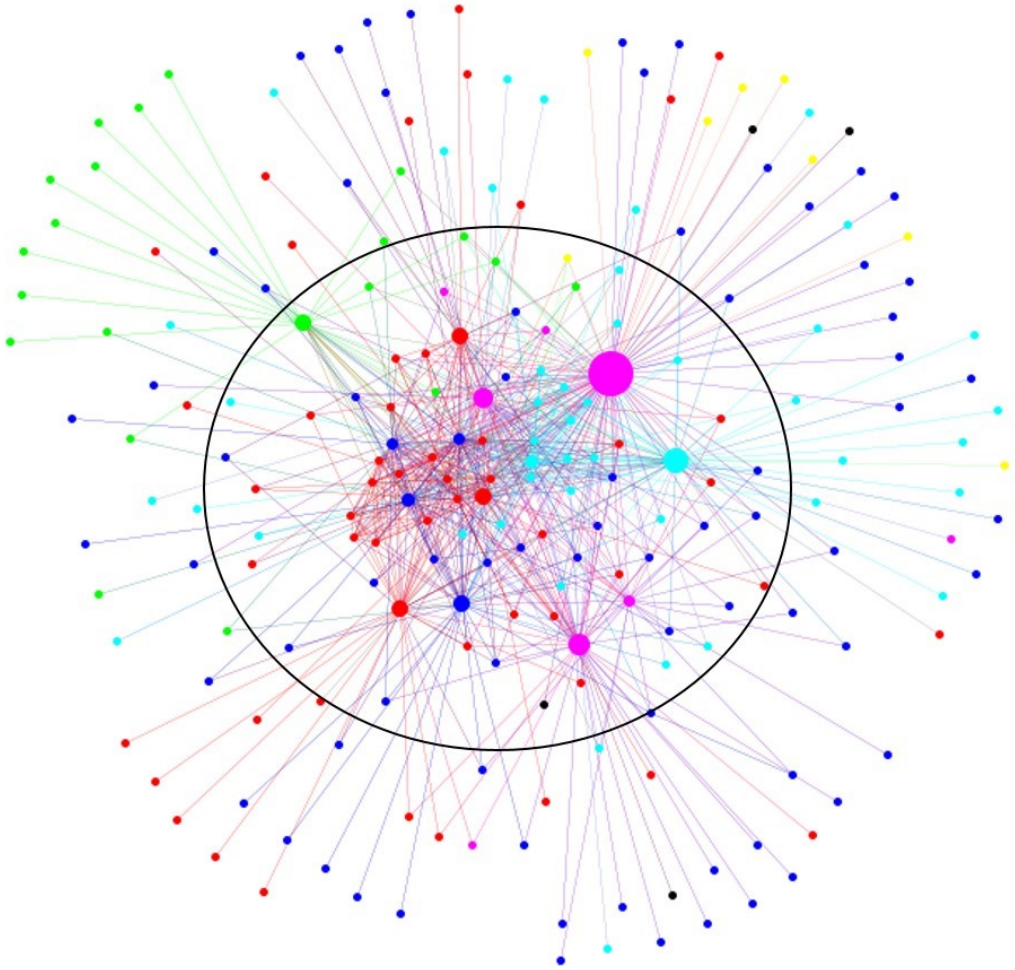


Figure 5. Tidal power communication network for the Bay of Fundy region of Nova Scotia with nodes sized by betweenness centrality. The black circle distinguishes the “core” of the network from the “periphery.” Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green=First Nations, Yellow=fishing and aquaculture, Black=tourism.

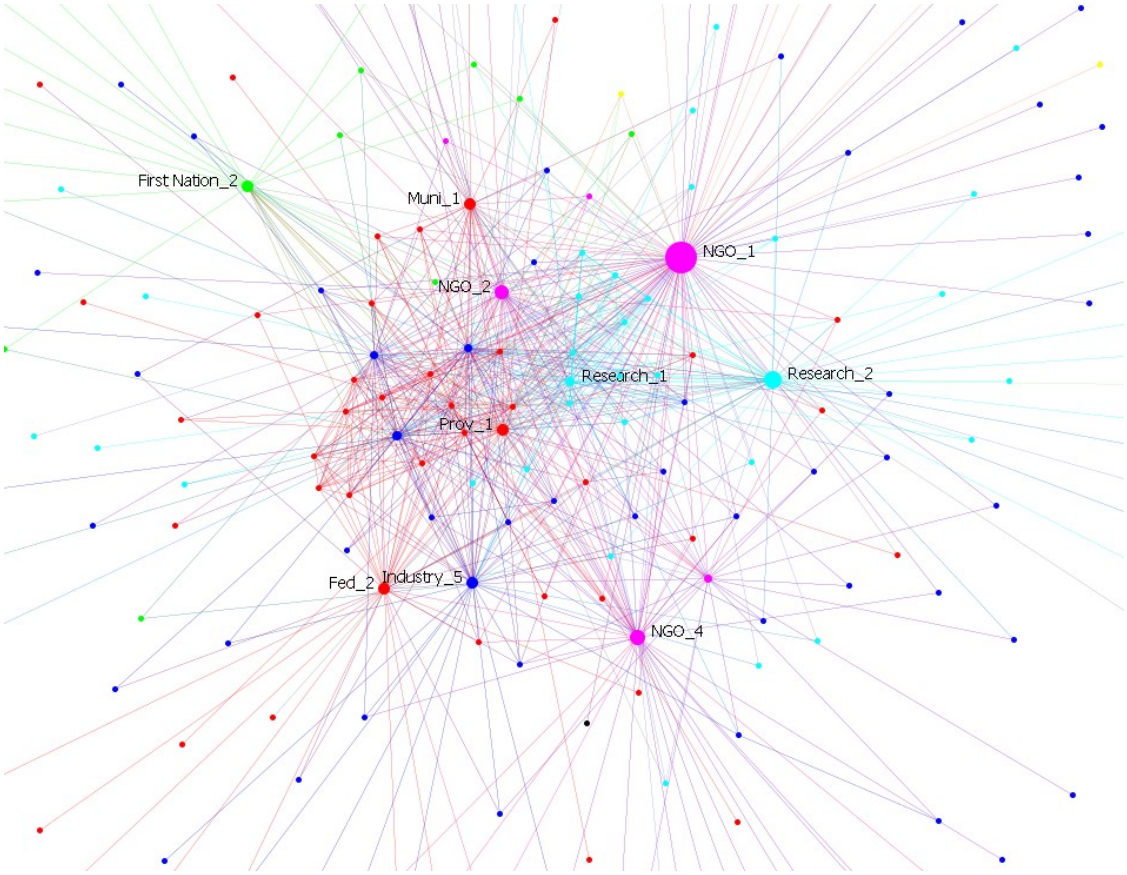


Figure 6. Core of the tidal power communication network for the Bay of Fundy region of Nova Scotia with nodes sized by betweenness centrality. Organizations with the ten highest betweenness centrality scores are labeled. Zoom was set at 4. Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green=First Nations, Yellow=fishing and aquaculture, Black=tourism.

4.4.3 Cluster Analysis

Cluster analysis is a technique that divides a network into its constituent components, or "clusters," based on a selected algorithm (Carley et al., 2010). The Girvan-Newman algorithm, which removes ties possessing high betweenness values (Girvan & Newman, 2002), was used. The algorithm was chosen as a means of examining the effect bridgers, i.e., organizations with a high betweenness centrality score, had on the network. The algorithm was run seven times, after which point the test ceased to have a noticeable impact on the network, i.e., new "clusters" were comprised on only one or two

nodes. Figure 7 shows the seven community clusters identified in the network, sized according to betweenness centrality and coloured by sector.

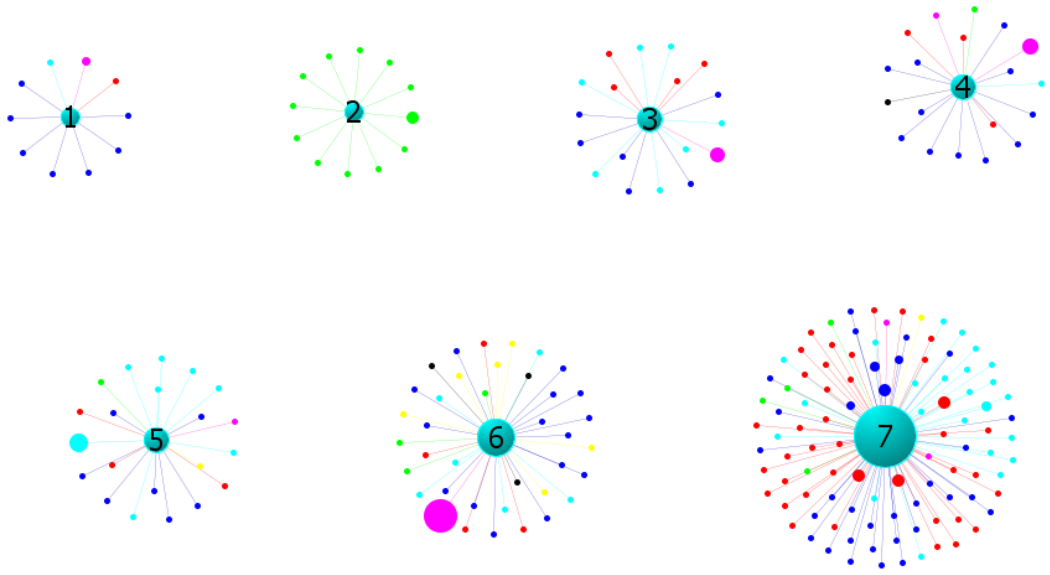


Figure 7. The tidal power communication network divided into seven clusters using the Girvan-Neman algorithm. Nodes are sized by betweenness centrality and coloured by sector. Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green=First Nations, Yellow=fishing and aquaculture, Black=tourism.

Clusters 1 through 6 are comprised of many organizations that are only connected to the network through an organization that possesses a high betweenness centrality score. Hereafter, such organizations are referred to as “champions.” NGOs act as champions for clusters 1, 3, 4, and 6, while clusters 2 and 5 are championed by organizations in the First Nations and the research sectors respectively. Cluster 6 is comprised of a diverse group of organizations including fishers, First Nations, research, industry, and tourism and is championed by NGO_1 (Figure 8). NGO_1 has the highest betweenness centrality score, and is also the most diverse in its network connections, i.e., NGO_1 connects with organizations across multiple sectoral boundaries. This finding suggests that this organization could be encouraging multi-sectoral communication in the network.

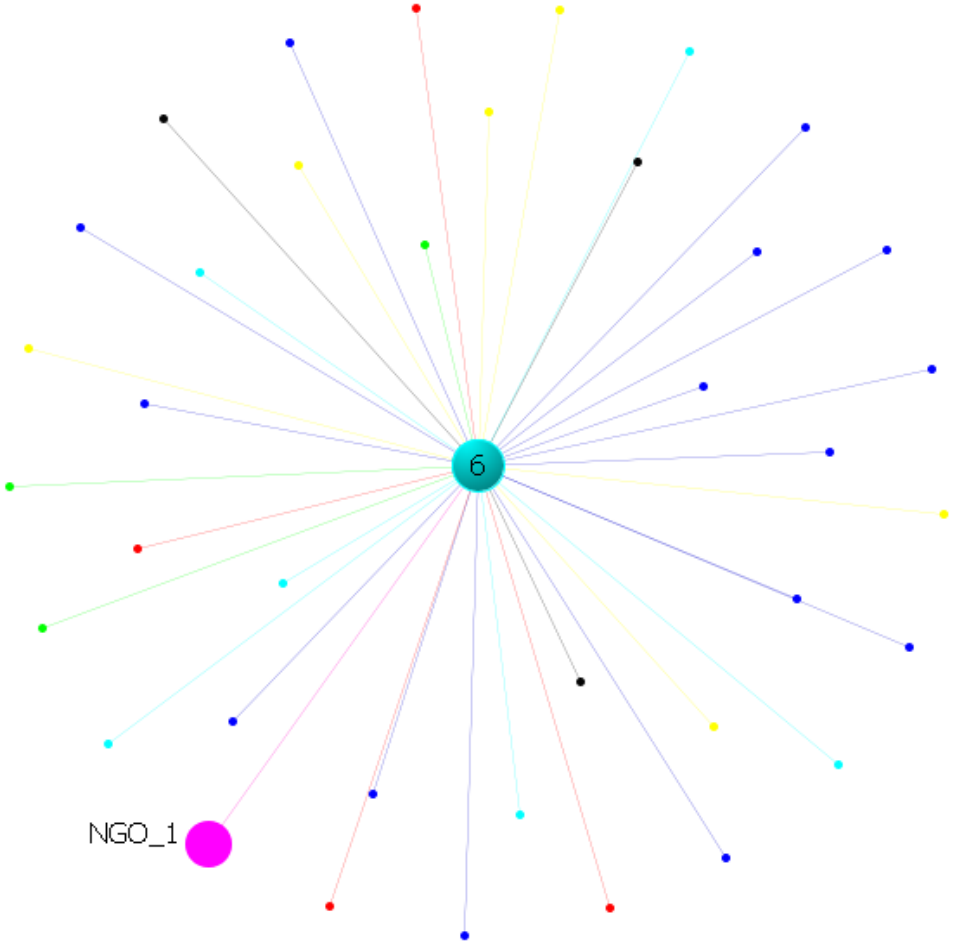


Figure 8. “Cluster 6” generated using the Girvan-Newman algorithm.

Clusters 1 and 4 are primarily comprised of industry groups and are championed by NGOs that are closely connected to the industry sector (Figure 9). One is an MRE industry association and the other seeks to develop commercial opportunities for companies connected to ocean sciences research.

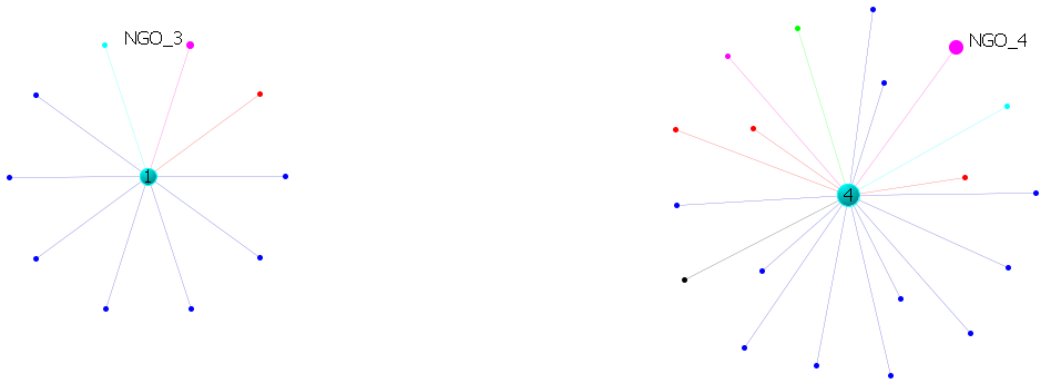


Figure 9. “Cluster 1” (left) and “Cluster 4” (right) generated using the Girvan-Newman algorithm.

Clusters 3 and 5 also possess a similar distribution of organizations according to sector in that both clusters contain organizations from the research, industry, and, to a lesser extent, government sectors (Figure 10). In addition, both clusters are championed by organizations with complementary mandates. Research_2 is a research group tied to a university with a focus on tidal energy research and NGO_2 is an NGO with a mandate to fund and oversee research projects. Clusters 1 & 4 and 3 & 5 indicate that some bridgers specialize in bringing particular sectors into the network, i.e., industry-focused NGOs connect to industry organizations, while research-focused NGOs connect to research organizations.

Figure 10. “Cluster 3” (left) and “Cluster 5” (right) generated using the Girvan-Newman algorithm.

Cluster 7 is a largest and most diverse cluster (Figure 11). It contains many of the organizations that possess central positions in the network, i.e., organizations that have high in-degree centrality scores. This configuration includes all of the tidal power developers and regulators, as well as a research network for tidal energy. Organizations from NGOs, First Nations, and fishing and aquaculture are also represented. Sectoral diversity within clusters could indicate that communication about tidal power issues is occurring across sectors. That said, certain stakeholder groups, namely First Nations, fishing and aquaculture, and tourism, are not as well represented in Cluster 7, i.e., the cluster representing the “core” of the tidal power network. In fact, as Cluster 2 shows, some First Nations organizations are not connected to any other sectors (Figure 12). Additional data than was obtained in the participatory mapping exercise are required to determine the reasons for this apparent isolation.

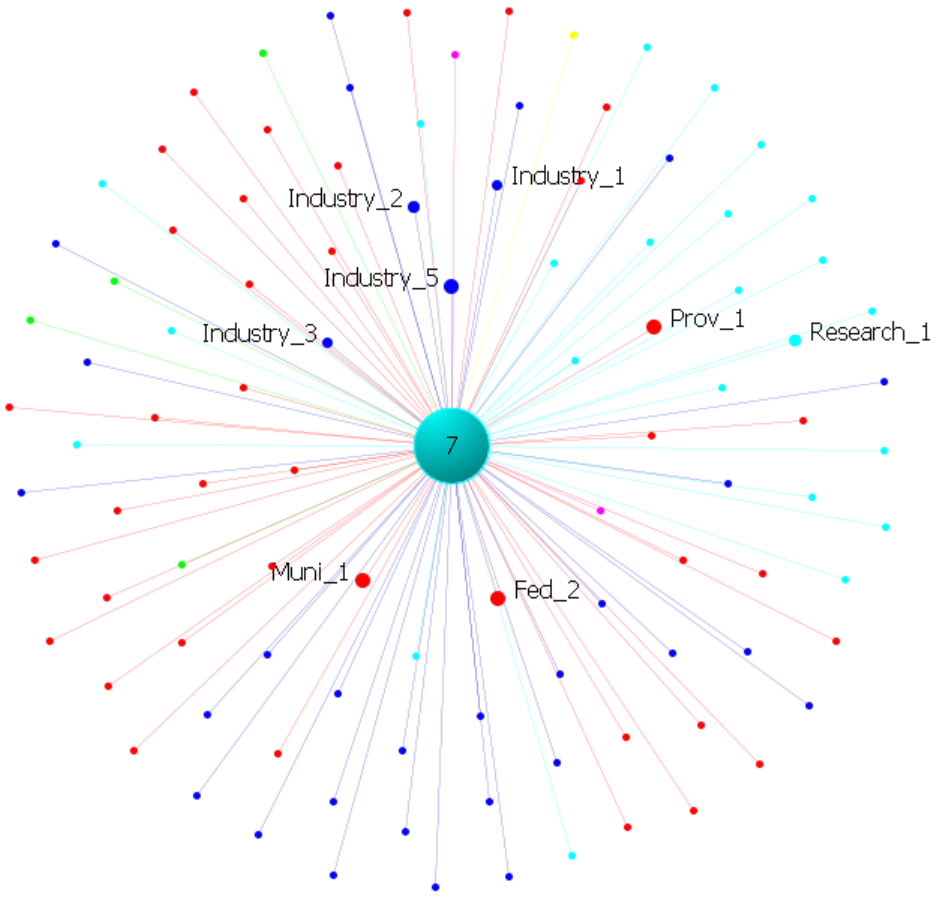


Figure 11. “Cluster 7” generated using the Girvan-Newman algorithm.

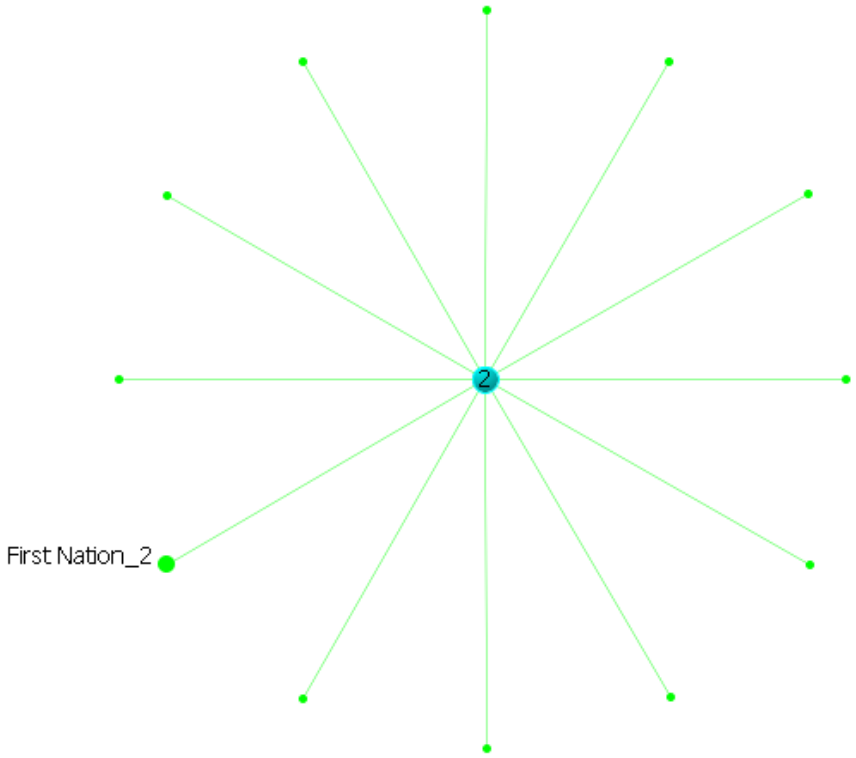


Figure 12. “Cluster 2” generated using the Girvan-Newman algorithm.

4.5 External-Internal (E-I) Index

The External-Internal Index (E-I) is a statistical analysis test devised to measure the proportion of external ties, e.g., ties occurring between organizations from different sectors, relative to the number of internal ties, e.g., ties occurring between organizations in the same sector (Hanneman & Riddle, 2005). The result, i.e., the “E-I value,” provides an indication of whether network actors are communicating more often within their own sector, or if communication is occurring more often across sectoral lines (Cárcamo, Garay-Flühmann, & Gaymer, 2014; Vance-Borland & Holley, 2011). The E-I value is calculated by subtracting the number of external ties from the number of internal ties, and then dividing the result by the total number of ties (Hanneman & Riddle, 2005). The highest possible result, 1, occurs when actors only possess external ties, while the

lowest possible result, -1, is given for actors who only possess internal ties (Hanneman & Riddle, 2005). The test was conducted using UCINET (version 6.570) statistical analysis software (Borgatti, Everett, & Freeman, 2002). Following the recommendations of Legendre and Legendre (1998), 10,000 permutations, i.e., iterations, of the test were conducted to ensure "the stability of probability estimates" (p. 26). The E-I value for the communication network is 0.312 (Table 6). The majority of the permutation-derived values were not as low as observed ($P \leq 0.001$), suggesting a slight prevalence of cross-sector ties (Hanneman & Riddle, 2005).

Table 6. External-Internal (E-I) Index results for the communication network with organizations categorized by sector and using 10,000 permutations in UCINET.

External	Internal	E-I	E-I Min.	E-I Ave.	E-I Max.	P≤ Obs.
0.656	0.344	0.312	0.207	0.519	0.706	0.001

Table 7 presents E-I values by sector. Since no participants in this study represented the fishing and aquaculture or tourism sectors, all ties appear as external. It is possible that some organizations within these sectors are communicating information about tidal power with other organizations either within or outside their sectors, but were not identified in this study. In general, all sectors displayed a tendency towards external ties. Of the sectors with participant representation in this study, the NGO sector had the highest E-I Index (0.857), indicating that NGOs communicate more with organizations in other sectors than within the NGO sector. This result is consistent with the betweenness centrality measures and the cluster analysis which also portrayed NGOs as cross-sector bridgers. One factor likely contributing to the high ratio of external to internal ties for NGO groups is the fact that they are a small sector with many network ties.

The industry sector had an E-I Index (0.535), suggesting a prevalence of external ties. Although organizations from the industry sector had lower betweenness centrality scores

relative to the NGO, government, and research sectors, four out of the five proponents were shown to be central in the network, i.e., were among the top ten organizations in terms of in-degree scores. Therefore, the high number of external ties could be a product of being connected to by many different organizations across sectors.

The research (0.102) and First Nations (0.063) sectors had lower E-I Index values, but still tended to look outside their sectors when communicating information about tidal power. Government entities had the lowest E-I Index (0.027) suggesting that, relative to other sectors, within-sectoral connectivity is higher among government groups. A possible explanation for this latter result is the effect rendered by the One Window Committee for tidal energy that ensures all appropriate government bodies are communicating regularly with each other about tidal power. The effect of committees, sub-committees, and working groups on inter-organizational communication is explored in Chapter 5, Section 5.6 and Chapter 6, Section 6.3.1.3.

Table 7. External-Internal (E-I) Index results for the communication network by sector.

Sector	External	Internal	Total	E-I
NGO	234	18	252	0.857
Research	189	154	343	0.102
Industry	277	84	361	0.535
Government	251	238	489	0.027
First Nations	34	30	64	0.063
Fishing and Aquaculture	11	0	11	1
Tourism	4	0	4	1

Chapter 4 has presented findings from the SNA. Chapter 5 now presents the findings from the thematic coding of the qualitative interview data. The findings of both chapters are discussed in Chapter 6.

CHAPTER 5. QUALITATIVE DATA RESULTS

5.1 Introduction

This chapter presents the results from 20 semi-structured interviews with 22 participants representing 19 different organizations (see Chapter 3, Section 3.3). The interviews were coded using established thematic coding techniques as described in Chapter 3, Section 3.4. The thematic codes were developed to understand the kinds of information and how it was being shared among tidal power stakeholders. “Sector” codes were used to indicate which sectors were being discussed in relation to each theme. Multiple codes were applied to segments of the interview transcripts where appropriate. The following sections present the results from the six identified thematic categories: 1) types of information exchanged, i.e., the “product” that was being shared; 2) the reasons for information sharing, i.e., activities undertaken by tidal power stakeholders that encourage information sharing, including whether the activities were more operational and project-based, or high level strategic planning; 3) use of information, i.e., how exchanged information is used by organizations; 4) role in the network, e.g., is an organization an industry regulator or a project developer?; 5) mechanisms of communication, i.e., the means by which information was communicated; and 6) factors affecting information sharing, i.e., enablers and barriers to information sharing. For each section, the results for the “main themes” are presented. See Chapter 3, Section 3.4 for a description of how the main themes were identified. Note that it was not possible to normalize the data when cross-tabulating “sector” codes with the main themes because the numbers, i.e., the frequency with which a theme was coded alongside a particular sector, do not have a direct, one-to-one correlation with the number of participants representing a sector.

5.2 Types of Information Exchanged

The “types of information exchanged” theme refers to the “product” of information sharing, i.e., the kinds of information that organizations shared about tidal power. The thematic analysis revealed 18 distinct “types of information exchanged.” This section relates to research question 1. e.: “what type(s) of information is/are shared among stakeholder organizations?”

As shown in Figure 13, “updates/reports” (85%), “research” (85%), “state of the industry” (85%), “economic development” (85%), “legislation/regulation/policy” (80%), “funding information” (80%), and “needs” (75%) were the types of information referred to by the highest number of participants. Figure 14 displays the number of times each type was referred to in all interviews. “Research” (135) and “reports/updates” (112) were referenced the most, followed by “legislation/regulation/policy” (74), “needs” (74), “economic development” (63), “state of the industry” (53), and “funding information” (33). As evidenced by “state of the industry” and “needs,” the percentage of participants who discussed a topic does not necessarily correspond with the number of times it was referenced in the interviews.

All of the main themes centered on sharing information pertaining to industry development. Tidal power stakeholders are communicating information about the current state of the tidal industry, possible economic development opportunities, how to obtain funding for future research, what needs exist for tidal power proponents, e.g., infrastructure or research needs, where gaps in information occur and how can these be reconciled, information pertaining to legislation and policy development, and the acquisition of regulatory approval. Interview sections coded as “research” were further subdivided into “physical/natural sciences,” “engineering,” and “socio-economics” where specified. In some cases, the participants did not indicate the types of research being

shared and so these interview sections were coded under the generic “research” theme. Cross-tabulation of “research” and its subcategories with “sector” was used to discover which sectors were sharing what types of research information.

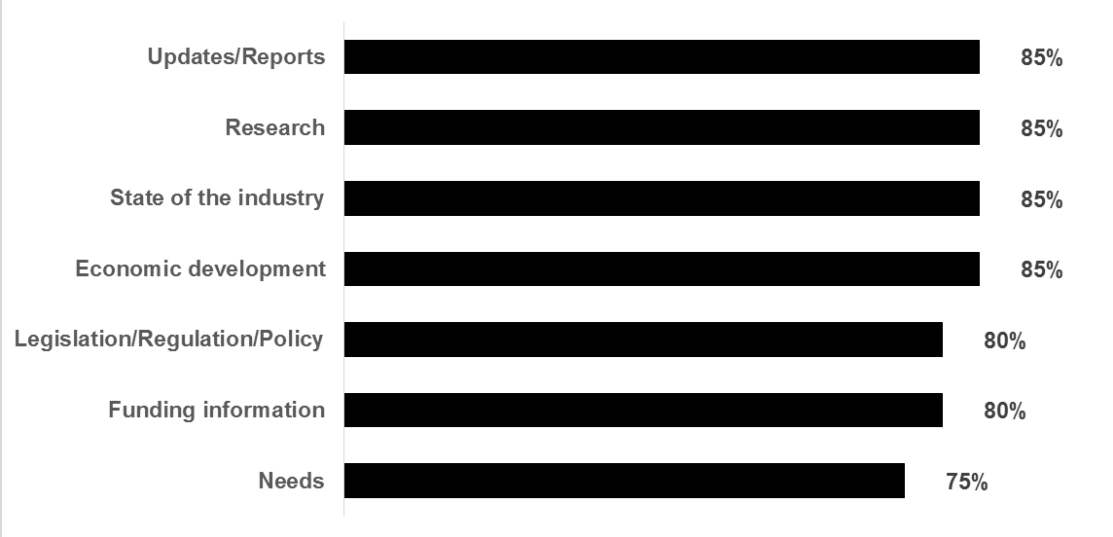


Figure 13. Main themes for “types of information exchanged” by the percentage of participants (N=20).

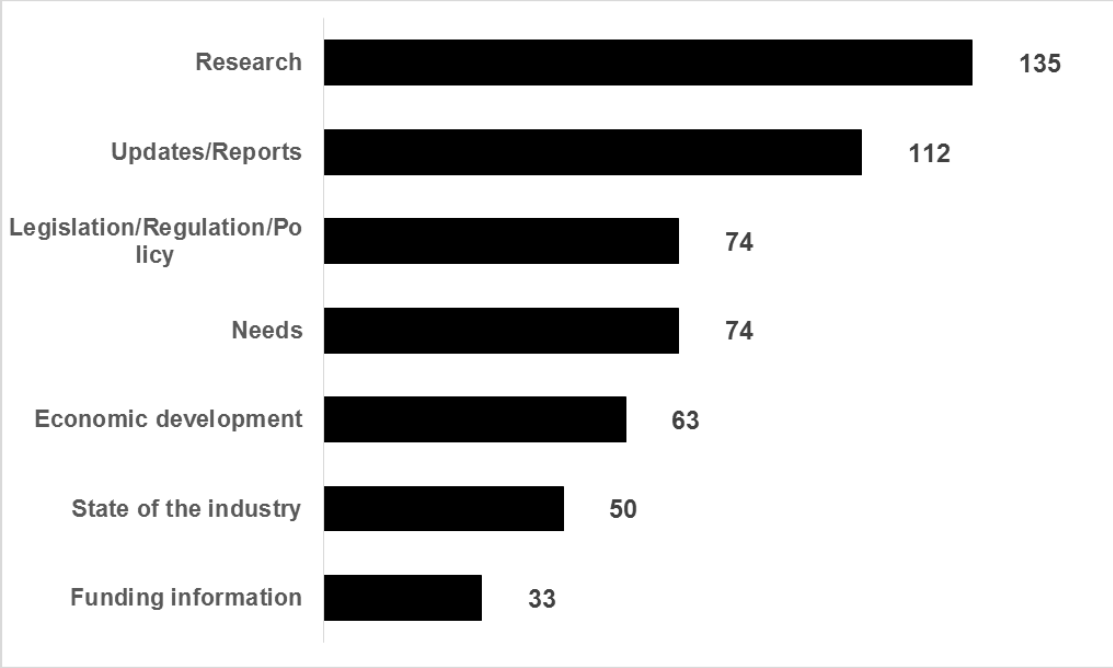


Figure 14. Main themes for “types of information exchanged” by the frequency of mention by participants (N=650).

Table 8 shows the number of times a sector was coded alongside “research,” “engineering,” “physical/natural sciences,” and “socio-economics.” “Socio-economics” (33) was coded the least among the research categories. The NGO (71) and research (58) sectors were coded with “research” most often, followed by government (50) and industry (49). First Nations (9) and fishing and aquaculture (2) were co-coded with “research” substantially less. Low numbers of references for these latter sectors could be because First Nations was only represented by a single participant and the fishing and aquaculture industry was not directly represented in this research. However, the methods used in data collection in this study captured data about information sharing among all organizations identified in the network, not solely the organizations represented by the interviewees. That is, if the First Nations and the fishing and aquaculture sectors were engaged in sharing information related to research, then participants from other sectors would have discussed this relationship. Among the “research” subcategories, “physical/natural sciences” (87) was co-coded with the various sectors the most. An unexpected result is the finding that NGOs were coded with “research,” “engineering,” and “physical/natural sciences” more often than the research sector.

Table 8. Cross-tabulation of "research" by "sector."

	Research*	Engineering	Physical/Natural Sciences	Socio-economics	Total
First Nations	2	0	5	2	9
Fishing and Aquaculture	1	0	1	0	2
Government	11	8	19	10	50
Industry	15	11	18	5	49
NGO	21	18	25	7	71
Research	17	13	19	9	58
Total	67	50	87	33	-

* "Research" was assigned when the interviewee did not specify the types of research being conducted.

Organizations in the NGO sector are conducting research, much of which relates to environmental monitoring and to a lesser extent about socio-economic subjects. The industry sector conducts similar types of research, but also benefits from research undertaken by NGOs and the other sectors. One NGO participant suggested that much of the research is "based on things that are going to help to move the [industry] forward" (Participant #8 [NGO]) and that "a lot of it is based around the environmental programs side of things … because a lot of the sensors and technologies and methods [used] in other marine environments don't work in the Minas Passage, because of the environment" (Participant #8 [NGO]). Environmental research aimed at advancing the industry complements the socio-economic research focused on identifying and building a supply chain for the tidal sector. In addition to sharing research information, some NGOs also provide funding support to facilitate joint research projects between separate organizations. This facilitating or "bridging" role is explored in greater detail in Section 5.5. NGOs were also described as being the users of research conducted by other sectors, namely, research and government.

The research sector conducts research and provides advice to the other sectors. Participants representing organizations in this sector talked about using their expertise to advise NGOs on the types of environmental science and monitoring needs to be studied to allow the industry to develop in an environmentally sustainable manner. A participant from the research sector described that organization's interactions with NGOs:

> we work very closely with them … we provide advice to them, … scientific technical advice, as well as advice on priorities, what they should be looking for, approaches they should be doing, [and] who they should be in contact with on various topics… (Participant #6 [research])

5.3 Reasons for Information Sharing

While "types of information exchanged" presented the kinds of information being communicated by stakeholder organizations, "reasons for information sharing" explores why. That is, what activities are being undertaken by stakeholder organizations that motivate information sharing in the network? Examples include: providing updates and reports about tidal power projects, sharing experience or advising on tidal power, and collaborating with other organizations to conduct a trade mission to a foreign country. Understanding the activities that underpin inter-organizational interactions will explain why organizations are choosing to share information within the network.

Samaddar, Nargundkar, and Daley (2006) developed a framework for examining inter-organizational information sharing that divided information into two broad types: strategic and operational (see Chapter 2, Section 2.5). Their framework has been adapted for this research because it provides a means of understanding the different reasons motivating information sharing. Rather than focusing solely on information, this research applies their concepts of "strategic" and "operational" to the different types of activities within the

network that result in exchange of information across organizational boundaries. Information is shared strategically in the network to: build awareness about tidal power projects, share experience or advice on tidal power activities, and foster inter-organizational relationships. Organizations engage in operational information sharing in relation to specific projects or a continuing transactional relationship, e.g., tidal power proponents are required to provide periodic project updates and reports to government regulators to ensure that development meets regulatory standards. Sometimes operational relationships are collaborative partnerships, e.g., joint research ventures, whereas others are more transactional, e.g., applying for funding or permits. The coding of the interviews revealed six types of “strategic” and seven types of “operational” reasons for information sharing. “Operational” themes were grouped into “project-based” activities related to either “research” or “business.”

5.3.1 Strategic

Figure 15 shows which “strategic” reasons for information sharing were mentioned most frequently. “Experience sharing/advising” (100%) was discussed by all of the participants. “Reporting/updating” (95%) was the second highest, followed by “educating/awareness building” (85%) and “stakeholder engagement/consultation” (80%). Figure 16 presents the most referenced reasons for information sharing. Both figures show similar results. Stakeholders in the tidal power network are communicating information in order to advise and share experience, provide updates and reports about tidal energy projects, to educate or raise awareness about tidal developments, and to fulfill formal consultation or engagement obligations. Examining the main strategic information sharing themes by “sector” illustrates which sectors engage in which types of strategic information sharing.

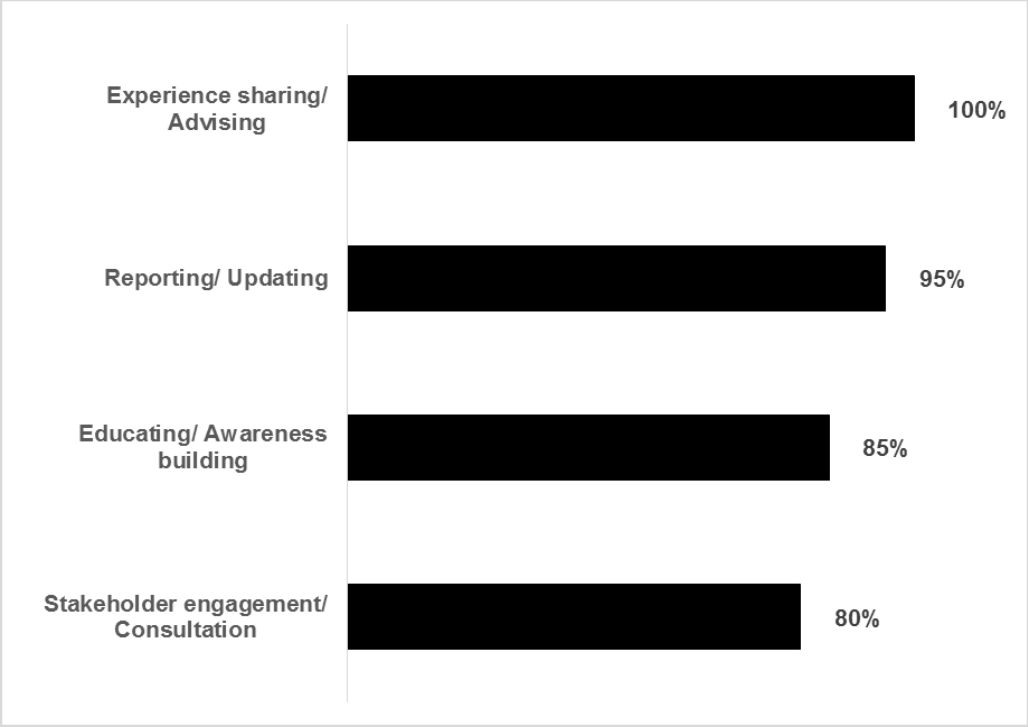


Figure 15. Main strategic "reasons for information sharing" by percentage of participants (N=20).

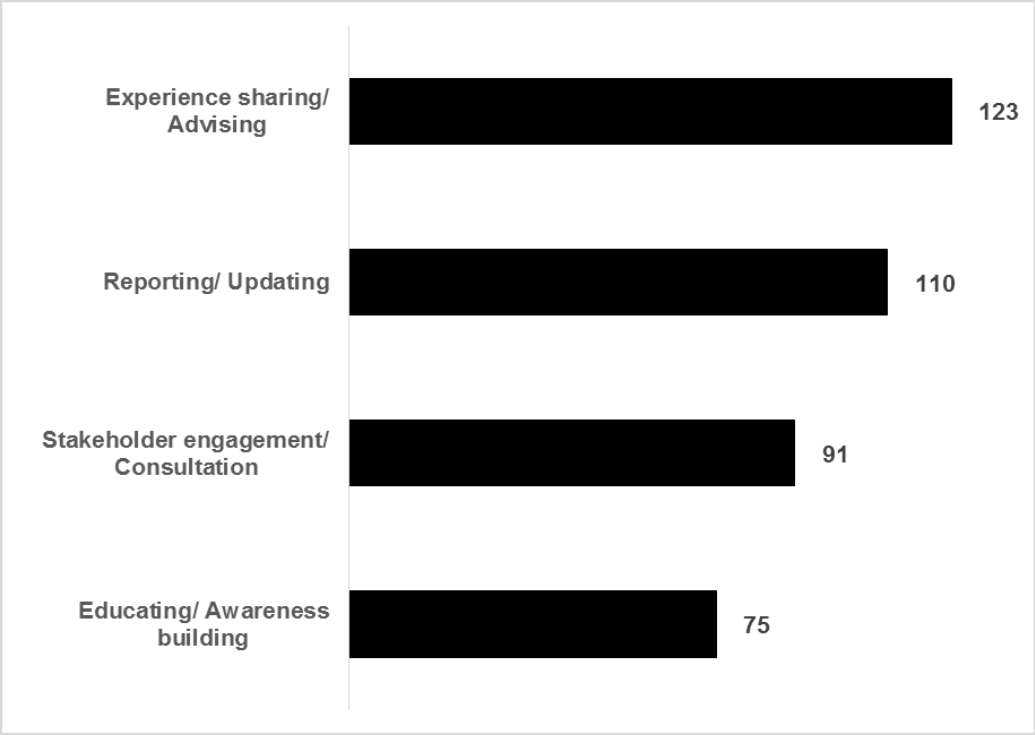


Figure 16. Main strategic "reasons for information sharing" determined by frequency of reference by participants (N=441).

Table 9 shows the results of the cross-tabulations of both the main “reasons for information sharing” themes and sectors. Higher numbers for a sector relative to others may mean that a type of information sharing activity is more common for that sector than others. Government (234) was cross-coded the most for “reasons for information sharing,” followed by NGOs (200), industry (165), and research (81). NGOs (33) had the second highest number of co-coding for “experience sharing/advising,” “reporting/updating” (52), and “stakeholder engagement/consultation” (44). Industry (36) was co-coded more often with “educating/awareness building” than NGOs (33). Relative to the other three main strategic themes, First Nations (36) was coded higher for “stakeholder engagement/consultation.” This result is likely due to the legal mandate for government and industry to engage with First Nations. Similarly, participants from the NGO sector talked about setting up public forums for stakeholder and public engagement.

Table 9. Cross-tabulation of top strategic "reasons for information sharing" by sector.

	Educating/ Awareness building	Experience sharing/ Advising	Reporting/ Updating	Stakeholder engagement/ Consultation	Total
First Nations	5	2	16	36	59
Fishing and Aquaculture	0	0	5	14	19
Government	39	75	71	49	234
Industry	36	50	39	40	165
NGOs	33	71	52	44	200
Research	19	27	26	9	81
Tourism	1	0	0	0	1
Total	133	225	209	192	-

"Experience sharing/advising" was the main "reason for information sharing." The government (75) and NGO (71) sectors were co-coded the most with this theme, followed by industry (50) and research (27). First Nations (2), fishers and aquaculture (0), and tourism (0) were co-coded substantially less or not at all. Sharing experience internationally was mentioned frequently, often between government entities. A Canadian federal government department participant stated that:

> I think that … this is really an initiative undertaken by the Nova Scotia Department of Energy to try to open up lines of communication on the international level recognizing that there's not a lot of activity within Canada alone and so it's looking at what other international bodies are involved in tidal power and how can we share information, how can we collaborate better, and what can we learn from one another to try to help ensure that this industry moves along, but also moves along in a

> manner where regulators, proponents, everyone, and the public, have information about what the environmental effects might be. (Participant #5 [government])

A participant representing a provincial department commented:

> It's mostly about best practices. So what lessons have you learned, how can we learn from you, and that goes both ways … what are areas that you're having trouble with that we can help you address and vice versa. Where can we work together, and we definitely have seen that through cooperative research calls between the jurisdictions. (Participant #17 [government])

Participants from the research, NGO, and industry sectors also discussed how government-facilitated international trade missions aided international experience sharing. Referring to an upcoming mission, an industry participant said:

> It’s a supply chain mission to take companies that are involved in tidal in Canada and take them around the UK to talk to companies there and see if there's anything we can initiate. See if we can use the expertise that they have already developed and see if there's a way to bring it over here. (Participant #13 [industry])

Government organizations were also advised by the other sectors, particularly in relation to the development of policy, legislation, and regulation. Industry participants noted that they are often consulted by government departments undertaking policy or legislation development:

> the [Nova Scotia] Department of Energy is developing [Marine Renewable Energy legislation] and they certainly have taken into account input from us in terms of how we need to see that legislation develop and they had done up a …

> discussion document back in late December and we met with them on a number of occasions to explain to them what we need in terms of project development and in terms of leasing a site. (Participant #2 [industry])

A First Nations participant also commented on advising about policy and legislation development, suggesting that they "have been consulting on [policy development] for years, the one that [the Nova Scotia Department of Energy] just put up on their website,[5] so we have been consulting on that since I think maybe 2008-2009" (Participant #12 [First Nations]). Advising on policy development also occurs internally within the government sector. A provincial government participant suggested that communication activities increased "due to the fact that the [Nova Scotia] Department of Energy has been developing legislation around [tidal power] and the need for consultation with various departments, not just ours, has increased" (Participant #7 [government]).

The NGO sector was co-coded the second most frequently with "experience sharing/advising." NGOs engage in advising and experience sharing across sectors, often by hosting committees to facilitate the activity. For example, the Environmental Monitoring Advisory Committee (EMAC) coordinates expertise on environmental issues and advises on research and environmental monitoring needs to ensure that the industry progresses in an environmentally responsible manner. Speaking about this coordinating role, an industry participant stated that their company is "constantly being dragged in by MRC, FERN, and OERA to collaborate and provide input on policy for government" (Participant #10 [industry]). Organizations from the research sector also advise NGOs on how to synthesize and communicate information:

[5] The participant referred to the Marine Renewable Energy Legislation introduced by the province in April 2015 which has yet to gain Royal Assent (Nova Scotia Department of Energy, 2015).

> We've been working a lot with FORCE lately helping them synthesize what they've done in terms of research and get that communicated out because that's something they've been struggling with, both in terms of organizing of their data as well as the general research. (Participant #6 [research])

The research sector also advises industry on scientific research:

> My group also interacts with a lot of these people [industry], but it's mostly for advice on scientific matters. They say, "we've got this data, can you model this up for us and tell us what we should be doing, or is this a problem?" So we provide a service based on our expertise. (Participant #1 [research])

Companies operating in the industry sector, e.g., tidal power proponents, also share experience among themselves. A participant representing a proponent with a project in the Minas Passage berth site discussed the kinds of experience sharing among some of the proponents:

> The information that gets exchanged is … how big is your project? What do you need and how can we work together on this? What can be synergized? Working together to make sure the cables don't get damaged where we were on the site. How do we make communication plans with people regarding where we have these cables in the water, you can't just be anchoring around them. How do we educate the community? How do we spend money that is a pooled resource? (Participant #13 [industry])

5.3.2 Operational

Figure 17 gives "operational" "reasons for information sharing" by the percentage of participants who mentioned this theme at least once during an interview. Ninety-five

percent of participants talked about sharing information as a result of “project-based” activities, while “regulatory/permitting” and “funding” activities were given as a reason for information sharing by 65 and 60 percent respectively. The findings given in Figure 18, which shows the main “operational” “reasons for information” determined by the frequency with which theme was referenced across interviews, are consistent with Figure 17. The results indicate that tidal power stakeholders are sharing information due to “project-based” activities more often than other operational reasons. The following paragraphs examine the different types of “project-based” information sharing activities cross-tabulated with “sector.”

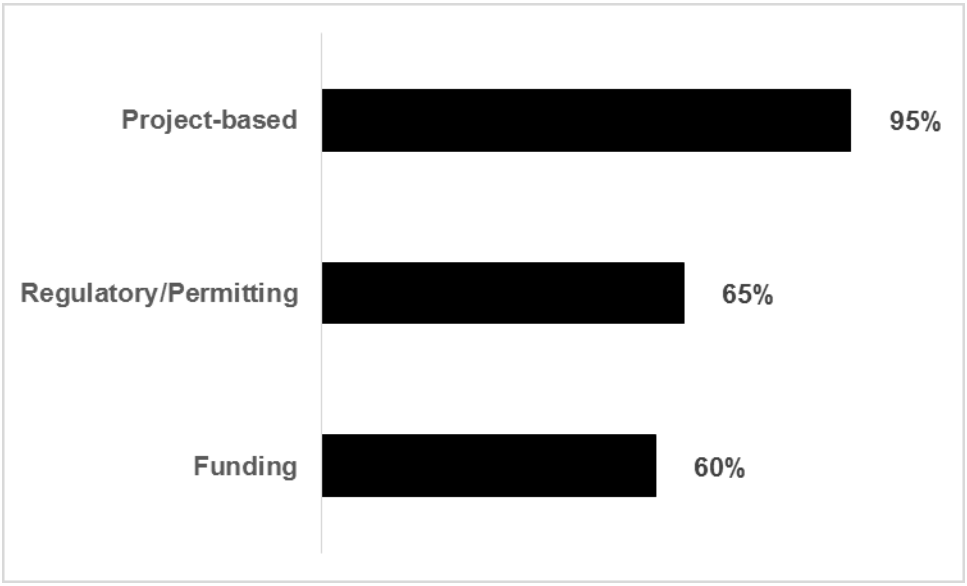


Figure 17. Main operational “reasons for information sharing” by the percentage of participants (N=20).

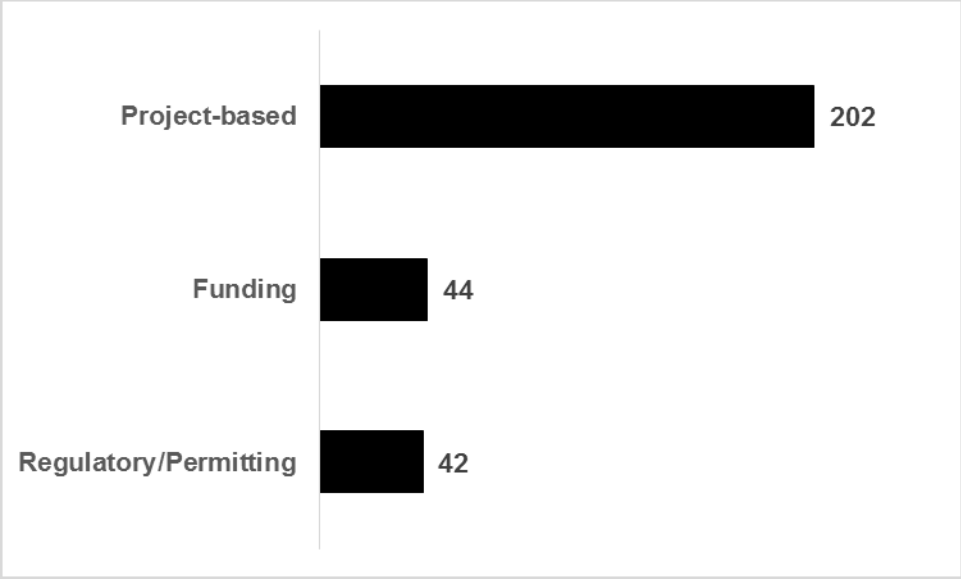


Figure 18. Main operational “reasons for information sharing” by the frequency the types were referenced by participants (N=330).

The “project-based” information sharing activity was subdivided into “research” and “business.” Research-based information sharing typically deals with ongoing projects in the three main fields related to tidal power, i.e., natural/physical sciences, socio-economics, and engineering. Business-based projects range from everyday operational transactions to negotiating power purchase agreements. Cross-tabulation (Table 10) of these themes by “sector” shows which sectors were associated with “reasons for information sharing.” In total, “research” (161) was associated with “sectors” more than “business” (107), suggesting that tidal power stakeholders are more engaged in sharing information about research than business-based projects at this time. The research sector (46) was referenced most often with the “research” theme, followed by NGOs (37), government (35), and industry (35). First Nations (5), fishers and aquaculture (3), and tourism (0) are cross-coded much less frequently or not at all.

Table 10. Cross-tabulation of “operational,” “project-based” codes for the “reasons for information sharing” category by “sector.”

	Business	Research	Total
First Nations	4	5	9
Fishing and Aquaculture	0	3	3
Government	31	35	66
Industry	42	35	77
NGO	29	37	66
Research	1	46	47
Tourism	0	0	0
Total	107	161	-

Although the research sector is co-coded most often with “research,” many research projects are collaborative. A research sector participant talked about working with the government on research initiatives: “[the government] is doing some similar work on GIS, so we're … trying to figure out ways of sharing the things that we do so we don’t end up duplicating work and we actually move forward with synergy” (Participant #1 [research]). Organizations from other sectors are working to create shared infrastructure for organizations to conduct research:

> we are creating a venue for researchers as well as doing our own research, specific to what data we need, but then we are … creating a plan applicable to many other sites and types of research … to be applicable to general ocean science, to fish biology, and maybe fisheries results, and I mean obviously other industries like offshore wind certainly would benefit from improvements in physical oceanography as well as biological monitoring. (Participant #9 [NGO])

Some research funding providers even build in requirements for cross-sector collaboration into their Call for Proposals (CFPs):

> OERA will run … [CFPs] to fund massive projects that … require input from educational institutions, technology providers, developers and they … usually partner with someone overseas … to pull all of that information that is gathered and known in places like Ireland, Scotland, and France, places where they have been doing tidal energy and getting it over here, so OERA requires that sort of meshing. (Participant #2 [industry])

Industry (42) was coded more frequently with "business" project-based information sharing activities than other sectors, followed by government (31) and NGOs (29). First Nations (4) and "business" were coded together infrequently, and fishing and aquaculture (0) and tourism (0) were not cross-coded at all. The three most commonly discussed subdivisions of "business" related to building a supply chain for the industry, conducting international trade missions, and research and development (R&D). R&D is differentiated from other research-based projects by the virtue of being a predominantly contractual relationship between a company and a private research entity, e.g., research consultants, that is focused on the development of technology, usually considered proprietary in nature. Some NGO organizations are working with developers and industry to try to discover needs and forge relationships:

> we have been working with developers to understand what their project requirements are, what their supply chain inputs would be, we have identified a list and that is difficult at this point because industry is still very new, and then from there we've done … a supply chain mapping process [and] we have identified close to 400 companies or organizations that could potentially have skills that would be useful for the industry, and that is just within Atlanta Canada … and we have done a little analysis on what those capabilities are and do they really have capabilities that can serve the industry. (Participant #16 [NGO])

5.4 Use of Information

Participants were also asked questions pertaining to how the information exchanged was used by the organizations. This section relates to research question 1. f. “how is the received information being used?” Thematic coding of the interviews revealed 14 distinct types of information use. Figure 19 presents the main “use of information” themes determined by the percentage of participants who discussed the themes at least once during an interview. The main themes are “strategic planning” (85%), “development of research projects” (75%), “legislation/regulation/policy development” (65%), “industry development” (60%), “education” (55%), and “acquiring/administering regulatory approval” (35%). Figure 20 gives the main “use of information” themes based on the frequency the themes were referenced by participants during the interviews. “Industry development” (48) received the most references despite only being discussed by 60 percent of participants. This result suggests that although this type of information use was less common than others in all sectors, it was discussed frequently by some participants. The results also indicate that information is being used to: support high-level, strategic planning; develop research projects; develop legislation, regulation, and policy; develop the tidal energy industry; educate stakeholders about tidal energy and tidal energy activities; and to acquire or administer regulatory approval.

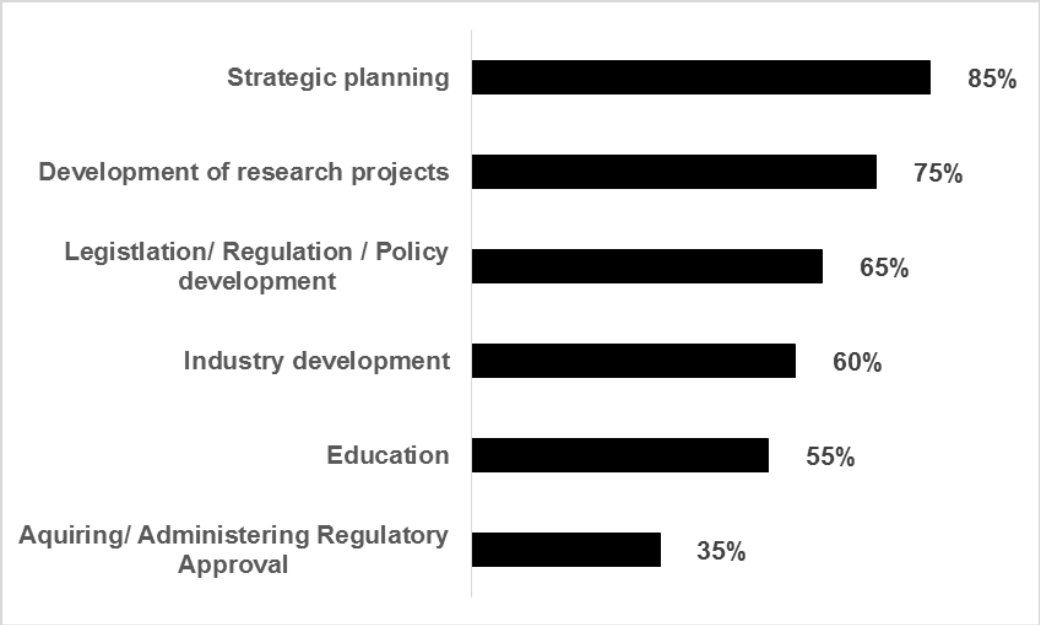


Figure 19. Main "use of information" themes by the percentage of participants (N=20).

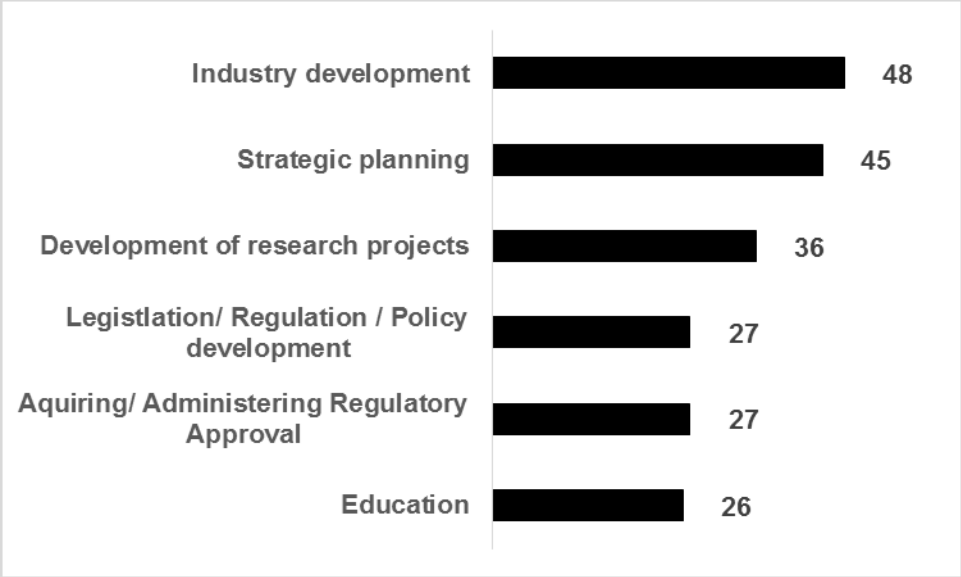


Figure 20. Main "use of information" themes by the frequency with which the themes were referenced by participants (N=281).

Information use can be difficult to categorize and fully understand because the definition of "use" is not always clear, e.g., is learning about a piece of information enough to be considered "use," or does information need to be applied, or put into practice, before it can be considered as "used?" Nutley, Walter, and Davis (2007) describe information use as a continuum ranging from conceptual use, e.g., awareness building or education, to

instrumental use, e.g., the development of policy, legislation, and/or regulation (Figure 21). With regard to “strategic” and “operational” reasons for information sharing discussed above, use of information for “strategic” purposes is closer to “conceptual” end of the Nutley et al. (2007) spectrum than “operational” use, which by its nature tends to be “instrumental.” For example, using information for strategic planning is largely “conceptual,” whereas using information to obtain permits for tidal turbine deployment is an “instrumental” use of information.

Cross-tabulation of types of “use of information” mentioned by at least 50 percent of participants identifies relationships between the various uses and “reasons for information sharing.” Table 11 presents the cross-tabulation of “use of information” themes with “strategic” or “operational” “reasons for information sharing.” “Strategic planning” (38), “education” (25), and “legislation/regulation/policy development” (22) were coded more often with “strategic” reasons for information sharing, while “development of research projects” (25) was considered to be more “operational.” “Industry development” was almost evenly split between the two categories. As Table 11 shows, information use in this network tends to be more “strategic” than “operational,” or, using Nutley et al.’s (2007) framework, is more “conceptual” than “instrumental.”

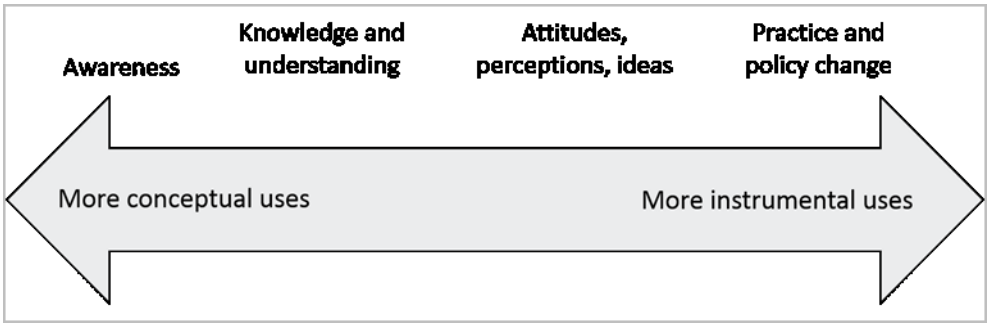


Figure 21. Continuum of Research Use adapted from Nutley, Walter, and Davies (2007).

Table 11. Cross-tabulation of types of "use of information" referenced by at least 50 percent of participants by "operational" and "strategic" "reasons for information sharing."

Types of Information Use	Types of Activity		
	Operational	Strategic	Total
Development of research projects	25	12	37
Education	4	25	29
Industry development	26	25	51
Legislation/ Regulation/ Policy development	6	22	28
Strategic planning	15	38	53
Total	76	122	-

5.5 Role in the Network

"Role in network" was assigned to interview sections where participants discussed the various roles taken on by organizations in the network. An organization's role is often related to the types of information it exchanges, e.g., regulators tend to exchange information about regulation, legislation, or policy, as well as the types of information sharing activities it engages in, e.g., regulators engage in regulatory or permitting relationships with tidal power proponents. Organizations operating in the tidal power network have taken on 13 distinct roles. Figure 22 presents the main themes for "role in the network" by the percentage of participants who mentioned the code at least once during an interview. "Bridger" (95%) and "industry promoter/advocate" (90%) were mentioned by most of the participants, followed by "researcher" (75%), "funder" (75%), and "regulator" (70%). Figure 23 shows the "role in the network" main themes according to the number of references made by participants. "Bridger" (222) was referenced most often, receiving more than double the number of references to the next most-referenced theme (105).

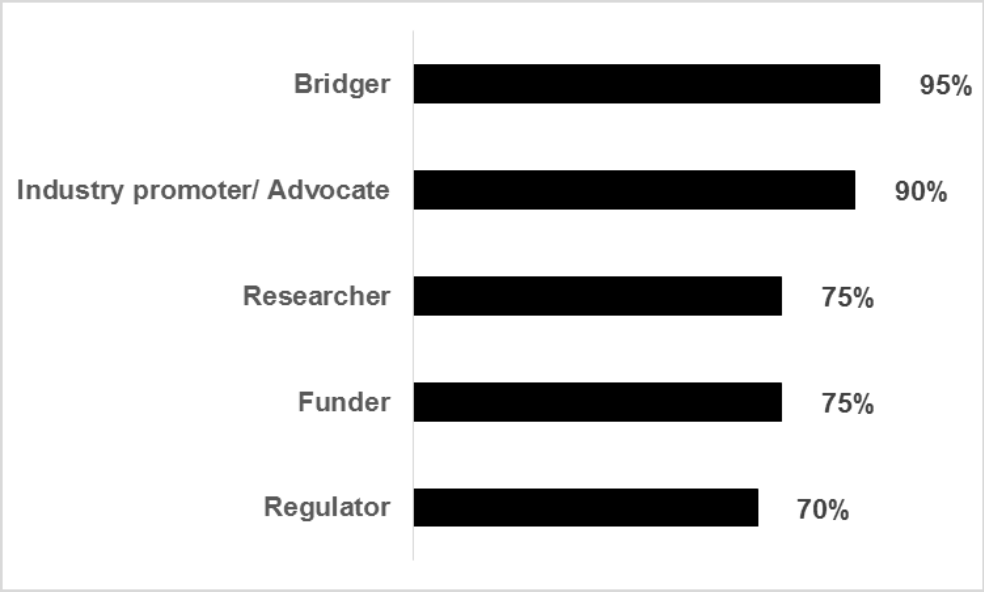


Figure 22. Main themes for “role in the network” by the percentage of participants (N=20).

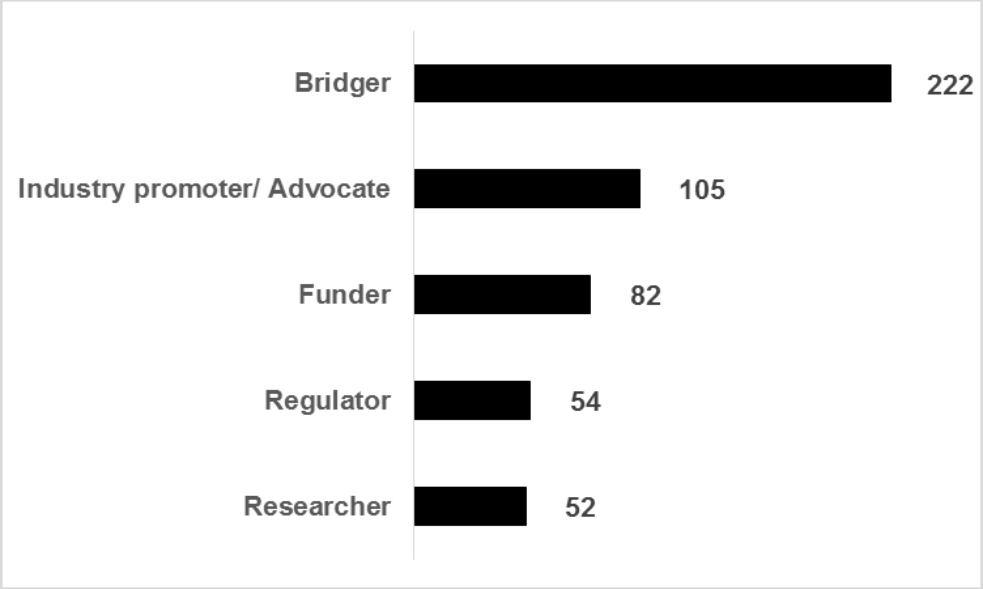


Figure 23. Main themes for “role in the network” by the frequency of reference (N=664).

Bridgers connect organizations and facilitate information sharing both within and across sectors. Participants suggested that organizations that have a mandate to connect organizations, either by communicating information or facilitating joint projects, across sectors are essential in growing an emergent industry (see Section 5.5.1 for further details about the role of bridgers).

Industry promoters and advocates are organizations whose mandate is to promote the industry through public education, organizing events and workshops, and liaising with funding bodies. A NGO participant described the importance of organizations that play an advocacy role as follows:

> Advocacy, I think that's probably the key role, when you talk to the person there [Marine Renewables Canada], [s/he] is all about keeping the noise level up to ensure that funding sources are aware of the importance of this and where it is all going, and [s/he] is very good at that, so I think that's probably the big one … it's still a nascent industry right, so they still need all that. (Participant #11 [NGO])

Table 12 shows the cross-tabulation for main "roles in the network" themes by "sector." The "NGO", "government," and "industry" sectors were referenced the most with the "industry promoter/advocate" theme.

Table 12. Cross-tabulation of "role in the network" coding by "sector."

	Bridger	Funder	Industry promoter/ Advocate	Regulator	Researcher	Total
First Nations	14	2	6	4	6	32
Fishing and Aquaculture	6	0	1	1	2	10
Government	123	66	48	53	14	304
Industry	72	24	43	22	14	175
NGO	106	50	64	15	22	257
Research	53	19	18	5	36	131
Tourism	1	0	0	0	0	1
Total	375	161	180	100	94	-

The interview data suggest that tidal energy promotion is largely targeted at the general public to garner social license for the field. For example, an industry participant described the role played by NGOs in promoting public awareness:

> FORCE has the interpretive center, which of course is extremely helpful for pulling in [the] public… probably the biggest advantage … for FORCE right now, is that they are well-regarded, especially in the local community in Parrsboro, and everybody is familiar with their website and you can usually say the [berth site] area and people know what that means, so being able to … lean on that has been a huge benefit for us, and I'm sure for all of the developers. (Participant #2 [industry])

Of all the sectors, the government sector was related the most with "regulator" and the research sector was coded the most with "researcher," emphasizing that organizations from these sectors are engaged in industry regulation and research respectively, which is expected. The cross-tabulation indicates that government organizations and NGOs are fulfilling the role of "funder" within the network. Table 12 also shows that government organizations and NGOs frequently act as bridgers in the network; however, the role played by bridgers is multifaceted and difficult to discern as illustrations of bridging because such instances where an organization attempts to connect two or more other organizations often involve multiple organizations across the sectors.

5.5.1 Bridgers

NVivo allows researchers to apply directionality to thematic coding, i.e., it is possible to indicate the direction of information flow. To probe the characteristics of bridging, when interview text was coded as "bridger," it was also coded by relationship, so that the sector acting as the bridger and the sector(s) benefiting from the bridging could be

identified. For example, an NGO acting as a bridger for the industry sector was described as follows:

> the idea is that [workshops] will connect the two groups in a more meaningful way because in the past we have had information sessions where just the supply chain shows up but then they never get to meet the actual project developers and so then it goes nowhere, so we are just trying to play that facilitation role. (Participant #16 [NGO])

The “bridger” subtypes described below all foster communication between organizations or sectors in different and important ways.

The data shows that “bridging” can be subdivided into three similar, but ultimately distinct roles: “information mediator,” “connector,” and “coordinator.” Information mediators act as a hub, receiving and then sending information back out into the network; coordinators facilitate connections and encourage collaboration among organizations in an ongoing basis, e.g., project coordinators; and connectors introduce organizations that have complementary mandates or competencies, but do not remain in an intermediary role. See Chapter 6, Section 6.4.1 for a discussion about the different types of bridgers operating in the tidal power network.

Table 13 presents the frequency with which the “bridger” themes were coded for each sector. The additional layer of coding, i.e., relationship codes, ensure that only instances where an organization acted as the bridger, rather than the beneficiary, are included. Government organizations (78) and NGOs (70) act as bridgers more often than other sectors in the network, followed by the research sector (32). Industry (12) and First Nations (8) are less often involved in bridging roles.

Table 13. Cross-tabulation of “types of bridging” by “sector.”

	Government	NGO	Research	Industry	First Nations	Total
Information mediator	18	23	14	2	4	61
Connector	31	23	10	1	0	65
Coordinator	29	24	8	9	4	74
Total	78	70	32	12	8	-

The most referenced “bridger” type was “coordinator” (74), followed by “connector” (65) and “information mediator” (61). Government organizations (29) and NGOs (24) act as coordinators more frequently than industry (9), research (8), and First Nations (4). This pattern is also similar for the roles of “connector” and “information mediator,” although the research sector (14) was co-coded more often with “information mediator” than the other bridger types. Industry (12) and First Nations (8) were identified as bridgers much less often than the other sectors.

The interview data also reveals an interplay between mechanisms of communication and bridging roles. Cross-tabulation showed that “committee/sub-committee/working group” was coded more often with “coordinator” (10) and “information mediator” (10), whereas “conference/workshop/symposium/webinar” was coded more often with “connector” (11) (see Table 14).

Table 14. Cross-tabulation of "bridger” types and themes from the “mechanisms of communication” category.

	Committee/ Sub-committee/ Working group	Conference/ Workshop/ Symposium/ Webinar
Connector	4	11
Coordinator	10	3
Information mediator	10	1

5.6 Mechanisms of Communication

The mechanisms of communication in a network can refer to both the physical means of communication, e.g., face-to-face encounters, email, and telephone, and the structures providing venues and opportunities for information sharing, e.g., committees and conferences. This section relates to research question 1. h.: “What are the mechanisms through which information sharing occurs?” Figure 24 shows the main themes based on the percentage of participants who discussed the code at least once during the interviews. Ninety-five percent of participants talked about “technologically mediated/distance communication” and “committee/sub-committee/working group” as the mechanisms through which they communicated information about tidal power. “Formal meeting” (90%) and “conference/workshop/symposium/webinar” (85%) were mentioned by slightly fewer participants. Figure 25 displays the main “mechanisms of communication” themes by the number of times they were referenced by participants. Despite being referenced by a majority of participants, “technologically mediated/distance communication” (82) and “formal meetings” (77) were referenced fewer times than “conference/workshop/symposium/webinar” (123), and substantially less than “committee/sub-committee/working group” (217).

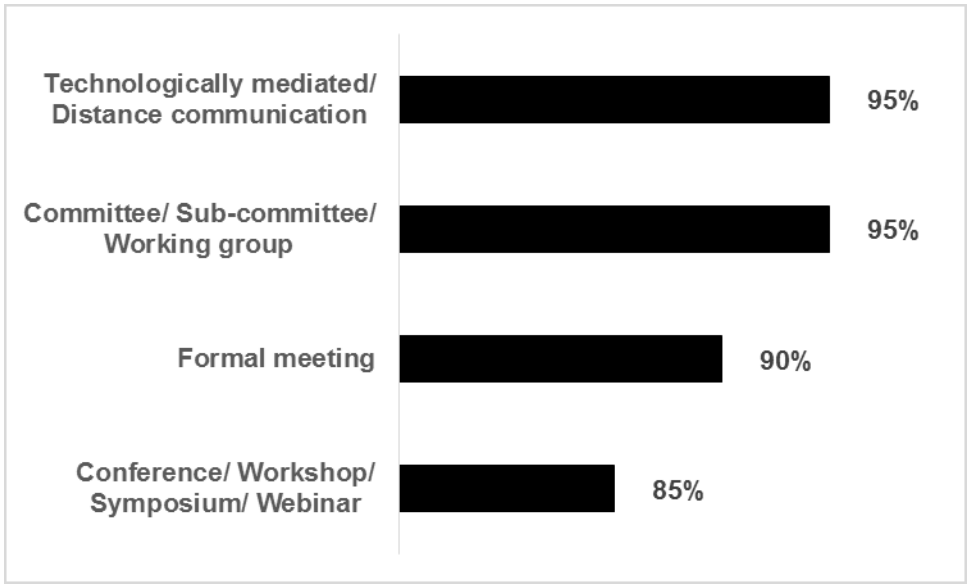


Figure 24. Main “mechanisms of communication” themes by the percentage of participants (N=20).

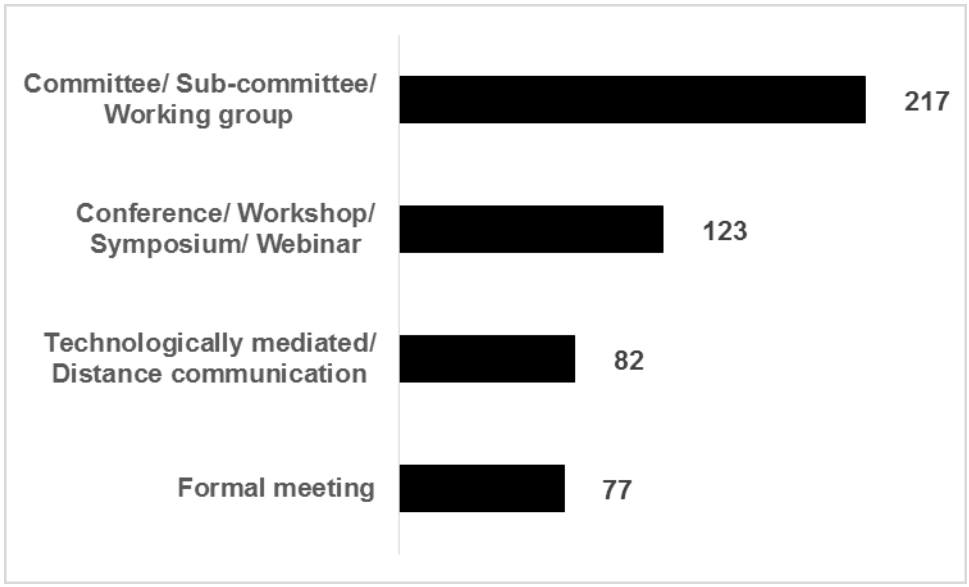


Figure 25. Main “mechanisms of communication” themes by the frequency the themes were referenced by participants (N=626).

Cross-tabulation of the main communication themes with “sector” codes reveals the frequency each sector is referenced with each mechanism (see Table 15).

Table 15. Cross-tabulation between the main themes for “mechanisms of communication” and “sector”.

	Committee/ Sub-committee/ Working group	Conference/ Workshop/ Symposium/ Webinar	Formal meeting	Technologically mediated/ Distance communication	Total
First Nations	28	7	8	7	50
Fishing/ Aquaculture	16	0	1	2	19
Government	135	46	49	57	287
Industry	79	43	32	34	188
NGO	94	71	30	28	223
Research	66	42	7	10	125
Tourism	1	1	0	0	2
Total	419	210	127	138	-

The government (135), NGO (94), industry (79), and research (66) sectors were coded with “committee/sub-committee/working group” more than any other communication mechanism. The high number of references (94) made to both the “NGO” and “committee/sub-committee/working group” themes relative to the number of NGOs present in the network (8) is likely because NGO_1 hosts several tidal power committees. The First Nations (28) and fishing and aquaculture (16) sectors were also coded with “committee/sub-committee/working group” more than any other mechanisms, suggesting that this form of communication is the primary means by which these groups are connected to the network.

Committees, sub-committees, and working groups in the tidal power network were subdivided into three categories: community outreach committees, scientific research committees, and regulatory committees. The one community outreach committee, the Community Liaison Committee (CLC), is hosted by an NGO and is comprised of industry representatives, members of municipal governments, First Nations representatives, local business owners, and citizens. During meetings, members discuss concerns and share information about tidal power, e.g., project updates. Periodically, stakeholder organizations involved in tidal power are invited to give presentations.

Several scientific research committees are hosted by organizations from the NGO and research sectors. Membership on these committees includes scientists, both retired and actively employed; other academics; industry representatives, proponents and technology developers; and representatives from all tiers of government. Different committees focus on the physical and social sciences. Research-based committees coordinate research projects, share expertise, and discuss research findings. One of the physical science committees, EMAC, also plays an advisory role on the types of environmental monitoring needed to ensure that the industry develops in an environmentally sustainable manner.

Regulatory committees act as a venue for tidal power proponents to present potential projects to the relevant government departments, as well as a means for intra-governmental coordination on tidal power. The regulatory committee for tidal power in the Bay of Fundy is the One Window Committee for Tidal Energy. Membership in this committee is restricted to government departments, but it also serves to connect the government with developers through project presentations. The role of committees, sub-committees, and working groups as an enabler in the tidal power communication network is discussed in Section 5.7.1 and Chapter 6, Section 6.3.1.3.

Of all the sectors, the NGO sector was coded the most with “conference/workshop/ symposium/webinar” (71). NGOs often organize conferences, workshops, and webinars for tidal power stakeholders. For example, an NGO participant talked about an up-coming workshop organized by that NGO:

> So we will do things, for example in two weeks we are having a workshop that is focused on sea bed characterization and geotechnical needs for the tidal projects in the Bay of Fundy, so what we have done with that is identified companies that have skills or expertise in that area and invited them to the workshop. (Participant #16 [NGO])

The government sector was co-coded more frequently with “formal meeting” (49) and “technologically mediated/distance communication” (57) than other sectors, followed by industry and NGO. The research sector was coded fewer times with “formal meeting” (7) and “technologically mediated/distance communication” (10) when compared to “committee/sub-committee/working group” (66) and “conference/workshop/ symposium/webinar” (42). The frequency with which these two mechanisms were discussed during interviews suggests that they are the primary means by which the research sector shares information in the network. A participant from the research sector emphasized this point by stating that “our main mode of functioning is through our subcommittees” (Participant #6 [research]), which help stakeholder organizations to

> communicate what they’re doing and what their expertise is and helps them brainstorm project ideas and how they might be able to work together. So a lot of projects have come out of brainstorming. We also have symposiums and workshops and things like that that bring all those groups together [to] talk to each other. (Participant #6 [research])

5.7 Factors Affecting Information Sharing

Participants were asked to discuss factors that they felt acted as either enablers or barriers to communication. Enablers and barriers were mentioned 1268 times during the interviews, with enablers referenced slightly more often than barriers (652 to 615). Enablers and barriers are diverse and cover a wide range of topics. After initial coding, the sizeable number of themes was collapsed into broader concepts. For example, references to a lack of inter-organizational and intra-organizational coordination or cohesion were collapsed into a single "lack of coordination/cohesion category." In the following sections, the main enablers and barriers, as determined by the percentage of participants who mentioned a theme at least once during their interview and the frequency with which a theme was mentioned in all interviews, are discussed. Cross-tabulations between the main themes and "sectors" are then presented to show which sectors were discussed with which enablers or barriers most often.

5.7.1 Enablers

Enablers promote the flow of information among organizations and are the conditions that positively affect information sharing. Participants identified 43 different types of enablers. Figure 26 presents the main "enablers" based on the percentage of participants who discussed the theme at least once during their interview. "Strong relationships," i.e., personal and frequent interaction with members of an organization, were mentioned by the highest number of participants (85%), followed by "bridgers" (75%), i.e., an organization that acts as a boundary-spanner between organizations and sectors, "committees/subcommittees/working groups," (75%) and "willingness to share information/valuing communication" (70%). Figure 27, which shows the main "enablers" determined by the number of times themes were referenced in all interviews, gives similar results.

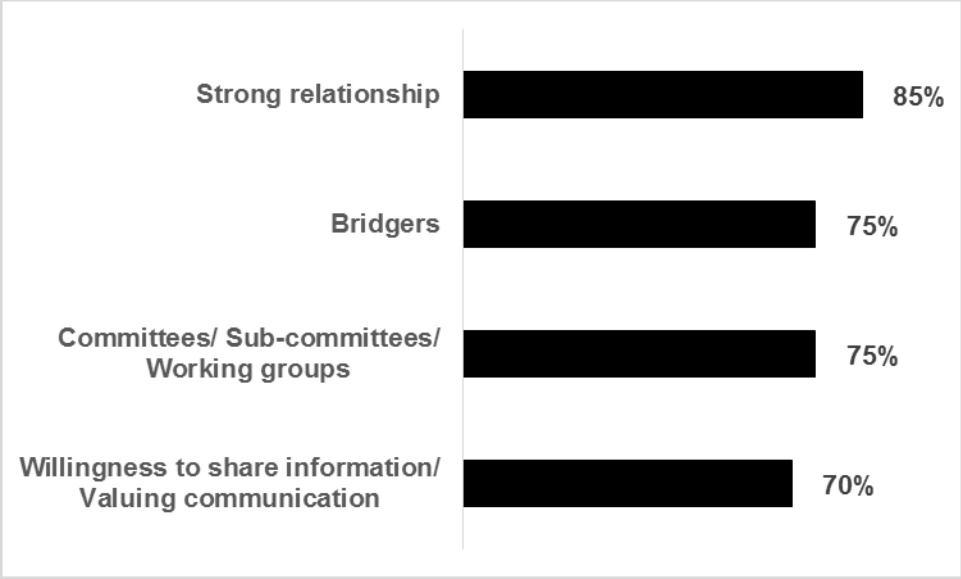


Figure 26. Main “enablers” for “factors affecting information sharing” by the percentage of participants (N=20).

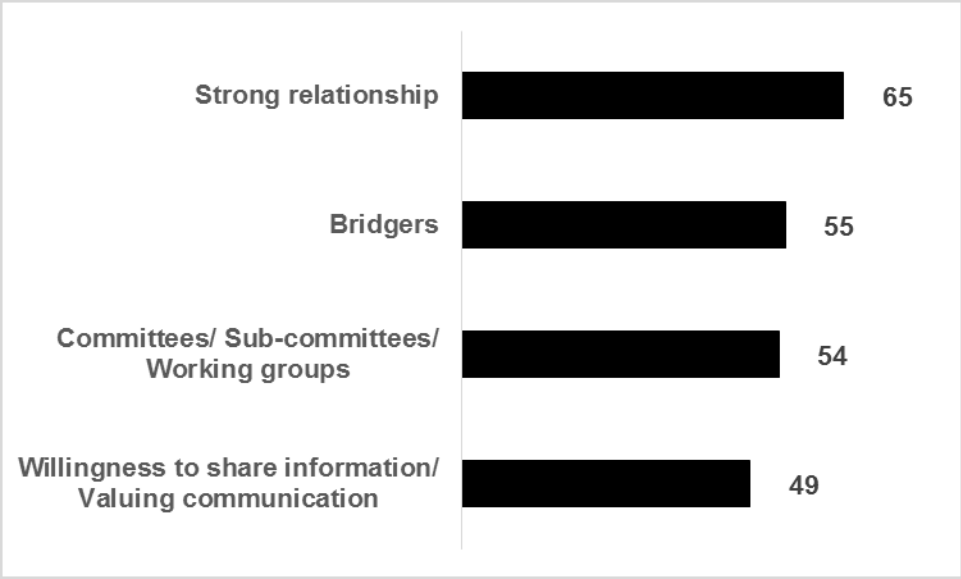


Figure 27. Main “enablers” for “factors affecting information sharing” by the frequency the themes were referenced by participants (N=652).

Table 16 presents the cross-tabulation of the main “enablers” with “sector.” Government was coded most with “bridgers” (39), “committees/sub-committees/working group,” (37) and “willingness to share information/valuing communication” (28). The NGO sector was coded more frequently than other sectors with “strong relationships” (39) and was

second among the sectors with “bridgers” (20) and “willingness to share information/valuing communication” (19). “Industry” had the second highest number of cross-coding with “committees/sub-committees/working groups” (23) behind “government” (37). Despite being coded with committees, sub-committees, and working groups as a mechanism of communication (see Section 5.6, Table 15), participants did not discuss NGOs alongside “committees/sub-committees/working groups” (15) as an enabler as often as some other sectors. The research sector was cross-coded with the main enablers less often than the government, NGO, and industry sectors, but was cross-coded with “committees/sub-committees/working groups” (18) slightly more often the NGO sector. The First Nations, fishing and aquaculture, and tourism sectors were co-coded with the main enablers either much less than the other sectors or not at all.

Table 16. Cross-tabulation between the main enablers for “factors affecting information sharing” and “sector.”

	Bridgers	Committees/ Sub-committees/ Working groups	Strong relationship	Willingness to share information/ Valuing communication	Total
First Nations	1	3	6	7	17
Fishing and Aquaculture	0	2	2	0	4
Government	39	37	28	28	132
Industry	16	23	18	17	74
NGO	20	15	39	19	93
Research	14	18	16	11	59
Tourism	0	0	0	0	0
Total	90	98	109	82	-

5.7.2 Barriers

In the context of this research, barriers are factors that impede information flow. Thematic coding of interviews revealed 53 different types. Figure 28 presents the main "barriers" determined by the percentage of participants who discussed the themes at least once during interviews. "Competition," e.g., industry competitors, was talked about by many participants (80%), followed by "limited resources" (75%), e.g., both financial/physical resources and human resource capacity, "lack of cohesion/coordination" (70%), i.e., within the sector, within organizations, or between government departments, and "lack of engagement" (70%), i.e., either one or both parties not making an effort to engage in information sharing. Figure 29 shows the main "barriers" based on the frequency with which each theme was coded in all interviews. Despite being mentioned by only 70 percent of participants, "lack of engagement" was the theme referenced most often by participants (61). Conversely, although "limited resources" was discussed by 75 percent of participants, it was referenced the least among the main "barriers" (37).

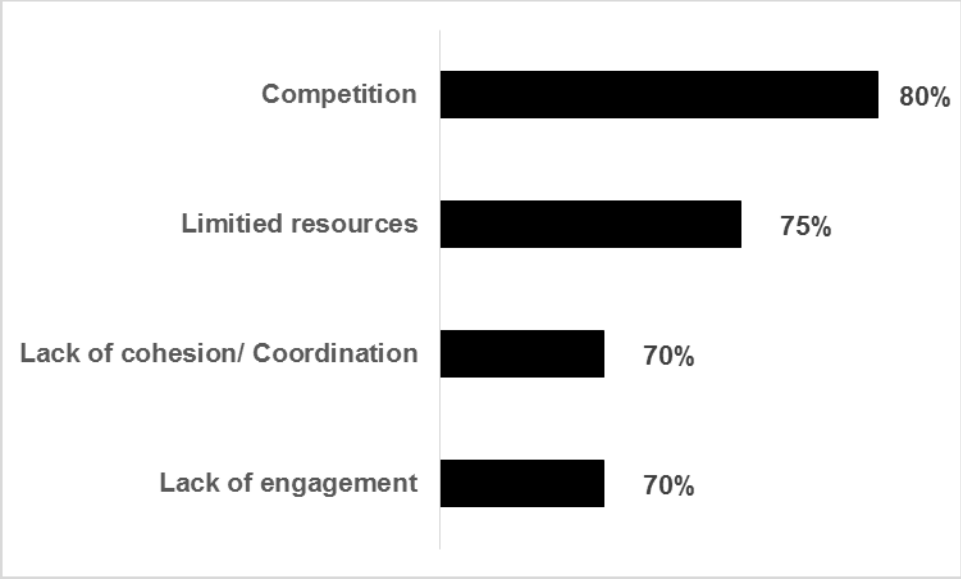


Figure 28. Main "barriers" for "factors affecting information sharing" by the percentage of participants (N=20).

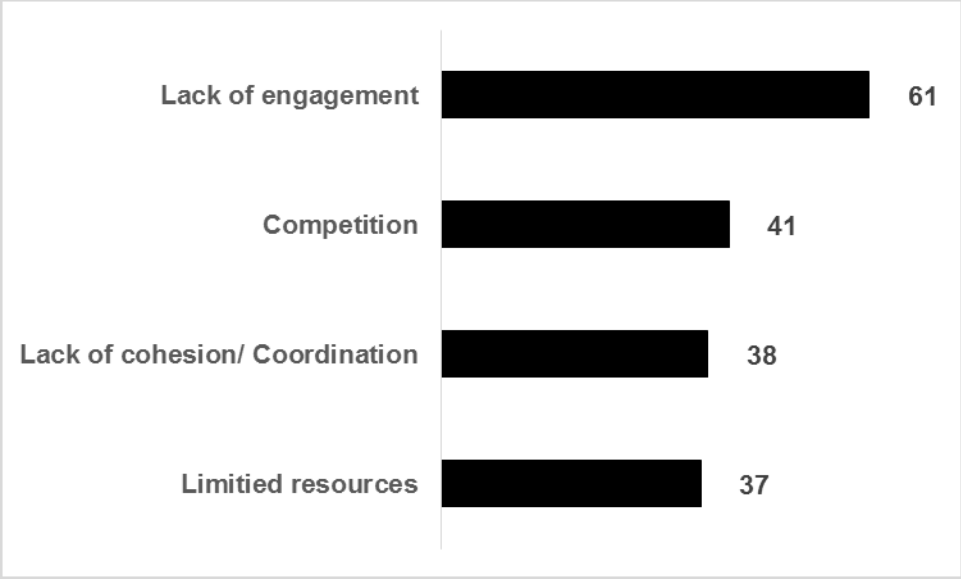


Figure 29. Main themes for “barriers” for “factors affecting information sharing” by the frequency with which the themes were referenced (N=615).

Table 17 presents the cross-tabulations of the main barriers by sector. “Lack of engagement” was coded most with the research (29) and NGO (29) sectors followed by industry (23) and government (17). The industry sector was coded the most with “competition” (19) and the NGO sector was coded the most with “lack of cohesion/coordination” (18). “Limited resources” was coded most often with the NGO (16) and industry (15) sectors. Cross-tabulation can indicate which sectors either discussed certain barriers more often, or were associated with certain barriers by participants from other sectors. The effects of the identified barriers and enablers to communication are discussed further in Chapter 6.

Table 17. Cross-tabulation between the main barriers “factors affecting information sharing” and “sector.”

	Competition	Lack of cohesion/ Coordination	Lack of engagement	Limited resources	Total
First Nations	0	3	5	6	14
Fishing and Aquaculture	0	4	10	2	16
Government	11	14	17	13	55
Industry	19	8	23	15	65
NGO	12	18	29	16	75
Research	11	15	29	11	66
Tourism	0	0	2	0	2
Total	53	62	115	63	-

CHAPTER 6. DISCUSSION

6.1 Introduction

This chapter discusses the findings from the Social Network Analysis (SNA) (Chapter 4), the results from the thematic coding analysis of interview data (Chapter 5), as well as the findings from an examination of existing research (Chapter 2). The results are discussed with regard to the research questions set out in Chapter 1. The discussion is presented in four sections: 1) communication in tidal power networks, i.e., with whom and to what extent are stakeholders communicating information about tidal power activities in the Bay of Fundy region of Nova Scotia; 2) factors affecting information sharing, i.e., what factors act as either enablers or barriers to communication in the tidal power network; 3) key figures in the network, i.e., which organizations figure most prominently in the network; and 4) gaps in the network, i.e., which organizations/sectors are not represented or underrepresented in tidal power communication.

6.2 Communication in Tidal Power Networks

As a coastal development, tidal power exists within a multi-jurisdictional, multi-stakeholder environment. Activities occurring in Canadian coastal areas are ostensibly governed by the integrated oceans management (IOM) framework as articulated in the *Oceans Act, S.C. 1996, c. 31*. IOM is a wholly integrated, participatory form of management that spans sectorial, organizational, and governmental boundaries (Bastien-Daigle, Vanderlinden, & Chouinard, 2008; Taljaard, Slinger, & Van Der Merwe, 2011; Wiber, Rudd, Pinkerton, Charles, & Bull, 2010; Wilson & Wiber, 2009). This type of management is accomplished through the creation of a participatory governance framework wherein all stakeholders are provided an equal opportunity to debate coastal issues (Bremer & Glavovic, 2013; Coffey & O'Toole, 2012). However, as of yet, no IOM policy for marine renewable energy (MRE) has been developed for the Bay of Fundy

(AECOM, 2014). In the absence of policy, questions remain about how, or even if, communication occurs among organizations affected by tidal developments, i.e., tidal power stakeholders. The primary research question driving this study was: “with which organizations and to what extent are stakeholder organizations communicating information about tidal power in the Bay of Fundy?”

6.2.1 Social Network Analysis

Participant-led mapping and Social Network Analysis (SNA) were used to identify and visualize communication among organizations in the various sectors within the timeframe of this research, i.e., fall/winter 2014 to winter/spring 2015. Two-hundred and nineteen stakeholder organizations were identified across seven sectors: government, industry, First Nations, research, NGOs, fishing and aquaculture, and tourism. Among the 219, there were 762 “ties” representing inter-organizational communication which resulted in a network density of roughly three percent. Low density can suggest that the stakeholders are not highly connected (Cárcamo, Garay-Flühmann, & Gaymer, 2014). However, for this study, low density could be a product of the small study population. That is, a network analysis survey sent out to each of the 219 organizations could reveal additional connections and possibly additional organizations. Other network features, e.g., the average distance between organizations (roughly 2.5) and the network diameter (4), indicate that information can spread easily in this network, i.e., does not have to travel long pathways to potentially reach all organizations in the network (Borgatti & Parker, 2002; Long, Cunningham, & Braithwaite, 2013). The composition of network maps also reveals aspects of inter-organizational communication.

Figure 30 shows the tidal power network with organizations coloured by sector and sized by in-degree centrality, i.e., highly connected organizations are depicted as larger nodes than organizations possessing fewer connections. A black circle was added to the image

to distinguish the “core” of the network, i.e., the most connected organizations, from the “periphery,” i.e., the least connected. At its core, the tidal power network is mainly comprised of government, industry, research, NGOs, and First Nations. The multi-sectoral composition of the core indicates that some communication/information sharing is occurring among organizations across five out of the seven identified stakeholder sectors. The fishing and aquaculture and tourism sectors are not represented in the core, but are featured in the periphery, suggesting that organizations from these sectors are present in the network, but not well connected, e.g., they possess few ties.

Cluster analysis also revealed characteristics of the core of the tidal power network. Cluster analysis divided the network into seven community clusters based on betweenness centrality scores as identified by the Girvan-Newman algorithm (Girvan-Newman, 2002). “Custer 7” was the largest and most diverse cluster (Figure 31). It contained many of the organizations in the core of the network, i.e., tidal power proponents, government regulators, and the research network for tidal energy. Because of this configuration, Cluster 7 may be considered representative of the main tidal actors. It also housed organizations from the First Nations, fisheries and aquaculture, and tourism sectors. The diversity found in this “main cluster” suggests that some multi-sectoral communication is occurring in the tidal power network. However, some sectors, i.e., First Nations, tourism, and fisheries and aquaculture, are underrepresented in the core cluster (see Section 6.5).

The relative positioning of organizations in the network map is also suggestive of how communication takes place. Research organizations located in the core of the network are clustered together, indicating that research organizations tend to communicate information with each other. Government organizations, primarily regulators and policy makers, are clustered together with tidal proponents (Figure 30). Industry and

government participants talked about sharing information within a regulatory and permitting context. One developer described the relationship as follows:

> With the province it [i.e., communication] is mostly [about] technical and policy-related information to the projects, so getting permits, dealing with UARB [Nova Scotia Utility and Review Board], and Power Purchase Agreements ... So you are providing reporting, you are applying for things, you are providing details upon request of a regulatory nature. (Participant #10 [industry])

One of the mechanisms facilitating government and industry interaction is the One Window Committee for tidal energy (see Chapter 5, Section 5.6) that connects tidal proponents with government regulators:

> Environmental permitting and planning is a massive part of this [industry] and it is unexplored territory, nobody really knows where [the tidal industry] is going and everybody is making it up as they go along … and so the One Window Committee is a great step towards trying to build that infrastructure. (Participant #14 [industry])

The inter-connectedness of government organizations in the core of the network illustrates the effect rendered by the One Window Committee. A participant from the provincial government said that inter-departmental interactions on tidal power occurred almost exclusively through the One Window Committee and that it is “a good forum for providing general information, updates about regulatory developments, upcoming meetings, presentations, minutes, and that sort of thing” (Participant #7 [government]). The participant also stated that “the committee serves the purpose of a venue for communication through email as well, so obviously the minutes, the presentations, but also updates regarding changes to legislation or [Memoranda of Understanding], or

relevant documents" (Participant #7 [government]). Thus, the One Window Committee also connects government organizations in an ongoing basis through listserv-style email chains. Strong intra-governmental communication was also suggested by the lower E-I Index[6] value for government relative to the other sectors. Despite this focusing of the information exchange, participants still pointed to governmental "silos" as a barrier to communication in the network (see Section 6.3.2.3).

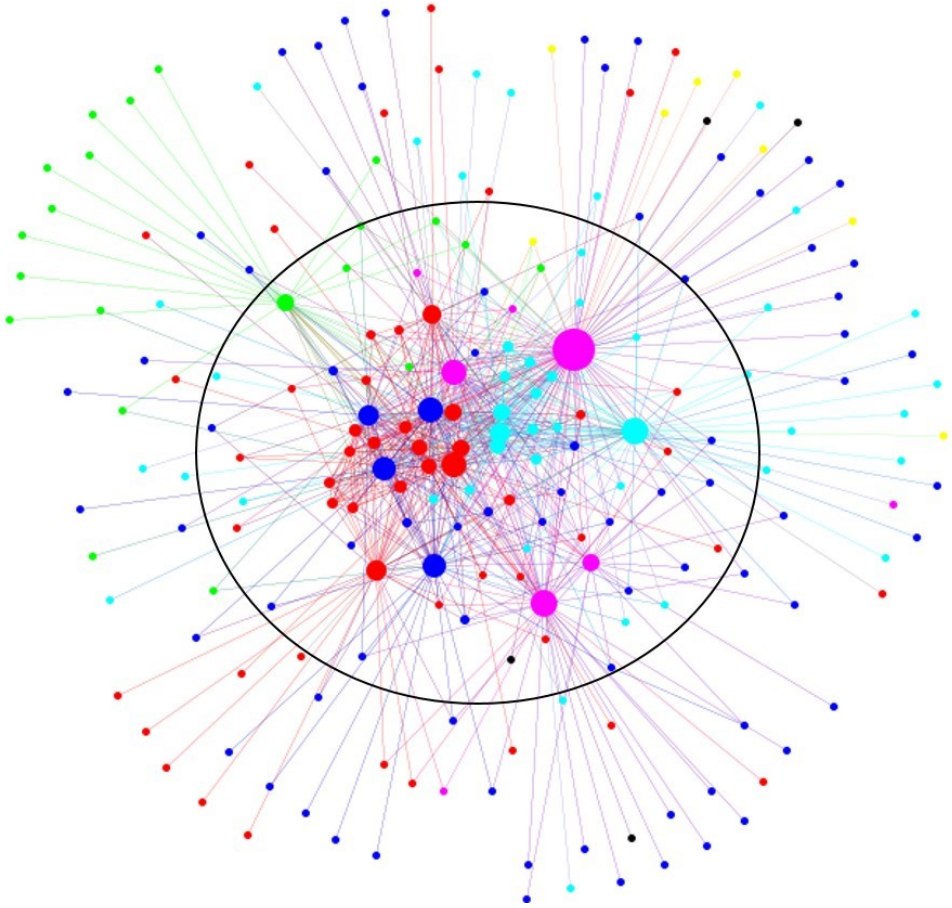


Figure 30. Tidal power communication network for the Bay of Fundy region of Nova Scotia with nodes sized by in-degree centrality. The black circle distinguishes the "core" of the network from the "periphery." Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green= First Nations, Yellow=fishing and aquaculture, Black=tourism. Note: Figure 30 is a duplicate of Figure 3.

[6] The E-I Index test was used to determine the level of inter- and intra-sectoral communication in the network.

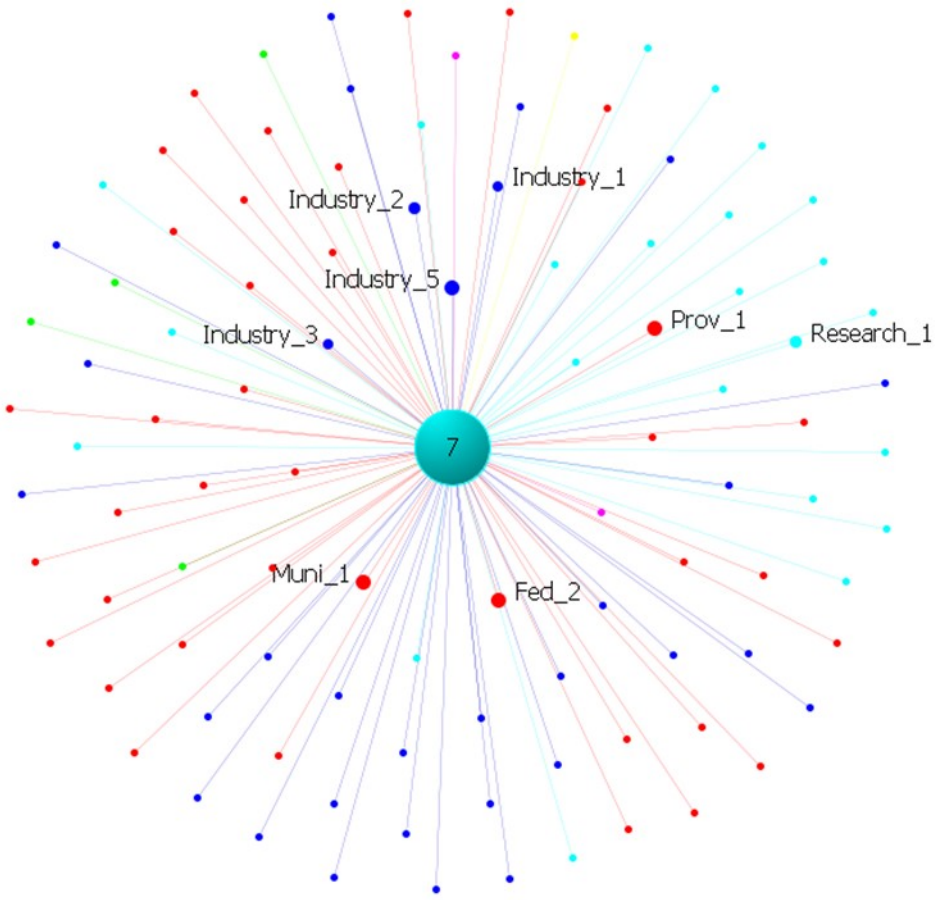


Figure 31. "Cluster 7" generated using the Girvan-Newman algorithm. Note: Figure 31 is a duplicate of Figure 11.

6.2.2 Participant-led Mapping and Semi-Structured Interviews

During the participant-led mapping exercise, participants were asked, through a series of semi-structured interview questions, to describe interactions with identified organizations. The results suggest that communication in the network is more strategic than operational, and centered on building the emergent tidal power industry.

It was found that tidal power stakeholders are communicating information about the current state of the tidal industry; possible economic development opportunities; how to obtain funding for future research; what needs exist for tidal power proponents, e.g.,

infrastructure or research needs; where gaps in information occur and how can these be reconciled; information pertaining to legislation and policy development; and the acquisition of regulatory approval (see Chapter 5, Section 5.2). The reasons for information sharing were subdivided into “strategic” and “operational” thematic categories. Strategically, stakeholders in the tidal power network are communicating information in order to advise and share experience, provide updates and reports about tidal energy projects, to educate or raise awareness about tidal developments, and to fulfill formal consultation or engagement obligations. Operationally, tidal power stakeholders are sharing information due to “project-based” activities most often, followed by regulatory/permitting and funding relationships (see Chapter 5, Sections 5.3.1 & 5.3.2). The results also indicate that information is being used to support high-level, strategic planning; develop research projects; develop legislation, regulation, and policy; develop the tidal energy industry; educate stakeholders about tidal energy and tidal energy activities; and to acquire or administer regulatory approval (see Chapter 5, Section 5.4). It was also found that information use in this network tends to be more strategic than operational, or, using Nutley, Walter, and Davies’ (2007) framework, is slightly more conceptual than instrumental. The findings about communication in the network point to the nascent state of the industry and highlight the need for strategic information sharing that can alleviate uncertainty and help to fill knowledge gaps.

Particularly in Canada, tidal power is a less developed field relative to other types of energy production, e.g., offshore oil and gas, with many uncertainties and unknowns (Nova Scotia Department of Energy, 2010a; Nova Scotia Power Inc., 2015). An NGO participant tasked with presenting potential opportunities to technology developers called tidal power “an industry in waiting” and stated that:

> There isn't a whole lot of economic activity around it yet, but it's a huge natural resource and one that I think will grow over time. So we put a lot of effort into it, but sometimes it's difficult to see the results in the short-term in terms of business activity. (Participant #11 [NGO])

MRE is more developed in Europe and the UK and is closer to becoming a mature industry (Todd, 2012; Wright, 2015). The sharing of experience between international and Nova Scotian organizations at this stage is essential for determining how the industry can move forward. An industry participant described the information exchange between the emerging tidal industry in Nova Scotia and international developers as follows:

> [Europe and the UK], that's where all the conferences are held … there are probably three or four this year alone … and they're in Scotland, one of them is in London, they are all over there and … that's helpful because there is always a lot of information and new technologies being developed all the time and new ways to model and study and monitor these turbines. So that's mainly what we use it for, background knowledge. All of the technology providers seem to be [international] too because the political environment [is] very positive towards developing tidal energy in Europe, so they've been given this ability … to get lots turbines in the water and test them … we are just a little behind on that. (Participant #2 [industry])

In addition to conferences, international trade missions are also being conducted to develop an understanding of what kinds of expertise exists outside of Atlantic Canada so that international organizations can contribute to the supply chain (see Chapter 5, Section 5.3.2). Companies identified during trade missions may then be contracted for

research and development (R&D) projects designed to create the technologies to be used by tidal power proponents in energy generation, e.g., in-stream tidal turbines. Yet, despite greater advancements in tidal power abroad, the industry is still at an early stage and rife with uncertainties.

Locally, information is shared largely for strategic purposes and is, in part, used to reduce the number of unknowns currently affecting industry growth. In the UK, long project timescales, due to the length of time required to develop novel technologies and the subsequent unpredictability of costs, have been identified as possible barriers to private investment (Leete, Xu, & Wheeler, 2013). An NGO participant spoke about the detrimental effects of uncertainty on tidal power development in Canada:

> When you don't have a lot of previous knowledge, there's a lot of uncertainty and uncertainty equates to risk and when there's a lot of risk there tends to be limited investments and so from a developmental point of view, this industry is challenged, from a financial perspective, and also from a human resources, knowledge, and technology perspective. (Participant #19 [NGO])

“De-risking” the tidal industry involves inter-organizational and cross-sector communication about developing research projects that help to fill knowledge gaps and understanding of the needs, both infrastructure and research-related, of tidal developers. Information sharing of this nature is facilitated through various science, social-science, and community-oriented committees, as well as multi-sectoral conferences and workshops designed to bring tidal stakeholders together for high-level conversations. Science committees, such as the Environmental Monitoring Advisory Committee (EMAC), are used to advise the industry sector on what kinds of environmental monitoring and research are required to ensure that tidal power is moving forward

responsibly and sustainably (see Chapter 5, Section 5.6). An NGO participant spoke to the volume of tidal power conferences and workshops as follows:

> there's a large number of meetings and workshops and engagement around renewable energy, I think intentionally to try to spawn an industry … there's a lot of dialogue, where to compare that with a lot of mature sectors, let's say the naval sonar sector or the aquaculture sector where it is an existing business … the conversations tend to be very tactical and specific ... [MRE] in the Bay of Fundy stuff tends to be more abstract and broad. (Participant #11 [NGO])

Alongside the idea of organizations working to “spawn an industry” is the fact that regulation and policy for both tidal, and marine renewables in general, are still in development:

> Especially for this whole tidal energy thing, it's all new so there are a lot of unknowns and there are no real processes in place. We don't have marine renewable energy legislation in place, we have just gone through a major revision in the Fisheries Act, as well as the navigable waters act … so not only do we have these revised acts coming through and the processes are all different, there's really no guidelines that have been developed … so then to put a tidal energy project through that where there are already more unknowns, so everybody is kind of making it up as we go along. (Participant #2 [industry])

The difficulty is that, unlike more mature industries such as oil and gas, a clear-cut regulatory or policy framework for potential tidal developers does not yet exist. The removal of uncertainties, both technological and environmental, and the development of clear regulation and policy is the bedrock on which the tidal industry must be built in order to achieve success. However, some strategic information sharing, e.g., public

education/awareness building and formal stakeholder engagement sessions, were used as a means to obtain social license for tidal power development.

Social license generally refers to the acceptance of a development or industry by stakeholder groups, principally the general public, i.e., local communities (Yates & Horvath, 2013). New developments, particularly those occurring in coastal waters, are often met with opposition (Alexander, Wilding, & Jacomina Heymans, 2013; Baily, West, & Whitehead, 2011). Studies in the UK found that negative public perception surrounding MRE development is related to concerns about visual "pollution" created by MRE devices and possible environmental impacts (Appiott, Dhanju, & Cicin-Sain, 2014; Baily et al., 2011; West, Bailey, & Winter, 2010). Especially at an early stage, stakeholder engagement about possible MRE developments is essential in obtaining social license (Yates & Horvath, 2013). An industry participant stated that:

> social license is hugely important … we will not be able to develop a commercial-scale project without social license … developing those relationships early on is what is super important … and [providing] the right information. So we have developed a communication strategy, a consultation strategy, and an engagement strategy and … the message that we put out has to be consistent … timed correctly and … correct about the project [so] that it can dispel some myths… (Participant #2 [industry])

This view is consistent with the literature on ICZM which found that public perception, community engagement, and consensus building were all viewed as critical in creating sustainable ICZM (Sessa & Ricci, 2010; Taljaard et al., 2011). The idea that cross-sector communication must occur in the early stages of project development was also echoed in the research examining ICZM (Taljaard et al., 2011; Wilson & Wiber, 2009). An NGO

participant described the need for open channels of communication with the various stakeholder groups and the general public in similar terms:

> [tidal power] is still a very nascent sector with a lot of stakeholders and unless you are engaging people and making sure that communication is open, … there's just a ton of consequences in terms of … what we call our public acceptance … making sure that the public is aware that we're doing things in a conscious manner in terms of the environment and also socially, I think, communication is very important to make sure of that as well. (Participant #8 [NGO])

The importance of open communication and social license is reiterated in the need for the development of a shared vision for the tidal industry, the absence of which was identified as a barrier to inter-organizational communication (see Section 6.3.2.3).

6.3 Factors Affecting Information Sharing

The literature on both ICZM and interpersonal, inter- and intra- organizational information sharing often examines sharing practices in terms of the factors that affect information sharing decisions, which can possess the double-edged quality of being both enablers and barriers to information flow. For example, sharing past work-related experiences with individuals or organizations may result in a stronger tendency towards information sharing if the past experience was positive. Conversely, negative experiences might result in a decreased tendency towards information sharing. In addition, understanding the effect rendered by the factors is difficult because 1) the factors are not often standalone concepts and can function in tandem with other aspects of information sharing, e.g., mechanisms (see Chapter 5, Section 5.5), as well as with other factors, e.g., trust is closely related to strong relationships; and 2) the impact a

factor has on information sharing is often subjective and therefore cannot be easily measured.

In this research, participants were asked to discuss possible enablers and barriers to information sharing with identified organizations. The responses were coded by theme and the "main" enablers and barriers were identified by comparing the frequency with which a theme was referenced with the percentage of participants who mentioned the theme at least once during interviews. The frequency with which a theme was co-coded with a particular sector was also tabulated. In the following section, the main themes are discussed, where appropriate, in terms of: 1) how the themes were discussed in relation to sector, 2) if and how the themes were interrelated, and 3) how the main themes intersected with previous studies. Although categorized as "enablers" and "barriers," the themes explored below are simply factors that had a tendency towards having either positive or negative effects on communication, as perceived by participants.

6.3.1 Enablers

6.3.1.1 Strong Relationships

In the network, "strong relationships" were characterized by personal and frequent interaction among individuals within the separate organizations, i.e., a "close" relationship. The finding that strong relationships were a main enabler of information sharing is consistent with existing research that found that such relationships, whether interpersonal or inter-organizational, are essential to information sharing (Cheng, 2011; Hansen, 2002; Wang & Noe, 2010; Yang & Maxwell, 2011). Participants often described strong relationships as being a product of established connections, or carried over from mutual work on earlier projects. For example, an industry participant described how past work experience helped to foster strong relationships:

> I have been in the consulting industry for about eight years … and so I have been dealing with all of the groups for probably a decade now, I am very familiar with all of them on a personal/business level, which is a huge help. … when I joined this project there wasn't a need to introduce myself to anybody because I know pretty much everyone. (Participant #2 [industry])

Trust, particularly, trusting another party to use information provided in a responsible and conscientious manner, was also mentioned. This finding is consistent with Willem and Buelens' (2007) study which found that individuals are more likely to share information when they trust that another party will not try to use the information in an opportunistic or underhanded manner. Many participants also talked about the importance of informal, usually face-to-face meetings, e.g., meeting in a coffee shop, for building strong relationships. However, technologically mediated communication, e.g., email or telephone, was also discussed in relation to these relationships and was correlated with sharing frequent communications, e.g., being comfortable enough to send short, informal emails with ideas, plans, etc. An NGO participant spoke about having a close relationship with a government department:

> we don't have any problem just to float them off an email … I will send them a one-liner, and just ask a quick idea, so I think having that established relationship with them is … favourable to [good communication]. (Participant #8 [NGO])

Frequent communication was often suggested as an enabling factor for the development of good interpersonal relationships, which then serve to foster strong ties between organizations.

6.3.1.2 Bridgers

"Bridgers" are organizations that specialize in brokering connections between multiple organizations and have formal mandates to bring actors together into networks (Collins-Dogrul, 2012). During the interviews, participants spoke about "bridger" organizations as a factor that enabled information sharing and suggested that bridgers are important in nascent industries because they encourage growth through the facilitation of novel inter-organizational connections, e.g., via workshops or trade missions intended to build the supply chain. Bridgers also help to identify and fill "gaps" in knowledge or expertise:

> [networks] are about building confidence, it's about building expertise, it's about figuring out where the gaps are and how we can fill the gaps. Gaps in knowledge, gaps in understanding … who do we need to bring in, where do we need to put some effort? (Participant #1 [research])

Bridgers also provide a conduit through which small, low-capacity organizations can interact with larger organizations, e.g., connecting municipalities with large, multinational corporations. A municipal government representative discussed how an NGO helped to connect the government with tidal developers:

> Mostly it's contact from us to [Marine Renewables Canada] and then they have contact with … the developers because we are a small entity and they are a large … organization. And we can't do all of this development ourselves, we can't make a call to Scotland or France or something and say... For myself, I wouldn't begin to know how to make contact. (Participant #3 [government])

Bridgers help to keep organizations in the network aware of current projects while also ensuring that the information flowing through the network is consistent, thereby helping to prevent the spread of misinformation. Similarly, bridgers were often described as

facilitating the spread of a holistic or region-wide perspective for tidal energy and are therefore related to the development of a “shared vision/common understanding” enabler. In the literature, the concept of “boundary-organizations” acting as information brokers is discussed as a possible means of bridging the gap between the science and policy sectors (Bremer & Glavovic, 2013; Coffey & O’Toole, 2012; McNie, 2007). While bridgers in this network do connect the science and policy sectors, this research suggests that such organizations are actually facilitating communication across a wider variety of sectors (see Section 6.4 for a discussion about key figures in the network).

6.3.1.3 Committees, Sub-committees, and Working Groups

Wilson and Wiber (2009) suggested that stakeholders in multi-sectoral networks require the creation of mechanisms, e.g., workshops, public consultation forums, and conferences, to ensure that they have a meaningful forum in which to represent concerns. In the tidal network, committees, sub-committees, and working groups were subdivided into three categories: community outreach committees, scientific research committees, and regulatory committees (see Chapter 5, Section 5.6). Regulatory committees expedite the regulatory and permitting process by proving a shared venue for proponents and government to discuss tidal power projects without the need for several separate meetings. While membership on the federal/provincial regulatory committee for tidal energy, i.e., the “One Window Committee,” is confined to government organizations, tidal power proponents described presenting to the committee as a:

> very positive experience … they handle communications amongst themselves which saves us having to get a hold of 13 departments to coordinate the responses … so that's all pretty smooth, very efficient with minutes and information provided, immediate follow-up if you needed this that and the other thing, concerns, etc. (Participant #10 [industry])

Another industry participant described how the One Window Committee "gives developers a chance … to meet all [government organizations] in one room and bring up certain things that are … creating … unknowns" (Participant #2 [industry]).

Coordinating action in this way also serves to demystify the regulatory process, as well as break down departmental "silos" often found in government. A government participant discussed the creation of the One Window Committee:

> understanding that [tidal energy development] was a complex web of federal and provincial and potentially municipal regulators, we established a One Window Committee of provincial and federal departments that would … get together fairly regularly with [The Fundy Ocean Research Centre for Energy] and industry at that time to talk about what the requirements might be [and] to look at ways to streamline or harmonize. (Participant #5 [government])

The strong interconnectivity among government organizations in the core of the network (Figure 30) also illustrates the bridging effect rendered by the One Window Committee. Yet, participants still identified governmental silos and a lack of coordination among departments as a barrier to inter-organizational communication (see Section 6.3.2.3).

Participants also discussed how community outreach and scientific research committees create a semi-formalized venue for connecting representatives from sectors/organizations that may not otherwise have a reason to meet. In the same vein, committees offer an opportunity for individuals to meet outside of normal work routines and the confines of organizational structures. These arrangements allow for broader, more strategic conversations to take place, which contributes to the development of a shared vision for the tidal power industry. Sharing information through committees also means that committee members receive the same information, potentially dispelling

conflict precipitated by misinformation or a lack of information. Consistent with the findings in Section 6.2.1, committees also act as bridgers, connecting otherwise disconnected sectors and organizations.

However, despite being consistently identified by participants as an enabling factor for information sharing, some participants questioned the effectiveness and utility of committees. Participants highlighted the Community Liaison Committee (CLC) in particular as being an ineffective tool for engagement with the general public, i.e., the "community," and the fishing and aquaculture sector. An NGO participant described the lack of engagement as follows:

> the general public has a strong representation on our CLC and that has been criticized sometimes because they're not overly active or engaged … we have been through stages where we felt, I think, we were giving lots of information but it was ending at the meeting and it wasn't being shared because … [the general public] is not an overly impassioned or engaged stakeholder, or representing any impassioned stakeholder group, and so nobody they know cares and they don't particularly care. (Participant #9 [NGO])

In terms of representation from the fishing and aquaculture sector, a participant from government stated: "participation at the few CLC meetings that have taken place has not been very successful, I understand that at one meeting, one … fisherman, attended" (Participant #7 [government]). Fishing and aquaculture organizations were found to be one of the least engaged stakeholder groups in the network, both in terms of fishers being not able and/or willing to reach out, as well as other sectors not being able and/or willing to engage with this sector (see Section 6.3.2.1). An NGO participant spoke about the challenges of obtaining representation from the fishing and aquaculture sector:

> the CLC was intended to have a strong fisher's representation from the outset, but it has proven difficult to have meaningful representation unless you have specific concerns from fishers brought together and then reported to the CLC because of the tendency, I think human nature, of people to try to speak to the concerns of other stakeholders [while] having zero background in, for example, fishing. (Participant #9 [NGO])

Research-focused committees were also criticized for failing to coordinate research among members, as well as members being either unwilling, or unable, to share certain information, e.g., proprietary information. An industry participant, who also spoke about the potential value of committees, described the challenge as follows:

> on subcommittees we give general project updates and not a whole lot more than is public information already … there are … more probing questions asked … [but] other berth holders are on those subcommittees as well and so it's a little bit of touchy feely, trying to pull a little information out, “give a little, get a little” kind of thing … it doesn't often amount to much. It's never yielded anything terribly useful to us … [the engineering subcommittee] is supposed to be a forum for everyone to talk about engineering challenges, but nobody goes and divulges everything, they keep their cards pretty close to their hands, but it is friendly ... I've met folks from the other berth holders that I might not have met otherwise, so it's a good way to keep everybody in the loop. Again, I think we benefit from being seen to be fully engaged, and really rigorously so, and so I always try to [attend]... and the frustration of some of my colleagues [who say]: “your time is better spent doing other things.” [They] don’t know that, it could pay dividends down the road! (Participant #14 [industry])

A government participant discussed the lack of coordination that sometimes plagues committee meetings:

> It really depends on who is leading it and how much they can get consensus within the group. [The Fundy Energy Research Network] tends to be a lot of different people with a lot of different opinions and not a lot of coordinated thought, everyone is sort of me me me first, so that's really not that useful. We're going to try to change that, or I am trying to change that. (Participant #18 [government])

Optimism concerning the future of committees was echoed by an NGO participant talking about the CLC:

> the last couple of [CLC] meetings have been a lot more [effective], so I am optimistic because being a community member myself I want people to be engaged in this process, I want them to ask the questions that I would ask if I was in their position. (Participant #9 [NGO])

Many of the challenges faced by committees relate to either the inability or unwillingness of an organization to share information in a public setting, as well as a lack of coordination within the tidal sector (See Section 6.3.2.3).

6.3.1.4 Willingness to Share Information/Valuing Communication

This theme describes an organizational culture with an open disposition, a propensity for information sharing, and a valuing of inter-organizational and cross-sector communication and collaboration. Studies have shown that organizations with a culture that promotes information sharing, especially when support for information sharing comes from upper management levels, act as enablers to information flow (Cabrera,

Collins, & Salgado, 2006; Connelly & Kelloway, 2003; Li & Lin, 2006). This theme also relates to the concept of altruistic motivations for information sharing (Jarvenpaa & Staples, 2001; Wang & Noe, 2010), although such sharing has also been shown to provide organizations with a competitive advantage (Cheng, 2011; Li et al., 2006; Samaddar et al., 2006; Wang & Noe, 2011). An important aspect of this enabler is that an organization makes an intentional effort to cross organizational and sectoral, and also cultural, gaps. A participant from the First Nations sector talked about how government departments with an employee with specific training in Mi'kmaq consultation helps to foster strong channels of communication. Other intentional boundary spanning efforts take the form of voluntary participation in mechanisms and structures designed to enable inter-sectoral communication, such as committees or conferences.

Studies have also shown that organizations that do not cultivate a culture that values information sharing act as a barrier to integrated management initiatives (Bremer & Glavovic, 2013; Taljaard et al., 2011). Similarly, individuals or organizations that withhold information, either from an unwillingness to share or from a view of information as a strategic asset, are a barrier to information sharing (Constant, Kiesler, & Sproull, 1994). In the tidal network, organizations from the industry sector tended to be more guarded about sharing information, particularly any information that could be considered proprietary. This reticence is, in part, due to the fact that tidal power technologies are still in the R&D phase of development, with no clear technology yet emerging as the "industry standard." Speaking to the difference in information sharing propensities between research organizations and industry, one participant stated:

> there have been some issues with communication between industry developers and the researchers [but]… it's not so much any kind of animosity … developers tend to be tight-lipped about what they want to do and researchers are very open

> … it’s just really a matter what information they’re willing to share, what data, and how does [the sharing] work. (Participant #6 [research])

Some researchers felt that working with industry was difficult because of the restrictions often set in terms of what could be shared, i.e., non-disclosure agreements (NDAs) result in a contractual obligation for silence:

> I try not to [sign NDAs], personally I don't like to do that, because I don't see that that's what it is that we should be doing. Then we become industry. And so we try to avoid situations that require us to do that because we are supervising research students and wanting to be able to talk about what it is that we do and [if] we can't be sharing any of that … it's very difficult. (Participant #1 [research])

A participant from a government department also spoke about the challenges caused by industry’s guarded stance towards information sharing: “we are regulating and we may not get all the information that we desire because it's not in the written word [i.e., information that is not legally or contractually mandated] so that could potentially be a barrier” (Participant #17 [government]).

In addition to being guarded about sharing proprietary information, participants also cited closed dispositions or uncooperative attitudes possessed by certain organizations and sectors acting as a barrier to communication. An industry participant described how one of the berth holders in the Fundy Ocean Research Centre for Energy (FORCE) test site was not willing to engage in open communication or information sharing, particularly with non-industry stakeholders:

> there's nothing that anybody knows about [Atlantis Resources, Ltd.]. There's no announcements. There's stuff that they might be saying at the FORCE board

> meeting, but that would be confidential. There's no public information about whether they are involved in projects. (Participant #13 [industry])

Another industry participant suggested that Atlantis:

> doesn't participate well and doesn't play well with others … So we have an absentee berth holder at FORCE who is antagonistic, and so that's not a great relationship to have, whereas with the others, we're competitors, but we're not necessarily adversarial. (Participant #14 [industry])

The fishing and aquaculture sector was also described by participants as being sometimes unwilling to communicate and share information. As a research sector participant suggested:

> they tend not to want to [talk]… I think it's just the nature of distrust of … government or elite … so we don't, as FERN, I mean we have some fishers that are members that are kind of general members, and then we deal with them through other organizations, but not a lot of direct contact with them. (Participant #6 [research])

An NGO participant described the challenge of engaging with the fishing and aquaculture sector as follows:

> Barriers I guess are… some of them [fishers] don't want to meet with us, some of them are [not interested] … for whatever reason, either they've been contacted in the past and they didn't like what they heard or they just aren't interested in talking period … I think some of them just probably don't support the project, so some of them voice that, whereas some of them just choose to not talk to us,

> …because they think that it's going to affect their livelihood. (Participant #8 [NGO])

An unwillingness to communicate offers a possible explanation for why fishing and aquaculture groups were seemingly underrepresented in the network. The "lack of engagement" barrier points to other reasons for why members of the fishing and aquaculture sector may not be being engaged on tidal power developments.

6.3.2 Barriers

6.3.2.1 Lack of engagement

This theme was assigned to interview text sections where participants discussed a lack of effort to engage in communication by either one or both parties. Organizations and sectors for which tidal power was not directly related to their mandate, or simply is not a priority, were often described as unengaged. Discord between organizations, or people, within a sector was also identified as contributing to a lack of engagement. The fishing and aquaculture and tourism sectors were described by participants most often as being unengaged, with the exception of a Nova Scotian university that some participants felt should be more engaged. A research sector representative discussed how fisher organizations are difficult to engage because of the absence of sector-wide representation: "you can't really pinpoint necessarily a particular person who … represents [fishers], and even when you're talking about the various [fishing] industry associations … there's not really an individual who really represents that group" (Participant #6 [research]). Interviewees suggested that members of the fishing industry are generally not interested in discussing tidal power, engaging with tidal power research, do not see themselves as having a clear role in tidal power, and are distrustful of authority figures, e.g., government. An industry participant described the challenges related to engaging members of the fishing sector:

> Fishers I like to meet face-to-face, even like stopping by their house, that type of face to face, so very casual in the kitchen conversation. … fishing organizations in Nova Scotia …prefer to meet one-on-one. It's also better to work around their schedule so that … if they have been on a boat all day they don't have to come back out we can just be there to sit down and have a coffee. This kind of [office] environment, a lot of them are not … that comfortable … they're much more comfortable with a very casual meeting. (Participant #2 [industry])

These comments relate to the "work/project schedules incompatible" barrier. A participant representing an NGO posited that:

> Because of the nature of fishers' livelihoods, it is really difficult for them to participate in a group or an organization, hence why it is very difficult to find out if a fisher's association still exists or how it exists, because their livelihood is so dependent on weather and the tides. (Participant #9 [NGO])

Other reasons given for the possible lack of engagement were barriers related to proximity and the idea that some fishers are simply unsupportive of the tidal power industry.

6.3.2.2 Competition

"Competition" was the second-most referenced barrier to communication. Competition was often related to "overlapping mandates," i.e., organizations with similar roles. One participant described the Nova Scotia organizational landscape as "Venn diagrams on Venn diagrams" (Participant #11 [NGO]) to account for the extent of overlap. Overlap leads to competition over funding opportunities, e.g., research grants, and competition about which organization can claim "ownership" of particular roles:

> there is very limited available funding … and especially when you're talking about the research sector, so there's competition amongst the different research groups for funding and for that esteem… that they want to be known as key people and sometimes people will come in and decide that they want to be the major organization and another group was like "well we were already here and you're stepping on our toes.'" The larger groups taking out the smaller groups, it's really the idea of competition… (Participant #6 [research])

These comments relate to the "limited resources" barrier. Bastien-Daigle et al. (2008) found that the competition for limited financial resources acted as a barrier to inter-organizational communication and cooperation. Limited funding resources fuels competition among organizations, particularly the research and NGO sectors, while overlapping mandates force organizations to spend time and human resources justifying their existence:

> But that's what the public sector does all day every day and I think by extension the non-profit organizations as well. So you spend a huge amount of time justifying your existence based on, well I facilitated this, I facilitated that, and I facilitated that and … there's a lot of energy that goes into that, to be very honest. (Participant #11 [NGO])

Competition due to overlapping mandates also relates to tidal power developers, as well as municipalities that hope to be chosen by developers to host the emerging tidal power industry and thereby reap the potential economic benefits. A research sector participant stated that competition will increasingly become an issue as the industry moves towards commercialization:

> Competition's going to become an issue when we start putting in arrays, then things will change quite a bit. Five years from now... it could look really different. Could be some people falling away, some people having not so good relationships with each other, right now nothing has happened to upset anybody. I mean there's nothing worse than money for creating bad relations … right now we're not in that place, right now we're the early phase… (Participant #1 [research])

Even at the pre-commercial stage, developers are competing over site selection for turbine testing: “there are developers that are not happy with their berth site and want a different berth site … so that, I'm sure, could cause friction down the road” (Participant #2 [industry]). Since the technology for in-stream tidal power is still being developed, industry competition also involves withholding proprietary information, and, to a lesser extent, environmental monitoring data. This hesitancy to communicate is consistent with previous research that found that information sharing and collaboration is not always advantageous in a competitive environment (MacDougall & Colton, 2013) and that some information, e.g., proprietary information, or information relating to ongoing research and development projects within a competitive market can be more valuable unshared (Cheng, 2011). A government participant talked about how competition among tidal developers inhibited information exchange:

> I think that there's some concern with industry that right now, where it’s a new industry, it's a competitive industry, and they're concerned about proprietary information, and information that, once it's made public, other developers could potentially use … so I think there's reluctance for industry to share all of the information that they have with regulators or government bodies. (Participant #5 [government])

Despite being competitors, a sense still exists that collaboration among industry members is needed to ensure that the tidal industry is capable of reaching maturity, i.e., commercialization. As a tidal power developer participant suggested:

> We're competitors, but we're competitors who want to see an industry where we can compete. So it's very much like this is the ball field. We want the pitcher to get into the ball field, then it's up to our team. (Participant #13 [industry])

6.3.2.3 Lack of Cohesion/Coordination

"Lack of cohesion/coordination" refers to organizations' inability to work together or coordinate actions acting as a barrier to communication. Participants who talked about this barrier identified a lack of coordination among government departments and different levels of government as hindering communication. A federal government participant highlighted the challenges in exchanging information internationally:

> the biggest thing is … trying to open up … lines of communication internationally. … as a regulator we have so much knowledge and experience, but how do you exchange information with a regulator that's from Scotland or Australia or wherever who might have worked with these types of turbines in the past, or who is currently working on something and learning as they go, and they might have recommendations. (Participant #5 [government])

The participant continued:

> sometimes it's more challenging for regulators to share information at various levels of government … on an international level, how can the U.S. government exchange information with the Canadian government on what they are learning

> through regulatory [action]… if there was a way to open up the ability to share that information, that would be good. (Participant #5 [government])

Participants from the research and industry sectors also pointed to inadequate communication within government as a barrier to information sharing. For example, a research participant stated:

> there is a lack of coordination within [government] groups … there's often different conflicts, inconsistencies among the different groups, and they're also very busy so it's hard to get them involved and also there's certain things they can't talk about which makes things complicated. (Participant #6 [research])

A tidal energy developer representative talked about how funding acquisition for tidal projects can be delayed by a lack of intergovernmental communication:

> The barriers I experience within the province are interdepartmental communication problems, where you have a lead on policy … that requires financial support from other agencies or buy in to work. Perhaps, sometimes between ministers or between bureaucrats, that case isn't made strong enough so when you show up at the door expecting something, they don't know what you're talking about or they don't actually have the support of it. (Participant #10 [industry])

These findings are consistent with Wiber et al. (2010) who found that "siloing" among government departments hindered communication. The issue of intra-organizational and intra-sectoral "siloing" was not unique to government, however. The research sector, particularly universities, were also identified as lacking cohesion and coordination. As one participant stated, universities "just don't connect … so there's a barrier and even

within one institution it tends to be a little bit siloed to the individual researcher" (Participant #11 [NGO]).

Tidal power is a diverse field comprised of many stakeholders in several sectors with sometimes competing interests. As a result, cohesion among the various organizations can be difficult to achieve. A participant representing an industry association articulated the difficulty of trying to coordinate and balance the needs of multifarious stakeholders:

> The challenge with that is that our members are pretty diverse, geographically and in terms of company size, so we have large companies and their membership … but then we have small businesses that have like two people working for them, so there are very different needs and so it's a matter of trying to balance those issues. (Participant #16 [NGO])

Bremer and Glavovic (2013) similarly found that sometimes competing interests and differing organizational cultures confounded inter-organizational communication among types of non-governmental entities, e.g., private sector companies, NGOs, and community groups. A related barrier to "lack of cohesion/coordination" is "lack of a shared vision/common understanding," i.e., a cognitive disconnect about the direction of the industry and what tidal power stakeholders hope to achieve. Robins, Bates, and Pattison (2011) posit that a strong "macroculture," i.e., a shared vision/common understanding, among network actors is an essential ingredient to a well-functioning network. Interview sections assigned this theme focused on the need for a unified message to present to outside parties, e.g., the general public or the federal government; and to generally try to create a situation in which tidal power stakeholders are "on the same page" or "working from the same set of premises." Speaking to the current state of sectoral cohesion/unified vision, one participant stated that although the

"leaders" of the various sectors involved in tidal power do meet, a lot of mistrust and miscommunication between them remains:

> Leaders from the different spheres tend to get together, they do talk, they continue to have their own agenda and they don't work well together. There's a whole lot of mistrust, there's a lot of miscommunication and I am finding that a major challenge because I am attempting to try to get between all these people to make sure that we are all working … from the same set of information, the same premises. So there is good leadership in all of them, but the leaders do not work well together. (Participant #18 [government])

6.3.2.4 Limited Resources

The "limited resources" theme includes a lack of human resource capacity and a shortage of financial resources. Participants noted that many organizations, particularly NGOs, government organizations, and First Nations, were over-extended. For example, a participant from the research sector suggested that "[First Nations groups] are very, very busy. I think one of the key barriers is that they're very busy, they have very few staff and they're dealing with a lot of stuff" (Participant #6 [research]). This finding is consistent with Ernoul and Wardell-Johnson (2013) who found that the absence of funding opportunities for NGOs limited their capacity to promote cross-sector collaboration. Budget cuts and departmental restructuring were identified as a leading cause of reduced human resource capacity in government. For example, in describing their organization's interaction with various government departments, an industry participant said:

> [government] doesn't have a lot of capacity ... I think that Transport Canada went from nine people to two people, and [Fisheries and Oceans Canada (DFO)] went

> from like three guys and then the main one who has done tidal energy has left to go over to [another department], so … just those two dealing with the rest of it. So the one guy we deal with … has everything, he has tidal, oil and gas, aquaculture, the Maritime Link, so he's just overwhelmed with projects, so that's a big thing. (Participant #2 [industry])

Limited capacity was also related to problems with knowledge transfer, e.g., an individual leaves a position and either 1) does not pass along knowledge to a replacement, or, 2) no one is hired to take on the vacant position. In concert with findings from Sarkki et al. (2014), limited human resources also led to a trade-off situation where other matters, e.g., policy development, were prioritized over inter-organizational communication/collaboration. For financial resources, participants noted how the absence of federal and provincial monetary support for tidal power, and tidal power research, acted as a barrier to alleviating some of the problems associated with limited human resource capacity. This perspective mirrored findings from Appiott et al. (2014) who found that restricted funding represented a significant obstacle to MRE development in the UK. Consequently, the tidal sector was characterized as being comprised of "a multitude of small… financially challenged entities," that are "starved" and "just trying to get by" (Participant #19 [NGO]).

6.4 Key Figures in the Network

At the core of any industry-based field is industry itself. The tidal energy industry would not exist without project developers, technology developers, investors, maintenance facilities, etc. Yet, tidal power is still a nascent, pre-commercial industry as shown in Section 6.2.2. At this early stage, organizations that provide an industry support role are essential for the continued growth of the industry. Information being shared among tidal

stakeholders is primarily strategic in nature and intended to increase awareness about tidal power, for both the public and government funding bodies; garner social license for the tidal industry; and build the supply chain network through conferences, industry workshops, and international trade missions. Many of these activities are enacted by "bridger" organizations with a mandate beyond developing a commercial product. Bridgers serve to expand the tidal power network by bringing in new ideas, perspectives, and knowledge, as well as connecting organizations with complementary mandates and competencies. The results from the SNA revealed which sectors seem to be fulfilling a bridging role in the network.

Centrality measures, e.g., degree and betweenness centrality, are used in SNA to identify the key actors in a network (Long et al., 2013). While degree centrality measures the number of ties an actor possesses, thereby indicating which actors are most "central" within a network, betweenness centrality scores actors based on their tendency to connect with otherwise disconnected actors, i.e., identifies bridgers (Hanneman & Riddle, 2005). Tabulation of betweenness centrality scores in the communication network found that organizations from the NGO, research, government, and First Nations sectors were fulfilling bridging roles. Vance-Borland and Holley (2011) also found that NGOs had the highest "bridging" scores in their network. In the network map, bridger organizations were often positioned near the edge of the "core," closer to the "periphery" (Figure 32). This position illustrates the intermediary role played by bridgers. Cluster analysis also highlighted bridging activities in the network. With the exception of "Cluster 7," each of the seven detected community clusters contained "champion" organizations, i.e., bridgers, that brought otherwise unconnected organizations into the network (Figure 33). Additionally, Clusters 1 & 4 and 3 & 5 showed how different bridgers seem to connect different types of sectors to the network, i.e., Clusters 1 & 4

both specialize in bringing industry organizations into the network, while Clusters 3 & 5 bring in more research-sector organizations. This finding helps to explain how such a relatively small network can support multiple NGOs: each has a particular speciality. For example, NGO_2, i.e., the “champion” of Cluster 3, coordinates and funds research projects, thereby connecting to organizations from the research and industry sections (Figure 34). Similarly, NGO_4, i.e., the “champion” of Cluster 4, is an MRE industry association and therefore primarily serves to connect organizations from the industry sector into the network (Figure 35).

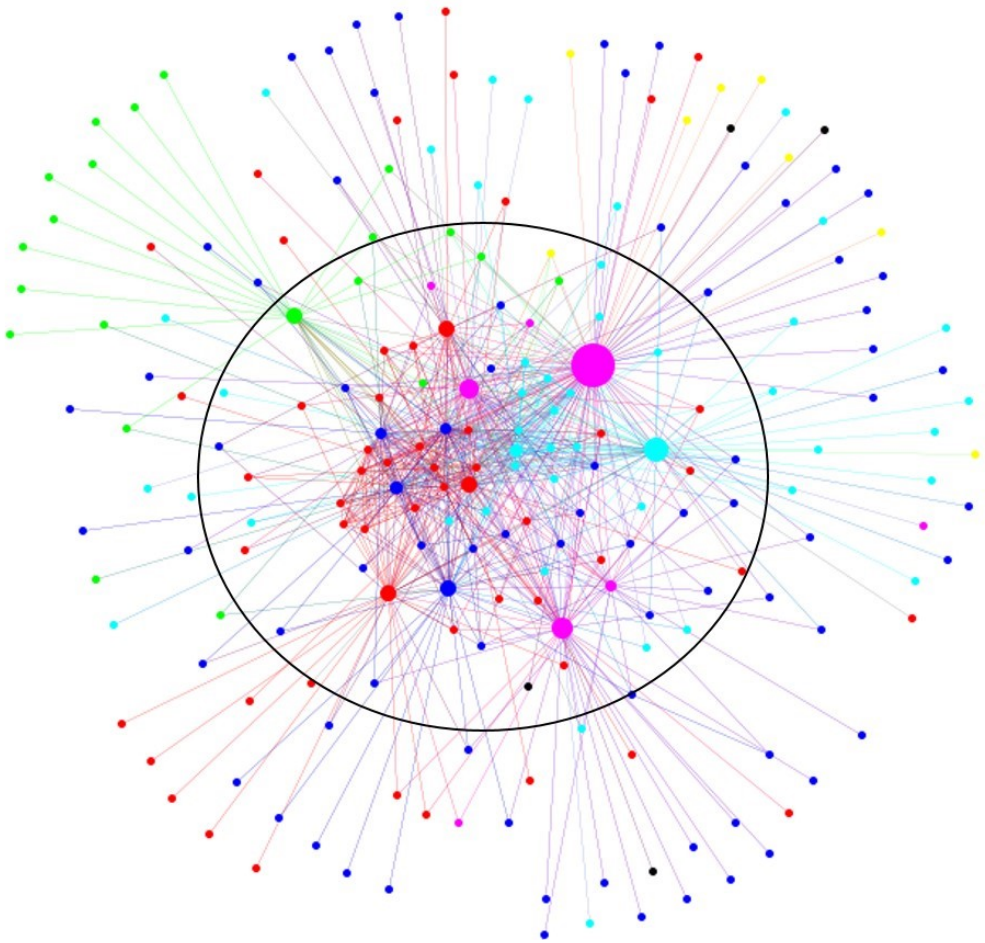


Figure 32. Tidal power communication network for the Bay of Fundy region of Nova Scotia with nodes sized by betweenness centrality. The black circle distinguishes the “core” of the network from the “periphery.” Red=government, Turquoise=research,

Blue=industry, Purple=NGOs, Green=First Nations, Yellow=fishing and aquaculture, Black=tourism. Note: Figure 32 is a duplicate of Figure 5.

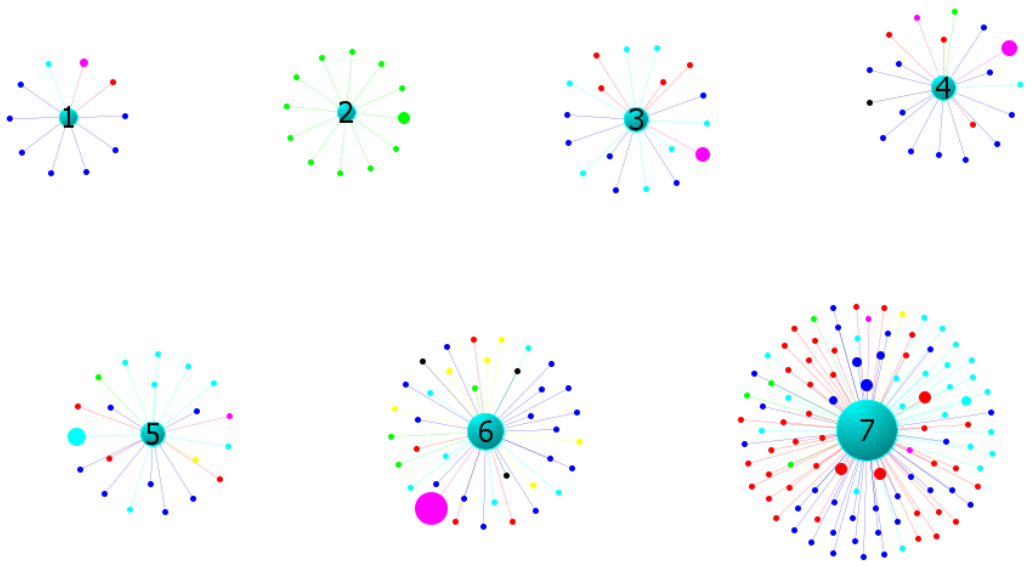


Figure 33. The tidal power communication network divided into seven clusters using the Girvan-Neman algorithm. Nodes are sized by betweenness centrality and coloured by sector. Red=government, Turquoise=research, Blue=industry, Purple=NGOs, Green=First Nations, Yellow=fishing and aquaculture, Black=tourism. Note: Figure 33 is a duplicate of Figure 7.

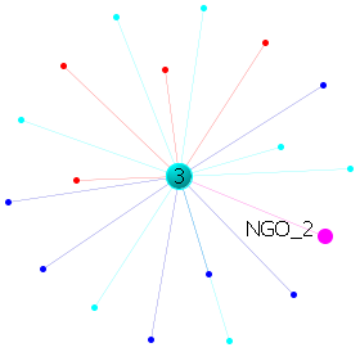


Figure 34. "Cluster 3" generated using the Girvan-Newman algorithm.

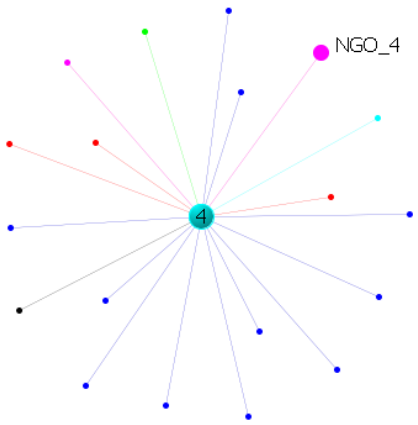


Figure 35. “Cluster 4” generated using the Girvan-Newman algorithm.

6.4.1 Types of Bridgers: Coordinators, Connectors, & Information Meditators

In SNA, bridgers are network actors that facilitate the flow of information between at least two otherwise unconnected groups or actors (Hanneman & Riddle, 2005; Long et al., 2013). The literature is divided about how bridgers function within a network (Collins-Dogrul, 2012). One theory, *tertius gaudens*, states that bridgers maintain an intermediary position between disconnected groups in order to maintain control over access to, and transmission of, information (Burt, 1992). According to *tertius gaudens*, a bridger may either facilitate information sharing among groups, or, conversely, act as a “gate-keeper” or “bottleneck” for information (Easley & Kleinberg, 2010). The second prevailing theory, *tertius iungens*, asserts that bridgers act more as network facilitators: actively forging new connections among unconnected actors, thereby closing structural holes rather than exploiting them (Collins-Dogrul, 2012; Obstfeld, 2005; Snow, Miles, & Coleman, 2000). Both theories have developed a set of bridger “roles” to explicate the different types of bridger activities found in networks (see Chapter 2, Section 2.6.1). This research builds upon literature from both camps, finding that bridging activities in the tidal power network are both intermediary and connection-based.

Participant interviews provided further insight into which sectors act as bridgers in the network, as well as the qualities that comprise the different “types” of bridging found in the network. Bridging is a multifaceted activity that manifests in different ways. The data shows that bridging can be subdivided into three similar, but ultimately distinct roles: “coordinator,” “connector,” and “information mediator.”

Coordinators connect organizations and then remain in that intermediary position. For example, OERA fulfills a coordination role by funding joint research projects that require organizations to maintain contact with each other through periodic reports. Connections fostered by coordinators may result in operational, project-based collaboration, but can also be strategic, i.e., relationship building. Speaking to its role as a coordinator, an industry participant described the NGO, Marine Renewables Canada (MRC), as the “lubricant that keeps the collaborative work between the berth holders going” (Participant #14 [industry]). A participant from the federal government discussed the coordination role played by the Nova Scotia Department of Energy as follows:

> The Nova Scotia [Department of] Energy has really taken on a number of steps to try to make sure this industry grows in the province and one of these steps is to open lines of communication, to share information, not only internally to provincial departments, but also across federal departments, [and to] look at collaborative relationships in terms of developing these statements of best practice, developing memorandums of understanding. They've also established working groups, groups that have included individual fisher stakeholders that are potentially affected, [and] First Nations that are potentially affected. (Participant #5 [government])

As these statements suggest, committees, sub-committees, and working groups are also associated with the coordination role. Organizations hosting multi-sector committees, such as FORCE and the Fundy Energy Research Network (FERN), bring organizations from across sectors together on an ongoing basis to share information and collaborate on future projects. Organizations from the government and NGO sectors were identified as coordinators most often.

"Connectors" are closely related to "coordinators" since both involve facilitating direct communication and/or collaboration between otherwise separate organizations. Where they differ is that once a connector brings the parties together, it does not remain in that facilitating role, whereas a coordinator does. A connector organization acts like a person who ties two threads together and walks away once the knot is completed. The connector role is closely related to Snow et al.'s (2000) "architect." For example, an NGO participant described how a government department helped connect the NGO with government departments:

> [The Nova Scotia Department of Energy] helps us, they know that we're such a small entity that they help us with some of the things that we're tasked with, they … provide some support. For example they will set up meetings with other government bodies, to help facilitate us, for example with the Department of Natural Resources, they'll help facilitate the meetings and pull people together. (Participant #8 [NGO])

A participant representing a municipal government described how the Atlantic Canada Opportunities Agency (ACOA) helped to connect it with an NGO:

> [we] had ideas about … a feasibility study for the Parrsboro area to have it tidal power ready. Like the infrastructure and whatnot … and we were starting to think

> about how we could get this going, and then we were informed by ACOA that maybe MRC was already doing something similar, so then we got introduced and that's how MRC got introduced to the tidal readiness committee and then everybody got sort of formed together that way. (Participant #3 [government])

Government organizations acting as “connectors” also facilitated connections among organizations in the industry sector through one-off, international trade missions.

In contrast to coordinators and connectors, information mediators do not necessarily bring organizations together, rather, they act as an information conduit, passing information among organizations. Information mediators can also be thought of as “gatekeepers” who can selectively choose whether to pass information on (Burt, 1992; Easley & Kleinberg, 2010). For example, a participant from an organization that acts as a network for tidal power research described its role as an information mediator:

> I mean it’s basically what we do, we feed [information] out and our members use it however they use it. We’re almost like… if you take this diagram [the participatory map] … you have arrows in and arrows out, … we consider ourselves … a hub for all of these other organizations. So they provide information in and we send it back out to everybody. (Participant #6 [research])

The interview data also showed an interplay between mechanisms of communication and bridging roles (see Chapter 5, Section 5.5.1). Committees, sub-committees, and working groups seemed to facilitate coordinator and information mediator roles, while conferences, workshops, symposia, and webinars were more related to connector roles. Committees, subcommittees, and working groups bring organizations together on an ongoing basis, facilitating coordination among sectors. Organizations that host committees then push the information shared in meetings out into the wider network,

often in the form of meeting minutes, thereby acting as an information mediator. Conversely, the one-off nature of conferences, workshops, and symposia helps to foster initial connections that may not necessarily continue in the long term, much like the role played by connectors.

6.4.2 Sectors that Bridge

The government, NGO, and, to a lesser extent, research sectors were identified by participants most consistently as fulfilling bridging roles in the network. These findings are consistent with the high betweenness centrality scores for organizations in these sectors. However, despite being mentioned the most as bridgers in the interview data, government organizations were not among the top five organizations with the highest betweenness centrality scores, nor were they shown to be facilitating novel network connections in the cluster analysis. Several possible reasons for this disparity exist. First, government was co-coded the most with “connector.” Connectors are difficult to identify using SNA measures because of the transient nature of the role. That is, once a connection has been fostered among the target organizations, the connector moves onto another project. Since SNA generally only captures a “snapshot” of a network within a particular window of time, it is more likely that organizations with fleeting connections will be missed than those with long-term relationships, e.g., such as those found with coordinators and information mediators. The second is that, unlike many NGOs, the government sector does not have “bridging” as its primary mandate. Many government departments and agencies are primarily responsible for policy development and regulation. Fostering communication and growing the industry is often a secondary activity, and one that is further complicated by the generally low human resource capacity and high rates of turnover found in government (see Section 6.3.2.4). Sarkki et al. (2014) described this situation as a trade-off between time spent interfacing, i.e.,

engaging in inter-organizational communication, and time spent fulfilling one's main role, e.g., industry regulation. Finally, the bridging role fulfilled by government is somewhat different from the other sectors. While government organizations connect organizations across sectoral boundaries by facilitating new relationships and projects, they do not appear to be introducing new organizations into the network as often as the NGO and research sectors, as shown by the cluster analysis. That is, government organizations appear to foster connections among organizations that are already engaged in tidal power, rather than bringing new, e.g., otherwise unconnected, organizations into the network. Understanding how bridging roles can differ among the sectors also sheds light on why certain sectors are more suited to fulfilling bridging roles than others.

Despite being central in the network, i.e., possessing high degree centrality scores, organizations from the industry sector do not appear to be acting as bridgers in the tidal power network, with the exception of Industry_5, which was among the organizations with the ten highest betweenness centrality scores. A participant from industry talked about efforts to cultivate connectivity among municipal entities through the creation of the Tidal Energy Communities Alliance (TECA) collective:

> we organized the Nova Scotia tidal power summit at FORCE last year which was the first time that all of [the municipalities] sat down in one place and … they agreed to … commit towards trying to find a common document. So we've been drafting something that they would all find agreeable … none of them have committed any money towards it, but they all agree that it's necessary. It's just now finding the wording of an agreement document that they can all settle on. And it's kind of on the back burner right now, but it's seen as a positive thing to have ... and so they all stand to benefit from it, and we stand to benefit from showing leadership. (Participant #14 [industry])

Yet, during interviews, participants representing municipal governments seemed hesitant about committing to industry-driven collectives:

> Well we haven't participated in them … but they have been proposed by private industry and private people, it's a [memorandum of understanding]. So there would be a request for a tidal alliance kind of thing …their value has been questioned I guess, and the motives of it. (Participant #21 [government])

This concept of "motives" suggests why organizations in the industry sector were not often seen as bridgers. While the NGO, government, and research sectors are more concerned with the growth of the tidal energy sector as a whole, tidal developers naturally promote the interests of their companies within a competitive market. Tidal developers are, of course, not unconcerned with growing an industry, as was repeatedly noted during interviews with industry participants. An NGO participant summarized the contrast between industry and NGO motivations as follows:

> we would never advocate for an individual member or developer on their own … because our mandate is to support the industry as a whole whereas obviously each of the developers have their own business needs and so they would go out and look for funding and advocate for their project. (Participant #16 [NGO])

Similarly, another NGO participant stated: "we really try to emphasise that we are a third party here, we're not making any money off this, that's not our purpose; our purpose is to be here and to help" (Participant #8 [NGO]). A research participant also discussed the importance of neutrality as a driver for objectivity:

> we're academics and it's about objectivity and credibility ... we're not in the business of being commercial; we're in the business of informed decisions and

> about participating in ways that provide information-based advice that is objective … not taking a stance one way or the other. (Participant #1 [research])

A participant from the federal government reiterated the above comments, suggesting that as tidal power enters a more competitive phase, the need to ensure that information and opportunities are being presented evenly to all tidal developers is growing. These findings, which are supported in the literature, point to the perception of neutrality as a requisite quality for bridger organizations operating within a competitive, industry-driven environment (Fernandez & Gould, 1994; Friedman & Podolny, 1992).

6.5 Gaps in the Network

Cluster analysis revealed that some First Nations groups were isolated from the other sectors, i.e., were only connected to the network through another First Nations organization, pointing to a possible lack of engagement. In fact, Cluster 2, which is comprised entirely of First Nations, indicates that this sector may not be engaged by the other sectors (Figure 36). The interview data suggests that the gap may be partially caused by the processes surrounding First Nations engagement. The Assembly of NS Mi'kmaq Chiefs acts as a representative for the 13 Mi'kmaq bands of Nova Scotia and the KMKNO is an executive arm of that assembly responsible for overseeing the consultation process as laid out by the Terms of Reference for a Mi'kmaq-Nova Scotia-Canada Consultation Process (Office of Aboriginal Affairs, 2012). A participant representing the industry sector stated that "KMKNO is a somewhat lumbering process or deliberative process body, and so it can be very slow to work within [it]" (Participant #14 [industry]). When asked if communications with this organization were expected in the future, the participant replied, "I think we're still on the docket to see KMKNO at some point, but it is such a slow process, I don't even know where we are, if we are, in that process" (Participant #14 [industry]). A participant from a government agency

commented that when engaging First Nations, proponents and other stakeholders must follow a process that, “while important and ensures that the right information is shared in the right manner, can slow communications down” (Participant #18 [government]). Another participant from the research sector suggested that a lack of human resource capacity could also have an effect on communications with First Nations:

> The problem with the First Nations groups is that they have to be involved in every single thing and they are just meeting to death. They just go from meeting to meeting to meeting and they cannot make them all because they have to be consulted all the time. It's hard for them. (Participant #1 [research])

Additionally, a participant from First Nations involved in the consultation process suggested that organizations with individuals who are experienced in working with First Nations can help to bridge possible cultural gaps and act as an enabler to communication (see Section 6.3.1.4).

The fishing and aquaculture and tourism sectors were also less involved in the network than the other sectors. Although participants spoke very little about the tourism sector, a lack of engagement with the fishing and aquaculture sectors was discussed frequently (see Section 6.3.2.1). The results point to incompatible work schedules, i.e., fishers are governed by the seasons, weather, and the tides; proximity, i.e., fishers most often live in rural areas, whereas many tidal stakeholders operate in urban settings; and a closed disposition/unwillingness to communicate about tidal developments (see Section 6.3.1.4). Fishing and aquaculture represents a key industry for the Canadian Maritime provinces, ranking second in Gross Domestic Product (GDP) impact for the Nova Scotian oceans sector (Gardner Pinfold Consulting Economists Ltd., 2005), making a lack of engagement with this sector problematic. Fishers operating in the Bay of Fundy

have expressed concerns about the possible impact in-stream turbines could have on local fish populations (Beswick, 2015). Further, proposed marine renewable energy (MRE) legislation would designate certain areas as “safety zones,” effectively blocking any non-tidal power activities, including fishing and aquaculture activities, within those areas (Nova Scotia Department of Energy, 2015). In the UK, researchers have found that fishers’ acceptance of MRE activities was predicated on being made aware of future development sites and being included in the consultation process (Alexander et al., 2013; de Groot, Campbell, Ashley, & Rodwell, 2014). Without increased engagement, fisher opposition could create barriers for the growth of a potential tidal industry in the Bay of Fundy region of Nova Scotia.

In addition, in 2010, revenues from the tourism industry in Nova Scotia totaled over two billion dollars, which includes tourism in the Bay of Fundy (Tourism Industry Association of Nova Scotia, 2015). Without participant representation or interview data from participants representing other stakeholders, more information is needed to determine the effect that low stakeholder engagement with this sector could have on the tidal industry.

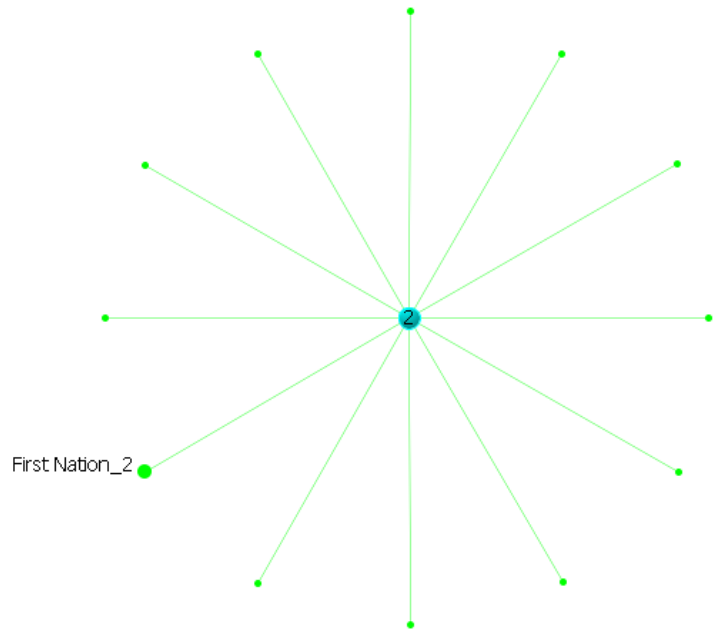


Figure 36. “Cluster 2” generated using the Girvan-Newman algorithm. Note: Figure 36 duplicates Figure 2.

6.6 Conclusions

Information sharing in tidal power networks is largely strategic and used to alleviate uncertainties in a new field and to acquire social license for tidal power developments. Multi-sectoral information exchange is occurring, but mostly among the government, industry, NGO, and research sectors. First Nations, fishing and aquaculture, and tourism sectors are not communicating information to the same extent. Information sharing across sectors is largely enabled by bridgers, i.e., organizations that purposefully facilitate network connections, and mechanisms that encourage multi-sector communication, e.g., committees and conferences. Strong relationships and positive organizational cultures toward information sharing, i.e., a willingness to share information, also encourage communication in the network. In addition to some sectors not being engaged, barriers are related to competition, sometimes fueled by a scarcity of

resources, and the absence of a shared vision among tidal power stakeholders, i.e., a lack of cohesion/coordination. In the next chapter, key findings and factors affecting information sharing are used to inform recommendations about how communication within the tidal power network could be enhanced.

CHAPTER 7. CONCLUSIONS

7.1 Introduction

The conclusions arising out of this research are outlined in three sections: 1) the key findings are summarized with regard to their effect on information sharing in the network; 2) several recommendations about how communication in the network could be enhanced are posited; and 3) concluding remarks discuss multi-sectoral engagement for tidal power in the absence of clear policy governing integrated ocean management (IOM), and how the empirical approach taken in this research allowed for a deeper understanding about how, why, and what kinds of information is being shared in the network.

7.2 Key Findings

7.2.1 Tidal Power Communication Network

The results from the Social Network Analysis (SNA) contribute to this field of study by presenting a network map that details inter-organizational communication in an emergent, renewable energy industry. The SNA reveals: 1) which organizations and sectors are engaged in or affected by tidal power activities in the Bay of Fundy region, 2) which organizations are the most central in the network and which are not well-connected, and 3) whether communication is occurring across sectors. The tidal power communication network is comprised of 219 organizations from seven sectors: fishing and aquaculture, First Nations, government, industry, NGO, research, and tourism. Industry (36%), government (24%), and research (21%) are the most represented, while First Nations (10%), NGOs (4%), fishing and aquaculture (4%), and tourism (2%) are the least. However, it is important to note that the number of organizations identified is not

indicative of their individual or collective importance in the network, nor does it necessarily mean that certain sectors are not engaged in communication.

At its core, the tidal power network is mainly comprised of government, industry, research, NGOs, and First Nations. This structure was evidenced by the “central” positioning of organizations from these sectors in the network, their high in-degree centrality scores, and the composition of the “main” network cluster, i.e., Cluster 7 (see Chapter 6, Figure 31). Research organizations located in the core of the network are clustered together (see Figure 30), suggesting that research organizations tend to communicate information with each other, whereas government organizations, primarily regulators and policy makers, are clustered with tidal proponents. The analysis of the interview data suggests that information shared by these latter groups is mainly regulatory in nature. The fishing and aquaculture and tourism sectors are not represented in the core, but are featured in the periphery, suggesting that organizations from these sectors are present in the network, but not well connected, e.g., they possess few ties. A multi-sectoral network core indicates that communication/information sharing is occurring among organizations across five out of the seven identified stakeholder sectors. This finding is corroborated by the results from the External-Internal (E-I) Index test (0.312) which found that communication in the tidal power network tends to be across, rather than within, sectors.

This research also reveals the types of information sharing occurring in the nascent tidal power industry. Communication in the tidal power network is primarily strategic, e.g., planning future projects/collaborations, educating stakeholders about tidal power, and sharing experience or advice about tidal power activities, rather than operational, e.g., project-based, acquiring and administering regulatory approval, and applying for and dispensing funding. Information is shared strategically to alleviate uncertainty and fill

knowledge gaps in an emerging field that has many unknowns. Strategic communication is also used as a means to garner social license through stakeholder engagement and public education/awareness building about tidal power activities. Communication in the network is primarily technologically mediated, e.g., email or telephone; however, participants highlighted the importance of the bridging role fulfilled by face-to-face encounters in committees, sub-committees, and working groups, as well as conferences and workshops, in promoting in cross-sector communication. Regulatory committees, e.g., the One Window Committee, were also shown to be effective tools for breaking down departmental silos in government, ameliorating both internal and external channels of communication.

7.2.2 Mechanisms of Communication

Committees, sub-committees, and working groups were highlighted as important mechanisms of, and enablers to, inter-organizational communication. Tidal power committees can be divided into three categories: community outreach committees, scientific research committees, and regulatory committees. With the exception of the "One Window Committee," committee membership is multi-sectoral. Some committees, e.g., the Environmental Monitoring Advisory Committee (EMAC) and the Community Liaison Committee (CLC), were borne out of recommendations made in the 2008 Strategic Environmental Assessment (SEA) and represent one of the ways in which an integrated management policy is expressed in tidal power development (Offshore Energy Research Association, 2013a). Regulatory committees, e.g., the One Window Committee, expedite the regulatory and permitting process by proving a shared venue for proponents and government to discuss tidal power projects without the need for several separate meetings. Community outreach and scientific research committees create a semi-formalized venue for connecting representatives from

sectors/organizations that may otherwise not have a reason to meet. Ideally, committees offer an opportunity for broader, more strategic conversations to take place, which contributes to the development of a shared vision for the tidal power industry. Yet, participants also highlighted several areas where the effectiveness of committees could be improved, including increased fisher representation and engagement with the general public, greater coordination, fewer restrictions on information sharing, and reduced uncertainty towards the effectiveness of information sharing, particularly in regard to information that is being distributed across the network (see Sections 7.3.1 & 7.3.3.1).

7.2.3 Bridging Role of Key Organizations in the Network

In the context of this study, “key organizations” are those that serve to connect otherwise unconnected organizations in the network. These key organizations are referred to as “bridgers.” Bridgers in the tidal power communication network facilitate connections among organizations within a network, bring new organizations into a network, make strategic connections to help fill gaps in knowledge or expertise, connect low-capacity or small organizations with larger organizations, share current information to keep stakeholders up-to-date, and share consistent information to ensure that stakeholders have access to the same information. These findings are aligned with Obstfeld’s (2005) definition of a bridger as a network facilitator. There is some evidence that bridgers remain in an intermediary position between organizations; however, the stated goals of this practice, i.e., sharing information as a means of strengthening the industry as a whole, seem to be more closely akin to what Collins-Dogrul (2012) describes as “a role that changes as relationships change, with an emphasis on fostering connections among actors with varying degrees of contact over time” (p. 993). That is, bridgers in the tidal network are more system-oriented, seeking to improve the network as a whole rather than to exploit intermediary power positions for personal gain.

This research uses concepts taken from both *tertius gaudens* and *tertius iungens* in characterizing the three similar, but ultimately distinct types of activities undertaken by bridger organizations in the network: “coordinator,” “connector,” and “information mediator.” Coordinators bring organizations together in an ongoing basis and then remain in the intermediary role; connectors facilitate a connection among organizations, but do not remain in that role; and information mediators act as a hub, receiving and then sending information out into the network. Although it could be assumed that coordinators are the most influential, i.e., coordinators exchange information, facilitate connections, and remain to help coordinate projects on a long term basis, each of the bridger roles has its own set of advantages and disadvantages. For example, connectors generally facilitate an initial connection, after which point communications among the targeted organizations may cease. Yet, forging connections is a low-cost action when compared to remaining in an intermediary, coordinating position, allowing connectors to potentially affect many more organizations than coordinators. Information mediators that push information out into a network, e.g., via a listserv or email, are also engaging in low-cost information transactions capable of reaching a wide audience. However, like the connector, the impact of the mediator is uncertain and difficult to discern. Conversely, although coordinators may foster stronger, more certain relationships, novel connections are high-cost and require continual resources to maintain. Therefore, it is not a question about which type of bridger is superior, but rather learning to understand how each role works, selecting the best role in each instance of bridging, and ensuring that it is performed effectively.

Bridger organizations were identified through: 1) an examination of betweenness centrality scores and the network positioning of organizations possessing a high betweenness centrality, 2) a cluster analysis technique that subdivided the network into

a series of clusters based on betweenness centrality, and 3) the application of thematic coding designed to capture relationships and the directionality of information flow in the interview data. Taken together, the findings suggest that organizations from the government, NGO, and to a lesser extent, research, sectors fulfilled bridging roles more often than other sectors in the network. Government organizations acted as connectors the most and tended to connect organizations already in the network, rather than bringing in outside organizations. Although the NGO sector is small with only eight representative organizations in the network, NGOs were essential bridgers that introduced many otherwise unconnected organizations into the network. This role is evidenced by the high betweenness centrality scores – NGOs held three out of the five top scores – and the prevalence of NGOs as “champions” of the community clusters, i.e., four out of the seven clusters were championed by an NGO organization. Research organizations also played a bridging role, mainly through hosting tidal power-specific committees.

Despite holding central network positions, i.e., high in-degree centrality scores, industry organizations, particularly tidal power developers, were not found to be acting as bridgers in the network. The interview data suggest that commercial interests may act as a barrier to bridging. Companies operating within a competitive market are expected to act with a certain degree of self-interest. While bridgers may work strategically in terms of which sectors they focus on bringing together (see below), the activity is generally holistic in that: 1) particular organizations within a sector are not favoured over others, i.e., all organizations are provided with the same information/opportunities and are given an equal chance to participate; and 2) bridging is performed with the primary intent of strengthening the tidal sector as a whole, rather than promoting the interests of a single organization or company. While participants from industry discussed the virtues of using

communication to nurture the emergent tidal industry, attempts at bringing organizations together, e.g., through collective agreements, were met with skepticism (see Chapter 6, Section 6.4.2). Participants representing bridger organizations in the government, NGO, and research sectors all discussed the importance of being perceived as credible and objective when undertaking bridging activities. Thus, neutrality appears to be a requisite quality for bridger organizations operating within a competitive, industry-driven environment.

In addition to the variety of bridging "types," bridger organizations often work predominantly within a particular sector. With the exception of NGO_1, which connected a diverse array of organizations across sectors (see Chapter 4, Section 4.4.3), bridgers tended to specialize. That is, while one NGO acted as a strong bridge to organizations within the industry sector, another had stronger connections with research bodies. Therefore, robust communication channels in multi-sector networks may require multiple organizations fulfilling specialized bridging functions. While this research has expanded the definition of a "bridger" into three separate roles, identifying which sectors are best suited to bridge, and by indicating the importance of sector-specialization in bridgers, additional research is needed to determine the impact of bridgers, e.g., the impact of each type, as well as the total effect rendered by bridgers on a network.

7.2.4 Factors Affecting Information Sharing

During the interviews, participants were asked to identify possible enablers and barriers affecting information sharing with identified organizations. The responses were coded by theme and the "main" enablers and barriers were identified by comparing the frequency with which a theme was referenced with the percentage of participants who mentioned the theme at least once during interviews. Analysis of this data revealed that many of the "enablers" and "barriers" to information sharing were generally neutral "factors" that had

a tendency towards either positive or negative effects on network communication, depending on how they were perceived by participants. In addition, enablers and barriers were often coded in tandem with other factors and mechanisms, e.g., committees, sub-committees, and working groups were co-coded alongside certain bridger types (also see Chapter 6, Section 6.3). The main findings are presented in Table 18. While many of the findings corresponded to factors identified in the literature, information sharing settings, e.g., networks, often possess unique challenges and opportunities. Therefore, gaining a basic understanding of the types of enablers and barriers operating within the tidal power network is an essential first step towards more focused research. For example, future research could measure the impact that the factors have on a network and also explore the interrelatedness of the factors in greater depth. The implications of the factors affecting information sharing are used to inform some of the recommendations made in the following section.

Table 18. Main factors affecting information sharing.

Factors Affecting Information Sharing	
Enablers	**Description**
Strong Relationships	Personal and frequent interaction, e.g., a “close” relationship.
Bridgers	Organizations connecting otherwise separate organizations and sectors acting as enablers.
Committees/sub-committees/working groups	Communication occurring through committees, sub-committees, and working groups acting as enablers.
Willingness to share information/valuing communication	An organizational culture with an open disposition, a propensity for information sharing, and a valuing of inter-organizational and cross-sector communication and collaboration.
Barriers	**Description**
Lack of Engagement	Either one or both parties not reaching out, e.g., organization A does not respond to organization B’s communication attempts.
Competition	Competition includes, e.g., issues over financial resources or positioning within the Bay of Fundy.
Lack of Cohesion/ Coordination	Within a sector, within organizations, between government departments.
Limited Resources	Both in financial and human resource capacity.

7.3 Recommendations

This section contains several recommendations designed to improve communications within the tidal power network based on key findings.

7.3.1 Committees, Sub-committees, and Working Groups

Committees, sub-committees, and working groups were highlighted as important mechanisms of, and enablers to, inter-organizational communication (see Section 7.2.2). Recommendations:

1) **Improve engagement with the general public on the Community Liaison Committee (CLC).** Increased public engagement could be achieved by identifying and connecting members of the community most interested in tidal power development, i.e., the “interested public” (Soomai, MacDonald, & Wells,

2013). The interested public may be identified through public engagement forums, e.g., town hall-style meetings, and also by observing who is most active/vocal on social media, e.g., Twitter and Facebook. Having active citizenry on the CLC will make the committee more effective, as well as increase the flow of information out into the community.

2) **Make better use of information broadcasting mechanisms.** While organizations in the tidal power network are making some use of social media, e.g., for general project updates/announcements, social media output could be increased. For example, the CLC could create a Twitter account that would "live tweet" meetings to followers in the community. Research-based committee hosts, e.g., NGOs and research organizations, need to ensure that information exchanged/created during meetings is shared with the wider network. Online repositories that are actively maintained and promoted could serve this purpose. Research being conducted by committee members should also be advertised. A periodic newsletter sent to the network would also help draw attention to work being done by committees and committee members. Some research networks, e.g., The Fundy Energy Research Network (FERN), are already doing this.
3) **Increase coordination within committees.** While the One Window Committee was lauded by both the government and industry sectors as reducing the friction sometimes associated with communication with, and within, the government sector, departmental silos were still identified as a barrier to communication. Increased communication among member organizations may be needed to overcome departmental silos. Similarly, participants spoke positively about the ability of committees to bring otherwise disconnected stakeholders together around a shared table. However, self-interest and a general lack of coordination were identified as barriers to effective committee functioning. Increased

coordination, possibly by host organizations, in the form of clear goals, e.g., yearly/quarterly aims, and tangible outputs, could help keep track of the progress made by committees and shape future research.

7.3.2 Bridgers

Bridger organizations play a varied and important role in the network. However, as emphasized by the prevalence of the "limited resources" barrier, bridger organizations are often small, i.e., are lacking in human resource capacity, and are financially challenged (see Chapter 6, Section 6.3.2.4). In addition, the impact of bridging activities can be difficult to measure since the effect, e.g., monetary, of facilitating connections/networking is not always obvious. The intangibility of bridging can cause such activities to be undervalued, or be seen as unnecessary.

Recommendations:

1) **Increase support for bridgers.** Many bridger organizations, i.e., NGOs and research groups, are non-profit entities that rely on external support, i.e., funding. Ernoul and Wardell-Johnson (2013) found that the absence of funding opportunities for NGOs severely limited their capacity to facilitate cross-sector collaboration. Especially during the early stages of the tidal power industry, the work of bridging organizations is essential to the continued growth of the industry. Increased support, either financial or in-kind contributions, would help to ensure that such work can continue in the future. Additionally, it is important for organizations, particularly in the government sector, to value bridging activities undertaken by employees. Time and, consequently, resources must be allocated specifically to bridging/networking activities, e.g., attending conferences or committee meetings.

2) **Find a way to translate the value of bridging activities into measureable terms.** Since the effects of bridging are largely intangible, efforts need to be undertaken to ensure the value of bridging is recognized. Expressing the value of bridgers in conceptually simple terms, e.g., dollar values, could help to increase awareness of the importance of this role.

7.3.3 Stakeholder Gaps

7.3.3.1 Fishing and Aquaculture

The fishing and aquaculture sector was described by participants as being sometimes unwilling to communicate and share information due to issues of trust, as well as a lack of support for tidal power developments. Fishers operating in the Bay of Fundy expressed concerns about the possible impact of in-stream turbines on fish populations (Beswick, 2015), as well as the placement of "safety zones" that would prohibit fishing activities in certain areas (Nova Scotia Department of Energy, 2015). Other challenges to engagement with the fishing and aquaculture sector are related to scheduling difficulties, differing organizational cultures, and proximity to meeting venues. Researchers in the UK found that fishers' acceptance of marine renewable energy (MRE) activities was predicated on being made aware of future development sites and being included in the consultation process (Alexander, Wilding, & Jacomina Heymans, 2013; de Groot, Campbell, Ashley, & Rodwell, 2014).

Recommendations:

1) **Pursue timely, continued, and targeted consultation.** Yates and Horvath (2013) posited that to be effective, stakeholder engagement must start early and continue periodically throughout a project's lifecycle. While some engagement with fisher groups has occurred for tidal power developments, more is needed. Additionally, engagement sessions should target concerns specific to fishers, i.e.,

impacts on marine species and placement of “safety zones.” A participant from government described a targeted engagement strategy employed by one tidal power developer:

> [Fundy Tidal Inc.] held at least one session and invited fishermen and as I understand they had a map of the area and had the industry members [i.e., fishers’ representatives], with markers, mark off the sections there where either they set traps or their transportation routes to access those traps. So by doing that, it left these patches where there was little fishing and so I think Fundy Tidal's intention was to use those [maps] to site the devices in those [unused] areas if there was tidal power potential, if those two things lined up. (Participant #7 [government])

Similar engagement strategies for other areas in the Bay of Fundy, if performed at an early stage, could help to allay concerns over possible impacts to fishers’ livelihoods and gain sector support for tidal projects.

2) **Plan engagement sessions around fishers’ schedules.** The fishing and aquaculture sector is governed by external factors such as the seasons, the tides, and the weather. Additionally, fishing activities tend to operate in rural areas, whereas other stakeholders, e.g., NGOs and industry, are more urban-based. Therefore, careful consideration must be taken to ensure that engagement sessions accommodate the needs of this sector. An NGO participant described the strategy undertaken by their organization:

> we have just steadily built a contact list of every fisher we've ever connected with at any event ever and we maintain that list and when we have a [fisher’s liaison] meeting we will call everybody and email everybody and say “hey, we are having a meeting can you come, can you make it, [and] what is the best time?” (Participant #9 [NGO])

Other mechanisms, such as a fisher's liaison committee, would also serve to increase engagement with this sector if the aforementioned challenges to coordination could be surmounted.

7.3.3.2 First Nations

Although several First Nations organizations were present in the network, communication with this sector tended to be less integrated than with other sectors. That is, while many participant organizations were found to be communicating with First Nations, much of the communication occurred with a single group, i.e., the Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO). The KMKNO serves as the executive action arm of the Assembly of NS Mi'kmaq Chiefs and is responsible for overseeing the formal First Nations consultation process as dictated by the Terms of Reference for a Mi'kmaq-Nova Scotia-Canada Consultation Process (Terms of Reference) (Office of Aboriginal Affairs, 2012). This singular focus is evidenced in the cluster analysis which revealed that many First Nations are only connected to the network through the KMKNO, and were, therefore, not being engaged by any organizations from other sectors within the timeframe of this research (see Chapter 4, Section 4.4.3).

Recommendations:

1) **Undertake engagement beyond legally mandated processes.** The Terms of Reference delineates the legal First Nations consultation requirements for developers and government. Participants described the consultation process as important, but also as "lumbering" and "slow" due to the high volume of consultations. Alternate engagement strategies could serve to increase communication with First Nations. For example, one tidal power proponent talked about reaching out to other groups, in addition to the KMKNO, that are not as restricted in terms of process:

> other groups like Mi'kmaw Conservation Group, Mi'kmaq Employment Training Secretariat, and Mi'kmaw Native Friendship Centre … have really dynamic people and … [a] very nimble ability to move around and to choose projects and directions for themselves … That's where we've found the most responsive communications by far. (Participant #14 [industry])

Working with First Nations groups outside of formal consultation processes offers a more robust form of engagement and would help to increase the network connectivity for this sector.

2) **Employ trained personnel.** Participants, both from First Nations and the other sectors, also described how cultural differences can act as a barrier to communication. This barrier was echoed in the ICZM literature through the challenges inherent in reconciling separate knowledge systems (Bremer & Glavovic, 2013; Coffey & O'Toole, 2012). Although this problem is multifaceted, a participant from the First Nations sector talked about how government departments with an employee with specific training in Mi'kmaq consultation can improve communications. Essentially, individuals and organizations should make efforts to understand and appreciate cultural differences, and also be willing to work towards mutually agreeable solutions.

7.3.4 Industry Competition

Competition was the second most referenced barrier to communication in the tidal power network after a lack of engagement. Given that the tidal power industry is still in an early, pre-commercial stage, information, and particularly technical information related to turbine development and information pertaining to site characteristics, e.g., environmental data, is seen as a strategic asset. Such competition inhibits information

sharing in multi-sectoral settings, e.g., committees and conferences, and puts pressure on research groups to enter into a non-disclosure agreement (NDA) when working with industry. Participants from the research sector have described NDAs as antithetical to the tenets of academia, i.e., the open production of information for the betterment of society, the environment, etc. Although safeguarding proprietary information is a necessary aspect of doing business within a competitive and developing market, being overly guarded could be detrimental to the continued growth of the fledgling tidal industry.

Recommendations:

1) **Strike a balance between competition and cooperation.** Like many industries, tidal power is a competitive venture. However, until the sector becomes commercially viable, there is no tidal industry in which companies can compete. Nurturing industry growth to ensure that tidal power can reach maturity requires some degree of cooperation among proponents. Determining the balance between open information sharing and safeguarding proprietary information needs to be a priority for organizations operating within the industry sector.
2) **Pool resources.** In the same vein, companies should be looking for opportunities where resources can be combined for the benefit of the sector as a whole. Funding and subsidized rates for tidal energy are not limitless. Support for tidal power is contingent on the production of results within an acceptable timeframe. Cost-sharing on research and technology deployment can save money, freeing resources to be allocated elsewhere, and also help to move the industry towards self-sufficiency, i.e., commercialization, at a faster rate.

7.4 Limitations and Recommendations for Future Research

The in-stream tidal power industry is a developing field characterized by many unknowns. Although some research on the environmental, socio-economic, and political ramifications of tidal power implementation in the Bay of Fundy region exist (see Colton & Isaacman, 2013; Howell & Drake, 2012; MacDougall & Colton, 2013; Moore et al., 2009), little secondary, or contextual, data are available to researchers examining the industry from a socio-economic lens (Kerr et al., 2014). Further, the industry is in flux and undergoing rapid changes as proponents march towards the initial deployment of test turbines. Thus, the aim of this research was to act as a groundwork study about inter-organizational communication in an evolving environment.

To accomplish this objective, a mixed-methods approach involving network analysis (via participatory mapping) supported by qualitative interview data was employed. This mix-methods or comparative analysis facilitated consideration of the research questions from multiple angles. Network data made it possible to examine communication patterns in aggregate, allowing for conclusions to be drawn about key network actors and their role in the network; the composition of the tidal power network, i.e., which organizations are communicating about tidal power and with whom; as well as the degree to which multi-sectoral communication was occurring. Interviews produced rich qualitative data that made it possible to understand the types of information being shared, motivations for information sharing, mechanisms for informational exchange, use of the information shared in the tidal power network, and the factors that either enabled or inhibited communication. The comparative approach also led to findings that would not have been possible using only SNA or thematic coding of interview data. For example, the inability to view government entities identified in the interviews as bridgers in the network map (see Chapter 6, Section 6.4.2) helped develop the different bridging “types,” i.e.,

“connectors” are difficult to capture in network visualizations. Although qualitative interviews produce rich datasets, they are also time consuming and generate a high volume of data that must be processed and analyzed. Such limitations necessitated a small study population. Future research could build on the results of this study by using a network survey tool capable of reaching more organizations. This approach would enrich the network map and potentially capture more connections between organizations. Network surveys could also use variables such as frequency of communication to “weigh” connections, offering additional insights into which organizations are communicating information about tidal power frequently.

Despite repeated invitations and related efforts to obtain participants, representation from the fishing and aquaculture or tourism sectors was not achieved. While findings from this study suggest that involvement of these sectors is limited, i.e., participants did not identify many organizations during the participatory mapping sessions, organizations from the fishing and aquaculture and tourism sectors are stakeholders whose viewpoints would strengthen understanding of inter-organizational communication in the network, as well as possibly provide more insight into their apparent lack of engagement. In addition, four out of the five tidal power proponents operating in the Bay of Fundy region participated in this research, as well as a participant representing the interests of local businesses. Yet, representatives from the other sub-sections of industry (see Appendix H) would serve to strengthen network identification. Industry representation in the network was further complicated by the nascent state of the tidal sector. The participants were reticent about revealing relationships with companies where contractual relationships were still under negotiation, e.g., companies involved with the developing supply chain. Understanding the supply chain will become increasingly important as the

tidal industry moves from development into maturity. The field would benefit from increased research in this area.

Finally, network maps produced by this research generated a “snapshot” of an emergent, natural resource-based industry. Future research could track the evolution of the network over time to determine if, for example, organizations that are central early on, e.g., NGOs acting as bridgers, remain important. In addition to longitudinal network data, future studies might employ a more granular approach to study communication within the network. This research utilized an organizational perspective that was helpful in achieving a general understanding about tidal power communication. However, communication actually occurs between individuals and some individuals operate within multiple organizations. Individuals also move between organizations and share information in a personal, or non-official, capacity, i.e., within informal networks (Collet & Hedstrom, 2013). Research examining communication between individuals might strengthen understanding about the extent and effectiveness of communication occurring in the network, as well as how individuals operate in a bridging capacity. Additionally, while this research discovered much about how bridgers operated in the network, future research is needed to gain a deeper understanding about this complex role. For example, questions remain about what motivates bridger organizations and what factors act as either enablers or barriers to bridgers.

7.5 Concluding Remarks

Developments in highly active coastal environments involve multiple stakeholder groups across sectors. The current literature suggests that the development of strong communication and information-sharing networks is essential to the success of such endeavors (Bastien-Daigle, Vanderlinden, & Chouinard, 2008; Bremer & Glavovic, 2013; Mitchell, Clark, & Cash, 2006; Sessa & Ricci, 2010; Wilson & Wiber, 2009). In Canada,

the IOM framework was conceived to ensure that the interests of all stakeholders are represented (*Oceans Act, S.C. 1996, c. 31)*. Currently, no policy specifically governing integrated management principles has been developed for MRE developments, leading to questions about how, or even if, stakeholders are being engaged.

In addition, few studies have examined information sharing in the context of complex, multi-sector networks. In single sector networks, e.g., an industry supply chain network, the reasons for inter-organizational information sharing are often self-evident, e.g., information sharing pertains to transactions, operations, logistics, etc. (Li & Lin, 2006). In more diverse networks, i.e., the tidal power stakeholder communication network, reasons for information sharing are less obvious. Understanding the reasons for information sharing required an examination of how and what kinds of information were shared in the network. Unlike past research that was highly theoretical and tended to focus only on the factors affecting information sharing (see Chapter 2, Section 2.5.3), this research collected empirical data about what, how, and why information sharing occurred among organizations affected by or involved in tidal power developments. Knowing the types of information being shared leads to a better understanding of the informational needs of stakeholder organizations in the network. Understanding how information is shared, i.e., the enabling mechanisms, allows recommendations to be made about how such structures could be improved. Further, Yang and Maxwell (2011) noted that a SNA approach could be used to discover “whether social networks could facilitate inter-organizational information sharing when participating organizations are diversified or have very different functions” (p. 173). This research, using a mixed-methods SNA and qualitative data analysis approach, has found that, even in the absence of clearly developed IOM policy, communication among diverse stakeholder groups operating in this multi-sectoral network has manifested itself in several ways.

Organizations directly involved in the tidal industry, i.e., proponents, government organizations, NGOs, and research groups, share strategic information for two main reasons. First, these organizations recognize the importance of stakeholder engagement and social license, e.g., public buy-in, as essential to the success of the developing tidal power field. This perspective is evidenced through the prevalence of strategic information sharing aimed at increasing public education and awareness. The alleviation of uncertainties, e.g., technological and regulatory unknowns, also motivates strategic inter-organizational information sharing in the network, as groups seek to exchange research and experience in the relatively new field. Stakeholder engagement is enacted mainly through multi-sectoral committees, conferences, and workshops, and bridger organizations with a primary mandate to encourage information sharing in the network.

The 2008 Strategic Environmental Assessment (SEA) mandated that mechanisms for stakeholder engagement be created (Offshore Energy Research Association, 2013a). These have developed in the form of inter-organizational, multi-sectoral committees, sub-committees, and working groups that have proved to be effective in promoting integrated communication. While imperfect, such mechanisms do act as a strong enabler for multi-sectoral communication, a role that could be enhanced going forward (see Section 7.3.1). Another way in which the ideals of integrated management have panned out in the tidal power communication network is through sector-spanning conferences and workshops that seek to bring together a wide array of stakeholders to discuss needs, research, and other priority matters.

Additionally, bridger organizations, found chiefly in the government, NGO, and research sectors, work to forge connections within the network. Despite these efforts, a few relevant sectors, i.e., fishing and aquaculture and tourism, are not highly engaged. Further, while First Nations involvement is taking place, communication is predominantly

through the legally mandated consultation process, leaving some First Nations groups connected only tenuously to the network. Bringing marginalized sectors into the types of strategic conversations currently permeating the network offers a means to improve communication channels, as well as to accrue the benefits of drawing upon a diversity of perspectives. While a state of integrated management has not yet been achieved, continued support for mechanisms that enable communication across sectors, e.g., multi-sector committees and bridgers, will help to strengthen the communication network and guide the tidal power industry from a grand “science experiment” to a thriving, Maritime industry.

REFERENCES

AECOM. (2014). Tidal energy: Strategic Environmental Assessment update for the Bay of Fundy. Retrieved from http://www.oera.ca/marine-renewable-energy/strategic-environmental-assessment/sea-phase-ii-bay-of-fundy-update/

Alexander, K. A., Wilding, T. A., & Jacomina Heymans, J. (2013). Attitudes of Scottish fishers towards marine renewable energy. *Marine Policy, 37*, 239–244. doi:10.1016/j.marpol.2012.05.005

Appiott, J., Dhanju, A., & Cicin-Sain, B. (2014). Encouraging renewable energy in the offshore environment. *Ocean & Coastal Management, 90*, 58–64. doi:10.1016/j.ocecoaman.2013.11.001

Aronson, J. (1994). A pragmatic view of thematic analysis. *The Qualitative Report, 2*(1). http://www.nova.edu/ssss/QR/BackIssues/QR2-1/aronson.html

Bailey, I., West, J., & Whitehead, I. (2011). Out of sight but not out of mind? Public perceptions of wave energy. *Journal of Environmental Policy & Planning, 13*(2), 139–157. doi:10.1080/1523908X.2011.573632

Bastien-Daigle, S., Vanderlinden, J.-P., & Chouinard, O. (2008). Learning the ropes: Lessons in integrated management of coastal resources in Canada's Maritime provinces. *Ocean & Coastal Management, 51*(2), 96–125. doi:10.1016/j.ocecoaman.2007.04.006

Bay of Fundy FORCE study looking at tidal power turbine potential. (2014, September 02). *CBC News*. Retrieved from http://www.cbc.ca/news/canada/nova-scotia/bay-of-fundy-force-study-looking-at-tidal-power-turbine-potential-1.2753363

Bay of Fundy Tourism Partnership. (2014). *Tides in the Bay of Fundy*. Retrieved from http://bayoffundytourism.com/tides/

Bazeley, P. (2007). *Qualitative data analysis with NVivo*. Los Angeles; London: SAGE.

Beswick, A. (2015, August 14). Fishing organization wary of turbines. *The Chronicle*

Herald. Retrieved from http://thechronicleherald.ca/novascotia/1305247-fishing-organization-wary-of-turbines?utm_source=email&utm_medium=business_insider&utm_campaign=business_insider

Borgatti, S. P., Everett, M. G. and Freeman, L. C. (2002). *Ucinet 6 for Windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Bradley, E. H., Curry, L. A., & Devers, K. J. (2007). Qualitative data analysis for health services research: Developing taxonomy, themes, and theory. *Health Services Research, 42*(4), 1758–1772. http://doi.org/10.1111/j.1475-6773.2006.00684.x

Bremer, S., & Glavovic, B. (2013). Mobilizing knowledge for coastal governance: Re-Framing the science–policy interface for integrated coastal management. *Coastal Management, 41*(1), 39–56. doi:10.1080/08920753.2012.749751

Bruckmeier, K. (2005). Interdisciplinary conflict analysis and conflict mitigation in local resource management. *Ambio*, *34*(2), 65–73.

Burt, R. S. (1992). *Structural holes: The social structure of competition*. Cambridge: Harvard University Press.

Cabrera, Á., Collins, W. C., & Salgado, J. F. (2006). Determinants of individual engagement in knowledge sharing. *International Journal of Human Resource Management*, *17*(2), 245–264. http://doi.org/10.1080/09585190500404614

CanmetENERGY. (2011). The marine renewable energy sector early-stage supply chain. *Natural Resources Canada*. Retrieved from https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/MarineRenewableEnergySupplyChain_EN.pdf

Cárcamo, P. F., Garay-Flühmann, R., & Gaymer, C. F. (2014). Collaboration and knowledge networks in coastal resources management: How critical stakeholders interact for multiple-use marine protected area implementation. *Ocean & Coastal Management, 91*, 5–16. http://doi.org/10.1016/j.ocecoaman.2014.01.007

Carley, K. M. (2011). Organizational Risk Analyzer [Computer software]. *Center for Computational Analysis of Social and Organizational Systems*. Pittsburgh, PA: Carnegie Mellon University.

Carley, K. M., Reminga, J., Storrick, J., & Columbus, D. (2010). *ORA user's guide*. Pittsburgh, PA: Carnegie Mellon University.

Cheng, J.-H. (2011). Inter-organizational relationships and information sharing in supply chains. *International Journal of Information Management*, *31*(4), 374–384. http://doi.org/10.1016/j.ijinfomgt.2010.09.004

Chiu, C.-M., Hsu, M.-H., & Wang, E. T. G. (2006). Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. *Decision Support Systems*, *42*(3), 1872–1888. http://doi.org/10.1016/j.dss.2006.04.001

Chow, C. W., Deng, F. J., & Ho, J. L. (2000). The openness of knowledge sharing within organizations: A comparative study in the United States and the People's Republic of China. *Journal of Management Accounting Research*, *12*, 65–95.

Cheliotis, G. (2010). Social network analysis: Including a tutorial on concepts and methods. [Slideshare]. Retrieved from http://www.slideshare.net/gcheliotis/social-network-analysis-3273045

Christie, P. (2005). Is integrated coastal management sustainable? *Ocean & Coastal Management*, 48, 208–232.

Coffey, B., & O'Toole, K. (2012). Towards an improved understanding of knowledge dynamics in integrated coastal zone management: A knowledge systems framework. *Conservation and Society, 10*(4), 318–329.

Collet, F., & Hedstrom, P. (2013). Old friends and new acquaintances: Tie formation mechanisms in an interorganizational network generated by employee mobility. *Social Networks, 35*(3), 288–299. http://doi.org/10.1016/j.socnet.2013.02.005

Collins-Dogrul, J. (2012). *Tertius iungens* brokerage and transnational intersectoral cooperation. *Organization Studies, 33*(3), 989–1014. doi: 10.1177/0170840612445118

Colton, J., & Isaacman, L. (2013). Tidal energy community engagement handbook. *Acadia Tidal Energy Institute*. Retrieved from http://www.oera.ca/wp-content/uploads/2013/09/Tidal-Energy-Engagement-Handbook_FINAL_August-27-2013.pdf

Connelly, C. E., & Kelloway, E. K. (2003). Predictors of employees' perceptions of knowledge sharing cultures. *Leadership & Organization Development Journal*, *24*(5/6), 294–301.

Constant, D., Kiesler, S., & Sproull, L. (1994). What's mine is ours, or is it? A study of attitudes about information sharing. *Information Systems Research*, *5*(4), 400–421.

Cross, R., Borgatti, S. P., & Parker, A. (2002). Making invisible work visible: Using social network analysis to support strategic collaboration. *California Management Review, 44*(2), 25–46.

Cross, R. & Borgatti, S. P. (2004). The ties that share: Relational characteristics that facilitate information seeking. In M. H. Huysman and V. Wulf (Eds.), *Social capital and IT*. MIT Press: Cambridge.

de Groot, J., Campbell, M., Ashley, M., & Rodwell, L. (2014). Investigating the co-existence of fisheries and offshore renewable energy in the UK: Identification of a mitigation agenda for fishing effort displacement. *Ocean & Coastal Management, 102*, Part A, 7–18. doi:10.1016/j.ocecoaman.2014.08.013

Doelle, M., Russell, D., Saunders, P., VanderZwaag, D., & Wright, D. (2006). The regulation of tidal energy development off Nova Scotia: Navigating foggy waters. *UNB Law Journal, 55*, 27–70.

Easley, D., & Kleinberg, J. (2010). *Networks, crowds, and markets: Reasoning about a highly connected world*. Retrieved from http://www.cs.cornell.edu/home/kleinber/networks-book/

Edwards, G. (2010). Mixed-method approaches to social network analysis. *National Centre for Research Methods*. Retrieved from http://eprints.ncrm.ac.uk/842/

Environmental Information: Use and Influence. (2014). *Understanding the influence of information at the science-policy interface*. Retrieved from http://eiui.ca/#!prettyPhoto[light_roundedGROUP3]/0/

Emmel, N. (2008). Participatory mapping: An innovative sociological method. *National Centre for Research Methods*. Retrieved from http://eprints.ncrm.ac.uk/540/

Ernoul, L., & Wardell-Johnson, A. (2013). Governance in integrated coastal zone management: A social networks analysis of cross-scale collaboration. *Environmental Conservation, 40*(3), 231–240. http://doi.org/10.1017/S0376892913000106

Fedorowicz, J., Gogan, J. L., & Culnan, M. J. (2010). Barriers to interorganizational information sharing in e-government: A stakeholder analysis. *The Information Society*, *26*(5), 315–329. http://doi.org/10.1080/01972243.2010.511556

Fernandez, R. M., & Gould, R. V. (1994). A dilemma of state power: Brokerage and influence in the national health policy domain. *American Journal of Sociology, 99*, 1455–1491.

Ferrin, D. L., & Dirks, K. T. (2003). The use of rewards to increase and decrease trust: Mediating processes and differential effects. *Organization Science*, *14*(1), 18–31.

Fisheries and Oceans Canada. (2013). *Assessment of lobster (Homarus Americanus) in Lobster Fishing Areas (LFA) 35–38*. Retrieved from http://www.dfo-mpo.gc.ca/library/348828.pdf

Friedman, R. A., & Podolny, J. (1992). Differentiation of boundary spanning roles: Labor

negotiations and implications for role conflict. *Administrative Science Quarterly, 37*, 28–47.

Fundy Ocean Research Centre for Energy (FORCE). (2015a). *Fundy Advanced Sensor Technology (FAST) platform*. Retrieved from http://fundyforce.ca/environment/fundy-advanced-sensor-technology-fast-platform/

Fundy Ocean Research Centre for Energy (FORCE). (2015b). *The Fundy Standard*. Retrieved from http://fundyforce.ca/renewable-and-predictable/the-fundy-standard/

Fundy Tidal Inc. (2014, September 11). *Fundy Tidal attracts investment and project partner for Digby Gut project*. Retrieved from http://www.fundytidal.com/news-a-events/101-fundy-tidal-attracts-investment-and-project-partner-for-digby-gut-project

Gardner Pinfold Consultants Inc., & Acadia Tidal Energy Institute. (2015). Value proposition for tidal energy development in Nova Scotia, Atlantic Canada, and Canada. Retrieved from http://www.oera.ca/wp-content/uploads/2015/04/Value-Proposition-FINAL-REPORT_April-21-2015.pdf

Gardner Pinfold Consulting Economists Ltd. (2005). Economic value of the Nova Scotia ocean sector*. Fisheries and Oceans Canada.* Retrieved from http://www.dfo-mpo.gc.ca/Library/314642e.pdf

Gewin, V. (2014, July 23). Science and politics: Hello, governor. *Nature*. Retrieved from http://www.nature.com/news/science-and-politics-hello-governor-1.15593

Girvan, M., & Newman, M. E. J. (2002). Community structure in social and biological networks. *Proceedings of the National Academy of Sciences of the United States of America, USA, 99*(12), 7821–7826. doi: 10.1073/pnas.122653799

Gould, R. V., & Fernandez, R. M. (1989). Structures of mediation: A formal approach to brokerage in transaction networks. *Sociological Methodology, 19*, 89–126. http://doi.org/10.2307/270949

Government of Nova Scotia. (2015). *Government of Nova Scotia policy and guidelines: Consulting with the Mi'kmaq of Nova Scotia*. Retrieved from http://novascotia.ca/abor/docs/April%202015_GNS%20Mi%27kmaq%20Consultation%20Policy%20and%20Guidelines%20FINAL.pdf

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78*(6), 1360–1380.

Gruzd, A., & Haythornthwaite, C. (2013). Enabling community through social media. *Journal of Medical Internet Research, 15*(10), e248. doi: 10.2196/jmir.2796

Hanneman, R. A., & Riddle, M. (2005). *Introduction to social network methods*. Riverside, CA: University of California, Riverside.

Hansen, M. T. (2002). Knowledge networks: Explaining effective knowledge sharing in multiunit companies. *Organization Science*, *13*(3), 232–248.

Hartley, T. (2014). In the eye of the beholder: Scientific uncertainty and information flow in governance networks. Paper presented to the Coastal Zone Canada Conference, Halifax, Nova Scotia, 15-19 June.

Heath, S., Fuller, A., & Johnston, B. (2009). Chasing shadows: Defining network boundaries in qualitative social network analysis. *Qualitative Research*, *9*(5), 645–661. doi:10.1177/1468794109343631

Howell, A., & Drake, C. (2012). Scoping study on socio-economic impacts of tidal energy development in Nova Scotia: A research synthesis & priorities for future action. *Fundy Energy Research Network*. Retrieved from http://www.oera.ca/wpcontent/uploads/2013/05/Socioeconomics-Final-Report.pdf

Jarvenpaa, S. L., & Staples, D. S. (2001). Exploring perceptions of organizational

ownership of information and expertise. *Journal of Management Information Systems*, *18*(1), 151–183.

Jiacheng, W., Lu, L., & Francesco, C. A. (2010). A cognitive model of intra-organizational knowledge-sharing motivations in the view of cross-culture. *International Journal of Information Management*, *30*(3), 220–230. http://doi.org/10.1016/j.ijinfomgt.2009.08.007

Kerr, S., Colton, J., Johnson, K., & Wright, G. (2015). Rights and ownership in sea country: Implications of marine renewable energy for indigenous and local communities. *Marine Policy, 52*, 108–115. doi:10.1016/j.marpol.2014.11.002

Kerr, S., Watts, L., Colton, J., Conway, F., Hull, A., Johnson, K., … Vergunst, J. (2014). Establishing an agenda for social studies research in marine renewable energy. *Energy Policy, 67*, 694–702. doi:10.1016/j.enpol.2013.11.063

Kilduff, M., & Brass, D. J. (2010). Organizational social network research: Core ideas and key debates. *Academy of Management Annals*, *4*, 317–357. doi:10.1080/19416520.2010.494827

Kleiner, A. (2002, October 11). Karen Stephenson's quantum theory of trust. *Strategy and Business*, *29.* Retrieved from http://www.strategy-business.com/article/20964?pg=0

Kolekofski Jr., K. E., & Heminger, A. R. (2003). Beliefs and attitudes affecting intentions to share information in an organizational setting. *Information & Management*, *40*(6), 521–532. http://doi.org/10.1016/S0378-7206(02)00068-X

Leete, S., Xu, J., & Wheeler, D. (2013). Investment barriers and incentives for marine renewable energy in the UK: An analysis of investor preferences. *Energy Policy, 60*, 866–875. doi:10.1016/j.enpol.2013.05.011

Legendre, P., & Legendre, L. (1998). *Numerical ecology* (2nd English ed.). Amsterdam: Elsevier Science BV.

Li, S., & Lin, B. (2006). Accessing information sharing and information quality in supply chain management. *Decision Support Systems*, *42*(3), 1641–1656. http://doi.org/10.1016/j.dss.2006.02.011

Li, J., Sikora, R., Shaw, M. J., & Woo Tan, G. (2006). A strategic analysis of inter organizational information sharing. *Decision Support Systems, 42*(1), 251–266. http://doi.org/10.1016/j.dss.2004.12.003

Long, J. C., Cunningham, F. C., & Braithwaite, J. (2013). Bridges, brokers and boundary spanners in collaborative networks: A systematic review. *BMC Health Services Research 2013, 13*, 158. Retrieved from http://www.biomedcentral.com/1472-6963/13/158

MacDougall, S., & Colton, J. (2013). Community and business toolkit for tidal energy development. *Acadia Tidal Energy Institute*. Retrieved from www.oera.ca/wp-content/uploads/2013/05/Community-and-Business-Toolkit-for-Tidal-Energy-Development_FINAL-REPORT.pdf

McNie, E.C. (2007). Reconciling the supply of scientific information with user demands: An analysis of the problem and review of the literature. *Environmental Science & Policy 10*(1), 17–38. doi:10.1016/j.envsci.2006.10.004.

Mitchell, R., Clark, W., & Cash, D. (2006). Information and influence. In R. Mitchell, W. Clark, D. Cash, & N. Dickson (Eds.), *Global environmental assessments: Information and influence* (pp. 307–338). Cambridge: MIT Press.

Moore, D., Googoo, J., Francis, R., Hodder, C., Moore, A., McEwan, K., Googoo, M., E., Wells Sr., L. (2009). Mi'kmaq ecological knowledge study (MEKS). *Membertou Geomatics Consultants*. Retrieved from http://www.oera.ca/wp-content/uploads/2013/04/MEKS-Phase-I-Final-Report.pdf

Moreno, J., L. (1960). *The sociometry reader*. Glencoe, IL: The Free Press.

Nielson, L. A. (2001). Science and advocacy are different – and we need to keep them

that way. *Hum Dimens Wildlife*, *6*, 39–47.

Natural Resources Canada. (2015). *Tidal energy project in the Bay of Fundy*. Retrieved from https://www.nrcan.gc.ca/energy/funding/current-funding-programs/cef/4955

Nova Scotia Department of Energy. (n.d.). *Offshore renewable energy generation regulatory flow-chart for industry initiated test and commercial sites*. Retrieved from http://energy.novascotia.ca/sites/default/files/Tidal-Policy-Framework-Nova-Scotia.pdf

Nova Scotia Department of Energy. (2008). *Tidal energy: A response to the strategic environmental assessment*. Retrieved from www.gov.ns.ca/energy

Nova Scotia Department of Energy (NSDOE). (2010a). *Renewable electricity plan*. Retrieved from https://www.novascotia.ca/energy/resources/EM/renewable/renewable-electricityplan.pdf

Nova Scotia Department of Energy (NSDOE). (2010b). *Marine renewable energy legislation for Nova Scotia: A discussion paper.* Retrieved from http://energy.novascotia.ca/sites/default/files/NS-MRE%20Legislation.pdf

Nova Scotia Department of Energy (NSDOE). (2012). *Nova Scotia marine renewable energy strategy*. Retrieved from http://energy.novascotia.ca/sites/default/files/Nova-Scotia-Marine-Renewable-Energy-Strategy-May-2012.pdf

Nova Scotia Department of Energy (NSDOE). (2014). *Nova Scotia tidal energy: The power of the highest tides in the world. The plan to harvest it.* Retrieved from http://energy.novascotia.ca/sites/default/files/Tidal%20Energy.pdf

Nova Scotia Department of Energy (NSDOE). (2015). *Marine renewable energy legislation*. Retrieved from http://energy.novascotia.ca/renewables/marine-renewable-energy/marine-renewable-energy-legislation

Nova Scotia Power Inc. (2015). *What is the current breakdown in the renewable energy mix for NS (% and MW installed)?* [online discussion forum]. Retrieved from http://tomorrowspower.ca/answer/1000

Nutley, S. M., Walter, I., & Davis, H. T. O. (2007). *Using evidence: How research can inform public services*. Bristol: Policy Press.

Obstfeld, D. (2005). Social networks, the *tertius iungens* orientation, and involvement in innovation. *Administrative Science Quarterly, 50*, 100–130.

Oceans Act, S.C. 1996, c. 31. Retrieved from http://laws-lois.justice.gc.ca/eng/acts/O-2.4/

Office of Aboriginal Affairs. (2012). *Proponent's guide: The role of proponents in crown consultation with the Mi'kmaq of Nova Scotia*. Retrieved from https://www.novascotia.ca/nse/ea/docs/ea-proponents-guide-to-mikmaq-consultation.pdf

Offshore Energy Research Association (OERA). (n.d.). *Nova Scotia's federal-provincial one window committee on tidal energy*. Retrieved from http://www.oera.ca/wp-content/uploads/2013/11/One-Window-Committee-on-Tidal-Energy-Presentation_November-25-2013-FINAL.pdf

Offshore Energy Environmental Research Association. (2008). *Fundy tidal energy strategic environmental assessment*. Retrieved from http://www.oera.ca/wp-content/uploads/2013/06/FINAL-SEA-REPORT.pdf

Offshore Energy Research Association (OERA). (2013a). *Strategic Environmental Assessment – Bay of Fundy (Phase I)*. Retrieved from http://www.oera.ca/marine-renewable-energy/strategic-environmental-assessment/sea-phase-i-bay-of-fundy/

Offshore Energy Research Association (OERA). (2013b). *Strategic Environmental*

Assessment – Cape Breton region. Retrieved from http://www.oera.ca/marine-renewable-energy/strategic-environmental-assessment/sea-phase-ii-cape-breton-coastal-region/

Offshore Energy Research Association (OERA). (2015). *Changing tides: A business case for tidal energy in Nova Scotia, Atlantic Canada and Canada*. *Key messages.* Retrieved from http://www.oera.ca/marine-renewable-energy/tidal-research-4projects/other-tidal-research/value-proposition-for-tidal-energy-development/

Oreskes, N. (2015, January 3). Playing dumb on climate change. *The New York Times*. Retrieved from http://www.nytimes.com/2015/01/04/opinion/sunday/playing-dumb-on-climate-change.html?_r=0

Parag, Y., Hamilton, J., White, V., & Hogan, B. (2013). Network approach for local and community governance of energy: The case of Oxfordshire. *Energy Policy, 62*, 1064–1077. doi:10.1016/j.enpol.2013.06.027

Percy, J. A. (2009). Tweaking tidal energy: Harnessing Fundy's phenomenal tides? *Bay of Fundy Ecosystem Partnership: Fundy Issues, 30*, 1–12. Retrieved from http://www.bofep.org

Prell, C., Hubacek, K., Quinn, C., & Reed, M. (2008). "Who's in the Network?' When stakeholders influence data analysis. *Systemic Practice & Action Research*, *21*(6), 443–458. doi:10.1007/s11213-008-9105-9

Prell, C., Hubacek, K., & Reed, M. (2009). Stakeholder analysis and social network analysis in natural resource management. *Society & Natural Resources*, *22*(6), 501–518. doi:10.1080/08941920802199202

Rainie, L., & Wellman, B. (2012). *Networked: The new social operating system*. Cambridge, MA: MIT Press.

Rice, J. C. (2005). Implementation of the ecosystem approach to fisheries management: Asynchronous co-evolution at the interface between science and policy. *Marine*

ecology. Progress series, *300*, 265–270.

Robins, G., Bates, L., & Pattison, P. (2011). Network governance and environmental management: Conflict and cooperation. *Public Administration, 89*(4), 1293–1313. http://doi.org/10.1111/j.1467-9299.2010.01884.x

Ryan, G. W., & Bernard, H. R. (2003). Techniques to identify themes. *Field Methods, 15*(1), 85–109. http://doi.org/10.1177/1525822X02239569

Samaddar, S., Nargundkar, S., & Daley, M. (2006). Inter-organizational information sharing: The role of supply network configuration and partner goal congruence. *European Journal of Operational Research*, *174*(2), 744–765. http://doi.org/10.1016/j.ejor.2005.01.059

Sarewitz, D. (2013, October 31). Science's rightful place is in service to society. *Nature, 502*, 595.

Sarkki, S., Niemelä, J., Tinch, R., van den Hove, S., Watt, A., & Young, J. (2014). Balancing credibility, relevance and legitimacy: A critical assessment of trade-offs in science-policy interfaces. *Science & Public Policy, 41*(2), 194–206.

Sessa, C., & Ricci, A. (2010). Working with and for the citizens. *Innovation, 23*(1), 49–60. doi:10.1080/13511611003791174

Siemsen, E., Balasubramanian, S., & Roth, A. V. (2007). Incentives that induce task-related effort, helping, and knowledge sharing in workgroups. *Management Science*, *53*(10), 1533–1550.

Simmel, G. (1902a). The number of members as determining the sociological form of the group. I. *The American Journal of Sociology, 8*(1), 1–46.

Simmel, G. (1902b). The number of members as determining the sociological form of the group. II. *The American Journal of Sociology, 8*(1), 158–196.

Singh, G. G., Tam, J., Sisk, T. D., Klain, S. C., Mach, M. E., Martone, R. G., & Chan, K.

M. (2014). A more social science: Barriers and incentives for scientists engaging in policy. *Frontiers in Ecology & the Environment*, *12*(3), 161–166. doi:10.1890/130011

Smajgl, A., & Ward, J. (2013). A framework to bridge science and policy in complex decision making arenas. *Futures*, *52*, 52–58. doi:10.1016/j.futures.2013.07.002

Snow, C. C., Miles, R. E., & Coleman, H. J. Jr. (2000). Managing 21st century network organizations. In D. Preece, I.M. McLouglin, & P. Dawson (Eds.), *Technology, organization, and innovation: Critical perspectives on business management* (pp. 1621–1638). London: Routledge.

Soomai, S. S., MacDonald, B. H., & Wells, P. G. (2013). Communicating environmental information to the stakeholders in coastal and marine policy-making: Case studies from Nova Scotia and the Gulf of Maine/Bay of Fundy region. *Marine Policy, 40*, 176–186.

Steinel, W., Utz, S., & Koning, L. (2010). The good, the bad, and the ugly thing to do when sharing information: Revealing, concealing, and lying depend on social motivation, distribution, and importance of information. *Organizational Behavior and Human Decision Processes*, *113*(2), 85–96. http://doi.org/10.1016/j.obhdp.2010.07.001

Suskevics, M., Tillemann, K., & Kuelvik, M. (2013). Assessing the relevance of stakeholder analysis for national ecological network governance: The case of the Green Network in Estonia. *Journal for Nature Conservation*, *21*(4), 206–213. doi:10.1016/j.jnc.2012.12.007

Taljaard, S., Slinger, J. H., & Van Der Merwe, J. H. (2011). Criteria for evaluating the design of implementation models for integrated coastal management. *Coastal Management, 39*(6), 628–655. doi:10.1080/08920753.2011.616670

Tethys. (2015). *Fundy Ocean Research Center for Energy test site*. Retrieved from

tethys.pnnl.gov/annex-iv-sites/fundy-ocean-research-center-energy-test-site

Todd, P. (2012). Marine renewable energy and public rights. *Marine Policy, 36*(3), 667–672. doi:10.1016/j.marpol.2011.10.020

Tourism Industry Association of Nova Scotia. (2015). *The economic impact*. Retrieved from http://www.tians.org/

Turner, D. W. (2010). Qualitative interview design: A practical guide for novice investigators. *The Qualitative Report, 15*(3), 754–760.

United Nations Environment Programme. (2010). *Climate change*. Retrieved from http://www.unep.org/gc/gc26/factsheet/pdfs/Climate_change.pdf

Vance-Borland, K., & Holley, J. (2011). Conservation stakeholder network mapping, analysis, and weaving. *Conservation Letters, 4*(4), 278–288. doi:10.1111/j.1755-263X.2011.00176.x

Wang, S., & Noe, R. A. (2010). Knowledge sharing: A review and directions for future research. *Human Resource Management Review*, *20*(2), 115–131. http://doi.org/10.1016/j.hrmr.2009.10.001

Wenjing, L. (2011). Government information sharing: Principles, practice, and problems – An international perspective. *Government Information Quarterly, 28*, 363–373. doi: 10.1016/j.giq.2010.10.003

West, J., Bailey, I., & Winter, M. (2010). Renewable energy policy and public perceptions of renewable energy: A cultural theory approach. *Energy Policy, 38*(10), 5739–5748. doi:10.1016/j.enpol.2010.05.024

Wiber, M. G., Rudd, M. A., Pinkerton, E., Charles, A. T., & Bull, A. (2010). Coastal management challenges from a community perspective: The problem of “stealth privatization” in a Canadian fishery. *Marine Policy, 34*(3), 598–605. doi:10.1016/j.marpol.2009.11.010

Willem, A., & Buelens, M. (2007). Knowledge sharing in public sector organizations: The

effect of organizational characteristics on interdepartmental knowledge sharing. *Journal of Public Administration Research & Theory*, *17*(4), 581–606.

Wilson, L., & Wiber, M. G. (2009). Community perspectives on integrated coastal management: Voices from the Annapolis Basin area, Nova Scotia, Canada. *Ocean & Coastal Management, 52*(11), 559–567. doi:10.1016/j.ocecoaman.2009.08.008

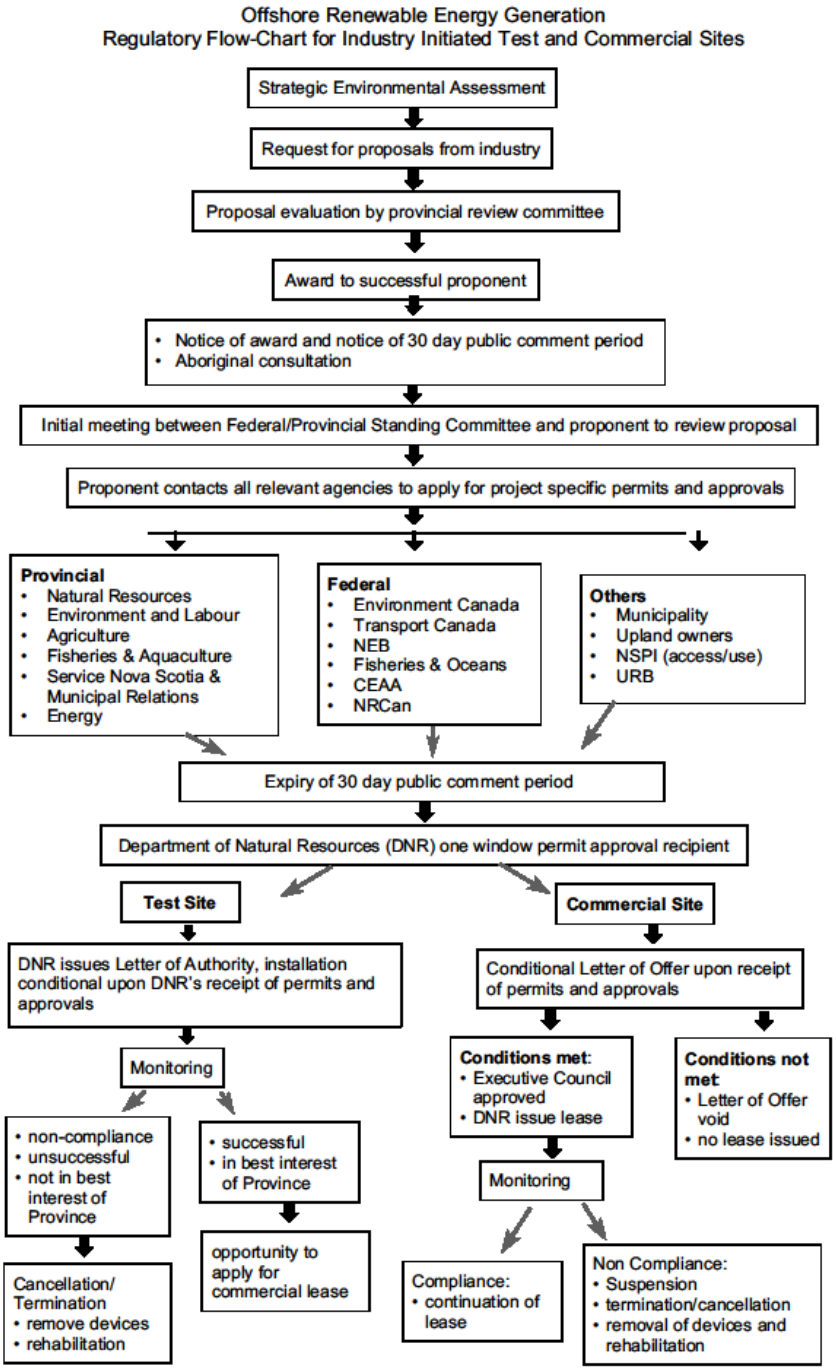
Withers, P., & LaRoche, J. (2015, April 29). Bay of Fundy tidal power legislation outlines rules for companies. *CBC News*. Retrieved from http://www.cbc.ca/news/canada/nova-scotia/bay-of-fundy-tidal-power-legislation-outlines-rules-for-companies-1.3053936

Wright, G. (2015). Marine governance in an industrialised ocean: A case study of the emerging marine renewable energy industry. *Marine Policy, 52*, 77–84. doi:10.1016/j.marpol.2014.10.021

Yang, T.-M., & Maxwell, T. A. (2011). Information-sharing in public organizations: A literature review of interpersonal, intra-organizational, and inter-organizational success factors. *Government Information Quarterly*, *28*(2), 164–175. http://doi.org/10.1016/j.giq.2010.06.008

Yates, B. F., & Horvath, C. L. (2013). Social license to operate: How to get it, and how to keep it. *2013 Pacific Energy Summit*. Vancouver: The National Bureau of Asian Research. Retrieved from http://www.nbr.org/downloads/pdfs/eta/PES_2013_ summitpaper_Yates_Horvath.pdf

APPENDIX A – Offshore Renewable Energy Generation Regulatory Flow-Chart for Industry Initiated Test and Commercial Sites (retrieved from fundyforce.ca)



APPENDIX B – Interview Protocol for Semi-Structured Interviews and Participatory Mapping with Tidal Energy Stakeholders in the Bay of Fundy

Introductions, a brief explanation of the project, and the signing of the consent form.

Demographical/contextual questions

1. Please state the name of the organization that you are representing in this interview [with regard to tidal energy implementation within the Bay of Fundy].

2. Please describe your role within this organization.

3. What are the primary operations of your organization?

4. What is your organization's role regarding tidal power in the Bay of Fundy?

5. Please estimate the percentage of your organization's time that was devoted to tidal power issues within the past year.

    a. How important is tidal power to your organization? (e.g., very important, important, somewhat important, not at all important). To what extent does tidal power affect the operations of your organization?

Participatory Mapping with Selected Tidal Energy Stakeholders in the Bay of Fundy

Preamble: For this section of the interview, I would like you to think about the different organizations with which your organization has communicated information related to tidal power in the past six months. Please do not identify or discuss specific individuals in the organizations with which your organization communicates. Possible types of organizations to consider are:

- Government entities
- Commercial (Tidal Energy Industry)
- Commercial (Other) (e.g., fisheries or tourism)
- Research groups
- Community or environmental groups
- Boundary organizations (e.g., NGOs, private funding bodies)
- First Nations communities

Please state the organization names and watch as I write them down to ensure that they are spelled correctly. Please name as many organizations as you can, and then I will ask you to choose an organization to begin our discussion. We do not necessarily have to discuss all of them, but I would like to get a sense about your organization's relationship with those you consider to be the "main" organizations.

A series of probing questions will be asked about each organization indicated in the diagram:

- Can you tell me how frequently you communicate with [organization name]? Prompt: *Monthly, weekly, daily?*
- What type(s) of information do you distribute to [organization name]?
- What type(s) of information do you receive from [organization name]?
- How is the information received from [organization name] used by your organization? *Prompt*: How does it support your organization's operations?
- Can you tell me what helps communication with [organization name]?
- Can you tell me what hinders communication with [organization name]?
- What evidence do you have that communication does occur with [organization name]? *Prompt*: Do you and/or your colleagues communicate with/ receive information from [organization name]?
- What are the primary mechanisms through which your organization communicates or receives information from [organization name]? *Prompt*: email, face-to-face meetings, communications, individuals embedded in other organizations, etc.

Now that you have identified and discussed your organization's relationship with other tidal power stakeholders, which of these organizations do you perceive to be communicating about this issues. Please note that this can be based on an assumption.

Whole network questions/General, open-ended questions:

- What is your general sense of communication networks around the issue of tidal power?
    - Do you think communication between organizations around this issue is important? Why or why not?
    - What is your opinion about the general state of communication and information sharing about tidal power activities?
    - What, in your opinion, are the best means to promote inter-organizational communication around this issue? (e.g., conferences, workshops, community outreach, etc.).

- If you had an opportunity to change the ways in which these networks operate, what changes would you make?
    - Possible probes: In your opinion, are there any stakeholders that are missing and/or under-represented within tidal power networks?
    - Does the network as it currently exists work well for your organization?

After: Would you say that what you have described for the past month is typical? Are there any organizations with which you have communicated information about tidal power in the past, but not in the last month?

APPENDIX C – Consent Forms for Participation in Semi-Structured Interviews and Participatory Mapping

DALHOUSIE UNIVERSITY
FACULTY OF MANAGEMENT

CONSENT FORM

Project Title: *The Communication of Information in Inter-Organizational Networks: A Case Study of Tidal Power Network(s) in the Bay of Fundy Region*

Lead researcher:
Lee Wilson
Master of Library and Information Studies
Dalhousie University
lee.wilson@dal.ca
902-233-8927

Other researchers:
Dr. Bertrum MacDonald
School of Information Management
Dalhousie University
bertrum.macdonald@dal.ca
902-424-2472

Introduction:

We invite you to take part in a research study being conducted by Lee Wilson who is a Student in the Master of Information Studies program at Dalhousie University. Taking part in the research is up to you; it is entirely your choice. Even if you do take part, you may leave the study at any time for any reason. The information below tells you about what is involved in the research, what you will be asked to do and about any benefit, risk, inconvenience or discomfort that you might experience.

Please ask as many questions as you like. If you have any questions later, please contact the lead researcher.

Purpose and outline of the research study:

The principal research question for the Master's research is: With which organizations and to what extent are affected organizations communicating information about tidal power in the Bay of Fundy? This question will be approached by examining the perceived level of inter-organizational communication between groups affected by tidal energy development. The main objective of the research is to gain insight into how, and indeed if, affected groups are communicating about this multi-organizational, coastal zone issue. If appropriate, recommendations will be made about how communication channels might be ameliorated within the network(s).

To develop an understanding of tidal power communication networks in the Bay of Fundy, a case study consisting of interviews and participant led communication mapping will be conducted. Data collection will be completed during the spring of 2015.

Who can take part in the research study?

You have been invited to participate in this study because of your position with an organization that has been identified as a group affected by or involved with tidal energy development in the Bay of Fundy region. For the purposes of this study, this can be any organization which is affected, either directly or indirectly, by tidal power activities.

How many people are taking part in the study?

Although interviews will be conducted individually, there will be roughly 12-15 other participants representing other organizations.

What you will be asked to do:

To help us understand inter-organizational communication regarding tidal power implementation in the Bay of Fundy, we will ask you to be interviewed by the principal researcher, Lee Wilson, in person, at a time and location convenient to you. The interview will last for approximately 60 minutes. You will be asked questions pertaining to your organization's involvement in communications about tidal power development in the Bay of Fundy region. This interview will include questions and a "participatory mapping" exercise wherein you will be asked to draw a diagram showing the different organizations with which your organization interacts about this issue. With your permission, the interview will be audio recorded. When a transcription of your interview has been completed, the audio recording will be erased. Should you prefer that the interview not be audio recorded, the interviewer will make notes of your responses during the interview. As an added layer of confidentiality, your diagram of

communication networks will be transcribed digitally using Social Network Analysis software.

Possible benefits, risks and discomforts:

While it is not expected that participants of this study will accrue any direct benefits, it is anticipated that there may be benefits to the case study organizations as the research will generate substantial new data and information to advance understanding about inter-organizational communication about tidal power in the Bay of Fundy region.

Participation in this study should be of minimal risk to you. Given the relatively small number of organizations involved in tidal power implementation in the Bay of Fundy, there is a possibility that readers of the final report might guess at who participated in the study. However, the probability of any harm occurring because of disclosing information regarding your organization's role in tidal power communication networks is very low. All information provided will be categorized into broad types such as government information, industry information, community concerns, etc. Participation in the study is voluntary and you may withdraw at any time.

How your information will be protected:

Information that you provide to us will be kept private. In most cases, only the research team will have access to this information. In some cases, other authorized officials at the University such as the Research Ethics Board or the Scholarly Integrity Officer may have access as well. We will describe and share our findings in a thesis, class presentations, and possible publications. To help maintain participant confidentiality, with your permission, any responses that may be included in reports and publications arising from this research will not be attributed to you but will be designated to a genericized version of your role within your organization (e.g., a "technical manager" would be referred to simply as a "manager"). This means that ***you will not be identified in any way in our reports***. The people who work with your information have an obligation to keep all research information private. Also, we will use a participant number (not your name) in our written and computerized records so that the information we have about you contains no names. All your identifying information will be kept in a separate file, in a secure place. All transcripts and notes from this research will only be accessible to the principal investigator and his supervisor and will be retained in secured cabinets and on password-protected computers at Dalhousie University for five years after which they will be destroyed.

If you decide to stop participating:

You are free to leave the study at any time. If you decide to stop participating at any point during the study, you can also decide whether you want any of the information that you have contributed up to that point to be removed or if you will allow us to use that information. You can also decide for up to 1 month if you want us to remove your data. After that time, it will become impossible for us to remove it because it will already be anonymized.

How to obtain results:

We will provide you with a short abstract of group results when the study is finished. No individual results will be provided. You can obtain these results by visiting the EIUI research initiative website (www.eiui.ca) in approximately 6 months.

Questions:

We are happy to talk with you about any questions or concerns you may have about your participation in this research study. Please contact Lee Wilson (lee.wilson@dal.ca).

If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study you may also contact my supervisor, Professor Bertrum MacDonald at 494-2472,
bertrum.macdonald@dal.ca (if you are calling long distance, please call collect). We will also tell you if any new information comes up that could affect your decision to participate.

If you have any ethical concerns about your participation in this research, you may also contact the Director, Research Ethics, Dalhousie University at (902) 494-1462, or email: ethics@dal.ca

If you choose to participate, please email the principal investigator (lee.wilson@dal.ca). You will be asked to complete the attached consent form 1 before conducting the interview. At that time, please also feel free to ask any additional questions. You will be asked to complete consent form 2 after you complete an interview.

Lee Wilson

School of Information Management
Dalhousie University, Halifax,
Nova Scotia, Canada
Email: Lee.Wilson@dal.ca

DALHOUSIE UNIVERSITY
FACULTY OF MANAGEMENT

CONSENT FORM (1)

The Communication of Information in Inter-Organizational Networks: A Case Study of Tidal Power Network(s) in the Bay of Fundy Region.

I have read the explanation about this study. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I hereby consent to take part in this study.
However, I realize that my participation is voluntary and that I am free to withdraw from the study at any time.

Please indicate whether you agree to audio recording of the interview (as applicable):

□ I agree to audio recording of the interview.

□ I do not agree to audio recording of the interview.

_____
Signature of Participant

_____
Signature of Researcher

_____
Date

DALHOUSIE UNIVERSITY
FACULTY OF MANAGEMENT

CONSENT FORM (2)

The Communication of Information in Inter-Organizational Networks: A Case Study of Tidal Power Network(s) in the Bay of Fundy Region.

Having now completed the interview, I hereby consent to the conditions regarding quotations from my interview outlined below.

Please check each of the conditions (as applicable):

□ I agree to use of substantial direct quotations from my interview in reports and publications arising from this research.

□ I agree that only my role within my organization (e.g., Participant 1 is a manager of [government department] or executive member with [name of organization]) will be identified as author of substantial direct quotations from my interview used in reports and publications arising from this research.

_____
Signature of Participant

_____
Signature of Researcher

_____
Date

APPENDIX D – REB Letter of Approval of Research Ethics

REB # 2015-3469 Letter of Approval

sharon.gomes@dal.ca

Tue 2/24/2015 8:30 AM

To:Lee Wilson <Lee.Wilson@Dal.Ca>;

Cc:Bertrum MacDonald <Bertrum.MacDonald@Dal.Ca>; Sharon Gomes <Sharon.Gomes@Dal.Ca>;

DALHOUSIE UNIVERSITY
Research Services

Social Sciences & Humanities Research Ethics Board
Letter of Approval

February 24, 2015

Mr Lee Wilson
Management\Information Management

Dear Lee,

REB#: 2015-3469
Project Title: The Communication of Information in Inter-Organizational Networks: A Case Study of Tidal Power Networks(s)in the Bay of Fundy Region

Effective Date: February 23, 2015
Expiry Date: February 23, 2016

The Social Sciences & Humanities Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

[redacted]

Dr. Valerie Trifts, Chair

Post REB Approval: On-going Responsibilities of Researchers

After receiving ethical approval for the conduct of research involving humans, there are several ongoing responsibilities that researchers must meet to remain in compliance with University and Tri-Council policies.

1. Additional Research Ethics approval
Prior to conducting any research, researchers must ensure that all required research ethics approvals are secured (in addition to this one). This includes, but is not limited to, securing appropriate research ethics approvals from: other institutions with whom the PI is affiliated; the research

institutions of research team members; the institution at which participants may be recruited or from which data may be collected; organizations or groups (e.g. school boards, Aboriginal communities, correctional services, long-term care facilities, service agencies and community groups) and from any other responsible review body or bodies at the research site

2. Reporting adverse events
Any significant adverse events experienced by research participants must be reported **in writing** to Research Ethics **within 24 hours** of their occurrence. Examples of what might be considered "significant" include: an emotional breakdown of a participant during an interview, a negative physical reaction by a participant (e.g. fainting, nausea, unexpected pain, allergic reaction), report by a participant of some sort of negative repercussion from their participation (e.g. reaction of spouse or employer) or complaint by a participant with respect to their participation. The above list is indicative but not all-inclusive. The written report must include details of the adverse event and actions taken by the researcher in response to the incident.

3. Seeking approval for protocol / consent form changes
Prior to implementing any changes to your research plan, whether to the protocol or consent form, researchers must submit them to the Research Ethics Board for review and approval. This is done by completing a Request for Ethics Approval of Amendment to an Approved Project form (available on the website) and submitting three copies of the form and any documents related to the change. Please note that no reviews are conducted in August.

4. Submitting annual reports
Ethics approvals are valid for up to 12 months. Prior to the end of the project's approval deadline, the researcher must complete an Annual Report (available on the website) and return it to Research Ethics for review and approval before the approval end date in order to prevent a lapse of ethics approval for the research. Researchers should note that no research involving humans may be conducted in the absence of a valid ethical approval and that allowing REB approval to lapse is a violation of University policy, inconsistent with the TCPS (article 6.14) and may result in suspension of research and research funding, as required by the funding agency.

5. Submitting final reports
When the researcher is confident that no further data collection or analysis will be required, a Final Report (available on the website) must be submitted to Research Ethics. This often happens at the time when a manuscript is submitted for publication or a thesis is submitted for defence. After review and approval of the Final Report, the Research Ethics file will be closed.

6. Retaining records in a secure manner
Researchers must ensure that both during and after the research project, data is securely retained and/or disposed of in such a manner as to comply with confidentiality provisions specified in the protocol and consent forms. This may involve destruction of the data, or continued arrangements for secure storage. Casual storage of old data is not acceptable.

It is the Principal Investigator's responsibility to keep a copy of the REB approval letters. This can be important to demonstrate that research was undertaken with Board approval, which can be a requirement to publish (and is required by the Faculty of Graduate Studies if you are using this research for your thesis).

Please note that the University will securely store your REB project file for 5 years after the study closure date at which point the file records may be permanently destroyed.

7. Current contact information and university affiliation
The Principal Investigator must inform the Research Ethics office of any changes to contact information for the PI (and supervisor, if appropriate), especially the electronic mail address, for the duration of the REB approval. The PI must inform Research Ethics if there is a termination or interruption of his or her affiliation with Dalhousie University.

8. Legal Counsel
The Principal Investigator agrees to comply with all legislative and regulatory requirements that apply to the project. The Principal Investigator agrees to notify the University Legal Counsel office in the event that he or she receives a notice of non-compliance, complaint or other proceeding relating to such requirements.

9. Supervision of students
Faculty must ensure that students conducting research under their supervision are aware of their responsibilities as described above, and have adequate support to conduct their research in a safe and ethical manner.

APPENDIX E – Invitation to Selected Tidal Power Stakeholders to Participate in Semi-Structured Interviews and Participatory Mapping

Dear [Name of Participant],

My name is Lee Wilson, and I am a student in the Master of Library and Information Studies (MLIS) Program at Dalhousie University, Halifax, Nova Scotia. You are invited to participate in my master's degree research project, *The Communication of Information in Inter-Organizational Networks: A Case Study of Tidal Power Network(s) in the Bay of Fundy Region*, which is being conducted within the Environmental Information: Use and Influence (EIUI) research program based in the School of Information Management, Faculty of Management, Dalhousie University (www.eiui.ca). The research is supervised by Dr. Bertrum MacDonald, Professor of Information Management, Dalhousie University.

To develop an understanding of how information pertaining to tidal power is created, communicated, and used by organizations in the Bay of Fundy region, I am conducting a case study on tidal power communication networks. The implementation of tidal power infrastructure within the Bay of Fundy is a multifaceted issue involving many stakeholders (e.g., municipal, provincial, and federal governments; NGOs; environmental groups; industry both foreign and domestic; universities; and community groups). Current literature suggests that strong channels of communication and stakeholder collaboration are vital to the success of complex, multi-stakeholder endeavours. This research will help to evaluate the current state of tidal power communication networks by gaining insights from individuals involved with key stakeholder organizations.

You have been invited to participate in this study because of [your position][7] with an organization that has been identified as a tidal power stakeholder in the Bay of Fundy region. For the purposes of this study, a stakeholder organization can be any organization which is affected, either directly or indirectly, by tidal power activities. If you agree to participate, you will be interviewed by the principal researcher, Lee Wilson, in person at a time and location convenient to you. The interview will last for approximately 60 minutes. You will be asked questions pertaining to your organization's involvement in communications about tidal power in the Bay of Fundy. This interview will include

[7] This text changed depending on the type of organization being contacted (e.g., government entity was "manager"; research initiative was an "executive member")

questions and a “participatory mapping” portion wherein you will be asked to draw a diagram showing the different organizations with which your organization interacts about this issue.

Participation in this study should be of minimal risk to you. The probability of any harm occurring because of disclosing information regarding your organization’s role in tidal power communication networks is very low. Participation in the study is voluntary and you may withdraw at any time. With your permission, the interview will be audio recorded. When a transcription of your interview has been completed, the audio recording will be erased. Should you prefer that the interview not be audio recorded, the interviewer will make notes of your responses during the interview. As an added layer of confidentiality, your diagram of communication networks will be transcribed digitally using Social Network Analysis software and the original will be destroyed.

Attached is an Informed Consent Form with details on the study and two signature pages. If you wish to participate in the study, please reply to this email (email: lee.wilson@dal.ca). You will be asked to complete the attached consent form 1 before conducting the interview, at which time you may also ask any additional questions. You will be asked to complete consent form 2 after you complete an interview.

If you wish to obtain further information about the research initiative, I will be happy to respond to your questions.

Lee Wilson

School of Information Management
Dalhousie University, Halifax,
Nova Scotia, Canada

APPENDIX F – A List of Participant Organizations with Descriptions

Name	Description	URL
Acadia Tidal Energy Institute (ATEI)	"The Acadia Tidal Energy Institute (ATEI) is a non-profit organization conducting tidal energy research, training, education and outreach to support sustainable development of the emerging tidal energy industry."	http://tidalenergy.acadiau.ca/
Black Rock Tidal Power	"Founded 2013 and located in Halifax, Black Rock Tidal Power is a privately-owned company offering tailor-made tidal energy converter systems and related services for the North American market."	http://www.blackrocktidalpower.com/
Cape Sharp Tidal	"Cape Sharp Tidal is a joint venture between Emera Inc. and OpenHydro, a DCNS company, with the objective of providing tidal energy to Nova Scotians beginning in 2015."	http://capesharptidal.com/
Cumberland Energy Authority	"The Cumberland Energy Authority was formed in 2012 through an Inter-Municipal Agreement between the Municipality of the County of Cumberland, the Town of Parrsboro, and the former Town of Springhill to promote regional energy development."	http://www.cumberlandcounty.ns.ca/cumberland-energy-authority.html
Fisheries and Oceans Canada (DFO)	"Fisheries and Oceans Canada (DFO) has the lead federal role in managing Canada's fisheries and safeguarding its waters."	http://www.dfo-mpo.gc.ca/index-eng.htm
Fundy Energy Research Network (FERN)	"The Fundy Energy Research Network (FERN) is an independent non-profit organization initiated by academic and government researchers as a forum to: coordinate and foster research collaborations, capacity building and information exchange to advance knowledge, understanding and technical solutions related to the environmental, engineering & socio-economic factors associated with	http://fern.acadiau.ca/

	tidal energy development in the Bay of Fundy."	
Fundy Ocean Research Centre for Energy (FORCE)	"FORCE acts as a host to technology developers, providing the electrical infrastructure to deliver power to the grid; FORCE also oversees an independently reviewed environmental monitoring in the Minas Passage. FORCE also conducts research to better understand the site conditions, estimated to contain 2,500 megawatts of extractable power."	http://fundyforce.ca/
Fundy Tidal Inc.	"Fundy Tidal was established on Brier Island in 2006 as a result of local interest to generate marine renewable energy from the tidal currents of the Outer Bay of Fundy, Nova Scotia including Digby Gut, Grand Passage and Petit Passage. Fundy Tidal's focus is small-scale tidal energy projects that involve community ownership and local benefits."	www.fundytidal.com/
Institute of Oceans Research Enterprise (IORE)	"Atlantic Canada hosts several federal research laboratories, multiple universities and a growing private sector focused on oceans. IORE is building partnerships among these groups to both boost marine research and translate it into real economic opportunity. IORE is the core outreach vehicle for the Canada Excellence Research Chair in Ocean Science and Technology."	http://iore.ca/
Mi'kmaq Rights Initiative: Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO)	"The Mission of Kwilmu'kw Maw-klusuaqn Negotiation Office is to address the historic and current imbalances in the relationship between Mi'kmaq and non-Mi'kmaq people in Nova Scotia and secure the basis for an improved quality of Mi'kmaq life. KMKNO will undertake the necessary research, develop consensus positions on identified issues, and create public and community awareness in a manner	http://mikmaqrights.com/about-us/kmkno-mission-statement/

	that supports the ability of the Assembly to fully guide the negotiations and the implementation and exercise of constitutionally protected Mi'kmaq rights."	
Marine Renewables Canada (MRC)	"Marine Renewables Canada aligns industry, academia and government to ensure that Canada is a leader in providing ocean energy solutions to a world market."	http://www.marinerenewables.ca/
Minas Energy	"Everyone has energy opportunities. We convert energy opportunities into results, so you can focus on your strengths. Energy projects require significant coordination and expertise. Minas Energy can take care of it all, or perform smaller scopes as part of your team."	http://www.minasenergy.com/
Municipality of the District of Digby (MODD)	MODD is a municipal district in Digby County, Nova Scotia, Canada.	http://www.digbydistrict.ca/
Nova Scotia Department of Energy (NSDOE)	NSDOE is a provincial department in Nova Scotia, Canada with a mandate for energy regulation.	http://energy.novascotia.ca/
Nova Scotia Department of Fisheries and Aquaculture	"The Department of Fisheries and Aquaculture has a legislated mandate to manage, promote, support and develop the fishing, aquaculture and seafood processing industries that contribute to the economic, environmental and social prosperity of Nova Scotia's coastal and rural communities."	http://novascotia.ca/fish/
Offshore Energy Research Association (OERA)	"Offshore Energy Research Association of Nova Scotia (OERA) is an independent, not-for-profit organization that funds and facilitates collaborative offshore energy and environmental research and development including examination of renewable energy resources and their interaction with the marine environment."	http://www.oera.ca/
Parrsboro and Area District Board of Trade	"The Parrsboro and District Board of Trade promotes business along the Parrsboro Shore of Nova Scotia from Apple River to Bass River, and north	http://pdbot.ca/

	to Southampton, including parts of Cumberland and Colchester Municipalities.”	
Town of Parrsboro	Parrsboro is a Canadian town located in Cumberland County, Nova Scotia.	http://www.town.parrsboro.ns.ca/
Anonymous Government Organization	One interviewee from government agreed to take part in the participatory mapping exercise, but did not consent to the use of quotations or for the organization to be identified as a participant.	

APPENDIX G – Organizations in the Tidal Power Communication Network

Organization	Sector
Aboriginal Affairs and Northern Development	Government
Acadia Centre for Estuarine Research	Research
Acadia First Nation	First Nations
Acadia Tidal Energy Institute	Research
Acadia University	Research
AECOM Canada Ltd.	Industry
Aecon Atlantic Industrial Inc.	Industry
Akoostix Inc	Industry
Albert County	Government
Allswater Marine Consultants	Industry
Alstom	Industry
Andritz Hydro Canada Inc.	Industry
Annapolis Valley First Nation	First Nations
Aon Reed Stenhouse Inc.	Industry
ATCO	Industry
Atlantic Canada Opportunities Agency	Government
Atlantic Coastal Zone Information Steering Committee	Research
Atlantic Towing	Industry
Atlantis Resources Ltd.	Industry
Bay of Fundy Ecosystem Partnership	Research
Bay of Fundy Tourism Partnership	Tourism
Bear River First Nation	First Nations
Bedford Institute of Oceanography	Research
Blackrock Tidal	Industry
Blomidon Naturalist Society	Research
Blue Water Energy Services	Industry
Business Development Bank of Canada	Government
Canada Revenue Agency	Government
Canada-Nova Scotia Offshore Petroleum Board	Industry
Canadian Environmental Assessment Agency	Government
Canadian Whale Institute	Research
Cape Breton Regional Municipality	Government
Cape Breton University	Research
Cape Sharp Tidal (OpenHydro/Emera)	Industry
Central Nova Tourist Association	Tourism
Cherubini Metal Works Limited	Industry
Clean Current	Industry
Connors Diving Services Ltd	Industry

Cumberland Energy Authority	Government
Dalhousie University	Research
Davis MacIntyre & Associates Limited	Industry
Department of Fisheries and Oceans Canada	Government
Department of Foreign Affairs, Trade and Development	Government
Digby and Area Board of Trade	Industry
Discovery Centre	Research
DNV GL	Industry
Dominion Diving Limited	Industry
DP Marine Energy Ltd.	Industry
Dynamic Systems Analysis Ltd.	Research
Ecology Action Centre	NGO
Efficiency Nova Scotia	Research
EMO Marine Technologies Ltd.	Industry
Encana Corporation	Industry
Engineers Nova Scotia	Industry
Environment Canada	Government
Environmental Services Association of Nova Scotia	Government
Eskasoni First Nation	First Nations
ETA Ltd.	Industry
European Marine Energy Centre	Research
Export Development Canada	Government
Federation of Canadian Municipalities	Government
FloWave Ocean Energy Research Facility	Research
Fort Folly First Nation (NB)	First Nations
Fundy Energy Research Network	Research
Fundy Geological Museum	Tourism
Fundy Ocean Research Center for Energy	NGO
Fundy Tidal Inc.	Industry
Gardner Pinfold Consulting	Industry
General Dynamics Canada	Industry
Geo-Spectrum Technologies Inc.	Industry
Glas Ocean	Industry
Glooscap First Nation	First Nations
Ground Fishers	Fishing
Gulf of Maine Institute	Research
Halcyon Tidal Power	Industry
Halifax Regional Municipality	Government
Hants County	Government
Heavy Current Fishers Association	Fishing
Hughes Offshore and Shipping Services	Industry

Huntsman Marine Science Centre	Industry
IEA Ocean Energy Systems (OES)	Research
Igloo Innovations Inc.	Industry
Industrial Research Assistance Program	Government
Industry Canada	Government
Innovacorp	Industry
Innovate UK	Research
Institute for Oceans Research Enterprise	NGO
International Electrotechnical Commission	Industry
International Network on Offshore Renewable Energy	Research
Internetworking Atlantic Inc.	Industry
Irving Transportation Ltd.	Industry
Islands Tidal Power Advisory Group	Industry
JASCO Research Ltd.	Industry
KMKNO (Mi'kmaq Rights Initiative)	First Nations
Lengkeek Vessel Engineering Inc.	Industry
LFA 35	Fishing
Lions Club	NGO
Lloyd's of London	Industry
Lockheed Martin	Industry
Longline Fishers Group	Fishing
Marine Current Turbines	Industry
Marine Environmental Observation Prediction and Response	Research
Marine Renewables Canada	NGO
Marine Scotland	Research
Maritime Tidal Energy Corp.	Industry
Maritimes Energy Association	NGO
Martec Limited	Industry
McInnis Cooper	Industry
Membertou First Nation	First Nations
Mi'kmaq Employment Training Secretariat	First Nations
Mi'kmaw Conservation Group	First Nations
Mi'kmaw Native Friendship Centre	First Nations
Millbrook First Nation	First Nations
Minas Energy	Industry
Mount Allison University	Research
Mount Saint Vincent	Research
Municipality of Argyle	Government
Municipality of Clare	Government
Municipality of the County of Annapolis	Government
Municipality of the County of Colchester	Government

Municipality of the County of Cumberland County	Government
Municipality of the County of Kings	Government
Municipality of the District of Digby	Government
National Research Council Canada	Government
Native Council Of Nova Scotia	First Nations
Natural Resources Canada	Government
Natural Sciences and Engineering Research Council	Government
Nautricity	Industry
New Energy Corp	Industry
Newfoundland and Labrador Environmental Industry Association	Industry
Newfoundland and Labrador Oil and Gas Industries Association	Industry
Nova Scotia Business Inc.	Industry
Nova Scotia Community College	Research
Nova Scotia Power Inc.	Industry
Nova Scotia Utility and Review Board	Industry
NS Communities, Culture and Heritage	Government
NS Department of Energy	Government
NS Department of Finance	Government
NS Department of Fisheries and Aquaculture	Government
NS Department of Natural Resources	Government
NS Economic and Rural Development and Tourism	Government
NS Environment	Government
NS Intergovernmental Affairs	Government
NS Labour and Advanced Education	Government
NS Municipal Affairs	Government
NS Office of Aboriginal Affairs	Government
NS Transportation and Infrastructure Renewal	Government
Ocean Array Systems Ltd.	Industry
Ocean Networks Canada	Research
Ocean Renewable Power Company	Industry
Ocean Sonics	Industry
Ocean Technology Council of Nova Scotia	Research
Ocean Tracking Network	Research
Oceans Ltd.	Industry
Offshore Energy Research Association	NGO
Pacific Northwest National Laboratory	Research
Paqtkek First Nation	First Nations
Parrsboro and District Board of Trade	Industry
Parrsboro Harbour Commission	Industry
Pictou Landing First Nation	First Nations

Potlotek First Nation	First Nations
Privy Council Office Canada	Government
Public Works and Government Services Canada	Government
Queen's University	Research
R.J. MacIsaac Construction	Industry
Rafe’s Construction	Industry
Rockland Scientific International	Industry
RSA Group Canada Insurance Co	Industry
Safe Bass Fishers	Fishing
Saint Mary's University	Research
Schottel	Industry
Scottish Association for Marine Sciences	Research
Scottish Development International	Industry
Sea Mammal Research Unit	Research
Seaforth Geosurveys Inc.	Research
Shellfish/Clam Fishers Organization	Fishing
Siemens Canada	Industry
Sipekne'katik First Nation	First Nations
SLR Consulting Ltd.	Industry
St. Francis Xavier University	Research
Stantec Consulting Ltd.	Industry
Striped Bass Association	Fishing
Strum Consulting	Industry
Sustainable Development Technology Canada	Government
TD Friends of the Environment	Industry
Tekmap Consulting	Research
The Confederacy of Mainland Mi'kmaq	First Nations
The Crown Estate	Government
The Probus Club of Annapolis Valley	Industry
Tidal Readiness Committee (Parrsboro)	Industry
Tidal Stream Limited	Industry
Tocardo	Industry
Town of Amherst	Government
Town of Digby	Government
Town of Hantsport	Government
Town of Parrsboro	Government
Town of Springhill	Government
Trade Centre Limited	Tourism
Transport Canada	Government
Tri-Tech Services	Industry
U.S. Department of Energy	Government

UK Department of Energy and Climate Change	Government
Ultra Electronics	Industry
Unama'ki Institute of Natural Resources	First Nations
University of Maine	Research
University of Manitoba	Research
University of New Brunswick	Research
University of Southampton	Research
University of St Andrews	Research
University of Strathclyde	Research
University of Victoria	Research
University of Washington	Research
Vemco	Industry
Verschuren Centre	Research
Village of Scot's Bay	Government
Wagmatcook First Nation	First Nations
Weir Fishers	Fishing
We'koqma'q First Nation	First Nations
Western Economic Diversification Canada	Government
World Wildlife Foundation	NGO

APPENDIX H – Industries Involved in Tidal Power (adapted from CanmetENERGY, 2011)

Supply Chain Segment	Description
Technology Developers	Marine energy conversion device innovators, designers, and developers.
Manufacturers and suppliers	Manufacturers and component suppliers.
Project developers	Utilities and independent power producers.
Development services	Resource assessment/modelling, mapping, environmental impact assessment, sea floor environmental assessment and related marine safety and supply consulting, permitting, approvals planning, marine corrosion consulting.
Supporting technology providers	Wave/tidal current resource measurement devices, environmental monitoring devices, buoys, underwater remote vehicle operators/owners, technical resource monitoring, and data collection.
Engineering and construction	Safety management, work platforms, underwater operators, cabling and electrical interconnection for marine operations/facilities, anchoring systems, engineering firms (electrical, civil, mechanical), on-site supervision, and management.
Operations and maintenance	Operational monitoring, transportation, port facilities, and marine operators with related experience (including transport vessels and operators and certified diving teams) with the ability to do deployment/removal, emergency repair, mitigation strategies, and asset management.
Business services	Legal, financial, insurance, business, communications, market research, and training activities.