The ties that bind: Connections, patterns, and possibilities for marine protected areas

by

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A thesis
presented to the University of Waterloo
in fulfillment of the
thesis requirement for the degree of
Doctor of Philosophy
in
Social and Ecological Sustainability

Waterloo, Ontario, Canada, 2015

AUTHOR'S DECLARATION

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions (p. iii). This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

STATEMENT OF CONTRIBUTIONS

I am the sole author of Chapter 1 and Chapter 5 of this dissertation. Chapters 2 – 4 are based on manuscripts that were co-authored. Chapter 2 was co-authored with Derek Armitage. Chapter 3 was co-authored with Derek Armitage and Anthony Charles. Chapter 4 was co-authored with Derek Armitage and Peter Carrington. I was the lead author for all three co-authored manuscripts. Bibliographic citations for the co-authored chapters have been included below.

Chapter 2 – A social relational network perspective for MPA science

Alexander, S. and Armitage, D. 2015. A social relational network perspective for MPA science. *Conservation Letters 8*(1): 1-13.

Chapter 3 – Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries

Alexander, S., Armitage, D., and Charles, A. 2015. Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries. *Global Environmental Change 35*: 213-225.

Chapter 4 – Social connectivity in an emerging marine reserve network and the challenge of governance 'fit'

Alexander, S., Armitage, D., and Carrington, P. Social connectivity in an emerging marine reserve network and the challenges of governance 'fit'. *Manuscript.*

ABSTRACT

The purpose of this doctoral research is to characterize and assess how social networks enhance and inhibit the governance of marine protected areas (MPAs). Specifically, I examine the structure and function of multiple networks between social actors to better understand their role in the governance of MPAs, and to address a gap in our understanding of how formal and informal rules, rule-making systems, and actor networks contribute to different MPA outcomes. A focus on the social dimensions of MPAs is critical, as they have emerged as a significant marine conservation and climate change adaptation strategy with substantial implications for coastal communities. The research pursues three specific research objectives: (1) to conceptually develop and illustrate the utility of a social relational network perspective for policy-relevant MPA science; (2) to identify and describe how social networks support and constrain transitions to co-management of small-scale fisheries and MPAs; and (3) to examine how social connectivity among actors affiliated with a MPA network can enhance and inhibit governance fit.

Formal and informal social networks have been repeatedly cited as a key attribute of multi-actor governance arrangements (e.g., co-managed MPAs) in the broader natural resource management literature. Similarly, the role of social networks has been identified as one of the research frontiers for policy-relevant MPA science. However, not all networks are structurally equal with research suggesting that different patterns of social relations contribute to different management and governance outcomes. Accordingly, understanding how social networks influence outcomes of MPAs is a key research area that has been understudied.

A synthetic review was first conducted to outline the emergence and benefit of applying a structurally explicit, social relational network perspective to inform the establishment and governance of MPAs and MPA networks. This social relational network perspective was then used to gain key insights regarding the role of networks for the governance of MPAs and MPA networks based on two empirical cases in Jamaica. The first was a comparative study focused on three *Special Fishery Conservation Areas* (SFCAs) – i.e., marine no-take areas – and focused on ties between individual fishermen and wardens. The second case examined the actors associated with the national network of *Special Fishery Conservation Areas* – of which there are fourteen in total – and thus focused on ties between organizations from across the island that contribute to the governance of the SFCAs. Data were collected via a social relational survey (n = 380), semi-structured interviews (n = 63), an organizational network survey (n = 18), focus groups (n = 10), literature and document review, and participant observations. Social network analysis was coupled with qualitative content analysis to assess how patterns of relational ties and interactions between social actors enhance and inhibit the governance of MPAs.

This thesis conceptually develops and empirically illustrates the insights and contributions to be gained from taking a social relational network perspective to examine MPA governance, including how such an approach can be applied at different scales (e.g., community level interactions, organizational interactions) and to understand different aspects and issues (e.g., transitions to co-management, governance fit). The second contribution of this study is to illustrate the utility of a social relational network perspective to examine and understand key governance attributes previously identified in

the literature – specifically community cohesion and leadership. The third contribution of this study concerns the re-orientation of thinking about MPA networks from a purely ecological and biophysical perspective towards a greater emphasis on social connectivity. A re-orientation towards the consideration of social connectivity among actors associated with a MPA network contributed to preliminary insights concerning how the structure and function of governance networks may enhance and inhibit mismatches (i.e., spatial, temporal, functional) that plague individual MPAs. While the findings presented here are based on research in Jamaica, they are germane to a wide range of contexts given the global expansion of MPAs and MPA networks where similar social relational challenges and opportunities are bound to occur.

ACKNOWLEDGEMENTS

I would like to start by thanking all of the participants in this study, including those from the communities of Bluefields Bay, Oracabessa Bay, and Orange Bay. I would also like to express my gratitude and acknowledge the Caribsave Partnership, especially Owen Day, Donovan Campbell, Simone Lee, and Michelle McNaught, and the Fisheries Division of the Jamaican Ministry of Agriculture and Fisheries, especially Oliver Squire and Anginette Murray, for their ongoing field support and insights. In addition I am grateful for the many field assistants from Bluefields Bay (Janice Mair, Tamekia Hughes, Vanessa Morgan, and Theresa Vaz), Oracabessa Bay (Sellina Jarrett, Shanna-Kay Brown, Jodi-Ann Holland, Abigail Adams), and Orange Bay (Samantha Mullings, Michell James, Kimberley Dacres, Ladeisha Blidgen) that made this research possible.

Despite only spending a relatively short time in Waterloo, I always had a strong and supportive community of colleagues including those in my cohort in the Department of Environment and Resource Studies and through the Environmental Change and Governance Group. I would like to especially thank Mark Andrachuk, Samantha Berdej, Kaitlyn Rathwell, and Jeremy Pittman for the many informative conversations and collaborations throughout this journey and always being willing to review drafts of my work.

A huge thank you to my advisor Dr. Derek Armitage for his continuous support, timely feedback, guidance, and wisdom. Thank you also to my committee, Drs. Peter Carrington, Rob de Löe, and Tony Charles for your insights and feedback throughout.

I would like to also acknowledge the following funding sources that made this research possible: Social Sciences and Humanities Research Council (SSHRC) Doctoral

Fellowship; International Development Research Centre (IDRC) Doctoral Research Award; Ontario Ministry of Training, Colleges, and Universities Ontario Graduate Scholarship; Partnership for Canada-Caribbean Community Climate Change Adaptation (IDRC and Canada Tri-Council – SSHRC, NSERC, CIHR | PI's: Drs. Daniel Scott and Murray Simpson); and the University of Waterloo.

I have been fortunate and am forever grateful for the support and encouragement I received from my friends and family both near and far. I would like to especially thank Jackie Dawson for her invaluable insights and advice at every step of the process. Not to mention, she was the one to suggest I reach out to Derek as I was searching for potential advisors to work with. Finally, words cannot express my sincere gratitude and appreciation for the unwavering love and support from my best friend and wife, Marianne Alexander.

DEDICATION

This dissertation is dedicated to the numerous communities around the world who are working tirelessly to find innovative ways to thrive socially and ecologically in the face of significant environmental change. This dissertation is also dedicated to my son Arlo and the rest of his generation who will be left with our legacy. May you find hope and inspiration from those that came before you.

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LIST OF ABBREVIATIONS

ABM	Agent Based Model
BBFFS	Bluefields Bay Fisherman's Friendly Society
CaMPAM	Caribbean Marine Protected Areas Management Network and Forum
CARSEA	Caribbean Sea Ecosystem Assessment
CBD	Convention on Biological Diversity
CBO	Community-Based Organization
CCI	Caribbean Challenge Initiative
DBML	Discovery Bay Marine Lab
ERGM	Exponential Random Graph Model
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEF	Global Environment Facility
GPS	Geographical Positioning System
IOJ	Institute of Jamaica
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JCRMN	Jamaica Coral Reef Monitoring Network
MPA	Marine Protected Area
NEPA	National Environment and Planning Agency
NGO	Non-Governmental Organization
PIOJ	Planning Institute of Jamaica
POC	PEW Oceans Commission
SFCA	Special Fishery Conservation Area
SIDS	Small Island Developing States
SNA	Social Network Analysis
SST	Sea Surface Temperature
WCPA	World Commission on Protected Areas

Chapter 1
Introduction

1.1 Research Context and Problem Rationale

Coastal-marine systems are highly vulnerable to both current and future environmental change, including climate change. In response to the vulnerability and health of coastal-marine ecosystems, various strategies have been proposed, including integrated-coastal zone management (Cicin-Sain and Knecht 1998), marine spatial planning (Ehler and Douvere 2009), and ecosystem-based management (McLeod and Leslie 2009). One particular strategy that has garnered attention is Marine Protected Areas (MPAs) (Box 1.1).

In a relatively short time frame, MPAs have emerged as a significant marine conservation strategy (Lubchenco, *et al.* 2003; Christie 2011). Globally, the number of MPAs has increased dramatically, from less than 200 in 1970 to more than 11,000 to date (Thorpe, *et al.* 2011; Marine Conservation Institute 2015). This trend is expected to continue, especially considering the Contracting Parties to the Convention on Biological Diversity recently reaffirmed their goal to protect and/or manage 10% of the world's oceans and seas by means of MPAs by 2020 (Toropova, *et al.* 2010). The establishment of the world's single largest marine protected area in 2015 (PEW 2015) and the largest marine protected area system in 2012 (PEW 2012) are evidence of this trend.

Box 1.1 Selected definitions of marine protected areas

Marine Protected Area (IUCN/WCPA 2008)
A clearly defined geographical space recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Marine Protected Area Network (WCPA/IUCN 2007)
A collection of individual marine protected areas operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological aims more effectively and comprehensively than individual sites could alone.

Simultaneously, there has been a small but increasing cohort of scholars noting the lack of consideration concerning the social dimensions of MPAs and MPA networks, including governance (Christie, *et al.* 2003; Charles and Wilson 2009; Christie 2011; Fox, *et al.* 2012a; Bennett and Dearden 2014). Governance systems have been cited as enabling or constraining the establishment and performance of marine protected areas (Charles and Wilson 2009; Jones 2014). Furthermore, a recent comparative study of 127 MPAs illustrates the complexities of governance having found rule compliance to be influenced by an array of social, political, and economic factors rather than a simple function of enforcement (Pollnac, *et al.* 2010). As such, there is a need to move beyond viewing MPAs as simply a legal and spatial tool. Governance is defined here as the formal and informal rules, rule making systems, and actor networks at all levels (i.e., local, regional, global) that influence how societies make decisions and implement actions (see Box 1.2 for actor networks) (adapted from Biermann, *et al.* 2009). Accordingly, governance provides a valuable analytical entrée to examine the emerging diversity of actors, institutions (i.e., formal and informal), and processes concerning MPAs.

Formal and informal social networks have been repeatedly cited as a key attribute of multi-actor governance arrangements (e.g., co-managed MPAs) in the broader natural

resource management literature (Dietz, *et al.* 2003; Pretty 2003; Folke, *et al.* 2005; Lebel, *et al.* 2006; Gutierrez, *et al.* 2011; Armitage, *et al.* 2012). Similarly, Fox *et al.* (2012a) identified the role of social networks as one of the research frontiers for policy-relevant MPA science. However, not all networks are structurally equal with research suggesting that different patterns of social relations contribute to different management and governance outcomes (Newman and Dale 2005; Bodin, *et al.* 2006; Bodin and Crona 2009; Henry and Vollan 2014). Accordingly, understanding how social networks influence outcomes of MPAs is a key research area that has been understudied (Alexander and Armitage 2015; see Chapter two).

1.1.1 Research Objectives

Social networks have been repeatedly cited as a key governance attribute, yet much remains unknown as to their specific role. Therefore, the purpose of this doctoral research is to characterize and assess how social networks enhance and inhibit the governance of marine protected areas. This study explores the structure and function of multiple networks between actors to better understand their role in the governance of MPAs. Within the broader purpose stated above, there are three specific research objectives:

1. To conceptually develop and illustrate the utility of a social relational network perspective for policy-relevant MPA science;
2. To identify and describe how social networks support and constrain transitions to co-management of small-scale fisheries and MPAs; and
3. To examine how social connectivity among actors affiliated with a MPA network enhance and inhibit governance fit.

Through these objectives three significant contributions are made. This thesis conceptually develops and empirically illustrates the insights and contributions to be gained from taking a social relational network perspective for examining MPA governance, including how such an approach can be applied at different scales (e.g., community level interactions, organizational interactions) and for understanding different aspects and issues (e.g., transitions to co-management, governance fit). The second contribution of this study is illustrating the utility of a social relational network perspective for examining and understanding key governance attributes previously identified in the literature – specifically community cohesion and leadership (Gutierrez, *et al.* 2011; Pomeroy, *et al.* 2011; Ayers and Kittinger 2014; Levin and Richmond 2014). The third contribution of this study concerns the re-orientation of thinking about MPA networks from a purely ecological and biophysical perspective towards a greater emphasis on social connectivity. This re-orientation specifically contributes to preliminary insights concerning how social connectivity may enhance and inhibit mismatches (i.e., spatial, temporal, functional) that plague individual MPAs (see Chapter Five).

This dissertation adopts a manuscript-style form. Three stand-alone manuscripts written specifically for publication in peer-reviewed journals make up the core of the dissertation and align with the three objectives outlined above. The next section briefly considers the governance of MPAs and associated governance challenges. The remainder of this chapter then provides an overview of the empirical context and methods used in the research. The chapter concludes with an overview of the structure of the dissertation.

1.2 Governance of Marine Protected Areas

While an emerging literature exists concerning the management of MPAs (e.g., Thorpe, *et al.* 2011), fewer studies take an explicit governance perspective (Jones, *et al.* 2011; see Van Trung Ho, *et al.* 2014). Management and governance are neither synonymous nor mutually exclusive (Armitage, *et al.* 2012). While management is concerned with operational decisions, specific outcomes, and shorter timeframes, governance is characterized by a longer purview and the consideration of additional social dimensions, structures, and processes (e.g., institutions, values, social networks) (Folke, *et al.* 2005; Lebel, *et al.* 2006; Paavola 2007; Kooiman, *et al.* 2008; Armitage, *et al.* 2012). As such, governance considers and provides the context that enables management (Folke, *et al.* 2005; Lebel, *et al.* 2006; Armitage, *et al.* 2012).

Jones and colleagues (Jones, *et al.* 2011; De Santo, *et al.* 2013; Jones 2014) have conducted perhaps the most extensive empirical examination concerning the governance of MPAs. Synthesizing twenty case studies from around the world, they focused on the role of five incentives (i.e., economic, interpretive, knowledge, legal, and participative) (Jones, *et al.* 2011). Findings point to the importance of employing a diversity of incentives and the coupling of top down and bottom up approaches. The latter point reflects a similar argument put forward and illustrated by Sievanen *et al.* (2011). While these are important contributions that advance our collective understanding of MPA governance, the study conducted by Jones and colleagues was largely concerned with the institutional dimensions of governance with its focus on incentives. Similarly, recent studies have begun to explore the governance of MPA networks (e.g., Horigue, *et al.* 2012; 2014; Solandt, *et al.* 2014). These studies have largely focused on the legal (e.g.,

Lowry, *et al*. 2009) and institutional (e.g., Lowry, *et al*. 2009; Green, *et al.* 2011) dimensions of governance. Overall, few studies have focused explicitly on the social networks among the resource users associated with MPAs (e.g., Ramirez-Sanchez 2011) or among the actors (i.e., state and non-state) associated with MPAs networks (e.g., Pietrie, *et al.* 2009; Cohen, *et al.* 2012). Accordingly, this dissertation employs a social relational network perspective to examine two acute MPA governance challenges and the associated role of social networks: 1) transitions to co-management and 2) the problem of governance fit.

1.2.1 A Social Relational Network Perspective for MPA Governance

This dissertation develops and applies a social relational network perspective – defined here as a conceptual model and associated suite of analytical methods (*sensu* Alexander and Armitage 2015; see Chapter 2). A social relational network perspective is informed by relational sociology (e.g., Emirbayer 1997; Mische 2011) and social network analysis (e.g., Wasserman and Faust 1994), and emphasizes: i) relations among individuals rather than personal attributes; ii) networks rather than groups; and iii) specific relations or patterns of relations relative to their broader relational context (Marin and Wellman 2011; Alexander and Armitage 2015). Taken together, these three points provide the underpinnings of a network perspective to examine the social dimensions of MPAs and MPA networks.

A social relational network perspective provides a theory-driven framework for further modeling and empirical analysis. Specifically, it provides one entrée to consider, individually and in concert, the social processes (e.g., participation, collaboration), social attributes (e.g., trust), and actor roles (e.g., bridging organizations) associated with MPAs

and MPA networks (see Figure 2.2). The social relational network perspective for MPA science emerges from several interdisciplinary bodies of literature (Bodin and Prell 2011), although I draw attention in particular to social networks (e.g., Wasserman and Faust 1994), conservation planning (e.g., Mills, *et al.* 2013) and environmental governance (e.g., Armitage, *et al.* 2012) (see Figure 2.2). The social relational network perspective for MPA governance is further developed in Chapter 2.

1.2.2 Transitions to Co-management

Co-management arrangements for the conservation of natural resources have been discussed for decades (e.g., Charles 1988; Pinkerton 1989) and are increasingly adopted in coastal-marine environments (Evans, *et al.* 2011; Gutierrez, *et al.* 2011). The establishment and adoption of co-management approaches for marine protected areas (MPAs) – including marine reserves – have followed a similar trend (Johannes 2002; Alcala and Russ 2006; Govan, 2009). These newly established co-management arrangements often involve the devolution of responsibilities associated with day-to-day management of natural resources, and in some instances a transfer of power and authority from national government agencies to communities and sub-national governments (Pomeroy, *et al.* 2004; Carlsson and Berkes 2005). In addition, co-management can involve the participation of local community groups or resource users in decision-making, implementation, and enforcement (Jentoft, *et al.* 1998; Berkes 2010). When MPAs are contemplated for coastal areas, there are typically strong interactions with small-scale fisheries, which can create significant governance issues, in terms of interactions between resource users and conservationists (Garcia, *et al.* 2014), and for governance of MPAs themselves (Jones 2014).

Box 1.2 Actor networks and environmental governance

Following Biermann *et al.* (2009) governance, as it is defined here, includes *actor networks at all levels (i.e., local, regional, global)*. Below I describe and define how I have operationalized the concept of *actor networks* (e.g., conceptually, analytically) throughout this dissertation as I have taken a pluralistic approach.

Social Network

A A social network is a set of socially relevant nodes connected by one or more relations (Marin and Wellman 2011, p. 11). Socially relevant nodes are commonly individuals or organizations, but could also include other units that are connected to each other such as departments within a university.

B Social networks reflect the relational ties that connect individuals/ stakeholders (e.g., fishermen, wardens) "within a fairly well-defined management area" (Bodin, *et al.* 2006, p. 1).

Governance Network

Governance networks reflect the vertical and horizontal relational ties that connect individuals (e.g., harvesters), agencies (fisheries departments), organizations (e.g., local conservation committees, fishermen cooperatives), and private sector interests in collaborative efforts to achieve a range of objectives (e.g., restoration, protection, multi-use) (Alexander, *et al.* in press).

Differentiating between social networks (Def. B) and governance networks

One of the main differences as defined here is that social networks are concerned with ties between individuals while governance networks are concerned with ties between organizations (e.g., government agencies, NGOs, cooperatives, universities, private foundations, etc.). While the reference to social networks used throughout the latter part of the dissertation tends to focus on connections between individuals within a "well-defined management area" (Bodin *et al.* 2006, p. 1) they can span place and space. Similarly, while reference to social networks used throughout the dissertation tends to focus on connections between individuals at a single level (e.g., among local fishermen), they can also include connections to individuals who hold positions in organizations and agencies at other levels (e.g., administratively, politically).

Chapter 2

Social network is used throughout Chapter 2. Here, it is used in the broadest sense referring to connections between individuals in some instances while at other times the connections between organizational entities. Accordingly, it reflects definition A.

Chapter 3

Social network is used throughout Chapter 3. Here, its use reflects definition B as the focus is on relational ties between individuals associated with a particular marine reserve (i.e., a well-defined management areas). The reference to horizontal and vertical linkages in this chapter aligns conceptually with what is being defined above as governance networks. However, for consistency and clarity in the manuscript an additional term was not introduced.

Chapter 4

Governance network is used throughout Chapter 4. Here, its use reflects the above definition as the focus is on relational ties between organizational entities (e.g., government agencies, NGOs, cooperatives, universities, private foundations, etc.).

Chapter 5

Both social network and governance network are referred to in Chapter 5.

Chapter 2 was written early on and reflects how the term social network is most commonly used in the literature (Definition A). However, because of my interest and pursuit to understand multiple interacting and overlapping 'social networks' I felt more specific terms and language were needed to better capture the analytical and conceptual diversity I was seeking. It is important to note that examining both social networks (Definition B) and governance networks provide insights into the governance of MPAs and MPA networks. Accordingly, I use the term social network (Definition A), in its broadest sense when articulating the overall objective of this dissertation – *to characterize and assess how social networks enhance and/or inhibit the governance of marine protected areas*.

In such cases, when MPAs and small-scale fisheries interact, it is crucial to consider the corresponding 'human dimensions' (e.g., social, cultural, economic, and political aspects) (Charles and Wilson 2009). Considerable progress has been made in understanding how these human dimensions influence transitions to co-management of MPAs and small-scale fisheries (Chuenpagdee and Jentoft 2007; Cinner, *et al.* 2012; Ayers and Kittinger 2014). A key ingredient is the existence of formal and informal social networks to enable effective multi-actor management and governance arrangements (e.g., co-managed MPAs) (Carlsson and Sandström, 2008; Bodin, *et al.* 2011). Social networks (see Box 1.2) – and associated aspects of leadership, social capital, and appropriate institutions – have been suggested to play a critical role in effective transitions to co-management of small-scale fisheries (Crona and Bodin 2010; Cinner, *et al.* 2012; Gutierrez, *et al.* 2011; Pomeroy and Andrew 2011). Social networks are considered to contribute to increased collaboration (Armitage, *et al.* 2009; Berkes 2009), collective action (Ostrom 1990; Pretty 2003), and the adoption of new norms (Friedkin, 1998; Frank 2011; Nunan, *et al.* 2015).

However, not all networks are structurally equal. Different patterns of social relations (i.e., network structures) contribute to different management and governance outcomes (Bodin, *et al.* 2006; Bodin and Crona 2009; Bodin and Prell 2011). Accordingly, two major questions arise. First, how do social networks support and constrain the transition to co-management, particularly in the context of weak state support (e.g., financial, institutional)? And second, what characteristics of the networks play the most significant role in this regard?

Chapter 3 addresses these questions in the context of marine reserves and small-scale fisheries in Jamaica. Specifically, a comparative analysis is provided of the social networks associated with three *Special Fishery Conservation Areas* (SFCAs) – i.e., marine no-take areas. Results suggests that the transitions to co-management were supported by a combination of three network structure and relational attributes: i) the presence and position of institutional entrepreneurs; ii) a dense central core of network actors; and iii) the prevalence of horizontal ties and vertical linkages held by the community-based organizations formally responsible for the management of the marine reserves (Alexander *et al.* 2015; see also Chapter 3). Findings also show that overall low network cohesion in the three reserves and limited social influence among the wardens may be problematic for sustained collective action that extends beyond the core set of network actors (Alexander *et al.* 2015; see also Chapter 3).

1.2.3 MPA Networks and the Problem of Governance Fit

The argument regularly put forward for the establishment of MPA networks (see Box 1.1) is premised on the limitations of single MPAs to adequately improve and/or maintain healthy ecosystems – i.e., a failure of fit (Agardy 2005; see Table 4.1). The problem of fit is described here as a mismatch (i.e., lack of congruence) between the attributes or features of a system of governance (i.e., rules, rule-making systems, and actor-networks) and the larger set of attributes or features of a social-ecological system (Folke, *et al.* 1998; Galaz, *et al.* 2008; Epstein, *et al.* 2015), commonly resulting in unintended consequences (e.g., further degradation, displacement). For example, individual MPAs become islands of protection, unable to effectively protect migratory and/or wide-ranging pelagic fish stocks (i.e., spatial mismatch) (Chakalall, *et al.* 2007), or

MPAs which protect single habitat types, in turn failing to account for the full life cycle requirements of marine species (i.e., temporal mismatch) (Agardy *et al.* 2011).

The problem of fit is particularly prevalent in coastal-marine systems (Berkes 2006; Crowder, *et al.* 2006; Wilson 2006). For example, a lack of consideration for the rights, rules, access, and sanctions associated with MPAs may in turn contribute to displacement (i.e., shifting activities and effort from one place to another). Thus, rather than improving fit, the MPA further contributes to the problem of fit. As Agardy *et al.* (2011) highlight, such displacement has potential ecological consequences (e.g., new stocks and/or new species exploited) as well as social consequences (e.g., increased competition and conflict among resource users).

The pervasiveness of mismatches reflects the unique challenges presented by coastal-marine systems including their transboundary nature (Crowder, *et al.* 2006), multi-sectoral setting (Crowder, *et al.* 2006; Fanning, *et al.* 2007), temporal and spatial variability (Crossland, *et al.* 2005), and prevalence of cross-scale dynamics (Wilson 2006). In addition, coastal-marine systems have a history of fragmented governance resulting from a tradition of sector-based approaches, whereby sectors such as fisheries, aquaculture, shipping, oil and gas, and marine mammal conservation are separately addressed (Crowder, *et al.* 2006). For example, in the United States there are approximately twenty different federal agencies responsible for over one hundred and forty ocean-related statutes (Crowder, *et al.* 2006). The result is a diversity of institutional arrangements, overlapping jurisdictional boundaries, and multiple agencies operating at different levels that may or may not be communicating with one another.

Addressing the problem of fit is a formidable challenge, yet necessary if MPAs

and MPA networks are to effectively address the impacts of marine resource exploitation and environmental change, including climate change. Most MPA networks are designed only with ecological processes in mind (see Table 4.2). However, improving fit requires moving beyond ecological processes and attributes (e.g., connectivity, replication, representation) (Alexander 2014). It requires critically examining the governance of MPA networks. As Galaz *et al.* (2008) posit, "[b]asing institutional design on ecological knowledge alone, without recognizing the fundamental impact of other institutions and social actors on ecological systems, is a simplistic approach that fails to appreciate the complexity of governance processes, mental models, and the social features that enable management of dynamic ecosystems" (p. 159-160).

Governance networks (i.e., formal and informal networks of actors; see Box 1.2) are one particular attribute that has been repeatedly suggested to address issues of fit in the broader environmental governance literature (Olsson, *et al*. 2007; Galaz, *et al.* 2008). For example, multi-actor governance networks have been noted to facilitate collaboration (Schneider, *et al.* 2003; Folke, *et al.* 2005; Cohen, *et al.* 2012), serve as a source of novelty and innovation (Folke, *et al.* 2005), and contribute to social learning through improving the flow of information and knowledge exchange (Olsson, *et al.* 2007; Weiss, *et al.* 2011).

While there is general agreement regarding the broad role of governance networks for addressing issues of fit, what is less well known and understood are the particular causal pathways for improving fit. This raises four interrelated questions. First, how do different network structures enhance or inhibit key governance processes (e.g., collaboration, knowledge exchange)? Second, do those key governance processes address

issues of fit? If those governance processes do indeed address issues of fit, then which particular aspects of fit (i.e., spatial, temporal, functional) do they address? And specifically how do those processes address different aspects of fit?

Chapter 4 addresses these questions concerning social connectivity in the context of an emerging network of marine reserves in Jamaica. Research findings suggest that multilevel linkages (e.g., linkages between local organizations managing the marine reserves and government agencies) likely played the greatest role in updating the rules and regulations associated with the marine reserves in a timely fashion to facilitate the effective management of lionfish and ongoing monitoring (i.e., overcoming a functional mismatch and avoiding a temporal mismatch). However, considering the prevalence of weak ties, lack of a culture of sharing and collaboration, and limited resources, the propensity of the multi-actor and multilevel networks for continuing to enhance fit and overcome mismatches remains uncertain.

1.3 Empirical Context

1.3.1 Caribbean

Coastal-marine systems in Small Island Developing States (SIDS) of the Caribbean are highly vulnerable to both current and future environmental change, including climate change (IPCC 2014, CARSEA 2007). Increased storm intensity, sea level rise, coastal erosion, coral bleaching, ocean acidification, and declining marine fisheries threaten the region (Pulwarty, *et al.* 2010; Nicholls and Cazenave 2010; see Table 1.1). Additionally, multiple drivers of change (e.g., coastal development) are producing cumulative effects that are complex, emergent, and cross-scale (CARSEA

2007). At stake are the health of marine ecosystems and the livelihoods and wellbeing of millions of coastal people.

A recent study conducted by the World Resources Institute found that more than 75% of Caribbean reefs are considered threatened (Burke, *et al.* 2011), due to a combination of impacts and environmental change including overfishing (Jackson, *et al.* 2001) and the die-off of long-spined sea urchins (*Diadema antillarum)* (Gardner, *et al.* 2003). As Burke *et al.* (2011) note, "[t]he co-occurrence of multiple threats is a particular problem. Reefs have survived heavy overfishing, but the combination of this threat with disease, hurricanes, pollution, and coral bleaching has been devastating for countries such as Jamaica, and for many areas in the Lesser Antilles" (p. 64). Jackson *et al*.'s (2014) *Status and Trends of Caribbean Coral Reefs* – the most comprehensive and rigorous region wide analysis to date – reaffirmed the poor status of the reefs, yet highlighted the potential for appropriate conservation and management strategies to be put in place to effectively address local impacts (e.g., overfishing, land-based pollution).

1.3.2 Jamaica

Jamaica is part of the Greater Antilles and the third largest island in the Caribbean. An island dominated by a mountainous topography with a narrow coastal plain, Jamaica has approximately 1,022 km of coastline. The coastal-marine environment includes several habitat types – beach, rocky shore, sea grass beds, mangroves and coral reefs – that provide a number of critical ecosystem services. Coral reefs, for example protect the coastline, contribute to the sandy beaches central to tourism, and provide critical habitat for fish (CARSEA 2007). As with other Caribbean islands, Jamaica is highly dependent on tourism. In 2013, travel and tourism contributed to one quarter of the country's gross

domestic product (GDP) (World Travel & Tourism Council, 2014). In addition, reef-dependent fisheries contribute to the livelihoods of nearly five percent of the island's population and upwards of seventy-five percent of households' in some communities (Burke and Kushner 2011; Burke, *et al.* 2011). Moreover, near shore artisanal fisheries provide close to ten percent of protein consumed by Jamaicans making it a matter of food security, especially for rural fishing communities (Waite, *et al.* 2011).

Figure 1.1 Map of Central America and the Caribbean

Map produced by the Cartographic Research Lab, University of Alabama

However, the coastal-marine systems – including coral reefs – of Jamaica are highly vulnerable to the impacts of climate change and are similarly faced with multiple issues, including sedimentation, pollution, and overfishing (Burke and Kushner 2011). The current projected effects of climate change on Jamaica's coastal-marine systems are outlined in Table 1.1. Regional projections for changes in the frequency and intensity of hurricanes are unclear due to highly uncertain modeling and confounding variables.

However, there is relatively high certainty for other climate related changes including ocean acidification, sea surface temperatures, and sea-level rise. The impacts of climate change have already been observed throughout the Caribbean and Jamaica. For example, the region experienced mass coral bleaching events in 1987, 1990, 1995, 1998, 1999, and 2005 (McWilliams, *et al.* 2005). It is important to note that the climate change-related impacts to coastal-marine systems – as outlined in Table 1.1 – will occur on different time scales ranging from years (e.g., coral bleaching events related to increases in SST) to multi-decadal (e.g., the deterioration of the structural integrity of coral reefs related to increases in acidity) (Cochrane, *et al.* 2009)

The synergistic and cumulative effects of climate change may significantly alter the structure and function of coastal-marine environments, which in turn could influence their ability to deliver the critical ecosystem services currently supporting society. Moreover, the drivers could contribute to regime shifts – i.e., a rapid transition to an alternative stable state – resulting in the loss of whole bundles of ecosystem services (Hughes, *et al.* 2003; Cochrane, *et al.* 2009).

In addition to the potential impacts of climate change, Jamaica faces a number of development challenges. Challenges range from high levels of crime and violence and inadequate transparency and accountability in governance to rising levels of unemployment and poverty (PIOJ 2012). Plagued by unemployment and underemployment, the rate of poverty across Jamaica in 2010 rose to an average of 17.6% (PIOJ 2012). However, in rural areas (which includes the majority of fishing communities), the poverty rate is even higher at 23.2% – with close to 1 in 5 living at or below poverty (PIOJ 2012).

Table 1.1 Climate change projections and potential impacts for coastal-marine environments of Jamaica and the Caribbean

Attribute	Projections	Confidence of Projections	Potential impacts on the coastal-marine environments of Caribbean & Jamaica
Hurricanes	• Increased intensity of events (including near storm rainfall and peak winds) but not necessarily an increase in storm frequency (Simpson, *et al.* 2012)	• Moderate to high confidence of intensity increases • Low to medium confidence in frequency due to primitive modeling and confounding variables (Simpson, *et al.* 2012)	• Infrastructure *Direct impacts* • Damage to coral reefs • Damage to mangroves (Simpson, *et al.* 2012) • Blowouts in sea-grass beds *Indirect impacts to coral reefs and sea grass beds:* • Increased sedimentation • Increased pollution
Sea surface temperature	• GCMs project annual mean SST increases of 0.9 to 2.7 C by 2080s relative to 1970-99 avg. (Simpson, *et al.* 2012)	• High confidence; increases already observed in some areas	• Contributes to coral bleaching (McWilliams, *et al*. 2005; Parry, *et al*. 2007) • Affects lifecycles of coral reef fish • Causes some species to shift range due to thermal tolerance • Corals often at upper thermal limit (Hughes, *et al.* 2003; Cochrane, *et al.* 2009)
Sea-level rise	• Increase of sea-level of 17-32 cm RCP2.6 or 19-33 cm RCP4.5 by 2046-2065; and 19-33 cm RCP2.6 or 32-63 cm by 2081-2100 (IPCC 2013)	• Medium confidence; increases already observed in some areas (Simpson, *et al.* 2012; IPCC 2013)	• Beach loss • Salinization of wetlands • Inundation of low lying areas • Growth of reefs unable to keep up (Knowlton 2001) • Loss of total mangrove area due to inability to migrate landward • Change in mangrove structure & species composition
Ocean acidification	• Decrease in surface ocean pH by end of 21st century: 0.06-0.07 RCP2.6, 0.14-0.15 RCP4.5 (IPCC 2013)	• Virtually certain; though research here is in its infancy and the impacts are uncertain (Cochrane, *et al.* 2009)	• Coral reefs and other marine organisms with carbonate skeletons (Parry, *et al.* 2007) • Possible impacts to broadcast spawning marine species (Havenhand, *et al*. 2008)

Coastal communities and the fishery sector face a number of additional challenges including: 1) a weak fisheries management regime; 2) limited resources for monitoring and enforcement; 3) conflicts among resource users; and 4) poor fishery practices (FAO 2005). With the newest Fisheries Bill in draft form since 2009, the fishery sector has had

to base management on the 1976 Fisheries Industry Act with outdated fines and a severely limited scope (Jamaica Observer 2012). Outdated legislation coupled with the limited resources for monitoring and enforcement have resulted in the near shore artisanal fishery being largely *de facto* open access. Simultaneously, coastal communities and fishermen are plagued by conflicts among resource users. As a result, many fishermen have taken to the practice of forgoing a marker buoy on their fishing pots – relying instead on GPS or geographical markers – for fear of them being stolen or the lines being cut by others.

Poor fishing practices also persist. While the prevalence of dynamite fishing is slowly declining, fishermen continue to employ a variety of unsustainable practices ranging from the use of undersize mesh (i.e., less then 1.5") on their fish traps to breaking coral to retrieve fish that have been speared (*personal observation, personal communication*). These additional challenges coupled with the projected impacts of climate change will continue to significantly alter the structure and function of coastal-marine environments in Jamaica, eroding their capacity to deliver critical ecosystem services currently supporting the livelihoods and wellbeing of coastal communities. This suite of additional challenges that characterize the social context of coastal-marine systems points to the necessity for considering the role of governance networks and governance more broadly to identify effective strategies for reducing the vulnerability of coastal communities to environmental change.

1.3.3 Caribbean Challenge Initiative

In an attempt to effectively address the potential impacts of and vulnerability to climate change, loss of biodiversity, and marine resource exploitation, eight Caribbean

nations, including Jamaica, launched the *Caribbean Challenge Initiative* (CCI) in 2008 (Toropova, *et al.* 2010). In signing the CCI, nations committed to protecting approximately 20% of their near shore marine area by 2020, an even more ambitious goal than that reaffirmed by the Contracting Parties to the Convention on Biological Diversity (Toropova, *et al*. 2010). To date the CCI has grown to a unique coalition of governments, companies, and partners (e.g., NGOs).

Jamaica has already begun the process of protecting more of its near shore marine area with the establishment of twelve additional *Special Fishery Conservation Areas* (SFCAs) – i.e., marine no-take areas – between 2009 and 2012 with a legal mandate that they be co-managed (see section 1.4.3.1), bringing their island wide total to fourteen (Figure 1.3). The SFCAs range in size from approximately 1 km^2 to 18.73 km^2. The majority of these SFCAs are in proximity to several small coastal communities with an active small-scale and artisanal fishery (Aiken and Kong 2000). The fishery is best characterized as mixed gear (e.g., fish traps, gill nets, handlines, spearguns) and multi-species (e.g., reef fish, spiny lobster, conch, small coastal pelagic finfish, large offshore pelagic finfish) with the majority occurring near shore (Aiken and Kong 2000).

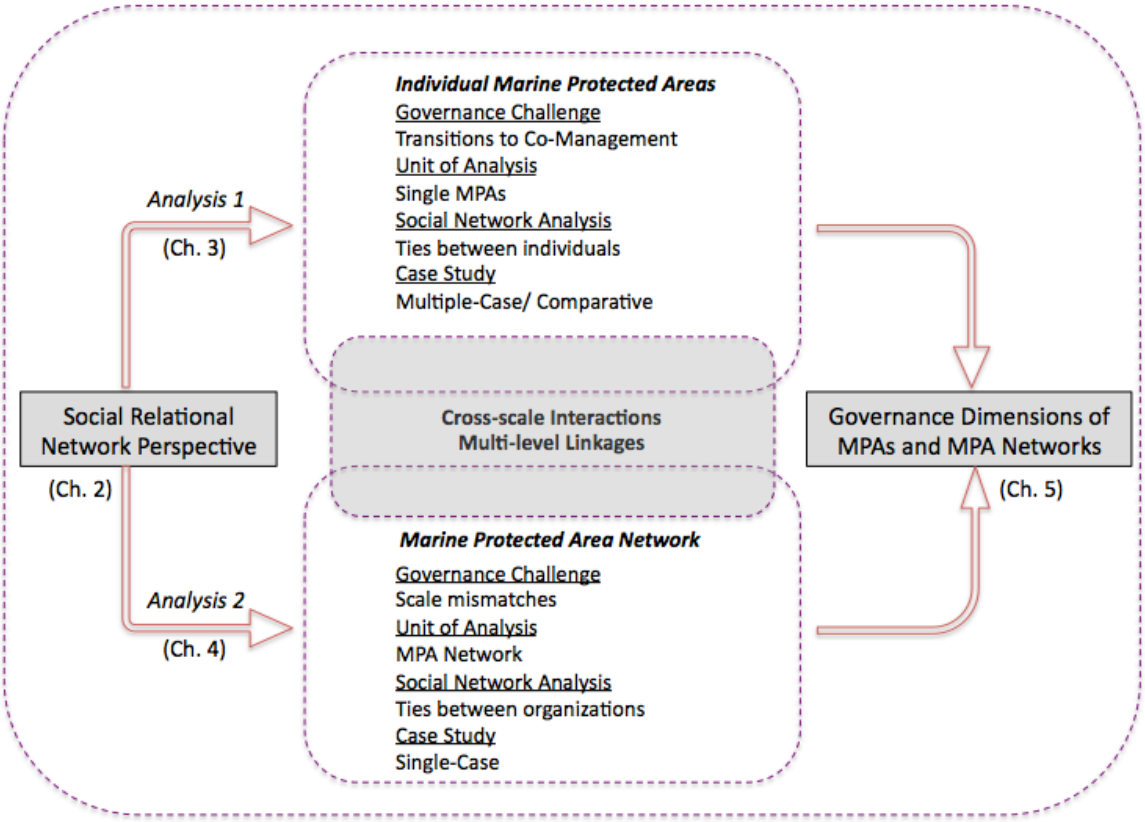
1.4 Methodology

1.4.1 Research Design

The overall research design is outlined in Figure 1.2 below. Collectively, the research seeks to examine the structure and function of social network ties at multiple levels – spanning from resource users to government agencies and beyond. Accordingly, the first analysis focused on ties between individual fishermen and wardens while the

second analysis focused on ties between organizations from across the island that contribute to the governance of the SFCAs. Details concerning the specific cases follow in the proceeding sections.

Figure 1.2 Research Design



1.4.2 Rationale for Case Study Method

A case study of the *Special Fishery Conservation Areas* in Jamaica (see Figure 1.3) was used to examine the governance dimensions of marine protected areas. The intensive nature of case studies makes them particularly well suited for the exploration of the in-depth nuances and contextual influences of governance (Baxter 2010). As such they contribute to a more holistic understanding (Baxter 2010). In addition, case studies have been noted repeatedly for their contributions to theory development, refinement, and testing – i.e., corroborating (George and Bennett 2005; Baxter 2010; Newing 2011).

Underpinning case studies is an emphasis on quality rather than quantity. As Baxter (2010) states "there is no statistical notation to adequately account for the importance of context, and any use of 'N' or 'n' does not do justice in the value of case study research" (p. 85).

Embedded within this study is a multiple-case, comparative component. The comparative study focused specifically on three of the fourteen *SFCA*s (*see next section for selection criteria and rationale*). Baxter (2010) notes that comparative case studies provide a broader basis and present "opportunities to generate and modify concepts and theory so that they explain commonalities across cases *despite* contingencies or context" (p. 92). Moreover, Sandström and Rova (2010b) highlight the contributions of comparative case studies to examine the social relational dimensions of natural resource governance. Such comparative case studies enable the preliminary testing of hypotheses to relate network structure and function, and in turn to provide the potential of "inductively identifying the design principles of successful systems [(i.e., governance arrangements)]" (Sandström and Rova 2010b, p. 546). The authors go on to note the need for more comparative case studies concerning the social relational dimensions of environmental governance, citing a general lack of such empirical research (Sandström and Rova 2010b).

It is important to note that case studies have limitations. Generalizability is one issue that has been noted (Fryvberg 2006; Baxter 2010). Generalizability – also referred to as external validity – is described by Baxter (2010) as "the degree to which findings apply to other cases of the phenomenon in question" (p. 93-94). However, Fryvberg (2006) notes that if designed appropriately – carefully choosing cases and theory that is

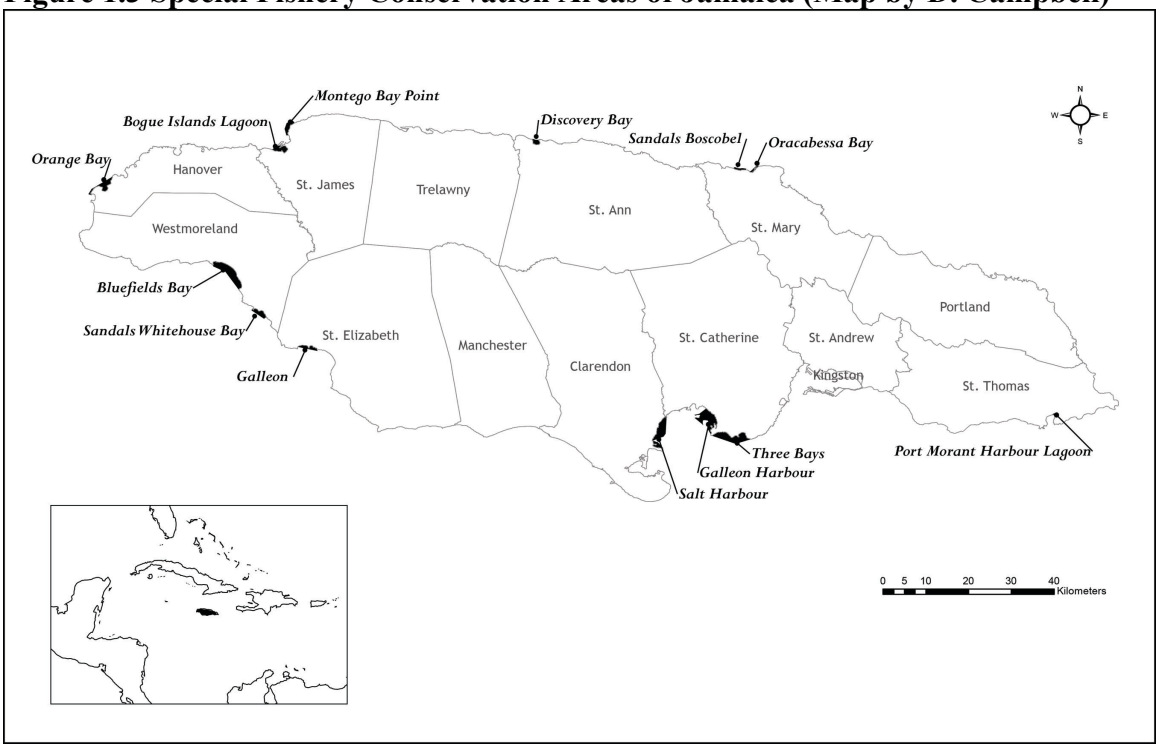
neither abstract nor case specific – case studies can contribute to generalizability. In this regard, case studies contribute to what Baxter (2010) describes as *analytical (theoretical) generalization* rather than *statistical generalization*.

1.4.3 Cases

1.4.3.1 Island Wide Special Fishery Conservation Area System

As noted previously, the Jamaican government recently established twelve *Special Fishery Conservation Areas* (Figure 1.3, Table 1.2), with more under consideration. Indeed, the Government of Jamaica just announced four more SFCAs to be established within the year (Angus 2015). The identification of possible locations for establishing SFCAs was based on a number of criteria (e.g., ecological, social) established by an advisory committee (see Aiken, *et al*. 2012). The presence and involvement of a Non-Governmental Organization (NGO) to play a lead role in monitoring and enforcement was deemed essential (Aiken, *et al*. 2012). Accordingly, the Government of Jamaica (i.e., Fisheries Division) established co-management arrangements with local non-governmental organizations and fishermen co-operatives that devolve roles and responsibilities (e.g., monitoring) associated with the day-to-day management of these marine reserves (see Chapter Three and Alexander, *et al.* 2015). The result is a constellation of actors that includes both state and non-state actors (i.e., organizations) from across the island – and some beyond the island. Moreover, these diverse actors are operating at multiple jurisdictional, administrative, and political levels.

Figure 1.3 Special Fishery Conservation Areas of Jamaica (Map by D. Campbell)



In addition to the *Island Wide Special Fishery Conservation Area System,* three individual SFCAs were identified to examine local level social networks (i.e., ties between individuals). The criteria utilized to select these three SFCAs included: i) sanctuary size; ii) number of fishermen; iii) organizational type of CBO with management mandate; and iv) initiation for establishment (see Table 1.3). The resulting cases represent diversity across these criteria.

Table 1.2 Summary of Fishery Conservation Areas

SFCA	Size (km^2)	Year Declared	CBO with Management Mandate	Organizational Type
Bluefields Bay	13.59	2009	Bluefields Bay Fishermen's Friendly Society	Fishermen's Friendly Society
Bogue Island Lagoon	4.5	1979	Montego Bay Marine Park Trust	Environmental NGO
Discovery Bay	1.68	2009	Alloa Fishermen Cooperative & Jamaica Fishermen Cooperative Union	Fisherman's Cooperative
Galleon	2.6	2009	The Breds Foundation	Community Foundation
Galleon Harbour	18.73	2009	C-CAM Foundation	Environmental NGO
Montego Bay Point	3.03	2009	Montego Bay Marine Park Trust	Environmental NGO
Oracabessa Bay	0.84	2010	Oracabessa Bay Foundation & St. Mary Fishermen Cooperative	Community Foundation + Fishermen's Cooperative
Orange Bay	5.36	2009	Negril Area Environmental Protection Trust	Environmental NGO
Port Morant Harbour Lagoon	0.58	1986	Division of Fisheries	Government
Salt Harbour	10.22	2009	C-CAM Foundation	Environmental NGO
Sandals Boscobel	0.99	2010	Sandals Foundation	Foundation
Sandals Whitehouse	2.94	2012	Sandals Foundation	Foundation
South West Cay	15.15	2012	Jamaica Environment Trust	Environmental NGO
Three Bays	12.61	2009	C-CAM Foundation	Environmental NGO

1.4.3.2 Bluefields Bay Special Fishery Conservation Area

The Bluefields Bay Special Fishery Conservation Area is located along the southwest coast of Jamaica in the parish of Westmorland. The small rural community of Bluefields was once known as the wealthiest and most productive 'sugar bowl' of Jamaica. However, post-Emancipation – from British rule – alternative industries were developed including the production of logwood, processing of pimento oil, and cattle

farming (IOJ 2010). Unfortunately, by the 1990s, several of these industries had collapsed (IOJ 2010). Today, predominate livelihood activities supporting the community of Bluefields include artisanal fishing, smallholder farming, and more recently tourism (e.g., community tourism, private guest houses, villas).

The Bluefields Bay SFCA is 13.59 km^2 – making it among the largest in Jamaica. Officially legislated and declared in 2009, an MOA was established with the Bluefields Bay Fishermen's Friendly Society (BBFFS). When the Minister of Agriculture and Fisheries first announced the new initiative to establish a number of 'fish sanctuaries' Bluefields Bay had not been considered. However, shortly after hearing the announcement, the BBFFS wrote to the Minister requesting that Bluefields Bay be considered as a possible site to establish a 'fish sanctuary'. Today, Bluefields Bay SFCA employs eight full-time wardens who maintain a twenty-four hour patrol.

In the vicinity of Bluefields Bay, the estimated 200+ fishers largely live in the coastal communities of Belmont, Cave, and Paradise. These fishers launch their boats from approximately seven different landing sites found within and beyond the boundaries of the Bluefields Bay SFCA. These landing sites vary significantly in their size (~4-50+ fishers), composition with regards to gear type, and formality – that is only two of the seven are considered official by the Fisheries Division.

1.4.3.3 Oracabessa Bay Special Fishery Conservation Area

The Oracabessa Bay Special Fishery Conservation Area is located along the north coast of Jamaica in the parish of St. Mary. The small rural community of Oracabessa Bay was once a major port for exporting bananas from the 1920's to 1960's. Today, the

predominate livelihood activities supporting the community of Oracabessa Bay include artisanal fishing, smallholder farming, and tourism (e.g., private guest houses, villas).

The Oracabessa Bay SFCA is 0.84 km^2 – making it one of the smallest in Jamaica. Officially legislated and declared in 2010, an MOA was established with the Oracabessa Bay Foundation in partnership with the St. Mary Fishermen Cooperative. Today, Oracabessa Bay SFCA employs four full-time wardens and another eight part-time wardens. In addition, a manager divides their time between the Oracabessa Bay SFCA and the neighboring Boscobel SFCA located a few kilometers down the coast. With support from the Global Environment Facility (GEF) through their Small Grants Program, the Oracabessa Bay SFCA has established an active coral restoration project – which has out-planted over 3,000 fragments of staghorn coral (*Acrapora cervicornis*) propagated from 150 fragments – and a successful sea turtle conservation program.

In the vicinity of Oracabessa Bay, the estimated 200+ fishers largely live in the coastal communities of Oracabessa, Boscobel, Stewart Town, and Rio Neuvo. These fishers launch their boats from approximately five different landing sites found within and beyond the boundaries of the Oracabessa Bay SFCA. These landing sites vary significantly in their size (~6-80+ fishers), composition with regards to gear type, and formality – that is one of the five are not officially recognized by the Fisheries Division. However, many of the spear fishermen here – as with those found across the North Coast of Jamaica – don't have a regular landing site they operate from. Rather, they take a taxi most days to different access points as the highway runs in close proximity to the coast.

1.4.3.4 Orange Bay Special Fishery Conservation Area

The Orange Bay Special Fishery Conservation Area is located along the western tip of Jamaica in the parish of Hanover. The predominate livelihood activities supporting the small rural community of Orange Bay include artisanal fishing, smallholder farming, and tourism – with many working in neighboring Negril, one of three major tourism destinations in Jamaica.

The Orange Bay SFCA is 5.36 km^2 and located directly within the larger Negril Marine Park. Officially legislated and declared in 2009, an MOA was established with the Negril Area Environmental Protection Trust (NEPT), a local environmental NGO that is also responsible for the management of the Negril Marine Park through an MOA with the National Environment and Planning Agency in partnership with the Negril Coral Reef Preservation Society. Today, NEPT employs two full-time wardens who are also responsible for monitoring the Negril Marine Park.

In the vicinity of Orange Bay, the estimated 100+ fishers largely live in the coastal communities of Orange Bay and Green Island. These fishers launch their boats from approximately five different landing sites found within and beyond the boundaries of the Orange Bay SFCA. These landing sites vary significantly in their size (~6-40+ fishers), composition with regards to gear type, and formality – that is one of the five are not officially recognized by the Fisheries Division.

Table 1.3 Comparative case selection

Selected Cases	Bluefields Bay	Oracabessa Bay	Orange Bay
Similarities Across Cases			
Predominate livelihoods	Small-scale fishing; smallholder farming; tourism		
Time since establishment	All established within 7 months (July 2009 – February 2010)		
Governance arrangement	Co-management		
Differences Across Cases			
Sanctuary Size	13.59 km^2	0.84 km^2	5.36 km^2
Number of fishermen	~200+	~200+	~100+
Organizational type of CBO with management mandate	Fishermen's Friendly Society	Community Foundation + Fishermen's Cooperative	Environmental NGO
Initiation for establishment	CBO/ Community	CBO/ Community	Government

1.4.4 Data Collection

This research employed a mixed methods approach (Creswell 2009; Hay 2010; Hollstein 2014). The rationale for using both qualitative and quantitative methods and data for this study was three-fold. First, drawing upon diverse data sources contributed to corroboration and the convergence of evidence – i.e., data triangulation (Creswell 2009; Yin 2009; Prell 2012). Second, some of the data collected assisted in contextualizing the study. Third, integrating qualitative and quantitative data provides significant benefits for the interpretation of network data – e.g., the content and meaning of individual ties (Cross, *et al.* 2009; Hollstein 2014). The following section provides an overview of the data collection methods employed for this research. Further details can be found in Chapter Three, Chapter Four, and in Appendices A – C and E.

The literature review played a key role throughout this research. Drawing upon both theoretical and empirical work published in peer-reviewed literature contributed to developing the theoretical framework (Chapter 2), informed the methodology, guided data collection, and aided in identifying appropriate analytical approaches. Furthermore, the literature review provided a critical means to more effectively situate this research, particularly with regards to the significant and original contributions to knowledge. While a substantial portion of this work took place early on in the process, the literature review

continued throughout the research to track ongoing theoretical and empirical developments of direct relevance.

The ongoing document review included relevant organizational and agency reports, community profiles, management plans, policies, legislation, and other written materials (e.g., speeches, press releases). The document review contributed to the identification of relevant actors, formal relational ties, key events, and formal institutions. Furthermore, it contributed to the convergence of evidence (i.e., data triangulation) and assisted in contextualizing the research.

Participant observation is best described as an unstructured interactive method (Kearns 2010; Puri 2011). It serves as a process to document what people say and do, along with how the researcher feels and their experiences (Puri 2011). Participant observation can be complementary and contextual (Kearns 2010). As a field method, participant observation can help with the more intangible social aspects of a community (e.g., institutions, customs, codes) along with providing insights into the underlying motivations and rationale of particular patterns of social relations (Puri 2011). As Puri (2011) notes, "[b]y accumulating these experiences the researcher can build up a picture of 'the way things are done' and develop a deeper understanding of who these people are, how they think and how they differ among themselves" (p. 85). Another benefit of participant observation is that it can help to cope with the unintentional and intentional biases that commonly surface in more formal focus group and interview settings (Kearns 2010; Puri 2011).

Box 1.3 Participant observation

Participant observation took place throughout all of the fieldwork. Examples of some of the activities and venues for participant observation included:
- Visiting several landing sites repeatedly;
- Visiting fish markets and vendors;
- Attending a marlin tournament and lionfish derby;
- Joining multiple patrols with SFCA wardens & marine police;
- Assisting SFCA managers and wardens with CLIF monitoring; and
- Assisting Fisheries Division with a lobster survey.

For the purposes of this research, participant observation specifically focused on *SFCA* wardens through selected participation in daily patrols and monitoring excursions (see Box 1.3). A second group, included fisherfolk – both at sea and on shore – through a combination of informal interactions and general observations (e.g., noting location of fish traps within the boundaries of the SFCA). Observations were collected over five months of fieldwork between November 2012 and February 2015, with the majority of data collection taking place from August 2013 through November 2013. Participant observation both contextualized relational patterns within the community and provided additional insights to complement that which was revealed in the focus groups and social relational surveys (i.e., data triangulation). A field notebook was utilized to gather and collect observations. Note taking did not always happen during a particular event or activity depending on the nature of said activity. However when note taking did not occur in real-time, the first available opportunity to compile notes was used (e.g., in the evening). In addition, informants were regularly consulted for confirmation and validation of interpretations and observations.

Semi-structured interviews are generally based on an interview guide that can include a variety of open-ended questions and/or a general list of topics serving as prompts, often covered in an order that reflects the focus and interests of the respondent (Dunn 2010; Newing 2011). However, Dunn (2010) notes that in some instances an

interview guide can be used which is composed of carefully crafted questions. Accordingly, semi-structured interviews are more targeted than unstructured interviews yet more flexible than structured interviews or questionnaires (Newing 2011).

Such flexibility provides a number of benefits. Semi-structured interviews are a format conducive to open responses and allow the respondent the freedom to express their own experiences and opinions (Dunn 2010). As the interviewer, it provides the opportunity to follow up with additional questions and prompts so as to be able to dig deeper into particular responses, issues, experiences, and opinions that emerge (Dunn 2010; Newing 2011). Similarly, semi-structured interviews allow the interviewer to verify tentative conclusions and their preliminary understanding of the responses (Dunn 2010).

Semi-structured interviews (n=63) were conducted with local community organizations, fisherman cooperatives, non-governmental agencies (e.g., local, national, international) and government agencies (e.g., national) involved with the SFCAs – including wardens (Table 1.4). Interviews were conducted in person over five months of fieldwork between November 2012 and February 2014, with the majority of interviews conducted between August 2013 and November 2013. The interviews lasted thirty to ninety minutes in length and were usually undertaken at the respondents' office. Respondents were selected using a snowball sampling technique in which each respondent was asked to provide contact information for other potential respondents (Hay 2010). To reduce bias in the sample, multiple snowballs were initiated. SFCA managers – or community-based organization board representatives – served as initial respondents. Interviews continued until the majority of relevant governance organizations had been

sampled. This was determined as the point when individuals from new organizations (e.g., agencies, divisions, departments, NGOs) were no longer being suggested as possible respondents (i.e., network closure had been reached) (Hanneman and Riddle 2005).

In addition to capturing relevant background information and insights concerning the establishment of the *Special Fishery Conservation Areas,* the interview guide contained open-ended questions designed to cover three dimensions of governance with regards to the SFCAs: i) co-management arrangements; ii) institutions and fit; and iii) actor networks (Appendix A). Interviews were digitally recorded and transcribed verbatim. Due to the Jamaican accent, pronunciation, phrasing, and integration of patois phrases and terms, professionals in Jamaica transcribed the interviews. Formal member checking – also known at participant verification – of the transcribed interviews were not completed due to a number of contextual challenges (e.g., low levels of literacy among some participants). While interview participants did not verify their transcripts, other strategies were employed throughout the study to ensure accuracy and fair representation of participant responses. For example, informal member checks were regularly conducted through the use of paraphrasing, summarization, and clarifying questions. These informal member checks took place during the semi-structured interviews, during informal interviews, and during focus group discussions. Other techniques used to ensure accuracy and trustworthiness included prolonged engagement and triangulation (Creswell 2009).

Table 1.4 Summary of participant interviews

Organizational Type	Individual MPA Cases			MPA Network	Number of Interview Participants by Type
	Bluefields Bay SFCA	Oracabessa Bay SFCA	Orange Bay SFCA	Island Wide Special Fishery Conservation Area System	
Managing Organizations	8	6	3	16	**33**
CBO/NGO	1	0	4	5	**10**
University	0	0	0	4	**4**
Government Agency	5	2	3	5	**15**
Intergovernmental Organization	0	0	0	1	**1**
Total Interviewed*	**14**	**8**	**10**	**31**	**63**

*some participants were interviewed more than once

Data collection also included the administration of two sociometric surveys. These surveys asked respondents to identify the presence and nature of their relational ties associated with the *Special Fishery Conservation Areas.* The *National Organizational Network Survey* (Appendix B) targeted the organizations and agencies affiliated with the governance of the national system of SFCAs. The survey was administered through personal interviews with 18 respondents representing the core organizations (see Appendix G). All surveys were administered between August 2013 and November 2013. In two thirds of the instances, the sociometric survey was administered at the same time as the semi-structured interviews. In the other third of the instances, the sociometric survey was administered during a follow up with the participants. See Chapter Four for additional information concerning the survey questions and Appendix G for details regarding the administration of the survey.

Additional social network data was collected via a questionnaire administered by a team of field assistants through personal interviews with fishermen (n=380) (Appendix C). The sociometric survey, built into this questionnaire, captured data related to

information sharing between fishermen at the individual level. The distribution of the questionnaires across the three cases is as follows: Bluefields Bay (n=130); Oracabessa Bay (n=147); and Orange Bay (n=103). The target population was defined as all fishers based at landing sites located within the boundaries of the SFCA in addition to those landing sites directly adjacent to the boundary. To capture as complete a network data set of fishermen as possible, lists of registered fishers provided by the Fisheries Division were coupled with lists of fishers produced by local community partners. Respondents from the list were asked to suggest other fishers at each landing site. In addition, multiple visits to each landing site at varying times of day over the course of two weeks were made. Through this process, additional 'snowballs' were initiated with fishermen who were not on any of the original lists. Accordingly, this helped to ensure – to the extent possible – that parts of the network and/or certain 'groups' were not missed. This modified snowball sampling method was carried out until network closure had been reached – i.e., the addition and mention of new names is minimal, akin to saturation (Hanneman and Riddle 2005). See Chapter Three for additional information concerning the survey questions and details regarding the administration of the questionnaire.

Focus groups (n=10) – i.e., pre-arranged group 'interviews' (Cameron 2010; Newing 2011) – were conducted with fishermen at landing sites within or directly adjacent to the three *Special Fishery Conservation Areas.* The number of participants at each focus group session ranged from 4 to 12. The focus groups lasted on average between sixty and ninety minutes in length covering four main topics: i) rules governing the use of the SFCA; ii) alternatives to the current rules, regulations, and boundaries of the SFCA; iii) participation with regards to the planning and management of the SFCA;

and iv) relational ties and patterns of interactions between fishermen (and other persons) with respect to the management of the SFCA (Appendix D). Recruitment of focus group participants was done during the administration of the questionnaire to fishermen. Those individuals who noted their willingness to be contacted and participate in a follow up focus group were compiled and randomly reordered. Individuals were then contacted based on the new order until approximately ten participants orally confirmed their availability for the date and time of the focus group. In some instances, not all who confirmed showed up. In other instances, there were participants who showed up and contributed who had not been contacted.

The strength of focus groups is their interactive nature (Cameron 2010; Newing 2011). For example, a comment by one participant can trigger others to respond as well, what Cameron (2010) refers to as the *synergistic effect*. Similarly, through such an interactive process, participants are exposed to and/or reconsider particular points of view (Cameron 2010). Focus groups are also very helpful for exploring and capturing the social nuances and complexities associated with communities whose livelihoods and wellbeing is intimately tied to particular landscapes and seascapes (Cameron 2010).

1.4.5 Data Analysis

This section provides a brief overview of the analytical methods used for this research. Additional details can be found in Chapters Three and Four. Social Network Analysis (SNA) was used to examine the components (e.g., actors and linkages) and overall structure (e.g., density) of the governance networks associated with the *Special Fishery Conservation Areas*. UCINet version 6.509 (Borgatti, *et al*. 2002) and Gephi (an open source platform for network analysis) were used for social network analysis (SNA)

while Netdraw (Borgatti 2002) and Gephi, were used to generate network visuals. Details and descriptions regarding specific measures and calculations can be found in Chapters Three and Four along with Appendices E and F.

SNA was employed at two 'levels' of analysis for this research. In Chapter Three, the focal level of analysis concerned relational ties between individual fishermen associated with three of the SFCAs – i.e., Bluefields Bay, Oracabessa Bay, and Orange Bay. In Chapter Four, the focal level of analysis concerned relational ties between organizations associated with the governance network of the island wide SFCA system.

Interviews were analyzed using qualitative analysis software NVivo 10 (QSR International). The coding process was both inductive and deductive. An initial set of codes was developed *a priori* based on the associated theoretical frameworks yet additional codes were allowed to emerge from the interview data (Gilgun 2010; Miles, *et al.* 2014). Thematic analysis occurred through an iterative process of coding and pattern recognition (Miles, *et al.* 2014). This allowed for primary information about MPA governance networks to be both grounded in existing theories from the literature but also in the interviews themselves.

Qualitative content analysis results derived from interviews, focus groups, documents, and observations were further combined with social network analysis results. Integrating qualitative and quantitative results contributed to corroboration and the convergence of evidence – i.e., data triangulation (Creswell 2009; Yin 2009; Prell 2012). Furthermore, the integration of analytical results provided significant benefits for the interpretation of network data (Cross, *et al.* 2009; Bodin and Prell 2011; Prell 2012; Hollstein 2014). As Hollstein (2014) explains, quantitative strategies "are tailored toward

analyzing the structural dimensions of relationships and networks" while qualitative strategies (i.e., interpretive) "are designed to capture practices, meanings, and the social contexts of relationships and networks" (p. 11).

1.4.6 Ethics

This research followed Canada's Tri-Council ethics protocols for research with human participants and was approved by the University of Waterloo's Office of Research Ethics (see Appendices A, C – D). Particular consideration was given to consent, fairness, equity, privacy, confidentiality, and the concerns associated with the specific research methods used.

Protecting participants throughout the study was accomplished through multiple measures. Research objectives were outlined for participants orally – and in writing upon request. An introductory letter was included in instances where participants were first contacted via email for an interview. Prior and informed consent (oral) was upheld throughout the study. This included consent to participate, to remain anonymous as a participant, and to be audio recorded in instances where an interview was conducted. Furthermore, participants were informed of all data collection devices and activities.

Additional ethical considerations were taken into account in response to particular research methods and methodology, specifically related to community-based research, focus groups, participant observation, and the collection of social network data. Community-based and participatory research draws particular attention to the responsibility of the researcher to the community and the considerations thereof, including: 1) the nature and extent of community engagement; 2) potential for conflict in opinion within the community; 3) the presence and role of 'gatekeepers;' and 4) ensuring

reciprocity and mutual benefit (Newing 2011). In addition to *confidentiality* and *privacy*, the general principles of *veracity* and *fidelity* were used to guide the research and address the above concerns. Newing (2011) defines *veracity* as "telling the truth and presenting yourself and your intentions honestly" and *fidelity* as "presenting honestly what has been said and observed and not distorting information to fit hypotheses" (p. 234-235).

The use of focus groups presents the added considerations associated with having multiple research participants at any given time including: 1) the discussion of sensitive topics by participants in front of others; 2) inappropriate responses by fellow group members; and 3) the potential inability to guarantee total confidentiality (Smithson 2008). To address these considerations, ground rules (see Appendix D) were established and articulated before proceeding with each focus group and the consent process was explicit about confidentiality (Newing 2011; Smithson 2008).

Participant observation, as with other approaches presents a suite of possible ethical issues that must be taken into consideration. Throughout the study *free*, *prior*, and *informed* consent (orally) was attained (Puri 2011) and *confidentiality* of participants was maintained in the publication and communication of results through data anonymization (Kearns 2010). In addition, as a foreigner and outsider, I continuously took into consideration how my presence may have altered the behavior of the community (i.e., those being observed) and related issues of power and knowledge (Kearns 2010).

Finally, the collection and use of social network data has some added considerations associated with confidentiality and anonymity (Prell 2011). As per standard protocol for confidentiality, responses were not shared with others. While a roster – i.e., a predefined list – was used to collect ties associated with the national

network, all data was collected at the organizational level. Where data was collected related to ties between individual fishermen, participant codes were used to cross-reference all surveys. However, after the data was collected, it was made anonymous so that no individual could be identified for the purposes of any reporting out of results.

1.5 Organization of Dissertation

Four remaining chapters contribute to this dissertation. Chapters Two, Three, and Four are written as stand-alone manuscripts. Due the nature of the manuscripts there is some repetition found in Chapters Three and Four related to the research context and methods. Each chapter is outlined below. Please refer to page iii for full citations, including co-authors.

- Chapter Two presents the manuscript entitled *A social relational network perspective for MPA science*. This manuscript is a synthetic review, which outlines the emergence and benefit of applying a structurally explicit, social relational network perspective to inform the establishment and governance of MPAs and MPA networks. Drawing on concepts from relational sociology and social network analysis it highlights the theoretical foundations of a social relational network perspective. Selected examples are then used to: 1) illustrate the analytical utility and application of this network perspective to systematically examine attributes recognized as important for MPA establishment and governance; and 2) provide new insights on crucial practices and processes (e.g., knowledge exchange), core social attributes (e.g., social capital), and the roles and

positions of diverse MPA actors. This manuscript was published in *Conservation Letters.*

- Chapters Three and Four build upon the conceptual and theoretical perspective put forward in Chapter Two. Chapter Three presents the manuscript entitled *Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries.* This empirical paper is a comparative analysis of the social network structures associated with the transition to co-management in three Jamaican marine reserves. Data from quantitative social relational surveys are integrated with data from semi-structured interviews and focus groups to assess how patterns of relational ties and interactions between and among fishermen and other local level actors (e.g., managers, wardens, NGO staff) support and constrain transitions to co-management. Findings suggest that the transitions to co-management were supported by a combination of three network structure and relational attributes. This manuscript has been published in *Global Environmental Change*.

- Chapter Four presents the manuscript entitled *Social connectivity in an emerging marine reserve network and the challenge of governance 'fit'*. This empirical paper examines specific structural features and characteristics of the governance network associated with the marine reserve network in Jamaica. Data from quantitative social relational surveys are integrated with data from semi-structured interviews to assess how the network structure and function contribute to

knowledge exchange and collaboration among organizations. It then discusses the potential of this social connectivity – or lack thereof – to address particular aspects of fit (i.e., spatial, temporal, functional) that plague MPAs. This manuscript will be submitted to *Biological Conservation*.

Chapter Five both summarizes the major research findings and outlines the contributions of the research. This final chapter considers the strengths and limitations of the research and identifies areas of further research.

Chapter 2
A social relational network perspective for MPA science

2.1 Chapter Summary

This mini-review outlines the emergence and benefit of applying a structurally explicit, social relational network perspective to inform the establishment and governance of MPAs and MPA networks. This is an important conservation research and policy frontier. We draw on concepts from relational sociology and social network analysis to highlight the theoretical foundations of a social relational network perspective. Selected examples are used to: 1) illustrate the analytical utility and application of this network perspective to systematically examine attributes recognized as important for MPA establishment and governance; and 2) provide new insights on crucial practices and processes (e.g., knowledge exchange), core social attributes (e.g., social capital), and the roles and positions of diverse MPA actors.

2.2 Introduction

Marine protected areas (MPAs) and MPA networks (Box 2.1) have emerged as a significant conservation and management strategy (Lubchenco, *et al.* 2003; Christie 2011). Globally, the number of MPAs has increased dramatically, from less than 200 in 1970 to more than 5,000 to date (Thorpe, *et al.* 2011). In addition, the Contracting Parties to the Convention on Biological Diversity (CBD) recently reaffirmed the goal to protect and manage 10% of the world's oceans and seas by means of MPAs by 2020 (Toropova, *et al.* 2010).

Box 2.1 Selected definitions of marine protected areas

Marine Protected Area (IUCN/WCPA 2008)
A clearly defined geographical space recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Marine Protected Area Network (WCPA/IUCN 2007)
A collection of individual marine protected areas operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological aims more effectively and comprehensively than individual sites could alone.

Fox *et al.* (2012a) have indicated that significant advances in the ecological and social sciences of MPAs will be required to achieve the CBD targets. They identified several research frontiers for policy-relevant MPA science and pointed specifically to the importance of better understanding the "role of social capital and social networks in the establishment and performance of MPAs" (Fox, *et al.* 2012, p. 6). This is crucial given that MPAs and MPA networks will increasingly be located nearer to growing coastal populations (Spalding, *et al.* 2013). Social networks are also now recognized as a key variable for understanding conservation outcomes (Bodin and Crona 2009). Formal and informal social networks are central to multi-actor governance arrangements (e.g., co-managed MPAs) (Carlsson and Berkes 2005), and have been repeatedly cited as a key attribute in the broader natural resource management literature (Bodin, *et al.* 2011). However, not all networks are structurally equal. Different patterns of social relations contribute to different conservation outcomes (Bodin, *et al.* 2006; Bodin and Crona 2009). Systematic and place-specific analysis of differences in networks of social relations is emerging as a crucial dimension of MPA science.

Our goal in this mini-review is to outline the emergence and benefit of a social relational network perspective to policy-relevant MPA science. We draw on concepts from relational sociology (Emirbayer and Goodwin 1994) and social network analysis (Wasserman and Faust 1994) to highlight the theoretical foundations of this perspective.

Several examples are used to illustrate the analytical utility and application of a social relational network perspective to more systematically examine and make sense of attributes and processes (e.g., trust, knowledge exchange) identified as central to the establishment and governance of MPAs and MPA networks.

2.3 A Social Relational Network Perspective

Consideration of the social connectivity associated with MPAs and MPA networks has only recently emerged (Christie, *et al.* 2009; Lowry, *et al.* 2009; Pietri, *et al.* 2009; Bustamante and Vanzella-Khouri 2011; Green, *et al.* 2011; Horigue, *et al.* 2012). Most assessments are largely anecdotal or reflect a "binary metaphorical approach" (i.e., the network is either present or absent; see Bodin, *et al.* 2011), with the exception of a few empirical studies (e.g., Pietri, *et al.* 2009, Horigue, *et al.* 2012; Cohen, *et al.* 2012) (Table 2.1). We believe it is imperative to move beyond a binary view of social networks and thus offer concepts and tools to help with our understanding of the establishment and governance of MPAs and MPA networks. Adoption of a structurally explicit, social relational network perspective is an important contribution to this challenge.

We consider a social relational network perspective here as a conceptual model, the accompanying theoretical assumptions, and its associated methodological toolbox (*sensu* Bodin 2006). This social relational network perspective is largely informed by: i) relational sociology (Emirbayer and Goodwin 1994; Emirbayer 1997; Mische 2011) and ii) social network analysis (Wasserman and Faust 1994). As Bodin and colleagues (2011) note, "[r]elational sociology stipulates that social relations are not completely random, but that they show patterns or particular configurations, which are important features of the lives of the actors who display them" (p. 9).

Table 2.1 Conceptualizing social networks

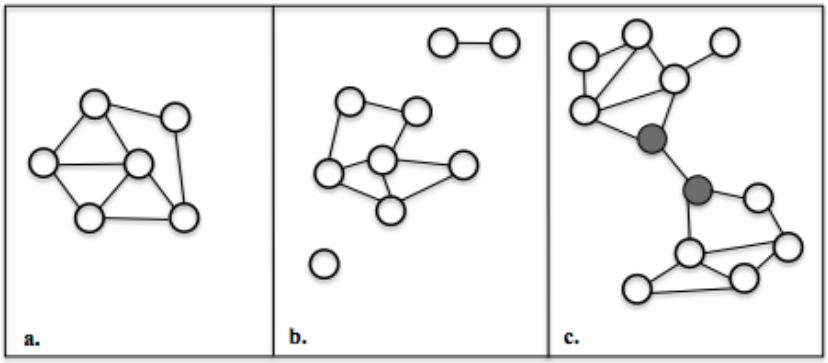
Network Approach	Characteristics	Selected examples from MPA literature
Binary Metaphorical Approach	• Considers social networks as an unspecified binary variable (i.e., the network is or is not present) (Bodin, *et al.* 2011) • No consideration of the internal structural characteristics (e.g., positionality, structure) or of actual ties between actors (Bodin, *et al.* 2011) • Actors considered to be either socially connected or socially detached	• Lowery *et al.* (2009) note that "[i]n order to enhance the administration and management of ecological networks, social networks are being formed through communication and sharing of results and coordination among institutions" (p. 276). While a rationale is provided with regards to the role of the social networks, they are considered to be either present or absent with no reference to specific ties between actors and MPAs. • Bustamante and Vanzella-Khouri (2011) note that "[s]ocial MPA networks can be formed to facilitate learning, coordination and optimization of resources" (p. 90) as was the case with the establishment of the Caribbean Marine Protected Area Management Network and Forum (CaMPAM). However, social connectivity is considered present or absent.
Descriptive Approach	• With attention given to particular features and/or attributes (e.g. bonding ties, bridging ties) (Bodin, *et al.* 2011) it embraces and recognizes that not all networks are created equally (Newman and Dale 2005) • May lack clear methodological strategies for the empirical investigation and analytical differentiation of network structures and/or features (Bodin, *et al.* 2011)	• Pietri *et al.* (2009), through their examination of two MPA networks in the Philippines introduce the concepts of information diffusion and homophily, whose origins and development are found in the social network literature. While consideration is given to ways of improving information diffusion, it is treated in a very general manner with no specifics as to the structure and function of the network. • Horigue *et al.* (2012), through their examination of the challenges of establishing MPA networks in the Philippines, note the important role of bridging organizations for scaling up to MPA networks. Again, however, there is no mention of the structure and function of the network.
Structurally Explicit Approach	• Draws attention to social structures, noting that structure matters • Conceptualizes social networks as composed of actors (i.e., nodes) connected via a particular tie(s) (e.g., knowledge exchange, trust) • There can be variation in the types of ties (see Borgatti and Halgin 2011 for a typology of tie types), strength of ties, and/or number of ties between a set of actors • Ties can be formal or informal	• Cohen *et al.*'s (2012) examination of the Solomon Islands Locally Managed Marine Area Network provides an illustrative example of a structurally explicit conceptualization of an MPA network. Here the authors consider two different ties among a set of actors and their respective social networks, including: i) collaboration, where ties represented the flow of resources (e.g., human, financial, technical) and ii) knowledge-exchange where ties represented the flow of information relevant to management (Cohen, *et al.* 2012).

*General organizing typology adapted from Bodin *et al.* (2011)

A structurally explicit social relational network approach (Table 2.1) goes beyond binary metaphorical and descriptive approaches (Table 2.1) and draws attention to social

structures. Here, social structure refers to the "regularities in the patterns of relations among concrete entities" rather than "a harmony among abstract norms and values or a classification of concrete entities by their attributes" (White, *et al.* 1976, p. 733-34). Such an approach conceptualizes social networks as composed of actors (i.e., nodes) connected via a particular tie (e.g., knowledge exchange, trust) (Figure 2.1a). For example, managers associated with an MPA network could be connected via particular patterns of communication through which they exchange ecological knowledge (e.g., the presence and spread of invasive species) or via particular patterns of collaboration. However, the social networks do not have to be fully connected (i.e., interconnected), but rather can be fragmented (Borgatti and Halgin 2011) such that two managers may communicate and/or collaborate with each other exclusively and not with the other managers (Figure 2.1b).

Figure 2.1 Conceptualizing social networks: (a) composed of actors (e.g., MPA managers) (represented by the open circles) connected via particular relational ties (e.g., knowledge exchange) (represented by the lines); (b) social networks can be fragmented with the potential that two actors are connected via one relational tie yet not connected to the other actors or a single actor can lack any relational ties (i.e., an isolate); (c) the significance of the tie between the two solid color actors (i.e., connecting two otherwise unconnected subgroups) is only realized when placed in the larger context of relational ties.



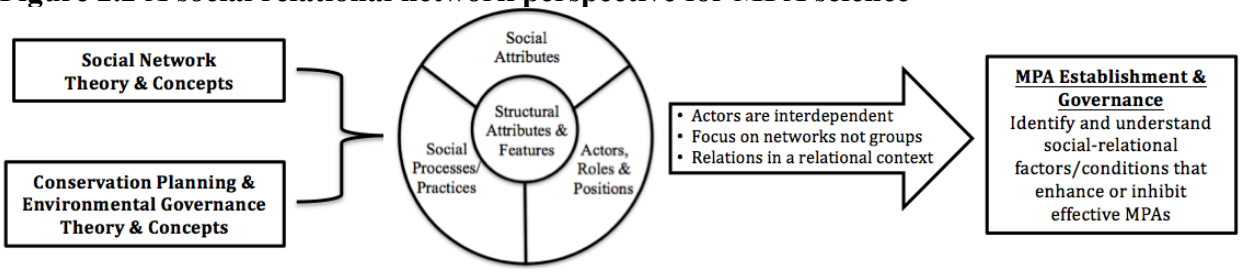
There is a diversity of relational ties that can be identified and/or used for analytical purposes. Borgatti *et al.* (2009) provide a useful typology for categorizing and conceptualizing the variety of ties, which include: i) similarities (e.g., location,

membership, attribute); ii) social relations (e.g., kinship, affective, cognitive); iii) interactions (e.g., knowledge exchange, helped); and iv) flows (e.g., information, resources). While any one of the types of ties outlined by Borgatti *et al.* (2009) could provide key insights concerning social processes and outcomes of relevance to MPA establishment and governance, the final decision and most appropriate relational tie to examine ultimately depends on the research questions, objectives, and context. For example, to better understand how social networks contribute to the planning process in MPAs it is helpful to consider relational ties based on membership to a fisher co-operative or those based on attendance at community planning meetings, although this has yet to be a focus of research. Similarly, Frank (2011) has suggested that to better understand the role of social networks with regards to sustainable behaviors and practices, or the establishment of new norms, it is useful to identify relational ties that represent the flow of influence among a community of resource users such as fishers.

The social relational network perspective for MPA science emerges from several interdisciplinary bodies of literature (Bodin and Prell 2011), although we draw attention in particular to social networks (e.g., Wasserman and Faust 1994), conservation planning (e.g., Mills, *et al.* 2013), and environmental governance (e.g., Armitage, *et al* 2012) (Figure 2.2). The theories, concepts, and models developed within the field of social networks such as the strength of weak ties (Granovetter 1973) and social influence (Friedkin 1998) significantly aid in understanding how the structure and function of networks relate to differing social processes and outcomes. Similarly, theories and concepts related to collective action and adaptive capacity from the related fields of conservation planning and environmental governance help to clarify the social processes

and conditions required for positive natural resource governance and conservation outcomes (Crona, *et al.* 2011). There is no singular theoretical underpinning, but rather the linking of concepts from these interdisciplinary bodies of literature that provides the foundations of a social relational network perspective for MPA science. These foundations can be used to examine more systematically the context-specific social relational dimensions that influence how MPAs and MPA networks function. In addition, these ideas and those that follow have a broader application including terrestrial protected areas (e.g., García-Amado, *et al.* 2012), natural resource management (e.g., Bodin and Crona 2009), and conservation planning (e.g., Mills, *et al.* 2014).

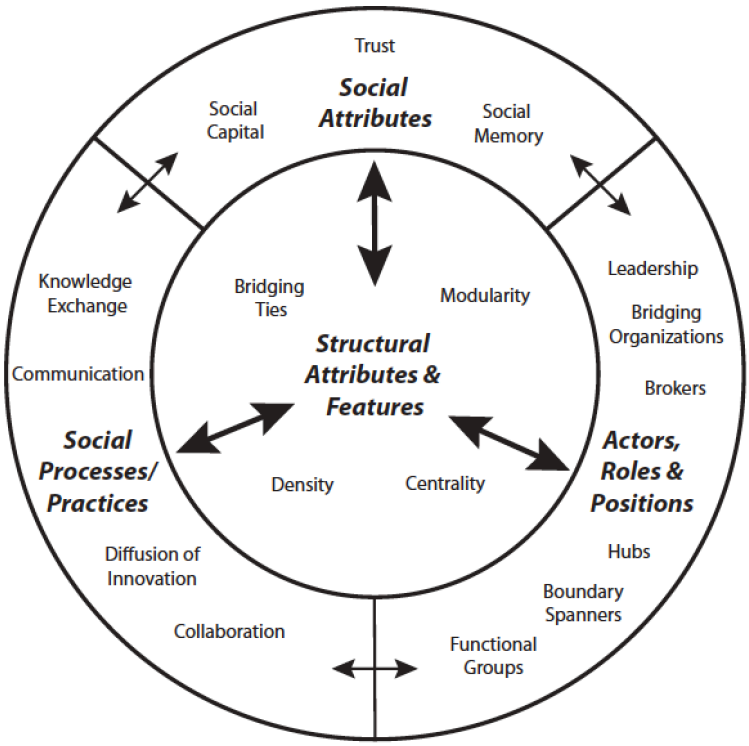
Figure 2.2 A social relational network perspective for MPA science



These theoretical foundations also provide an entrée to systematically considering the features, attributes, and processes associated with MPAs and MPA networks (Figure 2.3). We group these features and attributes (Figure 2.3*;* see also Appendix E) into three broad categories: i) practices and processes (e.g., knowledge exchange, collaboration); ii) social attributes (e.g., social capital, trust); and iii) actors, roles, and positions (e.g., bridging organizations, brokers). Identifying, observing, measuring, and/or modeling specific network structures and features (e.g., modularity, density, bridging ties) associated with the above attributes and examining the relationship between the two serves as an analytical entrée. While the list of attributes (Figure 2.3) is not exhaustive, we include those that have been emphasized in the literature (see Appendix E for

references). In addition, the examination of various attributes and processes is not mutually exclusive (see Figure 2.3). For example, specific network structures and features can be considered in relation to both knowledge exchange (social process) and cross-scale brokers (actors, roles, and positions) (e.g., Cohen, *et al*. 2012).

Figure 2.3 Features, attributes, and processes associated with MPAs and MPA networks. The primary arrows represent the possible analytical relationships examined between specific network structures/ features and the various attributes. The secondary arrows represent the possible analytical relationships between the different categories of features and attributes.*



**Refer to Appendix E (Table E 1) for theoretical and empirical references drawn from the broader natural resource management and environmental governance literature associated with each feature and attribute.*

Three theoretical assumptions are central to the social relational network perspective we outline here. First, emphasis is placed on relations rather than personal attributes. In this regard, "actors and their actions are viewed as interdependent rather than independent, autonomous units" (Wasserman and Faust 1994, p. 4). The structural

environment of the network is thus considered as either enabling or constraining to actors and processes (Wasserman and Faust 1994). Researchers or managers can use this perspective to ask a variety of questions about the structure and function of networks as they relate to differing conservation processes and outcomes. While emphasis is placed on relations, personal attributes (e.g., gear type, occupation, landing site) are still taken into consideration. Similarly, a social relational approach seeks to merge rather than aggregate individual agency and social structure (Emirbayer 1997; Mische 2011). Agency is viewed here as the "temporally constructed engagement by actors of different structural environments" (Emirbayer and Mische 1998, p. 970). Agency is also considered to have an iterative relationship with social structure. As such, engagement "both reproduces and transforms those structures in interactive response to the problems posed by changing historical situations" (Emirbayer and Mische 1998, p. 970).

The second premise of a social relational network perspective is that analytical and theoretical emphasis is placed on examining networks rather than groups (e.g., a discretely bounded collective of individuals organized formally or informally). A focus on the network encourages analyses to move beyond assumptions about uniformity and group homogeneity, and to recognize the significant potential for heterogeneity in any MPA context (e.g., differences in levels of commitment, connections, and recognition) (Marin and Wellman 2011). For example, fisherfolk adjacent to or operating within MPAs are often treated as a homogenous group and aggregated as a unitary stakeholder. In fact, there is likely to be significant heterogeneity based on gear type and/or the extent to which individuals are reliant on fishing for their livelihood. Shifting the emphasis to networks allows for the possibility to: a) define a 'group' empirically rather than *a priori*;

b) have an actor be a member of multiple 'groups' rather than mutually exclusive groups; and c) move beyond clearly identifiable groups (e.g., fisherfolk co-operatives) (Marin and Wellman 2011). As such, shifting the emphasis to networks allows one to ask questions and empirically examine the relational connectivity between and among resource users (e.g., fisherfolk), diverse stakeholder groups (e.g., tourism, conservation NGOs), and/or the relevant management agencies and organizations associated with MPAs and MPA networks.

The third premise of a social relational network perspective is that we can only understand specific relations or patterns of relations relative to their broader relational context (Marin and Wellman 2011). For example, a key tie between two MPA managers (see Figure 2.1c - solid circles) that connects two otherwise unconnected groups of governance actors (empty circles) only emerges when the broader relational context is viewed as compared to being considered in isolation. Furthermore, a social relational view "recognizes that from these relations greater wholes are formed that display emergent or novel properties, above all, social structure" (Bodin, *et al.* 2011, p. 8).

2.4 Potential Benefits of Applying a Social Relational Network Perspective

A social relational network perspective is a theory-driven approach to further MPA science and policy. For example, the perspective provides a basis to more systematically contribute to an empirical analysis of social attributes and processes (e.g., trust, knowledge exchange) increasingly crucial in MPA contexts located adjacent to and directly affected by growing coastal populations. We show here the analytical utility of a social relational network perspective with regards to understanding and informing: i) the

establishment and ii) governance of MPAs and MPA networks. Key benefits and contributions to conservation policy are summarized in Table 2.2.

Table 2.2 Empirical questions and applications for policy relevant MPA science

Core concerns	Issues/ Aspects	Empirical Questions & Applications
Establishment	*Enabling Conditions*	• Identifying bridging and bonding ties along with measuring the density of ties provides key insights on the levels and types of social capital necessary for effective conservation outcomes
	Stakeholders	• Identifying relevant stakeholders and actors in diverse positions within the social networks (e.g. including those on the periphery) helps to address issues of marginalization and avoid potential conflict (Prell, *et al.* 2009; Prell, *et al.* 2011)
	Location/ Boundary Setting	• Coastal-marine seascapes are spatially heterogeneous with regards to use (e.g., different gear types often target different habitats, species and/or depths). Similar to stakeholder analysis above, the identification of different users contributes to their inclusion in deliberative decision-making regarding the location and boundaries associated with a new MPA as they may be differentially impacted. • Identifying the location and distribution of local knowledge related to key ecological processes and patterns (e.g., spawning patterns & larval dispersal) among social networks contributes to establishing appropriate ecological boundaries (Frank, *et al.* 2011)
	Decision Making/ Advisory Councils	• Similar to stakeholder analysis it contributes to the identification of key individuals (e.g., actors with particular types of ties and/or numerous ties) for decision-making entities and advisory committees (e.g., board members for an MPA)
	Evaluating the Planning Process	• Post MPA establishment, participatory social network mapping (e.g., identifying actors and influence) can be used to evaluate the planning process and inform future collaborative and participatory processes associated with the management of the MPA and/or the establishment of future MPAs
	Participation & Engagement	• How might social relational ties within and between social network subgroups influence participation in MPA planning meetings? • Using two-mode network data one could consider how an actor's location or position within the network is impacted by membership in fisherfolk co-operatives, tourism associations, etc. (Frank 2011)

Table 2.2 Empirical questions and applications (Continued)

Governance	*Adaptive Management*	• How might relational patterns between MPA managers enhance or inhibit to the diffusion of innovative practices? • What structural and/or social relational features of networks foster collective learning for adaptive management of MPAs? (e.g., Newig, *et al.* 2010) • How do social networks contribute to the monitoring and evaluation of MPA goals, targets and management plans? • Similar to stakeholder analysis it helps to identify key individuals for network intervention to facilitate social learning among a given set of actors. (e.g., Prell *et al.* 2011) • How does the structure of social networks (formal and informal) enhance or inhibit the integration and application of different types of knowledge? • What role do social networks play regarding the detection and response to invasive species (e.g., Indo-pacific lionfish in the Caribbean)? • How do relational patterns within MPAs and MPA networks contribute (i.e., facilitating or constraining) to the capacity of governance systems to adapt to climate change?
	Collaborative Management	• How does composition and connectivity of sub-groups facilitate or constrain collective action related to community-based MPAs? • Examining network structures and patterns of influence provides insights into power asymmetries, which may constrain collaboration among relevant actors. (e.g., Weiss, *et al.* 2012) • How might relational patterns in one network facilitate or constrain the relational patterns of another?
	Formal & informal institutions	• Examining the role of relational ties regarding the flow and diffusion of community norms associated with MPAs for insights concerning compliance (Frank 2011). • Identifying institutional entrepreneurs and understanding the structural/social relational factors that enhance or inhibit such individuals (Crona, *et al.* 2011). • How do relational patterns associated with an MPA network contribute to the establishment of new formal institutions (e.g., rules, regulations, legislation)?

2.4.1 MPA Establishment

A social relational network perspective provides several entry points with which to better understand relevant features and processes (Figure 2.3) associated with the planning of MPAs and MPA networks (Table 2.2). Here we highlight the added value of a social relational network perspective to identify stakeholders, understand participation, and consider the enabling social conditions for effective establishment and conservation outcomes (see Table 2.2).

The identification and inclusion of relevant stakeholders is a critical component of MPA planning and establishment (Fox, *et al.* 2012a). Through the explicit consideration of actors, roles, and positions (Figure 2.3) a social relational network perspective provides a complementary approach to more traditional qualitative stakeholder analysis. Such a relational approach can serve to not only identify the diversity of relevant stakeholders, but to indicate: 1) the diverse position of actors within social networks relevant to MPAs and 2) the particular types of ties and/or number of ties among MPA actors (Prell, *et al.* 2009). For example, Prell *et al.* (2011), applied measures of centrality and positional analysis to select stakeholder representatives to participate in site visits associated with participatory natural resource management of the Peaks District National Park in the UK. Based on their approach, the individuals identified for inclusion from the network represented not only the range of stakeholder categories but also those that represented unique positions within the network, and the most central role within the positional groupings (Prell, *et al.* 2011). In the case of MPA establishment, such an approach helps to identify stakeholders found on the periphery of the network (e.g., fishers using certain gear types, fishers from smaller landing sites) that might otherwise not be considered in initial planning discussions. Applied in this way, a social relational network perspective contributes to strategies aimed at reducing marginalization, and the potential for future conflict.

A social relational network perspective can also provide key insights regarding the structural and relational factors associated with participation in the planning and establishment of MPAs and MPA networks. For example, two-mode network data (i.e.,

affiliation ties) can be used to represent attendance at an event or membership to an organization as compared to one-mode data, which traditionally represents direct ties between individuals (e.g., social relations, interactions, flows). In the context of MPA establishment, such network data might be composed of fishers and their attendance at different planning meetings or their membership to a local fisherfolk co-operative. Defining an actor's position within a two-mode network can provide critical insights of relevance to MPA establishment such as the adoption of new norms and the diffusion of attitudes. As Frank (2011) posits, an actor's position within a two-mode network "might then anticipate the formation of close friendships through which knowledge and normative influence can flow" (p. 199).

Understanding the enabling social conditions relevant to the establishment of MPAs may help contribute to positive conservation outcomes and the scaling up of MPAs (e.g., more MPAs, bigger MPAs and/or networks of MPAs) (Fox, *et al.* 2012b). For example, a social relational network perspective can help researchers and managers understand the degree of social capital in MPA contexts (Crona and Bodin 2011; Marin, *et al.* 2012), an attribute repeatedly cited as critical for successful conservation outcomes (Pretty and Ward 2001). Marin *et al.* (2012) examined a coastal benthic co-management system in Chile and found the higher performing fisher organizations more likely to show attributes of linking social capital (i.e., cross-scale linkages or vertical ties to higher levels such as the state), even in the absence of bridging social capital (i.e., horizontal ties to other communities – often distant and weaker – at the same level such as other fisher organizations). Recognizing that the role of social capital (including levels and types) is context dependent serves as a reminder for MPA managers and scientists as to the

importance of systematic and place-specific analysis of social relational networks. Furthermore, identifying and understanding the social capital within communities is paramount when considering the establishment of community based and/or co-managed MPAs. As Mills *et al.* (2013) show, for example, understanding the social characteristics that contribute to the feasibility of conservation (i.e., strong compliance) helps to guide efforts towards effective outcomes and the best use of limited resources (e.g., human, technical, financial).

The feasibility of applying a social relational network perspective depends upon the practicalities of data collection (Bodin, *et al.* 2011), despite the potential. For example, relevant social relational data might be readily available in meeting notes, membership directories, or public records of permits/quotas. In other cases, data collection could be problematic or prohibitive because secondary sources are not accessible, or because primary collection of social relational data is time intensive and respondents are often hesitant to share that type of information.

2.4.2 MPA Governance

A social relational network perspective is gaining traction as an analytical approach in an increasing number of environmental governance and natural resource management settings (Bodin, *et al.* 2011). Experiences from these settings provide valuable insights for the governance of MPAs and MPA networks (see Cohen, *et al.* 2012) (Table 2.2). Here we draw upon several cases (e.g., Kenya, Chile, and Mexico; see Table 2.3) to demonstrate the diversity of features and attributes that can be examined with a social relational approach (Figure 2.2), provide key insights on its application, and

illustrate the potential for a social relational network perspective to both contribute to and advance policy-relevant MPA science.

As noted above, Marin and colleagues (Marin and Berkes 2010; Marin, *et al.* 2012) applied a social relational network perspective to examine a coastal benthic co-management arrangement in Chile involving local fisher associations, state institutions, and technical assistance institutions (Table 2.3). Their analysis revealed several insights for MPA governance given the emphasis on organizational ties among seven functional groups that play different roles and contribute in different ways to the success of the co-management arrangement (Marin and Berkes 2010). Their analysis also revealed how a high degree of centralization of state agencies may hinder experimentation at the local level (Marin and Berkes 2010). Yet, as the authors note, "[t]he stability of the state and the rule of the law provide a solid base for actors and the management system" (Marin and Berkes 2010, p. 856).

For MPA managers and scientists, it is important to remember that different network structures and features contribute to different governance processes and thus it is a challenge to identify the most favorable levels and combinations of structural characteristics (Bodin and Crona 2009). In addition, moving beyond collaborative relationships – via the examination of both facilitating and hindering ties – helps to show a more realistic representation of co-management arrangements in which multiple state agencies interact with each other and communities through a combination of relational ties that enhance and/or inhibit various governance processes (e.g., decision making) (Marin and Berkes 2010). The inclusion of new actors and stakeholders in MPAs and MPA networks requires new tools and ways of understanding their roles and the

implications for conservation outcomes. As illustrated here, a social relational network perspective provides one helpful way to address this need.

Considering various social attributes also serves as a useful entry point to gain valuable insights with regards to the governance of MPAs and MPA networks. For example, bonding, bridging, and linking social capital have been cited as necessary preconditions for collective action. However, an analysis by Ramirez-Sanchez and Pinkerton (2009) of information sharing among fishers in a small-scale commercial fishery in Mexico (see Table 2.3) showed that despite the presence of all three types of social capital (i.e., bonding, bridging and linking) and a general awareness of the ecological conditions, the communities had yet to leverage their capacity to address the continued resource decline. The analysis serves as a reminder for MPA managers and scientists that social capital alone is often not sufficient for collective action and collaborative management. Furthermore, it serves as an example where an increased understanding of social networks and social capital provides a foundation for the possible establishment of new institutions (Ramirez-Sanchez and Pinkerton 2009). However, Frank (2011) cautions that natural resource management approaches and interventions informed by networks, which were successful in one context, may not be appropriate in another.

Examining social processes and practices (Figure 2.2) similarly provides valuable insights for the governance of MPAs and MPA networks. For example, Crona and Bodin's (2011) application of a social relational network perspective to understand the continued decline of marine resources within a mixed gear artisanal fishery in a rural Kenyan village (Table 2.3) focused on knowledge exchange. Knowledge exchange has

been noted as important in governance processes designed to encourage learning and adapting in the face of change and uncertainty (Armitage, *et al.* 2012). The authors found that the subgroups among the fisherman – based on primary occupation (e.g., seine net, deep-sea) – possessed diverse but complementary local ecological knowledge (Crona and Bodin 2011). However, due to homogeneity among the deep-sea fisherman and a lack of connections to other subgroups, the knowledge they possess is not communicated to others in the same user group, thus posing a challenge to social learning (Crona and Bodin 2011). Such findings highlight possible explanations for the continued degradation of marine resources and lack of collective action, and also point to opportunities for network building (e.g., Vance-Borland and Holley 2011).

Table 2.3 Selected coastal-marine case studies applying a social relational network perspective

Case Study	Social Network Features & Attributes Used in Analysis	Key Insights	References

Kenya	• Social Capital
	• Knowledge Exchange
	• Cross-scale linkages
	• Leadership
	• Brokers
	• Hubs
		• Subgroups possessed diverse and complementary local ecological knowledge
		• Deep-sea fishermen occupied a central position. However, due homogeneity & lack of connections to other subgroups, the complex knowledge possessed by the deep-sea fishermen is likely to only be communicated to others in the same user group.
		• Highly connected actors
		  • Predominately occupied by deep-sea fisherman
		  • Often had connections to outside agencies (i.e., cross-scale linkages).
		• Postulated that the mobility of the pelagic fish and the lack of time spent in the area (i.e., many deep-sea fishermen are semi-migrant from Tanzania) were contributing factors concerning this perceptual difference (i.e., deep-sea fisherman did not perceive the changes to the fishery that other user groups noted).
		• Suggested that the reduced sense of place and higher mobility help to explain the lack of incentives and perceptions necessary for actors in central positions to mobilize others for collective action.
			Crona & Bodin 2006; Crona & Bodin 2011; Crona & Bodin 2012

Table 2.3 Selected coastal-marine case studies (continued)

Case Study	Social Network Features & Attributes Used in Analysis	Key Insights	References

Chile	• Social Capital
	• Collaboration
	• Functional Groups
	• Actor positions
	• Multilevel linkages Diffusion of innovation
		• Co-management includes several functional groups not just state and community
		  • However, no single sector dominated entire co-management network
		• Grass roots constrained by current network structure characterized by:
		  • Centralized decision making/ concentration of power in government
		  • Min. horizontal exchanges and collaboration between fisher organizations
		• Moving beyond collaboration (i.e., facilitation & hindrance) shows a more complete picture of co-management arrangements
		• Levels of social capital varied significantly between fisher orgs.
		• Found linking social capital more regularly associated with higher performing fisher org despite lack of bridging social capital
		• May be a reflection of the current co-management structure where fisher orgs. may benefit greater from linking rather than bridging ties
			Marin & Berkes 2010; Marin *et al.* 2012

Mexico	• Social capital • Knowledge Exchange • Diffusion of innovation Actor Position	• Awareness & network structure (e.g., bonding, bridging and linking social capital) present for collective action, however yet to be mobilized • have adaptive capacity but lack proactive resilience, requiring the need for institution building • Social networks among resource users activated depending upon varying ecological conditions • Actor centrality can vary based on level of aggregation (i.e., local vs. regional) • Importance of considering both individual and relational attributes to identify resource users	Ramirez-Sanchez & Pinkerton 2009; Ramirez-Sanchez 2011A; Ramirez-Sanchez 2011B

A social relational network perspective can help to incorporate social theory into MPA science. The examples highlighted illustrate the analytical insights to be gained using a structurally explicit, social relational network approach (Table 2.2). Furthermore, the examples indicate the utility of the approach when applied at different levels of analysis (i.e., whole network, subgroup, individual/node), and in highlighting the diversity of types of ties (e.g., information sharing, collaboration) that are important to MPA and MPA network settings. However, there are limitations with the application of a

social relational approach. As noted, some of these limitations are related to data access and analytical challenges. However, there are also instances when the role or social relational networks in MPA contexts are not as important to establishment or governance as other factors, or where the appropriateness and utility of a social relational network perspective requires the consideration of context (Bodin *et al.* 2011; Frank *et al.* 2007). In some instances, for example, market forces or institutional factors (e.g., lack of state support and/or recognition of local management arrangements, weak sanctions) may contribute more significantly to particular MPA governance arrangements, conservation outcomes and/or human behavior. Furthermore, limitations exist with regards to the application of some theories and concepts. For example, Frank and colleague's (2011) theory of social embeddedness is based on the premise that actors identify with a given community, which the authors note may not always be the case (e.g., mobile fishers, migrant resource users) and thus these actors are unlikely to be influenced by community norms.

2.5 Conclusion

The continued degradation of the marine environment and anticipated impacts of climate change will require policy-relevant MPA science informed by both ecological and social theory. Fox *et al.* (2012a) have identified several research frontiers to advance MPA science, one of which is greater attention to the role of social networks. This mini-review outlines the emergence of a social relational network perspective and its contributions to policy-relevant MPA science, including the potential for more systematic identification and examination of actor roles, social attributes, and processes (e.g., trust,

knowledge exchange) crucial to the establishment and governance of MPAs and MPA networks (Table 2.2). There are no simple approaches to examining the social context of MPAs and MPA networks but the approach outlined here provides a theory-driven framework for further modeling and empirical analysis. We identify four key insights associated with the application of a social relational network approach to policy-relevant MPA science:

- The additional scope of Aichi Target 11 – established in 2010 – to conserve areas of particular importance for ecosystem services and secure greater benefits for people while being equitably managed requires additional conceptual models and analytical methods (Spalding, *et al.* 2013). A social relational network perspective contributes to this need to explicitly consider the social dimensions of MPAs and MPA networks so as to inform future policy and practice.
- Understanding how social relational networks enhance or inhibit the establishment of MPAs and MPA networks can provide new insights into the "enabling environments" that contribute to scaling up of MPAs (Fox, *et al.* 2012b), and identifying prospective areas where conservation is feasible and collective action more likely (see Mills, *et al.* 2013).
- The emergence of hybrid governance arrangements in conservation contexts (Armitage, *et al.* 2012), and the inclusion of new actors and stakeholders associated with MPAs and MPA networks, requires more explicit and systematic approaches to examine the formal and informal social networks that are central to multi-actor governance arrangements (e.g., co-managed MPAs) (Carlsson and Berkes 2005).

- Scholars studying social networks are generating valuable analytical approaches to examine different types and dimensions of social networks (e.g., temporal networks). Several of these approaches, as outlined in Table 2.4, represent important research frontiers of a social relational network perspective for policy-relevant MPA science with promising applications to better understand various conservation outcomes.

Table 2.4 Social network research frontiers for policy-relevant MPA science

Research Frontier	*Why Crucial*	*Implications for MPA science*
Temporal Networks	• Longitudinal studies of social networks can reveal network evolution as it relates to the structure, function and associated actors • Furthermore, it helps move beyond the traditionally static nature of social network analysis that only provides a snapshot in time	Such an approach may provide: • Key insights as to whether different network structures and actor positions are associated with conservation planning and MPA establishment vs. the ongoing active management and governance of MPAs. • Key insights linking changes in network structure and function with changes in the ecological & biophysical condition of MPAs • Key insights into the transformation of governance arrangements contributing to improved conservation outcomes associated with MPAs
Spatial Networks	• It has long been noted that space can influence social relations in varying ways • Furthermore, CPRs such as fisheries and coral reefs have a significant spatial component to them • Coupling social relational data with GIS data in turn situates social networks in their geographic context	Such an approach may provide: • Key insights relevant to scaling up from MPAs to Ecosystem Based Management • Key insights relevant to building capacity to develop and/or expand MPA networks (i.e., identifying actors and linkages that connect communities and/or regions)
Multilevel Networks	• It has been noted that different actor groups may be active at different scales with different and often scale specific knowledge (Ernstson, *et al.* 2010) • Social networks are not closed but rather nested resulting in the potential to exhibit different hierarchical levels of scale	Such an approach may provide: • Key insights into the continuous debate between top down and bottom up strategies for MPA governance • Key insights with regards to the interplay between local level networks of resource users and national networks of actors contributing to decision-making, policy, research, funding, financing, etc. (i.e., emergent structures; constraint)
Social-Ecological Networks	• There has been an increasing recognition of the linked and interdependent nature of social-ecological systems including MPAs	• Such an approach may provide key insights into the structure and function of MPA networks that are linked ecologically and/or socially through resource users and governance actors

Supporting Information

Additional Supporting information has been included for this chapter:

Appendix E (Table E 1)**:** Theoretical and empirical references drawn from the broader natural resource management and environmental governance literature associated with each social relational network feature and attribute included in *Figure 2.3*

Chapter 3

Social networks and transitions to co-management in Jamaican marine reserves and small-scale fisheries

3.1 Chapter Summary

How social networks support or constrain the transition to co-management of small-scale fisheries and marine reserves is poorly understood. In this paper, we undertake a comparative analysis of the social network structures associated with the transition to co-management in three Jamaican marine reserves. Data from quantitative social relational surveys (n=380) are integrated with data from semi-structured interviews (n=63) and focus groups (n=10) to assess how patterns of relational ties and interactions between and among fishermen and other local level actors (e.g., managers, wardens, NGO staff) support and constrain the transition to co-management. Our research suggests that the transitions to co-management were supported by a combination of three network structure and relational attributes: i) the presence and position of institutional entrepreneurs; ii) a dense central core of network actors; and iii) the prevalence of horizontal ties and vertical linkages held by the community-based organizations formally responsible for the management of the marine reserves. Our findings also show that overall low network cohesion in the three reserves and limited social influence among the wardens may be problematic for sustained collective action that extends beyond the core set of network actors. These findings suggest the importance of strategies to enhance collective action, specifically through attention to the attributes of the corresponding social networks, as a means to contribute to successful transitions to co-management of marine reserves and small-scale fisheries. Our results provide more precise guidance,

through social network analysis, on where in the respective networks social capital and leadership may require support or enhancement, and thus on how to target interventions for greatest effect.

3.2 Introduction

Co-management arrangements for the conservation of natural resources have been discussed for decades (e.g., Charles 1988; Pinkerton 1989) and are increasingly adopted in coastal-marine environments (Evans, *et al.* 2011; Gutierrez, *et al.* 2011). The establishment and adoption of co-management approaches for marine protected areas (MPAs) – including marine reserves – have followed a similar trend (Johannes 2002; Alcala and Russ 2006; Govan 2009). These newly established co-management arrangements often involve the devolution of responsibilities associated with day-to-day management of natural resources, and in some instances a transfer of power and authority from national government agencies to communities and sub-national governments (Pomeroy, *et al.* 2004; Carlsson and Berkes 2005). In addition, co-management can involve the participation of local community groups or resource users in decision-making, implementation, and enforcement (Jentoft, *et al.* 1998; Berkes 2010). When MPAs are contemplated for coastal areas, there are typically strong interactions with small-scale fisheries, which can create significant governance issues, in terms of interactions between resource users and conservationists (Garcia, *et al.* 2014), and for governance of MPAs themselves (Jones 2014).

In such cases, when MPAs and small-scale fisheries interact, it is crucial to consider the corresponding 'human dimensions' (e.g., social, cultural, economic, and political aspects) (Charles and Wilson 2009). Considerable progress has been made in

understanding how these human dimensions influence transitions to co-management of MPAs and small-scale fisheries (Chuenpagdee and Jentoft 2007; Cinner, *et al.* 2012; Ayers and Kittinger 2014). A key ingredient is the existence of formal and informal social networks to enable effective multi-actor management and governance arrangements (e.g., co-managed MPAs) (Carlsson and Sandström 2008; Bodin, *et al.* 2011). Social networks – and associated aspects of leadership, social capital, and appropriate institutions – have been suggested to play a critical role in effective transitions to co-management of small-scale fisheries (Crona and Bodin 2010; Cinner, *et al.* 2012; Gutierrez, *et al.* 2011; Pomeroy and Andrew 2011). Social networks are considered to contribute to increased collaboration (Armitage, *et al.* 2009; Berkes 2009), collective action (Ostrom 1990; Pretty 2003), and the adoption of new norms (Friedkin 1998; Frank 2011; Nunan, *et al.* 2015).

However, not all networks are structurally equal. Different patterns of social relations (i.e., network structures) contribute to different management and governance outcomes (Bodin and Crona 2009; Bodin and Prell 2011). Accordingly, two major questions arise. First, how do social networks support and inhibit the transition to co-management, particularly in the context of weak state support (e.g., financial, institutional)? And second, what characteristics of the networks play the most significant role in this regard? We address these questions in the context of marine reserves and small-scale fisheries in Jamaica. Specifically, a comparative analysis is provided of the social networks associated with three *Special Fishery Conservation Areas* (SFCAs) – i.e., marine no-take areas.

We use a social relational network perspective as a conceptual model and associated suite of analytical methods to frame our analysis (see Alexander and Armitage 2015). A social relational network perspective is informed by relational sociology (e.g., Emirbayer 1997; Mische 2011) and social network analysis (e.g., Wasserman and Faust, 1994), and emphasizes: i) relations among individuals rather than personal attributes; ii) networks rather than groups; and iii) specific relations or patterns of relations relative to their broader relational context (Marin and Wellman 2011; Alexander and Armitage 2015). Taken together, these three points provide the underpinnings of a network perspective to examine the social dimensions of MPAs.

Empirical work to date concerning the role of social networks for natural resource management has largely focused on single case studies (e.g., Crona and Bodin, 2010). This study contributes to the limited number of comparative case studies that empirically examine the social relational dimensions in a natural resource management setting (Sandström and Rova 2010a, 2010b). As Sandström and Rova (2010b) posit, comparative case studies enable the testing of hypotheses relating to network structure and function, and in turn provide the potential for "inductively identifying the design principles of successful systems [(i.e., governance arrangements)]" (p. 546). The differing co-management arrangements and actors associated with the three selected *Special Fishery Conservation Areas* we examine here provide a unique comparative opportunity (see Section 3.4.1 Case Study Context).

The paper is organized as follows. First, we outline the theoretical foundation of our approach. An overview of the case study context and background is then provided along with a detailed account of the research methods we use. Next, we analyze specific

structural features and characteristics of the three social networks against those theorized to influence key social processes. We then discuss the potential of the social networks to support and inhibit transitions to co-management of small-scale fisheries and MPAs. Accordingly, this paper presents a formative analysis (i.e., focusing on process) rather than a summative analysis (i.e., outcome-based). Furthermore, we consider the extent to which particular structural features, network ties, and key actors help to explain previous experiences, as well as their implications for future and sustained collective action.

3.3 Social Networks and Co-management of Small-scale Fisheries

Much has been written about the co-management of small-scale fisheries (Berkes, *et al.* 2001; Pomeroy and Andrew 2011) and participatory approaches in implementing MPAs (e.g., White, *et al.* 2002; Pomeroy, *et al.* 2007; Charles and Wilson 2009). There has also been considerable study of the interactions between MPAs and fisheries in terms of both biological/ecological (Hilborn, *et al.* 2004) and social, economic, and governance aspects (e.g., Christie and White 2007; Charles 2010; Jones 2014). What is relatively new to small-scale fisheries and MPA analysis, however, is the social relational network perspective (e.g., Ramirez-Sanchez and Pinkerton 2009; Crona and Bodin 2010). Here we focus on applying that perspective to identify the factors influencing transitions to co-management of small-scale fisheries and MPAs from centralized government-based management.

An important starting point in this exploration is the recognition that there is no ideal network structure for the diverse social processes necessary in natural resource governance contexts (Newman and Dale 2005; Bodin and Crona 2009). For example, a tension exists in regards to the right combination of bonding ties (i.e., "strong" ties that

result from a combination of frequency of interaction, reciprocity, and emotional investment) and bridging ties (i.e., ties that connect two networks or sub-groups that would not otherwise be connected). While bonding ties develop local level trust, they can also lead to increased homophily (i.e., the process by which a network becomes composed of actors more similar with regards to socio-demographic, intrapersonal, and behavioral characteristics and thus less diverse), which has been shown to discourage experimentation and lead to the imposition of strict social norms (Newman and Dale 2005). Similarly, bridging ties serve to introduce new information, yet tacit knowledge of complex systems requires repeated interactions associated with bonding ties (Bodin and Crona 2009).

Insights from social network analysis imply that there are inevitable tradeoffs associated with favoring particular network characteristics and governance processes (Bodin and Prell 2011; Henry and Vollan 2014). There is, as a result, no ideal network structure. One network will not necessarily serve all requisite social processes equally well. Different 'ideal' network structures may exist for different purposes. A high probability of tradeoffs associated with differing network structures requires an examination of multiple features, attributes, and processes. We focus here on social influence, network cohesion, as well as horizontal ties and vertical (i.e., multilevel) linkages to examine the role of social networks in fostering transitions to co-management of small-scale fisheries and MPAs.

Social influence serves as an entry point to consider the potential to establish new norms within a community of resource users (e.g., fishermen), such as shifting from open access to the implementation of no-take MPAs within a broader fishing ground. As

Marsden and Friedkin (1993) suggested, relational ties "provide a basis for the alternation of an attitude or behavior by one network actor in response to another" (p. 127). Frank (2011) has further suggested that to better understand the role of social networks with regards to sustainable behaviors and practices, or the establishment of new norms, it is useful to identify relational ties that represent the flow of influence among a community of resource users such as fishermen. Central to the examination of social influence is the identification and examination of key actors.

Certain actors embedded within social networks can play a critical role with regards to introducing new norms and behaviors (Crona and Bodin 2010; Crona, *et al.* 2011; Frank, *et al.* 2011). Such roles and individuals have been referred to by different terms, including opinion leaders (Crona and Bodin 2010) and institutional entrepreneurs (Maguire, *et al.* 2004; Garud, *et al.* 2007). We follow Crona *et al.* (2011) and adopt the concept of institutional entrepreneurs for natural resource governance contexts, focusing here on community actors whom may be in a position to guide the Jamaican SFCAs. Institutional entrepreneurs are defined here as those actors who "have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones" (Maguire, *et al.* 2004, p. 657). Moreover, they are actors who often possess a particular combination of structural and relational characteristics (e.g., high degree centrality) and personal attributes (e.g., capability to envision an alternative future) (Crona, *et al.* 2011; Moore and Westley 2011).

Network cohesion – used here as a proxy for social cohesion – has been identified as a key attribute for the successful co-management of fisheries (Gutierrez, *et al.* 2011; Pomeroy, *et al.* 2011) and MPAs (Rudd, *et al.* 2003). Network cohesion is crucial in the

promotion of common norms and values (Pretty 2003; Crona and Bodin 2011). Repeated interactions between individuals lead to development of trust and contribute to the establishment of mutual understanding about the status and conditions of natural resources (Ostrom 1990, 2005; Ostrom and Walker 2003). Strong relational ties further contribute to the development of shared views, perceptions, behaviors, and norms (Prell, *et al.* 2010). The importance of network cohesion and the promotion of common norms is particularly acute in the context of co-management arrangements where there is weak state support as it reduces transaction costs and contributes to self-monitoring (Pretty 2003; Berkes 2010; Nunan, *et al.* 2015).

Horizontal ties and vertical (i.e., multilevel) linkages are critical for successful conservation and natural resource management outcomes (Cash, *et al.* 2006; Armitage, *et al.* 2012). Horizontal ties – also referred to as bridging ties – connect specific individuals and organizations with other community-based organizations and resource management initiatives (e.g., other marine reserves). Horizontal ties also facilitate knowledge exchange and the diffusion of innovative practices (Ramirez-Sanchez and Pinkerton 2009; Ramirez-Sanchez 2011a; Marin, *et al.* 2012). Vertical network ties to higher levels of organization (e.g., jurisdictional, political) are also an important mechanism to access and leverage resources, ideas, and information/knowledge needed for successful co-management (Bodin and Crona 2009; Marin, *et al.* 2012).

3.4 Research Methods

3.4.1 Case Study Context

Coastal-marine systems in Small Island Developing States (SIDS) of the Caribbean are highly vulnerable to both current and future environmental change,

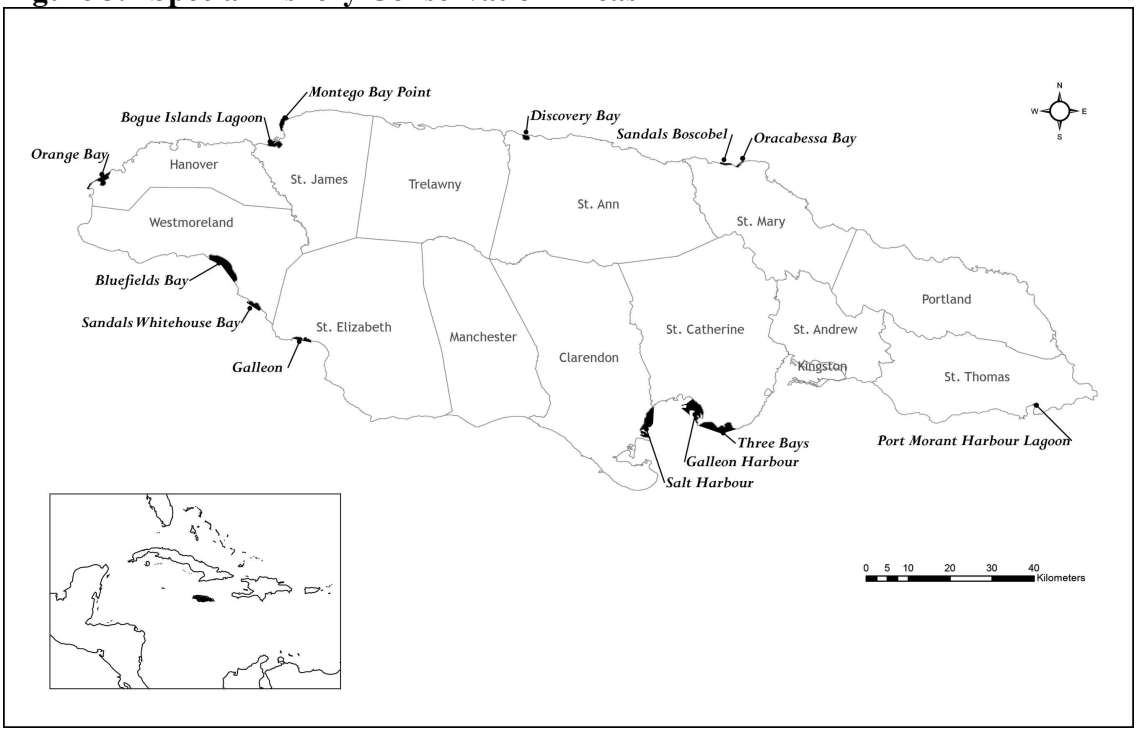
including climate change (CARSEA, 2007; IPCC, 2014). Increased storm intensity, sea level rise, coastal erosion, coral bleaching, ocean acidification, and declining marine fisheries threaten the region (Pulwarty, *et al.* 2010; Nicholls and Cazenave 2010). Additionally, marine resource exploitation combines with other drivers of change (e.g., urbanization, tourism development) to produce cumulative effects that are complex, emergent, and cross-scale (CARSEA 2007).

Jamaica is no exception to the general trends of the region. Coral reefs in Jamaica are vulnerable to the impacts of climate change and are similarly faced with multiple issues, including sedimentation, pollution, and overfishing (Burke and Kushner 2011). A recent global assessment of coral reefs found that Jamaica is highly dependent upon coral reefs that rank globally among the most vulnerable to environmental change (Burke, *et al.* 2011). As with other Caribbean islands, Jamaica is highly dependent on tourism. In 2013, travel and tourism contributed to one quarter of the country's gross domestic product (GDP) (World Travel & Tourism Council, 2014). In addition, reef-dependent fisheries contribute to the livelihoods of nearly five percent of the island's population and upwards of seventy-five percent of households' in some communities (Burke and Kushner 2011; Burke, *et al.* 2011). Moreover, near shore artisanal fisheries provide close to ten percent of protein consumed by Jamaicans making the health of coral reefs a matter of food security, especially for rural fishing communities (Waite, *et al.* 2011).

To address the potential impacts of climate change, loss of biodiversity, and marine resource exploitation, eight Caribbean nations, including Jamaica, launched the *Caribbean Challenge* in 2008. In signing the Challenge, nations committed to protecting approximately 20% of their near shore marine area by 2020. Accordingly, the Jamaican

government established twelve *Special Fishery Conservation Areas* (SFCAs) between 2009 and 2012, with more under consideration (Figure 3.1). SFCAs are marine no-take zones, and recent efforts to expand the SFCAs build upon formerly established no-take areas. The identification of potential sites for SFCAs is based on a number of social and ecological criteria established by an advisory committee (see Aiken, *et al.* 2011). One of the key criteria is the presence and involvement of "at least one functioning Non-Government Organization that will operate the sanctuary and enforce the regulations protecting it" (Aiken, *et al.* 2011, p. 162). To date, thirteen of the fourteen SFCAs are under active co-management, though with varying levels of monitoring and enforcement, ranging from a few patrols a week to near twenty-four hour coverage.

Figure 3.1 Special Fishery Conservation Areas*



*Not shown is the South West Cay SFCA located at Pedro Bank, approximately 80 km south of Jamaica (Map by D. Campbell)

The Jamaican government has established co-management arrangements that devolve roles and responsibilities (e.g., monitoring) associated with the day-to-day management of marine reserves to local non-governmental organizations and/or fishermen co-operatives. The co-management roles and responsibilities are supported by formal Memorandums of Agreement. The Government of Jamaica (i.e., Fisheries Division) maintains the power and responsibility to gazette the boundaries of the SFCAs as well as to establish and amend relevant regulations and fines. The local non-governmental organizations and/or fishermen co-operatives are responsible for hiring and training wardens, maintaining regular patrols of the SFCAs, enforcing fishery regulations, conducting ongoing monitoring, and providing regular reports.

The three SFCAs included in this study (Table 3.1) range in size from approximately 1 km^2 to 13.5 km^2, and all three are in proximity to several small coastal communities. In these communities – as with the majority of coastal communities around the island – the fishery is predominately small-scale and artisanal (Aiken and Kong 2000). The fishery is best characterized as mixed gear (e.g., fish traps, gill nets, handlines, spearguns) and multi-species (e.g., reef fish, spiny lobster, conch, small coastal pelagic finfish, large offshore pelagic finfish) with the majority of capture occurring near shore. While each of the SFCAs has a formal co-management arrangement with the government (i.e., Fisheries Division), these take different forms. In Orange Bay, the arrangement is between a local environmental NGO and the government. In Bluefields Bay, the arrangement is between a local fisherman's society and the government. In Oracabessa Bay, the arrangement is between a local fisherman's cooperative, a local private community foundation, and the government. All three SFCAs have been under active co-

management for 5 – 5 ½ years (see Table 3.1).

The three SFCAs in this study have several key similarities and differences. For example, the characteristics of the near-shore fishery and length of time under active co-management were similar across all three sites. However, they differed based on their overall size, number of fishermen, and the type of co-management arrangement – including the types of organizations involved. Furthermore, the establishment of two of the SFCAs – Bluefields Bay and Oracabessa Bay – were largely driven by local fishermen groups, while the third – Orange Bay – was sited within an established marine park.

Table 3.1 Summary of Special Fishery Conservation Area Attributes

SFCA	Size (km^2)	Declared	CBO with Management Mandate	Number of Wardens	Fishermen's Cooperative	Number of Landing Sites Targeted
Bluefields Bay	13.59	July, 2009	Fishermen's Friendly Society	8	Yes	7
Oracabessa Bay	0.84	February, 2010	Community Foundation + Fishermen's Cooperative	12	Yes	5
Orange Bay	5.36	July, 2009	Environmental NGO	2	No	5

3.4.2 Data Collection

This study employed a mixed methods approach (Creswell 2009; Hay 2010; Hollstein, 2014), including questionnaires, focus groups, semi-structured interviews, document review (e.g., management plans, legal material), and participant observation. Data were collected over five months of fieldwork between November 2012 and February 2014, with the majority of data collection taking place from August 2013 through November 2013.

Social network data were collected via questionnaires administered through personal interviews with fishermen (n=380). The distribution of the questionnaires across the three cases is as follows: Bluefields Bay (n=130); Oracabessa Bay (n=147); and Orange Bay (n=103). The target population was defined as all fishers based at landing sites located within the boundaries of the SFCA in addition to those landing sites directly adjacent to the boundary. To capture as complete a network data set of fishermen as possible, lists of registered fishers provided by the Fisheries Division were coupled with lists of fishers produced by local community partners. Respondents from the list were also asked to suggest other fishers at each landing site. In addition, multiple visits to each landing site at varying times of day over the course of two weeks were made. This modified snowball sampling method was carried out until network closure had been reached – i.e., the addition and mention of new names is minimal, akin to saturation (Hanneman and Riddle 2005). Network data collected was based on information-sharing ties. Questions capturing information-sharing ties employed a *name generator* with free-recall which asked respondents to list individuals with various relational ties (e.g., knowledge exchange) (Marsden 2011). Chua *et al.* (2011) note this technique is well suited to capture strong ties. Data related to personal attributes and fishing activities of each respondent were also collected through the questionnaires (e.g., gender, age, gear type, landing site).

Additional social network data were collected via a sociometric survey administered through personal interviews (n=18) with organizations and agencies affiliated with the governance of the national network of SFCAs. This data captures the collaboration and knowledge exchange ties among actors – at the organizational level –

across the island including managers, NGOs, academic institutions, and government agencies. Participants were provided a roster with different organizations and agencies and asked to identify the presence or absence of relational ties to each (e.g., collaboration, knowledge exchange). *Name interpreter* questions were used to elicit responses on the nature of the ties (e.g., frequency). Participants were also given the opportunity to add organizations and agencies not included on the roster with whom they had relevant ties with.

Focus groups (n=10) were conducted with fishermen at landing sites within or directly adjacent to the three *Special Fishery Conservation Areas.* The number of participants at each focus group session ranged from 4 to 12. The focus groups lasted on average between sixty and ninety minutes in length covering four main topics: i) rules governing the use of the SFCA; ii) alternatives to the current rules, regulations, and boundaries of the SFCA; iii) participation with regards to the planning and management of the SFCA; and iv) relational ties and patterns of interactions between fishermen (and other persons) with respect to the management of the SFCA.

Semi-structured interviews (n=63) were conducted with local community organizations, fisherman cooperatives, non-governmental agencies (e.g., local, national, international) and government agencies (e.g., national) involved with the SFCAs – including wardens. Interviews lasted thirty to ninety minutes in length and were usually undertaken at the respondents' office. Respondents were selected using a snowball sampling technique in which each respondent was asked to provide contact information for other potential respondents (Hay 2010). To reduce bias in the sample, multiple snowballs were initiated. SFCA managers – or community-based organization board

representatives – served as initial respondents. Interviews continued until the majority of relevant governance organizations had been sampled. This was determined as the point when individuals from new organizations (e.g., agencies, divisions, departments, NGOs) were no longer being suggested as possible respondents (i.e., network closure had been reached) (Hanneman and Riddle 2005). In addition to capturing relevant background information and insights concerning the establishment of the *Special Fishery Conservation Areas,* the interview guide contained open-ended questions designed to cover three dimensions of governance with regards to the SFCAs: i) co-management arrangements; ii) institutions and fit; and iii) actor networks. Interviews were digitally recorded and transcribed verbatim. They were then analyzed using qualitative content analysis in NVivo 10 (QSR International).

3.4.3 Social Network Analysis

Social Network Analysis (SNA) was used here to examine network components within each SFCA including actors and linkages (e.g., information flows), along with network structure (e.g., density) to reveal both formal and informal relational ties (Wasserman and Faust 1994). Social network analysis results were further combined with qualitative content analysis of data derived from interviews, focus groups, and observations. Integrating the data types provides significant benefits for the interpretation of network data – e.g., contextual background, the content and meaning of individual ties (Cross, *et al.* 2009; Bodin and Prell 2011; Prell 2012; Hollstein 2014). UCINet (Borgatti, *et al.* 2002) and Gephi were used for social network analysis while Gephi, an open source platform for network analysis, was used to generate visuals.

Network cohesion was examined by analyzing fragmentation. Fragmentation

reflects the proportion of pairs of actors within the network that cannot reach each other (Borgatti, *et al.* 2002). Further analysis to identify cohesive subgroups was done through the examination of modularity. Modularity captures subgroups, or community structure, through the partitioning of the network to reflect groups of nodes that have a higher density of ties within the group as compared to ties between the groups (Blodnel, *et al.* 2008). The modularity function in Gephi was used for this analysis, which adopts the algorithm developed in Blondel *et al.* (2008). Specifically, the modularity function was used to identify the largest cohesive subgroup rather than to capture a network wide 'index'.

Social Influence was examined by focusing upon the wardens via the measure of K-reach, calculating the percentage of the network reached within two steps of the wardens. Specifically, K-reach was calculated through a three-step process. First, the total number of actors within two network ties was calculated for each SFCA warden – i.e., one relational tie removed from the warden. Overlap of actors and ties to other wardens were then subtracted from the total sum. For example, this ensured that "Fishermen 1" is only counted once even though the fishermen may be connected to both SFCA "Warden A" and "Warden B." The final number of actors within two steps of the wardens is then calculated as a percentage of the total number of actors found within the network.

Horizontal ties and vertical (i.e., multilevel) linkages were examined by calculating the degree centrality of the community-based organizations formally responsible for the management of the three SFCAs (i.e., counting the direct horizontal and vertical ties held by each). Horizontal and vertical refer here to jurisdictional level. For example,

horizontal ties include those ties to other community-based organizations locally as well as other SFCAs around the island, while vertical ties would include connections to actors such as national NGOs and government agencies.

3.5 Results

The collective responses from the questionnaires resulted in three respective social networks: Bluefields Bay (188 actors, 221 ties), see Figure 3.2; Oracabessa Bay (191 actors, 167 ties), see Figure 3.3; and Orange Bay (126 actors, 118 ties), see Figure 3.4 (see Appendix F for rationale concerning non-response and missing data). Figures 3.2 – 3.4 include all actors identified by respondents and all isolates (i.e., respondents with no connections). The network ties in Figures 3.2 – 3.4 represent undirected information sharing ties between two given actors in the network (i.e., A says s/he communicates about fishing with B and/or B says s/he communicates about fishing with A). The National Environment and Planning Agency of Jamaica was removed from the network in Orange Bay to ensure the social network analysis best reflected the information-sharing network among individual resource users.

Figure 3.2 Graphical visualization of the information-sharing network among fishers in the vicinity of the Bluefields Bay Special Fishery Conservation Area. Red nodes indicate wardens.

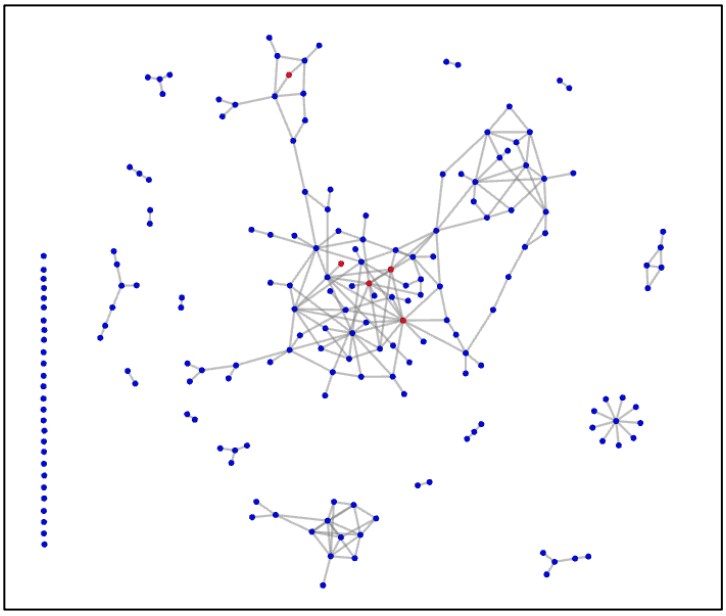


Figure 3.3 Graphical visualization of the information-sharing network among fishers in the vicinity of the Oracabessa Bay Special Fishery Conservation Area. Red nodes indicate warden.

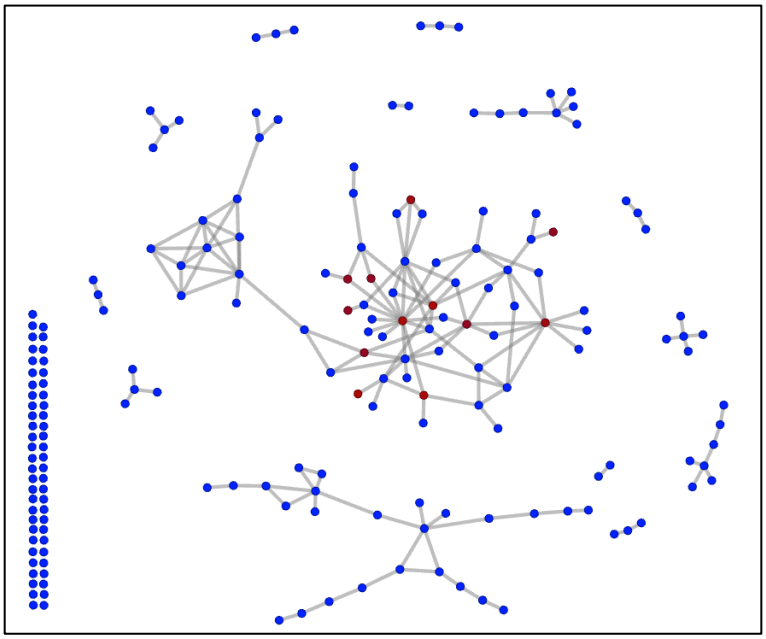
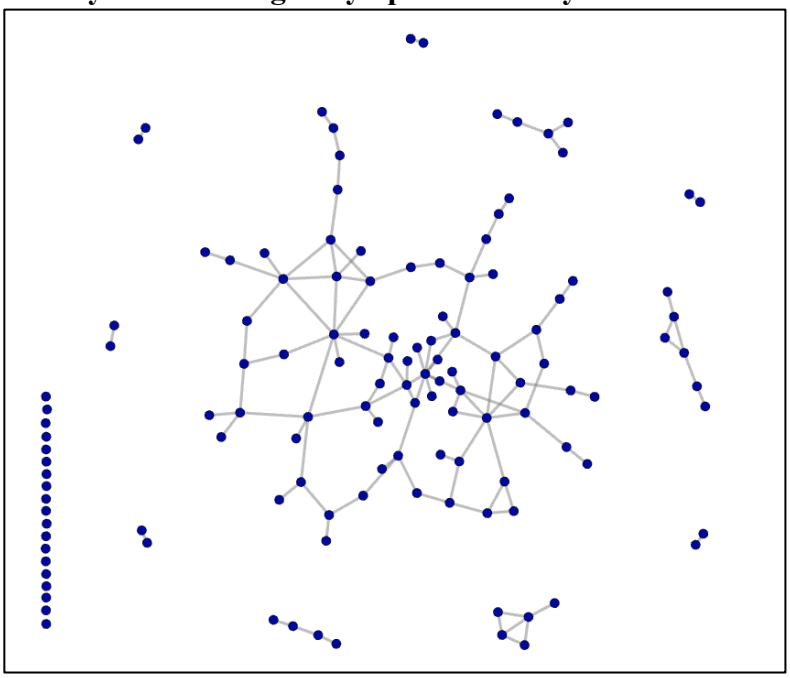


Figure 3.4 Graphical visualization of the information-sharing network among fishers in the vicinity of the Orange Bay Special Fishery Conservation Area.



As noted above, Figures 3.2 – 3.4 include all isolates (i.e., respondents with no connections). Orange Bay had the fewest isolates – 19 of 126 – while Oracabessa Bay had the most isolates – 55 of 191. Bluefields Bay fell in the middle with 27 isolates of 188 total actors in the network. In all three cases, the large majority of these individuals appearing as isolates responded that they do not share or receive information from others, nor were they identified by fellow respondents (Orange Bay 94.7%; Oracabessa Bay 89.1%; Bluefields Bay 77.8%; see Supplementary Material F).

3.5.1 Social Influence

The establishment of the *Special Fishery Conservation Areas* resulted in a shift from open access to closed access (i.e., no-take areas). Accordingly, it requires establishing new norms and behaviors within the community of resource users (i.e., fishermen) with regards to how they interact with the near shore marine environment.

This challenge is particularly acute considering the persistent problems with compliance and conflict revealed through personal observations, interviews, and focus groups. Problems range from illegal fishing in the SFCAs to conflicts over the boundaries resulting in the repeated cutting of marker buoys and general displeasure resulting in threats to the wardens – and in some instances even altercations.

3.5.1.1 Network Measures

Results related to social influence (Table 3.2) focus on one particular network measure in relation to the wardens. The K-Reach (2) for Bluefields Bay included 29.3% of the network (Figure 3.5), while the same calculation for Oracabessa Bay included 20.9% of the network (Figure 3.6). Oracabessa Bay has more wardens embedded in the network (i.e., 50% more) than Bluefields Bay. However, their K-reach is smaller. Orange Bay has two wardens. However, neither was identified during the administration of the questionnaire to the fishermen. Accordingly, they were not included in the network.

Table 3.2 Summary of comparative social network analysis

SFCA	Network Cohesion	Social Influence (Wardens)	Horizontal & Vertical Linkages (Organization)	
	Fragmentation	K-Reach (2) %	Horizontal	Vertical
Bluefields Bay	0.746	29.3	5	13
Oracabessa Bay	0.868	20.9	5	11
Orange Bay	0.642	0	1	5

Figure 3.5 Bluefields Bay Special Fishery Conservation Area – K-Reach (2), 29.3% coverage. Red nodes = those actors that are 2 steps or less from the wardens.

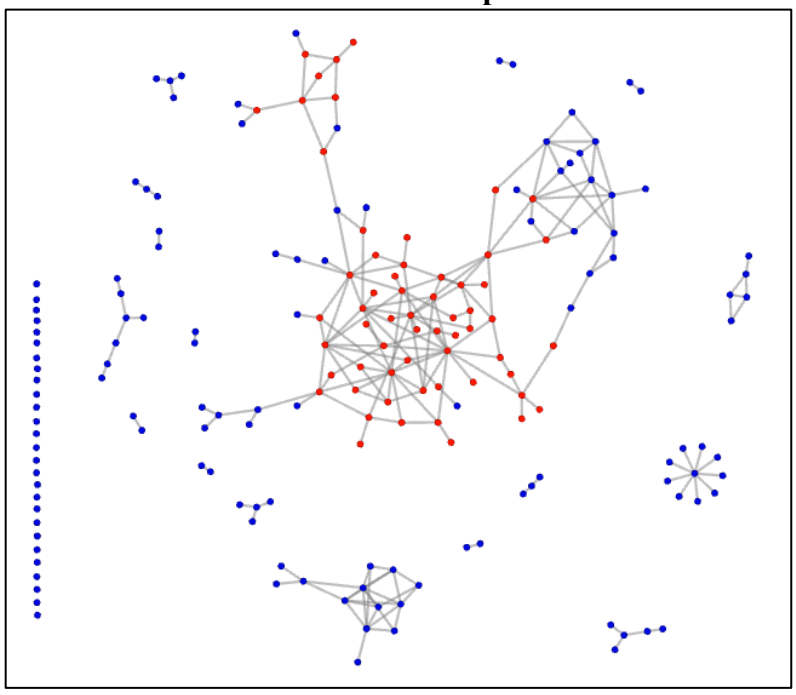
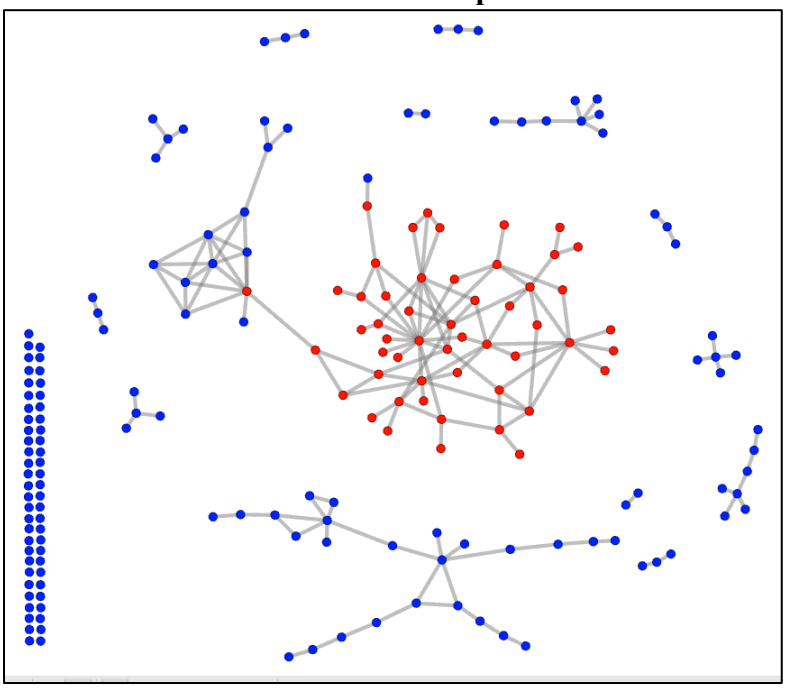


Figure 3.6 Oracabessa Bay Special Fishery Conservation Area – K-Reach (2), 20.9% coverage. Red nodes = those actors that are 2 steps or less from the wardens.



3.5.1.2 Institutional Entrepreneurs

Identifying key actors and the role of social influence serve as important entry points to understand the potential for the introduction and adoption of new norms. Some of the wardens (i.e., approximately two to three respectively) in Bluefields Bay and Oracabessa Bay have played a critical role as early adopters of new norms (e.g., establishing marine no-take areas) and as institutional entrepreneurs (*sensu* Crona *et al.* 2011; Maguire *et al.* 2004). They are current and former fishermen who have concluded that new norms are necessary for a better future. These select individuals are currently involved with monitoring, enforcement, and outreach, and they have contributed since 'step zero' (i.e., pre-implementation) before their formal warden position was established. These individuals have influenced other network actors through community meetings, fisherman cooperative meetings, and visits to neighboring landing sites

There are several commonalities among these institutional entrepreneurs in both Bluefields Bay and Oracabessa Bay. They are well positioned with high degree centrality to introduce new ideas and norms into their community. Moreover, the actor with the highest degree centrality in both Bluefields Bay (n=13) and Oracabessa Bay (n=15) were wardens. These two wardens with the highest degree centrality are also the respective presidents of the local fishermen's cooperatives in Bluefields Bay and Oracabessa Bay, which likely contributes to their high degree centrality. In addition to being well positioned with a high degree centrality, however, interviews and personal observation revealed that these same individuals often had established personal ties through repeated interactions with other community organizations, NGOs, and government agencies often exposing them to new ideas, information, and training.

A third common trait among these individuals is that they can envision an alternative future and believe strongly that it is possible to redefine their trajectory (i.e., overcome path dependency). As one warden noted:

> *"So all we need, all of us just come together and just make it work. And it will work….It's going to work. Throughout the island this is one of the best. Most improved….So I want to, maybe the next ten years when I sit back I just, maybe can just come at the beach and just watch fishes…and just sit down and say yeah, that's what I started. Somebody have to carry it on." – Respondent 10*

In conjunction with this vision for an alternative future was a historical perspective that these individuals had, a perspective that includes observation of changes to the local marine environment and fish populations over time.

Finally, the wardens whom are playing the role of institutional entrepreneurs are so committed to the vision and new norms that they have often made sacrifices. They have patrolled without pay, used their own boats and purchased their own fuel, and have divided salaries to support more wardens when they did get paid. As one warden explained:

> *"So now we are seeing the effects – we are not going to sit back – whether we are getting paid or not, and let nobody destroy it. So that is why I'm here working the past two months without a dollar and I'm not complaining because I see what I want to see – I see the fishes coming back and that's what I need to see for my grandchildren, not even for me. Because, I used to see them – I know there was a time they were there –*

lots and lots of fish, and then I see them dwindle away, so they're coming back now. I love that – I am happy for that." – Respondent 18

Moreover, they have continued to make such sacrifices in the face of repeated threats (i.e., verbal) and in some case physical altercations.

In light of this particular combination of structural position and supporting traits, some of the wardens who were identified as institutional entrepreneurs, also had some polarizing qualities. As highlighted in informal interviews and focus groups, some of the fishermen and groups of fishermen expressed distaste for these particular individuals, and describe a situation of us vs. them.

No institutional entrepreneurs were identified in Orange Bay. Furthermore, neither of the two wardens in Orange Bay were identified during the administration of the questionnaire and thus do not show up in the network. The fact that the wardens were neither former fishermen nor from the community likely explains why they were not identified. In addition, the local environmental NGO with the mandate to manage the Orange Bay SFCA is based in a different community. This lack of daily physical presence coupled with the less frequent patrols greatly reduces the frequency of interactions the wardens have with many of the fishermen as compared to the Bluefields Bay and Oracabessa Bay SFCAs. However, the wardens are building rapport with the fishermen and recognize the importance of spending time with them to build those important relational ties.

3.5.2 Network Cohesion

Network cohesion plays an important role in the promotion of common norms and values (Crona and Bodin 2011), and we focus here on network measures, analyzing

subgroup cohesion, and the establishment and adoption of new norms.

3.5.2.1 Network Measures

Results related to network cohesion (Table 2.2) varied across the three SFCAs. Fragmentation, which reflects the proportion of pairs of actors within the network that cannot reach each other, is lowest in Orange Bay (0.642) and highest in Oracabessa Bay (0.868), with Bluefields Bay (0.746) in the middle. This latter measure of fragmentation suggests low cohesion overall as sixty-four to approximately eighty-seven percent of actors within the respective networks are not able to reach each other.

3.5.2.2 Cohesive Subgroups

Analysis of the main network component in both Bluefield Bay and Oracabessa Bay – based on relational ties – identified cohesive subgroups. In both cases a single more dominant subgroup stands out due to: a) number of total actors; b) number of ties; and c) density of ties. The composition of these two dominant subgroups is worth noting as well. In Bluefields Bay, approximately 47% of the fishermen were from a single landing site while in Oracabessa Bay, approximately 75% of the fishermen were from a single landing site. In both instances, the landing sites are also the location of management offices for the respective SFCAs. The second compositional characteristic of these two dominant subgroups concerns membership in the local fishermen's cooperative. In Bluefields Bay, approximately 26% of the fishermen were members of the fishermen's friendly society while in Oracabessa Bay, approximately 34% of the fishermen that make up the cohesive subgroup are members of the local fishermen's cooperative.

3.5.2.3 Establishing and Adopting New Norms

These dominant subgroups are not only where the institutional entrepreneurs are embedded, they are also characterized by a group of actors who often share a similar landing site and/or membership in the local fishermen's cooperative indicating opportunities for repeated interactions and the development of new norms.

The adoption of new norms associated with the establishment of the Special Fishery Conservation Areas in Bluefields Bay and Oracabessa Bay is starting to emerge and gain traction. This is evident in the perceived compliance. As one warden from Bluefields Bay noted:

> *"The majority of them know – the majority of them know – as a matter of fact, you hardly find anyone from this beach fishing in the sanctuary. You kind of can tell that we actually have a hundred percent compliance from this beach" – Respondent 18*

Another example is the emergence of a community alert 'network' in Bluefields Bay and Oracabessa Bay whereby not only fellow fishermen but also community members who live on the coast will call the wardens when they see individuals fishing in the SFCA. For example, as one warden from Bluefields Bay explained:

> Respondent 10: "*People do, when I would say help then, if a person see somebody down there… they will alert us… They call us sometimes and say somebody is fishing."*
>
> Interviewer: *"Are you seeing more people calling you now and reaching out to you?*"

Respondent 10: *"Yes, yes yes yes. And that's one of the things, that's one of the things now that help us to be more vigilant in what we are doing. And the people now, the fishers now understand, because they are saying now, they are in the far end of the corner, how did we see them… I would say, we got a call saying that you're here…So is not only we alone watching you. We're all watching you."*

In addition, there are other fishermen who noted that while they might not call, they would confront the individual themselves. In both cases it reflects the adoption of these new norms and development of shared values.

3.5.3 Horizontal Ties and Vertical (i.e., multilevel) Linkages

3.5.3.1 Network Measures

Results for multilevel linkages (Table 2.2) reflect the degree centrality of the community-based organizations formally responsible for the management of the three SFCAs. The degree centrality for Bluefields Bay was highest at 18, which included five horizontal ties and 13 vertical ties. The degree centrality for Oracabessa Bay was similar at 16, which included five horizontal ties and 11 vertical ties. The degree centrality for Orange Bay was significantly lower at six, which included one horizontal tie and five vertical ties.

3.5.3.2 Leveraging Resources and Information

The horizontal and vertical linkages identified in Bluefields Bay (n=18) and Oracabessa Bay (n=16) included relational ties to other community-based organizations locally, other SFCAs around the island, national NGOs, and government agencies. These horizontal and vertical ties proved vital, particularly in the early stages of establishing the

marine reserves. Through these ties, the CBOs with a mandate to manage the marine reserves were able to leverage resources, ideas, and information critical for community-based natural resource management efforts. For example, in one case, the organization didn't wait for the government to support their efforts. Rather, they approached another local group for initial funding for gas. This support continued for a year until the government started providing necessary funding. In another case, several organizations – particularly specific individuals within those organizations – were identified as regular 'touchstones,' serving as sources of ideas, information, and advice. Other benefits and outcomes from these horizontal and vertical linkages included contributions to capacity building, annual monitoring (e.g., dive surveys), coral restoration projects, habitat mapping, and gear (e.g., mesh exchange).

While the environmental NGO in Orange Bay had significantly fewer multilevel linkages (n=6), they have nonetheless played an important role. Similar to the other cases noted above, the relational ties included another active CBO in the community along with national government agencies and departments. Through these ties, the CBO responsible for the Orange Bay SFCA were able to leverage needed resources. For example, when their boat had been out of commission they were able to go out on joint patrols with the Marine Police. As the data show, it is not just about the number of horizontal and vertical ties. The quality, depth, and strength of those linkages are critical as well.

3.6 Discussion

Our findings across the three cases provide several insights about collective action and transitions to co-management of small-scale fisheries and marine reserves in the study sites. These insights, arising through a social relational network perspective, add to

a growing recognition of the need to develop new norms for co-management transitions and processes both for fisheries and for MPAs – and in many cases, for the two together (e.g., Castrejón and Charles 2013). The results suggest that a combination of three structural and relational conditions may help to explain the previous experiences with the transition to co-management in Bluefields Bay and Oracabessa Bay. This includes the role and position of institutional entrepreneurs, a dense central core, and a prevalence of horizontal and vertical linkages. While Orange Bay lacked this same combination, structural and relational conditions did emerge that may have contributed to their transition to co-management.

3.6.1 Social Influence

Transitions to co-management of small-scale fisheries and MPAs are often accompanied with new institutions (i.e., rules, rights, and norms) that govern how resource users interact with the near shore environment (Pomeroy and Berkes 1997; Nielsen, *et al.* 2004; Nunan, *et al.* 2015). In the case of the SFCAs examined here there has been a shift from open access in adjacent coastal waters to access restrictions (e.g., establishment of no-take areas in the SFCAs). This change in access has required establishing new norms and behaviors within the community of resource users (i.e., fishermen). In situations of weak state support, the establishment of new local institutions can take upwards of 10 to 15 years as was documented in Turkey (Berkes 1986). At the same time, newly established institutions can quickly erode when there is inadequate state support, as was the case in the Gulf of California, Mexico (Cudney-Bueno and Basurto 2009).

Certain actors embedded within social networks can play a critical role in transitions to new institutional arrangements (Crona and Bodin 2010; Crona, *et al.* 2011; Frank, *et al.* 2011). For example, a study of a mixed gear artisanal fishery in a rural Kenyan village suggests that the informal opinion leaders – who were characterized by their structural position, diverse knowledge, and potential influence – may have served as barriers to collective action and new institutional arrangements despite continued declines in the condition of marine resources (Crona and Bodin 2010). Here, however, we find that key actors whom we have identified as institutional entrepreneurs – i.e., particular park wardens – have played an important role with regards to the transition to co-management in two of the SFCAs (Bluefields Bay and Oracabessa Bay).

The identified institutional entrepreneurs served as early adopters and introduced the new norms and behaviors to other fishermen in the community through outreach – e.g., community meetings, fisherman cooperative meetings, and visits to neighboring landing sites – before the SFCAs were established. The combination of structural characteristics and personal attributes that these institutional entrepreneurs had in common is particularly notable. In addition to being well positioned with a high degree centrality among the network of fishermen, these same individuals often had established personal ties that extended beyond that immediate community of resource users (e.g., other community organizations, NGOs and government agencies). The latter, external ties are what some refer to as bridging and linking social capital (e.g., Marin, *et al.* 2012). While the external ties served as an important mechanism for exposing them to new ideas and information, their high centrality served as a conduit for introducing those new ideas and associated norms (i.e., the marine reserve) to their community of fellow fishermen.

At the same time, these individuals possessed an important if not unique combination of personal attributes, which included: i) a historical perspective; ii) a vision of an alternative future; and iii) a commitment to that vision including a willingness to make sacrifices.

The common characteristics and conditions found among these key individuals highlighted above draw attention to the dual role of agency and structure – through the social networks with which they are embedded – reflecting what Garud *et al.* (2007) refer to as embedded agency. As Garud *et al.* (2007) note, the structural conditions not only have the potential to constrain agency but also to foster agency by "provid[ing] a platform for the unfolding of entrepreneurial activities" (p. 9). The structural conditions, therefore, open up the opportunity for transformation and change

3.6.2 Network Cohesion

The second structural and relational condition likely contributing to a transition to co-management in Bluefields Bay and Oracabessa Bay relates to the level of network cohesion. While collective action and collaboration at the community level is imperative (Ostrom 1990; Ghimire and Pimbert 1997; Brown 2002), communities are not homogenous – i.e., there is no single group of stakeholders. Rather, communities are defined by complex patterns of relational ties between actors – and groups of actors – with differing values, perceptions, resource uses, and influence (Carlsson and Berkes 2005). This reality can have a significant impact on the establishment of MPAs in fishing communities (White, *et al.* 2002; Christie 2004; Mills, *et al.* 2013).

Despite the overall level of fragmentation of the social networks in Bluefields Bay and Oracabessa Bay that reflects some of the heterogeneity (e.g., gear type, landing sites),

both sites possessed an identifiable cohesive subgroup. Not only are the institutional entrepreneurs found within these subgroups, they are characterized by a group of actors who often share a similar landing site or membership in the local fishermen's cooperative. As noted elsewhere, such strong multiplex ties have been shown to contribute to the development of shared views, perceptions, behaviors, and norms (Prell, *et al.* 2010). Establishing and adopting new norms and behaviors is especially crucial for the transition to co-management of small-scale fisheries and MPAs, which requires a shift to new institutional arrangements (Nielsen, *et al.* 2004; Gelcich, *et al.* 2010; Nunan, *et al.* 2015). Furthermore, such community cohesion has been shown to serve as a buffer against changes (e.g., institutional, economic, environmental) (Ostrom 1990). However, while the cohesive sub-group may have played an important role in the transition to co-management the resulting co-management arrangement may not be equally beneficial to all members of the community. For example, those members outside of the sub-group could be marginalized or experience fewer benefits if decisions are not made in their favor.

3.6.3 Horizontal and Vertical Linkages: Leveraging Resources and Information for Action

The third structural and relational condition likely contributing to collective action and transitions to co-management of small-scale fisheries and MPAs concerns the prevalence of horizontal and vertical linkages in Bluefields Bay and Oracabessa Bay. These horizontal and vertical ties have been repeatedly identified as playing an important role for successful conservation and natural resource management outcomes (Cash, *et al.* 2006; Armitage, *et al.* 2012) as they facilitate knowledge exchange and the diffusion of innovative practices, and provide an important mechanism for accessing and leveraging

necessary resources (Bodin and Crona 2009; Ramirez-Sanchez and Pinkerton 2009; Marin, *et al.* 2012). Moreover, such linkages can provide opportunities to make local changes (Adger, *et al.* 2005). Our findings are consistent with Marin *et al.* (2012) who examined a coastal benthic co-management system in Chile and found that higher performing fisher organizations had more horizontal and vertical linkages. Indeed, in a fishery context, this reflects the classic recognition that in co-management, it takes "two to tango" – i.e., that fishers and governments need to act together, typically across levels (Pomeroy and Berkes 1997).

In the Jamaican context, these horizontal and vertical linkages were invaluable but the nature of these relational ties was often tenuous. Respondents repeatedly noted that while ties existed between different organizations and agencies, they were often associated with particular individuals. When organizations and leadership change, those strong relational ties could quickly disappear – and in some instances they already have. For example, the head of the NGO managing the Orange Bay SFCA resigned within the last year, which may help to explain the lower number of horizontal and vertical linkages the organization had (see section 3.5.3.1). This highlights one of the challenges where high turnover among staff in CBOs and NGOs is common, such as in Jamaica. In addition, it suggests the important role of bridging organizations to foster and cultivate horizontal and vertical linkages (Berkes 2009), especially in instances where capacity is limited and turnover high.

3.6.4 Challenges and Barriers to Co-management

Our findings on network cohesion are consistent with recent assessments that find community cohesion and high social capital to be important attributes contributing to the

successful co-management of fisheries (e.g., Gutierrez, *et al.* 2011; Pomeroy, *et al.* 2011) and MPAs (e.g., Rudd, *et al.* 2003). However, structural and relational conditions were also identified that may pose a challenge to network cohesion and successful co-management outcomes in the long-term (i.e., social and ecological). The overall low network cohesion – reflected particularly through the fragmented nature of the networks – and limited social influence may be problematic for sustained collective action that extends beyond the core set of actors. This is evident in some of the continued problems with compliance and conflict that have persisted in each of the three sites. Key problems include illegal fishing in the SFCAs, conflicts over the boundaries that have resulted in the repeated cutting of marker buoys, and general displeasure resulting in threats to the wardens – and in some instances even altercations.

Four possible barriers that may inhibit an increase in network cohesion and social influence also emerged. The first concerns the polarizing qualities associated with some of the institutional entrepreneurs. While these individuals have been able to leverage their social networks and mobilize the dense central core, others noted their distaste for particular individuals and groups painting a picture of 'us vs. them'.

A second barrier to network cohesion and adoption of this new institutional arrangement (i.e., marine reserves) is the pervasiveness of the negative connotations associated with being considered an 'informant'. As one recent headline read: "Time to rid country of 'informer fi dead'[1] culture – Mayor Harris" (Jamaica Observer 2014). While the Mayor's comments were targeted at more traditional issues of crime (e.g.,

[1] This Jamaican Patois phrase roughly translates to "the snitch must/should die."

robbery, vandalism, violence) it is equally applicable to issues concerning illegal fishing. In some cases fishermen do fear for their lives. For example, one warden noted that despite building good rapport with the fishermen, "[t]hey don't really talk a lot of what is going on out there" as there is "always the fear for [their] health and safety" (Respondent 42). While fearing for one's life isn't necessarily of concern for more minor instances, the predominating view among fishers is that 'informers' are considered the lowest class with little if any respect.

A third possible barrier that may inhibit an increase in network cohesion and social influence is related to the number of isolates found in all three cases. The number of isolates contributes to both overall low network cohesion and social influence with upwards of 29% of network actors being isolates – as is the case in Oracabessa Bay. The pervasiveness of isolates reflects a culture of independence and autonomy that is common among rural Jamaican communities, and especially predominates among those who fish (see Espeut 1993), thereby limiting social cohesion in fisheries and fishery-related activities.

A fourth challenge to network cohesion and social influence is the limited membership in the local fishermen's cooperative and/or the complete lack of a cooperative. This finding, related to the third point above, reflects the historical lack of self-organization and limited presence of active fishermen's cooperatives in Jamaica (see Espeut 1993). Participation in local organizations can play an important role with regard to sustainable fishing practices and behavior (e.g., compliance) (Viteri and Chávez 2007). Not only does this participation contribute to increased legitimacy (Jentoft, *et al.* 1998), it serves as a forum and opportunity to strengthen social ties and to open up the possibility

to increase network cohesion and social influence, which have also been shown to contribute to improved compliance (Viteri and Chávez 2007). While the lack of self-organization and involvement may limit the success of co-management arrangements, if the latter can be made to succeed, this may in itself help to overcome the lack of self-organization, by providing the necessary incentive for more active engagement and increased membership in cooperatives.

Network cohesion and the development of strong relational ties founded upon trust lubricate cooperation, result in reduced transaction costs and the promotion of self-monitoring, and are a critical component to successful outcomes (Ostrom 1990, 2005; Ostrom and Walker 2003). The 'informer fi dead' culture in Jamaica highlights the importance of considering how particular cultural norms interact with social networks to ultimately inhibit successful transitions to co-management. At the same time, there is evidence that certain cultural norms coupled with high levels of network cohesion can contribute to collective action and successful natural resource management outcomes, such as the case of the 'harbor gangs' associated with the Maine lobster fishery (Acheson 1988). However, it is worth noting that positive resource outcomes documented often came with significant social costs (e.g., threats, intimidation, potential for violence) (Acheson 1988).

3.6.5 Network Weaving for Transitions to Co-management

A social relational network perspective and our analysis serve as an entrée to identify specific 'network weaving' strategies and to consider the possible tradeoffs associated with different strategies that support transitions to co-management. Vance-Boreland and Holley (2011) describe network weaving as the process of communicating

results after assessing the structural characteristics and sharing network maps with stakeholders to encourage network change and address key gaps (e.g., collaboration, communication).

Two key attributes for successful transitions to co-management repeatedly identified in the literature are community cohesion and leadership (Gutierrez, *et al.* 2011; Pomeroy, *et al.* 2011; Ayers and Kittinger 2014; Levin and Richmond 2014). Our results reinforce these findings. However, we note that while community cohesion is important, how community is defined with regard to criteria and boundaries is just as important (e.g., landing sites, gear types, traditional use, administrative) (Carlsson and Berkes 2005). The perspective employed here provides key insights for heterogeneous social contexts – i.e., who is in the network and how they are connected – that can be leveraged to support new ties and/or reinforce existing ones (e.g., that extend to other landing sites and gear types) to improve transitions to co-management. Furthermore, the results provide important insights with regards to the role of social networks and social capital, which Fox *et al.* (2012a) identified as one of the research frontiers for policy-relevant MPA science.

While leadership – via the institutional entrepreneurs – is found to play an important role in the transition to co-management, these particular actors may be problematic in the long term due to some of their polarizing qualities. Overcoming the potential drawbacks of these particular actors requires different leadership types and actors in different positions. In the three cases presented here, other key actors (e.g., SFCA managers, an executive director of a community foundation) are a critical complementary component as they fostered important vertical and horizontal organizational ties while also tempering conflicting personalities. Our findings thus

support emerging evidence for the important role of multiple sources of leadership (e.g., Olsson, *et al.* 2008, Marin, *et al*. 2012). Furthermore, our results illustrate that it is not just leaders per se that are important, rather the broader network of linkages – i.e., how the leaders are connected, how others are connected, and where the leaders are positioned within the network – are equally important. Considering the previous insights, our findings support Evans *et al.* (2015) recent call for a more nuanced approach to leadership and its role in environmental management and conservation. To that end, the results illustrate the utility of a social relational network perspective to understand and examine the role of leadership.

3.7 Conclusions

Examining multiple network structures, attributes, and processes revealed a combination of structural and relational conditions that help to explain the previous experience with collective action that resulted in the establishment of the co-managed marine reserves in the case study communities. Specifically, our research suggests that transitions to co-management are supported by a combination of three main network structure and relational attributes: i) the presence and position of institutional entrepreneurs; ii) a dense central core of network actors; and iii) the prevalence of horizontal ties and vertical linkages held by the community-based organizations formally responsible for the management of the marine reserves. Our findings also indicate that overall low network cohesion (as in the three reserves) and limited social influence of those in positions of responsibility (as with the wardens of the marine reserves) may be problematic for sustained collective action that extends beyond the core set of network actors. These findings suggest the importance of strategies to enhance collective action,

specifically through attention to the attributes of the corresponding social networks, as a means to contribute to successful transitions to co-management of MPAs and small-scale fisheries.

While our findings apply explicitly to Jamaica, they are also germane to a wide range of contexts given the global expansion of MPAs and MPA networks (see Spalding, *et al.* 2013) where similar social relational challenges and opportunities are bound to occur (e.g., Crawford, *et al.* 2006; Fabinyi, *et al.* 2010). The results are also likely to apply to many fisheries, reinforcing past research showing the importance of social capital and leadership in fisheries co-management (Gutierrez, *et al.* 2011; Pomeroy, *et al.* 2011; Ayers and Kittinger 2014; Levin and Richmond 2014). More specifically, the results produced here provide more precise guidance, through social network analysis, on where in the respective networks social capital and leadership may require support or enhancement, and thus on how to target interventions for greatest effect. Understanding these network conditions and engaging in network weaving is needed as MPA and fishery systems (such as the SFCAs in Jamaica) will deal not only with fishing and conservation pressures but also with the context of warming waters, acidification, and coral bleaching associated with climate change.

There is much to be learned from formative analyses – i.e., focusing on process – of transitions to co-management as we show here. In the longer term, understanding how the different network features and components associated with the three SFCAs in Jamaica contribute to different ecological or social outcomes will require a complementary summative analysis – i.e., outcome-based – of the transitions we are documenting. Bodin *et al.* (2014) note that understanding the causal influence of

particular network structures on different conservation outcomes (social and ecological) represents an important research frontier; this is one to which we are now turning in the context of these Jamaican cases.

Chapter 4

Social connectivity in an emerging marine reserve network and the challenge of governance 'fit'

4.1 Chapter Summary

Governance "fit' is defined as the congruence between the attributes or features of a system of governance (i.e., rules, rule-making systems, and actor networks) and the larger set of attributes or features of a social-ecological system. The problem of governance fit is a formidable challenge, yet necessary if MPAs and MPA networks are to effectively address the impacts of marine resource exploitation and environmental change, including climate change. Most MPA networks are designed only with ecological processes in mind. The consideration of MPA networks as socially connected has only just emerged in the last few years. If we take the idea that social connectivity is just as important as ecological connectivity then we need new tools to think through the 'social' dimensions of fit. Therefore, we use a social relational network perspective to examine selected sources of social connectivity (e.g., knowledge exchange) associated with an emerging MPA network in Jamaica. Examining the presence and distribution of multi-actor and multilevel network ties reveals a combination of structural and relational conditions that provide key insights with regards to how social connectivity may address particular aspects of fit (i.e., spatial, temporal, functional) that plague MPAs. Our findings suggest that multilevel linkages may have played the greatest role in relation to early examples of overcoming a functional mismatch and avoiding a temporal mismatch. However, considering the prevalence of weak ties, lack of a culture of sharing and collaboration, and limited resources, the long-term propensity of the multi-actor and

multilevel networks to enhance fit and overcome mismatches is uncertain. A re-orientation towards the consideration of social connectivity among actors associated with a MPA network contributed to preliminary insights concerning how the structure and function of governance networks may enhance and inhibit mismatches. Moreover, this work provides the foundation to further unpack and examine the specific causal pathways to improve fit.

4.2 Introduction

Ecologically linked networks of Marine Protected Areas (MPAs; see box 4.1) are required to effectively address the impacts of marine resource exploitation and climate change (Lowry, *et al.* 2009; Green, *et al.* 2011; McLeod, *et al.* 2009; Fernandes, *et al.* 2012; Lagabrielle, *et al.* 2014). For example, increased frequency of coral bleaching events, ocean acidification, and declining marine fisheries threaten the health of diverse ecosystems and the livelihoods and wellbeing of millions of coastal people (POC 2003; UNEP 2006; Pulwarty, *et al*. 2010; Nicholls & Cazenave 2010). MPA networks that are designed based on ecological connectivity, replication, and representation provide an insurance scheme against uncertainty, help to maintain overall ecosystem function, and contribute to recovery after disturbances (McLeod, *et al.* 2009; Gaines, *et al.* 2010; Toropova, *et al.* 2010). However, the dynamics, scale, and uncertainty associated with environmental change (e.g., ocean acidification, declining marine fisheries) may undermine the current governance of MPAs (i.e., rules, rule making systems, and actor networks).

Box 4.1 Selected definitions of marine protected areas

Marine Protected Area (IUCN/WCPA 2008)
A clearly defined geographical space recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

Marine Protected Area Network (WCPA/IUCN 2007)
A collection of individual marine protected areas operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological aims more effectively and comprehensively than individual sites could alone.

The argument regularly put forward for the establishment of MPA networks is premised on the limitations of single MPAs to adequately improve and/or maintain healthy ecosystems – i.e., a failure of fit (Agardy 2005; see Table 4.1). The problem of fit is described here as a mismatch (i.e., lack of congruence) between the attributes or features of a system of governance (i.e., rules, rule-making systems, and actor networks) and the larger set of attributes or features of a social-ecological system (Folke, *et al.* 1998; Galaz, *et al.* 2008; Epstein, *et al.* 2015). This failure of fit commonly results in unintended consequences (e.g., further degradation). For example, individual MPAs become islands of protection, unable to effectively address migratory and/or wide-ranging pelagic fish (i.e., spatial mismatch) (Chakalall, *et al.* 2007). Similarly, a lack of consideration for the rights, rules, access, and sanctions associated with MPAs may in turn contribute to displacement (i.e., shifting fisher activities and effort from one place to another). Thus, rather than improving fit, the MPA further contributes to the problem of fit. As Agardy *et al.* (2011) highlight, such displacement has potential ecological consequences (e.g., new stocks and/or new species exploited) as well as social consequences (e.g., increased competition and conflict among resource users).

The problem of fit is particularly prevalent in coastal-marine systems (Berkes 2006; Crowder, *et al.* 2006; Wilson 2006). The pervasiveness of mismatches reflects the

unique challenges presented by coastal-marine systems, including their transboundary nature (Crowder, *et al.* 2006), multi-sectoral setting (Crowder, *et al.* 2006; Fanning, *et al.* 2007), temporal and spatial variability (Crossland, *et al.* 2005), and prevalence of cross-scale dynamics (Wilson 2006). In addition, coastal-marine systems have a history of fragmented governance resulting from a tradition of sector-based approaches, whereby sectors such as fisheries, aquaculture, shipping, oil and gas, and marine mammal conservation are separately addressed (Crowder, *et al.* 2006). For example, in the United States there are approximately twenty different federal agencies responsible for over one hundred and forty ocean-related statutes (Crowder, *et al.* 2006). The result is a diversity of institutional arrangements, overlapping jurisdictional boundaries, and multiple agencies operating at different levels that may or may not be communicating with one another.

Addressing the problem of fit is a formidable challenge, yet necessary if MPAs and MPA networks are to effectively address the impacts of marine resource exploitation and environmental change, including climate change. Most MPA networks are designed only with ecological processes in mind (see Box 4.2). However, improving fit requires moving beyond ecological processes and attributes (e.g., connectivity, replication, representation) (Alexander 2014). Addressing issues of fit requires critically examining the governance of MPA networks. We define governance here as the formal and informal rules, rule making systems, and actor networks at all levels (local, regional, global) that influence how societies make decisions and implement actions (adapted from Biermann, *et al.* 2009). As Galaz *et al.* (2008) posit, "[b]asing institutional design on ecological knowledge alone, without recognizing the fundamental impact of other institutions and

social actors on ecological systems, is a simplistic approach that fails to appreciate the complexity of governance processes, mental models, and the social features that enable management of dynamic ecosystems" (p. 159-160).

Various attributes, features, and functions of governance networks (see Box 4.3) have been suggested to address issues of fit in the broader environmental governance literature (Olsson, *et al*. 2007; Galaz, *et al.* 2008). For example, multi-actor governance networks have been noted to facilitate collaboration (Schneider, *et al.* 2003; Folke, *et al.* 2005; Cohen, *et al.* 2012), serve as a source of novelty and innovation (Folke, *et al.* 2005), and contribute to social learning through improving the flow of information and knowledge exchange (Olsson, *et al.* 2007; Weiss, *et al.* 2011).

While there is general agreement regarding the broad role of governance networks to address issues of fit, what is less well understood are the specific mechanisms (i.e., causal pathways) through which the structure and function of governance networks improve fit. This raises four interrelated questions. First, how do different network structures enhance or inhibit key governance processes (e.g., collaboration, knowledge exchange)? Second, do those key governance processes address issues of fit? If those governance processes do indeed address issues of fit, then which particular aspects of fit (i.e., spatial, temporal, functional) do they address? And specifically how do those processes address different aspects of fit? Accordingly, the objective of this paper is to consider if and how social connectivity within governance networks may address particular aspects of fit (i.e., spatial, temporal, functional) that plague MPAs (see Table 4.1).

Table 4.1 Individual marine protected areas as a failure of fit

Type of Misfit	Description	Coastal-Marine Examples
Spatial	• Jurisdictional boundaries too small or too large (Crowder, *et al.* 2006) • Source of the problem too far removed (Crowder, *et al.* 2006) • Governance systems considering inappropriate ecosystem variables or insufficient ecosystem variables (Galaz, *et al*. 2008) • Institutional jurisdiction unable to cope with actors or drivers external and/or internal that are important for maintaining the ecosystem(s) or process(es) affected by the institution (Galaz, *et al.* 2008)	• Local institutions (e.g. those associated with marine reserves) unable to cope with the development of global markets and highly mobile "roving bandits" (Berkes 2006; Berkes 2010a) (see Cudney-Bueno and Basurto 2009) • MPAs become islands of protection, unable to account for external impacts (e.g., pollution, fishing the edges) (Roberts, *et al.* 2001; Agardy, *et al.* 2011) or migratory/ wide ranging pelagic fish (Chakalall, *et al.* 2007) • MPAs contribute to displacement (shifting activities and effort) leading to possible new stocks and species being exploited or increases in competition and conflict among resource users (Agardy, *et al.* 2011)
Temporal	• Institution formed too early or too late to cause desired ecosystem effect(s) (Galaz, *et al.* 2008) • Short electoral cycles not conducive to the long-term requirements of planning and management (Cash, *et al.* 2006) • Institution (and possibly the actor interaction it entails) produces decisions and/or responses that are too fast, too slow, too short, or too long compared to the time taken for biophysical processes involved (Holling and Meffe 1996; Folke, *et al.* 1998; Crowder, *et al.* 2006).	• Local institutions (e.g. those associated with marine reserves) unable to cope with the development of global markets and highly mobile "roving bandits" (Berkes 2006; Berkes 2010a) (see Cudney-Bueno and Basurto 2009) • Single habitat MPAs fail to account for full life cycle requirements of marine species (Agardy, *et al.* 2011)
Functional	• Mismatch in scope; strategies may be too narrow or too broad with respect to the resource system (Folke, *et al.* 1998) • Specific desires or values by the resource users may drive narrowness in management actions while ignoring side effects (e.g., shifts to new stocks or species) in complex ecosystems (Folke, *et al.* 1998) • Functional scales of management do not align with functional scales of social-ecological system (e.g., rates of production and consumption) (Cumming, *et al.* 2006)	• Mismatch in monitoring MPA impacts hinders effective strategy development due to under-studying ecosystem services of interest to local communities (Fox, *et al.* 2012a) • MPA establishment shifts resource use to new stocks and/or new species (Agardy, *et al.* 2011) • Regional-scale planning unable to consider local level socio-cultural complexity results in ineffective MPA arrangements and local level action (Mills, *et al.* 2010)

Box 4.2 Marine protected area networks as a proposed governance strategy to improve fit

Mechanisms/ Processes
• Replication and connectivity align with the spatial dynamics and processes that characterize coastal-marine systems (Gaines, *et al.* 2010; Grorud-Colvert, *et al.* 2014) • Protecting multiple habitat types accounts for the full life histories of marine species (Gaines, *et al.* 2010) • Connectivity and key refuges (e.g., sites resistant to bleaching) will contribute to recovery after disturbances (e.g., storm events, coral bleaching) (Almany, *et al.* 2009; McLeod, *et al.* 2009; Toropova, *et al.* 2010) • Representation and replication contribute to spreading the risk and providing an insurance scheme (McLeod, *et al.* 2009; Gaines, *et al.* 2010; Toropova, *et al.* 2010) • Protecting the entire biophysical system within its boundaries contributes to maintaining ecosystem function (McLeod, *et al.* 2009) • Connecting MPA managers opens up opportunities for knowledge exchange, the diffusion of information, and the sharing of management issues (Agardy 2005; Lowry, *et al.* 2009; Horigue, *et al.* 2012)

The consideration of MPA networks as socially connected has only just emerged in the last few years (Christie, *et al.* 2009; Lowry, *et al.* 2009; Pietri, *et al.* 2009; Bustamante and Vanzella-Khouri 2011; Green, *et al.* 2011; Horigue, *et al.* 2012). However, aside from a handful of empirical studies (e.g., Pietri, *et al.* 2009, Horigue, *et al.* 2012), most assessments of social connectivity among MPAs networks are largely anecdotal and/or fall within the scope of what Bodin *et al.* (2011) refer to as a "binary metaphorical approach" (i.e., the network is either present or absent; see Lowry, *et al.* 2009; Bustamante and Vanzella-Khouri 2011). Few studies take a structurally explicit network approach (e.g., Cohen, *et al.* 2012) despite increasing evidence that specific patterns of relational ties (i.e., network structure) contribute to different management and governance outcomes (Bodin and Crona 2009; Bodin and Prell 2011). Here, we use a social relational network perspective (Alexander and Armitage 2015) to examine selected sources of social connectivity (e.g., knowledge exchange) within a governance network associated with an emerging marine reserve network, and assess the extent to which

different attributes, features, and functions of the governance network may enhance or inhibit particular aspects of fit (i.e., spatial, temporal, functional).

The paper is organized as follows. First, we outline the theoretical foundation of our approach. An overview of the case study context and background are then provided, followed by a detailed account of the research methods. Next, we analyze specific structural features and characteristics of the governance network associated with an emerging marine reserve network. Specifically we consider how the structure and function of the governance network contributes to knowledge exchange and collaboration. We then discuss the potential of this social connectivity – or lack thereof – to address mismatches (i.e., spatial, temporal, functional) that undermine, over the long term, the viability and impact of the marine reserve network.

4.3 Governance Networks and the Problem of Governance 'Fit'

The problem of fit is described here as a mismatch (i.e., lack of congruence) between the attributes or features of a system of governance and the larger set of attributes or features of a social-ecological system (Folke, *et al.* 1998; Galaz, *et al.* 2008; Epstein, *et al.* 2015). Similarly, the challenge of governance fit can be described as the congruence between the *governance system* and the *system-to-be-governed* (Kooiman, *et al.* 2008; Kooiman 2013). The emphasis on social-ecological system fit follows Epstein *et al.* (2015). As such, it "begins with the general assumption that institutions are likely to succeed (or fail) in relation to how institutions are designed for coupled systems of people and nature" (Epstein, *et al.* 2015, p. 37). This is in contrast to those perspectives that focus only on the congruence between institutions and biophysical systems (i.e., ecological fit; see Galaz, *et al.* 2008) or social systems (i.e., social fit; see Meek 2013).

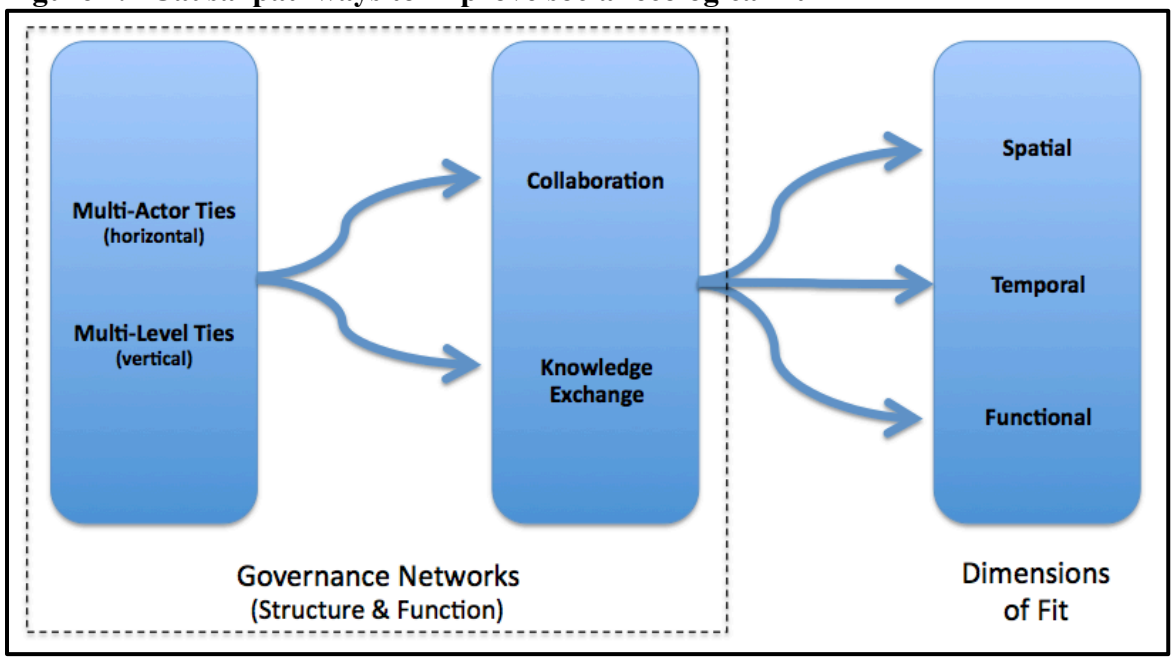
However, the emphasis on governance (i.e., rules, rule-making systems, and actor-networks) – as compared to focusing solely on institutions – marks a departure from Epstein *et al.* (2015). In this regard, we follow Galaz *et al.* (2008) who note that "[r]eference to governance in addition to institutions places a strong, appropriate emphasis on the multilevel patterns of interaction among actors, their sometimes conflicting objectives, and instruments besides institutions that are chosen to steer social and environmental processes" (p. 147).

Social-ecological fit has several dimensions (see Epstein, *et al.* 2015), which serve as a useful analytical tool to characterize the particularities of the problem. Here we focus on three dimensions in relation to MPAs and MPA networks: 1) spatial; 2) temporal; and 3) functional (see Table 4.1). Spatial fit refers to the congruence between the geographical extent of the problem and the governance system (e.g., Moss 2012). For example, issues concerning spatial fit can result from jurisdictional boundaries being too small (e.g., MPAs become islands of protection, unable to account for external impacts such as pollution or fishing the edges). Temporal fit refers to the congruence between the rate of social-ecological change and the responsiveness of the governance system (e.g., Crowder, *et al.* 2006). For example, issues concerning temporal fit can result from decisions or responses that are too fast or too slow (e.g., local institutions associated with marine reserves are unable to cope with the rapid development of global markets and highly mobile "roving bandits"; see Berkes 2006; Berkes 2010). Functional fit refers to the congruence of the dynamics and functionality of the social-ecological system with the governance system (e.g., Ekstrom and Young 2009). For example, issues concerning functional fit can result from narrowness in management actions that ignore side effects

in complex social-ecological systems (e.g., MPA establishment shifts resource use to new stocks and/or new species). It is important to note that these different dimensions of fit are not mutually exclusive (i.e., a given problem can be characterized by multiple dimensions).

While the various attributes, features, and functions of governance networks have been suggested as improving fit (Folke, *et al.* 2005; Olsson, *et al*. 2007), not all governance networks are structurally similar (Bodin, *et al.* 2006; Bodin and Crona 2009). Different network structures and patterns of social relations are beneficial in different ways with regards to governance processes (e.g., knowledge exchange, collaboration, coordination) (Bodin, *et al.* 2006; Carlsson and Sandstrom 2008; Bodin and Crona 2009). However, less well known and understood are the specific mechanisms (i.e., causal pathways) through which the structure and function of governance networks contribute to different outcomes related to fit. This requires examining two relationships (see Figure 4.1). The first is the relationship between network structures – and functions – and specific governance processes (e.g., collaboration, knowledge exchange) hypothesized to enhance fit (i.e., the left half of Figure 4.1). The second is the relationship between these governance processes and particular dimensions of fit – i.e., spatial, temporal, and functional (i.e., the right half of Figure 4.1). The result of such an examination is a more explicit understanding of how governance networks specifically contribute to fit.

Figure 4.1 Causal pathways to improve social-ecological fit



Two particular governance processes suggested to address issues of fit include knowledge exchange and collaboration (Folke, *et al.* 2005; Olsson, *et al.* 2007). Collaboration is defined here as the sharing of resources (e.g., human, financial, technical) or the organizing of joint activities and/or projects. Knowledge exchange and collaboration are mediated by the patterns of relational ties between actors (i.e., governance networks). Accordingly, knowledge exchange and collaboration are well suited to taking a social relational network perspective. In addition to the insights gained by examining the overall structure of these patterns, the *distribution, strength,* and *quality* of the interactions that contribute to differing outcomes are also important – i.e., the sub-structures related to different modes of interactions (see Guerrero, *et al.* 2014). We focus here on multi-actor (i.e., horizontal) and multilevel (i.e., vertical) linkages to examine the role of governance networks to enhance and inhibit knowledge exchange, collaboration, and coordination – social processes deemed critical for improving fit.

Box 4.3 Selected definitions of networks

Governance Network
Governance networks reflect the vertical and horizontal relational ties that connect individuals (e.g., harvesters), agencies (fisheries departments), organizations (e.g., local conservation committees, fishermen cooperatives), and private sector interests in collaborative efforts to achieve a range of objectives (e.g., restoration, protection, multi-use) (Alexander, *et al.* in press).

Multi-actor Network and Ties
Multi-actor networks and ties are those that connect actors horizontally (i.e., they exist at a single administrative or political level).

Multilevel Networks and Ties
Multilevel networks and ties are those that connect actors vertically across multiple administrative and political levels.

Multi-actor governance networks and ties – i.e., those that connect actors horizontally (see Box 4.3) – have been suggested as an important mechanism for addressing issues of fit (Crowder, *et al*. 2006; Olsson, *et al.* 2007; Pietri, *et al.* 2009). For example, such multi-actor ties can foster trust and facilitate collaboration (Schneider, *et al.* 2003; Folke, *et al.* 2005), serve as a source of novelty and innovation (Folke, *et al.* 2005), and contribute to social learning by improving the flow of information and knowledge exchange (Olsson, *et al.* 2007; Pietri, *et al.* 2009; Weeks, *et al.* 2014). Furthermore, multi-actor ties that span space and place can connect local sites of action and management that are geographically distributed (e.g., MPA networks) (Pietri, *et al.* 2009). Multi-actor governance networks can also contribute to increased coordination when spanning sectors, departments, and agencies (Cicin-Sain and Belfiore 2005; Crowder, *et al*. 2006).

Multilevel governance networks – i.e., those that connect actors vertically across multiple administrative and political levels (see Box 4.3) – have also been suggested as an important mechanism to address issues of fit (Cash, *et al.* 2006; Armitage, *et al.* 2012). For example, such linkages may tighten feedback loops between local monitoring and higher-level decision-making (Lebel, *et al.* 2006; Berkes 2010a), link actions at multiple

scales (e.g., place-based management and regional planning) (Guerrero, *et al.* 2013; Mills, *et al.* 2014), and provide an important mechanism for accessing resources, ideas, and information (Cohen, *et al.* 2012; Marin, *et al.* 2012; Guerrero, *et al.* 2014).

4.4 Methods

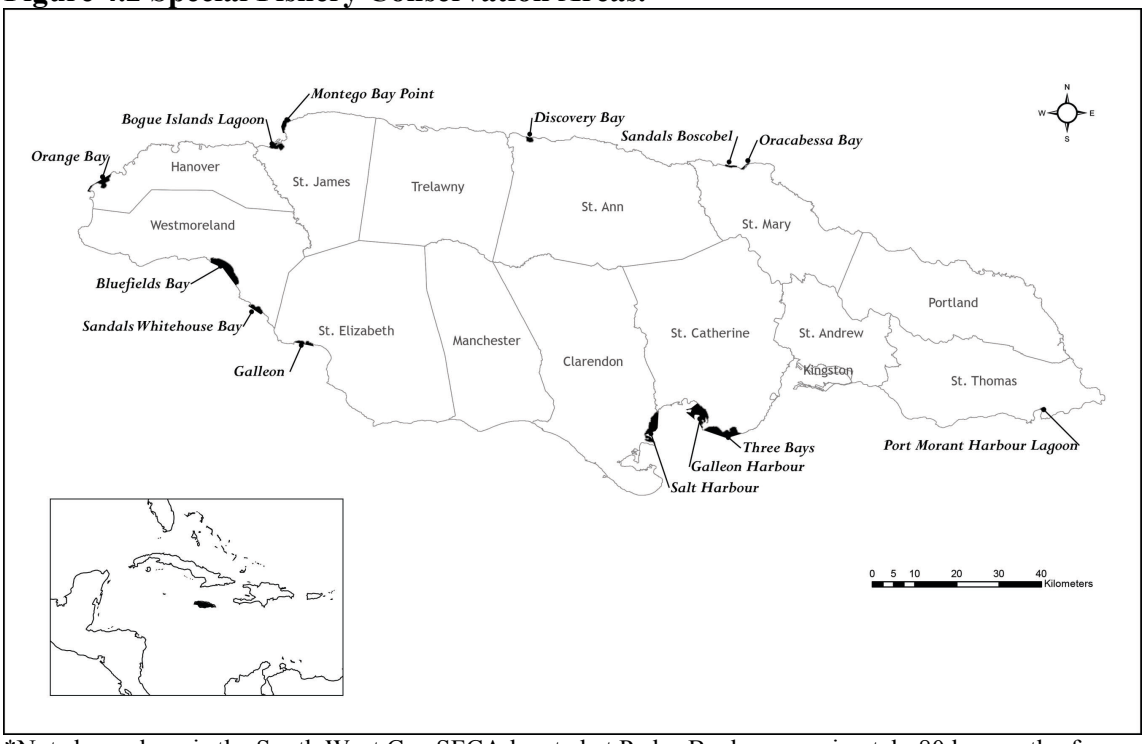
4.4.1 Case study context

The *Caribbean Challenge Initiative* was launched in 2008 to address the potential impacts of climate change, biodiversity loss, and overfishing. Eight Caribbean nations – including Jamaica – committed to protecting approximately 20% of their near-shore marine and coastal area by 2020. In response to this recent commitment, the Jamaican government established twelve *Special Fishery Conservation Areas* (SFCAs) – i.e., marine no-take areas – between 2009 and 2012, bringing their island wide total to fourteen, with more under consideration (Figure 4.2). The SFCAs (Table 4.2) range in size from approximately one km^2 to 18.73 km^2. The majority of these SFCAs are in proximity to several small coastal communities with an active small-scale and artisanal fishery that is mixed gear (e.g., fish traps, spear guns) and multispecies (e.g., conch, lobster, reef fish) (see Aiken and Kong 2000).

The identification of possible locations for establishing SFCAs was based on a number of criteria (e.g., ecological, social) established by an advisory committee (see Aiken *et al*. 2012). The presence and involvement of a Non-Governmental Organization (NGO) to play a lead role in monitoring and enforcement was deemed essential (Aiken, *et al*. 2012, p. 162). Accordingly, the Government of Jamaica (i.e., Fisheries Division) established co-management arrangements with local non-governmental organizations and/or fishermen co-operatives that devolve roles and responsibilities (e.g., monitoring)

associated with the day-to-day management of these marine reserves (see Alexander, *et al.* 2015).

Figure 4.2 Special Fishery Conservation Areas.



*Not shown here is the South West Cay SFCA located at Pedro Bank, approximately 80 km south of Jamaica (Map by D. Campbell)

Table 4.2 Summary of special fishery conservation area attributes

SFCA	Size (km^2)	Year Declared	CBO with Management Mandate	Organizational Type
Bluefields Bay	13.59	2009	Bluefields Bay Fishermen's Friendly Society	Fishermen's Friendly Society
Bogue Island Lagoon	4.5	1979	Montego Bay Marine Park Trust	Environmental NGO
Discovery Bay	1.68	2009	Alloa Fishermen Cooperative & Jamaica Fishermen Cooperative Union	Fisherman's Cooperative
Galleon	2.6	2009	The Breds Foundation	Community Foundation
Galleon Harbour	18.73	2009	C-CAM Foundation	Environmental NGO
Montego Bay Point	3.03	2009	Montego Bay Marine Park Trust	Environmental NGO
Oracabessa Bay	0.84	2010	Oracabessa Bay Foundation & St. Mary Fishermen Cooperative	Community Foundation + Fishermen's Cooperative
Orange Bay	5.36	2009	Negril Area Environmental Protection Trust	Environmental NGO
Port Morant Harbour Lagoon	0.58	1986	Division of Fisheries	Government
Salt Harbour	10.22	2009	C-CAM Foundation	Environmental NGO
Sandals Boscobel	0.99	2010	Sandals Foundation	Foundation
Sandals Whitehouse	2.94	2012	Sandals Foundation	Foundation
South West Cay	15.15	2012	Jamaica Environment Trust	Environmental NGO
Three Bays	12.61	2009	C-CAM Foundation	Environmental NGO

4.4.2 Data Collection

This study employed a mixed methods approach (Creswell 2009; Hollstein 2014), including a sociometric survey, semi-structured interviews, and document review (e.g., legal material). Data were collected over five months of fieldwork between November 2012 and February 2015, with the majority of data collection taking place from August 2013 through November 2013.

Semi-structured interviews (n=63) were conducted with representatives from agencies and organizations involved with the SFCAs. This included both government

agencies (e.g., national) and non-governmental organizations (e.g., local, national). Interviews lasted approximately twenty to ninety minutes in length and were usually undertaken at the respondents' office. Respondents were selected using a snowball sampling technique in which each respondent was asked to suggest other potential respondents and when possible provide contact information (Hay 2010). Multiple snowballs were initiated to reduce bias in the sample. SFCA managers – or board representatives from community-based organizations formally responsible for the management of an SFCA – served as initial respondents. Interviews continued until the majority of relevant governance organizations had been sampled. This was determined as the point when new organizations (e.g., agencies, divisions, NGOs) and/or individuals within those organizations were no longer being suggested as possible respondents (i.e., network closure had been reached) (Hanneman and Riddle 2005). The interview guide contained open-ended questions designed to capture relevant background information and insights concerning the establishment of the *Special Fishery Conservation Areas* in addition to covering three dimensions of governance: i) co-management arrangements; ii) institutions and fit; and iii) actor networks. Interviews were digitally recorded with oral consent and transcribed verbatim.

Social network data were collected via a sociometric survey administered through personal interviews (n=18) with representatives of organizations and agencies affiliated with the governance of the national network of SFCAs. Participants were provided a roster with different organizations and agencies (n=21) and asked to identify the presence or absence of relational ties to each. Specifically, participants were asked to consider three different types of organizational ties: 1) information sharing; 2) discussing

management issues; and 3) collaboration (see Appendix G – Supplementary Material). In addition, *name interpreter* questions were used to elicit responses on the strength of the ties. Participants were also given the opportunity to add organizations and agencies not included on the roster with whom they had relevant ties with. This social network data captures the collaboration and knowledge exchange ties among actors – at the organizational level – across the island including SFCA management organizations, NGOs, academic institutions, and government agencies. Accordingly, this data reflects the structure of the governance networks (i.e., the left half of Figure 4.1 – Causal Pathways to Improve Social-Ecological Fit). A subset of the sociometric survey interviews (n=11) were digitally recorded with verbal consent and transcribed verbatim capturing rich qualitative data that emerged during the administration of the survey (e.g., clarifying questions, personal nature of ties, context of interactions, etc.).

4.4.3 Social Network Analysis

Social Network Analysis (SNA) was used to examine the components (e.g., actors and linkages) and overall structure (e.g., density) associated with the governance network of the island wide *Special Fishery Conservation Area* system (Alexander and Armitage 2015). UCINet version 6.509 (Borgatti, *et al*. 2002) was used for social network analysis while Netdraw (Borgatti 2002), was used to generate network visuals. Social network analysis results were further combined with qualitative content analysis of data derived from semi-structured interviews. Integrating qualitative and quantitative data provides significant benefits for the interpretation of network data – e.g., the content and meaning of individual ties (Cross, *et al.* 2009; Hollstein 2014). Integrating data types also allowed

us to examine the dynamics, emergence, and persistence of ties associated with the governance network.

4.4.3.1 Multi-actor and Multilevel Ties

To examine the presence and distribution of multi-actor (i.e., horizontal) and multilevel ties (i.e., vertical), organizations were categorized based on two attributes: 1) their primary "level" of governance (e.g., local, national); and 2) organizational "type" (e.g., CBO, NGO, government) (Table 4.3). In addition, the strength of the organizational ties was categorized as weak or strong (see Appendix G – sections 1.1 and 1.4). To focus analyses on the core network of organizations, all isolates (i.e., those organizations that had no ties) and pendants (i.e., those organizations that only had one tie) were removed. The resulting networks were then dichotomized three times: all ties (weak and strong combined); weak ties (strong and absent combined); and strong ties (weak and absent combined) (see Appendix G, section 1.5). *Density by Groups* (Ucinet version 6.509) was then conducted on the dichotomized data to calculate both the sum and density of ties within and between groups (Borgatti, *et al.* 2002). Density reflects the number of ties present in a network in proportion to the total possible number of ties (e.g., a density of 1 would mean that every individual in the network is connected to every other individual) (Borgatti, *et al.* 2013). *Density by Groups* partitions data based on organizational attribute (e.g., level, type) to calculate density of ties within and between the different groups (e.g., local-local, local-national, national-national). The partitioning of the data and resulting analysis is similar to block modeling.

Table 4.3 Characterization and distribution of organizational actors

Level	Organizational Type						
	CBO	Managing Organization	NGO	Government Agency	Intergovernmental Organization	University	Private Sector
International	-	-	1	-	-	2	-
Regional	-	-	1	-	1	-	-
National	-	-	3**	12	-	3	1
Local	5	9*	-	-	-	-	-

*For the purposes of this study, all managing organizations were characterized as 'local' level.
**Two international NGOs have national offices and thus were characterized as 'national' level for the purposes of this study.
***While the 'parish' level would fall between local and national, none of the organizational actors in the governance network fall into this category

4.4.3.2 Actor Roles

To identify the presence and position of organizations playing key roles in the core networks of strong ties, two centrality measures were calculated: 1) in-degree; and 2) betweenness. In-degree centrality measures the number of ties received by an organization from others. Betweenness centrality measures the extent to which an organization falls along the shortest path between pairs of organizations within the network that would otherwise be disconnected (Freeman 1979). Accordingly, betweenness centrality can provide insights with regards to the potential of particular organizations to control the flow of information and resources moving through a network (Borgatti, *et al.* 2013). Together, these measurements provide a starting point for not only identifying the presence and position of key actors, but further considering how – and to what extent – these key actors may enhance or inhibit fit via their contributions to knowledge exchange and collaboration.

The social network analysis outlined in the previous three sections (4.4.3, 4.4.3.1, and 4.4.3.2) provides the analytical approach to examine the *structure* of the governance networks. Measuring the density and distribution of different ties (i.e., multi-actor, multilevel) along with identifying actors in key positions will provide the empirical

insights to better understand possible causal pathways linking the structure of governance networks to different outcomes related to fit (Figure 4.1). Specifically, social network analysis will help to provide insights related to the first set of causal pathways outlined on the left half of Figure 4.1 (i.e., how multi-actor and multilevel ties enhance and inhibit knowledge exchange and collaboration).

4.4.4 Qualitative Content Analysis

Interviews were analyzed using qualitative analysis software NVivo 10 (QSR International). The coding process was both inductive and deductive. An initial set of codes was developed *a priori* based on the theoretical framework (Section 4.3 – Governance Networks and the Problem of Governance 'Fit') yet additional codes were allowed to emerge from the interview data (Gilgun 2010; Miles, *et al.* 2014). For example, additional codes related to 'networking activities' were developed that collectively provided insights into possible conditions and processes contributing to the emergence of network ties (Section 4.5.2.1). Thematic analysis occurred through an iterative process of coding and pattern recognition (Miles, *et al.* 2014). This allowed for primary information about MPA governance networks to be both grounded in existing theories from the literature but also in the interviews themselves. This primary information was complemented and triangulated with the network survey data and secondary sources (e.g., grey literature, peer-reviewed publications).

The qualitative content analysis outlined above provides the analytical approach to examine the *function* of the governance networks. Furthermore, it allowed us to examine the dynamics, emergence, and persistence of ties. Examining the content and meaning of the individual ties and related processes of network dynamics will provide the

empirical insights to better understand possible causal pathways linking the *function* of governance networks to different outcomes related to fit (Figure 4.1). Specifically, qualitative content analysis will help to provide insights related to the first set of causal pathways outlined on the left half of Figure 4.1 (i.e., how multi-actor and multilevel ties enhance and inhibit knowledge exchange and collaboration). Integrating SNA and qualitative content analysis contributes to a more comprehensive understanding of the structure and function of the governance network. This understanding, in turn, provides the foundation to consider the propensity for the governance network to enhance and inhibit particular dimensions of fit (i.e., spatial, temporal, and functional; see Figure 4.1).

4.5 Results

The following section provides an overview of the results with an emphasis on network structure (section 4.5.1) – especially on the sub-structures related to different modes of interactions (i.e., multi-actor, multilevel) – and function (section 4.5.2). Accordingly, the focus in this section is on building the foundation to better understand how the structure and function of governance networks enhance and inhibit collaboration and knowledge exchange (i.e., the first set of causal pathways outlined on the left half of Figure 4.1). This in turn provides the foundation for the second set of causal pathways illustrated on the right half of Figure 4.1; considering how knowledge exchange and collaboration may address specific aspects of fit, which is addressed in the next section (4.6 Discussion).

4.5.1 Network Structure

Collective responses from the sociometric surveys resulted in three *extended* governance networks based on the nature of the relational tie: 1) information sharing (34 organizations, 176 ties), see Figure 4.3; 2) discussing management issues (36 organizations, 193 ties), see Figure 4.4; and 3) collaboration (36 organizations, 169 ties), see Figure 4.5 (Table 4.5). In total, 38 different organizations were found across the three *extended* networks. This included the 21 organizations listed on the survey and 17 additional organizations identified by respondents.

Table 4.4 Summary of network level results

	Information Sharing	Discussing Management Issues	Collaboration
Extended Network			
Organizations	34	36	36
Total Ties^	176	193	169
Density*^	0.23	0.22	0.20
Core Network			
Organizations	19	21	21
Total Ties^	161	178	154
Density^	0.69	0.42	0.37

*Isolates were not included in the calculation of this measure.
^Calculation is based on directed ties.

Further analysis focused on the *core* governance networks, defined as the governance network including all organizations identified two or more times by respondents. The removal of all isolates and pendants resulted in the following three *core* governance networks: 1) information sharing (19 organizations, 161 ties), see Figure 4.6; 2) discussing management issues (21 organizations, 178 ties), see Figure 4.7; and 3) collaboration (21 organizations, 154 ties), see Figure 4.8. The density of the respective *core* governance networks ranged widely with information sharing having the highest (0.69) and collaboration having the lowest (0.37) (Table 4.5).

Figure 4.3 Information sharing – extended network

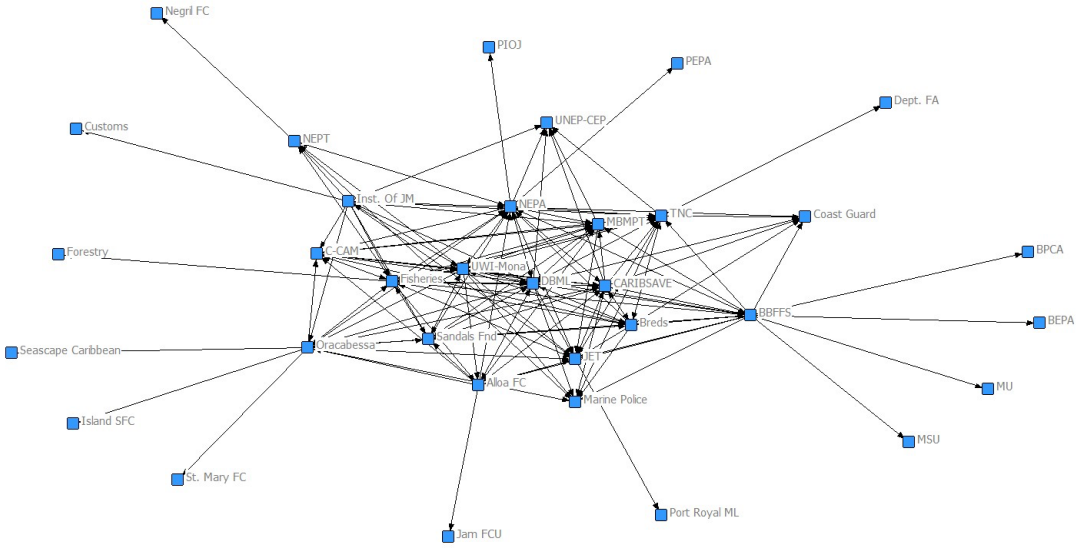


Figure 4.4 Discussing management issues – extended network

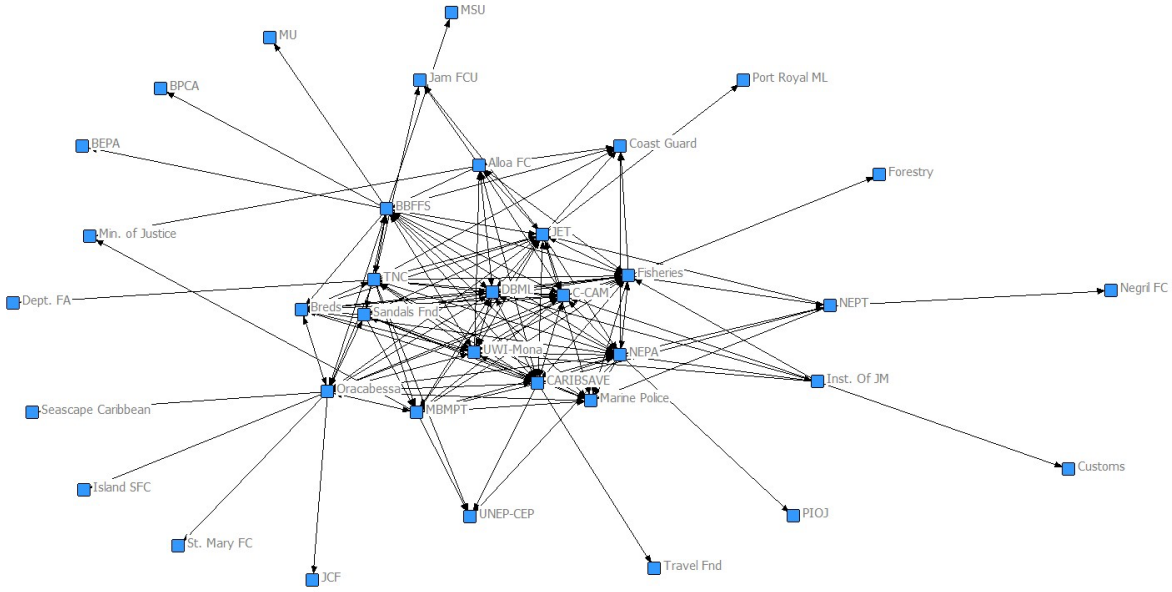


Figure 4.5 Collaboration network – extended network

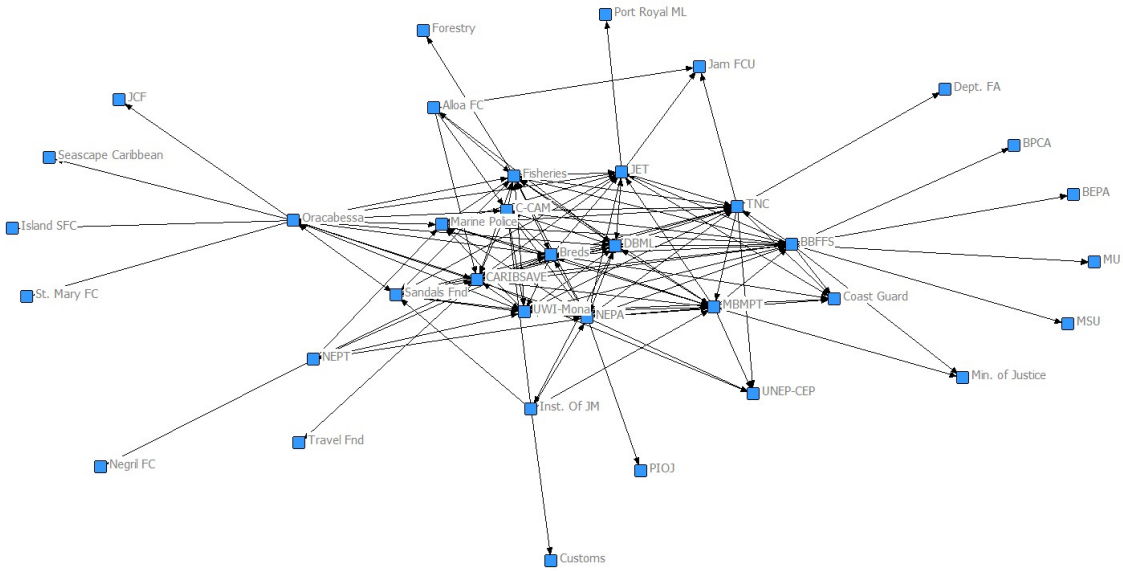


Figure 4.6 Information sharing – core network, strong ties only

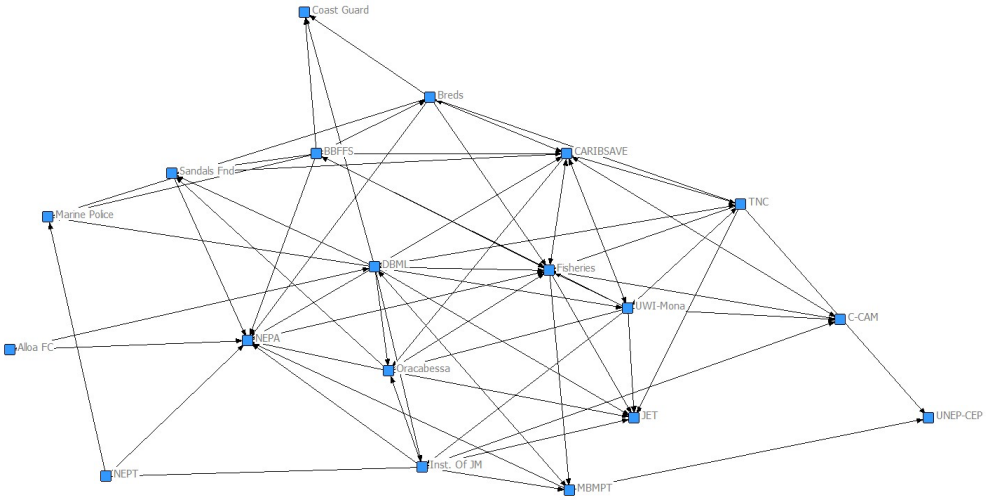
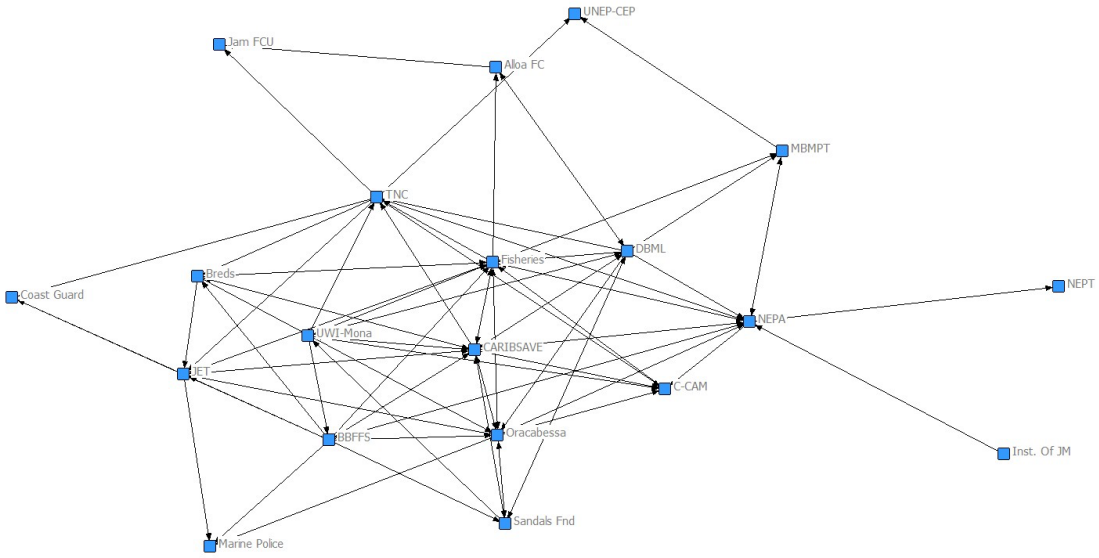
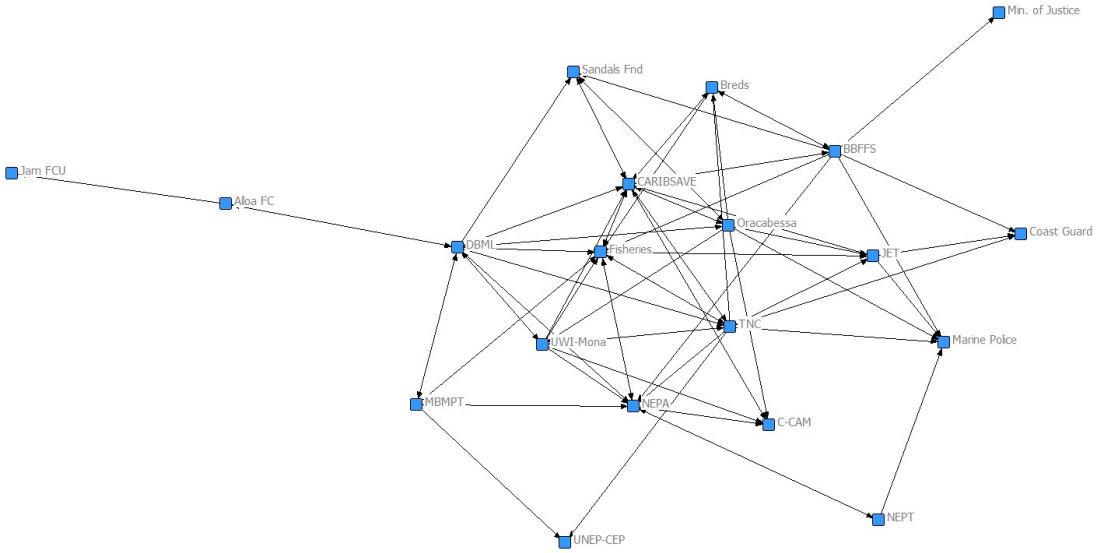


Figure 4.7 Discussing management issues – core network, strong ties only*



*The pendants (i.e., network nodes with only one connection) in this diagram are due to the removal of weak ties for this visualization (i.e., they have additional ties). Accordingly, they are not pendants of the core network when all ties are included.

Figure 4.8 Collaboration – core network, strong ties only*



*The pendants (i.e., network nodes with only one connection) in this diagram are due to the removal of weak ties for this visualization (i.e., they have additional ties). Accordingly, they are not pendants of the core network when all ties are included.

4.5.1.1 Multi-actor and Multilevel Ties

While categorically, there are a number of multi-actor (e.g., regional-regional) and multilevel linkages (e.g., local-regional), we focus here on three of them (Table 4.5; see table 4.3 for all possible linkages). The two multi-actor (i.e., horizontal) linkages of

particular interest are local-local and national-national. The multilevel (i.e., vertical) organizational linkages of particular interest are local-national. These three linkages are most prevalent in the core network and reflect the most plausible linkages for enhancing and inhibiting different aspects of fit in this governance context (i.e., Jamaica).

Table 4.5 Distribution of multi-actor and multilevel ties across all three networks

	Information Sharing		Discussing Management Issues		Collaboration	
	Ties	Density	Ties	Density	Ties	Density
All Ties						
Local-Local	22	0.31	38	0.53	23	0.32
Local-National	90	0.56	96	0.48	89	0.50
National-National	43	0.60	40	0.36	38	0.35
Weak Ties						
Local-Local	18	0.25	28	0.40	15	0.21
Local-National	45	0.28	52	0.26	48	0.24
National-National	19	0.26	18	0.16	16	0.145
Strong Ties						
Local-Local	4	0.06	10	0.14	8	0.11
Local-National	45	0.28	44	0.22	41	0.207
National-National	24	0.33	22	0.20	22	0.20

Local–local linkages were most prevalent in the *discussing management issues* network compared to the other two (i.e., information sharing and collaboration). In addition, findings revealed drastic differences with regards to the distribution and density of weak and strong ties associated with the local–local linkages. Across all three networks, weak ties were much more prevalent than strong ties. National–national linkages were highest in the *information-sharing* network in comparison to the other two. The distribution and density of weak and strong ties associated with the national–national linkages was found to be similar across all three networks.

The overall presence and density of local–national linkages was found to be similar across all three networks. In addition, the distribution and density of weak and strong ties associated with the local–national linkages was found to be similar across all

three networks. Analysis also revealed that the general presence and density of local–national linkages was higher in the *collaboration* network in comparison to local–local linkages and national–national linkages.

Further analysis examined the distribution and density of organizational ties (e.g., NGO–Government Agency) within the context of multi-actor and multilevel ties (see Appendix H – Table H 1). This analysis revealed that there were three different types of organizational ties that were dominant among local–national linkages: 1) management organization–NGO; 2) management organization–government agency; and 3) management organization–university. In addition, weaker ties were more prevalent than strong ties across these different types of organizational ties and all three networks. Findings also revealed that while the management organization–government agency had the highest number of ties across all three networks; they had the lowest densities among multilevel linkages.

The data reveal several different types of horizontal linkages at the national level (i.e., national-national). These linkages were both within and between NGOs, government agencies, and universities. Among this diversity of organizational linkages, Government–Government ties were noticeably low across all three networks.

4.5.1.3 Actor Roles

For the *information-sharing* network, the National Environment and Planning Agency (NEPA) and Fisheries Division had the highest in-degree centrality. Measuring betweenness centrality revealed two additional organizations: 1) Discovery Bay Marine Lab (DBML); and 2) Caribsave (Appendix I –Table I 1). For the *discussing management issues* network, both in-degree and betweenness centrality were highest among Fisheries

Division, Caribsave, and NEPA (Appendix I – Table I 1). Finally, for the *collaboration* network, both in-degree and betweenness centrality were highest among Caribsave, Fisheries Division, and NEPA (Appendix I – Table I 1).

4.5.2 Network Function

4.5.2.1 Emergence of Network Ties

Interviews revealed three possible conditions/ processes that collectively contributed to the emergence of the network ties captured in the sociometric survey. The first is that many of the organizational ties emerge through formal partnerships. In some instances, these formalized partnerships can be characterized as co-management arrangements between the local management organizations and the Jamaican government. In other instances they are partnerships between local management organizations and NGOs that are engaged in capacity building work, or between two different government agencies. The nature and strength of these formal organizational ties often reflects mandated reporting requirements. In many instances, reporting requirements was the extent of their social connectivity when organizational respondents acknowledged and described their *information-sharing* ties.

Despite the predominance of formal organizational ties, there were numerous informal ties between organizations that reflected the personal nature of the relationship between two individuals from their respective organizations. Rather than speak of the organization in generalities, respondents would identify specific individuals with whom they would share information, discuss management issues, and/or collaborate. As one respondent noted, these personal relationships between individuals are key.

Respondent: So I would say that the relationship between the university and the fish sanctuaries has improved significantly over the past five years.

Interviewer: What do you attribute that to?

Respondent: I attribute it to persons. Persons make an organization and if one person in an organization meets with one person in a university organization and they seem to hit it off, then they will work well together. – Respondent 3

In many instances these informal and personal ties between organizations were the result of either a shared history or current activities of specific individuals. A shared history could be related to previous positions, projects, committees, or university. For example, a local professor noted that they not only sat on an advisory committee with the chairman of one of the fisherman cooperatives, but that the two of them previously worked together at the Fisheries Division back in the 1970's. Similarly, a local researcher spoke of how they had established a solid collaborative partnership with the Sandals Foundation while in a previous position. Those ties ultimately served as a critical foundation when developing an island wide lionfish monitoring and culling program a few years later in their new position.

The third process by which these network ties emerge was through joint membership on advisory committees, boards, and projects. These served as venues to bring organizations and actors together for joint action and shared understanding. For example, in 2008 the Fisheries Advisory Board – which reports to the Minister of Agriculture and Fisheries – established the Fish Sanctuary Sub-Committee. Tasked with identifying, establishing, and setting up a system of Special Fishery Conservation Areas, the sub-committee brought together a cross-section of representatives from relevant

government agencies, NGOs, CBOs, private sector, and the university. While no longer in operation, the sub-committee played an early role in bringing diverse organizations from across the island together and providing a venue for the vertical flow of information and issues. Another illustrative example is the National Lionfish Project. This project was funded by the Global Environment Facility and spearheaded by the Discovery Bay Marine Lab. The project fostered the establishment of network ties between diverse organizations (e.g., government agencies, NGOs, CBOs, private resorts) across the island and resulted in the sharing of information, collaborating for data collection and monitoring, and discussions about management strategies.

4.5.2.2 Benefits and Outcomes of Network ties

Once established, the benefits and outcomes of the diverse network ties – both multi-actor and multilevel – have taken different forms. There are several examples where organizations were able to leverage particular network ties to access key resources. In some of the SFCAs, close collaborations between local management organizations and the Marine Police have resulted in regular patrols. Other benefits and outcomes from these horizontal and vertical linkages include contributions to capacity building, annual monitoring (e.g., dive surveys), coral restoration projects, habitat mapping, and gear (e.g., mesh exchange). Network ties have also resulted in the diffusion of different management practices, ranging from the culling and handling of lionfish to enforcement and outreach.

4.5.2.3 Maintenance of Network Ties

Joint membership on advisory committees, boards, and projects plays a role in establishing network ties and also in maintaining them. For example, the Jamaican Coral

Reef Monitoring Network (JCRMN) is an informal group of volunteers that helps conduct baseline studies and monitoring work. With membership spanning a number of NGOs, government agencies, and the university, the JCRMN helps to maintain informal ties between organizations across the island.

Similarly, face-to-face meetings were an important mechanism to foster and maintain network ties between organizations. The informal 'Sanctuary Managers Network' is largely composed of representatives from those organizations that have a mandate to manage one or more of the SFCAs. The level of involvement from various organizations and the frequency of meetings have fluctuated over the past few years, with generally longer time spans between meetings. However, for many of the organizations, these meetings represented their only interactions with some of the organizations. As one respondent noted, they only receive relevant information from a few of the fellow managing organizations "if they attend the joint meetings" (Respondent 28).

The maintenance of network ties also face some challenges. The first concerns the tenuous nature of the organizational ties. As illustrated above, respondents repeatedly noted that the organizational ties were often associated with particular individuals. Accordingly, when organizations and leadership change, those strong relational ties could quickly disappear – and in some instances already have. This is the case in more then one of the local organizations co-managing an SFCA.

Another challenge is the lack of a culture of sharing and collaboration that may well stem from being in direct competition with each other for limited funding and resources. As one respondent noted, while the 'Sanctuary Managers Network' provides a mechanism for information sharing and collaboration, it might not be enough:

As I said for a while we were very much hoping that that [the Sanctuary Managers Network] *would become a much stronger organization to help share information much more broadly. But in a lot of ways some of the partners have been very, I don't want to use the word competitive, but, in a way, that might apply. They haven't always been forthcoming with information, willing to participate and come to meetings, and share what's happening with them. We've been open, with those that are willing to share with us, we've developed very strong, almost unilateral partnerships with them. – Respondent 5*

Through a step-wise fashion, the results presented above provide the foundation to better understand how the structure and function of governance networks enhance and inhibit collaboration and knowledge exchange (i.e., the first set of causal pathways outlined on the left half of Figure 4.1). The results illustrate multi-actor and multilevel ties facilitating knowledge exchange and collaboration. However, the distribution, strength, and quality of those ties vary drastically across the networks. For example, knowledge exchange was more prevalent than collaboration via multi-actor ties (including both local-local and national-national). On the other hand, multilevel ties (i.e., local-national) facilitated both knowledge exchange and collaboration. However, the prevalence of weak ties, lack of a culture of sharing and collaboration, and limited resources, could prove inhibitive for multi-actor and multilevel networks to facilitate knowledge exchange and collaboration into the future.

4.6 Discussions

Our analysis of the island wide governance networks associated with the *Special Fishery Conservation Areas* provides several insights about knowledge exchange,

collaboration, and coordination, and the propensity for these networks to improve governance fit. Accordingly, the following discussion is anchored upon two key aspects. First, understanding how different network structures enhance and inhibit knowledge exchange and collaboration (i.e., the causal pathways illustrated on the left half of Figure 4.1). This in turn provides the foundation for the second; considering how the governance networks, through knowledge exchange and collaboration, may address specific aspects of fit (i.e., the causal pathways illustrated on the right side of Figure 4.1).

Our analysis revealed an *extended* network of organizations implementing and supporting governance of the SFCAs. Furthermore, the composition of actors represented a diversity of organizational types operating at multiple levels. Such diversity and composition reflects the general trend in the increased involvement of a broader array of conservation actors (Armitage, *et al.* 2012; Alexander, *et al.* in press). While some organizations were more peripheral, with few direct ties, they played important supporting roles as core organizations – particularly those with a management mandate – were able to leverage and access key resources via ties with those peripheral organizations (Alexander, *et al.* 2015).

While the overall structure of the three extended networks (i.e., discussing management issues, information sharing, collaboration) were similar, further analysis focused on the presence and distribution of particular types of network ties revealed important differences. Moreover, these differences provide key insights to consider how different modes of interactions (i.e., multi-actor ties, multilevel ties) may enhance and inhibit different dimensions of governance fit (i.e., spatial, temporal, and functional) via knowledge exchange and collaboration.

4.6.1 Dimensions of Governance Fit

4.6.1.1 Spatial Mismatches

Multi-actor governance networks and ties – i.e., those that connect actors horizontally – may be an important mechanism for addressing spatial mismatches (Crowder, *et al.* 2006; Pietri, *et al.* 2009; Bergsten, *et al.* 2014; Kininmonth, *et al.* 2015). As Pietri *et al.* (2009) note, when spanning space and place, such ties can connect local sites of action and management that are geographically distributed – e.g., MPA networks. Connections between two organizations operating at the local level (local–local) are one particular type of horizontal tie. Within the core governance networks, local–local network ties were those that existed between the organizations that had a specific mandate via an MOA with the Jamaican government to manage one or more of the SFCAs. Local–local linkages were most prevalent with respect to *discussing management issues*. However, the general lack of strong ties revealed through the SNA may well reflect the sense of competition and the lack of adequate resources for regular face-to-face meetings mentioned by some of the respondents. Accordingly, the current structure and function of these local horizontal ties may be problematic for fostering the flow of information, ideas, and knowledge exchange. Indeed, evidence from interviews and observations suggested a lack of information sharing. Despite examples of innovative approaches to management ranging from outreach and awareness to monitoring, respondents rarely noted sharing or receiving the ideas from others when prompted. Similarly, the lack of collaboration and coordination among local–local organizations poses a challenge and a missed opportunity for connecting SFCAs that are geographically distributed.

In addition to the SFCAs being spatially distributed around the island, many of them are quite small with an average size of 6.63 km^2 with three SFCAs not more than 1 km^2. Accordingly, there are many challenges and problems external to the jurisdictional boundaries both landward (e.g., pollution) and seaward (e.g., overfishing, destructive fishing practices) that the SFCAs are unable to cope with, highlighting one of the primary spatial mismatches that they must contend with. Multi-actor governance networks – particularly at the national level – can contribute to increased coordination when spanning sectors, departments, and agencies (Cicin-Sain and Belfiore 2005; Crowder, *et al*. 2006). However, the general lack of linkages in Jamaica related to *discussing management issues* and *collaboration* is worrisome for increasing coordination. Moreover, there is little evidence to suggest that this primary spatial mismatch has been effectively addressed or alleviated to date.

4.6.1.2 Temporal Mismatches

Multilevel governance networks – i.e., those that connect actors vertically across multiple administrative and political levels – have been suggested as an important mechanism for addressing temporal mismatches (Cash, *et al.* 2006; Armitage, *et al.* 2012). For example, multilevel linkages have been noted to tighten feedback loops between local monitoring and higher-level decision-making (Lebel *et al.* 2006; Berkes 2010a). In the collaboration network, the presence and density of these multilevel linkages (i.e., local–national) were higher in comparison to local–local linkages and national–national linkages. Further analysis revealed that the highest number of multilevel ties across all three networks was between management organizations and government agencies

suggesting that the results reflect the formal co-management arrangements that have been established.

Indeed, in Jamaica, tightening the feedback loop between local monitoring and place-based management with higher-level decision-making may have contributed to recent legislative changes that were both necessary and pressing. When the majority of the Special Fishery Conservation Areas were first established between 2009 and 2010 they were designated under the 1976 Fishing Industry Act as *Fish Sanctuaries* – a strict no-take marine reserve. However, with the recent invasion of the lionfish (*Pterois miles* and *Pterois volitans*) and the need for monitoring and culling, it was brought to the attention of the Ministry of Agriculture and Fisheries that the current legislation was too restrictive to effectively manage the marine reserves. As a result, new legislation was developed and formalized in 2012, designating all former *Fish Sanctuaries* as *Special Fishery Conservation Areas* which included clauses for particular situations in which fish could be removed and/ or added (e.g., removal of alien invasive species, research). In this situation, the numerous multilevel linkages between management organizations and government agencies potentially enhanced the governance fit and avoided an unnecessary time lag – not only a common underlying source of temporal mismatches but one that has been pervasive in Jamaica. For example, despite a new Fishery Bill being in draft form since 2009, it has not yet been passed resulting in the 1976 Fishing Industry Act still being in use.

4.6.1.3 Functional Mismatches

Multi-actor governance networks and ties have also been suggested as an important mechanism for addressing functional mismatches. For example, multi-actor

governance networks can contribute to increased coordination when spanning sectors, departments, and agencies (Cicin-Sain and Belfiore 2005; Crowder, *et al*. 2006). Therefore, our analysis also focused on those horizontal ties that existed between organizations operating at the national level (i.e., national–national). Analysis revealed several different types of horizontal linkages both within (e.g., NGO1–NGO2) and between NGOs, government agencies, and universities. In general, national–national linkages were highest in the *information-sharing* network in comparison to the other two, perhaps reflecting the more formal network ties and relationships involving reporting and consultation. Moreover, the general lack of linkages related to *discussing management issues* and *collaboration* is worrisome for increasing coordination.

Coordination between ministries, departments, and agencies has been repeatedly highlighted as being critical for improving functional mismatches as it relates to marine protected areas (Cicin-Sain and Belfiore 2005; Crowder, *et al*. 2006; Heck, *et al.* 2012; Yates, *et al.* 2013; Read and West 2014). Jamaica is no exception. The official mandate and associated legislation of the Special Fishery Conservation Areas are extremely limited, pertaining only to fish. Other species (e.g., sea turtles) and relevant habitat (e.g., coral reefs, sea grass, mangroves) fall under the purview of other ministries and agencies. As one respondent noted, the mere act of putting in the marker buoys to identify the boundary of the SFCAs required permission from a different agency. Such fragmented governance and narrow mandates can be incredibly problematic without effective coordination and collaboration.

Multilevel governance networks have also been suggested as an important mechanism for addressing functional mismatches (Cash, *et al.* 2006; Armitage, *et al.*

2012). For example, multilevel linkages have been noted to link actions at multiple scales (e.g., place-based management and regional planning) (Guerrero, *et al.* 2013; Mills, *et al.* 2014). Analysis of the strongest ties present within the core networks repeatedly pointed to the Fisheries Division and the National Environment and Planning Agency (NEPA), reflecting both the important coordinating role that these two organizations play as well as the formal co-management agreements that all of the management organizations have with one or both of these government agencies.

These multilevel linkages (i.e., those between local management organizations to either the Fisheries Division and/or NEPA) may have helped to address a recent functional mismatch associated with the SFCAs. As noted above, the SFCAs were designated as a strict no-take marine reserve. However, the invasion of the lionfish brought to light how limiting the institutional arrangement – i.e., current rules and regulations – was for effective management. For example, it precluded the removal of invasive species even though the invasive species were preying on the young fish, which was the primary objective of the SFCAs. The result of this functional mismatch was significant unintended consequences. However, this issue was quickly brought to the attention of the Ministry of Agriculture and Fisheries through these numerous multilevel linkages resulting in a new designation that effectively addressed the previous functional mismatch (i.e., management objectives and regulations that were too narrow in scope).

4.6.2 Enabling Conditions to Enhance Governance Fit

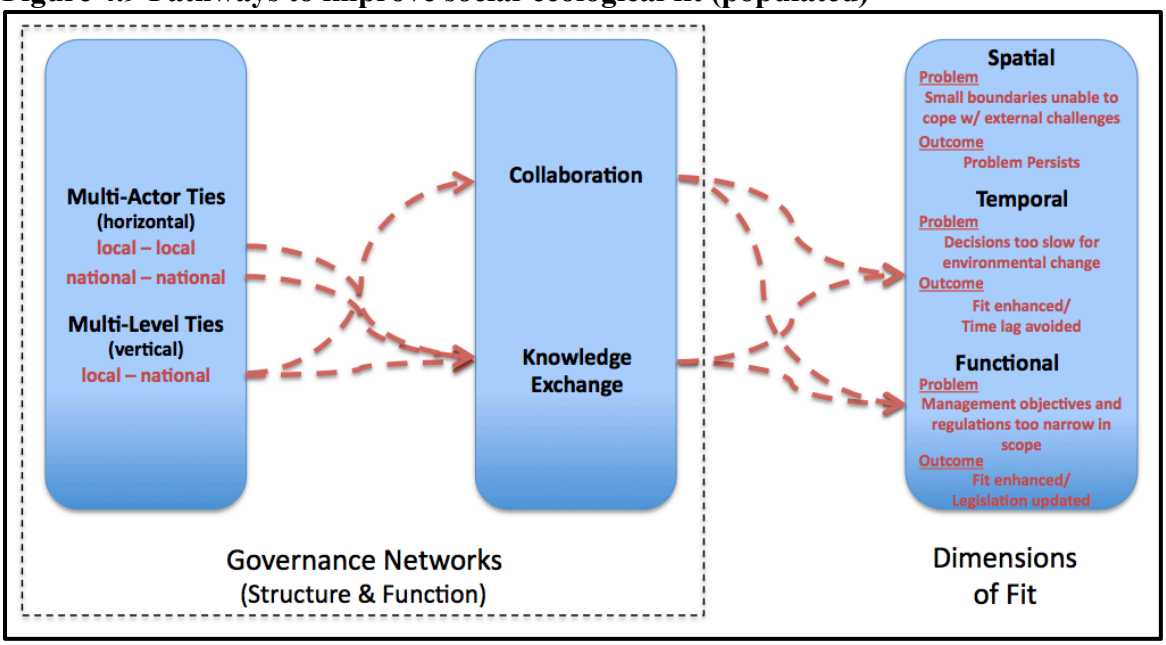
A social relational network perspective and our analysis serve as an entrée for considering the role of specific types of interactions – i.e., multi-actor, multilevel – and identifying the associated enabling conditions to enhance governance fit – i.e., those

conditions that contribute to the emergence and maintenance of network ties. In Jamaica, informal networks such as the Sanctuary Managers Network and the South West Friendly Fishers Alliance were important venues for bringing together actors and helping to maintain stronger ties. Cohen *et al.* (2012), who examined social networks supporting coastal governance in the Solomon Islands and the more formalized Solomon Islands Locally Managed Marine Area Network, similarly found such face-to-face meetings to be critical for facilitating knowledge exchange. Accordingly, identifying and ensuring the necessary resources are available to support regular and repeated gatherings is imperative. However, providing the necessary resources alone is unlikely to lead to success. Effort must be invested to develop the appropriate strategies and forums that will foster a culture of collaboration and collegiality rather than competition to ensure enduring partnerships are established and maintained.

4.7 Conclusions

Examining the presence and distribution of multi-actor and multilevel network ties revealed a combination of structural and relational conditions that provide key insights with regards to if and how social connectivity can address particular aspects of fit (i.e., spatial, temporal, functional) that plague MPAs. Our findings suggest that multilevel linkages may have played the greatest role in relation to early examples of overcoming a functional mismatch and avoiding a temporal mismatch (see Figure 4.9). However, considering the prevalence of weak ties, lack of a culture of sharing and collaboration, and limited resources, the propensity of the multi-actor and multilevel networks for continuing to enhance fit and overcome mismatches remains uncertain.

Figure 4.9 Pathways to improve social-ecological fit (populated)



Governance networks that are multi-actor and multilevel also present several specific challenges that are necessary to consider, such as the potential for increased transactions costs (Wilson 2006; Termeer, *et al.* 2010; Kark, *et al.* 2015) and the requirements of coordination and collaboration (Berkes 2010a; Termeer, *et al.* 2010; Kark, *et al.* 2015), particularly for those governance networks that are spatially distributed (Wyborn 2015). These challenges highlight and reinforce the importance of a nuanced approach that more effectively contextualizes specific problems of fit. For example, it is not enough to promote multilevel and participatory approaches (Galaz, *et al.* 2008). Rather there is also a need to understand the *quality* of interactions along with the social factors (e.g., situational, process-related) that enhance fit (Olsson, *et al.* 2007; Galaz, *et al.* 2008). And, as demonstrated here, it is equally important to consider the *distribution* and *strength* of those interactions that may enhance and inhibit fit.

As our study illustrates, a social relational network perspective provides a promising new tool to think through and evaluate the 'social' dimensions of fit. At the same time, this work provides the foundation to further unpack and examine the specific mechanisms (i.e., causal pathways) through which the structure and function of governance networks contribute to different outcomes related to fit. For example, are certain network structures (e.g., multilevel ties) more conducive to addressing specific dimensions of fit (e.g., temporal mismatches)? However, the development and testing of more specific hypothesis and propositions will likely require the application of additional analytical tools such as Exponential Random Graph Models (Wang, *et al.* 2013; see Guerrero, *et al.* 2014), qualitative comparative analysis (e.g., Crona, *et al.* 2015), or structural equation modeling (e.g., Shipley 2002) to begin testing causation.

Furthermore, our findings suggest the potential role of social connectivity within governance networks – or lack thereof – to address mismatches (i.e., spatial, temporal, functional) that undermine, over the long term, the viability and impact MPAs and MPA networks. Thus, while the consideration of MPA networks as socially connected has only just emerged in the last few years, this work highlights the insights to be gained from a more robust research agenda focused on the rules, rule making systems, and actor networks associated with MPA networks.

Chapter 5

Conclusion

This chapter reviews the main findings highlighted in the previous chapters and synthesizes the significant and original contributions of the research. The chapter begins with a review of the purpose and objectives of this study. Key research findings from the three previous chapters are then summarized followed by an overview of the significant and original academic contributions this research makes. In addition, insights and recommendations for conservation and natural resource management practitioners are highlighted. This is followed by a discussion of the study's limitations and opportunities for future research. The chapter concludes with research reflections.

5.1 Purpose and Objectives

The purpose of this doctoral research was to characterize and assess how social networks enhance and inhibit the governance of marine protected areas. My research emphasized the structure and function of multiple networks between actors to better understand their role in the governance of MPAs. A synthetic review was first conducted to outline the emergence and benefit of applying a structurally explicit, social relational network perspective to inform the establishment and governance of MPAs and MPA networks. I then used this social relational network perspective to gain key insights regarding the role of networks for the governance of MPAs and MPA networks based on two empirical cases in Jamaica.

The research had three specific objectives:

1. To conceptually develop and illustrate the utility of a social relational network perspective for policy-relevant MPA science (Chapters Two, Three, Four);
2. To identify and describe how social networks support and constrain transitions to co-management of small-scale fisheries and MPAs (Chapter Three); and
3. To examine how social connectivity among actors affiliated with a MPA network enhance and inhibit governance fit (Chapter Four).

Coastal communities in Small Island Developing States (SIDS) – including the Caribbean – are highly vulnerable to both current and future environmental change (IPCC 2014, CARSEA 2007). Furthermore, they are faced with declining marine fisheries (Jackson, *et al.* 2001). In response to the declining health of coastal-marine ecosystems and vulnerability of coastal communities, various strategies have been proposed (e.g., integrated-coastal zone management, ecosystem-based management). One particular strategy that has garnered attention is Marine Protected Areas. Indeed, MPAs have emerged as a significant marine conservation strategy (Lubchenco, *et al.* 2003; Christie 2011), a trend that is likely to continue (Toropova, *et al.* 2010). Yet, there has been a noted lack of consideration concerning the social dimensions of MPAs and MPA networks, including governance (Christie, *et al.* 2003; Charles and Wilson 2009; Christie 2011; Fox, *et al.* 2012a), which has been cited as enabling or constraining the establishment and performance of marine protected areas (Charles and Wilson 2009; Jones 2014). As such, there is a need to move beyond viewing MPAs as simply a legal and spatial tool. Rather, it is critical to turn our attention to the formal and informal rules,

rule-making systems, and actor networks associated with MPAs and MPA networks (see Chapter One).

5.2 Major Findings

Research findings were presented via three individual – yet interrelated – manuscripts. Chapter Two presented a synthetic review outlining a social relational network perspective for MPA science. Chapter Three presented a comparative analysis of the social network structures associated with three Jamaican marine reserves to understand their role in transitions to co-management. Chapter Four shifted the focus from ties between individual fishermen to ties between organizations from across the island that contribute to the governance of the SFCAs and their implications for enhancing and inhibiting governance fit – i.e., the congruence between the attributes or features of a system of governance and the larger set of attributes or features of a social-ecological system. The following section provides a summary of the major findings from each of the manuscripts.

Chapter Two presented a synthetic review that outlines the foundations – e.g., theoretical, methodological – of a social relational network perspective and highlights its contributions for MPA science. Specifically, the manuscript highlights the potential for the systematic identification and examination of actor roles, social attributes, and processes (e.g., trust, knowledge exchange) crucial to the establishment and governance of MPAs and MPA networks (Figure 2.3; Table 2.2). While there are no simple approaches to examine the social context of MPAs and MPA networks, the review illustrated that a social relational network perspective provides a theory-driven

framework for further modeling and empirical analysis. In addition, four key insights associated with the application of a social relational network approach to policy-relevant MPA science were identified. First, a social relational network perspective contributes to an identified gap in conceptual models and analytical methods that systematically consider the social dimensions of MPAs and MPA networks (Fox, *et al.* 2012a; Spalding, *et al.* 2013). Second, understanding how social relational networks enhance or inhibit the establishment of MPAs and MPA networks can provide new insights into the "enabling environments" that contribute to scaling up of MPAs (Fox, *et al.* 2012b), and help to identify communities where conservation is feasible and collective action more likely (see Mills, *et al.* 2013). Third, the inclusion of new actors and stakeholders associated with conservation and natural resource management (e.g., MPAs and MPA networks) (Armitage, *et al.* 2012; Alexander, *et al.* in press) requires more explicit and systematic approaches to examine the formal and informal social networks that are central to hybrid governance arrangements (e.g., co-managed MPAs) (Carlsson and Berkes 2005). Fourth, scholars studying social networks are generating valuable analytical approaches to examine different types and dimensions of social networks (e.g., temporal networks), many of which represent important research frontiers of a social relational network perspective for policy-relevant MPA science.

Chapter Three employed a social relational network perspective in a comparative analysis of the social network structures associated with the transition to co-management in three Jamaican marine reserves. Examining multiple network structures, attributes, and processes revealed a combination of structural and relational conditions that help to explain the previous experience with collective action. This collective action resulted in

the establishment of the co-managed marine reserves in the case study communities. Specifically, the results suggest that transitions to co-management are supported by a combination of three main network structure and relational attributes: i) the presence and position of institutional entrepreneurs; ii) a dense central core of network actors; and iii) the prevalence of horizontal ties and vertical linkages held by the community-based organizations formally responsible for the management of the marine reserves. Research findings also indicate that overall low network cohesion (as in the three reserves) and limited social influence of those in positions of responsibility (as with the wardens of the marine reserves) may be problematic for sustained collective action that extends beyond the core set of network actors. These findings suggest the importance of strategies to enhance collective action, specifically through attention to the attributes of the corresponding social networks (e.g., strengthening ties to neighboring landing sites), as a means to contribute to successful transitions to co-management of MPAs and small-scale fisheries.

Chapter Four presented an analysis of the social connectivity within a governance network associated with an emerging network of marine reserves across Jamaica. Examining the presence and distribution of multi-actor and multilevel network ties revealed a combination of structural and relational conditions that provide key insights about how social connectivity may enhance and inhibit particular aspects of fit (i.e., spatial, temporal, functional) that plague MPAs (Agardy 2005). Research findings suggest that multilevel linkages (e.g., linkages between local organizations managing the marine reserves and government agencies) may have played the greatest role in updating the rules and regulations associated with the marine reserves in a timely fashion to

facilitate the effective management of lionfish and ongoing monitoring (i.e., overcoming a functional mismatch and avoiding a temporal mismatch). However, considering the prevalence of weak ties between local management organizations (i.e., local–local) and between government agencies (i.e., national–national), lack of a culture of sharing and collaboration, and limited resources, the propensity of the multi-actor and multilevel networks to continue to enhance fit and overcome mismatches remains uncertain.

5.3 Contributions

5.3.1 Academic Contributions

Collectively, the research sought to examine the structure and function of social network ties at multiple levels – from resource users (i.e., fishermen) associated with a particular landing site to national government agencies (and even international conservation organizations involved in MPA development in Jamaica). Accordingly, the first empirical case (Chapter Three) focused on ties between individual fishermen and wardens, while the second empirical case (Chapter Four) focused primarily on ties between organizations from across the island that contribute to the governance of the SFCAs. Collectively, the synthetic review (Chapter Two) and empirical research (Chapters Three and Four) make three significant and related contributions to the literature.

First, the study developed and illustrated the utility of a social relational network perspective for policy-relevant MPA science. This contributed to an identified gap in conceptual models and analytical methods that systematically consider the social dimensions of MPAs and MPA networks (Fox, *et al.* 2012a; Spalding, *et al.* 2013). Earlier arguments for the consideration of social networks in natural resource

management and conservation focused on the insights from a structural perspective – i.e., focusing largely on network structure and its role in relation to key social processes (e.g., information sharing) (Newman and Dale 2006; Bodin, *et al*. 2006). However, building on the work of Ramirez-Sanchez (2007) and Bodin *et al.* (2011), the social relational network perspective outlined here draws upon social network literature (e.g., Wasserman and Faust 1994) as well as relational sociology (e.g., Emirbayer 1997) to clearly articulate underlying theoretical assumptions (see Chapter Two). Thus, the approach developed here is both structural and relational – accounting for the dual role of structure and agency. A more explicit articulation of the theoretical assumptions underlying a social relational network perspective provides a stronger foundation to consider how networks influence MPAs as well as the role of networks in the environmental governance literature more broadly (e.g., common pool resources, adaptive co-management, adaptive governance).

In addition to the conceptual development of a social relational network perspective, this study illustrated the utility of such an approach for MPA science. Chapter Two outlined the potential contributions of this network perspective with regards to understanding and informing the establishment and governance of MPAs and MPA networks (e.g., better understanding the enabling conditions, identifying relevant stakeholders; see Table 2.2). Chapter's Three and Four empirically illustrated the insights and contributions to be gained from taking a social relational network perspective. Furthermore, these two chapters illustrated how such an approach can be applied at different scales (e.g., community level interactions, organizational interactions) and used

to understand different governance issues (e.g., transitions to co-management, governance fit).

The second contribution of this study is illustrating the utility of a social relational network perspective to examine and understand key governance attributes previously identified in the literature – specifically community cohesion and leadership (Gutierrez, *et al.* 2011; Pomeroy, *et al.* 2011; Ayers and Kittinger 2014; Levin and Richmond 2014). Overall, the results from this study (specifically Chapter Three) reinforce the important role of community cohesion and leadership as a basis for successful co-management of fisheries and MPAs. However, while community cohesion is important, how community is defined with regard to 'membership' and boundaries is just as important (e.g., landing sites, gear types, traditional use, administrative). The perspective employed here provides key insights for heterogeneous social contexts – i.e., identifying who is in the network and how they are connected. These insights, in turn, can be leveraged to support new ties and/or reinforce existing ones (e.g., that extend to other landing sites and gear types) to improve transitions to co-management. Furthermore, the results provide important insights about the role of social networks and social capital, which Fox *et al.* (2012a) identified as one of the research frontiers for policy-relevant MPA science.

While leadership – via the institutional entrepreneurs – was found to play an important role in the transition to co-management in the Jamaican cases, these particular actors may be problematic in the long term due to some of their polarizing qualities. Overcoming the potential drawbacks of these particular actors requires different leadership types and actors in different positions. In the three cases presented here, other key actors (e.g., SFCA managers, an executive director of a community foundation)

served a critical complementary role as they fostered important vertical and horizontal organizational ties, while also tempering conflicting personalities. Findings thus support emerging evidence for the important role of multiple sources of leadership (e.g., Olsson, *et al.* 2008; Marin, *et al.* 2012). Furthermore, research results illustrate that it is not just leaders *per se* that are important, but rather the broader network of linkages are equally important – i.e., how the leaders are connected, how others are connected, and where the leaders are positioned within the network. Considering the previous insights, these findings support Evans *et al.* (2015) recent call for a more nuanced approach to leadership and its role in natural resource management and conservation. To that end, the results illustrate the utility of a social relational network perspective to understand and examine the role of leadership.

The third contribution of this study concerns the re-orientation of thinking about MPA networks from a purely ecological and biophysical perspective, towards a greater emphasis on social connectivity. As noted previously, moving beyond a focus on ecologically connected MPAs to the consideration of MPA networks as socially connected has only just emerged in the last few years (e.g., Christie, *et al.* 2009; Lowry, *et al.* 2009). Aside from a handful of empirical studies (e.g., Pietri, *et al.* 2009; Horigue, *et al.* 2012), most considerations and discussions are largely anecdotal and/or fall within the scope of what Bodin *et al.* (2011) refer to as a "binary metaphorical approach" (e.g., Lowry, *et al.* 2009), with few studies taking a structurally explicit network approach (e.g., Cohen, *et al.* 2012). Yet, if we take the idea that social connectivity is just as important as ecological connectivity then we need new tools to think through the 'social' dimensions of fit. The findings presented in Chapter Four suggest the potential role of social

connectivity within governance networks to address mismatches (i.e., spatial, temporal, functional) that undermine, over the long term, the viability and impact MPAs and MPA networks. Thus, while the consideration of MPA networks as socially connected has only just emerged in the last few years, this work highlights the insights to be gained from a more robust research agenda focused on the rules, rule making systems, and actor networks associated with MPA networks. Furthermore, the study illustrates how a social relational network perspective provides a promising new tool to think through and evaluate the 'social' dimensions of fit.

5.3.2 Contributions for Practitioners

The findings presented here are based on research in Jamaica, but they are germane to a wide range of contexts given the global expansion of MPAs and MPA networks (see Spalding, *et al.* 2013) where similar social relational challenges and opportunities are bound to occur (e.g., Crawford, *et al.* 2006; Fabinyi, *et al.* 2010). Furthermore, the governance context for community-based conservation and natural resource management is shifting in light of globalization – i.e., it is no longer isolated or exclusively local (Berkes 2007). Simultaneously, the constellation of governance actors is shifting – i.e., towards more diverse actors and groups of actors (Armitage, *et al.* 2012; Alexander, *et al.* in press). Social relational challenges, therefore, will be pervasive and persistent across diverse governance contexts. To this end, the study offers some key insights for conservation and natural resource management actors (e.g., researchers, practitioners) in relation to: a) navigating networks (see Alexander, *et al.* in press); and b) network weaving (see Vance-Boreland and Holley 2011). Network weaving has been described as the process of communicating results after assessing the structural

characteristics and sharing network maps with stakeholders to encourage network change and address key gaps (e.g., collaboration, communication) (Vance-Boreland and Holley 2011).

To assist governance actors in navigating the formal and informal networks they are embedded within, Alexander *et al.* (in press) outlined three waypoints. These waypoints align with three important challenges:

1. The boundary specification problem (Marin and Wellman 2011)
2. Actor interests and values are not always shared (Dryzek 1997; Agrawal and Gibson 1999; Forsyth 2013)
3. Not all networks are structurally equal (Wasserman and Faust 1994)

These three challenges can have significant implications with regards to the insights to be gained and simultaneously illustrate the many conceptual and analytical decisions that one encounters as they seek to understand and navigate the networks they are embedded within. Accordingly, I reflect on these challenges in relation to this study conducted in Jamaica to identify and illustrate the practical implications to be gleaned from the empirical chapters (Chapters Three and Four).

The boundary specification problem

The SFCAs in Jamaica have clear jurisdictional boundaries (i.e., there are lines drawn on a map). However, these same boundaries are not adequate for capturing the relevant actors and actor groups. Focusing exclusively on the relational ties among the fishermen whose landing sites – i.e., beaches where fishers continue to land and launch their boats – fall within the jurisdictional boundary of the SFCA would have excluded fishermen whom traditionally fished in those same waters prior to being designated a no-

take area, but whose landing sites are outside of the SFCA boundary. Alternatively, redefining the network boundary to capture both groups of fishermen in the network – see for example in Chapter Three – allows for the identification of actors who may play a bridging role between landing sites.

Similarly, considering the nested and multilevel governance networks associated with the SFCAs in Jamaica allowed me to bound part of the network depending upon the question. For example, in Chapter Three, the boundary was established at a more local level to examine relational ties between individuals. On the other hand, in Chapter Four, the boundary was established at a national level to examine relational ties between organizations across the island. However, these boundaries were – and continue to be – permeable. For example, in Chapter Three some of the individuals surveyed identified other actors – i.e., individuals and/or organizations – that were not based in their community when asked about sharing and receiving relevant information. Similarly, some actors such as SFCA managers and local NGOs were present within both locally bounded networks – i.e., Chapter Three – and the national level network – i.e., Chapter Four.

The boundary specification problem is about which nodes to include in a network (Marin and Wellman 2011). In the context of social networks and governance networks relevant to environmental governance, the boundary specification problem requires identifying who the relevant actors are both horizontally – i.e., across sectors or places – and vertically – i.e., across organizational, jurisdictional, or political levels. However, this may not be so simple and straightforward with new and emerging governance actors ranging from private sector entities to community groups (Alexander, *et al.* in press).

Simultaneously, the boundary specification problem requires governance actors (e.g., researchers, managers) to both make decisions and reflect critically on the criteria used to establish network boundaries. Moreover, it necessitates recognition that once a boundary is established, the governance actors do not operate in isolation – i.e., they are likely connected in multiple ways to those actors that exist beyond the established boundary. Accordingly, "how governance networks are bounded and the types of actors who are included – or excluded – determine the insights to be gained about their function and contributions" (Alexander, *et al.* in press, p. 3).

Actor interests and values are not always shared

In Chapter Three there were clear examples of differing values and perceptions between landing sites in all three cases – i.e., 'communities' – included in the comparative study. So much so in some instances that it created an environment best characterized as "us versus them." In other words, the landing sites were more than geographical spaces and places. They reflected groups of actors with differing experiences, concerns, and views related to the planning and establishment of the marine reserves. Accordingly, reflecting carefully on the boundaries and actors to be included contributed to capturing a more diverse set of values, interests, and perspectives. Therefore once the boundaries have been established and actors identified, one must turn their attention to considering how issues such as accountability, trust, and power manifest in the network. The shift to a wider array of governance actors inevitably results in a diversity of values and interests that in turn will contribute to different outcomes (Alexander, *et al.* in press). Even in a small community, the interests among actors are

not necessarily going to be shared (Dryzek 1997; Agrawal and Gibson 1999; Forsyth 2013).

Not all networks are structurally equal

It has been noted and illustrated throughout this dissertation that not all networks are structurally equal (see Chapters Two, Three, and Four) and that different patterns of social relations contribute to different management and governance outcomes (Wasserman and Faust 1994; Newman and Dale 2005; Bodin *et al.* 2006; Bodin and Crona 2009; Henry and Vollan 2014). Turning ones attention to how actors are connected requires not only a focus on the resulting structure, but also the criteria used to 'map' the network. For example, the connections could reflect social relations (e.g., kinship) or the flow of resources. Whether focusing on the former or the latter has important implications. As Alexander *et al.* (in press) note, this will "influence perceptions and empirical understandings about the efficacy of that network" (p. 6). Accordingly, examining structural patterns is as much about identifying potential hierarchies or subgroups as it is about considering how social relations have formed and changed over time.

The establishment of the individual SFCAs – examined in Chapter Three – also resulted in a national network of SFCAs – examined in Chapter Four. However, understanding different processes relevant to this governance network (e.g., collaboration, knowledge exchange) required examining the multiple (i.e., nested) governance networks characterized by different boundaries and groups of actors. For example, to understand the diffusion of new norms and compliance needs within individual SFCAs (Chapter

Three) an examination of community-level interactions among local fishers and wardens was required. At the same time, understanding collaboration and knowledge exchange among the island wide network of SFCAs – examined in Chapter Four – required an examination of relational ties among a different set of actors, including government agencies, NGOs, universities, and community organizations whose interests, information, and knowledge needs are quite different than those in the communities. In Chapter Three, considering how the actors were connected helped to identify marginalized actors (or sub-groups of actors) that were reflected in fragmented networks of relational ties. On the other hand, Chapter Four provides a good example of how the structure of the network, along with the presence and strength of ties will differ between actors depending upon what the nature or premise of the connection is (e.g., collaboration vs. information sharing).

Reflecting on the different boundaries, actors, their interests, and their connections serves as an entrée to identify specific 'network weaving' strategies and to consider the possible tradeoffs associated with different arrangements and relations. More specifically, the results produced here provide more precise guidance, through social network analysis, on how to target interventions for greatest effect. Understanding these network conditions and engaging in network weaving is needed as MPA and fishery systems (such as the SFCAs in Jamaica) will deal not only with fishing and conservation pressures, but also with the context of warming waters, acidification, and coral bleaching associated with climate change.

For example, when a community-based organization (CBO) responsible for managing the SFCA is interested in hiring and establishing new wardens, then specific

actors can be identified who might be well positioned to bridge different subgroups, and therefore, build network cohesion and trust. Alternatively, the results of social network analysis can be leveraged to support the current wardens to build new ties and/or reinforce existing ones. Moreover, the results can provide important insights as to whether time, energy, effort, and resources should be designated to build overall network cohesion among resource users within the community, strengthening horizontal and vertical linkages to other organizations and agencies, or both. At the same time, Frank (2011) cautions that natural resource management approaches and interventions informed by networks, which were successful in one context, may not be appropriate in another. Accordingly, the three important challenges outlined previously are very much necessary to consider before embarking upon any network weaving ensuring that any suggestions and/or 'interventions' are contextually appropriate.

5.4 Study Limitations and Future Research

The strength of any given perspective (e.g., conceptual, analytical, methodological) lies not only in its potential contributions, but also in knowing its limitations. The section below highlights the limitations of a social relational network perspective with regards to understanding MPA governance. One methodological limitation is the static nature of social network analysis (SNA) as a way to measure dynamic social relational networks. SNA generally provides a snapshot in time, while governing involves the continual interplay of actors, institutions, and social processes unfolding through space and time. Prell *et al.* (2011) note that this, however, is a challenge common to all cross-sectional research – as compared to longitudinal studies –

and methods are currently being developed to better address the dynamic nature of networks (see Table 2.4).

Indeed, examining social networks through time in relation to natural resource management and conservation represents a significant research frontier (see Chapter Two; Table 2.4). The study conducted here provides a significant opportunity for developing such a longitudinal study. There are key reasons why this study would provide a solid platform and starting point. The first concerns the extent and depth of data collected as one of the noted challenges related to social network studies are the resources necessary for social relational data collection (Prell 2012). The second reason has to do with the timing of when this study was completed – i.e., within the first three to five years of the SFCAs being established. Accordingly, the networks (both local and national) are likely to evolve through time with new actors and ties emerging while others fading away. For example, the Government of Jamaica has just announced that four more SFCAs will be established within the year (Angus 2015). A longitudinal study such as this would provide key insights with regards to the evolution, emergence, maintenance, and role of social networks for environmental governance.

Another limitation of this study is its ability to make causal connections. Indeed, the challenge of establishing causal inferences is a noted methodological limitation of single case studies employing social network analysis (Crona and Bodin 2011; Sandstrom 2011). Single case studies and/or a lack of longitudinal data challenge the ability to identify causal inferences between network structure (i.e., the independent variable) and the various dependent variables (e.g., governance outcomes, learning) commonly considered in studies concerned with natural resource management and conservation

(Bodin and Prell 2011). Bodin *et al.* (2014) note that understanding the causal influence of particular network structures on different conservation and natural resource management outcomes (social and ecological) represents an important research frontier. Indeed, this is one to which my collaborators and I are now turning to in the context of these Jamaican cases.

A social relational approach also presents analytical limitations with regards to understanding MPA governance. Understanding the role of incentives (e.g., economic) and variations in property rights, equally noted as important considerations (Charles and Wilson 2009; McCay and Jones 2011), are beyond the purview of a social relational approach as presented here. Jones *et al.*'s (2011) recently developed Marine Protected Area Governance framework could aid on this front, providing insights into a more effective approach for considering the role of incentives. Another limitation of a network perspective is its conceptual and analytical scope to consider institutions. Institutions surface regularly with regards to the problem of fit, both as a source of mismatches (e.g., institutional constraints) and as proposed solutions (e.g., nested institutions). Straton and Gerritsen (2005) argue for the contribution of a network perspective on this front as it "acknowledges that the structure of human interactions affects how rules and rule changes percolate throughout a system" (p. 43). While complementary, a social relational network perspective alone it is not nearly adequate to capture and understand all aspects of MPA governance (see Bennett and Dearden 2014). Rather, one might turn to Ostrom's (2007, 2009) SES framework, which builds on the previously developed Institutional Analysis and Development framework.

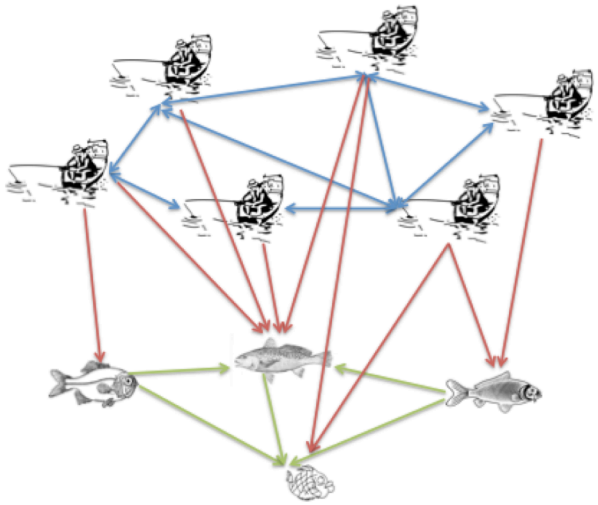
Untangling the numerous social-ecological interdependencies in the context of management has proved difficult, and understanding how different patterns of connections (e.g., between actors, between resource units, between actors and resource units) affect governance outcomes is poorly understood (Janssen, *et al.* 2006; Young, *et al.* 2006; Bodin and Tengö 2012). While there have been several conceptual frameworks developed of social-ecological systems (e.g., Berkes and Folke 1998; Liu, *et al.* 2007), much less progress has been made – theoretically and methodologically – with regards to quantitatively studying social-ecological interdependencies and how these patterns affect the possibilities and limitations for sustainable outcomes (Bodin and Tengö 2012).

One promising approach to address this fundamental gap is to model social-ecological systems as *social-ecological networks*, where actors (e.g., individuals, groups, organizations) and ecological entities (e.g., a species, forest patches, protected areas) are conceptualized as nodes and their interdependencies as links (see Box 5.1). Analysis of the resulting network concerning its structure, function, and dynamics can then be carried out. Importantly, such a cross-disciplinary integrated approach can contribute to theory development with respect to the relationship between diverse governance arrangements, managed ecosystems, and natural resource management outcomes (Bodin and Tengö 2012; Bodin, *et al.* 2014).

Box 5.1 Defining and conceptualizing social-ecological networks

Social-ecological networks are defined and conceptualized here as being composed of three different types of ties (*sensu* Janssen *et al.* 2006):

i. ties between social actors (*e.g.,* communication) (blue);
ii. ties between ecological entities (*e.g.,* habitat patches, different species such as those found in food webs) (green); and
iii. ties between social actors and ecological entities (*e.g.,* target fish species) (red).



The study of social-ecological networks is an emerging research frontier (Janssen, *et al.* 2006; Bodin and Tengö 2012). To date, the research in this area of study has focused on theorizing, conceptualizing, and modeling, with very few examples of empirically grounded social-ecological network analyses (e.g., Bodin, *et al.* 2014). The empirical cases examined in Chapter Three could provide the foundation for significant theoretical contributions concerning the governance of complex social-ecological systems, and methodological contributions concerning new applications of emerging network modeling methods to understand and analyze social-ecological networks.

Building on the data collected from this study, the development of three empirically grounded social-ecological networks – through the integration of Caribbean coral reef food web network data – provide a unique opportunity to examine the relationship between complex governance arrangements, the structure and function of managed ecosystems, and natural resource management outcomes. For example, through

the application of exponential random graph models (ERGMs) (Robins, *et al.* 2007; Wang, *et al.*2013), one could develop and test theoretically grounded hypotheses linking specific structural features within the three empirically grounded social-ecological networks with how well they have governed their natural resources. Indeed, Bodin and Tengö (2012) illustrate how such structures can be explicitly linked to existing and emerging theories within the social and natural sciences. Furthermore, Bodin *et al.* (2014) suggest that the application of ERGMs would provide a more robust way (i.e., statistically) to further tease apart the interdependencies associated with social-ecological systems.

Additionally, through the application of Agent Based Models (ABMs), one could assess the dynamics of the social-ecological networks based on different policy interventions and management strategies (e.g., restrictions on gear use, ban on particular species). In other words, to develop an understanding, through modeling and simulation, of how these networks change and evolve as policies change, and how they might then become more or less able to govern their resources sustainably. For example, how might placing a ban on parrotfish – an overexploited but ecologically important species for the overall health of coral reefs – change the overall structure and function of the social-ecological network – possibly resulting in unintended consequences? Whether through the development of a temporal data set or empirically informed models, there are a number of exciting ways to build on this research seeking to understand how the structure and function of social networks contribute to different conservation and natural resource management outcomes.

5.5 Research Reflections

> *The PhD program in Environment and Resource Studies (ERS) is devoted to understanding and pursuing sustainability in a dynamic and complex world, and to considering and integrating understanding across disciplines and scales from the organism to the planet.*
>
> Department of Environment and Resource Studies, University of Waterloo

Seeking to understand and pursue social and ecological sustainability is a normative endeavor informed by a perspective and position of how we ought to live. My dissertation is very much situated within this broader context of social and ecological sustainability. Globally, coastal communities and ecosystems are vulnerable to the impacts of climate change and declining marine fisheries. At stake are the health of coastal environments and the livelihoods of millions. Considering these challenges and the lack of success to date necessitates a focused effort on understanding how people interact with each other and with the environment, and in what instances these interactions contribute to socially just and ecologically sustainable outcomes.

One of the key tenets of the PhD program in the Department of Environment and Resource Studies is transdisciplinarity. It therefore seems appropriate to consider to what extent this dissertation reflects and embraces such an approach. While the concept of transdisciplinarity remains contested (Pohl 2010), there are three common characteristics that emerge. These three characteristics include: 1) being problem oriented and socially relevant (Hirsch Hadorn, *et al*. 2006; Miller, *et al*. 2008; Pohl 2010); 2) transcending and integrating disciplinary perspectives (Hirsch Hadorn, *et al*. 2006; Miller, *et al*. 2008; Pohl 2010); and 3) participatory research, requiring the inclusion of multiple knowledge

cultures beyond academia such as 'lay' knowledge and 'traditional' knowledge (Russell, *et al* 2008; Castan Broto, *et al*. 2009; Pohl 2010; Russell 2010). However, the last criterion – requiring or involving 'lay' knowledge – is not universal.

This thesis and the approach that guided my research reflect two out of the three common characteristics outlined above. Being problem oriented and socially relevant (e.g., governance of coastal-marine resources) benefits significantly from the integration of disciplinary perspectives. Indeed, I found it necessary to draw on concepts, methods, and theories from diverse disciplines (e.g., anthropology, sociology) to address my research objectives.

The third criterion – i.e., participatory research involving 'lay' knowledge – is what I believe to be one of the defining characteristics and what sets it apart from other research approaches (e.g., interdisciplinary). To this end, a transdisciplinary approach is a collaborative endeavor – rather than a singular undertaking. While there have certainly been many collaborative aspects through the process, this thesis by no-means reflects a participatory research approach that integrates 'lay' knowledge. Though this thesis may not reflect a truly transdisciplinary approach, I certainly aspire to partake in collaborative team science that engages stakeholders – whether they be fishermen, managers, or policy makers – throughout the process. To this end, I believe that through the research that contributed to this dissertation, I have laid the foundation, set the seeds, and established promising partnerships with communities and organizations in Jamaica that will hopefully lead to future collaborations and research that reflect the tenets of transdisciplinarity.

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Appendix A
Semi-Structured Interview Guide

INTRODUCTION

Thank you for sharing your time. The purpose of this study is to understand the role of communication, collaboration, and social networks among the diverse actors (e.g. fishers, managers, NGOs, Dept. of Fisheries personnel), with respect to the management of the *Special Fishery Conservation Area(s)* and coastal-marine resources more broadly. I am conducting this study as part of my graduate studies at the University of Waterloo in Ontario, Canada.

Is it alright if I record this? (Verbal Consent)
[If yes, turn voice recorder on.]

Your participation in this interview is voluntary. You can choose not to answer any of the questions and may withdraw your participation at any time. You will be asked to answer some questions about yourself and relations with other actors and organizations (e.g. fishers, managers, NGOs, agencies), with respect to the management of the *Special Fishery Conservation Area(s)* and coastal-marine resources.

With regards to the information that you are providing during this interview, how would you like to be cited in any publications, reports, etc. – by your name, your organization, or anonymously?

Should you wish to obtain a copy of the results of this study upon its completion, you can contact me at the Department of Environment and Resource Studies, University of Waterloo, 200 University Avenue West, Waterloo, ON, N2L 3G1. Email: s22alexa@uwaterloo.ca

Background

Interviewee Attributes

- Organization
- Position (e.g. manager, fisheries officer) and responsibilities **
- Length of time in this position**
- Prior positions (Formal/ Informal – official/ unofficial)**
- Involvement in other organizations, committees, etc.**

Talk me through the establishment of the *SFCA(s)*? If/when possible include:

- Key dates and/or events
- Key actors and/or organizations along with the nature of their involvement

In your view, what, if any, were key challenges (e.g. 2-3) with regards to establishing the *SFCAs*?

What are the current key challenges (e.g. 2-3) with regards to managing the *SFCAs*?

- Ecological? Social? Institutional?

In your view, what, if any, were key opportunities (e.g. 2-3) that facilitated the establishment of the *SFCAs*?

I am interested also in the overall planning and establishment of this network or system of fish sanctuaries:

- What considerations were taken into account when establishing the SFCAs?
- Are there any criteria used?
- How do new sites get selected?
- Are there additional sites under current consideration?
- Is there a target or goal that is guiding the process?

Governance Dimensions

(1) Co-management Arrangements

Potential Questions
How are the SFCAs managed? And by whom?

What types of activities are undertaken through the management of the SFCAs? By whom?
(e.g. management, enforcement, planning, research (data collection, data analysis), policy, education/ outreach)

How are decisions made about the *SFCA*s - for example, who is involved and in what capacity (information provider, decision maker, etc.) - made?

- About: i) Rules & regulations? ii) Penalties/ sanctions? iii) Boundaries? iv) Monitoring?

What is the role of fishers with regards to the management of the fish sanctuary? Were they actively involved in making the rules and establishing the boundaries for the fish sanctuary?

What factors (e.g., institutional/political, market/economic, social/cultural, biophysical/environmental/climatic) are considered when making decisions? Are certain factors prioritized?

- How is the information on these factors gathered or monitored? Are there gaps in information that arise? Can you provide examples? If so, how are these gaps addressed?
- Are different types of information considered when making decisions? In what ways or to what extent? Can you think of an example?

Generally, what factors (e.g.. institutional/political, market/economic, social/cultural) constrain or facilitate positive interactions among actors?

(2) Institutions & Fit

In your view, are the roles, responsibilities, and regulations governing the *SFCAs* administratively clear? Is there redundancy in roles? If so, is this problematic/beneficial?

Are there gaps in the formal policy and legislative framework? Please explain?
[Fishing Industry Act, Beach Control Act, Endangered Species Act, Wildlife Protection Act, Natural Resources (Marine Parks) Regulations]

Are there other initiatives, activities, projects or policies that are relevant to the management and conservation of the coastal-marine environment?

- To what extent is there co-ordination between and among these activities and/or projects?
- To what extent does the other initiatives and activities interface with the SFCAs?

What penalties exist to encourage compliance with the regulations governing the fish sanctuary?
(e.g. verbal warnings, written warnings, loss of access, confiscation of equipment, fines, etc.)

If caught breaking rules in the fish sanctuary, how often do rule-breakers receive a penalty?

What factors influence the choice of penalty?
(e.g. # of previous offenses, ecological impact of the offense, economic impact of offense, social impact of offense, wealth of rule breaker, political power of rule breaker, social status of the rule breaker)

Who monitors the monitors?

(3) Networks

Potential Questions
From whom have you received new *ideas, strategies or approaches* regarding marine resource management and conservation as it pertains to the *SFCAs*?

Can you think of innovative examples that have lead to or facilitated effective linkages among communities, government departments and other actors (e.g., businesses)? Have any of these lead to more sharing of power to make decisions?

Are there any particular meetings, events, projects, committees, etc. that bring actors involved in the national network of *SFCA*s together? What is/ was the nature of these? How often did/do they occur?

Information & Knowledge Exchange

- What type of information is shared (e.g., fisher knowledge of stocks, management strategies, environmental observations)?
- How is this data, information and knowledge shared (e.g. list serves, databases, websites, meetings, reports, informal personal exchanges)? (i.e., strategies, tools & modes of information exchange)
- Are there constraints or barriers to information & knowledge exchange?
- Is there any information not readily shared?

Wrap-up

This has been really fascinating and informative. Thank you for your help.

As you can see, I'm particularly interested in fisheries, coastal-marine resources and the SFCAs. With this in mind, is there anyone you might recommend that I speak to, either in your (agency, organization, association, etc.) or another?

Do you have any questions for me?

I will be conducting more extensive fieldwork later this year (Sept-Dec) and may be interested in following up with you if possible. In addition, I will be reporting back my findings next year (~March/April) *and if you are interested in follow up I'd be more than happy to ensure that you are contacted.*

Appendix B
National Organizational Network Survey

Q1 How often do you provide relevant information concerning the ecological condition of the SFCAs and/or the coastal-marine environment with the following organizations/ agencies?
(*e.g.* environmental changes, condition of the coral reef, invasive species, water quality, etc.)

Q2 How often do you receive relevant information concerning the ecological condition of the SFCAs and/or the coastal-marine environment from the following organizations/ agencies?
(*e.g.* environmental changes, condition of the coral reef, invasive species, water quality, etc.)

Q3 How often do you discuss management issues pertaining to the SFCAs with the following organizations/ agencies?
(e.g. illegal fishing, monitoring, rule enforcement, conflicts)

Q4 How often do you collaborate with the following organizations/ agencies when implementing marine resource management and conservation as it pertains to the *SFCAs?*
(collaboration = *sharing of human/financial/ technical resources, organizing joint activities or projects*)

How often: Never Occasionally (3-4x/ year) Regularly (2-3x/ month)

Organizations & Agencies
Montego Bay Marine Park Trust
Negril Environmental Protection Trust/ Negril Coral Reef Preservation Society
Bluefields Bay Fisherman's Friendly Society
Breds Foundation
Alloa Fisherman Cooperative
St. Mary Fisherman Cooperative
Oracabessa Foundation
Sandals Foundation
C-CAM
Jamaica Environmental Trust (JET)
Fisheries Division
National Environment & Planning Agency (NEPA)
NEPA Ecosystem Branch
NEPA Protected Areas Branch
Marine Police
Coast Guard
Ministry of Justice
Discovery Bay Marine Lab
UWI-Mona
The Nature Conservancy
CARIBSAVE
United Nations Environment Program - CEP
Environmental Foundation of Jamaica
Institute of Jamaica

***Other organizations or agencies may be added**

Organization: _____ Position: _____ Years in Position: _____

Organization	**Q1**			**Q2**			**Q3**			**Q4**		
	Provide Eco. Info			*Receive Eco. Info*			*Discuss Management Issues*			*Collaborate*		
	Never	**Occ.**	**Reg.**	**Never**	**Occ.**	**Reg.**	**Never**	**Occ.**	**Reg.**	**Never**	**Occ.**	**Reg.**
Montego Bay Marine Park Trust	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Negril Environmental Protection Trust/ Negril Coral Reef Preservation Society	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bluefields Bay Fisherman's Friendly Society	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Breds Foundation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Alloa Fisherman Cooperative	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
St. Mary Fisherman Cooperative	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oracabessa Foundation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sandals Foundation	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
C-CAM	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Jamaica Environmental Trust (JET)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fisheries Division	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
National Environment & Planning Agency	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
NEPA Ecosystem Branch	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
NEPA Protected Areas Branch	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Marine Police	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Coast Guard	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ministry of Justice	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Discovery Bay Marine Lab	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
UWI-Mona	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

The Nature Conservancy	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Organization	**Q1**			**Q2**			**Q3**			**Q4**		
	Provide Eco. Info			*Receive Eco. Info*			*Discuss Management Issues*			*Collaborate*		
	Never	**Occ.**	**Reg.**	**Never**	**Occ.**	**Reg.**	**Never**	**Occ.**	**Reg.**	**Never**	**Occ.**	**Reg.**
CARIBSAVE	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
United Nations Environment Program-CEP	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Environmental Foundation of Jamaica	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Institute of Jamaica	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Appendix C
Fisherfolk Questionnaire

INTRODUCTION

Thank you for sharing your time. The purpose of this study is to understand the role of communication, collaboration, and social networks among fishers and decision makers such as managers and Div. of Fisheries personnel, with respect to the management of the *fish sanctuary*. I am administering this study on behalf of Mr. Steven Alexander, a graduate student at the University of Waterloo in Canada whom has partnered locally with CARIBSAVE.

Your participation in this survey is voluntary. Your responses will be reported anonymously. You can choose not to answer any of the questions and may withdraw your participation at any time. The focus of the survey is on your impressions about fisheries related vulnerabilities and management activities. The three main topics in which our questions will be focused are:

1. Personal attributes related directly to your fishing activities
2. Preliminary perspectives concerning the planning and management of the fish sanctuary
3. Relational ties and patterns of interactions between yourself and other persons (e.g. fishers, managers, NGOs, Dept. of Fisheries personnel), with respect to the management of the fish sanctuary.

In total, the survey should take no longer than 25 minutes.

Respondent Code: _____ **Date:_____**

Interviewer: _____ Community: _____

SECTION A: Respondent Attributes & Fishing Activities

1. **Gender**: Male □ Female □
2. **Age: _____**
3. **What is your current residence (e.g. community)?_____**
    a. **How long have you lived in this community? _____** (Years)
4. **Have you lived and fished elsewhere?** Yes □ No □
    a. **If yes:**
        i. Previous residence (e.g. community): _____ Years? _____
        ii. Previous residence (e.g. community): _____ Years? _____
5. **Are you a registered fisher?** Yes □ No □
6. **Do you consider yourself a part-time or full-time fisher?** Part-time □ Full-time □
7. **How many times per week do you go to sea?**

    1-2 day/week ☐ 3-4 days/week ☐ 5-6 days/week ☐ 7 days/week ☐
8. **How long have you been fishing? _____**(years)
9. **What landing site do you regularly use?**

    Bloody Bay □ Orange Bay □ Green Island □ Negril □ Other □ _____

10. What fishing method(s) do you use (Check all that apply, star primary)

Fishing Method	Currently Use	Have Used	Know how to use
Hook & Line			
Fish Pot			
Net			
Spear Gun			
Other			

11. What are the five most common fish you catch?

1._____ 2. _____ 3. _____

4._____ 5. _____

Anything in season □ No Specific target □

12. In your opinion, how has your catch changed within the last five years? (Check all that apply)

More Fish □ Less Fish □ Smaller Fish □ Larger Fish □ No Changes □

13. What is your most common by-catch? (i.e., fish you throw back)

1._____ 2. _____ 3. _____

Throw nothing back □ Throw small ones back □

14. In your opinion, how has your by-catch changed within the last five years? (Check all that apply)

More Fish □ Less Fish □ Smaller Fish □ Larger Fish □ No Changes □

15. Do you go for conch? Yes □ No □

16. Do you go for lobster? Yes □ No □

17. Do you use a boat to fish? Yes □ No □ (Skip to 18)

a. If yes, what kind of boat?

Canoe □ Canoe w/ outboard □ Fiberglass w/ Outboard □ Other □

b. If yes, do you own the boat that you use? Yes □ No □

i. **If no, who owns the boat?**_____

c. If yes, are you the boat captain or crew? Captain □ Crew □

18. Where do you traditionally fish?

a. 0-2 miles from shore □ 2+ miles from shore □ Other □ _____

b. Farthest South/East (eg Negril) _____ Farthest North/East (eg Lucea) _____

19. Are you a member of a fisherfolk co-operative or organization? Yes □ No □ (Skip to 20)

a. If Yes

i. **Co-operative name:** Negril Fisherman's Co-Operative□ Other □

ii. **Position(s) held**: Yes, specify _____ No □

iii. **Length of time in this position:** _____ (Years)

20. Are you involved with any other community organizations, committees or social groups?

Yes □ specify _____ No □

21. Do you do other activities to support yourself and/or your family?

Yes □ specify _____ No □

a. If Yes, does it contribute: More than fishing □ Less than fishing □ The same □

SECTION B: Attitudes and perceptions

22. Are you aware of the fish sanctuary? Yes □ No □

23. Did you attend any meetings concerning the planning of the fish sanctuary? Yes □ No □

If Yes, how many? _____

24. To what extent did you have the opportunity to voice your opinion about the fish sanctuary?

1	2	3	4	5	□
never (Skip to 26)	rarely	occasionally	moderate amount	a great deal	No Response

25. To what extent do you believe your opinion influenced the planning of the fish sanctuary?

1	2	3	4	5	□
not at all influential	slightly influential	somewhat influential	very influential	extremely influential	No Response

26. How involved are you in the current management of the fish sanctuary?

1	2	3	4	5	□
not at all (Skip to 28)	minimally involved	somewhat involved	moderately involved	heavily involved	No Response (Skip to 28)

27. To what extent do you believe you are able to influence decision-making regarding the current management of the fish sanctuary?

1	2	3	4	5	□
not at all influential	slightly influential	somewhat influential	very influential	extremely influential	No Response

28. Are you aware of the boundaries of the fish sanctuary? Yes □ No □

29. Are you familiar with any of the rules and regulations of the fish sanctuary? Yes □ No □

If yes, please specify:

30. Since the establishment of the fish sanctuary, to what extent has illegal fishing been an issue?

1	2	3	4	5	□
non-issue	minimally	somewhat	moderately	serious	No Response

If yes (i.e., 2-5), is it fishers from: (Check all that apply)

Same Landing Site □ Other Local Landing Sites □ Neighboring Communities □

31. How likely are other fishers to report illegal fishing in the fish sanctuary?

1	2	3	4	5	□
Extremely Unlikely	Unlikely	Neutral	Likely	Extremely Likely	No Response

If Yes (i.e., 4-5), how? (Check all that apply)

Cell Phone □ Landline □ Email □ Text□ In Person □

SECTION C: Information on Social Relations

32. Do you exchange information with anyone, which is useful for your fishing & time at sea? (e.g. told you about practices, good fishing spots, equipment, timing and seasons, etc.)

Yes □ No □ (Skip to 33) Other Examples (when fishing is good or conditions are bad (poor visibility))

Emphasize that they're responses will not be shared with anyone

A. If yes, who have you provided information to in the last year? (Recall)

Name	Identifier/ Alias	Name	Identifier/ Alias
1.		11.	
2.		12.	
3		13.	
4.		14.	
5.		15.	
6.		16.	
7.		17.	
8.		18.	
9.		19.	
10.		20.	

B. If yes, who have you received useful information from in the last year? (Recall)

Name	Identifier/ Alias	Name	Identifier/ Alias
1.		11.	
2.		12.	
3		13.	
4.		14.	
5.		15.	
6.		16.	
7.		17.	
8.		18.	
9.		19.	
10.		20.	

33. If and when you notice changes in the natural environment, whom would you discuss this with? (*e.g.* environmental changes, condition of the coral reef, invasive species, water quality, etc.) (Recall) (Within the last year) □ No one □ No Response

Name	Identifier/ Alias	Name	Identifier/ Alias
1.		11.	
2.		12.	
3		13.	
4.		14.	
5.		15.	
6.		16.	
7.		17.	
8.		18.	
9.		19.	
10.		20.	

Prompt: (leave a blank space before adding responses from prompt)
In addition to those that you have already mentioned, might this include:
i) fish sanctuary managers or wardens; ii) persons from Division of Fisheries; iii) Researchers iv) persons from other organizations

34. If and when you see that someone is fishing illegally in the *fish sanctuary*, whom are you likely to share this with? (Within the last year) "I'm not an informant" □

Name	Identifier/ Descriptor	Name	Identifier/ Descriptor
1.		11.	
2.		12.	
3		13.	
4.		14.	
5.		15.	
6.		16.	
7.		17.	
8.		18.	
9.		19.	
10.		20.	

Prompt: (leave a blank space before adding responses from prompt)
In addition to those that you have already mentioned, might this include:
i) fish sanctuary managers or wardens; ii) persons from Division of Fisheries; iii) persons from marine police or coast guard

Wrap-up

Thank you for your help.

As you can see, we're particularly interested in fisheries, coastal-marine resources and the fish sanctuaries. With this in mind, are there other fishers you might recommend that we speak to?

1. _____
2. _____
3. _____
4. _____
5. _____

We will be conducting a small number of group discussions in a few weeks and are seeking potential participants. This would require a longer time commitment as it is expected to take between 1 – 1 ½ hrs. Due to the length, some food will be made available.

Would you be interested in possibly participating? Yes □ No □

If yes, is there a number we can reach you at? _____

Please note that depending on interest, we may end up selecting participants at random from those that expressed interest.

ADDITIONAL NOTES & COMMENTS

Note that questions 9, 18, and 19 were customized for the three different SFCAs (i.e., Bluefields Bay, Oracabessa Bay, and Orange Bay)

Appendix D
Fisherfolk Focus Group Protocol

Chapter 1 Overview

This document provides an overview of and guide for focus groups to be held with fisherfolk in Jamaica to be completed under the ParCA project. The protocol is intended to build on the fisherfolk survey which has been administered to a number of fishers at landing sites and fishing beaches both within and adjacent to the fish sanctuary. Contextual material will already have been collected through participant observation and semi-structured interviews with key informants. Additional questions may be asked based on participant responses as specific follow-ups, which will be case dependent.

The protocol is oriented to elicit the resource users (fishers) understanding of the rules governing the fish sanctuary and coastal-marine resources more broadly along with their perceptions concerning their participation in the establishment and management of the fish sanctuary.

Number of participants per focus group: 6-8
Selection of participants: Randomly selected from those that expressed their interest and willingness to participate upon the completion of the fisherfolk survey.

The focus group protocol has three sections: introduction/background, governance dimensions and related institutional attributes, and summary/wrap-up. When using this protocol during a focus group:

1. Ensure to get informed consent before beginning - identify community research assistants whom will be serving as note takers and note that only the research team will have access to the information provided.
2. Establish ground rules before proceeding:
    - Everyone will have the opportunity to respond to each question
    - Avoid talking over the top of one another
    - There are no right or wrong answers
    - Be respectful of other participants' responses

INTRODUCTION

Thank you for sharing your time with us. I am particularly interested in understanding the fish sanctuary, both with regards to the rules governing the use and your involvement in the planning and management of the sanctuary. In addition, we are interested in how decisions are made in regards to fisheries and coastal-marine resources (e.g., who is involved, what kind of information contributes to decision making, the effectiveness of those process).

Governance Dimensions

(1) Rules (Formal & Informal) & Sanctions

1. What rules govern marine resource use in the fish sanctuary? (*Formal and informal rules designate who is permitted or prohibited from doing what, where, when, and how.)*
2. How are the rules and boundaries of the fish sanctuary made clear to individuals who use marine resources within the vicinity of the fish sanctuary?
3. What penalties exist to encourage compliance with the rules governing marine resource use in the sanctuary? What dictates the penalty?
4. What other rules govern marine resource use beyond the fish sanctuary? Are these important? Should they be in place (why/why not)?

(2) Participation & Engagement

1. Who actively participated in making the decision to establish the fish sanctuary? Why/Why not?
2. Who actively participated in or is actively participating in deciding upon the boundaries of the fish sanctuary? Why/Why not?
3. Who actively participated in or is actively participating in making rules governing the fish sanctuary? Why/Why not?
4. How did you participate? What was the nature of the meetings?
5. How could fishers be involved more? What would you suggest be done differently to increase participation?

(3) Alternatives

1. What alternatives or adjustments would you suggest regarding the rules and boundaries associated with the fish sanctuary?
2. Beyond the fish sanctuary, are there other rules or regulations that should be established or adjusted?

(4) Networks

1. Whom would you bring your concerns to if you wanted to see changes in the rules, boundaries and sanctions associated with the sanctuary and/or marine environment more broadly?
2. Whom do you exchange information with, which is useful for your fishing & time at sea? (e.g. practices, good fishing spots, equipment, timing and seasons, or observations (e.g. environmental changes, condition of the coral reef, invasive species, water quality))
3. We talked about a few different rules governing marine resource use. If you ever notice someone not following these rules, do you share the observation with anyone (e.g. friends, officials) (why, why not)?

Summary /wrap-up

Thank you for your participation. As you can see, we're particularly interested in fisheries, coastal-marine resources and the fish sanctuaries. We will be reporting back our findings next year and if you are interested in follow up we'd be more than happy to ensure that you are notified.

Appendix E

Table E 1 Social relational network features and attributes with references*

Social Relational Network Features & Attributes		Empirical & Theoretical References (Natural resource management & governance literature)
Social Attributes	*Social Capital*	Straton & Gerritsen 2005; Ramirez-Sanchez & Pinkerton 2009; Marin & Berkes 2010; Crona & Bodin 2011; Marin *et al.* 2012
	Trust	Bodin *et al.* 2006; Ramirez-Sanchez 2011A
	Social Memory	Bodin *et al.* 2006
Social Processes/ Practices	*Knowledge Exchange*	Crona & Bodin 2006, Sandstrom & Rovaa 2010; Sandstrom & Rova 2010b; Ramirez-Sanchez 2011B; Weiss *et al.* 2011; Cohen *et al.* 2012
	Communication	Hartley 2010; Hartley & Glass 2010
	Diffusion of Innovation	Straton & Gerritsen 2005; Ramirez-Sanchez 2011A
	Collaboration	Schneider *et al.* 2003; Marin & Berkes 2010; Sandstrom & Rova 2010; Stein *et al.* 2011; Cohen *et al.* 2012
Actors, Roles & Position	*Leadership*	Straton & Gerritsen 2005; Stein *et al.* 2011
	Bridging organizations	Olsson *et al.* 2007; Rathwell & Peterson 2012
	Brokers	Straton & Gerritsen 2005; Ernstson *et al.* 2010; Stein *et al.* 2011; Cohen *et al.* 2012; Crona & Bodin 2012
	Hubs	Straton & Gerritsen 2005; Bodin & Crona 2011
	Boundary spanners	Schneider *et al.* 2003; Straton & Gerritsen 2005; Stein *et al.* 2011
	Functional Groups	Marin & Berkes 2010

*The above table includes select theoretical and empirical references – with an emphasis on coastal-marine contexts – drawn from the broader natural resource management and environmental governance literature associated with each feature and attribute for illustrative purposes. The features and attributes identified and included in the table are those that have been emphasized to varying degrees in the literature and show promising application for MPA science.

Appendix F

Table F 1 Non-response and missing data

Special Fishery Conservation Area	# of Questionnaires Administered	# of individuals whom did not respond to social relational questions when prompted	# of individuals whom did not respond but were mentioned as alters by others	# of fishers whom responded that they do not share information with anyone and not identified as an alter	# of non-responses unaccounted for
Bluefields Bay	130	45	18	21	6
Oracabessa Bay	147	65	12	49	4
Orange Bay	103	24	5	18	1

Non-response and missing data has been noted as an issue that can significantly impact the representative network structure and associated measurements (e.g., centrality) (Stork and Richards, 1992; Constenbader and Valente, 2003; Borgatti et al., 2006; Kossinets 2006; Wang et al., 2012). Indeed, it is an area that has been receiving increasing attention to develop effective methods that can take such missing data into account (e.g., Huisman, 2009). Here we outline the rationale supporting our belief that we have adequately captured the representative network and associated network ties.

Bodin and Prell (2011) note that in research related to natural resource management and conservation contexts, missing data up to 20% is generally acceptable. Looking exclusively at the number of individuals in each case whom did not respond when prompted to identify others whom they exchange information with suggests a less then optimal response rate. However, a closer look at the data and cross-referencing the data with other questions and respondents suggests otherwise. In all three cases, some of those individuals whom did not respond were still captured in the network as they were mentioned as alters by other respondents. The average number of times they were mentioned as alters ranged from 1.2 times in Orange Bay to 2.2 times in Bluefields Bay. Immediately before being prompted to identify others, the respondents were asked if they share information (Yes/No). The number of fishers whom responded that they do not share information with anyone and were not identified as an alter ranged from 17 in Orange Bay to 49 in Oracabessa Bay. This enables us to account for the majority of isolates. Accordingly, the final number of non-responses that are unaccounted for is less than 5% in all three cases, well within a reasonable response rate and reflects sufficient reliability for social network analysis.

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Appendix G

1.1 Sociometric Survey Questions

The following three interview questions were used to collect the social network data.

1. How often do you provide relevant information concerning the ecological condition of the SFCAs and/or the coastal-marine environment with the following organizations/ agencies?*
2. How often do you discuss management issues pertaining to the SFCAs with the following organizations/ agencies?**
3. How often do you collaborate with the following organizations/ agencies when implementing marine resource management and conservation as it pertains to the *SFCAs?****

*Examples of the types of ecological information provided to respondents included environmental changes, condition of the coral reef, invasive species, and water quality.
**Examples of the possible types of management issues discussed that were provided to respondents included illegal fishing, monitoring, rule enforcement, and conflicts.
*** Collaboration was defined here and for the respondents as the sharing of human, financial, and/or technical resources or the organizing of joint activities and/or projects.

For each organization and question, the respondents were asked to identify the frequency of each relational tie based on the following options:

Never	*Rarely* (1-2x/yr)	*Occasionally* (3-4x/yr)	*Frequently* (6-12x/yr)	*Regularly* (2-3x/mo)

1.2 Development of the Organizational Roster

In June 2013 a scoping trip and pilot study using semi-structured interviews of seven key informants composed of SFCA managers, community-based organization board representatives or staff, and a university researcher was conducted. In addition, a preliminary sociometric survey was administered in which respondents nominated individuals and noted their organizational affiliations. These responses coupled with organizations and agencies identified based on a review of grey literature were used to develop the final roster of organizations used in the administration of the sociometric survey.

1.3 Administering of the Sociometric Survey

The sociometric survey (N=18) was administered through personal interviews to 18 individuals associated with organizations and agencies affiliated with the governance of the national network of SFCAs. The resulting responses represented 16 different organizations and agencies. Two representatives from the National Environment and Planning Agency (NEPA), one affiliated with Protected Areas Branch and one affiliated with the Ecosystem Branch, completed the survey as these two branches were most commonly identified in the pilot study and interviews. However, because of the general difficulty for respondents to differentiate between the two when it came to frequency, NEPA was treated as a single organizational entity. Accordingly, the responses from the two complete surveys were combined. There was one other organization where two representatives were administered the survey. In this situation, the manager of the particular SFCA had been working there for less then a year. Accordingly, the survey was also administered to the Executive Director of the local foundation whom had been involved with the SFCA since its inception. Similarly, the responses from the two surveys were combined.

The five organizations and agencies included on the roster but did not complete the sociometric survey played more supporting roles indicated by the fewer nominations received by the management organizations and/or the primary government agencies. In addition, surveying three of them was impractical to capture the relational ties at an organizational level because of their distributed nature (i.e., Marine Police, Coast Guard, Ministry of Justice).

1.4 Categorizing Weak vs. Strong Ties

Frequency – as described above – was used as a proxy for tie strength. For the final analysis **weak ties** were defined as those that were identified as *Rarely* and *Occasionally* while **strong ties** were defined as those that were identified as *Frequently* and *Regularly*.

1.5 Categorizing network data

Dichotomizing is a process of transforming valued data (i.e., "1", "2", "3", etc.) into binary data (i.e., "0" and "1"). As Hanneman and Riddle (2005) note, "[i]t is not at all unusual for the analyst to want to change the values that describe the relations between actors, or the values that describe the attributes of actors." Our interest here was to transform the valued data (measured on a scale from 0 = no tie to 4 = Regularly) that captured tie strength (see 1.4 above) prior to analysis.

The network data were then dichotomized three times:

1. All ties (weak and strong combined);
   Here, ties greater than 0 became a 1 (i.e., 1, 2, 3, and 4). This then allowed us to measure and analyze the sum and density of ties within and between groups at the broadest aggregation (i.e. the presence or absence of a tie).

2. Weak ties (strong and absent combined); and
   Here, ties equal to 1 and 2 became a 1 (i.e., weak ties). All other ties present – 3 and 4 (i.e., strong ties) – became a 0. This then allowed us to measure and analyze the sum and density of *weak ties* within and between groups.

3. Strong ties (weak and absent combined).
   Here, ties equal to 3 and 4 became a 1 (i.e., strong ties). All other ties present – 1 and 2 (i.e., weak ties) – became a 0. This then allowed us to measure and analyze the sum and density of *strong ties* within and between groups.

This process of dichotomizing the data was done for all three networks: i) information sharing; ii) discussing management issues; and iii) collaboration.

Appendix H

Table H 1 Sum and density of multi-actor/ multilevel ties

	Information Sharing		Discussing Management Issues		Collaboration	
	Ties	Density	Ties	Density	Ties	Density
All Ties						
Local-Local						
Managing Organization-Managing Organization	22	0.31	38	0.53	23	0.32
Local-National						
Managing Organization-NGO	22	0.61	28	0.52	24	0.44
Managing Organization-Government Agency	42	0.47	43	0.40	41	0.38
Managing Organization-University	26	0.72	25	0.69	24	0.67
National-National						
NGO-NGO	1	0.50	3	0.50	3	0.50
NGO-Government Agency	12	0.60	9	0.25	8	0.22
Government Agency-Government Agency	6	0.30	8	0.27	7	0.23
Government Agency-University	14	0.70	10	0.42	10	0.42
Weak Ties						
Local-Local						
Managing Organization-Managing Organization	18	0.25	28	0.40	15	0.21
Local-National						
Managing Organization-NGO	12	0.33	13	0.24	9	0.17
Managing Organization-Government Agency	18	0.20	23	0.21	24	0.22
Managing Organization-University	15	0.42	16	0.44	15	0.42
National-National						
NGO-NGO	0	0	1	0.17	2	0.33
NGO-Government Agency	9	0.45	3	0.08	1	0.03
Government Agency-Government Agency	3	0.15	5	0.17	5	0.17
Government Agency-University	6	0.30	7	0.29	6	0.25
Strong Ties						
Local-Local						
Managing Organization-Managing Organization	4	0.06	10	0.14	8	0.11
Local-National						
Managing Organization-NGO	10	0.28	15	0.28	15	0.28
Managing Organization-Government Agency	24	0.27	20	0.19	17	0.16
Managing Organization-University	11	0.31	9	0.25	9	0.25
National-National						
NGO-NGO	1	0.50	2	0.33	1	0.17
NGO-Government Agency	3	0.15	6	0.17	7	0.19
Government Agency-Government Agency	3	0.15	3	0.10	2	0.07
Government Agency-University	8	0.40	3	0.13	4	0.17

Appendix I

Table I 1 In-degree and betweeness centrality for governance network organizations

	Information Sharing		Discussing Management Issues		Collaboration	
Organization	InDegree	Betweenness	InDegree	Betweenness	InDegree	Betweenness
Alloa	1	0	2	7.08	1	14
BBFFS	3	11.67	2	4.02	2	21.25
Breds	3	4.19	3	4.167	4	4.03
C-CAM	3	3.83	5	0.5	4	5
CARIBSAVE	6	46.742	8	51.395	9	89.8
Coast Guard	3	0	3	0	3	0
DBML	5	74.37	4	23.21	5	64.5
Fisheries	9	84.49	9	76.4	8	25.03
Inst. Of JM	2	14.53	0	0	-	-
JET	6	0	6	12.29	4	5.82
Jam FCU	-	-	2	0	1	0
MBMPT	3	12.5	3	5.92	2	11.917
Marine Police	4	0	3	0	5	0
Min. of Justice	-	-	-	-	1	0
NEPA	10	35.08	8	50.317	7	37.7
NEPT	1	1	1	0	1	1.2
Oracabessa	4	2.53	6	14.21	3	11.63
Sandals Fnd	4	0.17	4	2	4	0.7
TNC	3	6.53	4	26.9	4	28.2
UNEP-CEP	2	0	2	0	2	0
UWI-Mona	3	11.37	3	3.6	3	7.15