Towards Social-Ecological Resilience in Natural Resource Governance: Issues of Power, Diversity and Scale

Thesis submitted by

Kristen Cheri Weiss
B.S. (Hons) Conservation and Resource Studies,
University of California Berkeley

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School of Earth and Environmental Sciences
James Cook University
Townsville, Queensland 4811
Australia

Statement on the Contribution of Others

Intellectual Support
Supervision:
Professor Helene Marsh James Cook University
Dr Mark Hamann James Cook University

Statistical, analytical, modelling, and editorial support:
Professor Helene Marsh James Cook University
Dr Mark Hamann James Cook University
Mike Kinney

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Thesis Abstract

Adaptive co-management of natural resources is generally thought to confer greater resilience on social-ecological systems by developing aspects of good governance. However, many co-management attempts have proven unsuccessful due to a number of problems including power imbalances and co-option, exclusion of various stakeholder groups, and lack of accountability or transparency. In the case of mobile resources, such as migratory megafauna, developing collaborative management approaches across several management jurisdictions is especially challenging. Examining the impact of structural characteristics and the patterns of relational ties among network actors in co-management systems is crucial to understanding stakeholder interactions and resource flows, and is an important step in determining how to improve co-management arrangements to achieve more sustainable conservation outcomes.

My study is one of the first to consider network dynamics of a geographically extensive migratory species management system. I developed an in-depth case study of dugong and marine turtle management in Northern Australia using qualitative and quantitative social science methods, with the overarching goal of determining the capacity of this governance system to manage social-ecological resilience.

As coastal marine species governance in Australia involves a significant Indigenous component, I first explored the ways that Indigenous and non-Indigenous marine managers utilize 'scientific' and 'traditional ecological' knowledge to manage turtles and dugongs. While the value of incorporating Indigenous knowledge into natural resource management is generally acknowledged by the Australian government, large gaps in cross-cultural understanding and trust have limited successful knowledge integration to date. I explored Australian management documents and interviewed stakeholders in marine turtle and dugong management to determine how Indigenous and western scientific knowledge are perceived and utilized in various contexts and cultural settings. I found that understanding and engagement of these knowledge systems is often limited to

narrow contexts driven by political/power struggles, while the cultural underpinnings of each type of knowledge are oftentimes ignored, misunderstood, or rejected.

To explore relationships among stakeholders in marine turtle and dugong management more thoroughly, I used social network analysis to depict the various network linkages and institutional structures that link these stakeholders to each other. First I focused on power relations by comparing flows of knowledge and policy influence through the management network. My findings suggested that information exchange in the network is dense and decentralized, while policy power is concentrated in state and national government agencies, creating disconnect between knowledge and decision-making.

Next I looked at patterns of homophily (bonding ties) and heterogeneity (bridging ties) among stakeholders. Resilient social-ecological systems are thought to require a balance between bonding ties, which facilitate trust and solidify shared goals by linking likeminded stakeholders, and bridging ties, which encourage adaptive learning and innovation by linking diverse stakeholders. I compared patterns of knowledge exchange, policy influence, and collaborative linkages within versus among stakeholder groups involved in marine turtle and dugong management. Groups were differentiated based on their main organizational mandate, and were categorized either as conservation, industry, Indigenous, or research oriented groups. I found that network interactions occur more often between actors within the same interest group than between those in different groups, suggesting a lack of linkage heterogeneity in the network. While within-group communication may be sufficient, collaboration among diverse stakeholders is limited, potentially reducing adaptive capacity and resilience within the network.

Finally, I assessed the influence of scale on stakeholder interactions and institutional structure by dividing stakeholders by management level to compare within level versus across level linkages. Migratory species management is particularly susceptible to scale mismatch and related issues, yet the impacts of cross-scale network relations on the capacity to manage for social-ecological resilience are often ill understood. I attempted to fill this important knowledge gap by dividing stakeholders into local/community,

regional non-government, regional government, and national levels and use social network analysis to determine the extent of cross-scale interactions. I found that cross-scale collaborations are limited, especially at lower management levels, such as among local and regional organizations. Cross-scale knowledge transfer occurs more often but is limited to specific pathways. Policy influence, on the other had, extends from the national level to all lower levels, representing a classic political hierarchy. These results suggest a lack of bottom-up engagement capacity that limits equitable decision-making and sustainable cross-scale collaboration.

Based on the combined results of this PhD study, the ability of the turtle and dugong governance system to manage social-ecological resilience hinges on the development of improved knowledge and communication pathways through the network to encourage greater social learning, cross-cultural trust building, and more transparent and equitable governance processes. Such processes could be achieved in part by enhancing the bridging functions of regional organizations that connect knowledge producers, such as researchers, with policy makers. Greater investment in forums for capacity building and policy deliberation at multiple scales will similarly provide opportunities to strengthen network relations and improve social-ecological resilience in the system. I conclude this study by discussing some specific strategies to increase resilience in the governance system, and suggesting future research directions that will provide additional insight on the role of social networks and institutional structures on natural resource governance.

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1

Introduction

This introductory chapter provides the rationale for my research, which integrates the concepts of complex social-ecological systems, resilience thinking, and adaptive governance to explore the structure of an Australian natural resource management system. Natural and human systems are intricately tied; therefore managing natural resources requires a comprehensive understanding of the relationships between resource users, policy decision-makers, and the resources under management. The following sections present the theoretical context within which these relationships can be understood and explored.

1 General Introduction

> "The conservation of our natural resources and their proper use constitute the fundamental problem which underlies almost every other problem of our national life."
>
> -Theodore Roosevelt, American President (1901-09)

The problem of how to conserve natural resources while balancing the needs and priorities of the State and its diverse citizens has historically proven challenging to address. The complexity of contemporary resource management has grown exponentially over the past century due to a number of trends including population growth, technological advancement, and globalization, which have led to increased resource extraction and utilization. Yet so too have societal values changed towards the natural environment over time, along with human relationships toward nature. More recently, the flourishing of a societal ethos for environmental conservation has led to the development of scientific fields such as ecology, natural resource management and wildlife conservation, melded from more traditional disciplines including zoology, biology, sociology, and political science. The challenges faced by society today in protecting the environment and its resources are unparalleled; at the same time, however, new opportunities abound to explore novel theories and frameworks for understanding and facing these challenges. This thesis explores many of these challenges and evaluates some of the proposed solutions by examining the structure of a marine resource governance system in Northern Australia that involves Indigenous use of migratory

species of conservation concern—marine turtles and dugongs. In so doing, this fills an important gap in our knowledge regarding the impact of social networks and institutional structures on the ability of governance systems to manage wide-ranging natural resources across large geographic scales with diverse stakeholders. In this chapter, I will provide a background for the concepts and theories relevant to my study.

1.1 Environmental Governance and the Politics of Scale

Governance, the structures and processes by which societies share power, shapes individual and collective actions (Young 1992; Lebel et al. 2006). As opposed to 'government', governance encompasses a broad set of actors that includes both state and non-state entities such as industry, communities, and special interest groups (Bulkeley 2005). Lemos and Agrawal (2006, p. 298) describe environmental governance as "the set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes". These outcomes could be changes in, for example, environment-related incentives, knowledge, institutions, decision making, and behaviours. The framework of governance used to address a particular environmental issue will depend upon the interplay of various national and state policies, local decision-making structures, transnational institutions, and place-based norms, values, and rules (Young 1997). There is consequently a need to pursue a wider range of case studies than have been to date, under varying contexts that can be compared and contrasted. The study presented in this thesis is one such attempt to increase our empirical understanding of

natural resource governance systems, with a particular emphasis on coastal migratory species management.

'Scale' typically refers to the spatial, temporal, quantitative, and analytical dimensions used to characterize objects and processes. In the field of natural resource management, scale relates to distinctions among components of environmental governance such as levels of decision-making, managing, monitoring, enforcement, and compliance (Adger et al. 2003; Cash et al. 2006). Often, problems in resource management implementation arise as a result of a mismatch between the scale of management and the ecological scale of the natural resource being managed (Cumming et al. 2006). The management of migratory species, such as the dugongs and marine turtles which serve as the focal species of my case study, often shows signs of this type of mismatch, as migratory species may undertake large-scale movements greater than the scale of management applied to them. Alternatively, threats to migratory species may occur at scales greater than or external to the scale at which they are managed, especially in relation to community-based management (Berkes 2006). The protection of an animal in one small part of its range, for example, may be negated by unsustainable hunting in other parts of its range. Similarly, global threats such as increasing sea temperatures, large-scale commercial fishing, ocean acidification, and chemical pollution are often difficult to address at the local management level. As Cumming et al. (2006, p. 2) note,

> "An important difference between societies and ecosystems is that some individual humans, especially those in organizational roles, are able to influence ecosystem patterns and processes at scales well beyond what

> might be expected, and far exceeding those at which the influence of any individual organism of another species might be felt."

This perspective argues that changes in the relationship between humans and ecosystems, catalysed by such factors as technological development, changes in values, and a shift toward centralized nation-states, can cause problematic scale mismatches between social and ecological systems.

1.2 Overcoming Scale Mismatch

The multi-scale nature of environmental problems (e.g., biodiversity loss, climate change) occurring in today's globalized world demands regulatory responses that include assessments of problems at the appropriate scale, as well as integration of policies across all relevant scales, to elicit effective management (McDaniels et al. 2005). Until recently, much emphasis has been placed on 'global environmental governance' and top-down mechanisms of decision-making and regulation, "with the concomitant assumption that decisions are cascaded from international, to national, and then local scales" (Bulkeley 2005, p. 876). In response to failures of this 'trickle-down' paradigm, several authors have proposed alternative governance structures that recognize that environmental decisions are influenced at all scales by particular economic, political, social, cultural, and ecological contexts (Adger et al. 2003), and that encourage the development of local-level institutions and the strengthening of cross-scale management interactions (Berkes 2002; Adger et al. 2005; Cash et al. 2006; Cumming et al. 2006; Berkes 2007; Campbell 2007).

Indeed, as Adger et al. (2003) point out, while regulations enforced by international environmental institutions may constrain local populations (e.g., bans on harvesting and trade of endangered species), local communities can simultaneously gain influence and recognition at higher scales by initiating various local strategies of biodiversity conservation or resource management. This interaction illustrates the cross-scale nature of environmental governance (Berkes 2002), and raises the point that there may not be a predetermined 'optimal' level of decision-making for multi-scale environmental problems. Instead, management decisions should be reached by bridging the gap between centralized regulators and decentralized stakeholders by using inclusionary methods of deliberation that incorporate the concerns, values, and knowledge of these stakeholders into cross-scale management strategies (Holmes and Scoones 2000; Folke et al. 2005). One of the goals of my research was to examine the context of cross-scale linkages among stakeholders involved in migratory marine species management to provide needed information regarding the impact of formal and informal social interactions on management decision-making and implementation at multiple scales.

Some governance practitioners encourage following the subsidiarity principle, which dictates that a higher organizational level (e.g., a state or national agency) should not take on management functions that can be adequately performed by a more decentralized level such as city or local government (Stern et al. 2002; O'Flaherty et al. 2008). In essence, many researchers advocate a decentralized approach to environmental governance that is characterized by non-hierarchical networks of institutions and actors communicating and

sharing knowledge at multiple levels, as opposed to centralized regimes (Ostrom et al. 1999; Berkes 2002; Agrawal 2005). Simply including more stakeholders, however, does not inevitably equate to better environmental governance. Some scholars claim that 'new' forms of environmental governance have changed little in regards to their ability to engage already disempowered groups, instead maintaining hegemonic power relations that are embedded in a neoliberal economy (Ford 2003). Manring (2007), for example, argues that research on collaboration often assumes that stakeholders cooperate voluntarily, share common goals and have power, whereas in reality stakeholder interactions are more often characterized by political agendas and power inequalities. Therefore, while some decision making authority has branched out to the local level, a simultaneous increase in centralized authority over governance decisions has led to an often unequal stratification of decision-making ability across levels. As Lemos and Agrawal (2006, p. 313) explain:

> "Globalization and subnational challenges have led to the emergence of a rescaled state that simultaneously transfers power upward to supranational agencies and downward toward regional and local levels (Pelkonen 2005), changing the way policy-making capacity is distributed."

In such a case, this redistribution in not necessarily beneficial to environmental problem solving, especially if the level of governance administering regulatory power does not match the level of the environmental problem which is to be managed. Therefore, determining the extent that stakeholders who have traditionally been marginalized are capable of participating in (supposedly) collaborative governance systems is an important factor in assessing good governance. In my case study region, for example, Indigenous

involvement in natural resource management planning has been encouraged by government and researchers alike, but Indigenous perspectives are still under-represented in many cases. This thesis explores some of the institutional, political, and cultural barriers that have prevented sufficient inclusion of Indigenous expertise using novel approaches to map stakeholder communication and decision-making pathways.

Solutions to scale problems in resource management are likely to be complex and involve fundamental restructuring across many socio-political levels. Several possible approaches to cross-scale management have been outlined by various authors (Table 1.1) but few published accounts of successful implementation exist (Cumming et al. 2006). Despite a

Table 1.1: Some of the common management approaches proposed to address problems of scale mismatch in resource management, their defining features, and the characteristics common to all of them.

Approach	Defining Features	Shared Characteristics
Co-management -- Governance systems that combine state control with local, decentralized decision making and accountability (Singleton 1998)	Ideally intended to combine the strengths of and mitigate the weaknesses of centralized agencies and local resource users by sharing power and responsibility.	-Adaptability/flexibility -Social learning -Multi-disciplinary -Balanced knowledge and power sharing among stakeholders -Transparency/accountability -Cross-cultural literacy -Reconcile current top-down and bottom-up approaches -Sustainable funding and resource allocation -Progressive leadership -Political will to genuinely empower local communities
Adaptive Management -- A systematic process for continually improving management policies and practices by learning from the outcomes of operations (Berkes et al. 2000)	Uses tools of systems modelling and iterative hypothesis testing; typically focuses at the level of local ecosystem, at least until recently	
Boundary Management -- Development of various organizational arrangements and procedures that more effectively create knowledge that is salient, credible and legitimate across levels, timeframes and domains (Cash et al. 2003; Cash et al. 2006)	Used by institutions working at multiple scales; requires 'boundary organizations' (agencies, NGOs, etc.) that play intermediary roles between scales and domains by facilitating accountability, translation, coordination, and knowledge	
Ecosystem-based Management/Integrated Natural Resource Management -- An integrated approach that considers the entire ecosystem (as opposed to single species), including humans (Leslie and McLeod 2007)	Includes consideration of the interactions among ecosystem components and the cumulative impacts of multiple activities on ecosystem structure, function, and process	

growing awareness among social and natural scientists of the inherent cross-scale nature of natural resource management, there is a distinct lack of research addressing the factors which influence sustained and resilient management from the local (resource-user) level to the central organizational level (Adger et al. 2005). Cumming et al. (2006, p. 16) conclude that:

> "The question of how best to resolve scale mismatches remains a frontier for research on social-ecological management and policy. . . In particular, we are currently lacking information in several essential areas: we need to develop the tools to accurately diagnose scale mismatches, we need to understand the dynamics that maintain maladaptive institutional arrangements, and we need to determine what kinds of remedial action are most likely to be effective."

According to these and other researchers, more detailed accounts of scale mismatch as it occurs in cases of resource management, especially in a marine context, are needed in order to better understand how to recognize the causes of mismatch and how to resolve the problems associated with it. Indeed, understanding cross-scale interactions within and among social-ecological systems is an ongoing challenge for marine managers (Shackeroff 2008). This thesis is one such attempt to examine the institutional arrangements of a particular multilevel marine resource governance system, and to explore the extent of cross-scale linkages and potential scale mismatches affecting these arrangements. My study is one of the first to explore social network relations among stakeholders in a geographically extensive governance system for migratory coastal marine species, and as such provides valuable insight into the challenges facing similar systems in other regions of Australia and internationally.

1.3 Governing the Commons

Migratory species are generally considered 'common-pool' resources. According to Feeny et al. (1990), common-pool resources share two characteristics: (1) excluding or controlling potential users is difficult, and (2) each user is able to subtract from the welfare of all other users. Thus, common-pool resources are those for which the exclusion of beneficiaries, either through physical or institutional means, is particularly costly, and exploitation by one user reduces resource availability for others (Ostrom et al. 1999). Marine resources, such as migratory marine species, are archetypal common-pool resources—excluding potential users is difficult due to their trans-boundary movements, and exploitation by users in one part of their range reduces the availability of animals to users from other parts of their range.

In reality, however, "open access" resources are rarely available to all, and are often managed sustainably by groups of users, such as communities or collectives, without complete government control or formal regulation (McCay and Acheson 1987). Commons management is generally achieved by finding ways to limit access by outsiders or by self-regulating resource use via incentives. Indeed, the diversity and widespread prevalence of local-level commons management systems indicate their importance to many traditional societies and their relevance to contemporary resource management (Johannes 1998; Berkes 2006; but see Foale et al. 2010). However, stresses related to population growth, technological change, and economic development have in many cases contributed to the breakdown of communal property mechanisms for exclusion and self-

regulation (Berkes 1989). What's more, the forces of colonialism and globalization created open access systems for marine resources that largely ignore pre-existing fishing territories of many coastal communities (Berkes 2006). Modern management arrangements for common-pool resources typically develop through systematic interactions between resource users and the government, resulting in routinised expectations, or rules, regarding how transactions will occur; i.e., management arrangements become institutionalized (Meek 2009). Institutions may include sets of rules, practices, and decision-making procedures to govern both formal and informal interactions between management participants (Young 1994). These institutional arrangements affect user behaviour and incentives to cooperate and contribute to formulating, implementing, and enforcing management systems.

Commons theory has evolved significantly over the past several decades since Hardin's original "tragedy of the commons" model, growing to encompass and investigate resource governance models from local community-based systems of self governance to regional and global systems dealing with multiple resources and user groups (Ostrom 1990; Ostrom et al. 2002; Dietz et al. 2003). Research and theory on commons issues has tended to focus on community-based management schemes due to the relative ease of studying local level processes (e.g., Ostrom 1990). However, Berkes (2006) argues that findings of small-scale, community-based commons studies do not fully account for the cross-level nature of natural resource management, in which communities are embedded in a complex multilayered system impacted by external factors at multiple scales. In response to the limitations of small-scale commons research, some commons theorists

have turned to the concepts associated with complex adaptive systems, which allow for the examination of scale, self-organization, uncertainty, and resilience (Gunderson and Holling 2002). This approach emphasizes understanding the nature and dynamics of cross-scale linkages, as opposed to trying to understand management processes at a particular level and 'scaling up'. Recognizing cross-scale institutions is important as they provide crucial means to bridge processes across levels and provide ways to complement the linkages in complex adaptive systems (Berkes 2006). Examining horizontal and vertical institutional linkages and exploring the formation of social networks are two approaches to understanding the nature of cross-level linkages within resource governance (Lebel et al. 2006), each of which is discussed in greater detail within chapters 5-7. This thesis combines these approaches and takes a complex systems lens to perform a novel exploration of marine turtle and dugong governance, focusing on institutional and social network linkages.

1.4 Complex Systems

Marine systems in particular are frequently recognized as complex systems (Wilson et al. 1994; Walters 1997; Jentoft 2000) whose management is subject to significant levels of uncertainty (Meek 2009). "Complexity" in regards to social-ecological systems is the multiplicity of interconnected relationships and levels (Ascher 2001). Complex systems are characterized by the properties of emergence and self-organization. According to Yates et al. (1988, p. xi):

> "…natural systems become structured by their own internal processes: these are the self-organizing systems, and the emergence of order within them is a complex phenomenon that intrigues scientists from all disciplines."

Emergence refers to the appearance of behaviour unable to be anticipated from knowledge of the parts of the system individually, and is dependent on complex interactions (Dedeurwaerdere 2005). Self-organization implies that no external controller or planner manipulated the appearance of emergent features; rather, they appear spontaneously. For example, climate change represents the emergent properties of several complex interactions, most of which are not orchestrated by society, but self-organise into observed global climate patterns. Marine turtle and dugong governance can be considered a complex social-ecological system because many of the interactions and collaborations that occur among stakeholder groups and across scales emerge without prior (or external) formal planning. Regulatory processes create an overarching framework, but social networks emerge through organic interactions, adding informal institutional linkages that influence turtle and dugong management.

Gaining an improved understanding and ability to predict complex system behaviour has become a central goal for many resource managers so that they may be better able to model such behaviours and develop more adaptive and flexible strategies. Commons theory as it stands today provides some insight into handling regional and larger scale commons problems by moving beyond the community-based resource management paradigm and toward resource governance of complex systems (Berkes 2003; Dietz et al. 2003). However, the complexity of natural resource management often proves daunting to management agencies, or can threaten their institutional interests. As a result,

managers tend to reduce complexity to controllable levels, often leading to narrow doctrines, poor decision rules, unsound policies, and suboptimal practices (Ascher 2001). Ascher (2001) distinguishes nine aspects of complexity and the management dilemmas they cause (Table 1.2). While some reduction of complexity is inevitable and indeed necessary to effectively manage resources, managers must be able to address complexities, uncertainties, and conflicts of interest without oversimplifying social-ecological issues. The search for resource management frameworks that can deal with complex change and uncertainty by incorporating flexibility, multiple knowledge sources, and account for multiple drivers of system change (Berkes 2002; Young 2002), has led researchers to emphasize an integrated social-ecological system approach to manage for resilience.

1.5 Social-Ecological Resilience

Natural resource governance assumes that while human actions can degrade or damage the environment, they can alternatively act to restore or protect it (Berkes et al. 2003). This standpoint is the foundation for the concept of social-ecological systems, which presents humans and nature as coupled, co-evolved, and inseparable (Berkes and Folke 1998; Figure 1.1).

According to Berkes (2006, p. 4):

> "The social-ecological system represents the integration of the social/political and the ecological scales. It emphasizes the view that social and ecological systems are in fact linked, and that the delineation between the two is artificial and arbitrary (Berkes and Folke 1998). Such integrated

Table 1.2: Nine aspects of complexity in relation to the management of natural resources, and the benefits and risks related to increasing the complexity of natural resource management (adapted from Ascher 2001).

Aspects of Complexity	Benefits and Risks to Increasing Management Complexity
1. Overarching objectives of resource and environmental management 2. Objectives (i.e., mandates) of specific government agencies 3. Range and diversity of stakeholders involved in or granted standing in resourse decisions 4. Doctrines and decision rules for resource management 5. Analytic decision frameworks 6. Distinguishing differential impacts over time 7. Intraorganizational procedures 8. Ecosystem elements under construction 9. Scientific models and theories developed in the service of management	• Complex objectives, doctrines, and decision rules reflect the complexity of the full range of goals associated with sustainable development, but also make it more challenging to choose and maintain an appropriate balance • Complex decision analysis is an appropriate means for understanding current decision challenges, but it also may require an inordinate amount of information and analytic processing • Considering and involving the full breadth of stakeholders enhances accountability and acceptability of outcomes, but it may also increase conflict and make it more difficult to arrive at decisions • The recognition of complex intertemporal effects allows decisions to be based on considerations favouring longer-term sustainability, but thinking about short-, medium-, and long-term consequences introduces uncertainty and often affords less mastery than if the objectives are kept to the short term • Complex intraorganizational procedures are often essential for coordination, but they have an inherent risk for breakdown. Organizational complexity can also give individuals within government agencies more opportunities to pursue their own interests rather than those of the public due to superior information or a high degree of autonomy • The complexity of ecosystem and of the science required to understand such systems must be acknowledged, yet this complexity makes management more challenging and contentious

> systems of humans-in-nature are more likely to work if there is a fit between the level and boundary of the ecosystem and the institution designed to manage it. However, this is not to say that there can or should be political levels that perfectly match the ecological levels."

Continuing in this perspective, Shackeroff (2008, p. 90) explains:

> "Individual people, social networks, and institutions continually affect and are affected by ecological systems across local, regional, and global scales. A marine social-ecological system is thus multidimensional and integrative of people, their institutions, and economies as well as the biophysical system."

Seixas and Berkes (2003) note that societies are rarely, if ever, in balance with their resources, and commons institutions are seldom stable for long. Resource management systems therefore tend to be subjected to cycles of crisis and recovery, and of institutional renewal. By anticipating these cycles of change, rather than aiming for an unobtainable equilibrium, resource management institutions must shift their analytical focus from

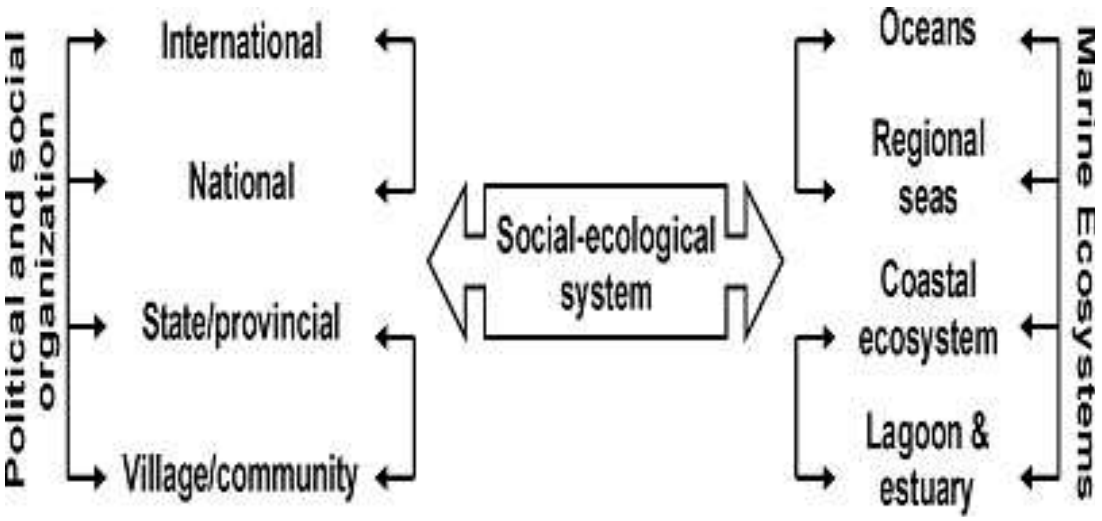


Figure 1.1: A sketch of cross-scale governance, showing levels of political and social organization and levels of ecosystem organization. The social-ecological system represents the integrated system of people and resources. (Adapted from Berkes 2006 and the Millennium Ecosystem Assessment 2003).

‘stability’ to ‘resilience’, and thus increase the capacity of management systems to learn by doing and effectively adapt to change (Folke et al. 2002).

‘Resilience thinking’ is gaining importance as a conceptual framework for understanding and governing complex social-ecological systems (Gunderson and Holling 2002; Folke et al. 2004) such as coral reef systems subjected to multiple anthropogenic impacts (Adger et al. 2005; Hughes et al. 2005), and this thesis uses the lens of resilience through which to examine the governance structure of marine turtle and dugong management. According to Walker et al. (2004p. 2), resilience is defined as “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.” Social-ecological resilience in particular refers to the degree to which a complex adaptive system is capable of self-organization (as opposed to a lack of organization or organization imposed by external factors) and the degree to which the system can build capacity for learning and adaptation (Folke et al. 2002; Carpenter et al. 2001). The capacity of actors in a social-ecological system to manage resilience is termed ‘adaptability’, which is mainly a function of the social component; i.e., the network of individuals and groups acting to manage the system (Walker et al. 2004). For this reason, I emphasize social networks as a key component in understanding resource governance throughout this thesis.

Resilience thinking provides a unifying concept for evaluating adaptive management approaches by emphasizing goal formation as a key social process to derive beneficial ecological and livelihood outcomes (Plummer and Armitage 2007). The general goal of

resilience management, according to Walker et al. (2002), is to prevent a social-ecological system from moving into an undesirable state or configuration, the definition of which depends upon the context of stakeholder interests (Armitage and Johnson 2006). The aim for actors within a social-ecological system is to adopt policies that enhance a system's capacity to reorganize and adapt within an acceptable state (Folke et al. 2002; Walker et al. 2002); e.g., policies that protect important habitat features such as nursery grounds or migratory corridors. Folke et al. (2002) suggest that resilience may be developed through active management strategies that encourage adaptive capacity by monitoring, clarifying, and slowly redirecting fundamental variables such as biological legacies and landscape processes that maintain 'ecological memory'.

Adger et al. (2005, p. 1039) agree that "socio-ecological resilience must be understood at broader scales and actively managed and nurtured." The authors further argue that incentives for generating and translating ecological knowledge into information directly relevant to resource governance are crucial. Multilevel social networks are similarly vital for supporting the legal, political, and financial frameworks that enhance sources of social and ecological resilience. Adger et al. (2005, p. 1039) conclude that:

> "The sharing of management authority requires cross-level interactions and cooperation, not merely centralization or decentralization. In many cases, improved, strong leadership and changes of social norms within management organizations are required to implement adaptive governance of coastal social-ecological systems."

1.6 Knowledge Diversity for Understanding and Managing Social-Ecological Systems

Understanding the complexities of social-ecological systems requires the incorporation of multiple knowledge systems. Berkes et al. (2003, p. 8) explain that particularly in social systems,

> "It is difficult or impossible to understand a system without considering its history, as well as its social and political contexts… A complex social-ecological system cannot be captured using a single perspective."

Indeed, the tightly linked co-evolutionary nature between humans and their environment in small-scale, sustainable social-ecological systems provides strong incentive to incorporate local knowledge (i.e., traditional ecological knowledge) into decision making and institutional design at multiple scales (Meek 2009). Folke et al. (1998) argue that local knowledge is a key component in the successful long-term management of resources.

In the recent past, resource management was based almost exclusively on scientific research and political agendas driven by a western colonial framework, ignoring the wealth of local, site-specific knowledge held by Indigenous or other long-term residents. More recently, managers and developers have begun to recognize the importance of cultural diversity and the value of Indigenous knowledge, and the multiplicity of resource conservation solutions offered by these different perspectives (Warren 1995). Traditional ecological knowledge (TEK) can arguably be considered a subset of local ecological knowledge, and is often awarded greater legal protection than is local knowledge in

general. The United Nations Declaration on the Rights of Indigenous Peoples (ECOSOC 2007, p. 2), for example, states explicitly that "respect for Indigenous knowledge, cultures and traditional practices contributes to sustainable and equitable development and proper management of the environment".

Yet along with this recognition comes the risk that managers may extrapolate local knowledge without the consent of knowledge holders and apply said knowledge out of context, with no benefit gained at the local level. To protect Indigenous peoples from such occurrences, several international conventions have drafted and endorsed guidelines that protect the rights of Indigenous and local cultures (Sillitoe 1998). According to Principle 22 of the Rio Declaration, for example, Indigenous knowledge plays a vital role in environmental management, and nations are encouraged to support Indigenous culture and interests by enabling their participation in sustainable development and management (Havemann and Smith 2007). Additionally, article 8(j) of the United Nations Convention on Biological Diversity 1992 requires the following of signatories:

> *Subject to its national legislation, respect, preserve, and maintain knowledge, innovations and practices of Indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity, and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations, and practices.* (UNEP 1993)

It is important to note that while article 8 promotes the protection of TEK, it only supports protection for knowledge and practices that are consistent with 'conservation'

and ‘sustainability’, and not necessarily all traditional practices (Havemann and Smith 2007). The issue of who has the authority to deem what is and what is not a conservatory practice is a problematic one, marked by a mismatch in the scale of political agendas, policy language, power, and knowledge bases at global and national institution levels compared to the local/Indigenous level (Pottier 2003).

The need to incorporate TEK into western science-based resource management is recognized by many social and natural science researchers (Berkes et al. 2000; Moller et al. 2004; Fraser et al. 2006). Yet Indigenous knowledge is by its definition considered place-based or ‘local’ knowledge, so at what scales can it be considered relevant to species management, and at what scales should it be applied (local scale only, regional, or larger)? While some anthropologists believe that Indigenous ecological knowledge should by adopted by western medical, agricultural, and resource management fields (Posey and Dutfield 1997), others caution that such views assume that Indigenous knowledge, once extracted from its cultural context, can still be useful as applied to science and society in general (Ellen et al. 2000). Suchet (2001, p. 131) further contends that generalizing traditional knowledge for wider management purposes may violate the rights of the Indigenous knowledge holders:

> “Choosing examples of TEK from local communities and generalizing them to correspond with conservation or management ideals denies communities the right to set their own agendas and motivations and to base their relationships on priorities other than management, conservation, and development. It can form romantic images of … ‘original conservationists’ that deny local people the right to change and adapt and thus incorporate new ‘non-local’ values and aspirations into their value systems.”

Suchet stresses that words such as ‘management’, ‘conservation’ and ‘sustainability’ are loaded terms backed by contentious ideologies and assumptions that are often more apparent to minority groups than conventional resource managers. Integrating traditional ecological knowledge into western scientific models of resource management is hence as much a political issue, centred on individual and community rights, as it is an issue of cultural heritage. It is also an issue of scale—the values and priorities of local communities are increasingly influenced by larger scale or external influences (and sometimes vice versa). Therefore disengaging traditional knowledge from its cultural context risks stripping such knowledge of its specific value and meaning to the communities from which it derived. These issues are crucial to marine turtle and dugong management in Australia and internationally, and are thus explored throughout this thesis.

Indigenous peoples and their ecological knowledge have much to contribute to the development of adaptive approaches to managing dynamic social-ecological systems; involving local people in ecosystem management can assist in identifying indicators of change and resilience which can be monitored, promote participatory processes, and develop social responses to deal with uncertainty and change (Peterson et al. 2003; Olsson et al. 2004). In complex social-ecological systems, several knowledge systems are affected by and themselves affect ecosystems, and therefore acknowledging the multiplicity of perspectives within a social-ecological system is an important component of developing inclusive adaptive governance (Berkes 2003).

However, even in instances where both managers and Indigenous communities agree to work together on resource management issues, the way forward is fraught with challenges. The main road block to successful management is often a lack of cross-cultural literacy, marked by a dearth of trust, clear communication, knowledge and power sharing, and mutual respect among the stakeholders (Nursey-Bray 2003). For example, Dowsley and Wenzel (2008) discuss problems associated with the integration of Inuit traditional knowledge and scientific information that have resulted in a comanagement conflict for polar bear management in the Canadian territory of Nunavut. Inuit observations suggest that polar bear populations have increased in the region, while scientific information indicates that climate change has concentrated polar bears in areas closer to human habitation, but populations are still in decline. The authors cite two main challenges associated with knowledge integration in this case; the first relates to direct observations of the environment by Inuit and scientists and the attempted synthesis of this information, while the second, more substantial problem relates to differences in the conceptualization of human-animal relationships between the two cultures, and the resultant difficulty of combining knowledge systems. Dowsley and Wenzel (2008) conclude that differences between Inuit and scientific knowledge are not sufficiently understood nor accounted for within the comanagement system, and the system does not effectively integrate Inuit cultural views.

Similar conclusions can be drawn from many studies within Australia. Palmer (2004), for example, describes the imbalanced power relations between Aboriginal traditional owners of Kakadu National Park, whose traditional knowledge and rights are pitted

against that of local non-Indigenous park users, science, and the State. Palmer argues that this vast inequality greatly disadvantages traditional owners' ability to manage and care for their country. Such circumstances provided the impetus for the portion of my study that investigates stakeholder perceptions of Indigenous and western scientific knowledge in northern Australia. The cultural and political challenges associated with knowledge integration are explored more fully in the context of Australian marine resource governance in chapter 4.

1.7 The Emergence of Adaptive Governance

Most resilience theorists stress the importance of collaborative, adaptive approaches to resource governance that incorporate actors across multiple levels of social organization, create opportunities for knowledge sharing and learning, and support flexible management systems that are able to cope with multiple drivers of system change, limited resources, and uncertainty (Berkes 2002; Young 2002; Dietz et al. 2003). Social-ecological resilience, however, can be a contested concept for systems in which certain elements are consciously designed (e.g., management agencies, laws) and which support certain actions while denying others (Meek 2009; Carpenter et al. 2001). For this reason, Anderies et al. (2004) suggest focusing on how to make social-ecological systems more robust, rather than how 'best' to manage resources. The authors propose considering a framework for 'robustness' to measure and discern those management strategies and institutional arrangements that maintain favoured ecological states and desirable goods and services, such as fisheries or irrigation systems. This thesis considers the robustness

of a natural resource governance system by assessing its capacity to both maintain viable populations of marine turtle and dugong and sustain the socio-economic well-being of stakeholders dependent on these species.

A robust governance structure is likely to be flexible and adaptive in nature. Adaptive governance refers to the ability of actors to learn and adapt in order to maintain social-ecological resilience. According to Folke et al. (2002), multilevel governance systems can be considered adaptive if their institutional arrangements and ecological knowledge are evaluated and revised in a continuous trial-and-error process. An adaptive governance framework depends upon the collaboration of a diversity of actors operating at different social and ecological scales (Hughes et al. 2005). The sharing of management power and responsibility among actors typically involves multiple institutional linkages among user groups or communities, government agencies, and non-governmental organizations, from local to international levels.

Lebel et al. (2006) outline the key attributes of adaptive governance systems, which include participation, representation, deliberation, accountability, empowerment, and social justice. Such systems should also be multilayered and polycentric (maintain several centres of authority or 'control'). The capacity of actors within a social-ecological system to manage resilience relies upon their collective ability to self-organize, learn, and adapt; these aspects in turn depend upon the capacity to deal with issues of scale and institutional fit, uncertainties, detection of thresholds, knowledge integration, and maintenance of social and ecological diversity. The relationship between these capacities

to manage resilience and the attributes of adaptive governance are depicted in Figure 1.2, and form the basis for my evaluation of the capacity for resilience in the marine turtle and dugong governance network.

1.8 Self-Organization

The ability of a governance system to self-organize refers to the process of polycentric (i.e., multiple decision-making centres) social coordination that develops voluntarily by individuals and organizations in the face of specific social-ecological problems or in times of rapid change (Folke et al. 2005). This 'spontaneous' self-organization often occurs in response to overly rigid governance structures, and is spurred by able leaders within the governance network who catalyse actor linkages. According to Lebel et al. (2006, p. 9),

> "An organizational structure with multiple, relatively independent, centres creates opportunities for locally appropriate institutions to evolve by tightening monitoring and feedback loops and by enhancing associated institutional incentives (Berkes and Folke 1998). In this situation, local governance arrangements can develop to better match the varied social and ecological contexts and dynamics of different locations."

Self-organizing 'adhocracies' are gaining interest as more viable alternatives to compartmentalized bureaucracies as they offer greater flexibility in project-driven

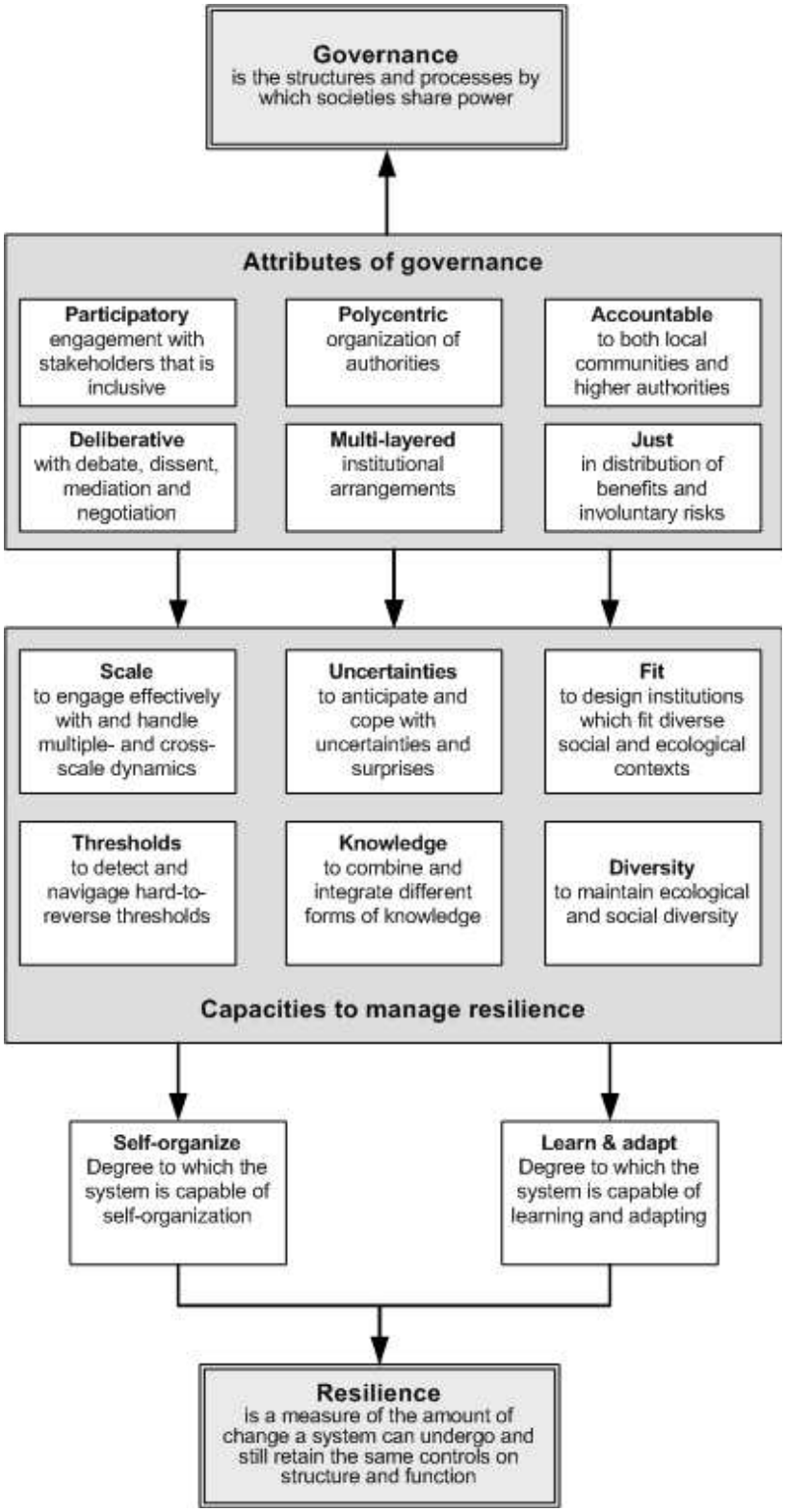


Figure 1.2: Associations between selected attributes of governance systems and the capacity to manage resilience. From Lebel et al. (2006).

leadership, decision-making, and networking (Hahn et al. 2006). Multilayered institutions additionally allow for level-dependent management decisions as well as providing mechanisms to deal with cross-level interactions without negating the ability to self-organize at any one level. Folke et al. (2005, p. 450) cite Schneider et al. (2003) to further conceptualize self-organizing governance systems:

> "Formal lines of authority are blurred in these self-organized network-based governance systems in which diverse policy actors are knitted together to focus on common problems, but these multilevel networks can stimulate collaboration, build trust, provide information, and encourage the development of common perspectives on policy issues. Such networks represent informal governance systems across organizational levels with an interest in influencing and implementing policies in a given resource area."

Networks of self-organized collaboration can be sparked by various actors and at various levels, and may be supported by formal legislation and institutional interactions (i.e., initiated by government agencies), or by informal and non-statutory arrangements. For example, the wetlands governance system in Kristianstad, Sweden is composed of voluntary participation based on loose vertical and horizontal linkages, with key individuals responsible for initiating ad hoc projects as issues arise (Hahn et al. 2006). Key leaders are crucial to developing trust, managing conflicts, linking actors, and creating partnerships, and promoting the shared visions that frame self-organizing processes (Westley 1995). Trust in particular provides the foundation for social capital and sustainable network relationships necessary for building communities of action. Folke et al. (2005, p. 452) conclude that self-organized governance systems require "a civic society with a certain level of social capital" to emerge and have the capacity to manage social-ecological resilience. Determining the extent and types of social capital

that exist in a particular governance system, and within what organizations or individuals this capital originates, is crucial to evaluating the adaptive capacity of actors within the system.

The study presented in this thesis fills a current knowledge gap regarding the amount of available (or potential) social capital in marine turtle and dugong governance by examining flows of knowledge and resources, communication pathways, and patterns of political influence among stakeholders. Focusing on these relationships and network connections allows the identification of sources of strength and resilience in the system, as well as weaknesses or gaps (e.g., lack of sufficient political will or absence of bridging institutions) that must be addressed to improve social-ecological resilience. Addressing weaknesses in large, interconnected governance networks must go beyond individual decisions to involve deliberation and cooperation among many stakeholder groups and across scales in a process known as social learning.

1.9 Social Learning

Social learning has become a key theme within the social-ecological literature (e.g., Gunderson and Holling 2002; Berkes et al. 2003; Keen et al. 2005), and has been characterized by multiple and sometimes contrasting definitions. According to Reed et al. (2010, p. 6), social learning refers to the "change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks". Similarly, Keen et al. (2005, p. 4) define social learning as "the collective action and reflection that takes place

amongst both individuals and groups when they work to improve the management of the interrelationship between social and ecological systems". Regardless of the specific definition used, social learning implies the diffusion of ideas and perspectives from individuals to groups, a process dependent upon collaboration, joint decision making, and multi-stakeholder arrangements that support learning communities (Kilpatrick et al. 2003; Folke et al. 2005). As Armitage et al. (2008) argue, the capacity for social learning is an essential prerequisite for joint action to better manage complex social-ecological systems.

Governance systems that promote learning and iterative testing of knowledge are important for building social-ecological resilience in the face of complexity and uncertainty. This iterative knowledge development may involve single, double, or triple-loop learning. Single-loop learning refers to routine learning, such as responding to errors and making small adjustments or identifying alternative actions to resolve specific problems (Armitage et al. 2008; Lof 2010); for example, adjusting species harvest quotas to improve future yields. Double-loop learning further implies the questioning of assumptions which underlie our actions, and an active attempt to change protocols and organizational norms (Reed et al. 2010). Such learning may involve redefining management goals or incorporating more diverse knowledge that ultimately changes stakeholder behaviour; e.g., replacing harvest quotes with more culturally appropriate seasonal closures. Finally, triple-loop learning encompasses fundamental changes to the governance or management process as a result of changing world views, values, and higher order thinking that underpin assumptions and actions (Keen et al. 2005; Lof 2010;

Reed et al. 2010); e.g., restructuring governance to devolve decision-making power to local entities.

Berkes (2009) envisions learning-as-participation in comanagement as an iterative process that steadily builds trust and capacity to tackle more complex problems by cycling through subsequent observation–planning–action–outcome phases, with periods of reflection in between (Figure 1.3). Institutional frameworks that encourage multiple-loop learning are characterized by trust-building efforts, a willingness to improve learning opportunities, decision-making transparency, and a high level of engagement with stakeholders (Diduck et al. 2005; Armitage et al. 2008). However, Reed et al. (2010) note that while learning may occur at multiple levels, it does not necessarily lead to changes in attitudes or behaviour, nor the building of trust, respect or shared goals. Social learning must be combined with other adaptive comanagement processes and resilience thinking in order to improve management of complex systems (Folke et al. 2002; Olsson et al. 2004). Throughout this thesis I evaluate the extent that social learning and other adaptive governance indicators are apparent in marine turtle and dugong management.

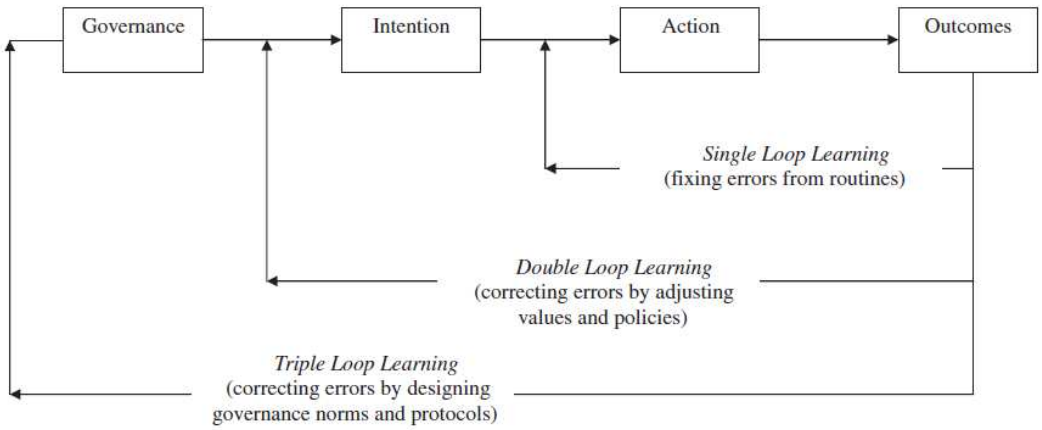


Figure 1.3: A multiple-loop learning framework for environmental and resource management (adapted from Diduck et al. 2005, Keen et al. 2005).

1.10 Adaptive Comanagement

Several approaches to adaptive governance have been proposed in the literature, many of which overlap and/or share similar features. Adaptive comanagement is one of the more commonly promoted approaches, integrating concepts of several resource governance strategies. Adaptive comanagement is characterized by the accumulation of knowledge and understanding about resource and ecosystem dynamics, the development of iterative learning-by-doing processes that respond to ecological feedback, and the support of flexible institutions and organizations that can promote adaptive management processes (Berkes and Folke 1998; Armitage et al. 2008). The term derives from a combination 'adaptive management', with its emphasis on iterative learning-by-doing associated with ecosystem-based management principles; and 'comanagement', the sharing of decision-making power between the state and resource users (Berkes et al. 1991; Singleton 1998).

Determining the extent that a particular resource governance system characterizes an adaptive comanagement approach is not a straight forward task. For one, no universally accepted definition for 'comanagement' exists (Armitage et al. 2007), and thus the term could refer to a variety of arrangements for joint decision-making with varying degrees of power sharing among user groups and government authorities, including: polycentric governance, network governance, and multilevel governance (Folke et al. 2005; Berkes 2009; Termeer et al. 2010). What's more, comanagement shares several features with other kinds of partnerships and cooperative governance arrangements that involve multiple actors (Berkes 2002). Generally, however, comanagement specifically centres

on formalized agreements between state actors and user groups. Comanagement strategies are also somewhat unique in their potential to integrate long-term local observations and knowledge (such as traditional ecological knowledge) with scientific research and government databases to provide a more accurate and/or precise understanding of ecological processes (Meek 2009). Adaptive comanagement is additionally situated to cope with surprise and change by integrating information across multiple scales for improved decision-making (Berkes 2002).

Adaptive comanagement relies on the collaboration of diverse stakeholders, from government authorities to community organizations, which operate at different levels (Olsson et al. 2004). Stakeholder collaboration involves vertical linkages across these levels of organization, as well as horizontal linkages among actors within the same level, creating a network of stakeholder relations (Olsson et al. 2007; Carlsson and Sandström 2008). However, pre-existing political agendas and economic interests in social-ecological systems often hinder the development of such linkages and prevent the implementation of truly adaptive governance. As Armitage (2005) explains, issues of power and authority, the partitioning of stakeholders, their knowledge and values, and the social construction of problems, all affect the ability to develop adaptive, collaborative resource management. Similarly, the characteristics that support the development of adaptive comanagement will necessarily vary depending upon specific geographic, historical, and institutional contexts. For these reasons, it is critical to consider the role of social network connections in affecting and being affected by institutional structures.

Exploring network connections among key actors in marine resource governance is thus a central focus for the case study presented in this thesis.

1.11 Towards Network Governance

Despite a steadily increasing emphasis on adaptive governance, understanding the impacts of social network structures, power relations, and cross-scale dynamics on the capacity of governance systems to manage social-ecological resilience has only recently become a central research focus in the field of natural resource management. Yet recognizing these aspects of governance systems is crucial to developing effective management frameworks that are considered legitimate and socially just. The recent incorporation of social network analysis into the field of natural resource governance has opened up a valuable new, in-depth method of evaluating the above features and their affect on governance structures (see Janssen et al. 2006; and Cumming et al. 2010 for historical accounts of social network analysis). As a result, 'network governance' has emerged as a new form of governance that can better manage complex environmental problems by emphasizing processes of collective learning (Newig et al. 2010).

The premise for social network theory in the context of resource governance is that society's ability to manage resilience resides in actors, social networks, and institutions (Lebel et al. 2006). Therefore, resource governance systems can be thought of as social networks comprised of various stakeholders, or actors, across a variety of organizations and hierarchical levels (Carlsson and Berkes 2005; Carlsson and Sandström 2008). These

actors are connected via various information pathways, resource dependencies, and institutional arrangements (Hahn et al. 2006; Janssen et al. 2006). Collaborative decision-making is considered an essential component of social networks for resource management (Berkes 2003).

Examining the structure of resource governance networks can help determine which actors are the most influential in different contexts. For example, powerful organizations may act as bridges—linking different management scales or knowledge systems—lowering the costs of collaboration and conflict resolution while providing a forum for knowledge co-production (Folke et al. 2005; Hahn et al. 2006; Olsson et al. 2007) . However, such organizations may instead act as gatekeepers, controlling a disproportionate amount of resources or political power and creating a barrier to political change (Olsson et al. 2006). Network resilience also depends upon a diversity of stakeholder interactions in the form of "bonding" and "bridging" ties; i.e., relations within social groups and between different social groups (Tompkins and Adger 2004; Newman and Dale 2005). Such diversity helps build trust while also providing access to a variety of resources and perspectives, ultimately fostering the resilience necessary to make collective decisions and adapt to unexpected change. Newig et al. (2010) similarly argue that the performance of network governance can be enhanced by better-informed and more creative governance decisions, as well as by better acceptance of decisions by the target actors/stakeholders, which leads to greater compliance and implementation. More detailed discussions regarding social network analysis and network governance are found in chapters 5-7.

Until recently there have been very few attempts to apply social network analysis to learning and governance issues, especially in relation to the structure characteristics of whole networks (Newig et al. 2010). One of the tasks of this thesis is to provide an in-depth examination of the role of social and institutional structures in enhancing or hindering the capacity to achieve adaptive comanagement for social-ecological resilience in a marine resource governance system. While certain of these aspects have begun to be explored at smaller scales in other studies, mine is one of the first to consider both the network structure and patterns of actor linkages within an extensive resource governance system for migratory species. To do so, I evaluate the attributes of the governance system and its ability to adaptively manage for resilience, and additionally explore the network structure created through actor relations to explore linkages in the system. The next section describes my study objectives in greater detail.

1.12 Study Objectives

Despite significant progress over the last decade in the realm of marine wildlife management, Australia still faces many obstacles on the road toward harmonizing the priorities of stakeholders in marine species conservation at all scales, and achieving governance arrangements that adequately manage for both social and ecological resilience. While new developments in comanagement and Indigenous management show great promise, their ability to increase cross-scale relations and improve governance structures needs to be investigated. This thesis intends to fill part of this knowledge gap

by conducting an in-depth exploration of governance network structures and processes. This study is one of the first of its kind to use a social network approach to comprehensively consider the institutional linkages and structural components that impact upon a migratory marine resource governance system.

The main objective of this study was to determine the capacity of the governance structure associated with marine turtle and dugong management in Northern Australia to manage social-ecological resilience in the region by considering four overarching characteristics related to adaptive governance:

(1) The extent of knowledge integration
(2) The distribution of power among stakeholders
(3) Stakeholder diversity and engagement
(4) Scale and cross-scale dynamics

My study builds upon the literature presented in this chapter by examining the network structure of a resource governance system composed of multiple scales, diverse stakeholders, and multiple management arrangements. I chose to use a network approach to explore the vertical and horizontal connections between actors in the system, including information flows, coordination, and policy influence, and how these connections impact the ability of the governance system to manage for social-ecological resilience. Through this case study I seek to understand the institutional and social processes impacting policy

formation and management implementation, and how policy choices affect the resilience of the system.

1.13 Overview of Thesis Structure

1.13.1 Chapters 1-3: Literature review, Case Study Background, and Methodology

In this first chapter I provided a literature review pertaining to the theories and concepts relevant to my research project, such as resilience theory, complex social-ecological systems theory, adaptive comanagement, and network governance. The chapter also outlined the contributions of my study to the field of natural resource governance, and my overarching objectives for the research.

In chapter 2, I provide a historical background to my case study and discuss some of the main institutional structures, policies, and frameworks that affect marine turtle and dugong management in the study region. Included in this chapter is an introductory discussion of attempts in the region to incorporate Indigenous knowledge and natural resource management practices into western management frameworks, a subject which is considered further in the data-driven chapters.

An overview of my methodology follows in chapter 3, in which I describe my mixed-methods approach to characterizing marine turtle and dugong governance using thematic coding, content analysis, and social network analysis as my main analytical devices.

Methods particular to individual components of my study, however, are detailed in their associated data-driven chapters.

1.13.2 Chapters 4-7: Empirical Research

In chapter 4, I examine the attitudes of Indigenous and non-Indigenous marine managers towards traditional ecological knowledge and scientific knowledge, and how these knowledge systems have been utilized and/or combined to inform marine turtle and dugong management in the study region.

In chapter 5, I explore the relationship between knowledge and power among actors in the study system using a social network approach, and determine which actors dominate information flow compared to which actors maintain the most influence over policy decisions.

In chapter 6 I use the Advocacy Coalition Framework in combination with Social Network Analysis as a theoretical basis to investigate patterns of interaction between coalitions of stakeholders to consider whether interactions occur more frequently within coalitions or across coalitions, and to determine which coalitions dominate network relations.

Finally, in chapter 7, I consider the scales involved in managing marine turtles and dugongs in the study region, and examine the amount of cross-scale interaction between actors in the governance system.

1.13.3 Chapter 8: Discussion and Conclusions

In the final chapter, I synthesize the themes and insights that emerged from the previous empirical chapters to present an overall analysis of the extent that the marine turtle and dugong governance network represents an adaptive, resilient social-ecological system. Additionally, based on the results of my study I present some suggestions and ideas regarding how government and non-government stakeholders can improve their capacity to manage resilience in the system. I conclude with recommendations for future research that will build upon the findings presented in this thesis.

2

Exploring governance in a marine management system: a case study of marine turtle and dugong management in Northeast Australia

The factors that influence contemporary success of a natural resource governance system are bounded by a particular time and through particular sets of interactions, but are also dependent upon prior relationships among actors, resource distribution, other power structures at multiple scales, and specific policy actors or institutions that shape behaviour. In this chapter, I provide an historical context to my case study and discuss some of the main institutional structures relevant to marine turtle and dugong management in the study region.

2 Case Study Background

2.1 An Introduction to the Focal Species

The Australasian region supports some of the world's largest remaining populations of the dugong (*Dugong dugon*; also known as the 'sea cow') and six marine turtle species, all of which are listed as species of conservation concern. Within Australia, these species are included among the natural heritage values identified in the listing of the Great Barrier Reef region as a World Heritage site (IUCN 1981). These species are also listed as protected under national and state wildlife legislation. However, there are two key exemptions: under the *Native Title Act 1993* Indigenous Traditional Owners have the legal right to hunt turtles and dugongs for traditional purposes within their sea country, and in most of the Torres Strait region, marine turtles and dugongs are listed as a traditional fishery sanctioned under the *Torres Strait Treaty 1982* and *Torres Strait Fisheries Act 1993*. Dugongs and marine turtles have had high cultural significance for many Indigenous Australians for thousands of years (McNiven and Feldman 2003), and several Indigenous groups have sought the legal right to participate in managing these animals.

I chose these species as the focus of my case study for two main reasons: (1) the management arrangements for these species have parallels with many other natural

resource management systems operating over large spatial scales; e.g., beluga whale and polar bear comanagement arrangements in North America (Fernandez-Gimenez et al. 2006), and comanagement of water resources in Kristianstad, Sweden (Olsson et al. 2007); and (2) as charismatic marine mega-fauna, they are high profile species both within Australia and internationally, with many large stakeholder groups involved in their conservation and management. Management arrangements for these species therefore have implications for a wide range of other marine resources, particularly species of conservation concern that are of high cultural value to Indigenous peoples. The lessons learned from this case study may be of particular value to resource managers looking to develop or improve comanagement approaches to natural resource management, especially in social-ecological systems comprised of diverse stakeholders.

2.1.1 Dugongs

Dugongs inhabit tropical and sub-tropical shallow waters in association with seagrass beds throughout the Australasian and South Pacific region, spanning over 3 countries. The waters of Australia, especially the Torres Strait and the Great Barrier Reef regions, support the largest remaining populations of dugongs in the world (Grech et al. 2011), whereas many other populations appear to be much smaller than historical estimates and in some cases near extinction (Dutton 1998; Kasuya et al. 2000; Marsh et al. 2002). Nearly a third of dugong populations may be in decline, while in over nearly half of the dugong's range there is simply insufficient data to determine the status of populations (Marsh 2008). Based on extensive aerial survey data, the overall dugong population in

Australian waters has recently been estimated at upwards of 70,000 animals, although estimates are outdated or unavailable for several regions (Marsh et al. 2011). Due to the limitations of aerial survey design and large-scale movement of dugongs, determining whether populations are stable or in decline has proven extremely difficult.

Because dugongs are slow to mature and reproduce, one of the greatest dangers to population stability is high adult mortality from anthropogenic impacts such as vessel strikes, commercial fishing, direct harvests, and destruction of seagrass habitat (Marsh et al. 1999). Most of these impacts threaten dugong survival in over 80% of the species' ecological range, while management efforts lag far behind, addressing only 20% of the species' range (Marsh et al. 2002). Recent studies have found that dugongs make both small and large-scale migrations, possibly due to local seagrass depletions or temperature fluctuations (Sheppard et al. 2006), and can cross geopolitical boundaries in both cases (Marsh et al. 2002). In north eastern Australia, for example, dugongs may cross between the boundaries of the Great Barrier Reef Marine Park and the Torres Strait fishery zone on a daily basis, which has important implications for regional and international cooperation in their management.

At the international level, dugongs have been listed on the IUCN's Red List of Threatened Species since its inception, and classified as "vulnerable to extinction" for over two decades due to increasing anthropogenic threats and lack of effective management implementation (Marsh 2006). International frameworks for dugong management, such as the Memorandum of Understanding on dugong conservation

administered through the Convention on Migratory Species (CMS 2006), the United Nations Environmental Project Dugong Status Report and Action Plan for Countries (Marsh et al. 2002), and the South Pacific Region Environmental Programme's Dugong Action Plan (SPREP 2003), have all been drafted over the past decade.

Nationally, the Australian government has adopted some of the international dugong conservation guidelines into domestic law through the *Environmental Protection and Biodiversity Conservation Act (EPBC Act) of 1999* (Havemann and Smith 2007), under which dugongs are included as 'listed marine species' and 'listed migratory species' However, the Indigenous right to hunt dugongs, as well as turtles, is protected under section 211 of the *Native Title Act 1993 (Cth)* and had been upheld in the High Court. To this end, the Natural Resource Management Ministerial Council in 2005 endorsed the "Sustainable Harvest of Marine Turtles and Dugongs in Australia - A National Partnership Approach" (DEH 2005). The main goals of the 'Partnership Approach' are: 1) to improve the information base available to Indigenous communities for managing the sustainable harvest of turtles and dugongs; 2) encourage respect for Indigenous and non-Indigenous knowledge and management; 3) improve education and awareness; 4) identify the economic, social and cultural factors that may contribute to unsustainable harvest levels and identify and implement measures to address them; and 5) protect sea country resources. While the Approach outlines a general policy framework, it is not a legal text and does not designate specific management actions. It does not explain how or to what extent traditional ecological knowledge should be incorporated into management practices. In 2010, a Commonwealth-Queensland State Taskforce was convened to

discuss future measures for dugong conservation, and a series of Dugong and Turtle Roundtable sessions were hosted by the Australian government.[1]

In Queensland, dugongs are listed as 'Vulnerable' under the *Nature Conservation Act 1992* and are a protected species under the Commonwealth's *Marine Park Act 1982* that applies to the Great Barrier Reef Marine Park (Smyth et al. 2006). As such, the Great Barrier Reef Marine Park Authority (GBRMPA) is obligated to protect dugongs within the Great Barrier Reef area and promote their recovery, also in part because dugongs are a key species listed under the World Heritage Area designation of the region (Dobbs 2007). In the Torres Strait however, dugongs (and turtles) are considered primarily as a fisheries resource under the *Torres Strait Fisheries Act 1984*, and are categorized under the general term 'fish' for the purposes of Indigenous rights to harvest marine resources as deemed in the Act (Havemann and Smith 2007). This categorization complicates their status as protected migratory species under both the *EPBC Act* and the *Queensland Nature Conservation Act*. The different financial and governance schemes operating in the Torres Strait versus the Barrier Reef region make it difficult to synchronize management for dugongs and marine turtles across geopolitical scales. Dugong population surveys, population viability analysis, and potential biological removal studies suggest that dugong populations in the northern Great Barrier Reef and Torres Strait regions appear to be stable, but are at risk from potentially increasing sea grass die-off

[1] On 24 August, 2011, the Australian Government announced the key achievement of the Commonwealth-Queensland State Taskforce—the dedication of $5 million to support Indigenous communities in playing a greater role in dugong management and conservation on a community-by-community basis. How Indigenous communities will be engaged and funding allocated under the package is not yet known, but this welcome recognition of the need to increase the capacity of Indigenous communities to manage natural resources should provide a valuable opportunity to observe and evaluate resultant changes to the governance system.

events and rising levels of traditional hunting (Marsh et al. 2004; Marsh et al. 2008). These studies indicate that while threats exist in the region, there is time to work with Indigenous stakeholders to develop culturally sensitive community-based management frameworks.

Dugongs maintain a high biodiversity value as the only extant member of the Dugongidae family (Heinsohn et al. 1977), a high ecological value for their role in seagrass productivity (Aragones et al. 2006), and a high socio-economic and cultural value for Indigenous peoples throughout their range. Problems arise when the global ecological significance of dugongs conflicts with their local socio-cultural significance as harvestable resources (Kwan et al. 2006). International conservation obligations may thus pit national and state agency agendas against those of Indigenous communities, presenting complex challenges for management institutions.

2.1.2 Marine Turtles

Marine turtles inhabit tropical and sub-tropical waters throughout the world (Bowen et al. 1992). Most species are highly migratory, travelling up to thousands of miles across oceanic and geopolitical zones between foraging grounds and nesting beaches (Kennett et al. 2004; Seminoff 2004; Maxwell et al. 2011). Although female turtles can produce up to several hundred eggs in a season, they may only breed once every several years, with high egg and juvenile mortality (Iverson 1991). Hatchling survival to adulthood may reach rates as low as 2.5 for every thousand hatched (Hirth and Schaffer 1974). Like

Table 2.1: Conservation status of marine turtles within the Great Barrier Reef Marine Park (adapted from Dobbs 2001).

Common Name	**Scientific Name**	**IUCN (World Conservation Union)**[1]	**Commonwealth *Environment Protection and Biodiversity Conservation Act 1999***[2]	**Queensland *Nature Conservation (Wildlife) Regulation 1994***[3]
Family: Cheloniidae				
Loggerhead	*Caretta caretta*	Endangered	Endangered	Endangered
Green	*Chelonia mydas*	Endangered	Vulnerable	Vulnerable
Hawksbill	*Eretmochelys imbricata*	Critically Endangered	Vulnerable	Vulnerable
Flatback	*Natator depressus*	Data deficient	Vulnerable	Vulnerable
Olive Ridley	*Lepidochelys olivacea*	Endangered	Endangered	Endangered
Family: Dermochelidae				
Leatherback	*Dermochelys coriacea*	Endangered	Endangered	Endangered

[1].IUCN Red List categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient (Source: 2002 IUCN Red List of Threatened Animals).
[2].Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient.
[3].Queensland *Nature Conservation (Wildlife) Regulation 1994* schedules: Presumed Extinct, Endangered, Vulnerable, Rare, Common.

dugongs, the life history traits of marine turtles, including slow growth and late-age maturity, put them at a particularly high risk of excessive mortality and rapid stock collapse from which they are likely to take decades to recover (Musick 1999; Balazs and Chaloupka 2004).

Six marine turtle species are found in northeastern Australia (Table 2.1), and several significant feeding grounds, nesting beaches, and migratory corridors for these species exist throughout the region. Tagging studies have found, for example, that green turtles nesting in the southern Great Barrier Reef region migrate to foraging grounds in the northern reef, Torres Strait, Papua New Guinea, and even New Caledonia, while turtles nesting in the northern Great Barrier Reef region have been tracked to foraging grounds

in the Gulf of Carpentaria, Indonesia, Papua New Guinea, and the Solomon Islands (Limpus et al. 1992). The Torres Strait region is particularly important for green turtles, as it not only provides nesting sites (Bramble Cay and Murray Island), and abundant seagrass and coral habitat for turtles at all life stages, but also serves as a major migratory pathway for turtles travelling between feeding grounds in the Arafura Sea to nesting grounds off the Great Barrier Reef, and visa versa. These features have for thousands of years rendered Torres Strait a prime marine turtle harvesting region for Indigenous communities, and more recently a key hot spot region for marine turtle conservationists (Cook 1994; Hunter and Williams 1998).

The ability of marine turtles to cross state/territory, Commonwealth, and international boundaries renders management coordination quite difficult. Specifically, there is mounting concern about the effects of habitat destruction and unsustainable harvests in areas such as South-East Asia and the South Pacific on turtles that nest or feed along Australia's shorelines (Limpus et al. 1992; Kennett et al. 2004). Recently, a multi-national attempt to coordinate marine turtle conservation in the Indo-Pacific region resulted in the drafting of the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of Indian Ocean South East Asia (IOSEA). Under this and other international convention agreements, Australia is obligated to protect all marine turtle species from extinction and to implement measures to stabilize their populations. As such, marine turtles are listed under much of the same legislation as dugongs, including the *Environmental Protection & Biodiversity Conservation Act 1999* and the *Great Barrier Reef Marine Park Act 1975*. In Queensland

green turtles are further protected under the Nature Conservation Act. The particular status of each turtle species at the international and domestic levels is listed in Table 2.1.

In 2003, Environment Australia prepared a document entitled 'Recovery Plan for Marine Turtles in Australia', which outlines the status of turtles throughout the country, the greatest threats to turtle populations, and recommends management strategies to protect turtles from further depletion. Recovery actions mentioned in the document include the protection of critical habitats, the reduction of direct mortality (from by-catch, marine debris, etc.), communication with stakeholders including Indigenous communities and general public, and cooperation with other countries throughout the Indo-Pacific. Within the Great Barrier Reef, the Great Barrier Reef Marine Park Authority is obligated to protect marine turtles from further depletion by addressing all human-related mortality issues while still respecting the Indigenous right to harvest turtles sustainably (Dobbs 2007). When marine turtles crawl onto local beaches to nest, they inadvertently pass between Commonwealth, state, and local government jurisdictions every time they cross the high tide mark and step onto land. Cross-boundary movement of this nature makes it imperative for government management agencies and local city councils to communicate with each other to coordinate consistent turtle management objectives and strategies, a task easier said than done.

Despite several existing management frameworks, signs of decreasing health and population sizes continue to be documented in some marine turtle populations in Australian waters by scientific experts (Limpus et al. 1994; Limpus 2000; Limpus and

Chatto 2004) as well as by Indigenous communities, especially in north-east Arnhem Land (Kennett et al. 2004). Addressing the many threats to turtles in Australia and throughout the Indo-Pacific region while simultaneously balancing various stakeholder rights of access will be the biggest challenge to marine turtle conservation for wildlife managers at all levels.

2.2 Case Study Region

The management network considered in this study covers a geographically extensive marine region across north-eastern Australia, encompassing the Great Barrier Reef World Heritage Area (348,000 km2) and the Torres Strait Protected Zone (over 35,000 km2) (Figure 2.1). The governance system managing dugongs and turtles across this large area is understandably complex and involves many jurisdictional scales, including: several national, state, and regional level government bodies; Indigenous management organizations and ranger programs; natural resource management (NRM) bodies; non-government organisations (NGOs); research institutions; and hired consultants.

The Torres Strait is a culturally distinct region of Australia stretching for 150 km from the northern tip of Queensland to the coast of Papua New Guinea. The Strait is composed of over 100 islands, cays, and reefs, and is home to approximately 8,000 people, 6,000 of which are Australian Indigenous Melanesians—the Torres Strait Islanders. The population is dispersed among 19 remote island communities, varying between roughly 70 to 750 people. The Torres Strait Regional Authority was established in 1994 as an independent Australian government statutory authority under the *Aboriginal and Torres*

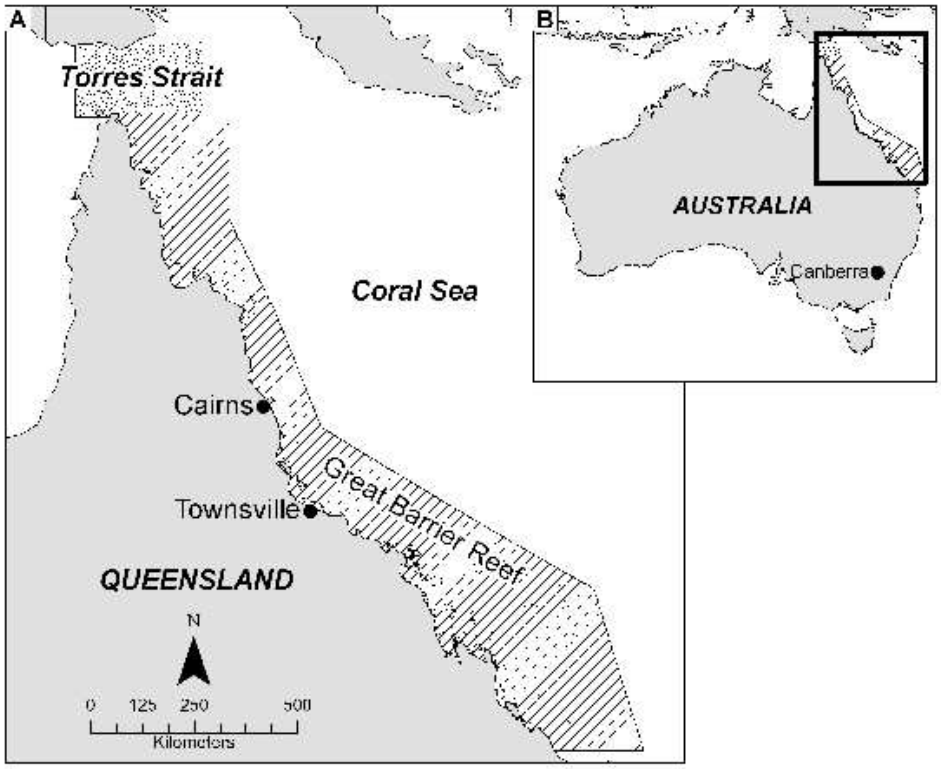


Figure 2.1: Map of main study region, including the Great Barrier Reef World Heritage Area (hashed region) and the Torres Strait Protected Zone (dotted area). Interviews were also carried out with national policy makers based in the Australian capital of Canberra.

Strait Islander Commission Act 1989. The Torres Strait Regional Authority aims to improve the lifestyle and wellbeing of the Torres Strait Islander and Aboriginal people living in the Torres Strait region by overseeing the protection of cultural, economic, health, and environmental assets for Islanders. The *Torres Strait Treaty*, ratified by Australia and Papua New Guinea in 1985, designates the region between the two countries as a protected zone within which both cultural and environmental assets must be protected. The treaty specifically allows for the traditional hunting of marine turtles and dugongs. Interested in promoting the sustainable harvest of traditional resources, fifteen Torres Strait island communities have collaborated to develop community-based

dugong and turtle management plans with assistance from the Torres Strait Regional Authority and national government funding.

In the Great Barrier Reef region, marine species conservation is managed largely by GBRMPA, a national government agency that applies an ecosystem-based management philosophy to marine protection based on a regional mixed-use zoning scheme. At the same time, community-based management in the Great Barrier Reef region is currently much less co-ordinated than in Torres Strait. Several sub-regional Indigenous organizations have developed comanagement agreements with GBRMPA, such as Traditional Use of Marine Resources Agreements (TUMRAs), or with the Queensland Department of Environment and Resource Management, such as Indigenous Protected Areas (IPAs). However, the lack of coordination across the entire region has contributed to these attempts having mixed social or ecological success, often failing to meet expectations of stakeholders (e.g., Nursey-Bray et al., 2010), as discussed in more detail below.

2.3 Indigenous Marine Wildlife Management

> "We live on the sea, dugong, turtle, fish. That's always been the way. We have to look after that sea to make sure we can still survive and can feed our families."
>
> -Lardil Traditional Owner in the Wellesley Islands

Scientific research suggests that current levels of dugong harvesting in Torres Strait and the northern Great Barrier Reef region are unsustainable (Heinsohn et al. 2004; Marsh et

al. 2004), putting pressure on Indigenous communities and wildlife managers to develop stricter guidelines for dugong management and conservation. Similar concerns have been raised about marine turtle harvesting. Devising collaborative management arrangements that simultaneously meet the needs of Indigenous peoples, other stakeholder groups, and the conservation priorities of management agencies is a task of utmost importance and also one of extreme difficulty, at least historically.

Indigenous peoples throughout Australia are actively establishing their own resource management initiatives, or entering into joint conservation and management agreements with government and management agencies. Recently, the development of Traditional Use of Marine Resource Agreements (TUMRAs) between GBRMPA and traditional owners of the region has provided a new avenue for comanagement. The concept of TUMRAs, which are legally recognized comanagement agreements under the *Great Barrier Reef Marine Park Act* between Indigenous traditional owners and the GBRMPA, was initiated by the Australian government as a means of creating a mutually acceptable framework for sustainable dugong and turtle harvesting that ideally reconciled subsistence needs and biodiversity conservation (Havemann et al. 2005). So far, TUMRA schemes have been pioneered by a few well known Indigenous groups, including Girringun Aboriginal Corporation and the Woppaburra Traditional Owner group. However, the scheme has yet to be largely accepted by Indigenous groups for which a large number of dugongs and marine turtles are still harvested. It remains to be seen whether these arrangements will have better success than previous comanagement attempts between Indigenous groups and government agencies.

Some Indigenous communities have chosen alternative strategies for managing their land and sea country, such as through 'Indigenous Protected Areas', non-binding comanagement agreements, and management plans facilitated by Aboriginal land management corporations or regional management bodies. One of the largest undertakings of this sort is the Dugong and Marine Turtle Management Project, coordinated by Northern Australia Land and Sea Management Alliance (NAILSMA), funded by the Commonwealth's Natural Heritage Trust. The community-based management plans recently implemented in the Torres Strait, as described in the previous section, present another example. According to Davies et al. (Davies et al. 1999), Indigenous community-based resource management represents Indigenous ownership and control over management decisions that results in returned benefits to the community, and which may involve the use of both traditional knowledge and western scientific methods, technologies, and approaches. However, despite the support of Queensland government agencies in promoting Indigenous involvement in resource management, Queensland resource management legislation (e.g., the *Aboriginal Land Act 1991* and the *Nature Conservation Act 1992*) was largely instated prior to the Australian High Court decision in *Mabo & Ors v. State of Queensland 1992*, which concluded that Aboriginal people hold native title rights. As such, this legislation does not officially recognize Native Title rights, and thus in many cases it constrains Traditional Owners to an advisory role in land and sea management (Hill 2006). Joint management has consequently been difficult to implement in the region without sufficient legal support.

For many Aboriginals and Torres Strait Islanders, scale issues also develop when they attempt to implement community-based management plans that include species whose ecological range extends outside community jurisdiction, as is the case for marine turtles and dugongs (Marsh 2007). In such a case, regional cooperation among stakeholders is needed in order to manage the species at an ecologically appropriate level. Another problematic scale mismatch is temporal in nature: government funding often runs on short cycles of three to five years, while the development and implementation of a marine management programme may take over more than a decade to have noticeable positive ecological and socio-economic effects (Cash et al. 2006; Cumming et al. 2006). Therefore agencies may require communities to adhere to unrealistic or unsustainable goals.

In the case of NAILSMA's Dugong and Marine Turtle project, for example, the Natural Heritage Trust provided initial funding for a total of three years, with no guarantee of renewal. Besides funding, the relatively short-term employment patterns of public servants can also limit the amount of progress made in management planning. As personnel continually change (a common occurrence related to government Community Development Employment Projects and other funding/project cycles), the knowledge and experience they accumulate may be lost with the influx of new inexperienced workers. Such a result is characterized by the concept of 'shifting baseline syndrome' in which each incoming generation uses the present environmental status on which to base management decisions without realizing that this status may be quite diffablerent (i.e., unnatural) compared to past generations (Pauly 1995).Thus even though local institutions

can theoretically respond more quickly to ecosystem changes (Folke et al. 2007), the structures imposed on them from centralized agencies detracts from this capability.

Some authors suggest that greater inclusion of Indigenous traditional ecological knowledge and traditional management practices into NRM policy can help counteract the problem of 'shifting baselines', and indeed help establish past ecological baselines (Horstmann and Wightman 2001). While incorporation of Indigenous management practices is a positive step forward in comanagement, the ability to transcend temporal scale mismatches also requires a significant commitment by national and state governments to re-structure their project and job funding schemes to more closely match both the socio-economic needs of communities and the ecological processes being managed at the local and regional scales.

2.4 Incorporating Indigenous Traditional Ecological Knowledge (TEK)

Australian Indigenous groups are still actively struggling to incorporate their traditional knowledge into both local and regional management plans for their sea country (Mulrennan 2007), and consequently most government management agencies have now incorporated a statement about the importance of using both traditional ecological knowledge and scientific research to inform management strategies across Australia. The extent that government agencies have actually incorporated traditional ecological knowledge into management policies, however, remains limited, mainly confined to bits of knowledge that have been extracted from their cultural context and made compatible

with western scientific and management principles (Sillitoe 1998; Suchet 2001). Chapter 4 discusses traditional ecological knowledge in detail, and explores the perceptions of northern Australian Indigenous and non-Indigenous marine managers towards traditional and western scientific knowledge as well as how these perceptions influence marine turtle and dugong management in practice.

In its recent rezoning development procedures GBRMPA attempted to incorporate multiple knowledge sources and perspectives by encouraging input from all stakeholders in reef conservation through community consultation and public comment periods (Jago et al. 2004). Fishermen, recreational boaters, tourism operators, Indigenous representatives, and others were given the opportunity to provide not only their opinions about the zoning plans but also their particular knowledge about the habitat or species within proposed zones. While the Marine Park Authority's strategy was by no means perfect, it was a giant step forward in integrative ecosystem management. Nevertheless, professionally based 'expert' knowledge still takes centre stage in many cases, even in the Barrier Reef region, while local knowledge is given the bit parts. Unequal power divisions between citizen knowledge and 'expert' knowledge are still a very real obstacle to comanagement regimes (Pottier 2003). Consequently, some stakeholder groups, such as small-scale tourism operators or coastal fishermen who have been associated with a particular geographic region for long periods of time and may have valuable knowledge about ecological conditions or environmental changes within the region, are given limited chances to share their observations with the appropriate managers.

2.5 Challenges to Comanagement Implementation

Adaptive comanagement initiatives face significant implementation challenges both within Australia and abroad. The role of power and knowledge relations in determining equitable outcomes must be acknowledged and understood (Nursey-Bray 2006). As well, Hauck and Sowman (2001) cite a number of challenges in developing effective comanagement frameworks, including:

- Establishment of access rights over resources
- Ensuring government commitment and support
- Need for capacity building and community empowerment
- Negative effect of fragmented objectives
- Development of enforcement and compliance strategies
- Coping with limited resources and time-frames
- Maintaining long-term leaders and monitoring/evaluation programs

These challenges are particularly relevant to the development of comanagement partnerships between Australian Indigenous communities and government management agencies, for which deliberations often suffer from a lack of cross-cultural capacity, discrepancies in available time and resources, and differing needs, objectives, and knowledge sources (Ross et al. 2009; Zurba 2009). Despite the positive attributes provided by adaptive comanagement frameworks, their successful implementation over

the long term is thus hindered by inequitable relations between the involved parties. As Nursey-Bray (2006, p. 75) states:

> "Fundamental to understanding these difficulties is the acknowledgement that comanagement regimes have rarely been effective at integrating both community needs and expectations regarding cultural survival with Management Agency responsibilities for biodiversity protection."

Obtaining equality for Australian Indigenous peoples in the management of natural resources, especially for resources considered conservation priorities by the government, presents a still largely unresolved challenge for much of the country.

Key issues that still need to be explored in this regard include how to: (1) develop better power-sharing and engagement strategies (Zurba 2009), (2) increase acknowledgement of multiple ways of knowing/perceiving the world (Suchet-Pearson and Howitt 2006), and (3) link management decisions and implementation across geopolitical scales. My chosen case study serves an important backdrop for examining the above issues and how they might be addressed to achieve greater social and ecological resilience in an expansive marine resource governance system comprising Indigenous, government, and other stakeholder groups. This thesis makes a direct contribution to the steadily emerging literature exploring the cross-scale dynamics of resource governance networks, and adds to the growing body of research within Australia providing insight into the challenges and solutions pertaining to marine resource management in a cross-cultural context.

2.6 Summary

- The case study presented in this thesis focuses on the governance system for marine turtle and dugong management in Northern Australia.
- Marine turtles and dugongs are species of conservation concern that are protected under Australian environmental legislation, but can be legally hunted for traditional purposes by Indigenous Australians according to the *Torres Strait Treaty* and statutory Native Title rights.
- Turtle and dugong management involves multiple stakeholder groups, from local community organizations to federal government agencies, creating a complex mosaic of jurisdictions, interests, ideologies, and knowledge bases which, unless successfully integrated, hinder region-wide coordination of management efforts.
- Incorporation of Indigenous perspectives and decision-making in Australian marine resource governance is steadily increasing, but a lack of established legislative support currently limits the ownership and access rights of Indigenous peoples to the marine environment, preventing equitable comanagement arrangements.
- This thesis uses the turtle and dugong management case study to explore issues of power sharing, knowledge exchange, and cross-scale collaboration in natural resource management in order to provide insight into how governance structures can be improved to promote social-ecological resilience.

3

Methodology

In chapter 3, I outline the methodology I developed to conduct my research with Indigenous and non-Indigenous marine managers in Northern Australia. Managing for environmental, economic, social, and institutional resilience requires an interdisciplinary approach to understanding resource governance. In the following pages I present my mixed-methods approach to data collection and analysis which was designed to address principles of rigor in qualitative research while being culturally appropriate and multi-faceted.

3 Methodological Overview

3.1 Framing the Study

I framed my research using a combination of qualitative and quantitative social science methods as a means of exploring governance issues from multiple angles (Winchester 2005). Due to the cross-scale nature of marine wildlife management in Australia and variable access to key individuals, meetings, and information, I developed a multi-pronged approach to data collection and analysis in order to triangulate and cross-check findings among sources of evidence. The rich qualitative data obtained in this study provided a detailed socio-political context for the quantitative analyses performed. Qualitative research in particular allows the researcher to explore how people experience the same events or processes differently as part of a shared reality constructed through multiple interpretations, frames of reference, and ontologies (McGuirk and O'Neill 2005).

My study also included a significant cross-cultural research component, and therefore involved specific ethical considerations regarding how I communicated with and about research participants from various backgrounds, and how participants differentially understood and felt about my research. I was aware that historically, Indigenous peoples have often been the subjects of social research without being adequately consulted by researchers, and many Indigenous communities are thus wary of unequal power

relationships and a lack of control over the research process (Tuhiwai Smith 1999; Gibbs 2001). I therefore attempted to foster relationships with participants, particularly Indigenous participants, that would make it possible for them to voice any concerns or feedback they may have about my research (Howitt and Stevens 2005). I attended two Indigenous cultural awareness training workshops that emphasized culturally-sensitive approaches to conducting research in Indigenous communities. Development of my research protocols was informed by several available documents and guidelines for working with and conducting research about Aboriginal and Torres Strait Islander people, including protocols developed by the Queensland Department of Aboriginal and Torres Strait Islander policy (QDATSIP 1999; 1999), and the principles of research negotiation developed by the Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS 2000).

Although my research did not require long periods of time in the field, I took the opportunity whenever possible to spend time with Indigenous stakeholders in their communities. Indigenous cynicism about research often derives from a lack of perceived benefit or change as a result of research into their lives (Smith 1997). To ensure that I was able to provide tangible benefits to Indigenous stakeholders involved in my study beyond published manuscripts and related materials, I additionally collaborated with Indigenous sea rangers at their request to produce documentary films for community use which documented community-based efforts to manage dugongs and marine turtles for future generations (Appendix A).

3.2 Data Collection

Fieldwork was conducted between 2008 and 2010, and was largely dependent on the availability of individual interview participants or the scheduling of various workshops and training sessions where I met with multiple interview participants, as explained in more detail below. All research was conducted according to university ethics guidelines (Appendix B).

3.2.1 Literature and Policy Review

I performed a thorough review of literature pertaining to marine turtle and dugong management in Australia, and reviewed 22 policy and management documents that were relevant specifically to turtle and dugong management within my study region to provide a thorough understanding of the institutional and historical context framing current management for these species.

3.2.2 Participant Observation

Participant observation was used in this study wherever possible as a means of gaining contextual information and cultural insight (Bernard 1988; DeWalt and DeWalt 2002), especially in regards to the socio-cultural underpinnings of Indigenous stakeholders in the

study region, and the politically charged interactions among both Indigenous and non-Indigenous stakeholders. As Jorgensen (1989) states:

> "Participant observation aims to generate practical and theoretical truths about human life grounded in the realities of daily existence…the methodology of participant observation provides direct experiential and observational access to the insiders' world of meaning" (Jorgensen 1989, p. 14-15).

For example, I attended two workshops, jointly hosted by the Torres Strait Regional Authority and James Cook University, which explored tools for community-based management of dugongs and marine turtles in the Torres Strait and surrounding regions. Several Indigenous marine rangers, government authorities, researchers, and community members attended and interacted throughout the workshops. I was given the opportunity to formally present my proposed research project to attendees, many of which were potential research participants for this study, and received valuable feedback and comments to help frame my study. I was also able to network with individuals informally throughout these workshops. In the Torres Strait, I participated in three separate week-long training sessions for Indigenous rangers during which I had informal discussions with participants and conducted several of my formal semi-structured interviews. Additionally I shadowed an Indigenous ranger for two weeks whilst assisting him to make a documentary about his community's dugong and turtle management, providing further opportunity to meet and learn from community members. In the Great Barrier Reef region, I attended planning meetings hosted by Girringun Aboriginal Corporation which were attended by Traditional Owners, members of the Queensland Department of Environment and Resource Management, and other resource management organizations.

These and other forms of participant observation were important for putting my interview themes into context, as well as providing a form of triangulation in which I could verify the responses of interview participants with my personal observations from various meetings and workshops. In addition to meeting potential interview participants whenever possible prior to conducting a formal interview, I created a brief factsheet about myself and my research which was sent to all potential participants so that they would also be aware of the context of my study and the purpose of the interviews (Appendix C). My intention was to gain rapport with participants and overcome issues of trust to further increase the rigour of this study (Baxter and Eyles 1999).

The continued interaction with stakeholders throughout the length of my study, along with the completion of formal training in social science methodology, helped improve the validity and reliability of my interview structure and identification of themes. Formal training consisted of three week-long workshops hosted by the Australian Consortium for Social and Political Research. The first workshop was an introduction to qualitative research methodology, which included social science theory and practical training in interviewing, observation, and focus group techniques. The other workshops provided specific software training related to qualitative data analysis: the first for using NVIVO software to thematically code the data, and the second for conducting social network analysis in UCINET.

3.2.3 Formal Semi-Structured Interviews

In depth semi-structured interviews (as per Silverman 1993; Dunn 2005) were conducted with 30 individuals, including Indigenous and non-Indigenous Australian marine managers, policy-makers, and researchers in the study region. This type of interviewing is considered a valuable method for exploring the various meanings and interpretations held by interview participants in regards to natural resource management issues (Baxter and Eyles 1999). Indeed, semi-structured interviewing has been used in numerous environmental policy and management studies to develop context-dependent concepts that are meaningful to particular stakeholder groups; e.g. studies on the perception of environmental risk related to waste management (Baxter 1997), the underlying values and beliefs that affect stakeholder policy networks in marine protected area development (Weible 2007), and the role of local fishers' knowledge in marine management (Gerhardinger et al. 2009).

I used a combination of purposive and snowball sampling (Patton 2002) to identify key informants from applicable scales of management and from relevant government agencies, Indigenous organizations, and research institutes (Table 3.1). Initial participants were chosen based on their intimate level of involvement in marine turtle and dugong management in the study region, and these participants were asked to recommend other individuals significantly involved in turtle and dugong management. In this manner I

Table 3.1 Organizational/professional affiliations of interview participants

Organization/Group Name	Indigenous Interviewees	Non-Indigenous Interviewees
Department of Sustainability, Environment, Water, Population, and Communities (SEWPAC)		4
Australian Fisheries Management Authority (AFMA)	1	1
North Australian Indigenous Land & Sea Management Alliance (NAILSMA)		1
Queensland Department of Environment and Resource Management (DERM)		2
Great Barrier Reef Marine Park Authority (GBRMPA) [3]		3
Torres Strait Regional Authority (TSRA) [1]	3	1
North Queensland Dry Tropics	1	1
Balkanu Cape York Development Corporation		1
Torres Strait Turtle & Dugong Officers/Rangers	3	
Townsville region Traditional Owners	3	
Independent consultants		2
Researchers	1	2
TOTALS:	**12**	**18**

gathered a representative cross-section of actors within the dugong and turtle management system. Potential interviewees were presented with the opportunity to give informed consent, or to decline an interview. Interviews generally lasted between 1.5-2 hours. Interviews were tape-recorded, transcribed, and stored in confidence, with transcript copies sent to each participant for verification. Any participants whose quotes were used in a potential publication pertaining to this study were sent a draft manuscript and were given an opportunity to comment prior to publication. Allowing participants to review and verify manuscripts was an additional means of triangulation to ensure

credibility of the research (Denzin 1978; Baxter and Eyles 1997) and appropriateness of my interpretations, while allowing participants to know how their transcripts were being "used" (Eyles and Perri 1993; Baxter and Eyles 1999).

I developed a general checklist of themes and associated questions to guide all interviews, but as per the nature of the semi-structured approach, the depth and scope of discussed topics varied depending upon the background and expertise of the participant (Table 3.2). Each participant was asked to describe their organizational role in managing or conserving marine turtles and dugongs in relation to: (1) their organization's objectives, key strategies, and sources of information; (2) other organizations or stakeholders they interact with, in what context, and to what extent; and (3) perceived social and ecological challenges related to managing these species. The three components I intended to address in each interview based upon the above lines of questioning were the roles of knowledge, collaboration, and power dynamics in determining the development and implementation of management strategies across the region.

The scale of interest for my study was that of institutional interactions—how various organizations cooperate or compete to create structures and mechanisms for governing marine resources. For this purpose, participant responses were considered representative of their affiliated organization or institution where dugong and marine turtle management was concerned. When possible, multiple participants were selected from larger organizations to achieve more comprehensive institutional representation. Equating the

Table 3.2: Semi-structured interview guide.

I. Personal Description

- Cultural affiliation(s)
- Professional background and education
- Current professional/organizational responsibilities

II. Organizational background

- Current dugong and sea turtle management activities and main reasons for managing these species
- Main strategies used to implement management activities
- Organizational mandate, goals, and objectives

III. Sources of information and knowledge

- What sources of knowledge/information are used to guide management, and where/how is that knowledge sources
- What role does western scientific or indigenous knowledge play in informing management
- What role do experts, advisory panels, researchers, etc. play in providing information to your organization

IV. Relationships with other organizations

- Amount and types of coordination with other actors/stakeholders across different management scales and jurisdictions
- Amount and quality of communication with various other stakeholders
- Consistency of staff/organizational relations over time

V. Reflections on current and future management approaches

- Level of awareness of management practices in other jurisdictions
- Ability of current practices to protect species across jurisdictions
- Types of approaches that seem to work and not work
- What policies and practices could be developed or improved

interests and perceptions of individuals with the organizations they represent is not unproblematic, as individuals do not necessarily identify wholly with the interests of their respective organization, and individuals within organizations change over time. However, I followed Newig et al. (2010) in assuming that network actors are individual persons, but are constrained by and mainly act according to their organizational affiliation.

3.2.4 Written Questionnaires

Follow-up structured questionnaires were sent to interview participants to verify responses from interviews and obtain additional quantitative information regarding inter-organizational interactions (Appendix D). Survey respondents were asked to identify which organizations they: (1) shared information with relevant to marine turtle and/or dugong ecology and management; (2) directly coordinated with in turtle and/or dugong management; and (3) exerted policy influence upon (in the form of legislation, professional guidance, or financial provision). The survey listed all previously identified organizations within the network. Respondents could also add new names to the list. This information was used primarily to construct social network maps as described is section 3.3.2.

3.3 Data Analysis

3.3.1 Qualitative Data Analysis/Content Analysis

Interviews were analysed using an iterative Grounded Theory approach in which I explored the association and distinctions among themes as they arose in the data rather than beginning with pre-conceived concepts, and updated themes repeatedly as I obtained new data and could better distinguish those most relevant (Strauss and Corbin 1998). Grounded theory provides a methodology that assists the development of explanatory

models grounded in empirical data (Glaser and Strauss 1967), and therefore aims to develop theory that is based in reality and relevant to research participants (Bringer et al. 2006). Grounded theory is increasingly gaining traction in the field of natural resource management as a useful means of categorizing and theorizing about stakeholder perspectives (e.g., Silver and Campbell 2005; Nursey-Bray 2006; Arnold and Fernandes-Gimenez 2007; Stephan et al. 2010).

Following the approach to Grounded Theory outlined by Strauss and Corbin (1998) I began the process of theorization with open coding by dividing the data into discrete groupings, and conceptualization; i.e., deriving conceptual names for these groupings. I coded emergent themes using a combination of manifest and latent content analysis (Babbie 1992). Content analysis broadly refers to the thematic coding and analysis of textual or visual data in order to find meaningful patterns. Thematic analysis is the process of identifying emergent themes from the data then applying these themes back to the data to achieve a greater understanding of their meaning within their original context (Tesch 1990; Orbe and Warren 2000; Wright 2000; Dougherty 2001).

Many of the identified themes were transformed into constructs within the theoretical framework for understanding how to manage marine wildlife to achieve social-ecological resilience. These constructs were derived from the most prominent themes in the 30 interview transcripts. Using UCINET 6, identified themes were initially recorded as codes in a hierarchical indexing system, a process called 'contextualized thematic analysis' that presents quotations from interview text as narratives that are connected to

codes (themes) that are often nested and can be quantified (Baxter and Eyles 1999). In other words, I connected quotations or narratives from the interview transcripts to particular codes, which I could then group into larger themes and constructs in a systematic and documentable manner (see Appendix E for a summary of my coding framework). This approach also allowed participant responses to be quantified in relation to the code(s) each response connected to. For example, all participants who discussed the use of Traditional Ecological Knowledge (TEK) would be coded together under the topic 'TEK'. Of these responses, those that discussed the strengths of TEK would be grouped under an additional sub-code (e.g., 'TEK strengths'), and those that discussed the weakness of TEK would be grouped separately under another sub-code ('TEK weaknesses'). I could thus ascertain the number of responses in each sub-code to quantitatively compare the number of times a particular subject of interest was discussed within various contexts.

3.3.2 Social Network Analysis

Network analysis is steadily becoming an integral tool for mapping the structure of resource governance systems and the patterns of stakeholder relations within them. According to Lebel et al. (2006), a society's ability to manage for resilience resides in actors, social networks, and institutions. Analysing comanagement systems as governance networks has a number of implications, such as placing emphasis on the roles and functions of various actor groups, highlighting flows of resource sharing and dependency, and drawing attention to horizontal and vertical linkages among actors

(Marín and Berkes 2010). Recent natural resource management research has emphasized the important role of social networks as a basis for stakeholder collaboration and problem solving (Folke et al. 2005; Hahn et al. 2006; Olsson et al. 2008). Social networks may indeed be more crucial than formal institutions for engendering support for and compliance with environmental regulations (Scholz and Wang 2006; Bodin and Crona 2009). In a review of the literature on social networks for resource governance, Bodin and Crona (2009) summarized four ways that social networks may improve collaborative governance by facilitating: (1) the generation, diffusion, and acquisition of different knowledge and information sources about the resources under management; (2) the mobilization and distribution of key resources for effective governance; (3) a commitment to common rules and integrated approaches among actors; and (4) conflict resolution.

3.3.2.1 Network Structure

Social Network Analysis maps interactions between actors (e.g., people or organizations) using several types of measures that describe the strength and patterns of linkages between members in the network (Meek et al. 2011). For example, Density is a measure of the extent to which actors are connected to each other, which can be used as a proxy for social cohesiveness (Scott 2000; Bodin and Crona 2009). Network Centrality is used to describe the pattern of power and control in the network, or which actor(s) have the most influence. Modularity describes the tendency for actors to form multiple groups (Bodin et al. 2006), while Betweenness represents an actor's influence according to the

degree to which that actor connects other actors who would not otherwise be linked (Burt 1992). Figure 3.1 provides some examples of archetypical network formations with varying levels of cohesion, centrality, and modularity.

The structural properties of networks, such as those described above, are assumed to influence the behaviour of actors and their interactions, therefore affecting the institutional arrangements regulating resource use and the resultant performance of the governance system (Sandström and Rova 2010). Successful network governance is generally thought to depend on both maintaining a sufficient degree of fragmentation and flexibility by including groups of actors with heterogeneous views, and simultaneously providing a certain level of cohesion between different societal sectors and governmental

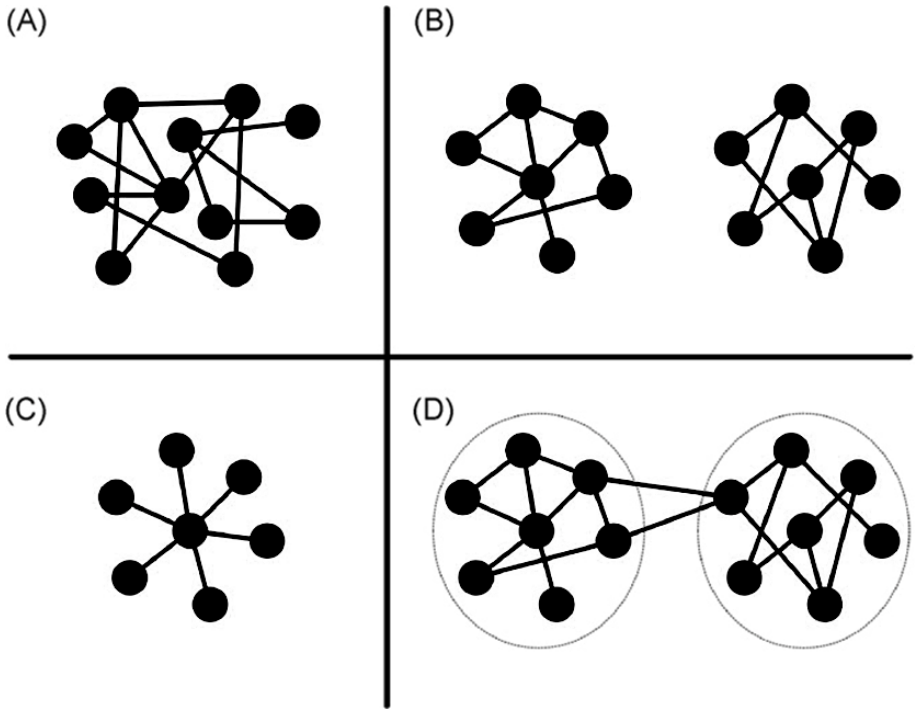


Figure 3.1: Schematic example of some representative network types (adapted from Bodin and Crona 2009). (A) A network with high cohesion and no distinguishable subgroups; (B) Network divided into two isolated subgroups; i.e., low cohesion and high modularity; (C) A highly centralized "star" network in which the middle node has much higher centrality than all other nodes; (D) Network with two distinguishable groups connected by bridging ties.

levels (Granovetter 1973; Bodin and Crona 2009; Hirschi 2010). Carlsson and Sandstrom (2008) describe this relationship as a trade-off between density and heterogeneity, and suggest further empirical research to determine whether there is any 'best' mix of these characteristics in particular contexts. More important to the persistence and stability of a resource governance system, however, may be the distribution of benefits from cross-scale linkages; i.e., the ability of the system to secure legitimacy and trust among resource users and government stakeholders (Adger et al. 2005). Multilayered institutional arrangements may help address scale-dependent governance challenges and encourage additional cross-scale interactions (Lebel et al. 2006). Social network analysis provides an insightful theoretical framework for understanding the nature of various institutional arrangements and their component linkages.

3.3.2.2 Defining the Network Boundary

Network boundaries are largely arbitrary and depend upon the relational ties or research question of interest (Wasserman and Faust 1994). In accordance with the Advocacy Coalition Framework literature, the unit of analysis chosen for this study was the policy subsystem, defined as the group of individuals or organizations which interact regularly over a period of years to influence policy formulation and implementation within a given policy area (Sabatier 1998; Weible et al. 2008). In this case the policy subsystem consisted of actors involved in marine turtle and dugong management in Northern Australia. I determined the boundary of the network inductively based on the stakeholders identified repeatedly in interviews with key informants (Weible and Sabatier

2006), limiting inclusion of stakeholders to those having at least two links to others within the network. This cut-off allowed me to focus on the main institutional players involved in dugong and marine turtle management within the study region.

3.3.2.3 Network Measures Examined in this Study

The key measurements I used to explore actor relations and network structure of marine turtle and dugong governance include network density and centralization, and actor centrality. These measures in particular were chosen so that I could explore how well-connected actors were based on knowledge exchange, coordination, and policy influence, which relational type was the most densely connected and/or centralized, and which actors were most (or least) central in each case.

Density and centralization are two key measures that describe how well a network is connected (Burt 2000; Carlsson and Sandström 2008; Sandström and Rova 2010). Density measures the proportion of all possible ties present in a network (Hanneman and Riddle 2005), thus providing an indication of how tight-knit actors are overall. Denser networks suggest closer communities and possibly higher redundancy or overlap of linkages, while sparser networks suggest much more loosely connected actors.

I calculated Degree Centralization to measure the extent to which each of my two network relations resembled an idealized 'star' network (100% centralization) in which all ties flow through a single actor (Wasserman and Faust 1994). Directionality was

important to our network analyses, so I included both in and out-Degree Centralization. Inward ties indicate receivers, i.e. actors receiving either knowledge or policy influence. Outward ties indicate providers; i.e. actors providing knowledge or influencing policy. These two measures, considered together, allowed me to compare how inclusive the knowledge exchange and policy influence networks are, as well as to assess for each network whether power is concentrated in a few actors or dispersed among many.

Another significant component of network configuration is the structural position of individual actors within the network. As Bodin and Crona (2009, p. 370) explain, "by occupying certain central positions in a social network, actors are able to exert influences over others in the network, and are better situated to access valuable information which can put them at an advantage." I measured two types of actor centrality: in/out-Degree Centrality and Betweenness Centrality. While Degree Centrality is a direct measure of the number of ties an actor has, Betweenness Centrality can be considered a measure of an actor's strategic advantage in terms of information control between other actors (Hawe and Ghali 2008), i.e. how often an actor lies along the pathway between two other actors, thus serving as a potential go-between. In my study, these two measurements allowed me to pinpoint: (1) actors who provide or receive the most information, and actors who have the most or least policy influence on others; and (2) which actors are the most prominent 'brokers' who create links between other actors that would otherwise have no connection and thus receive less information or have less policy influence.

3.3.2.4 Analysis

I quantitatively assessed the structural characteristics of the marine turtle and dugong management system by transforming the inter-organizational relationships described in interview and survey data into binary network matrices which defined the presence/absence (1 for presence, 0 for absence) of relations between all actors included in the study. These data matrices, analysed using UCINET 6.0 (Borgatti et al. 2002), formed the basis of the network analyses. Network diagrams visually depicting actor relations were created with NetDraw software (Borgatti 2002). Normalized values were used for all quantitative network analyses so that data could be compared among multiple networks. Network characteristics particular to only certain components of my study are discussed in greater detail in chapters 5-7.

3.4 Summary

- In this chapter I have described my mixed-methods approach to studying the marine turtle and dugong governance system in Northern Australia, which incorporated various sources of data for triangulation (interviews, documents, and participant observation), and a combination of qualitative and quantitative data analysis for thorough exploration.
- Qualitative data analysis was framed by grounded theory and content analysis, in which key themes that repeatedly emerged from the data were grouped into meaningful conceptualizations and used to construct theory directly relevant to study participants (i.e., end-users).
- Quantitative data analysis was structured by social network analysis and advocacy coalition theory to assess the structure of the governance system in term of patterns of relations between network actors. Network structure is considered an important feature in the success or failure of governance systems, and therefore was a central component of this study.

4

Bridging knowledges: understanding and applying Indigenous and western scientific knowledge for marine wildlife management

Cross-cultural knowledge sharing in natural resource management is receiving growing academic attention. Further consideration is necessary regarding how Indigenous and western knowledges are understood and validated by resource managers. In this chapter I explore how Indigenous and non-Indigenous managers engage with Indigenous and western scientific knowledge to manage dugongs and marine turtles. Based on interview responses I then develop a typology that describes the main ways resource managers engage with Indigenous and western scientific knowledge in this management system. I conclude by suggesting several steps to help achieve a more integrative approach to knowledge utilization in Indigenous co-management contexts.

Manuscript associated with this chapter:

Weiss, KC, Hamann M, Marsh H (*in press*). Bridging knowledge systems: understanding and applying Indigenous and scientific knowledge for marine wildlife management. *Society and Natural Resources* XX.

4 Bridging Knowledges: understanding and applying Indigenous and Western Scientific knowledge for marine wildlife management

4.1 Introduction

The value of incorporating Indigenous knowledge (IK) into 'western' science-based resource management is recognized by many social and natural science researchers (e.g., Berkes et al. 2000; Huntington 2000; Moller et al. 2004; Fraser et al. 2006). Yet explorations into how different knowledge sources are interpreted and validated within environmental governance frameworks have only recently gained widespread interest (Gerhardinger et al. 2009). In particular, few studies have investigated the influence that non-Indigenous stakeholders' understanding of Indigenous knowledge, or Indigenous stakeholders' understanding of western scientific knowledge (WSK), have on their ability to effectively communicate with each other. The ways in which IK and WSK are perceived by managers and policy makers could profoundly impact how that knowledge is interpreted and subsequently absorbed into management frameworks. The research presented in this chapter examines in detail the way IK and WSK are understood and used by Australian marine resource managers to gain a broader understanding of whether and how multiple knowledge sources are integrated to manage marine wildlife, as well as the implications of observed knowledge engagement for Indigenous co-management more broadly.

4.1.1 Defining Knowledges

I followed Wohling (2009) in using the term 'Indigenous knowledge (IK)' throughout as it is a commonly accepted term among the Australian Aboriginal and Torres Strait Islander cultures within which my study was conducted. In its broadest sense, IK has been defined by authors such as Usher (2000, p. 185) as "all types of knowledge about the environment derived from the experience and traditions of a particular group of people." While Huntington's definition is inclusive, it does not consider the embeddedness of traditional knowledge within Indigenous worldviews or value systems that are distinct from a western scientific context. Alternatively, Berkes (2008) provides the oft-cited definition of IK as a knowledge-practice-belief complex encompassing four interrelated levels of analysis: (1) local knowledge of land and animals (factual or empirical), (2) land and resource management systems (applied knowledge), (3) social institutions (norms and values), and (4) worldview (conceptual knowledge, belief system). More recently, Houde (2007) adapted Berkes' model, modifying the hierarchical structure of knowledge into a pentagon representing six interactive 'faces' of IK. Forming the pentagon are the faces of 'factual observation', 'management systems', 'past and present uses', 'ethics and values', and 'culture and identity'. The sixth face, cosmology, sits at the centre of the figure. Houde frames these aspects of knowledge in terms of their relevance to a resource management context that attempts to bridge the western reductionist approach of classification with a more encompassing representation of IK.

Indigenous knowledge is inherently multidisciplinary, linking concepts of nature as well as politics and ethics with no clearly defined boundaries between them (Pierotti and Wildcat 2000). Some authors, such as Barsh (1999), argue that IK can be considered on par with science in regards to its empirical, experimental, and systematic nature. However, for Barsh, IK differs from science in that it also encompasses social and legal dimensions, and there is an emphasis on a web of social relationships not only among humans, but also between humans and other species, the land, and spirits/ancestors. In other words, one of the distinctive features of IK that sets it apart from science and other types of knowledge is its 'holism' (Davis 2006). While post-positivist scientific fields such as conservation biology also stretch across disciplines and begin to break down conventional academic barriers of objectivity and specialization (Drew 2005), they still sit within a western scientific framework that conceptually differs from that of Indigenous cultures (Howden 2001).

Defining scientific knowledge, as opposed to non-scientific ways of knowing, is similarly challenging. Historically, science has been rooted within two key traditions: 1) the hypothetico-deductive method, in which testable hypotheses are devised and either proven or falsified through the gathering of empirical data; and 2) a positivist/reductionist perspective, which argues that all processes are knowable and reducible to physical, physiological, or chemical events that can be measured using the scientific method (Pierotti and Wildcat 2000; Aikenhead and Ogawa 2007; Dickison 2010). However, the above characteristics are unable to fully differentiate between science and IK, as both systems are in many ways "empirically testable and . . . concerned with understanding

and guiding practical activity within the same domain of phenomena" (Bala and Joseph 2007, p. 42). Bala and Joseph (2007) provide a detailed discussion of many other challenges associated with distinguishing Indigenous and scientific knowledge, determining their legitimacy, and tracing their cross-transmission throughout history.

4.1.2 Challenges of Integrating Knowledges

While Indigenous knowledges in their entirety (i.e., their empirical as well as socio-cultural components) are steadily gaining more academic consideration, there is less evidence that resource management practitioners are as able or willing to comprehensively engage with alternative forms of knowledge. Moreover, few natural resource managers question the socio-cultural underpinnings of western science and how it can be better assimilated with alternative knowledge sources. This gap in cross-cultural understanding makes many Indigenous co-management processes extremely difficult, and in many cases unsuccessful.

One of the challenges for successful co-management is the acknowledgement that both Indigenous and scientific knowledges develop within culturally distinct spheres of beliefs and values (Houde 2007). Indigenous knowledge, as situated knowledge, represents a claim to authority over land and sea resources that may counter the prevailing western power structure (Palmer 2004). IK can thus serve as a validation of Indigenous identity, and is some cases as a threat to the established approach to western resource management.

The cultural underpinnings of WSK, on the other hand, are often more ambiguous. As Shackeroff & Campbell (2007, p. 352) argue:

> "One source of power in western science is its perceived lack of cultural context, i.e., science is portrayed as a universal means of accessing truth (Nader 1996). While western scientists might be able to see the cultural context of IK [traditional ecological knowledge], they are less likely to see the cultural context of their own knowledge (Forsythe 2003)."

A lack of recognition of the cultural context of western scientific as well as Indigenous knowledges impedes meaningful dialogue across cultures and can result in the denigration of certain world views and the validation of others. Competing cultural contexts can consequently hamper effective resource co-management because different actors relate in very different ways to the resources in question, define knowledge and social-ecological relationships in different ways and at different scales, and use different definitions to pursue social/political agendas based on their own culture and personal experience (Berkes 2008). As Stephensen and Moller (2009) explain, when political tensions develop across cultures, determining *who* makes the decision becomes more important than *what* the actual decision might be. Consequently, while the incorporation of IK and WSK into collaborative resource management is arguably one pathway toward Indigenous empowerment, this 'integration' may be fraught with power inequalities detrimental to Indigenous interests resulting from government dominated power structures (Nadasdy 1999).

Disempowerment may also occur through knowledge 'validation'. IK is often compared to western science to test its ability to corroborate scientific knowledge, and is typically considered a secondary choice for knowledge when quantitative scientific information is unavailable (e.g., Aswani and Hamilton 2004; Gilchrist et al. 2005). While measuring the validity of any ecological knowledge source is important for successful natural resource management, the assumptions, limitations, and constrains of all knowledges should be considered equally (Brook and McLachlan 2005). Similarly, the socio-political contexts of each knowledge source cannot be disentangled from the information gleaned.

Finally, Indigenous ecological knowledge is often considered synonymous with 'traditional' knowledge, falsely labelling IK as a source of culturally static, historical information rather than as a dynamic, on-going relationship between Indigenous peoples and their landscapes (Aikenhead and Ogawa 2007). Framing Indigenous knowledge as 'traditional' is often an act of disempowerment that mystifies Indigenous knowledge and devalues its use as a valid contemporary way of knowing. As Wohling (2009) stresses, Indigenous natural resource managers have 'agency' (i.e., the ability to participate) in natural resource management decisions independent of their cultural knowledge. As well, contemporary Indigenous ecological knowledge is generally a hybridization of multiple knowledge sources (the same can be argued for western science). Failure to recognize these facts results in cross-cultural communication attempts that are fraught with tension and misunderstanding.

4.1.3 The Australian Context

In Northern Australia, many Aboriginal and Torres Strait Islander people still live on their traditional lands as part of remote settlements, and a large portion of the coastline is under statutory customary ownership (Wohling 2009). The Australian government formally recognizes Indigenous Australians as knowledge holders and key partners in managing Australia's natural and cultural heritage (SEWPAC 2010). However, in recent decades many Indigenous Australians have made strong claims for self-determination and sovereignty over traditional natural resources, creating a web of legal complications that have further politicized and challenged issues of environmental policy and management (Lane and Corbett 2005). In response, the Australian government has steadily incorporated more decentralized approaches to natural resource management through funding schemes aimed at local involvement and decision-making. Unfortunately, despite these changes in governance, Indigenous Australian perspectives are often overlooked or misinterpreted by local and regional institutions (Lane 2002).

The recognition of IK as an important contributor to natural resource management in Australia has become a prominent issue (NAILSMA 2004). However, the lack of a clear conceptualization of IK in Australia has resulted in its reification as a 'universal' solution to many natural resource management issues, without proper consideration of the geographic, socio-cultural, or political scales at which the use of IK is relevant or appropriate. Nor has the influence of shifting land use patterns, management techniques, and other external influences on IK over time been adequately acknowledged (Wohling

2009). The characterization of IK in northern Australia is further complicated by the reliance of Indigenous Australians on their ecological and cultural knowledge as 'proof' of an on-going connection with the landscape in order to regain legal rights to their traditional lands (Langton 1999). Indigenous peoples are thus understandably protective of their knowledge and defensive against suggestions that it may not adequately explain current ecological conditions.

In the following sections, I investigate the key challenges facing knowledge integration for natural resource co-management in northern Australia, and present possibilities for addressing and overcoming these challenges. The purpose of this component of my thesis was to compare the ways in which Indigenous and scientific knowledge have been categorized and applied to dugong and marine turtle management in the Great Barrier Reef and adjacent Torres Strait region in northern Australia.

4.2 Methodology

Data collection involved in-depth semi-structured interviews with 30 research participants as described in more detail in chapter 3 (section 3.2.3). Analysis of interview transcripts was based upon Grounded Theory and Discourse Analysis frameworks as detailed in chapter 3 (section 3.3.1).

I used the six categories of traditional ecological knowledge defined by Houde (2007) as my basic coding framework to investigate how Indigenous and non-Indigenous managers

understood and applied Indigenous and western scientific knowledge in a resource management context. However, as described above, additional thematic categories were identified as the interview process progressed, resulting in a set of themes that, while comparable to Houde (2007) and other similar studies, were unique to my case study and region and led to the development of a knowledge typology. I confirmed the usefulness of using Houde's knowledge categories as a basis for my initial categorization by conducting pilot interviews and determining that participant responses about knowledge could be distinguished fairly clearly by his six categories. I also asked these participants to comment on whether Houde's model meshed with their own conceptual framework, to which all responded in the affirmative. I realize that any approach to representing knowledge will necessarily be shaped by the cultural and professional framework in which we as researchers are embedded. It is thus not my intention to present the "best" approach to interpreting knowledge, but rather to use a transparent approach to explore the different ways that knowledge is understood and engaged with by different cultural groups.

4.3 Results

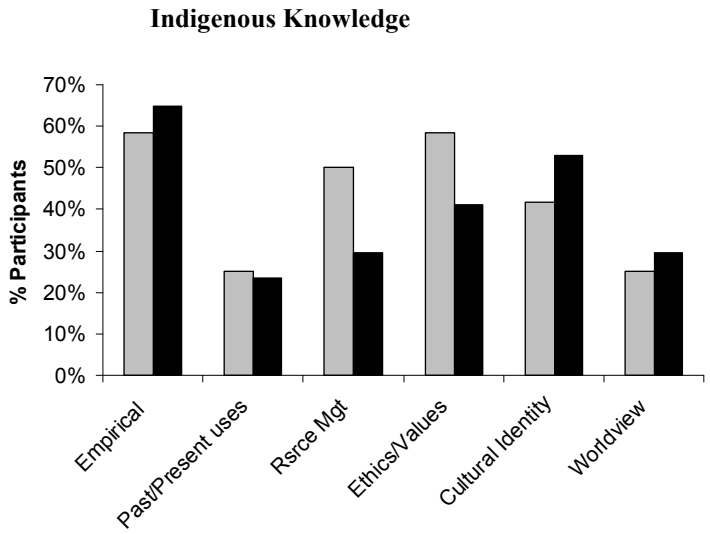
The pattern of responses from my interviews suggests that many resource managers, whether Indigenous or non-Indigenous, have a fragmented understanding of how each culture's underlying cosmology influences management decision-making, and only engage meaningfully with certain aspects of IK and WSK.

Indigenous knowledge was considered most often as empirical information, although several Indigenous and non-Indigenous respondents discussed IK in terms of its other components (Figure 4.1 a). The ethics and values associated with IK were recognized by a high proportion of Indigenous participants, followed closely by IK as resource management, and as cultural identity. Many non-Indigenous managers, too, discussed IK in terms of values and culture. Western knowledge showed a distinctly different trend (Figure 4.1 b). Again the empirical component of WSK was discussed by a large proportion of participants; yet Indigenous participants rarely discussed WSK in any other context save for its relation to resource management. Non-Indigenous managers rarely discussed the cultural identity of western science or the worldview it embodies, although a larger proportion discussed the ethics and values associated with science.

Non-Indigenous respondents were typically familiar with scientific research methods and emphasized the importance of quantitative approaches to management, including accurate and detailed data sets, and testable hypotheses. These were thus the traits most sought after when engaging with IK:

> "Indigenous people are just so incredible and their depth of knowledge that comes about the habits of animals…their observational skills, their skills as field scientists, as field naturalists; pretty astounding." (Non-Indigenous Researcher)

a.



b.

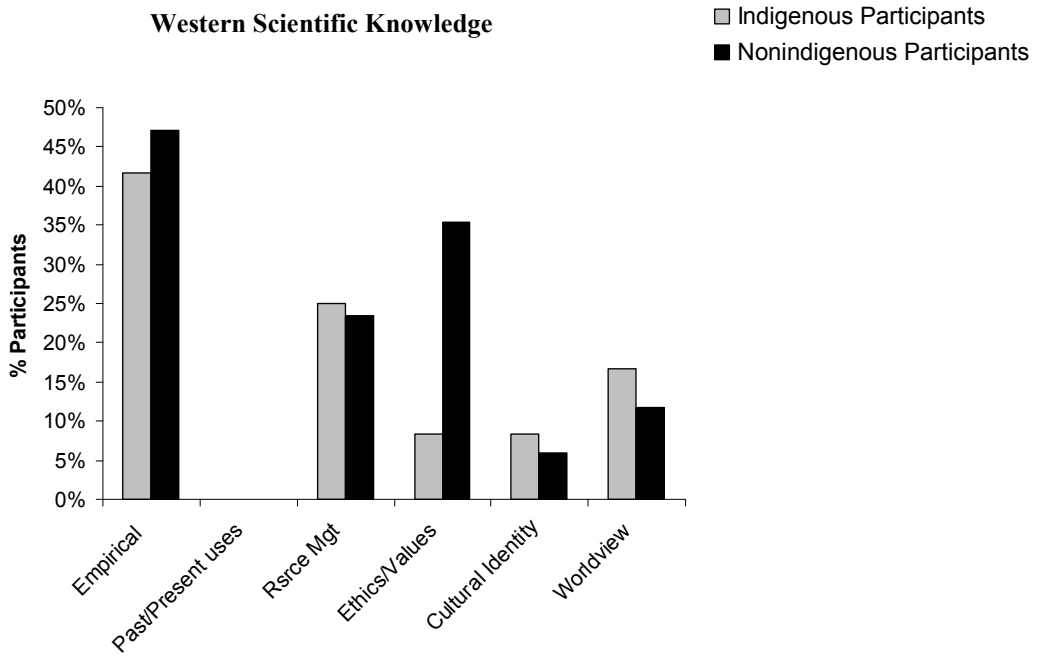


Figure 4.1: Percent of total Indigenous and non-Indigenous interview participants who referred to (a) IK and (b) WSK in each of six identified knowledge 'categories' or contexts. Note that no participants discussed WSK in terms of past or present resource uses (resources in this case referring to sea turtles and dugongs).

Although several non-Indigenous managers mentioned Indigenous spiritual and historical connections to sea country as important aspects of traditional knowledge, they often stated that aligning western and Indigenous values for co-management was an ongoing challenge fraught with misunderstandings and a lack of communication. One non-Indigenous participant stated, for example, that Indigenous knowledge is "not quantitative science, and some people may have preconceived judgments and it's harder for them to give that the same level of importance."

Just as some non-Indigenous respondents expressed concern over the perceived legitimacy of traditional knowledge, many Indigenous managers explained why scientific knowledge is often distrusted in Indigenous communities:

> "Traditional ecological knowledge, that's knowledge that has been passed down thousands of thousands of years. Whereas Western science has, we'll just use the dugong for an example, has only been developed in the last, maybe fifty or forty years … So you know that [Indigenous] knowledge versus Western knowledge is always questionable from a Torres Strait Islander perspective." (Indigenous manager)

In the context of worldviews, some participants discussed the tension between the narrow, quantitative focus of science and the more experiential, holistic approach of traditional knowledge. Meanwhile, several also discussed the competing paradigms of biodiversity conservation versus traditional hunting, emphasizing differences in values and environmental ethics. Indigenous managers were nonetheless generally enthusiastic about utilizing scientific knowledge along with IK, although they did not readily discuss

the cultural underpinnings of science. Most Indigenous respondents stated that scientific information is a useful 'tool' for monitoring resource bases and informing management, and supported collaborations with researchers. Indigenous managers viewed science as supplemental information about the environment or living resources. However, because the assumptions and worldviews inherent to western science are often ignored or misunderstood by Indigenous communities, some Indigenous managers expressed difficulty in applying scientific information in ways that are meaningful to the community and consistent with traditional management practices. Conversely, Indigenous respondents discussed their own knowledge most often as a foundation of cultural identity, and therefore an essential vector for empowerment and a justification for political aspirations such as autonomy and self-determination. In terms of management, Indigenous respondents identified IK as an essential foundation for sustainable hunting of dugongs and green turtles.

Overall, the data suggest a lopsided view of IK and WSK in which the cultural context and relationship between people and resources is much more recognized for Indigenous than western scientific knowledge, whereas the empirical/experiential component of both knowledges and its potential application to resource management is more readily engaged.

4.3.1 A Typology of Knowledge Engagement

My results suggest that the way (and the extent) that resource managers understand WSK and IK influences how they interact with these knowledges to make management decisions. I developed a typology that describes three types of knowledge engagement repeatedly displayed by interviewed resource managers: 1) utilitarian, 2) political, and 3) integrative (Figure 4.2). There will clearly be some overlap among the three types, but in general each can be attributed to a distinct way of engaging with IK and WSK. Additionally, individuals may exhibit more than one type of engagement, though commonly one type dominates.

The utilitarian type represents the extrapolation of empirical knowledge from one culture by another, often without adequate consultation or consideration of cultural values. The following quote for one of my respondents provides an example:

> "My entry point into all this Indigenous stuff was through extracting knowledge, doing this ethnobiology. And I guess that I always felt a bit unsatisfactory, because it definitely felt like you were just scraping a few bits off and taking away and not putting it all in context." (Non-Indigenous Consultant)

Although less prevalent now than historically, the utilitarian typology still exists, for example, in the conventional western top-down resource management structure. For this type of management, IK may serve as little more than supplementary information to help fill in scientific data gaps. For Indigenous communities a utilitarian interaction with WSK provides scientific data that may improve resource use or management, but without engaging the assumptions or

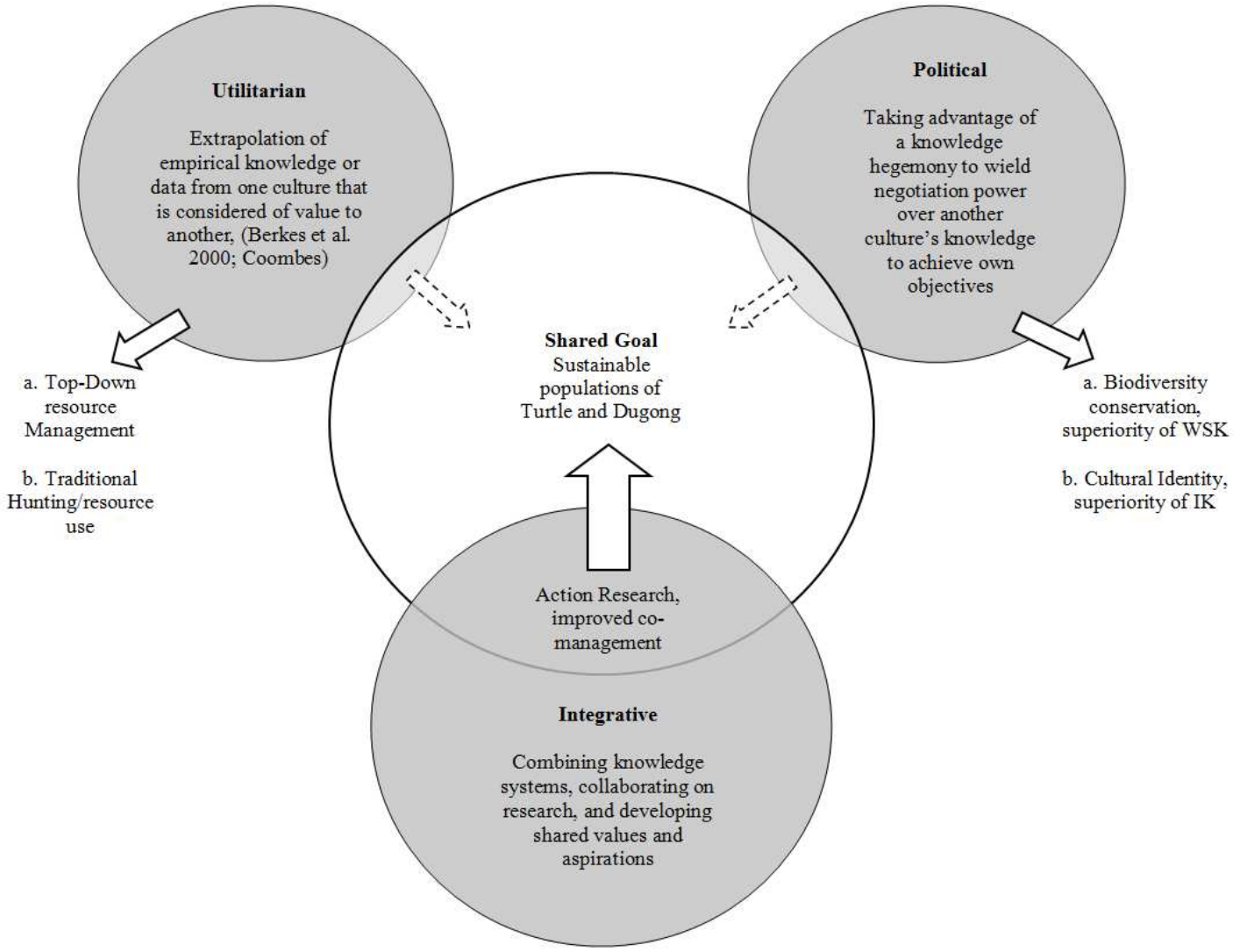


Figure 4.2: Three main ways that Indigenous and non-Indigenous stakeholders of turtle and dugong management engaged with TEK and WSK. The three outer circles represent the types of engagement. The inner circle represents the overarching goal that is shared by both stakeholder groups. Utilitarian and political types of engagement are less likely to achieve the shared goal, and instead reinforce competing knowledge claims (a = non-Indigenous case, b = Indigenous), while integrative engagement is more likely to lead to collaborative learning and management to achieve the shared goal.

values inherent to scientific research.

The political type of engagement characterizes individuals or institutions that wish to influence the power relations between the two knowledges or maintain hegemony:

> "I think in the past we've been guilty of only sourcing [IK] when we want to make a decision that we know Traditional Owners will be in favor of, you know refusing an application or something. We've tended not to source it when we think it will go contrary to a decision we want to make." (Non-Indigenous Marine Manager)

The integrative type goes beyond the utilitarian or political perspectives, encompassing a belief in collaborative research and building upon shared values between cultures for knowledge co-production. The integrative type of engagement was most often expressed by researchers and community-level managers, who stressed the importance of linking local experiential knowledge with scientific and bureaucratic knowledge for successful co-management:

> "What we should be trying to do is use that local knowledge about the various species and melding that with the scientific knowledge on species…we bring the scientists and the Indigenous communities together to do that kind of research." (Indigenous researcher)

> "Basically if you add up all the traditional knowledge in each of the [Torres Strait Islander] communities into a regional approach, it'll probably give you a good snapshot, and again with the western science, it'll give you a reasonable snapshot of what's happening as well. So I think they're on par, it's when the two join forces [that] it's pretty good." (Non-Indigenous Government Representative)

4.4 Discussion

The perspectives presented in this paper suggest that one of the challenges for successful marine species management in Australia is the fragmented understanding and engagement of IK and WSK among stakeholders. Managers selectively use empirical information without full awareness of the cultural frameworks (or the associated values and belief systems) influencing that knowledge. Selective use of knowledge reinforces a 'utilitarian' type of engagement in which knowledge is extrapolated as needed to supplement one's own knowledge base, or a 'political' engagement in which knowledge is used to defend one's position of power or identity. For example, Indigenous rangers consider scientific data regarding dugong population estimates and migratory routes interesting and potentially useful, but are wary about the implications that such a quantitative approach to monitoring can have on Indigenous ways of managing species. Their fears are based on several past attempts by the Australian government to establish strict harvest quotas for dugongs and turtles based on quantitative population estimates, despite Indigenous support for more culturally appropriate management techniques such as spatial closures or seasonal restrictions. Non-Indigenous researchers and policy makers have used the survey data, which shows large population sizes but indicates some possible declines, to argue for more stringent conservation policies across northern Australia to protect the greatest number of animals possible. Meanwhile, Indigenous stakeholders interpret the population estimates as substantiation that traditional hunting is not negatively impacting turtles and dugongs and thus should be allowed to continue according to customary practice. Consequently, Indigenous rangers tend to display a

utilitarian engagement with the scientific aerial survey data while rejecting the western cultural framework—and management prescriptions—from which they derive. In the case of non-Indigenous managers, the emphasis placed on objective and verifiable positivist-reductionist science reinforces western power, culture, and knowledge structures at the expense of other knowledges (Jacobson and Stephens 2009). Indigenous managers tend to promote traditional knowledge and management practices as an alternative to western science, wielding IK as a political tool to gain rights and access to resources.

This study indicates that these power struggles originate, at least in part, from the lack of recognition by Australian management agencies that western science is as much embedded in a particular socio-cultural context as is Indigenous knowledge. Part of the underlying problem with current co-management negotiations is that the Australian government has not adequately considered how to integrate multiple knowledge sources with each other and how to change decision-making as a result (Rydil 2007), especially in an Indigenous context. Government agencies have tended to initiate community consultations and lay down baseline terms within a western scientific/bureaucratic epistemology, thus constricting the process of community engagement to a particular set of norms from the start. For example, a series of workshops was recently hosted by the Australian government to gather information on turtle and dugong ecology for management purposes. Indigenous traditional owners and managers were invited along with non-Indigenous managers, researchers, and policy makers to share their 'expert' knowledge on the species. The bureaucratic format of the meetings, however, was

interpreted by Indigenous participants as offensive to their cultural protocols, while the pressure to reveal and document all shared information was considered intrusive because much Indigenous knowledge is ‘sacred’ or ‘secret’ knowledge. While a better understanding of both western scientific and Indigenous ways of knowing will not inevitably lead to better knowledge integration, it does provide a necessary basis for meaningful dialogue between Indigenous and non-Indigenous marine managers, creating a more equitable discourse to pave the way toward better collaboration.

These tensions between Indigenous and western knowledge arise from competing interpretations of empirical data according to differences in the social relationships, networks, and identities of which each cultural group is composed (Wynne 1992), and which often reflect competing stakes in the outcome of management implementation. Trust and legitimacy are central variables that influence the uptake of knowledge across social groups--each group is attempting to express and defend its social identity by questioning or rejecting external knowledge sources. Perceptions of legitimacy especially influence which knowledge system tended to dominate in various management contexts within my study region. For non-Indigenous managers, the emphasis on using science for decision making was a response to the public’s perception of science as objective and reliable, and therefore trustworthy. Conversely, for many Indigenous respondents the reliance on IK related to its long cultural heritage linked to sea country (home territory), and the resulting obligation they felt to their community to prioritize IK over western science.

To increase opportunities for negotiating knowledge and collaboration, Rydin (2007) suggests that as well as needing arenas that give voice to multiple knowledge claims—'opening-up', as she calls it—stakeholders also need space for testing and legitimizing knowledge claims, or 'closing-down'. Schusler et al. (2003) suggest that arenas that provide for this kind of knowledge deliberation and foster social learning rely on eight key 'process characteristics': open communication, diverse participation, unrestrained thinking, constructive conflict, democratic structure, multiple knowledge sources, extended engagement, and appropriate facilitation. Deliberative processes between stakeholders in turtle and dugong management encompass some of these characteristics better than others. For example, in turtle and dugong management there are a diversity of participants (and knowledge) and the presence of democratic structures, but insufficient open communication, conflict resolution, extended and continuous engagement, or facilitation using culturally appropriate formats. Creating ways to improve deliberation within turtle and dugong management frameworks will be crucial for developing the shared visions needed for joint action and learning.

4.4.1 Promoting an Integrative Knowledge Approach

In instances where my study participants considered knowledge in a more holistic sense, including an acknowledgement of its underlying worldview, an 'integrative' type of engagement was often apparent in which knowledge sharing was perceived as a basis for cross-cultural communication and collaborative management. The integrative approach to knowledge engagement emphasizes cross-cultural knowledge sharing and social learning,

and has recently been championed by postmodern, action research advocates and progressive resource managers (Hill 2006; Moller et al. 2009; Ross et al. 2009). Knowledge integration will be crucial for managing green turtle and dugong populations without hindering the socio-political aspirations of various stakeholders. The challenge of an integrated knowledge approach, as has been established in the literature and further outlined in the present study, is that it requires significant dedication on the part of all stakeholders to increase their capacity for communication, relationship and network building, and engaging multiple values and belief systems.

My data suggest that long-term professional relationships built on trust and frequent communication, such as those exhibited by researchers and community-based managers, promote more integrative thinking; whereas infrequent interactions and unstable relationships, such as those between government agency managers and local stakeholders, result in more polarized and abbreviated knowledge interactions. Researchers especially tend to provide necessary facilitation and translation between managers of Indigenous and non-Indigenous cultures where these functions would otherwise be absent or inadequate. Increasing the capacity of other key actors, such as government agencies and regional natural resource management bodies, to facilitate improved cross-cultural communication will greatly expand opportunities for collaboration.

Several steps can be taken to achieve an integrative approach to knowledge sharing that combine top-down legislative changes with bottom-up changes in the design and

implementation of knowledge sharing and co-management frameworks. As well as incorporating the eight 'process characteristics' described by Schusler et al. (2003) into cross-cultural resource management deliberations, these deliberations should be framed to recognize the socio-cultural underpinnings of all forms of knowledge, and to discuss their influence on management decisions. Some of the learning 'platforms' that can assist this process of deliberation include cultural capacity building (Nursey-Bray 2003; Stephenson and Moller 2009), negotiation of knowledge exchange protocols (Crawford 2009), and the development of cultural planning frameworks (see Hill 2008; Hill et al. 2008) and knowledge 'networks' (Berkes 2009). While in recent years several multi-stakeholder workshops for turtle and dugong management have been held throughout the study region, most exhibited only a few of these attributes. In general, participants complained that such workshops (mainly hosted by government agencies) were either too short, undemocratic, or lacking in appropriate organization to provide the foundation needed for collaborative learning (for an example see Table 6.3). Enhancing opportunities for valuable social learning can assist the improvement of capacity, appropriate processes and structures, and supportive policies, all of which are in need of development in Northern Australia.

4.5 Conclusions

One of the key challenges to successful marine turtle and dugong co-management in Australia, and likely in other regions where Indigenous and non-Indigenous stakeholders share management responsibility, is a fragmented engagement of IK and WSK based on

an inadequate consideration of the socio-cultural underpinnings of these knowledges. Using the knowledge categories derived from Houde (2007) as reference, IK and WSK are typically recognized most for their contribution of empirical information and applicability to resource management, with less frequent reference to their socio-cultural aspects—especially for WSK. Limited knowledge engagement results in reduced cross-cultural understanding and communication that often leads to cooptation or politicization of knowledge and power inequality.

There is currently a need to 'build bridges' between epistemologies to encourage a more integrative understanding of knowledge and recognition of the cultural context in which knowledge is embedded. The acknowledgement of multiple legitimate knowledge claims should provide the foundation for deliberation, the development of shared aspirations, collaborative knowledge production, and social learning, all of which contribute to a greater likelihood of successful co-management.

These interrelated issues of identity, culture and knowledge in contemporary society are of key significance to natural resource management in Australia, and deserve greater attention and discussion among resource managers and policy makers. Understanding how different ways of knowing interlace and inform management decisions will moreover be an important evaluative measure for co-management success, and will allow managers to identify potential opportunities to enhance cross-cultural engagement.

4.6 Summary

- In this chapter I explored the ways in which Indigenous and western scientific knowledge are understood by marine wildlife managers, and the challenges associated with combining knowledges when managing marine turtles and dugongs.
- My data indicate that the empirical value of both types of knowledge is well recognized by both Indigenous and non-Indigenous managers. Conversely, the cultural aspects of Indigenous knowledge are acknowledged but not easily engaged by non-Indigenous stakeholders, while the cultural aspects of western science are obscured by its 'objective', 'rational' framework.
- I developed a typology that presents the three general ways marine managers in this study engaged with Indigenous and western scientific knowledge—either in a utilitarian, political, or integrative manner.
- The integrative approach, often expressed by researchers and local organizations, emphasizes cross-cultural knowledge exchange and co-production for more inclusive management. This approach can be encouraged by encouraging greater capacity-building at multiple management levels, developing stronger cultural planning frameworks, and increasing opportunities for multi-stakeholder deliberation and relationship building.
- The following chapter uses a social network approach to further explore patterns of knowledge exchange, as well as policy influence, among actors in this governance system.

5

Knowledge Exchange and Policy Influence in a Marine Governance Network: An Exploration of Power Relations

This chapter uses social network analysis to further examine patterns of knowledge exchange and policy influence among stakeholders in marine turtle and dugong management in Northern Australia. Based on my results, I develop a typological 'map' of stakeholder roles in the network to characterize each stakeholder's contribution of knowledge and ability to influence policy, helping to identify gaps or overlaps in network linkages. I conclude by suggesting improvements to communication and collaboration among stakeholders that would increase social-ecological resilience in the management network by providing better protection for marine species while meeting the needs of diverse stakeholders.

Manuscript associated with this chapter:

Weiss, KC, Hamann M, Kinney MJ, Marsh H (2011). Knowledge exchange and policy influence in a marine resource governance network. *Global Environmental Change*. DOI: http://www.sciencedirect.com/science/article/pii/S0959378011001427.

5 Knowledge Exchange and Policy Influence in a Marine Governance Network: An Exploration of Power Relations

5.1 Introduction

Two tenants of successful co-management are power sharing and the exchange of knowledge for effective management decision-making (Berkes 2009). The use of social network analysis has become an accepted and indeed encouraged approach to examine these types of relationships among stakeholders in natural resource management (e.g., Janssen et al. 2006). Resource governance systems can be thought of as social networks comprised of various stakeholders, or actors, across a variety of organizations and hierarchical levels (Carlsson and Berkes 2005; Carlsson and Sandström 2008). These actors are connected via information pathways, resource dependencies, and institutional arrangements (Hahn et al. 2006; Janssen et al. 2006).

Understanding the patterns of relational ties among network actors can provide a clearer picture of knowledge and power interactions. For example, politically powerful organizations may act as bridges—linking different management scales or knowledge systems—lowering the costs of collaboration and conflict resolution while providing a forum for knowledge co-production (Folke et al. 2005; Hahn et al. 2006; Olsson et al. 2007). Such has been the case in Kristianstad, Sweden, where co-management of the

city's wetlands biosphere reserve has been largely facilitated and sustained through the development of a municipal organization that provides key bridging functions.

Identifying important structural properties of networks is also important for determining how to improve co-management arrangements to reduce network vulnerability and thus improve social-ecological resilience. A resilient social-ecological system is one that has the capacity to absorb or adapt to change and disturbance, whether anthropogenic or natural, without significant decline or degradation of crucial functions, structure, identity, or feedbacks (Walker et al. 2004; Folke et al. 2005). Adaptive governance has been proposed as an approach to comprehensively manage for social-ecological resilience. An adaptive governance framework depends upon the collaboration of a diversity of actors operating at different social and ecological scales to encourage social learning and adaptation (Hughes et al. 2005). The sharing of management power and responsibility typically involves multiple institutional linkages among user groups or communities, government agencies and non-governmental organizations, from local to international levels.

Lebel et al. (2006) outline the key attributes of adaptive governance systems, which include participation, representation, deliberation, accountability, empowerment, and social justice. Such systems should also be multilayered and polycentric (maintain several centers of authority or 'control'). The capacity of actors within a social-ecological system to manage for resilience relies upon their collective ability to self-organize, adapt, and learn; these aspects in turn depend upon the capacity to deal with issues of scale and

institutional fit, uncertainties, detection of thresholds, knowledge integration, and maintenance of social and ecological diversity.

Recent social network studies have begun to contribute a greater understanding of how resource governance systems and their composite institutions function, and why some are more successful than others. Janssen et al. (2006), for instance, characterize three different types of social-ecological networks and the different problems that influence their resilience to socioeconomic and ecological shifts. As well, Marin and Berkes (2010) use network analysis to investigate cross-scale interactions in a fisheries co-management network, while Crona and Bodin (2010) explore knowledge and power asymmetries in a small-scale fisheries management context. These studies, and several others, provide an important foundation on which to build additional in-depth network analyses across a greater variety of governance contexts and institutional scales, such as those explored in this thesis.

This chapter examined two relational ties in particular—knowledge transfer and policy influence—within the marine turtle and dugong management network in Northern Australia to: (1) compare overall network structure and actor characteristics associated with each relational type; (2) investigate how power relations impact the social-ecological resilience of the network; and (3) contribute to a greater understanding of the relationship between knowledge, influence, and political power in the context of natural resource management.

5.2 Methodology

The dugong and marine turtle governance system covers an extensive marine region across north-eastern Australia, making management complex and involving stakeholders from many jurisdictional scales, including: several national, state, and regional level government bodies; Indigenous management organizations and ranger programs; natural resource management (NRM) bodies; non-governmental organizations (NGOs); research institutions; and consultants (Table 5.1).

I conducted in-depth semi-structured interviews and follow-up questionnaires with 30 key-informants from these stakeholder groups to determine flows of knowledge exchange and policy influence throughout the management system (detailed interview and survey methods are outlined in chapter 3, section 3.2). 'Knowledge exchange' refers to the transfer of socio-cultural and ecological knowledge relevant to dugong and marine turtle management. By 'policy influence' I mean an actor's ability to affect legislative and management decisions of other actors. Data transformation and analysis was conducted using UCINET 6, as detailed in chapter 3 (section 3.3.2.4). More detailed background information regarding social network analysis can be found in Chapter 1 (section 1.11), and chapter 3 (section 3.3.2).

Table 5.1: Actors included in the dugong and turtle management network study, grouped by management level

Management Level	Actor	Abbreviation	Headquarters
National Government	Australian Fisheries Management Authority	AFMA	Canberra, ACT & Thursday Island, Torres Strait
	Dept of Agriculture, Fisheries, and Forestry	DAFF	Canberra, ACT
	Dept of Sustainability, Environment, Water, Population, and Communities	SEWPAC	Canberra, ACT
	Great Barrier Reef Marine Park Authority[1]	GBRMPA	Townsville, QLD
Regional Government	Queensland Dept of Primary Industries and Fisheries	DPIF	Brisbane, QLD
	Queensland Dept of Environment & Resource Management	DERM	Brisbane, QLD
	Torres Strait Protected Zone Joint Authority	PZJA	Canberra, ACT/Thursday Island, Torres Strait
	Torres Strait Regional Authority	TSRA	Thursday Island, Torres Strait
Regional Non-Government	Balkanu Cape York Development Corporation	Balkanu	Cairns, North QLD
	Girringun Aboriginal Corporation	Girringun	Cardwell, North QLD
	Marine & Tropical Research Facility	MTSRF	Cairns & Townsville, QLD
	North Australia Indigenous Land and Sea Management Alliance	NAILSMA	Darwin, NT
	North Queensland Dry Tropics NRM Body	NQDT	Townsville, QLD
Local Non-Government	Academic researchers	Researchers	QLD, NT, various cities
	Independent environmental and resource mgt consultants	Consultants	QLD, various cities
	Sea Turtle Foundation	Sea Turtle NGO/ STF	Townsville, QLD
	Great Barrier Reef community rangers	GBR Rangers	QLD, various communities
	Torres Strait Island community rangers	TS Rangers	Torres Strait, various islands

[1]GBRMPA reports to the Australian Government Minister for SEWPAC

5.3 Network Measurements of Interest

The key measurements I used to explore actor relations and network structure of marine turtle and dugong governance, including network density and centralization, and actor centrality, are described in detail in chapter 3 (section 3.3.2.3). These measures in particular were chosen so that I could explore how well-connected actors were, which relational type was the most densely connected and/or centralized, and which actors were most (or least) central in each case.

I additionally generated a set of 100 random networks taken from a Bernoulli distribution, with the same number of nodes (18) and densities as the two network relations, and calculated the same set of measures on these random networks to determine whether the characteristics of my study network differed significantly from what would be expected by chance. Additionally, a Quadratic Assignment Procedure (QAP) Correlation test using the Jaccard Coefficient was run in UCINET 6 to test whether the matrix for knowledge exchange relations was positively associated with the matrix for policy influence relations; i.e., did the presence of knowledge sharing between pairs of actors correlate significantly with policy influence ties between them?

5.4 Results

5.4.1 Whole Network Characteristics

The policy influence network showed significantly higher Degree Centralization scores than would be expected by chance, especially for out-Degree (i.e. out-going ties; Table

Table 5.2: Comparison of whole network characteristics for knowledge exchange and policy influence compared to what would be expected by chance (represented by the average of 100 randomly generated networks with the same number of nodes and same density as each of the study networks). Significant differences are in bold.

	Knowledge Exchange	Random Network	Policy Influence	Random Network
Number of Ties	170	171 (SD ± 9)	106	106 (SD ±7)
Density (%)	56	56 (SD ±.3)	35	35 (SD ±2)
In Degree Centralization (%)	28	22 (SD ±6)	**31**	23 (SD ±6)
Out Degree Centralization (%)	**34**	22 (SD ±6)	**69**	22 (SD ±6)

5.2). The knowledge exchange network also displayed a significantly higher out-Degree than would be expected (though the difference is much smaller than for policy influence), while the difference was not significant for in-Degree (in-coming ties).

The knowledge network density was nearly double that of the policy network (Table 5.2). This difference was statistically significant according to a bootstrap paired sample T-test ($p < 0.01$) performed in UCINET. Additionally, while in-Degree Centralization was nearly equal between the networks, out-Degree Centralization for the policy network was more than double that of the knowledge network, indicating that policy influence was concentrated more heavily in a few actors, while knowledge provision was more dispersed. This result suggests that policy pressure, while originating in a few central actors, is felt by many other actors. Meanwhile, knowledge is both shared and received by many and thus is not highly concentrated within the system, nor does it accumulate to a great extent in one or a few actors.

The QAP Correlation results showed a significant correlation ($p=.03$) between the two network types, meaning that the presence of a knowledge tie between two actors indicates

greater probability of a policy influence tie between them. The various implications of this correlation are considered further in the discussion section.

5.4.2 Actor Centrality

5.4.2.1 Knowledge Exchange

The Torres Strait Regional Authority had the highest values for all network measures, making this government agency the most significant actor in the knowledge exchange network (Table 5.3a). Research actors and large government agencies were the second highest knowledge mediators, generally ranking higher than other actors for all measured network characteristics. Actors with the highest number of outgoing ties in the knowledge network also tended to fall between other actors' pathways most often. All but one of these actors (the Torres Strait Regional Authority) had moderately low in-Degree rankings.

Researchers and consultants were central players with similar positions in the knowledge exchange network; both had a high number of outgoing ties relative to incoming ties and a close proximity to many other actors, putting them near the centre of the network (Figure 5.1a), followed closely by several large government agencies. Actors with low out-Degrees tended to rank moderate to low in all other categories, especially Betweenness (Table 5.3a) These actors, comprising mainly local Indigenous and small conservation groups and three national government agencies, were on the periphery of the knowledge exchange network (Figure 5.1a) and had the least brokerage power. Only

Table 5.3: Actor characteristics of (a) knowledge exchange network, and (b) policy network, grouped by area of concern. Raw scores were converted to ranked scores of High (HI), High Medium (HM), Medium (ME), Low Medium (LM), and Low (LO).[1]

(a) Knowledge Exchange

Mandate	Actor	Out Degree	In Degree	Betweenness
Industry	AFMA	LM	LM	LO
	DAFF	LM	LM	LO
	DPIF	HM	HI	HI
	PZJA	LO	LM	LO
Indigenous	NAILSMA	HM	LM	LO
	TSRA	HI	HI	HI
	Balkanu	LM	LM	LO
	Girringun	HM	HM	LO
	GBR_Rangers	HM	HM	ME
	TS_Rangers	LO	LO	LO
Conservation	SEWPAC	LM	HM	LO
	DERM	HM	HI	HI
	GBRMPA	HM	HI	HI
	NQDT	LM	LM	LO
	SeaTurtleNGO	LO	LO	LO
Research	MTSRF	HI	LO	LO
	Consultants	HI	LM	ME
	Researchers	HI	HM	HI

(b) Policy Influence

Mandate	Actor	Out Degree	In Degree	Betweenness
Industry	AFMA	HI	LM	LO
	DAFF	ME	LO	LO
	DPIF	ME	HM	LO
	PZJA	ME	HM	LO
Indigenous	NAILSMA	LO	HM	HI
	TSRA	ME	HI	HI
	Balkanu	LO	HM	LO
	Girringun	LO	HM	LO
	GBR_Rangers	LO	HM	ME
	TS_Rangers	LO	LM	LO
Conservation	SEWPAC	HI	HM	HI
	DERM	HI	LM	LO
	GBRMPA	ME	HM	ME
	NQDT	LO	LO	LO
	SeaTurtleNGO	LO	LM	LO
Research	MTSRF	LO	LO	LO
	Consultants	LO	LO	LO
	Researchers	ME	HM	ME

[1]Ranks were determined by calculating the average value and standard deviation (SD) for each characteristic. Actors with values less than the average but higher than the lower SD limit were grouped as low medium (LM). Values less the lower SD limit were grouped as low (LO). Values greater than the average but less than the upper SD limit were grouped as high medium (HM), and values greater than the upper SD limit were grouped as high (HI). A post-hoc Tukey's HSD was used to verify that ranked groups for each characteristic were significantly different from each other ($p < .05$). In the few instances where two groups were not significantly different, we combined values into one group, reducing the number of groups to three: LO, ME (medium), and HI. We also used these three rankings in cases where the SD was greater than the highest or lowest value in a given characteristic.

the federal Department of Sustainability, Environment, Water, Populations, and Communities (SEWPAC) had moderately high scores for *receiving* knowledge despite lower scores for knowledge provision, while other national agencies (e.g., Australian Fisheries Management Authority, and Department of Agriculture, Fisheries, and Forestry) ranked lower in both cases. Thus, while the national agencies may have significant legislative authority over management (as discussed below), many clearly play a weaker role in knowledge exchange (Figures 5.1 and 5.2).

5.4.2.2 Policy Influence

The structure of policy influence relations varied from those for knowledge exchange (Figure 5.1). The density of ties for policy influence was noticeably less, and the central actor was SEWPAC, rather than researchers and consultants. SEWPAC was indeed the most influential actor in the policy network according to out-Degree and Betweenness, as opposed to its less important position in the knowledge network (Table 5.3b)

Larger government agencies again lay in the region next closest to the centre. For some government agencies (e.g., Australian Fisheries Management Authority, a national agency with regional presence in the Torres Strait and the Queensland Department of Environment and Resource Management) their position is due to their moderately high out-Degree (i.e., the ability to influence other actors, Figure 5.1b). The position of others (e.g., researchers and the Torres Strait Regional Authority, Figure 5.1b) is due to a high in-Degree (amount of incoming policy influence). Actors with moderate overall rankings for network characteristics tended to be mid-level organizations that both influence and

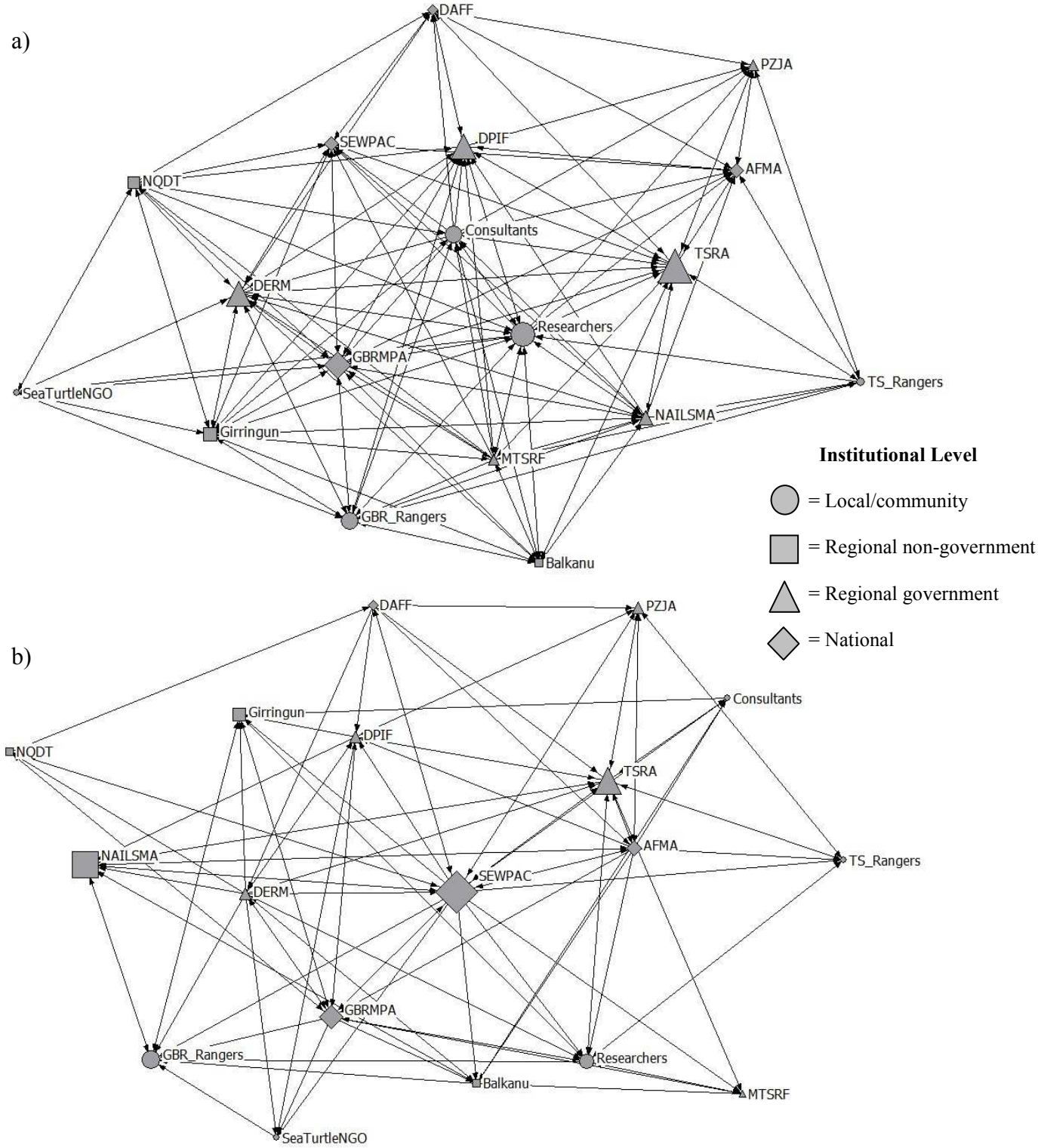


Figure 5.1: Model of (a) knowledge exchange, and (b) policy influence linkages in the dugong and marine turtle management network. Size of node correlates with the Betweenness value for each actor (larger node indicates higher Betweenness). Position of nodes indicates relative centrality of actor based on number of ties. Arrows indicate direction of relation. See Table 5.1 for full actor names and associated abbreviations.

are influenced by other actors operating at higher and lower management scales, resulting in high Betweenness values but lower rankings for other characteristics. For example, while Torres Strait Regional Authority is a key knowledge provider and liaises between many actors, the agency attracts a high amount of policy pressure while having only a moderate influence on the policy of others.

Local conservation and Indigenous groups were again on the periphery of the network and had the least policy influence (Figure 5.1b), but generally also felt less pressure from other actors. Also on the periphery of this policy network were government agencies for which dugong and turtle management plays a minor role in their overall organizational responsibilities; e.g., the Protected Zone Joint Authority and the Department of Agriculture, Fisheries, and Forestry.

5.4.3 A Typology of Actor Roles

I developed a typology of actors' roles in knowledge facilitation and policy influence by comparing their respective knowledge in-Degree and out-Degree values with their policy out-Degree value (Figure 5.2). These measures provide a qualitative indication of how much knowledge an actor receives, how much knowledge they produce, and how much influence they have over policy decisions, respectively. Actors were grouped into one or more of seven categories based on their positions: Powerful Producers, Moderate Producers, Marginal Producers, Powerful Consumers, Moderate Consumers, Marginal Consumers, and Low Impact.

No agencies in the dugong and marine turtle management network fall into the category of Powerful Producers, meaning no actor had high knowledge production as well as high policy influence. Only researchers and the Torres Strait Regional Authority act as Moderate Producers due to their important role in providing knowledge and moderate ability to influence policy. The Marginal Producers category comprises five actors: consultants, Marine and Tropical Research Facility, North Queensland Dry Tropics, Balkanu and North Indigenous Land and Sea Management Alliance (also a marginal/moderate consumer).

SEWPAC is the only agency categorized as Powerful Consumer. Seven actors are Moderate Consumers: Queensland Department of Environment and Resource Management, Department of Primary Industry and Fisheries, Great Barrier Reef Marine Park Authority, Torres Strait Regional Authority, Department of Agriculture, Fisheries, and Forestry, Torres Strait Protected Zone Joint Authority, and Australian Fisheries Management Authority. All of these agencies also exhibit a low to moderate amount of knowledge production (except the Torres Strait Regional Authority who is also a high knowledge producer), but their out-Degree values are lower in every case than in-Degree values, making them net consumers. Marginal Consumers include Balkanu, Great Barrier Reef region rangers, and Girringun Aboriginal Corporation (who also had a marginal/moderate amount of knowledge production). Finally, two actors grouped into the category of Low Impact due to their marginal involvement in both policy influence and knowledge exchange in this management system: Sea Turtle Foundation, and Torres Strait Rangers.

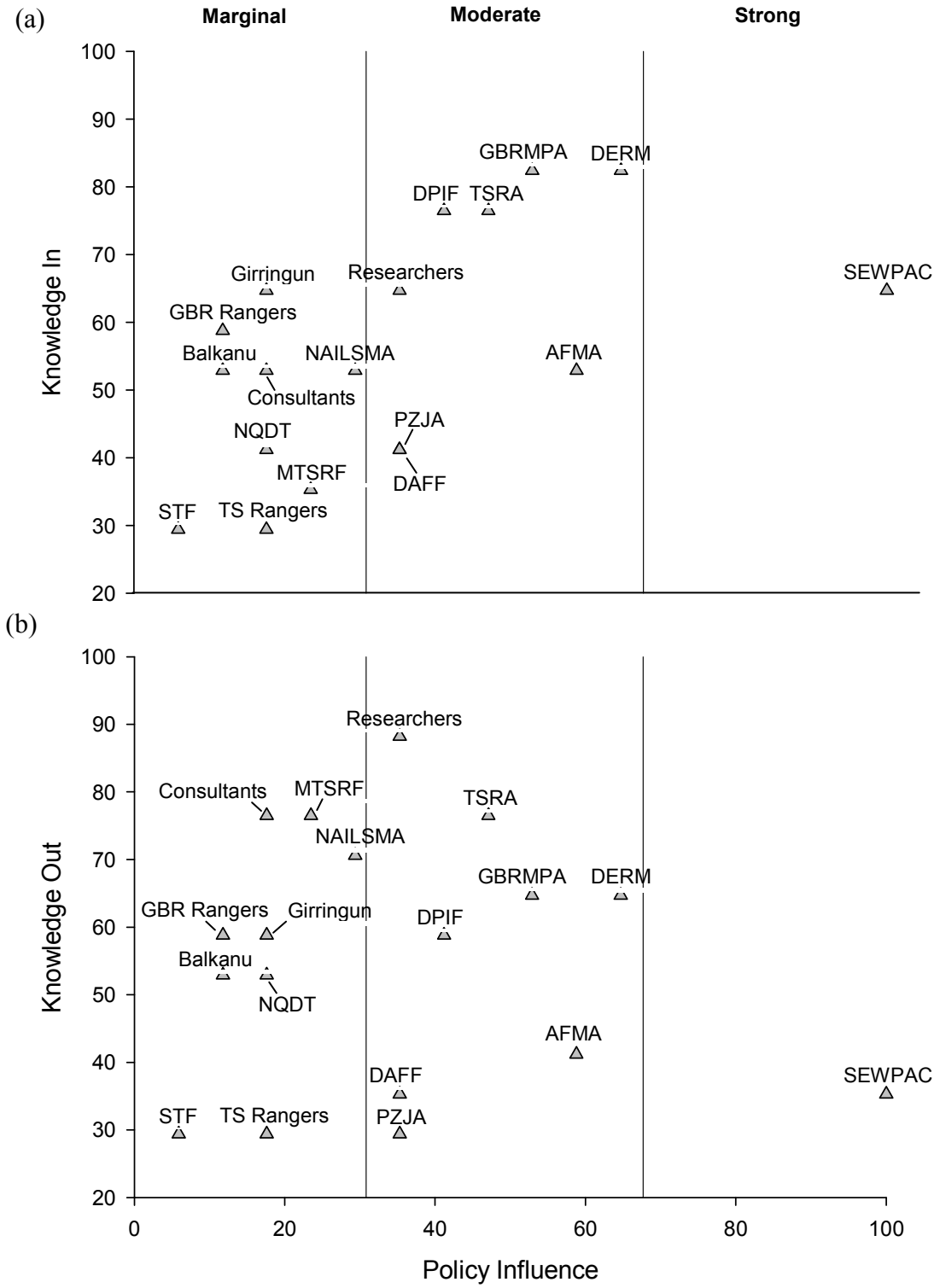


Figure 5.2: Distribution of network actors based on (a) Knowledge in-Degree and (b) Knowledge out-Degree related to Policy Influence out-Degree. The Policy Influence axis was spit into three equal sections indicating marginal, moderate, and strong influence over policy decisions. Actors were considered net producers if out-Degree ranked higher than in-Degree, and considered net consumers in the opposite case. Actors were considered Low Impact if all Degree measures ranked below 30%. See Table 5.1 for full actor names and associated abbreviations.

5.4.4 Links between Actor Groups

To explore patterns of links between actors in each of the roles identified above, I conducted contingency table analysis in UCINET 6, which compared the observed frequency of links between each group to what would be expected by chance (i.e., in a random network under a model of independence). For knowledge exchange links, Moderate Producers had some of the highest ratios of observed/expected with most other actor groups, sharing knowledge most often with other actors in their same group, as well as with powerful and moderate consumers (Table 5.4a). Marginal producers also had higher than expected linkage rates with every group. Low Impact actors displayed some of the lowest ratios. Consumers predictably showed lower ratios in general lower than Producers, reflecting their role as knowledge receivers rather than providers.

For policy influence linkages, the one Powerful Consumer (SEWPAC) was the single highest influencer on actors in every other group. Equally high ratios of observed/expected occurred within the Moderate Producer group and the Weak Consumer group (Table 5.4b), meaning that actors from these groups influence each other more than they influenced actors in other groups. Moderate Consumers also had higher than expected linkage rates with all other groups. Conversely, Marginal Consumers had the lowest policy influence ratios, and Marginal Producers and low impact actors also had lower than expected linkage rates.

Table 5.4: Ratio of the observed number of ties between each actor category vs. the expected number of ties assuming complete independence for (a) knowledge exchange and (b) policy influence. The higher the ratio, the greater the difference between observed and expected. A ratio above 1.0 indicates a higher than expected number of observed relations while values below 1.0 imply a lower than expected number of observed relations. The deviation of observed ties from randomness was statistically significant for both network relations ($p < .01$).

a) Knowledge Exchange

	Moderate Producer	Marginal Producer	Powerful Consumer	Moderate Consumer	Marginal Consumer	Low Impact
Moderate Producer	1.8	1.62	1.8	1.8	0.9	1.13
Marginal Producer	1.62	1.17	1.44	1.44	1.44	0.54
Powerful Consumer	0.9	0.36	N/A	1.35	0	0.45
Moderate Consumer	1.35	0.81	1.35	1.35	1.35	0.67
Marginal Consumer	0.9	1.26	0.9	1.35	1.8	0.45
Low Impact	0.9	0.09	0.45	0.9	0.67	0.6

b) Policy Influence

	Moderate Producer	Marginal Producer	Powerful Consumer	Moderate Consumer	Marginal Consumer	Low Impact
Moderate Producer	2.89	0.87	1.44	1.44	0.72	1.08
Marginal Producer	1.15	0.58	1.15	0.43	0.87	0.14
Powerful Consumer	2.89	2.89	N/A	2.89	2.89	2.89
Moderate Consumer	2.17	1.3	2.17	1.92	1.8	1.08
Marginal Consumer	0.72	0.29	0	0.36	2.89	0
Low Impact	1.44	0	1.44	0.9	0.36	0.96

5.5 Discussion

This study demonstrates strengths and weaknesses within the dugong and marine turtle governance system. The knowledge network is dense but highly decentralized, and knowledge producers have low to moderate direct policy influence on other actors. While a variety of stakeholder groups contributes information to the system, communication gaps between some groups (e.g., between actors in the top left region and bottom right region of Figure 5.2) impede collaborative management. Meanwhile, the policy network reflects a centralized, hierarchical structure with a few key government agencies maintaining most of the influence and brokerage power.

5.5.1 Centralization and Density

High values for network centralization and density may positively correlate with high levels of communication, collaboration, and reduced transaction costs associated with resource exchange and decision-making capabilities. In short, well-connected networks may foster social capital for joint action (Coleman 1990; Burt 2000; Carlsson and Sandström 2008). In contrast, highly centralized networks with lower density—as seen for my study network's policy influence linkages—can lead to asymmetric relations, reducing representation of marginal actors while a few central actors call most of the shots (Bodin and Crona 2009). Indeed, several of my interview participants from marginal organizations expressed frustration at the lack of recognition for and use of their expertise, as well as an underrepresentation of their specific needs and interests, by central network actors. In particular, participants cited limited Indigenous engagement as a cause for tension, reduced compliance, and a perceived lack of legitimacy in the governance network. As one participant stated, "policies can only be developed at a certain level in the Australian government, but . . . for turtle and dugong specifically, the biggest stakeholders are the Torres Strait Islanders, so the advice for the policy should come from them."

Powerful actors such as national government agencies are important for setting broad objectives, providing policy direction, and funding. However, while the centralized leadership found in this network study provides uniformity to the system and efficiency in decision-making, reliance on a few key leader organizations may stifle bottom-up creativity and flexibility (Marín and Berkes 2010) and make the network more vulnerable

if key actors are lost (Olsson et al. 2006). Additionally, some powerful agencies show a disproportionate amount of policy-making power compared to the amount of knowledge they receive within the system. This discrepancy between knowledge and policy influence potentially reduces the capacity of this system to make evidence-based management decisions.

Larger organizations that comprise significant amounts of human resources and capital, such as government agencies, may have a greater internal pool of knowledge and experience to draw from, reducing their dependency on external knowledge linkages. However, this reliance on internal expertise often leads to the 'silo' effect in which, as one interview participant commented, "people in one particular area are going ahead full steam and not necessarily recognizing other people might have valuable input or have an interest, or just want to know what's going on." For example, many Indigenous communities are aware of the scientific evidence suggesting a decline in turtle and dugong populations. Most are interested in developing culturally appropriate turtle and dugong management protocols that restrict hunting but provide flexible guidelines that allow animals to be harvested for various cultural events throughout the year. Such events include funerals, weddings, and various coming-of-age events, which are not always predictable and vary each year. Yet many government organizations fail to recognize this cultural need; instead they use scientific evidence to argue for the development of strict annual hunting quotas that satisfy their internal mandate for biodiversity conservation (e.g., via the federal *Environment Protection and Biodiversity Conservation Act 1999*), despite the cross-cultural conflict this creates.

High network density combined with lower centralization, as was exhibited for knowledge exchange, can result in numerous redundant knowledge channels without efficient concentration of relevant information, prohibiting efficient knowledge accumulation for decision-making. Interview participants discussed the difficulty of compiling the information and viewpoints of so many stakeholders in the region, and stated the need for more flexibility—both in regards to time frames and institutional frameworks—than currently exists in Australian marine governance to account for the wide array of perspectives. Inconsistent communication pathways were also considered a key problem. While information linkages are dense, they are not always reliable or predictable, reducing the strength of relationships and amount of trust present in the network.

The Indigenous hunting example highlights the interplay between knowledge, such as scientific data, and the power associated with using that data to influence certain policy decisions over others. Indeed, the significant results of the Quadratic Assignment Procedure (QAP) test indicated that the presence of a knowledge exchange link between two actors makes it more likely that a policy influence link will also exist between them, suggesting that these relationships are not independent. This interdependence between knowledge and influence over others could represent several relationship types between actors. For example, knowledge sharing may incite trust between actors who then are more likely to discuss policy options and take each other's perspectives into consideration. Alternatively, certain actors may have more policy influence by virtue of their extensive knowledge base compared with other actors. Net knowledge consumers in the network (generally the large government agencies), receive knowledge from a variety

of sources and possibly hold on to that knowledge rather than freely sharing it. This 'hoarding' behaviour puts certain organizations at a knowledge advantage at the management negotiation table, but can actually incite distrust and resentment from other stakeholders. One interview participant described the frustration resulting from a lack of data sharing between supposedly collaborative management organizations:

> "We need to improve [communication] a lot more. For example, we can't even adequately access the 'species of conservation interest' data . . . DPI hasn't been very forthcoming with a lot of information, or assessing their data in such a way that is user friendly, that can be used to really work out what we need to do to manage these areas more effectively."

5.5.2 Brains versus Brawn: A Map of Actor Positions

The typology of network actor roles is represented by a 'map' of each actor's position in the management network in regards to knowledge facilitation and policy influence. This map serves as a useful tool for organizations such as government agencies who may wish to evaluate or modify their communication and policy development practices. Additionally, the map serves as an index of redundancy for the overall governance system, identifying network positions shared by many actors compared to positions with few or no actors. Identifying various types of institutional redundancy within a management network is an important step in evaluating good governance practices that promote social-ecological resilience.

No actors in the dugong and marine turtle management network fit the profile of Powerful Producer, indicating that those actors providing the most knowledge in the system do not necessarily have strong legislative influence over others. The absence of

such actors is not necessarily disadvantageous to the network if sufficient knowledge is shared between them and policy makers. For example, the biggest knowledge providers typically tend to be research actors who operate outside the realm of policy creation. These actors must find pathways to transmit their knowledge to decision makers unless it is specifically sought. On the other hand, institutions with abundant legislative power that also make policy decisions based primarily on internal information, even if it is based on scientific or managerial expertise, may be seen as non-transparent, biased, or illegitimate if the concerns and perspectives of external actors are ignored (Ebbesson 2010). Therefore, while cross-boundary exchange between diverse knowledge producers and consumers may require larger transaction costs (e.g., greater effort), it can result in higher returns in terms of social capital (Lin 2001), including trust and compliance.

Moreover, government agencies may actually find it advantageous to seek external expertise on an as-needed basis rather than to continuously employ knowledge producers, as this option allows the agency more flexibility in program development and distribution of funds. However, the separation of knowledge provision and policy creation means that effective communication between these two groups is essential for consistent knowledge transfer and evidence-based decision making. Interestingly, Moderate Producers and Consumers showed higher than expected links with each other, as did Marginal Producers and Consumers. However, fewer than expected linkages occurred between Marginal and Moderate actor groups. This result indicates that while knowledge from Producers is reaching some of the key decision makers, the more marginal actors are less likely to transmit their knowledge to powerful policy makers.

Moderate Producers are important actors in the network due to their production of knowledge and links with policy makers. This category is similar to the "opinion leader" role described by Crona and Bodin (2010), in which actors are central players in knowledge exchange as well as in other important capacities—in this case, influencing the policy of other actors. As such, these actors are likely to have a disproportionately large impact on the opinions of other actors and their capacity to self-organize, especially at local management scales (keeping in mind that this influence would be more apparent in Powerful Producers if any existed in the network). Researchers and the Torres Strait Regional Authority both act as Moderate Producers, facilitating the flow of information particularly to Moderate and Powerful Consumers—generally the key policy makers. The Torres Strait Regional Authority in particular was the most influential agency in the knowledge network, acting as both a knowledge provider and consumer with links to the most powerful government agencies. The Torres Strait Regional Authority's high Betweenness suggests that this agency acts as a bridging organization, transferring information between local Indigenous management units and regional and national government institutions.

Moderate Producers, however, are competing for influence with the Powerful and Moderate Consumers, who produce less knowledge but receive more of it, and have similar amounts of policy influence ties toward others in the network. SEWPAC, whose mandate is to create policy for migratory and marine species such as dugongs and marine turtles, is the only Powerful Consumer. The agency wields the most power over policy creation within the network, dictating national conservation priorities for dugongs and marine turtles and controls funding for resource management projects across the country.

The SEWPAC is an outlier in Figure 5.2, with high policy influence but relatively low knowledge input or output. This disconnect, exacerbated by a high level of staff turn-over which several of my interview participants identified as a main hindrance to the retention of knowledge and inter-agency relations, may render it challenging for the agency to make consistent policy decisions.

The Moderate Consumers were comprised entirely of large regional government agencies. They are important actors in accumulating information and facilitating knowledge flow across management scales while also providing a certain amount of policy direction. The Great Barrier Reef Marine Park Authority, for example, maintains links with research institutions and is an important facilitator of scientific knowledge. However, several of the agencies in this category have incompatible mandates and institutional structures that hinder effective communication and policy implementation; e.g., conservation-oriented agencies versus commercial fisheries-oriented agencies. As one interview participant discussed,

> "[GBRMPA's] main focus is looking after the reef…making sure its functioning the way it should be. I think the classic example of where we have clashing is in the fishing…While principles of ecologically sustainable fishing are mentioned in [Queensland Department of Primary Industries] legislation, they focus more on the economic development side. Theoretically and in principle that shouldn't matter because to have economic viability you need your ecosystem functioning, so it should go hand in hand, but it often doesn't."

In addition, while these regional level management institutions are important to knowledge exchange, they tend to be more constrained by both higher level policy guidelines and demands from local actors. For example, while the Torres Strait Regional

Authority links Indigenous stakeholders to government agencies via information, national agencies such as SEWPAC still have the legislative mandate to dictate policy for local stakeholders as well as the Torres Strait Regional Authority, which can result in overlapping or conflicting legislative frameworks that further constrict the ability of local stakeholders to contribute to marine management development.

All of the Marginal Consumers in this network were Indigenous actors who have low influence on other network actors, as indicated by their peripheral network position. Though some of these Indigenous actors may be influential at local management scales, at the whole-network level the extent of their influence relies on strategic alliances with researchers and regional organizations who tend to be knowledge producers with higher levels of influence on national policy makers. The abolition of the Aboriginal and Torres Strait Islander Commission (ATSIC) in 2005 eliminated a key avenue for Indigenous involvement in broad scale government decision-making that has yet to be replaced in the Great Barrier Reef region (whereas in Torres Strait, the Torres Strait Regional Authority partially fills this role).

Torres Strait rangers and the Sea Turtle Foundation had low impact on both knowledge exchange and policy despite their vested interest in dugong and marine turtle management. Increasing the involvement of many local-level actors in dugong and marine turtle management is essential for developing legitimate, transparent co-management practices. Indeed, Low et al. (2003, p. 86) argue that redundancy and diversity at a local level enhance the performance of governance systems "as long as there are also overlapping units of government that can: (1) resolve conflicts, (2)

aggregate knowledge across diverse units, and (3) insure that when problems occur in smaller units, a larger unit can temporarily step in if needed."

5.5.3 Quantity versus Quality

The actor typologies described above provide a good indication of which actors are the most powerful knowledge producers and influential policy makers. However, it's likely that an actor's position in the network may be affected not only be the number of relations one has, but also *who* those connections are shared with, and how well connected an actor's neighbours are. SEWPAC, for example, may receive a boost in information uptake by linking with well-connected knowledge producers, while Indigenous rangers may increase their impact on policy by linking with more influential actors.

However, communication of knowledge through several actors cannot be assumed, especially in my case study where overall network Betweenness values were rather low. Much information can be lost between the source and final recipient, reducing decision-making capacity at higher or lower scales. Therefore, the effect of these relations can be taken into consideration when interpreting the actor typology (Figure 5.2), though I do not expect their influence to significantly change the patterns observed using in- and out-Degree values. Future exploration into the specific effects of having powerful versus weak neighbours in different network contexts would be useful to enhance understanding of network power dynamics.

5.5.4 Approaches to Facilitate Social-Ecological Resilience

Anthropogenic and natural causes of climate change, shifting land use, and resource availability are effecting the livelihoods and wellbeing of coastal communities throughout the world, as well as impacting the viability of populations of marine wildlife such as dugongs and marine turtles. In order for governance systems managing these species to create frameworks more conducive to both socioeconomic and ecological resilience in the face of these threats, effort must be made to improve linkages between various knowledge producers and the most influential policy makers. Despite a diversity of actors in the dugong and turtle network, cooperation is hindered by centralized decision making structures without consistent communication between actors in various network positions—particularly between knowledge producers with low policy influence and consumers with higher policy influence.

The presence of key bridging organizations such as Torres Strait Regional Authority and the Great Barrier Reef Marine Park Authority provides a promising foundation for developing stronger linkages, but improvement will depend upon a commitment to building communication capacity throughout the network and devolving more decision-making power to local actors that are currently marginalized. Stronger bridging organizations that link Indigenous actors to higher government bodies are also needed, particularly in the northern Great Barrier Reef region. Moving in such a direction would allow several of the key characteristics of adaptive governance systems—e.g., participation, deliberation, accountability, and empowerment—to develop and build the foundation for a more resilient governance system.

Berkes (2009) lists several strategies to improve natural resource governance, including co-production and bridging of knowledge, cooperation building tactics, participatory research, collaborative monitoring, fair distribution of power, and both upward and downward accountability. Bridging organizations often support many of these approaches, and can also provide the important function of maintaining memory of the broader network by liaising between various actors and across scales. Bridging organizations may enhance network relations by addressing conflicts, building trust, providing access to resources, and help construct shared goals between stakeholders (Hahn et al. 2006). However an effective bridging organization requires long-term capacity to provide such advantages. Bridging organizations are likely to be most effective if they exist at the appropriate jurisdictional scale and their role as facilitator is clearly stated in their institutional mandate.

Some government agencies have strong linkages to key knowledge producers, while others lack such relationships. The establishment of centralized information databases and formalized knowledge sharing procedures between management and research institutions would create more consistent communication pathways and effective knowledge accumulation to assist management decisions at multiple scales (Stephenson and Moller 2009). While various sources of decentralized knowledge may be readily available and easily accessible (e.g., via the internet), the reliability and quality of such knowledge is often questionable, or may be stored in a format ill-suited for institutional decision-making. Therefore, centralized knowledge databases can complement decentralized information by providing reliable data that has been verified and sifted for

use in natural resource management contexts—assuming that incentives exist for the continual processing and updating of such knowledge. Additionally, legislative and financial support for region-wide information and planning workshops could help establish consistent management strategies across the region and streamline communication pathways between actors and across scales. Linking actors from various stakeholder groups can increase participation, assist the development of management practices better matched to appropriate social and ecological scales, and build social resilience by increasing actor capacity and trust (Lebel et al. 2006; Olsson et al. 2006). These characteristics subsequently contribute to ecological resilience by paving the way toward more adaptive, flexible, and scale-appropriate resource management frameworks.

Institutional change from both the bottom-up (grassroots) and top-down (centralized government) is required to strengthen multilevel governance linkages (Folke et al. 2005). Greater legislative support for the incorporation of Indigenous and local knowledge and decision-making is a necessary step toward more inclusive marine resource co-management. Cultural awareness and capacity building among Indigenous and non-Indigenous managers would encourage better understanding and respect for multiple ways of knowing and create more equitable relations among actors (see chapter 4). This process not only improves network relations among stakeholders, but benefits marine species of concern by supporting the development of better synchronized and complementary conservation and management efforts across the region. Such capacity building is often facilitated by independent consultants and researchers, but prioritization on the part of government agencies for enhanced capacity for cross-cultural communication is necessary to increase the legitimacy of co-management frameworks in

this network. In this way the turtle and dugong governance system (and by extension, other marine resource governance networks) will better support the social-ecological resilience of the region by developing and implementing more integrative knowledge and policy feedback loops for comprehensive management decision making.

5.6 Conclusion

Being a significant knowledge provider or receiver is not a direct indication of power within this governance network. Nor do powerful actors necessarily have access to a sufficient diversity of information for integrative decision-making. While some knowledge production inevitably occurs internally in larger, better resourced organizations, decisions based predominately on this knowledge are sometimes perceived as lacking legitimacy or accountability by some other stakeholder groups who feel their own expertise is ignored.

Knowledge providers do not necessarily have strong direct influence on the policy of others, but they often act as bridging actors or brokers due to their long-term relationships with other actors, linking peripheral institutions to more powerful ones. In this network, however, an imbalance between knowledge and policy power exists among several actors. Many actors either have high political clout but low information uptake, or they have an abundance of information but little direct ability to affect policy. The key to a resilient natural resource governance framework therefore is to improve communication pathways between knowledge providers and policy decision makers.

Knowledge and political power clearly interact in complex ways, but using a network approach helps uncover the relationship between these factors and their impact upon the structure and functioning of governance systems. Using network analyses to conduct further empirical research on resource management systems holds much promise for providing insight into the association of network structure and decision making power, and their impact on the long-term resilience of resource governance systems.

5.7 Summary

- This chapter used social network analysis to explore patterns of knowledge exchange and policy influence among actors in the marine turtle and dugong governance system. Network maps were created to illustrate actor relationships and to measure various network characteristics including density, Degree Centrality, actor Centralization, and Betweenness.
- I developed a typology of actor roles according to each actor's intake and output of knowledge in relation to their ability to influence other actors' policy decisions. Actors were either net knowledge producers or consumers, and could have marginal, moderate, or high policy influence.
- Knowledge exchange is dense but highly decentralized, with knowledge producers having only a moderate ability to connect to influential policy makers. Policy influence, conversely, reflects a centralized, hierarchical governance structure with large government agencies at the apex.
- The gap between knowledge producers and influential policy makers in this governance system implies a need to improve bridging functions to make relevant information more readily available in management decision-making arenas. Improved communication, greater knowledge sharing, and decentralization of decision-making power will improve social-ecological resilience in the marine turtle and dugong governance network.
- The next chapter further examines these network relationships with a focus on patterns of interaction within and between specific stakeholder groups in the governance system.

6

Communication Barriers to Adaptive Resource Governance--Improving Interaction among Stakeholder Groups in a Marine Resource Management Network in Northern Australia

Designing co-management frameworks which incorporate diverse socio-cultural perspectives and enhance social-ecological resilience will require understanding of patterns of homophily—the tendency of individuals to associate with similar others—and heterogeneity—the tendency to associate with those from disparate social groups—in stakeholder interactions. The last chapter used social network analysis to explore the relationship between knowledge, policy influence, and power. This chapter goes a step further, using social network analysis as well as advocacy coalition theory to examine the extent of homophily (bonding ties) and heterogeneity (bridging ties) among stakeholder groups in the marine turtle and dugong governance system, and thus determine whether knowledge exchange, coordination of management, and policy influence are more likely to occur within stakeholder groups or between them.

Manuscript associated with this chapter:

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6 Communication Barriers to Adaptive Governance—Improving Interaction among Stakeholder Groups in a Marine Resource Management Network in Northern Australia

6.1 Introduction

The collaborative management (comanagement) of natural resources involves networks of stakeholders with various perceptions, knowledge bases, resources, and amounts of influence (Carlsson and Berkes 2005). The interactions upon which stakeholder networks are built may include information or resource exchange, the creation of coalitions with allies, the formation of relationships with influential actors, or coordination among actors with shared objectives (Weible and Sabatier 2006). Comanagement networks typically include vertical linkages across jurisdictional scales and horizontal linkages across institutional types, involving various government and non-government organizations who negotiate in both formal and informal power-sharing arrangements (Carlsson and Berkes 2005; Berkes 2009).

Effective comanagement is thought to require flexible, cross-scale governance systems which enhance institutional interaction, encourage experimentation, and generate social learning (Folke et al. 2002). The generation and application of knowledge is particularly important to the long-term sustainability of comanagement arrangements in order to adequately understand and manage complex social-ecological systems (Berkes 2009). The structural characteristics of comanagement networks, such as patterns of information

exchange, impact the distribution and variability of knowledge among actors, ultimately affecting the outcomes and perceived success or failure of management (Crona and Bodin 2006).

Knowledge exchange in turn relies on sufficient trust and communication among actors. These elements typically develop through homophily—long-term repeated interactions among actors with shared social characteristics, common backgrounds, or shared life experience (Reagans and McEvily 2003). Homophily may encourage within-group knowledge transfer, but may also impede access to and incorporation of external knowledge or resources while strengthening confirmation bias of individuals within a social group (Longstaff and Yang 2008). Indeed, individuals are often most influenced by the people with whom they interact frequently and/or share attributes (Newig et al. 2010). Thus in the context of resource management, actors tend to develop an understanding of the status of a natural resource similar to that of other members of their social group (Crona and Bodin 2006). The amount and content of knowledge useful to natural resource management may therefore differ widely among various groups of resource users (Ghimire et al. 2004; Crona and Bodin 2006).

The idea that belief similarities form the basis of actor relationships within policy networks is encapsulated in advocacy coalition framework theory (Weible and Sabatier 2006). The advocacy coalition framework predicts that actors in a management or policy network predominantly seek to coordinate and exchange information with actors of similar policy beliefs, creating advocacy coalitions that may compete to influence policy (Sabatier 1998; Weible 2005). Policy beliefs represent the values, priorities, and world

views of their respective coalition members; while actors will primarily interact with members of their shared group, interactions across coalitions may occur due to resource dependence or functional interdependence (e.g., overlapping legal jurisdictions) (Weible and Sabatier 2009).

As a result of the competition among advocacy coalitions to gain access to resources and influence management decisions, heterogeneous (between-group) communication and policy-oriented learning are often obstructed by the differing beliefs and understandings of rival coalitions. Strategically positioned or well-resourced actors can create dominant coalitions that have the most influence over identification, interpretation, and proposed solutions to various policy and management issues (Smith 2000). However, if policy brokers (also known as 'bridging organizations' in the adaptive comanagement literature) are present to facilitate deliberation, compromise, and conflict resolution, than collaborative learning and equitable coordination are more likely to take place (Sabatier 1998).

Designing comanagement frameworks that incorporate diverse socio-economic perspectives and enhance social-ecological resilience will require an understanding of patterns of homophily and heterogeneity in stakeholder interactions (Ghimire et al. 2004). While actors with multiple backgrounds and knowledge bases may exist within a comanagement network, there is no guarantee that consistent communication or coordination occurs between them (Sandström and Rova 2010). Therefore it is important to consider the patterns of exchange between groups of actors and their effect on network structure. For example, which coalitions dominate decision-making, and why? How

much interaction occurs within versus between coalitions, and what is the context of these interactions? What is the role of bridging organizations in mediating between stakeholder groups?

I address the above questions by examining the homophily and heterogeneity of interactions between actors in a marine turtle and dugong comanagement network in northern Australia. I use social network analysis and advocacy coalition framework theory as the basis with which to frame my analyses and interpretations of actor relational patterns including knowledge exchange, management coordination, and policy influence. The insights gained from this study are relevant to natural resource managers interested in improving communication and power-sharing arrangements within a variety of comanagement systems, and contribute more broadly to an improved understanding of knowledge and power dynamics in a governance context.

6.1.2 The Australian Context

The competing values and priorities held by various stakeholders in marine turtle and dugong management potentially inhibit meaningful coordination, as discussed in chapters 4 and 5. Indeed, previous attempts at comanagement between various actors, such as Indigenous communities and government agencies, have met with mixed social or ecological success, often failing to understand or meet the expectations of stakeholders (e.g., Nursey-Bray et al. 2010). Finding ways to improve communication and trust among stakeholder groups is an on-going challenge, but is imperative for developing truly collaborative approaches to migratory marine species management in the region.

The marine turtle and dugong management network is similar to many other comanagement networks characterized by the involvement of diverse stakeholders and multiple, often competing, knowledge systems—in particular those involving Indigenous stakeholders (see chapter 4 for an in-depth analysis of cross-cultural knowledge exchange in this case study). As a result of the varying belief systems and amounts of policy power held by different actors in the network, my case study provides a valuable opportunity to explore the extent that actors establish relationships based on policy core beliefs versus alliances based on resource or political dependencies. Understanding the motivations underlying different types of actor linkages in a resource governance system is an important step toward improving collaboration across stakeholder groups and institutional scales.

6.2 Research Methods

6.2.1 Data Collection

Between 2008 and 2010, in-depth semi-structured interviews and follow up surveys were conducted with 30 key-informant stakeholders in dugong and turtle management at all relevant institutional scales to ascertain flows of knowledge exchange, coordination, and policy influence throughout the management network. Details of interview methodology can be found in chapter 3 (section 3.2.3).

Participant responses were considered representative of their affiliated organization or institution where dugong and marine turtle management was concerned. Equating the interests and perceptions of individuals with the organizations they represent is not unproblematic, as individuals do not necessarily identify wholly with the interests of their respective organization, and individuals within organizations change over time. However, I follow Newig et al. (2010) in assuming that, although network actors are individual persons, they are constrained by and tend to act according to their organizational affiliation. When possible, multiple participants were selected from larger organizations to achieve more comprehensive institutional representation, as explained in chapter 3 (section 3.2.3).

6.2.2 Data Analysis

I quantitatively assessed the structural characteristics of the marine turtle and dugong management network using social network analysis as explained in chapter 3 (section 3.3.2.4). For the portion of my study outlined in this chapter, I focused on the analyses described in the following section.

6.2.2.1 Network Homophily versus Heterogeneity

The actors in my study network can be broadly categorized into four groups, or coalitions, based on their dominant institutional mandate (Table 6.1): (1) Industry; e.g., fisheries and natural resource extraction organizations; (2) Indigenous rights and well-being; (3) conservation/recovery of species and environment; and (4) scientific research,

Table 6.1: Actors included in the dugong and turtle management network study, grouped by institutional mandate. For organizational type, G = Government agency; NG = non-government organization or actor

Institutional Mandate	Actor	Organizational Type	Abbreviation	Geographic Location
Industry	Australian Fisheries Management Authority	G	AFMA	Canberra, ACT
	Dept of Agriculture, Fisheries, and Forestry	G	DAFF	Canberra, ACT
	Dept of Primary Industry and Fisheries	G	DPIF	QLD, various cities
	Torres Strait Protected Zone Joint Authority	G	PZJA	Canberra/Torres Strait
Indigenous	Balkanu Cape York Development Corporation	NG	Balkanu	Cairns, North QLD
	Girringun Aboriginal Corporation	NG	Girringun	Cardwell, North QLD
	Great Barrier Reef Indigenous rangers	NG	GBR Rangers	QLD, multiple communities
	North Australia Indigenous Land and Sea Management Alliance	NG	NAILSMA	Darwin, NT
	Torres Strait Indigenous rangers	NG	TS Rangers	Torres Strait, multiple islands
	Torres Strait Regional Authority	G	TSRA	Thursday Island, Torres Strait
Conservation/ Management	Dept of Sustainability, Environment, Water, Population, & Communities	G	SEWPAC	Canberra, ACT
	Great Barrier Reef Marine Park Authority	G	GBRMPA	Townsville, QLD
	QLD Dept of Environment & Resource Management	G	DERM	QLD, various cities
	North Queensland Dry Tropics Natural Resource Management Body	NG	NQDT	Townsville, QLD
	Sea Turtle Foundation	NG	STF	Townsville, QLD
Research	Academic researchers	NG	Researchers	QLD, various cities
	Independent Conservational and resource mgt consultants	NG	Consultants	QLD, NT, various cities
	Marine & Tropical Research Facility	NG	MTSRF	North QLD

including funding, conducting, and dissemination. I categorized these groups according to attributes identified by interview participants and literature/website information from the actors included in my study. Government and non-government actors were in each group.

Obviously some overlap may exist among actors' ideologies or motivations regardless of their overarching mandate; similarly, placing actors within the same mandate group does not imply that these actors have identical ideologies. Rather, I chose to group actors based on their institutional mandate because this attribute relates to the types of management goals and approaches an actor is likely to utilize and whether they emphasize economic, social, or ecological aspects of resource management, and may affect how actors work with others to achieve shared objectives (or block opposing ones). This type of group cohesion is also representative of 'epistemic communities', groups of actors which share the same basic causal beliefs and normative values (Haas 1992). I aimed to determine the amount of internal—or bonding—ties *within* social groups (homophily) and external—or bridging—ties *between* groups (heterogeneity) in the policy influence, knowledge exchange, and coordination networks.

To measure the extent of heterogeneous exchange within each network relation I counted the number of ties between members of the same group and between members of different groups. Using the Relational Contingency Table analysis function in UCINET, the actual number of relations within and between groups was then compared to the number of relations that would be expected by chance alone (assuming complete independence), and p value was calculated to determine whether each value significantly

deviated from values that would occur under a random network model. When significant, an observed versus expected ratio above 1.0 implies a higher than expected number of observed relations among those particular groups while values below 1.0 imply a lower than expected number of observed relations. As per Crona and Bodin (2006), I categorized the strength of a significant inter-group relation as "strong" if the ratio exceeded 1.0, "medium" if the ratio was between 0.5 and 1.0, and "low" if the ratio was below 0.5.

6.3 Results

6.3.1 Knowledge Exchange

All groups showed significant homophily for knowledge linkages, which was strongest for industry actors (Table 6.1 a). Conversely, the amount of between-group ties is less than expected in the majority of cases. The main exception is researchers, who have a higher than expected number of ties with all groups, and Indigenous actors, who share a higher number of ties with researchers, but not other groups.

Indigenous actors shared the fewest ties with conservation and industry actors, and most of the external linkages from Indigenous actors were maintained by high profile Indigenous organizations such as the Torres Strait Regional Authority and the North Indigenous Land and Sea Management Alliance (Figure 6.1). External knowledge exchange originating from conservation actors was dominated by the Great Barrier Reef Marine Park Authority and the Queensland Department of Environment and Resource

Table 6.2 a-c: Ratio of the measured vs. expected number of ties between each actor group. Within group values are in bold. The deviation of observed ties from randomness was statistically significant for all three network relations ($p < 0.001$ for knowledge exchange; $p=0.02$ for coordination; $p=0.003$ for policy influence).

2a: Knowledge Network

	Industry	Indigenous	Researchers	Conservation
Industry	**1.8**	0.53	0.45	0.54
Indigenous	0.75	**1.2**	1.4	0.9
Researchers	1.2	1.5	**1.5**	1.56
Conservation	0.54	0.9	0.48	**1.53**

2b: Coordination Network

	Industry	Indigenous	Researchers	Conservation
Industry	**2.07**	0.69	0.23	0.83
Indigenous	0.92	**1.19**	0.77	1.01
Researchers	0.23	1.38	**0.92**	0.74
Conservation	0.83	1.01	0.74	**2.07**

2c: Policy Network

	Industry	Indigenous	Researchers	Conservation
Industry	**2.17**	1.2	0.48	1.15
Indigenous	0.6	**1.06**	0.64	0.29
Researchers	0	1.28	**0.96**	0.58
Conservation	1.01	1.44	0.96	**2.02**

Management. These last two agencies also had the most internal linkages to other conservation actors.

6.3.2 Coordination

Industry, Indigenous, and conservation actors all showed higher than expected levels of homophily, while researchers showed lower than expected (Table 6.1 b). Meanwhile, all actor groups showed low to moderate external ties save for ties between researchers and Indigenous actors (strong), and conservation and Indigenous actors (slightly more than expected).

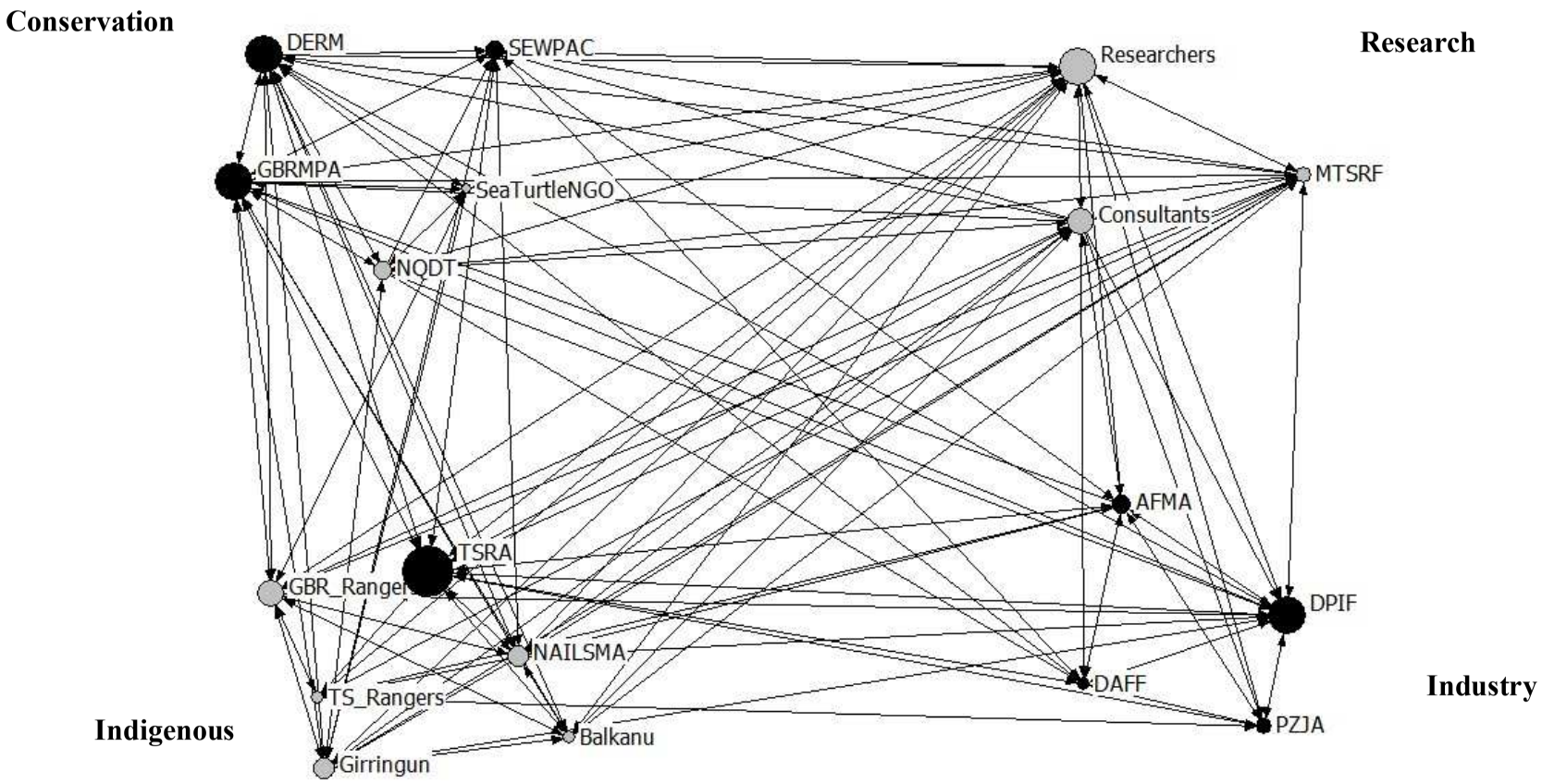


Figure 6.1: Diagram of knowledge exchange network connections, with actors grouped by institutional mandate. Size of note correlates to actor Betweenness Centrality—the larger the node, the more times an actor lies on the pathway between two other actors, thus acting as a potential broker or intermediary. Node colour denotes government actors (black), and non-government actors (grey).

One or two actors within each mandate group served as key coordinators, linking internal actors with each other and in some cases with other groups (Figure 6.2). Researchers tended to act as mediators between several Indigenous and conservation actors. The Queensland Department of Primary Industries and Fisheries, a state level government industry actor, linked with a variety of internal and external actors. Among Indigenous actors, the North Australia Indigenous Land and Sea Management Alliance (regional NGO) in particular played a key role in internal coordination, while the Torres Strait Regional Authority (federal government agency with regional responsibilities) had the most links to industry actors. Of conservation actors, the Queensland Department of Environment and Resource Management and the Great Barrier Reef Marine Park Authority (federal government agency with regional responsibilities) are the highest internal coordinators, and Queensland Department of Environment and Resource Management had the highest number of ties to other actors over all, especially to Indigenous actors. The federal Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) had the second highest number of overall ties.

6.3.3 Policy Influence

Industry and conservation actors showed the strongest amount of homophily for policy influence (Table 6.1 c). These two groups also had strong external ties to all other actors except researchers. Indigenous actors showed slight homophily but shared few ties with all other groups, while researchers shared higher than expected ties with Indigenous actors but fewer ties with all other groups, including themselves (or in the case of

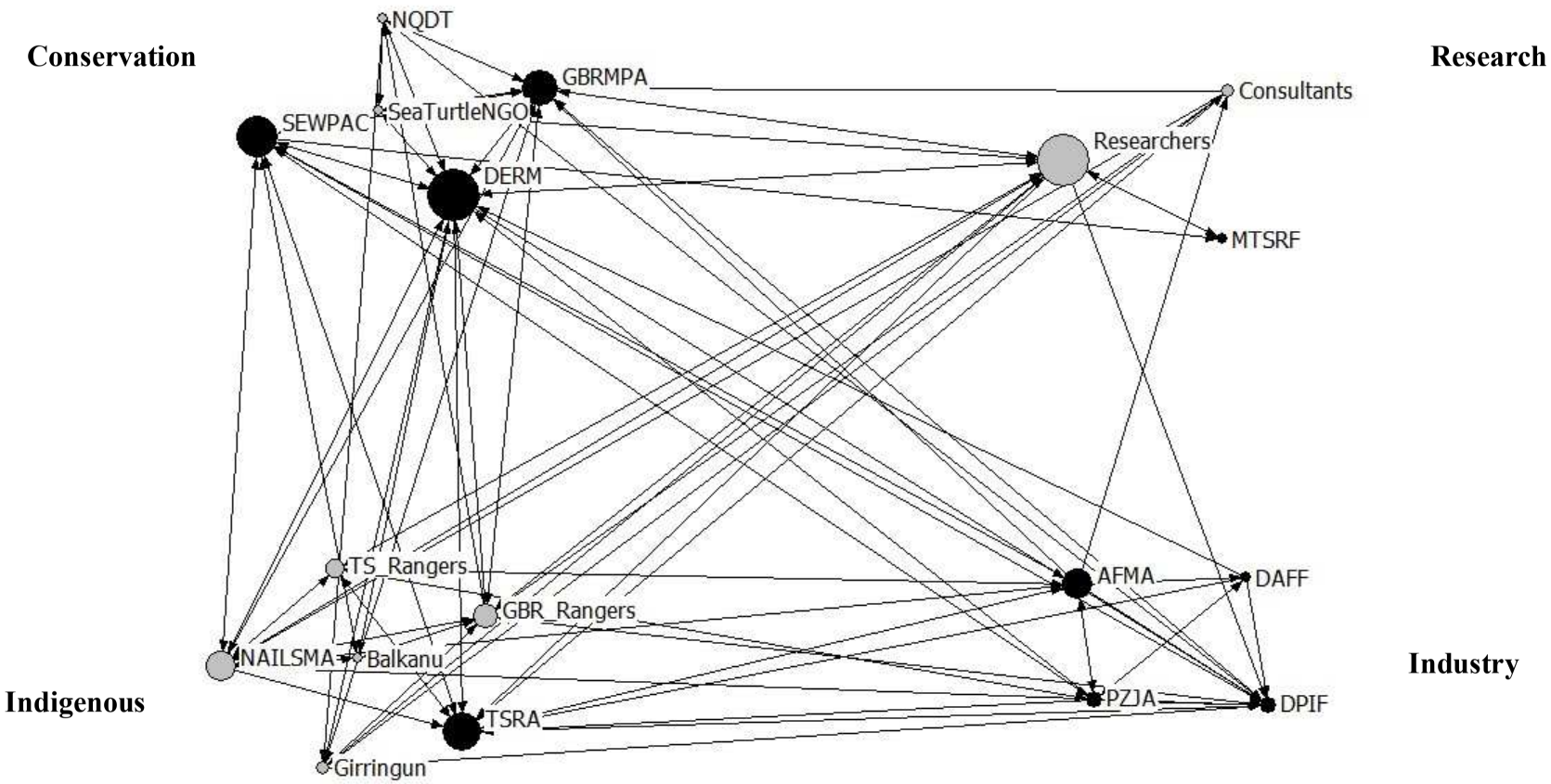


Figure 6.2: Diagram of coordination network connections, with actors grouped by institutional mandate. Size of note correlates to actor Betweenness Centrality—the larger the node, the more times an actor lies on the pathway between two other actors, thus acting as a potential broker or intermediary. Node color denotes government actors (black), and non-government actors (grey).

industry actors, no ties). Researchers received the least ties in this network, with no strong in-coming connections.

SEWPAC, which influences every other actor in the network, had the highest amount of links to other actors both within the conservation group as well as externally (Figure 6.3). The Queensland Department of Environment and Resource Management was the agency with the second highest number of links. Of the industry actors, the Australian Fisheries Management Authority and Queensland Department of Primary Industries and Fisheries were the two government agencies exerting the most influence on Indigenous and conservation actors. Most Indigenous actors had low impact on the policy network, except the Torres Strait Regional Authority which exerted some influence both within its own group and to external groups, presumably because of its unique status as an Indigenous government agency.

6.4 Discussion

The management of marine turtles and dugongs involves diverse interests and complex management decisions and encompasses several scales as well as cultural groups. While all actors included in my study network share an overarching goal related to the sustainable management of turtles and dugongs, the primary objectives, strategies, world views, and expertise among actors vary widely across my identified mandate groups. Some perspectives are complementary, while others create conflict or competition.

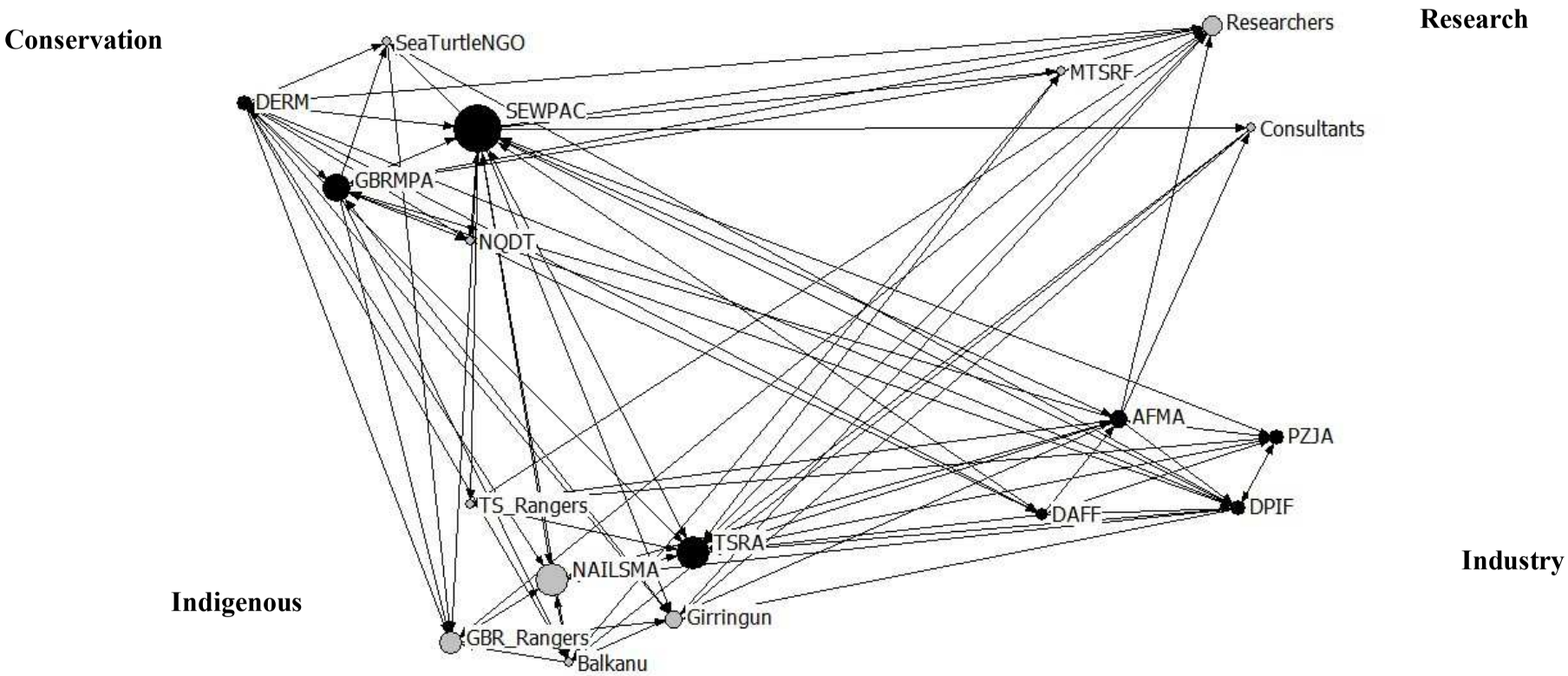


Figure 6.3: Diagram of policy network connections, with actors grouped by institutional mandate. Size of note correlates to actor Betweenness Centrality—the larger the node, the more times an actor lies on the pathway between two other actors, thus acting as a potential broker or intermediary. Node colour denotes government actors (black), and non-government actors (grey)

Weible and Sabatier (2006) presume that network interactions occur predominately with actors of shared policy core beliefs (i.e., actors within the same advocacy coalition), but with some cross-coalition interactions that occur partly due to functional interdependence or resource dependence. My network data suggest that the flow of information and the building of collaborative relationships are indeed constrained in large part by an actor's organizational affiliation, at least as it is represented by an institutional mandate and underlying management perspective. Policy influence, conversely, shows less organizational fidelity as it is exerted strongly both within and across mandate groups, and appears, predictably, to be dominated by well-resourced large government agencies which have statutory mandate.

6.4.1 Birds of a Feather…

Homophily dominates the knowledge exchange and coordination ties in my study network, indicating strong within-group relations for the majority of groups, with industry and conservation actors consistently sharing the highest amount of internal connections. Many of the actors in these two groups are large government agencies, confirming that government actors prefer to communicate with each other more so than with non-government organizations. A propensity for high internal knowledge connections, or 'bonding' ties, among all groups suggests that information for management may be shared densely within each mandate group, encouraging within-group trust and cohesion. Bonding social capital helps facilitate social solidarity and can potentially reduce group vulnerability (Munasinghe 2007).

Table 6.3: The Intergovernmental Dugong Taskforce represents an example of homophily in which government actors deliberated on turtle and dugong management issues with minimal direct consultation of other stakeholder groups, such as researchers and Indigenous representatives.

Membership of the Turtle and Dugong Taskforce:

- Australian Government:
- Australian Fisheries Management Authority
- Department of Employment, Economic Development and Innovation
- Department Sustainability, Environment, Water, Population and Communities
- Great Barrier Reef Marine Park Authority
- Torres Strait Regional Authority

State:

- Queensland Department of Employment, Economic Development and Innovation
- Queensland Department of Environment and Resource Management

Taskforce History:

- The Taskforce was established in 2010 following a round table discussion with Indigenous and fisheries stakeholder representatives to discuss hunting and by-catch issues; however this meeting was ill-received by Indigenous representatives due to a perceived lack of cultural sensitivity and appropriate planning on the part of the Taskforce
- The primary role of the Taskforce is to establish a comprehensive understanding of the existing dugong conservation, management, research and community engagement programs in Queensland coastal waters, and to recommend areas of improvement.
- To date, the Taskforce has made interim recommendations to the Australian and Queensland governments for improving compliance and enforcement measures, with a report to be shortly submitted to the two Ministers for consideration.
- In 2011, the Taskforce influenced the provision of $5 million from the Australian Government for the improvement of dugong conservation and management through increased engagement and capacity building of Indigenous stakeholders

Stakeholder Perceptions of the Taskforce

While the Taskforce has developed a general framework for engaging Indigenous communities in turtle and dugong management as well as integrating Indigenous and western scientific knowledge, the exclusively government membership and limited (or contentious) external consultations with non-government stakeholders has resulted in a lack of perceived legitimacy and transparency in the Taskforce's actions. Several interview participants in my study expressed concern regarding the limited engagement of external stakeholders throughout the Taskforce's lifespan. Others complained about the limited timeframes given for public comment and feedback and poor organization of round table and workshop events. The recently announced $5 million funding package may provide an opportunity to improve stakeholder relations by increasing Indigenous capacity for management decision-making and implementation at the community level, but it remains to be seen whether Indigenous representatives will gain a greater voice at larger government scales.

However, the existence of only moderate to low external connectivity, or 'bridging' ties, as occurs between all groups except researchers, limits the amount and diversity of new information introduced to the group and therefore imposes social norms that may discourage innovation and experimentation (Newman and Dale 2005). Excessively high network density and centralization with little cross-boundary communication may additionally reduce the effectiveness of collective action, or lead to homogenization of knowledge, ultimately reducing adaptive capacity within the network (Bodin and Crona 2009). In particular, the low number of ties between social groups and particularly between government and non-government organizations in the turtle and dugong management network is indicative of the limited capacity of this governance system to bridge experiential and scientific information from non-governmental sources with managerial knowledge wielded by government staff, as discussed in chapter 5. Information flow in the marine turtle and dugong management network is hindered in several ways, including the lack of coordinated knowledge sharing, irregular communication, and desire to retain ownership or hegemony over knowledge (see example in Table 6.3). This problem is exacerbated by the high staff turn-over rates within government agencies, and frequent changes to organizational structure. Information pathways are often opportunistic and reliant on individual relationships.

Similarly, in terms of management coordination most stakeholder groups in my study show strong homophily while only a few groups display significant external coordination (see Table 6.2 for an example of stakeholder homophily). This result aligns with the main tenant of advocacy coalition theory, which states that common policy beliefs are a good predictor of coordination networks, even more so than information/advice networks

(Weible and Sabatier 2006). Insufficient between-group coordination may result in redundant management strategies originating from institutions with competing mandates that are based on different knowledge bases and/or ideologies, and therefore conflict in their key objectives and outcomes. Lack of collaboration between several overlapping agencies with different mandates also hinders the development of inter-agency relationships necessary for comanagement decision-making. Indeed, several of my interview respondents pointed to these issues as major challenges in managing dugongs and marine turtles across Northern Australia (Table 6.3).

Cross-cultural information sharing and coordination between Indigenous and non-Indigenous managers is of particular concern in the marine turtle and dugong management network. While several research collaborations have provided Indigenous communities with the opportunity to combine aspects of their traditional knowledge with scientific information, my study demonstrates that there is still a lack of capacity, and possibly willingness, among non-Indigenous managers and policy makers to fully integrate traditional ecological knowledge into science-based management paradigms. Indeed, engagement across cultures and management scales remains inhibited by an inadequate understanding of the socio-cultural underpinnings of both Indigenous and Western knowledge systems, as discussed in chapter 4. My study shows that this inadequacy is most apparent between Indigenous managers and industry-based agencies, although the balance of power between Indigenous and conservation actors is still regarded as unequal (Table 6.3).

Table 6.4: Issues affecting network relations in the dugong and sea turtle co-management system as identified by interview participants.

Ineffective Communication

"A lot of times we'll talk with other NRM groups or government bodies on specific issues and then it just stops. So if we kept information sharing a lot more open, I assume that management strategies, management processes in sea country would be a lot more effective than it is to today." –Natural Resource Management Body staff

"Communication is impeded by just not even knowing that there's someone or some section or group to communicate to. So we've occasionally encountered times when we're doing something that is directly related to what another group is doing and neither of us knows about each other except by some serendipitous - it just happened." –Government Agency staff

Lack of Capacity

"I think a lot of times non-Indigenous people just don't understand. They don't have any knowledge at all about the Indigenous cultures they're working with—their law systems, their history, their culture, their traditions, the way knowledge works, all of that . . . So that capacity building I think of the non-Indigenous people can really help that." -Researcher

"We don't get a lot of funding, and each year we are cut back on our funding, usually. So, things like getting information on those dugongs and turtles is a really expensive exercise. So again that's why we try to get the outside organizations to do that . . . we steer them in the right direction to get the information we need which may not cost us anything." –Regional Government Marine Manager

Power Imbalance

"Advice for the policies should come right back from the grassroots because that's really, turtle and dugong specifically the biggest stakeholder in that group is the Torres Strait Islanders, so the advice for the policy should come from them." –Indigenous Agency Staff

"There's a tendency for non-Indigenous people or government people to say, 'well if you don't have any knowledge that's useful, you've got no role in managing that environment,' and effectively saying your rights to have a role [in management] is to do with your level of knowledge. And I definitely dispute that." –Consultant

Institutional Complexity

"There needs to be sort of formal approaches with consistent objectives from different agencies . . . Often there can be conflict with legislation . . . the day to day management is based on the legislation, and if that isn't good, and it isn't consistent, that can be really hard to make things happen in reality for these species." –Regional government marine manager

"Fishing is probably one of the most complex management issues on the reef because the role is split amongst at least three different government departments . . .So it's a bit of tense relationship about, you know, who takes precedent on an issue." –Regional government marine manager

Ideological Differences

"There are just so many different facets, so many different players, so many different dimensions to turtle and dugong management. We are talking about industrial activities, we are talking about community activities, we are talking research, we are talking about all sorts of things, as well as the science of managing these populations and the politics between governments." –National government agency staff

"I think the classic example of where we do have the clashing is in the fishing, where DPI is there, and while the principles of ecologically sustainable fishing are mentioned in their legislation, they focus more on the economic development side. Theoretically and in principle that shouldn't matter because to have economic viability you need your ecosystem functioning, so it should go hand in hand, but it often doesn't." –Regional government marine manager

6.4.2 Who is in control?

While policy influence ties show strong homophily within three of four mandate groups, this relational type also displays the highest amount of heterogeneous interactions. As opposed to knowledge sharing or coordination ties which tend to occur *within* groups, policy pressure is exerted *between* coalition groups which vie for political or jurisdictional dominance. Conservation actors, followed by industry actors, exert the most influence on other network actors. As mentioned previously, this pattern can likely be attributed to the fact that these two mandate groups are dominated by state and federal government agencies that hold the majority of resources and statutory authority in the management network. These dominant agencies are the most strategically positioned to articulate their policy core beliefs and enforce management policies based on these beliefs (Ellison 1998; 1998).

Policy influence in my case study may indeed be more related to institutional scale than to organizational mandate, with relations dominated by SEWPAC, which exerts some level of influence on every other actor in the network (the cross-scale dynamics within this network are explored in chapter 7). Additionally, ties in the policy network may reflect the choice of some actors who wish to connect with those whom they perceive as influential, regardless of their policy core beliefs. By making such connections, actors seek to gain external resources or achieve political objectives that would otherwise be unattainable (Weible 2005).

Researchers show weaker connections in the policy network as they typically do not play a direct role in management decisions, but rather provide knowledge and evidence for use by policy makers. The exception is the strong ties between researchers and Indigenous actors, indicating the key intermediary position held by researchers who often communicate on a much more individual level with Indigenous actors than do larger government agencies. Research collaborations with Indigenous communities have increased in the past decade as a result of explicit encouragement by organizations such as the Marine and Tropical Sciences Research Facility, as well as the nature of research work, which often requires significant amounts of time spent 'in the field' collecting data. The long-term focus of researchers is often valued by key Indigenous organizations that therefore support community linkages with research actors. Government agencies, on the other hand, are typically more time-constrained and lack sufficient capacity to work on the ground with community-level actors, especially over long time periods. Government staff members are also more likely to shift positions and/or levels of responsibility and thus may not retain long-term relationships with external stakeholders.

I found that Indigenous actors generally lack strong policy influence, especially with conservation actors, as most Indigenous stakeholders participate in management at the local level with only a few key regional Indigenous institutions representing their interests. This lack of engagement is of particular concern because many Australian Indigenous cultures do not feel comfortable with 'speaking' for others—i.e., having a few Indigenous individuals represent the views of several cultural groups—and instead support consultations at the individual community level. There is thus an evident inequity between Indigenous and conservation actors, many of which are regional or national

government bodies who often dictate environmental management legislation using a largely top-down approach. Government leaders often fail to link with disadvantaged groups, contributing to their further disempowerment (Munasinghe 2007). Indeed, the cultivation of empowerment and increased local participation in resource management is dependent on the subsidiarity principle—the decentralization of decision making authority to the lowest (or most local) scale at which it is still effective.

Ellison and Newmark (2010) contend that the advocacy coalition framework does not account for the fact that certain kinds of actors, specifically federal government agencies, will necessarily dominate policy making sub-systems due to their wide resource base, ability to control administrative processes, and capacity to maintain jurisdiction over critical policy areas. Ellison and Newmark go so far as to argue that "successful advocacy coalitions are dependent on agencies for leadership and the maintenance of belief systems (p. 671)," and additionally that "agency allies in advocacy coalitions seem to be dispensable to agencies." While federal agencies in my study network do indeed dominate policy influence relations, these same institutions are less prominent knowledge facilitators. Research actors, on the other hand, are key knowledge generators who link local actors to larger organizations; while they may not set the political agenda, these actors contribute meaningfully to the development of belief systems by mediating diverse knowledges and perspectives between multiple stakeholder groups. My network analysis suggests therefore that while politically powerful institutions may dictate policy direction, they do not necessarily control belief systems. At the same time, however, the limited ability of researchers to directly influence policy decisions of upper level government agencies indicates a disconnect between these two types of actors, and the

research presented in chapter 5 similarly points to the need for facilitation of bridging links between knowledge providers and policy makers and recognition of the bridging role as well as the knowledge production role of researchers.

It is also apparent from my study that successful advocacy coalitions must accrue sufficient resources and be able to access influential institutions if they are to contribute to policy direction, and that resource interdependencies can either facilitate or hinder such access (Smith 2000). The distribution of resources among advocacy coalitions, whether in the form of funding, information, or social capacity, is thus another factor along with shared ideologies that influences the pattern of relations among stakeholder groups. Thus, while several mid-level government agencies are well-placed to facilitate knowledge exchange among influential actors, many Indigenous actors still lack the resources, time, or social capacity to do so. A few key exceptions exist, notably the large Indigenous organization North Indigenous Land and Sea Management Alliance. This Indigenous NGO receives significant federal funding to coordinate region-wide natural resource management projects across northern Australia with a wide range of Indigenous communities. Additionally, the Torres Strait Regional Authority, as a government agency whose mandate is to strengthen the well-being of Indigenous Torres Strait Islanders, sits in a unique position to mediate between Indigenous community priorities and national objectives. As such, this agency plays one of the more significant roles in knowledge exchange, and to a lesser extent coordination, between non-government and government actors from different social groups. Even the communication and coordination capabilities of such large-scale organizations, however, do not yet extend to all

Indigenous communities affected by marine turtle and dugong policy decisions in the region, nor represent all of their concerns.

6.4.3 Bridging Boundaries

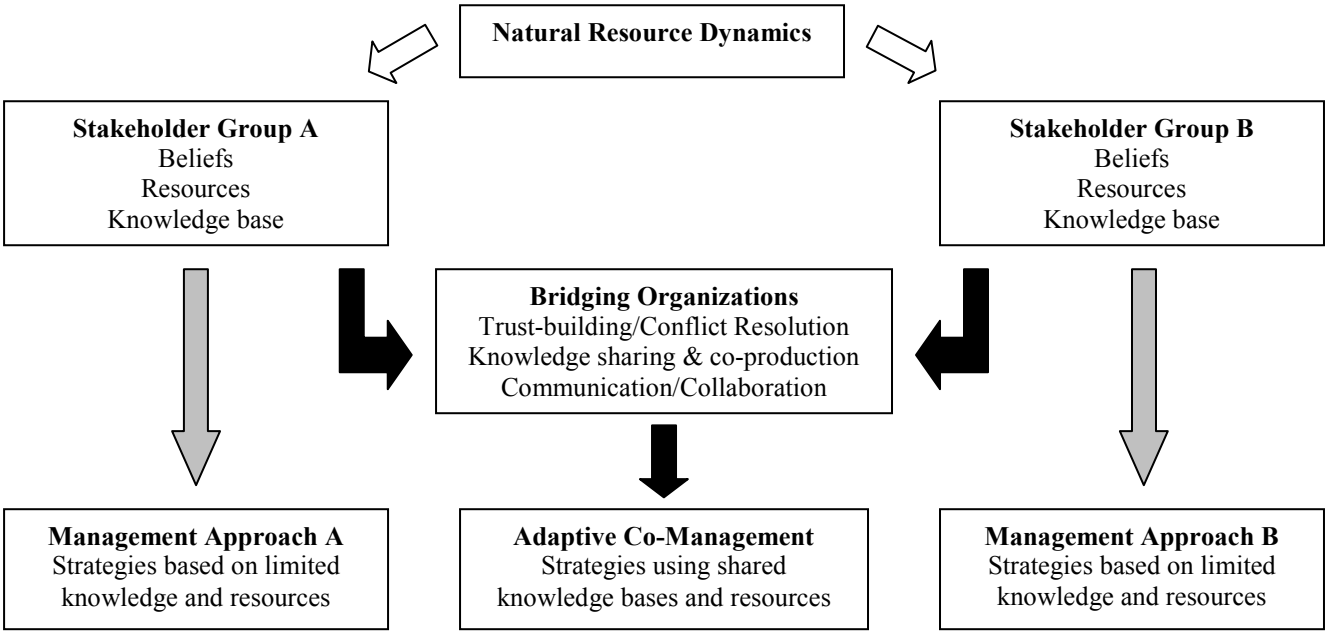
Functional, resilient comanagement networks require an adequate mix of both bonding and bridging ties in order to maintain internal trust and long-term relationships while still encouraging innovation and a diversity of perspectives. As Tompkins and Adger (2004, p. 8) found in their social network study on adaptation to climate change, "the integration of the different stakeholder groups, coupled with learning by the different agents involved in comanagement, contributed to a general sense of enhanced capacity to manage the problem, both its causes and consequences. It was generally perceived that this would over time translate into greater ecosystem resilience."

While in my study network all stakeholder groups typically have at least a weak tendency to interact, it is apparent that heterogeneous linkages, especially for management coordination, could be greatly improved. A few key actors are responsible for most internal and external linkages (Figures 6.1-6.3; also see chapter 5), acting as facilitators across resource and knowledge systems. These actors have the potential to provide opportunities for knowledge co-production, trust building, vertical and horizontal collaboration, and conflict resolution (Folke et al. 2005; Berkes 2009). Without such opportunities, management arrangements are likely to develop separately between various sub-groups of government agencies and private actors, resulting in a fragmented approach to marine species management. Managers from key bridging organizations need

to mobilize sources of information and understanding from different knowledge systems to generate greater social capital (Hahn et al. 2006). In addition, bridging organizations require added support in the form of enabling legislation and social incentives for collaboration (Malayang et al.2005). The incentives required to establish policy conditions supportive of comanagement have not been well defined in the literature (Armitage et al. 2008), but may involve, for example, the reduction of social and economic costs associated with management at various scales, or the development of informal coordination based on trust rather than formal policies which restrict or prohibit certain behaviours. The development of these kinds of informal processes will likely be dependent on the input of dedicated funds and motivated personnel.

Advocacy coalition framework theory argues that as conflict increases and groups become more polarized, interactions across coalitions will substantially diminish (Weible and Sabatier 2006). Yet, while discrepancies in political power between stakeholder groups contribute to tensions and conflict in the management system, they may also provide impetus for change and adaptation (Armitage et al. 2007; Marín and Berkes 2010). If bridging organizations exist to create forums for deliberation between various social groups who may be in conflict with each other, communication barriers can be removed as actors recognize that they have more power as a unified group than separately (Figure 6.4). This increase in between-group cohesion reduces the need for formalized institutional control while increasing opportunities to develop flexible, localized adaptive management strategies for marine resource management (Tompkins and Adger 2004).

Figure 6.4: Bridging organizations may provide several functions which support the development of adaptive co-management between various stakeholder groups (in this case coalitions based on shared policy mandates) and reduce fragmented management approaches. Diagram adapted from Hahn et al. (2006), Weible & Sabatier (2006), and Berkes (2009).



In my study network, researchers appear to play the most prominent role in bridging various stakeholder groups, providing a forum for discussions, knowledge exchange, and deliberation. Less developed are relations between industry actors, whose main concerns involve sustainable fisheries, and conservation actors, whose main concerns are protected species and habitat recovery/protection. In particular, research actors are the only group who show strong knowledge exchange with all other groups, and therefore play a crucial role in transferring knowledge. Researchers tend to maintain long-term knowledge bases and professional relationships compared with government or community-based institutions whose structure changes frequently due to political and economic shifts. In the marine turtle and dugong management network, most interviewed researchers were strong advocates of adaptive comanagement, working with Indigenous communities,

industry, and conservation institutions to integrate Indigenous and scientific data to inform management. As largely independent actors who are project- or issue-driven and often more flexible than government institutions, research actors are prime candidates for bridging actors who encourage trust-building, knowledge sharing, and collaboration between both formal and informal institutions (Hahn et al. 2006).

The extent that knowledge integration leads to comanagement, however, is still quite limited as evidenced by the lack of heterogeneous cooperative ties within the network. In order to bridge knowledge exchange and coordination, it is important to consider the institutions and practices which function upon different knowledge bases, rather than focusing on knowledge alone (Agrawal 2002; Ghimire et al. 2004). Often, barriers to participatory planning for resource management not only result from a lack of information or understanding, but also from social, cultural, and institutional factors (Tompkins and Adger 2004). For example, several government agencies show potential as bridging organizations, including the Torres Strait Regional Authority (an Indigenous agency), and the Queensland Department of Environment and Resource Management. The advantage of these organizations is that they each have formal institutional mandates which set established legal bounds to their jurisdiction and statutory authority. At the same time, however, these same legal bounds limit the extent of flexibility and adaptability of each institution, which potentially hinders the coordination of on-the-ground management with local institutions.

Prell et al. (2010) identified two kinds of institutional structures—formal and informal—which affect the actions of resource managers. Formal structures, which refer to

intentionally designed organizations based on laws and regulations, dictate many of the actions of the government agencies discussed above. However, informal structures, which are based on personal connections, beliefs, and communication networks, can also be influential in providing constraints and incentives for individuals to think or act in a particular way. Indeed, informal social structures may be more influential on stakeholder's perceptions than formal structures in certain cases. Thus, while I found that communication in the turtle and dugong governance system appears to occur more often between stakeholders from organizations with similar mandates, these communication links are dependent on the frequent interaction of individuals within organizations who are likely to have a strong influence on each other. Actors from government institutions may be more constrained by formal institutions than actors with non-governmental affiliations, resulting in the apparent communication gaps observed between these actors across stakeholder groups.

Possibly better suited for bridging functions are non-government institutions such as natural resource management bodies (e.g., North Queensland Dry Tropics, in my case study), and organizations such as the North Australian Indigenous Land and Sea Management Alliance. These types of actors, due to their less rigid institutional boundaries and more project-based organizational approach, are ideally situated to provide flexible leadership, knowledge transfer, forums for communication, and issue-focused collaborative projects. The challenge therefore is in directing sufficient financial and social capacity to such organizations so that they can fulfill these essential bridging functions. The support of government agencies and non-governmental institutions at multiple levels is crucial to the successful functioning of bridging organizations (Wilson

et al. 2006), and requires multiple coordinators and facilitators (Olsson et al. 2007). Greater recognition and support of the fundamental role played by bridging organizations and individuals, particularly researchers, in linking actors across scales and coalition groups is necessary in order to increase the capacity of actors within the marine turtle and dugong management network to successfully perform these valuable functions.

6.5 Conclusions

Using the combined lenses of social network theory and the advocacy coalition framework, I found that stakeholders involved in marine turtle and dugong management in northern Australia tend to share information and coordinate management with actors who share similar institutional mandates or ideologies, resulting in a network that exhibits a greater amount of homophily than heterogeneity of network connections. Research actors, as the only stakeholder group with significant amounts of heterogeneous knowledge ties, are vital to the exchange of information between various stakeholder groups due to their long-term relationships and institutional 'memory'. Researchers, however, play a lesser role in management coordination. Conservation and industry actors, many of which are state or federal government agencies with frequent staff turn-over and time constraints, exert the most policy influence on other stakeholders, but still rely on other actors for knowledge facilitation.

Ultimately, the dearth of heterogeneous linkages between different stakeholder groups, especially for management coordination, is likely a key limiting factor in integrating the economic, social, and environmental aspects of resilience in this governance system. To

increase the capacity to manage for social-ecological resilience, I suggest greater legislative and financial support for comanagement efforts, increased capacity building and resource distribution at all management scales, greater willingness among stakeholders to incorporate multiple knowledge sources/systems into decision making, and recognition of the multiple perspectives and resource rights which need to be considered when developing management.

While the belief systems upon which various stakeholder groups, or advocacy coalitions, are based are not always mutually exclusive, differences between group objectives and strategies create ideological divisions that require bridging by organizations appropriately situated to mediate and facilitate coordination. If the financial and social capacity of non-government organizations could be increased, these actors may be well suited to perform bridging functions that connect stakeholders from various backgrounds and scales to address specific resource issues, taking advantage of heterogeneous knowledge sources while building upon the communication and trust that exists within stakeholder groups. Finding a balance between 'bonding' and 'bridging' ties will support greater social learning and adaptive capacity while facilitating the integration of economic, social, and environmental aspects of resilience. Future exploration into the structural characteristics or other factors that favour the dominance of particular coalitions, and how various coalitions use resources or network position to their advantage, would provide additional information useful to characterizing the structure of more or less successful comanagement networks.

6.6 Summary

- This chapter explored patterns of homophily and heterogeneity of knowledge sharing, management collaboration, and policy influence among stakeholder groups of marine turtle and dugong management.
- Knowledge exchange and coordination occurred more frequently within stakeholder groups than between them, indicating high homophily for these relational types. Policy influence displayed a high amount of heterogeneous interactions, meaning that stakeholders frequently exerted policy influence on external groups.
- While homophily supports trust-building and communication within network sub-groups, heterogeneous linkages across groups are important for strengthening the network as a whole by supporting the integration of diverse knowledges, perspectives, and resources. Heterogeneity in the marine turtle and dugong network could be improved especially for management coordination.
- A few key actors provide (or have the potential to provide) bridging functions between stakeholder groups and thus facilitate greater heterogeneity of linkages to improve knowledge flow and collaboration among different stakeholders. Finding a balance between 'bonding' and 'bridging' ties will support greater social learning and adaptive capacity, leading towards improved social-ecological resilience.
- The next chapter provides further exploration of network actor relationships by exploring patterns of interaction within and across management levels to determine the extent of cross-scale communication and collaboration.

7

Overcoming issues of scale to improve natural resource governance: a case study of marine wildlife management in northern Australia

The previous chapters have examined various relationships among actors in marine turtle and dugong management, including cross-cultural knowledge sharing, the relationship between knowledge and power, and interaction across stakeholder groups. This chapter looks at another important type of network relationship—cross-scale interaction. I explore the extent that stakeholders interact across various jurisdictional levels and how these interactions affect the resultant resource governance framework. Cross-scale management collaboration is an important component of adaptive comanagement for social-ecological resilience. My study provides crucial information regarding patterns of cross-scale interaction among stakeholders in this governance system that will assist in improving future management design and implementation at multiple scales.

Manuscript associated with this chapter:

Weiss, KC, Hamann M, Marsh H (*in prep*). Overcoming issues of scale to improve social-ecological resilience in co-management systems. Target journal: *Marine Policy*.

7 Overcoming issues of scale to improve marine wildlife management in northern Australia

7.1 Introduction

The management of large, complex marine systems is challenging due to the numerous spatial, temporal, and institutional scales involved (Heikkila and Gerlak 2005). Cross-scale management can entail intense negotiation between an array of government and non-government stakeholders across jurisdictions, with different amounts and sources of knowledge, and fragmented management responsibility (Morrison 2006). In many cases of trans-boundary management, mismatches occur between human action and ecological systems, in which the jurisdiction of management institutions is not coterminous to the management problem being addressed, resulting in a lack of institutional 'fit' (Young 2002; Cash et al. 2006).

Migratory marine species management is particularly susceptible to scale mismatch between the ecological scale at which species operate and the scale(s) at which management strategies are developed and implemented (Berger 2004; Cumming et al. 2006). To address management complexity and scale issues, natural resource governance has steadily shifted toward more collaborative and participatory approaches, such as adaptive comanagement. Yet despite the emphasis placed on developing more flexible and inclusive governance, the impacts of social network structures and associated cross-

scale interactions on the capacity of resource governance systems to manage for social-ecological resilience have only recently become a central research focus in the field of natural resource management.

7.1.1 Characterizing Governance Systems

A central theme of natural resource management research is determining governance configurations that can manage for resilience; i.e., they are able to withstand or adapt to social or ecological change while maintaining basic structures and functionality (Walker et al. 2002; Lebel et al. 2006). Resource governance systems may range from monocentric structures in which the state is the centre of political authority and sets the management agenda from a top-down perspective, to multi-level governance systems that collaborate across clearly delineated administrative scales and levels, to flexible, adaptive governance that attempts to integrate management across scales that are complex and dynamic (Termeer et al. 2010).

Adaptive governance that also emphasizes collaboration among government and non-government stakeholders is often referred to as 'adaptive comanagement' in the resource management literature (see chapter 1, section 1.10). Briefly, adaptive comanagement is characterized by the accumulation of knowledge about resource and ecosystem dynamics, the development of iterative learning-by-doing processes that respond to ecological feedback, and the support of flexible institutions and organizations that promote social learning, trust building, and conflict resolution (Berkes and Folke 1998; Folke et al. 2005). Adaptive comanagement relies on the collaboration of diverse stakeholders, from

government authorities to community organizations, operating at different levels (Olsson et al. 2004). Stakeholder collaboration involves vertical linkages across these levels of organization, as well as horizontal linkages among actors within the same level, creating a network of stakeholder relations (Olsson et al. 2007; Carlsson and Sandström 2008). These linkages may represent flows of information, resources, or institutional arrangements between network actors. Information sharing between actor groups at different levels is seen as particularly important for supporting social learning processes that increase our understanding of cross-scale dynamics (Olsson et al. 2007).

According to Newig and Fritsch (2009), highly polycentric governance systems (i.e., those with multiple decision-making centres) that comprise many agencies and levels, yield higher environmental outputs than monocentric governance. Such systems display many of the features that define adaptive comanagement, and are better suited to cope with surprise and change, integrating information from multiple scales for improved decision-making (Berkes 2002). However, because the characteristics that support the development of adaptive comanagement will necessarily vary depending upon specific geographic, historical and institutional contexts (Armitage et al. 2007), innovative methods for studying resource governance in particular contexts must be considered.

7.1.2 A Social Network Approach

Network analysis is steadily becoming an integral tool for mapping the structure of resource governance systems and the patterns of stakeholder relations within them. According to Lebel et al. (Lebel et al. 2006), a society's ability to manage for resilience

resides in actors, social networks, and institutions. The structural properties of networks are assumed to influence the behaviour of actors and their interactions, therefore affecting the institutional arrangements regulating resource use and the resultant performance of the governance system (Marsh and Smith 2000; Sandström and Rova 2010). Based on empirical and theoretical studies of comanagement, Sandström and Carlsson (2008) suggested that networks characterized by a high number of ties (density), a diversity of interacting actors (heterogeneity), and sufficient ties to central actors (centrality) perform better than networks lacking those qualities in terms of providing improved decision-making efficiency/ability and resource mobilization. Analysing comanagement systems as governance networks has a number of implications, such as placing emphasis on the roles and functions of various actor groups, highlighting flows of resource sharing and dependency, and, most significant for this chapter, drawing attention to horizontal and vertical linkages among actors (Marín and Berkes 2010).

In this chapter I assess how cross-level network relations among actors at different jurisdictional levels of marine turtle and dugong management affect resource governance via the social processes of policy formation and implementation. I also explore how well the scale of policy choices 'fit' the social-ecological system they are designed to affect. I use the term "scale" in the sense of Gibson et al. (2000) and Cash et al. (2006), as the spatial, temporal, quantitative, or analytical dimensions used to measure phenomenon, and "levels" as the units of analysis located at different positions on a scale. The key question addressed in this chapter is: What is the extent of communication among actors operating at different jurisdictional levels in this system, and how does this impact the capacity to manage social-ecological resilience?

7.2 Research Methods

7.2.1 Data Collection

Between 2008 and 2010, in-depth semi-structured interviews and follow up surveys were conducted with 30 key-informant stakeholders in dugong and turtle management at all relevant institutional scales to ascertain flows of knowledge exchange, coordination, and policy influence throughout the management network. Details of interview and survey methodology can be found in chapter 3 (section 3.2.3).

7.2.2 Data Analysis

I quantitatively assessed the structural characteristics of the marine turtle and dugong management network using social network analysis as explained in chapter 3 (section 3.3.2.4). Network data for this chapter were represented visually using the principal components layout in Netdraw (Borgatti 2002) to identify the key actors for each of the three network relations studied. For this portion of my study, I focused on the specific analyses described in the following section.

7.2.3 Analysing cross-scale interactions

Jurisdictional scale is typically defined by bounded and organized political units such as villages or towns, counties, states, and nations, with linkages between them created through statutory processes (Cash et al. 2006). The actors in my study network were grouped into four observable jurisdictional levels based upon the scale at which each actor contributes to marine turtle and dugong management and/or policy: (1)

local/community; (2) regional non-government; (3) regional government; and (4) national (Table 7.1). Local actors in my study consisted mainly of Indigenous rangers and small NGOs. Researchers and consultants, while they may operate at a variety of scales, were considered 'local' actors in the context of this study as their work (e.g., field research, consultations) generally takes place within distinct communities and localized geographic locations. Regional non-governmental actors included natural resource management (NRM) bodies that operate within identified bioregions, and Indigenous organizations that represented several communities. Regional government actors included Queensland government agencies and federal agencies operating specifically at a regional level; for example, the Great Barrier Reef Marine Park Authority, while a federal agency, has legal jurisdiction only within the Great Barrier Reef World Heritage Area. National actors consisted of federal government agencies whose jurisdiction is Australia-wide.

A focus on four particular jurisdictional levels is unlikely to encapsulate every existing scale relevant to the management of natural resources; administrative boundaries, infrastructural links, community limits, and informal networks do not always correspond with physical or politically-delineated boundaries (Lovell et al. 2002). However, the four levels I highlight in my study are those which most clearly dominate formal institutional linkages within the resource governance system, and therefore served as an appropriate basis from which to analyse cross-level and cross-scale relations (Young 2006). Moreover, my approach allowed me to assess where gaps may exist between particular levels, and whether responsibilities of various agencies conflict due to jurisdictional overlap; i.e., where divisions among jurisdictions are unclear (Termeer et al. 2010).

Table 7.1: Actors included in the dugong and turtle management network study, grouped by institutional mandate. For organizational type, G = Government agency; NG = non-government organization or actor

Institutional Mandate	Actor	Organizational Type	Abbreviation	Geographic Location
Industry	Australian Fisheries Management Authority	G	AFMA	Canberra, ACT
	Dept of Agriculture, Fisheries, and Forestry	G	DAFF	Canberra, ACT
	Dept of Primary Industry and Fisheries	G	DPIF	QLD, various cities
	Torres Strait Protected Zone Joint Authority	G	PZJA	Canberra/Torres Strait
Indigenous	Balkanu Cape York Development Corporation	NG	Balkanu	Cairns, North QLD
	Girringun Aboriginal Corporation	NG	Girringun	Cardwell, North QLD
	Great Barrier Reef Indigenous rangers	NG	GBR Rangers	QLD, multiple communities
	North Australia Indigenous Land and Sea Management Alliance	NG	NAILSMA	Darwin, NT
	Torres Strait Indigenous rangers	NG	TS Rangers	Torres Strait, multiple islands
	Torres Strait Regional Authority	G	TSRA	Thursday Island, Torres Strait
Conservation/ Management	Dept of Sustainability, Environment, Water, Population, & Communities	G	SEWPAC	Canberra, ACT
	Great Barrier Reef Marine Park Authority	G	GBRMPA	Townsville, QLD
	QLD Dept of Environment & Resource Management	G	DERM	QLD, various cities Townsville, QLD
	North Queensland Dry Tropics Natural Resource Management Body	NG	NQDT	Townsville, QLD
	Sea Turtle Foundation	NG	STF	
Research	Academic researchers	NG	Researchers	QLD, various cities
	Independent Conservational and resource mgt consultants	NG	Consultants	QLD, NT, various cities
	Marine & Tropical Research Facility	NG	MTSRF	North QLD

To measure the extent of cross-level exchange within each network type I counted the number of ties between actors within a level and between actors across levels. Using the Relational Contingency Table analysis function in UCINET, the actual number of relations within and between levels was then compared to the number of relations that would be expected by chance alone assuming complete independence, and p value was calculated to determine whether each value significantly deviated from values that would occur under a random network model. When significant, an observed versus expected ratio above 1.0 implies a higher than expected number of observed relations among those particular groups while values below 1.0 imply a lower than expected number of observed relations. As per Crona and Bodin (2006), I categorized the strength of a relation as "strong" if the ratio exceeded 1.0, "medium" if the ratio was between 0.5 and 1.0, and "low" if the ratio was below 0.5.

7.3 Results

7.3.1 Knowledge exchange

Knowledge exchange exhibited high homophily values except among local actors (7.2 a), but significant cross-level exchanged was observed in several cases. The national level showed the highest degree of internal knowledge exchange, and also showed higher than expected links with regional government, but had minimal knowledge sharing with regional NGOs and local actors. Regional government agencies also had a low frequency of links to local actors, but had slightly higher than expected linkages with regional NGOs and national actors. Local actors showed high linkage rates with both regional government and non-government actors.

A network diagram of the knowledge network data (Figure 7.1 a) indicates that researchers and consultants played the most notable role in information exchange.

Research actors had the highest number of outgoing ties, exhibiting approximately 88% of all possible connections (Table 7.3). Regional government agencies, as well as two regional NGOs, competed as the most well-connected actors after researchers and consultants. The Torres Strait Regional Authority, although not the most central actor, showed the highest Betweenness value among all network actors, at over three times the mean (keeping in mind however that mean Betweenness for knowledge exchange was quite low; Table 7.3). Regional actors, along with one group of local actors (Indigenous rangers in the Great Barrier Reef Region),and two national agencies (the federal Department of Sustainability, Environment, Water, Population and Communities (SEWPAC), and Australian Fisheries Management Authority) played moderate roles in information sharing. Other local and national actors held peripheral positions in the knowledge exchange network.

7.3.2 Coordination

Coordination linkages within levels were strong at only the regional government and national levels (Table 7.2 b). Low coordination occurred among local and regional non-government actors. National level actors predictably had minimal coordination ties with the local level, and only moderate coordination with regional NGOs, but exhibited high rates of coordination with regional government agencies. Interestingly, these regional agencies, in turn, showed higher than expected links with all levels except regional NGOs. Local actors on the other hand

Table 7.2 a-c: Ratio of the measured vs. expected number of ties between each actor group. Within group values are in bold. The deviation of observed ties from randomness was statistically significant for all three network relations ($p < 0.01$).

a. Knowledge Network

	Local	Regional NGO	Regional Gov't	National
Local	**0.99**	1.01	1.22	0.72
Regional NGO	1.22	**1.17**	1.22	0.72
Regional Gov't	0.79	1.01	**1.44**	1.08
National	0.12	0.12	1.32	**1.8**

b. Coordination Network

	Local	Regional NGO	Regional Gov't	National
Local	**0.96**	1.1	1.43	0.18
Regional NGO	0.88	**0.41**	1.21	0.55
Regional Gov't	1.1	0.66	**1.52**	1.29
National	0.18	0.55	2.39	**1.84**

c. Policy Network

	Local	Regional NGO	Regional Gov't	National
Local	**0.58**	0.58	0.69	0
Regional NGO	0.58	**0.43**	0.58	0.77
Regional Gov't	1.15	1.27	**1.88**	1.35
National	1.54	1.35	2.5	**2.41**

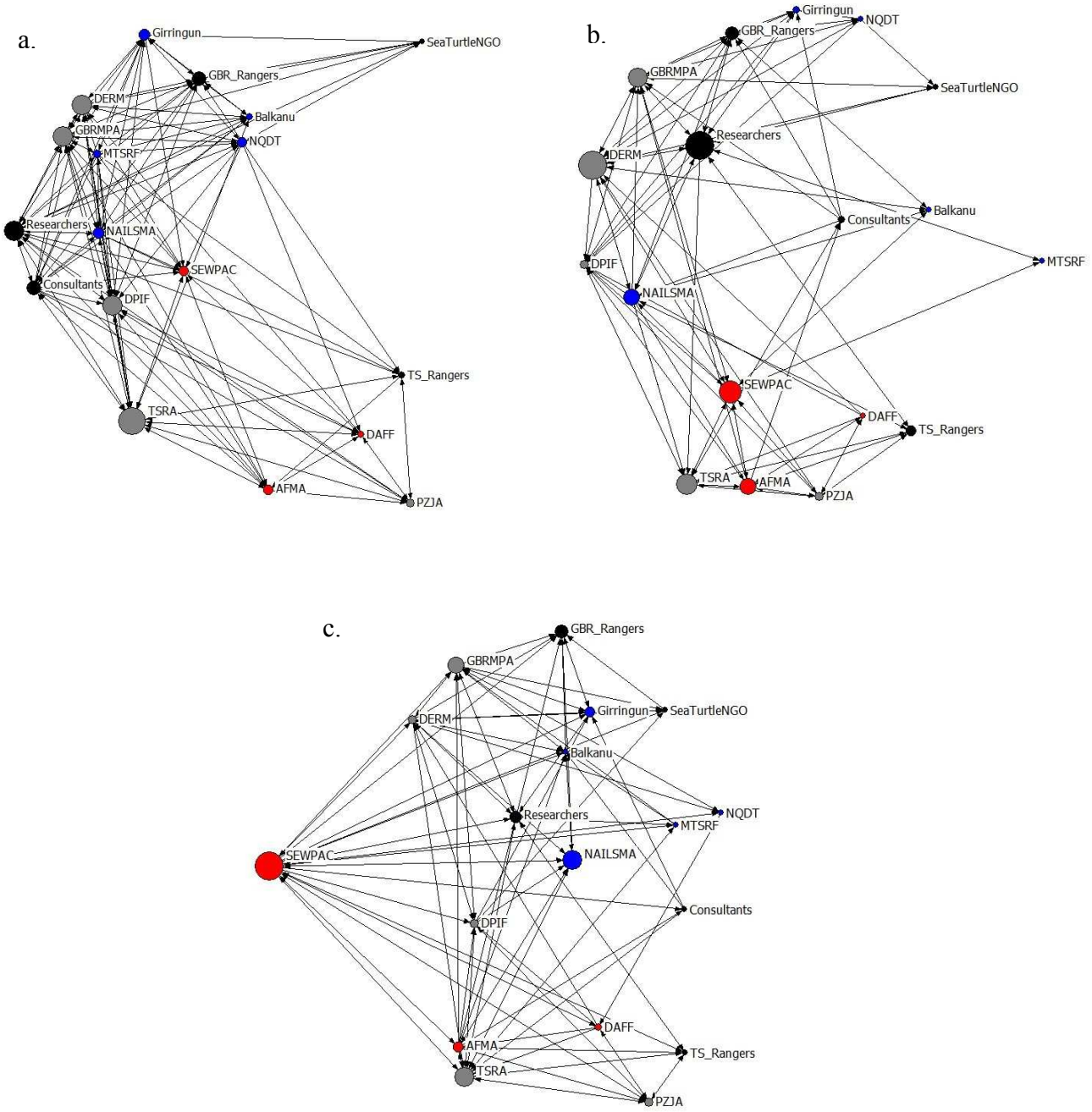


Figure 7.1 (a-c): Network diagrams using Netdraw's Principal Component layout for a) knowledge exchange, b) coordination, and c) policy influence. Actor centrality decreases from left to right. Size of actor node correlates with the Betweenness value for each actor (i.e. the number of paths in the network that pass through that actor). Colour correlates with jurisdictional level (red = national, grey = regional gov't, blue = regional NGO, black = local).

Table 7.3: Mean and highest Out Degree and Betweenness values (± Standard Error with 95% confidence) for each of the three tested network connections. Definitions of Degree Centralization and Betweenness are given in chapter 5 (section 5.3).

	Knowledge Exchange	Coordination	Policy Influence
Mean Out Degree (%)	55.56 (± SE 8.53)	36.28 (± SE 7.4)	34.64 (± SE 10.80)
Highest Out Degree (%)	88.24 (Researchers)	64.70 (DERM[1])	100.00 (SEWPAC[3])
Mean Betweenness (%)	2.88 (± SE 1.04)	4.80 (± SE 2.30)	5.31 (± SE 2.83)
Highest Betweenness (%)	8.38; (TSRA[2])	14.65; (Researchers)	22.76 (SEWPAC[3])

[1]Queensland Department of Environment and Resource Management. [2]Torres Strait Regional Authority. [3]National Department of Sustainability, Environment, Water, Population, and Communities.

displayed slightly higher than expected links with regional NGOs, as well as higher linkage rates with regional government actors.

The network diagram for management coordination again illustrates that state level actors were generally the most central to this relation type (Figure 7.1 b). In particular the Queensland Department of Environment and Resource Management had the highest Out-Degree at 64.7%, almost double the mean (Table 7.3). This same agency nearly tied with researchers for the highest Betweenness value at 14.41%, nearly four times the mean. Researchers, the North Indigenous Land and Sea Management Alliance (Indigenous NGO), SEWPAC, and the Australian Fisheries Management Authority remained moderately central, while other actors were more peripheral.

7.3.3 Policy Influence

Both the regional and national government actors showed quite high homophily for policy influence ties, whereas the local and regional NGO actors did not (Table 7.2 c). The pattern of policy influence in the dugong and marine turtle governance system exhibited a distinct managerial hierarchy flowing from government to non-government actors; the national level

had high rates of policy influence at all jurisdictional scales, while regional government actors displayed slightly lower but still significant links with all levels. Conversely, regional non-government and local actors had only moderate linkage values for policy influence, whether within or across levels—and local actors had no observed direct policy influence on national actors.

The network diagram for policy influence illustrates that SEWPAC was by far the most central actor (Figure 7.1 c), and indeed had an Out-Degree of 100%, signifying that the agency had policy links to every other actor in the network. This agency also had the highest Betweenness value at 22.76%, nearly 5 times the mean (Table 7.3). A series of state and national agencies, though much less influential than SEWPAC, secured the second highest tier of policy influence. The remaining network actors exhibited moderate to low policy influence at all levels.

7.4 Discussion

Key symptoms associated with scale mismatch in a governance system include evidence of resource-related conflict, feelings of powerlessness in the system, and possible changes in ecosystem function or biodiversity (Cash et al. 2006). My analysis of the turtle and dugong governance system identified each of these symptoms to varying extents, particularly in regards to a lack of stakeholder empowerment at lower management levels. Apparent conflicts over how dugongs and marine turtles should be managed, and the extent they should be harvested, were also described by interview participants, resulting from scientific research

indicating possible declines in several populations of these species. The effects of scalar issues on this governance system are discussed in greater detail in the following sections.

7.4.1 Knowledge pathways

Effective multi-scalar resource governance relies upon information flows and feedback between higher level policy makers—who constrain activities at lower levels—and lower level resource managers and users, who ideally provide information upwards regarding the feasibility and acceptability of broader constraints (McDaniels et al. 2005). In the marine turtle and dugong management system, knowledge sharing tends to occur more frequently within rather than between jurisdictional levels, but significant vertical linkages do exist in several cases, indicating a certain amount of cross-level communication necessary for effective decision-making that considers social and ecological dynamics at multiple scales.

That regional actors provide significant amounts of information upwards to national actors additionally suggests that broad-scale legislative decisions are at least in part based upon information that incorporates the knowledge, expertise, and values of lower level stakeholders (keeping in mind that regional actors still generally operate at a relatively broad geographic scale). While this is a positive step toward cross-scale resource management, my concurrent research (discussed in chapter 6) shows that information exchange in this management system tends to occur primarily between stakeholders with like-minded institutional mandates (and by proxy, similar perspectives regarding resource management), while actors with differing mandates are less likely to communicate. For example, conservation agencies may communicate with each other across scales, but are less likely to maintain cross-scale linkages

with Indigenous organizations, industry actors, or other stakeholder groups. Thus, information may span multiple management levels but only reach certain actors, limiting innovation and knowledge diversity. These particular horizontal and vertical linkages may promote individual institutions without contributing to the flexibility, trust, or adaptability of the overall management structure (Adger et al. 2005).

Even actors with similar institutional mandates operating at different jurisdictional levels often find it difficult to maintain communication pathways in the face of political power struggles (Table 7.4). Cross-scale linkages associated with multilevel governance systems, moreover, can be costly (in terms of time and effort) to develop and maintain (Hooghe and Marks 2003; Termeer et al. 2010), which can result in highly asymmetric knowledge accumulation within the governance system favouring better resourced actors (Adger et al. 2005). Powerful high level actors typically accumulate and disseminate information perceived to be relevant, while local actors' knowledge (and associated values) may go unheard (Cumming et al. 2006).

Information sharing between stakeholders at different levels in the system is facilitated mainly by researchers, who generally operate at local scales but maintain links with over 80% of network actors. These linkages help reduce the mismatch of knowledge at various spatial and jurisdictional scales in cases where researchers are involved in the collection and distribution of scientific and/or local knowledge. Regional non-government actors, too, maintain several cross-level links to local actors and regional government agencies, providing important bridging functions between actors such as Indigenous communities and fisheries management bodies. However, neither researchers and other locally-based actors, nor regional NGOs, maintain high rates of information exchange with federal government agencies. Instead,

national actors appear to rely on their connections to regional government agencies for information, making these agencies the key go-betweens in the network in regards to important knowledge. As long as regional government actors have the capacity to transmit knowledge between lower and higher level actors, vertical and horizontal information flow in the network is strong. However, issues identified by interview participants, ranging from lack of sufficient funding to conflicting management ideologies, may hinder sufficient knowledge flow between diverse actors in the turtle and dugong governance system.

No single jurisdiction or stakeholder group is likely to possess a sufficient range of knowledge to manage complex resources such as migratory wildlife. Actors at each level have 'scale-specific comparative advantages' (Cash and Moser 2000)—local institutions are best informed about local conditions (e.g., state of local marine species populations; livelihood needs of community members), while upper management levels have a regional and national vantage point and a repertoire of tools and resources (e.g., large scientific databases; expert panels) not typically available to local institutions (Berkes 2009). When information is not adequately available across levels, mismatches can occur between the scale of knowledge wielded by an organization and the scale at which they manage the migratory species, made worse if appropriate monitoring frameworks do not exist. As a result, the type and extent of knowledge acquired about a resource problem may be inadequate for making well-informed management decisions; available information may be incomplete or incorrect, making it difficult to understand the significance of a problem (Cumming et al. 2006). Many marine turtle and dugong managers expressed such concerns about the scale of knowledge applied to species management, especially in regards to cross-cultural challenges (Table 7.4).

Unfortunately, the hierarchical structure of policy power in the turtle and dugong management system (discussed in more detail below) limits social learning, equitable power distribution, and trust-building across levels, resulting in less than desired linkages for management coordination between actors across jurisdictions. I elaborate on patterns of observed coordination and their effects on the turtle and dugong management system in the following section.

7.4.2 Management Coordination

Similar to patterns of knowledge exchange, management coordination appears to be concentrated in regional government agencies, the only group with which all other levels share high linkage values. Conversely, the number of ties between local and regional non-government actors was relatively low, an unexpected result considering that researchers, Indigenous groups, and NRM bodies are active at these levels. While collaborations exist between certain of these groups, my data highlight the wider disconnect among such small-scale collaborative management efforts throughout the region. The North Australia Indigenous Land and Sea Management Alliance is the only non-governmental (and Indigenous) organization to play a significant coordination role, connecting Indigenous stakeholders and other actors from certain communities throughout the region.

Equally troubling is the paucity of coordination among regional non-governmental actors within the study area. As indicated by interview participants, many resource management bodies in this study function independently of each other and reflect a narrow subset of place-based priorities, methods, and perspectives which have yet to be integrated at a broader managerial scale. The result is a spatially fragmented approach to species management in which

each regional management body follows its own species conservation strategy without adequate coordination across the species' ecological range. Fragmented management of this kind is indicative of a mismatch between the scale of the ecological process or system being managed (in this case, several migratory marine species) and the scale at which management institutions operate (Cumming et al. 2006), indicating a lack of adaptive management. The consequence of these mismatches is a potential loss of social-ecological resilience in the governance system.

Why is coordination between regional non-government actors so low? Interview participants from regional organizations sited a number of challenges to inter-regional management, including policy constraints from higher management levels, the difficulty of accessing sufficient information, and a lack of capacity due to inconsistent and inadequate funding schemes (Table 7.4). One participant discussed the additional difficulty of addressing local needs when the majority of available funding originates with national government agencies that require recipients to address national, rather than regional and local, priorities. These concerns highlight fundamental problems associated with government funding schemes, both in terms of the competitive, anti-collaborative nature of the schemes, and the constraints placed on recipient organizations. Thus it appears that not only is collaboration in turtle and dugong governance hindered by a hierarchical policy system, but also by a flawed funding process that discourages cross-regional cooperation.

Another challenge is that the jurisdictional limits of regional NRM bodies are determined mainly by geographic features (e.g., bioregions), while regional Indigenous organizations operate at scales derived from complex socio-cultural relations and histories. Not only do these

Table 7.4: Management issues identified by interview participants (with exemplary quotes given), and the associated implications for turtle and dugong governance.

Issue	Examples	Implications for governance system
Competition for knowledge hegemony	"It can be quite distressing when we see things going in the direction we don't believe they should be going, and we don't appear to be in a position to do much about it because it's [sic] high level political decisions . . . we're actually on the spot, and we know what is happening up here. We know the local feeling." –State level marine manager	Expertise and advice from actors at lower levels goes unheeded by actors at higher levels, prohibiting collaboration and communication
Legitimacy/Trust	"I think we have a responsibility as managers and Government agencies to ensure that there isn't an imposed solution that's forced on people and on the region that might not necessarily have any practical affect on the sustainable management of the species. Because people can I suppose reject those imposed management solutions. And they can actually be counter to the desired environmental outcomes." –Indigenous marine manager	Devolving decision-making power to regional and local institutions increases management legitimacy, trust, and stakeholder involvement and compliance.
Limited scope of knowledge	"The problem is that today dugong numbers have been affected outside of the tradition—a range of impacts that the traditional owners may not have the knowledge or information or data to use in a decision making process within their own country in terms of modifying the catch from a higher level to a lower level or even to zero." –Indigenous researcher	Knowledge accrued at one scale regarding the species in question is unlikely to be adequate to make management decisions across the range of the species. Need to promote the respect for and integration of multiple knowledge sources across management levels and scales.
Competition for limited resources	"You want to use this money for your area, and you're just assuming what's happening outside that area is ok, because another agency is responsible for that. So you're not too keen to find out whether they are doing it properly because you don't want to have to funnel some money in that direction. It's not right, because as we've said, these species aren't going to do so well if we don't all start talking and make sure we're all working in the same direction.." –State level marine manager	Institutions dependent on unpredictable government funds compete with each other for limited resources, rather than working cooperatively. Obligations to high level funding bodies constrain ability of recipients to address local level priorities.
Jurisdictional overlap/fragmented management	"The threatening processes that act on the creatures are varied, complex, and quite often in the control of a different jurisdiction . . . We control the activity that can be conducted within a certain zone. So we have a partial sphere of influence there. We don't have a complete sphere of influence." –State level marine manager	Management frameworks and/or policies are not necessarily compatible across jurisdictions and thus create confusion and tension. Lack of regional coordination limits effectiveness of management efforts at individual scales.

actors' jurisdictions overlap with each other in many areas, but they also overlap with both higher and lower jurisdictional levels to create a complex management mosaic in which the authority to make species management decisions is constrained by—or deferred to—more powerful government actors, notably the Queensland Department of Environment Resource Management and the Great Barrier Reef Marine Park Authority. This tension between rigid governmental levels and more fluid regional boundaries has been observed by other authors; Hajer and Wagenaar (2003), for example, deem this mismatch the 'regional gap' or 'institutional void'. To coordinate management of migratory marine species across jurisdictions, better integration of institutional, ecological, and socio-cultural management scales is necessary. From a bureaucratic governmental perspective, however, such cross-level integration blurs jurisdictional boundaries, creating redundancies and conflicts of responsibility. Indeed, many interview participants expressed their frustration at trying to navigate the jurisdictional complexity within the turtle and dugong management system (Table 7.4), again indicating that this multilevel governance system lacks the capacity to integrate cross-scale and cross-level linkages into an adaptive governance approach.

A disconnect between national government agencies and local/regional non-government actors indicates a potential communication gap in the governance system that may contribute to some of the tensions and constraints identified by interview participants. While it would be impractical for national agencies to attempt to engage stakeholders at local scales, there is room for increased participation by national agencies in helping to integrate dugong and turtle management into more comprehensive strategies throughout

the species' ecological ranges at more appropriate social-ecological scales, as opposed to fragmented species management across several overlapping state and private actors.

In contrast, regional and national government actors of the marine turtle and governance system had more extensive coordination linkages within and between their respective levels. Indeed, national actors had a very high value for coordination with regional government agencies, despite having much lower values with other actor levels. Regional government agencies are therefore in a position to potentially provide important bridging functions to coordinate between local actors, NGOs, and national agencies, if linkages between these regional agencies and non-government actors at lower levels could be increased and maintained.

7.4.3 Influencing Policy Direction

The evident political hierarchy, in which policy influence decreases with each lower jurisdictional level, resembles the monocentric governance framework described by Termeer (2010). SEWPAC has policy influence ties to every other actor in the network, only a fraction of which are reciprocal. Federal management authority stretches across all management levels despite the comparatively lower amounts of knowledge exchange and coordination emanating from this level. As opposed to adaptive governance systems, monocentric governance proponents tend to reject informal arrangements encompassed in regional cooperation because they may obscure the distinct responsibilities of each autonomous municipality (Loughlin and Peters 1997; Schaap 2005). As a result, cross-

level interactions or integration is often discouraged, in favour of amalgamation or structural changes of the layered system.

Some of my interview participants expressed concern that the national government does not appear to consider the institutional arrangements necessary for connecting national priorities to local needs and aspirations. While a national agenda for marine turtle and dugong conservation can provide the broad framework within which to coordinate various regional management strategies, national actors need to consider how to better link national priorities with regional perspectives and capacities. The turtle and dugong governance network does display some cross-level exchange of information and collaboration, but these linkages are largely maintained by a few key actors (e.g., researchers, state government agencies) whose capacity to maintain strong bridging functions is limited, as discussed in chapter 5 and chapter 6. In order to achieve more adaptive, multilevel governance, key decision makers in the system will need to move beyond efforts to address resource management issues at individual scales, and instead provide greater support for flexible, cross-level and cross-scale linkages for integrated management.

Similar to the approach of many other federal governments (e.g., in the United States), SEWPAC tends to organize marine mammal management with a single-species focus driven by population assessment research and monitoring programs. This approach is not always compatible with that of other stakeholders such as Indigenous Traditional Owners, who consider themselves custodians for marine turtles and dugongs within their historical sea 'country' and prefer to manage their marine resources in a more holistic

manner. Although many government agencies put forth policy position statements which stress the need to balance species conservation with traditional rights to resource extraction, wider societal concerns and public opinion often outweigh Indigenous perspectives in government decision-making. My analysis of this governance system indicates that local actors such as Indigenous communities currently have a limited ability to affect species management decisions at upper management levels, although certain actors (especially in Torres Strait) have ties to intermediary organizations that are better connected to large government agencies. Empowering these actors requires an increased capacity to work across multiple scales, bridging the gap between the larger administrative levels and localized geographic areas where the ramifications of social and environmental policy are most strongly felt (Williams 1999).

Many regional and local actors would argue that management decisions made at the national level are largely less effective than those made at lower levels, especially when such decisions are not backed by sufficient funding or dedication of personnel. These actors stressed the need for the national government to allow lower level actors to define the scales of management most appropriate to them. This engagement would allow Indigenous communities, for example, to develop management strategies that encompass their entire sea 'country', or traditional territory, whereas currently these traditional territories are often partitioned between multiple government jurisdictions. The scale at which management issues are framed, and by *whom* they are framed, has important implications for determining the most appropriate level at which to address the issue, and also which interests are seen as relevant to the policy making process (Meek 2011). Empowering lower level actors to re-define the scale at which they address turtle and

dugong management would acknowledge the legitimacy and importance of local needs and interests alongside state and national considerations.

Devolution of decision-making power, as encompassed by the subsidiarity principle, implies that decisions affecting peoples' lives should be made by the lowest capable level of social organization (McCay and Jentoft 1996); i.e., those closest to the resource or problem. One of the cited limitations of centralized management is the tendency for national government policies to focus on a narrow aspect of conservation, such as individual species, whereas lower level jurisdictions tend to incorporate species conservation into integrated habitat management strategies. Another benefit therefore of localized decision-making is the likelihood of increased stakeholder support and compliance for the management plans (Table 7.4). One interview participant attributed the advantage of devolving decision-making power to Indigenous communities in particular to the "non-transferable interest in a species or environment" held by community members, who consider themselves custodians of their traditional land. As such, these individuals have access to "their own cultural knowledge and scientific knowledge", and are "much more likely to make a sensible management decision" than government officials at higher management levels who are constrained by legislation and electoral cycles. The concept of a non-transferrable interest in localized resource management aligns with many authors' findings that participatory local governance is more likely to produce ecologically rational outcomes than governance at higher levels (Leach et al. 2002), due both to the importance of local knowledge, and the capacity of local groups to self-organize, encouraging greater acceptance of management decisions (Newig and Fritsch 2009).

Additionally, developing stronger linkages among local level actors such as Indigenous rangers, researchers, and marine managers may improve their ability to mobilize and improve cross-jurisdictional management. These relations have the potential to foster greater resilience as they can bypass structural and political barriers to cross-level cooperation. Interlocal relations, characterized by situations in which local entities on either side of a contiguous border reach agreements or understandings across boundaries to solve shared problems (Meek 2009), occur to some extent in the Torres Strait among island communities involved in community based turtle and dugong management, facilitated in part by the Torres Strait Regional Authority. Other regional Indigenous organizations in the network, such as the North Indigenous Land and Sea Management Alliance, Girringun Aboriginal Corporation, and Balkanu Cape York Development Corporation, play a role in developing communication and cooperation linkages among Indigenous communities to develop management strategies that incorporate Indigenous aspirations and traditional cultural protocols. Yet even these organizations are constrained by frameworks outlined by the federal and state governments, in which strong legislative restrictions regulate access to and decisions regarding marine turtles and dugongs. Consequently, marine turtle and dugong management originates both from top-down and bottom-up institutions, but does not fully integrate these approaches into a truly cross-scale, multilevel governance system. A middle path that addresses the complexities inherent to multiple scales and levels is more challenging, but necessary, in order to increase the capacity of governance systems to manage for social-ecological resilience (Cash et al. 2006).

7.4.4 Building Network Resilience

Vertically and horizontally integrated government can be generated through several means, including informal networks of government authorities, the development of complementary plans or memoranda of understanding, and cabinet endorsements or other 'whole of government' processes (Morrison and Lane 2005). The role of individuals and their social network relations (including actor groups, knowledge systems, and social memory) are also essential to building integrated, adaptive governance. These networks weave together into a comprehensive adaptive governance system characterized by cross-level and cross-scale activities ideally framed by supportive governmental policy (Folke et al. 2005).

Several network attributes already exist within the turtle and dugong governance system which, if utilized more effectively, could potentially enhance adaptive governance by facilitating improved cross-scale, collaborative management. One such attribute is the relatively high amount of knowledge exchange in this system, which provides a strong foundation for improved resource governance (as evidenced by high density; see Table 5.2). As discussed in chapter 4, multiple sources of knowledge exist throughout the network including scientific data, local and Indigenous ecological knowledge, and managerial or bureaucratic knowledge. Integrating these sources more effectively across levels will be the key to enhancing social learning and overcoming barriers to adaptive governance (Folke et al. 2005). Indeed, Andersson and Ostrom (2008) assert that systems that can generate knowledge and acceptable decision-making procedures at multiple scales are more likely to succeed in governing common-pool resources than systems

streamlined to operate at a particular scale. Collective learning can lead to further exchange between actors, improving the density and reciprocity of coordination linkages. With significant sharing and deliberation of ideas, governance is more likely to shift toward new paradigms and rules of collective choice (Ostrom 1990). However, incorporating a wider variety of sources of knowledge across jurisdictional levels and cultural boundaries requires institutional shifts towards participatory governance and collaborative management, which take better advantage of the rich social networks in place.

The effectiveness of environmental governance and its acceptance by stakeholders can be improved by more informed and more creative governance decisions which incorporate a diversity of knowledge and values; better acceptance of decisions in turn leads to greater compliance and implementation (Newig et al. 2010). Creating social incentives for knowledge generation, monitoring, and translating environmental feedback may be important to strengthen the knowledge base of this governance network to support adaptive management (Folke et al. 2005). Regional environmental managers would benefit from skill-building to work simultaneously across scales, while local actors need skills in mediation, consensus building, collaboration, and networking, all of which require significant resource contributions from government (Morrison 2006).

The second characteristic inherent to the turtle and dugong governance system is a broadly shared vision across jurisdictions to maintain sustainable populations of marine turtles and dugongs. While the underlying objectives and priorities related to this goal vary widely across levels, from creating marine sanctuary zones to protecting traditional

harvest rights, common ground exists upon which to construct greater communication, trust, and collaboration across jurisdictional levels and organizational affiliations. Sharing a common vision is the first step toward positive institutional change, which also involves aspects of information sharing and social learning as discussed above (Argyris and Schön 1978), and may depend upon windows of opportunity in which various institutional and ecological components are sufficiently aligned (Cumming et al. 2006). For example, the recent emphasis placed by the Australian Government on climate change mitigation and adaptation may provide one such window of opportunity in which stakeholders can develop shared management aspirations in response to a commonly shared threat, if the appropriate forums and facilitation were provided. Focusing on threats or issues shared by all stakeholders (especially if they are 'external' threats not attributable to any particular stakeholder group), and deliberating the responses to those issues, can provide a starting point for developing shared goals and visions for future management frameworks.

Cross-scale interactions are largely negotiated outcomes of power relations, exercised through the application of knowledge, decision-making, and resources to resolve problems or further interest (Few 2002; Adger et al. 2005). The capacity of powerful actors, such as state and national governments, to dictate the scales at which problems are identified, policies are enacted, and information is gathered tends to reinforce centralized control over management decisions (Lebel et al. 2006). Policy makers in the turtle and dugong governance system must therefore be persuaded to support the wider establishment of co-management institutions with more equitable distribution of resources and decision-making power, as a counter-balance to the current centralized

policy making authority (Pinkerton 1989). Co-management institutions can mould networks for adaptation and collective action (Olsson et al. 2004), therefore better unifying the perspectives and actions of actors at multiple management levels.

The third network characteristic relevant to increasing social-ecological resilience in the turtle and dugong governance system is the presence of potential bridging actors, or 'brokers', who can act as network intermediaries (Cash 2001; Folke et al. 2005; Cash et al. 2006). Scale-crossing brokers sit in network positions in which they can integrate complementary knowledge and facilitate coordination between otherwise disconnected actor groups that interact with ecosystem processes at different institutional or geographic scales (Ernston et al. 2010). Building the capacity of those actors whose organizational structure or scope is amenable to brokering would reduce the transaction costs associated with developing cross-level and cross-scale linkages, enhancing the previously discussed characteristics (knowledge mobilization and developing a shared management vision). In so doing, brokers may enhance the ability of governance to adapt and respond to social-ecological disturbances (Burt 2005; Olsson et al. 2006). Several interviewed researchers mentioned the importance of incorporating information brokers into management projects to connect local planning efforts with regional and larger management frameworks. These brokers may be individuals or organizations already involved in the comanagement process, or positions/institutions may be created specifically to perform bridging functions and facilitate cross-scale communication.

Institutions that straddle levels and provide incentives for cross-scale sustainability efforts are a crucial component to managing marine commons resources, including

migratory wildlife (Adger et al. 2003; Hilborn et al. 2005). Besides the role of researchers in linking the knowledge of local communities or regions with wider ecological information, bridging functions in the turtle and dugong governance system are exhibited to various extents by independent consultants, natural resource management bodies, and several mid-level Indigenous and government organizations. For example, the Torres Strait Regional Authority already acts as a significant knowledge broker between local Torres Strait Islander communities, researchers, and upper level government agencies. If the capacity of this organization to bridge marine turtle and dugong management collaborations and direct regional policy were strengthened, it would improve cross-regional management efforts at an ecologically appropriate scale, assuming mechanisms of accountability are in place to check the organization's power. Such an organization is lacking in the Cape York region of northern Queensland, making it even more imperative to develop bridging capacity in the area to link Indigenous communities with wider decision-making bodies. As Berkes (2009, p. 1699) notes, 'bridging knowledge and bridging different levels of organization are closely related processes. Success in one can lead to success in the other." Government investments, such as project funding or salary provision for potential bridging actors, could create the incentive for greater brokering capacity in the governance system, improving feedback systems necessary for informed management decisions while also providing local authorities and organizations increased opportunities to gain influence and prestige (Ernston et al. 2010).

7.5 Conclusions

Presently, the turtle and dugong governance system in Northern Australia resembles a hierarchical system of multi-stakeholder arrangements characterized by top-down policy influence, decentralized knowledge exchange, and limited amounts of cross-jurisdictional coordination. Within the larger governance framework, however, there are examples of arrangements between state government agencies and certain stakeholders (e.g., particular Indigenous communities) that more closely fit the definition of true co-management—at least one strong vertical linkage between government and a user group, with formalized arrangements for sharing power and responsibility (Berkes 2002; Borrini-Feyerabend et al. 2004). These arrangements are counterbalanced, however, by the prevalence of a monocentric governance framework characterized by a political hierarchy with its apex at the national level, and several instances of stakeholder conflict derived from overlapping jurisdictional authority or gaps in management decision-making responsibility.

Co-management does not necessarily imply complete fairness or equity in power sharing, nor does knowledge sharing always lead to social learning and adaptation (Berkes 2009). However, formal management sharing agreements provide a process for less powerful groups to pursue their aspirations and legitimize their knowledge and belief systems, and thus should be more widely encouraged by turtle and dugong managers. As co-management evolves and becomes more adaptive over time, power sharing, shifts in world view, trust building, and development of denser network relations should increase (Berkes et al. 2007). While managing migratory marine resources requires coordination

beyond local level management frameworks, co-management arrangements provide an opportunity to coordinate local management efforts and integrate different knowledge bases across a wide region to better match management decisions to the ecological ranges of the species in question. Developing cross-scale linkages of this type can catalyse learning and communication among actors, fostering institutional resilience in the face of uncertainty and complexity. In order to maintain truly adaptive governance, actors involved in natural resource governance must balance the decentralized, dense transmission of knowledge among stakeholders with stable cross-scale governance institutions that foster collaborative relationships and shared learning across stakeholder groups and management jurisdictions.

7.6 Summary

- This chapter assessed the extent that stakeholders in marine turtle and dugong management share knowledge, collaborate, and influence each other across various jurisdictional levels of resource management.
- Knowledge is shared more frequently within management levels than between them, but researchers were found to facilitate cross-scale knowledge exchange among several stakeholders. Cross-scale management coordination was less frequent, and regional government agencies dominated these interactions. Policy influence was dominated by the national government level, representing a largely top-down structure.
- The jurisdiction of regional non-government actors appears to overlap with the jurisdiction of both local actors and state government agencies. Due to a lack of cross-scale integration of collaborative effort, this overlap creates a 'regional gap' due to a constant struggle/competition for funding, resources, and decision making authority between actors operating at different scales.
- This governance system should build upon its existing diversity of knowledge sources, shared vision among most stakeholders, and the presence of certain bridging actors to increase and strengthen cross-scale network linkages for management collaboration and policy decision-making, which will require significant financial and resource investment, leadership, and capacity-building.

8

Discussion

In this concluding chapter, I revisit the key findings of my multi-faceted exploration into the network structure and dynamics of marine turtle and dugong governance in Northern Australia. I discuss these findings in terms of their overall contribution to assessing the capacity of this governance system to manage social-ecological resilience, and provide suggestions for how government and non-government actors can increase such capacity. I conclude with suggestions for future research that could lead to a comprehensive understanding of how network structures and knowledge/power dynamics influence natural resource governance in a variety of contexts.

8 Discussion

> "The environment is where we all meet; where we all have a mutual interest; it is the one thing that all of us share. It is not only a mirror of ourselves, but a focusing lens on what we can become..."
>
> - Lady Bird Johnson

Throughout this thesis, I have argued that migratory marine species management can be evaluated from a complex systems perspective, using the lens of resilience, to provide a useful framework for understanding the connections, drivers, processes, and outcomes which may aid or hinder adaptive capacity of the system. In particular, social learning, reflexivity, and self-organization are considered key components to successful adaptive management. Differing social and ecological conditions, together with varying administrative, legal, and institutional contexts, present a myriad of conditions under which adaptive governance may or may not be effective in managing natural resources such as migratory species. It is thus important to learn from particular cases and experiences, such as the case study presented in this thesis, to improve governance in an iterative fashion (Marín and Berkes 2010). Indeed, collecting empirical data grounded in practice contributes to a broader understanding of adaptive co-management theory while additionally providing tangible evidence that can be employed by policy makers and resource managers (Plummer and Armitage 2007).

An important lesson gleaned from the adaptive governance literature over the past decade is that there is no 'best' or optimal strategy for resource management; social-ecological

systems may exist in multiple alternative stable states, depending on the interplay of stakeholders and their ecological resources (Walker et al. 2002; Scheffer and Carpenter 2003). Therefore, rather than trying to obtain or maintain a narrowly defined system configuration, adaptive governance practitioners encourage managing for resilience. Accordingly, I chose to evaluate the dugong and marine turtle governance system according to its ability to manage social-ecological resilience, measured via the capacity of the system to self-organize, learn, and adapt (as per Lebel et al. 2006). I have also built upon the premise that social networks are a key component to adaptive governance, as they allow for the formal and informal exchange of knowledge, ideas, and resources, and promote collaboration and communication. Networks developed through trust and collaboration are crucial foundations for self-organizing collective action and 'triple-loop' learning, as discussed in chapter 1 (section 1.9). Hence, understanding network structures and interactions is paramount for evaluating the adaptive capacity of a social-ecological system.

This thesis explored in depth the network structure of marine turtle and dugong governance in Northern Australia in order to determine the ability of this governance system to manage social-ecological resilience according to the capacities identified by Lebel et al. (2006), as originally discussed in section 1.7. In particular, I examined the extent of knowledge integration throughout the system (chapters 4-7), the distribution of power among network actors (chapters 5-7), patterns of stakeholder diversity and interaction (chapter 6), and the presence of cross-scale interactions and/or scalar issues (chapter 7). I summarize my findings from these chapters below and then consider their

contribution to self-organization, social learning, and adaptation within the system, and consequently their influence on the overall capacity of the system to manage resilience.

8.1 Knowledge Integration

Patterns of information exchange and knowledge engagement among actors in the turtle and dugong governance system are dependent on a number of factors, including the scale at which actors operate, the perceived legitimacy and applicability of information, and the cultural and/or socio-political underpinnings of knowledge sources. While interviewed marine managers were generally supportive of combining scientific information with Indigenous traditional ecological knowledge, a number of challenges prevent the equitable consideration of both knowledge systems throughout the policy and management process.

One such challenge is the limited cross-cultural capacity of both Indigenous and non-Indigenous managers, who often struggle to navigate unfamiliar protocols and social norms when attempting to collaborate with each other. In chapter 4, I suggested an increase in capacity-building workshops, wider use of knowledge sharing protocols, and the use of cultural planning exercises to improve Indigenous engagement in dugong and turtle co-management.

Another challenge is the limited amount of knowledge exchange between different stakeholder groups and across management levels. Instead, information is shared most often among actors with similar organizational affiliations and within the same management level. While this tendency potentially provides a foundation of trust and

solidification of particular norms and practices, it occurs at the expense of heterogeneous linkages necessary for system-wide social learning and adaptation. Research actors were the only exception; they shared significant links with all stakeholder groups and across a number of levels, maintaining important flows of information that would otherwise be absent. A key focus for the system should be to support and enhance the bridging capacity of additional actors and organizations best situated to facilitated knowledge flow between actor groups and scales, such as regional natural resource management bodies and Indigenous representative organizations.

8.2 Power Relations

Influence over policy decision-making appears to maintain a characteristic top-down, hierarchical structure in the governance system under examination. This structure contrasts with the decentralized flow of information through the network, indicating a potential disjunction between political power and knowledge retention marked by communication gaps across management levels and between competing organizations. The ability to influence policy rests foremost with state and national government organizations, most notably the Australian Department of Sustainability, Environment, Water, Population, and Communities. As the mandates of these dominant stakeholders mainly concern species conservation or fisheries management, other interests (such as scientific research, Indigenous well-being, and community concerns) receive less emphasis.

In my study, local and regional non-governmental organizations consistently showed a low ability to influence dugong and turtle policy decisions directly. I suggested in chapter

7 that policy makers should devolve a portion of the centralized decision-making power of this governance system to regional and local management bodies according to the subsidiarity principle, in which management decisions should be made by the least centralized competent authority. Renegotiating power structures in this way can allow for an expansion of problem definition, rule formation, system legitimacy, and resource mobilization to support wider collaboration among network actors.

8.3 Patterns of Stakeholder Diversity and Interaction

As mentioned above, I found that stakeholders involved in marine turtle and dugong management tend to share information with actors who share similar institutional mandates or ideologies, resulting in a network that exhibits a greater amount of homophily than heterogeneity of network connections. This pattern was also evident for management coordination linkages. Research actors, as the only stakeholder group with significant amounts of heterogeneous knowledge ties, are vital to the exchange of information between various stakeholder groups due to their long-term relationships and institutional 'memory'. Researchers, however, play a lesser role in coordination. Ultimately, the dearth of heterogeneous linkages between different stakeholder groups, especially for management coordination, is likely a key limiting factor in integrating the economic, social, and environmental aspects of resilience in this governance system. In chapter 6 I argued that finding a balance between 'bonding' and 'bridging' ties will support greater social learning and adaptive capacity necessary for social-ecological resilience.

A shift towards more adaptive network governance will require the cooperation of actors from various stakeholder groups and competing factions, and will depend upon the positional advantages and resources they command (Lof 2010). As discussed in the previous section, such a shift will also entail the devolution of some decision-making power from the dominant stakeholders (and the paradigms they impose), toward regional and local actors. By integrating different stakeholder groups and providing increased opportunities for social learning related to co-management, managers can achieve an increased capacity to avoid or better manage social-ecological problems (Tompkins and Adger 2004).

8.4 Scale and Cross-Scale Dynamics

At present, the turtle and dugong governance system is characterized by strong hierarchical divisions. Horizontal linkages occur among many actors within the same jurisdictional level (e.g., between regional government agencies), with fewer vertical linkages across levels of organization (e.g. between local actors and regional agencies). Within the larger governance framework, there are examples of arrangements between state government agencies and certain Indigenous communities or other lower level actors which more closely resemble co-management agreements; these arrangements are, however, a minority. The system is instead framed by the political power and dominant paradigms of national government agencies, with several instances of stakeholder conflict resulting from overlapping jurisdictional authority or gaps in management decision-making responsibility at various scales.

These conflicts emanate from the fact that the scales at which resource management organizations operate tend to be heterogeneous and unequal in relation to physical/geographic, institutional, and other significant parameters, making it difficult to define discrete scalar dimensions (Morrison 2007). As I explained in chapter 7, this is particularly true for regional organizations in the turtle and dugong governance system, as these organizations are defined by a number of contrasting responsibilities and jurisdictional boundaries, from watershed basins and bioregions to Indigenous traditional country affiliations and language boundaries. Hence the need to shift focus away from nested hierarchies of management power and towards *networks* of actors linked in an unbounded system with dispersed accountability (Morrison 2006). A network approach also helps curtail scalar mismatches in which institutional considerations at higher levels are irrelevant at lower levels and vice versa. As Shackeroff (2008) explains, ecological arguments are formulated differently at different management scales to promote certain conservation interests, all of which have consequences for the local rights of access to the resource in question. Increasing cross-scale network connections can encourage greater shared interests across scales and thus reduce tension among stakeholders as well as negative ramifications for resource users.

8.5 Synthesis—assessing the capacity to manage social-ecological resilience through self-organization and social learning

In the preceding chapters, as summarized in the previous section, I explored the capacity of actors in the turtle and dugong governance system to manage social-ecological resilience by considering knowledge, diversity, scale, fit, and power dynamics. These

various capacities are necessary prerequisites for social learning, adaptation, and self-organization, the staples for successful adaptive governance to achieve resilience . Therefore, in the following sections I will consider the extent that the capacities explored throughout this study represent a system capable of self-organizing, learning, and adapting, and thus whether an adequate foundation for resilience presently exists in this governance system.

8.5.1 Self-Organization

The capacity to self-organize implies that a system can maintain and re-create its identity while buffering the impacts of other systems without the need to be continually invested in, subsidized, or replenished (Ostrom et al. 1999; Lebel et al. 2006; Carpenter et al. 2001). The process requires key leadership, multiple centres of coordination and decision-making, flexibility, and multilayered institutions that allow cross-scale interactions. The question is, are the qualities of self-organization evident in the marine turtle and dugong governance system?

A number of potential leaders, both individuals and institutions, exist within the governance system. Certain researchers have catalysed information flow through the system, particularly by linking Indigenous communities and organizations with government agencies. The Torres Strait Regional Authority is an Indigenous government agency which also maintains a unique position as an influential knowledge facilitator. However, these actors still function within the rigid institutional framework defined by the Australian Commonwealth government, and their activities are largely dependent

upon often unreliable national funding schemes that operate on approximately 3-5 year funding cycles. Therefore, these actors currently have limited freedom to create new and innovative policies or management approaches independent from the current bureaucratic system, and are dependent on funding from the federal government.

Coordination and decision-making are facilitated by several actors and at multiple levels; however the majority of decision-making power originates with national level government agencies, based upon their political and financial dominance. Local institutions, such as Indigenous ranger programs, have steadily gained the right to make decisions at local scales, but their involvement in larger-scale management strategizing remains minimal. Researchers, due to the perceived legitimacy of their scientific world view, are active in coordinating local and mid-level management strategies as well as advising government policy makers; yet even research actors have a limited ability to directly influence policy decisions, as science is often subordinate to national political priorities in regards to resource management and conservation.

Coordination activities occur frequently within management levels, but less often across levels, resulting in a lack of sustained cross-scale institutional linkages. Again, researchers and some mid-level organizations facilitate flows of information and communication across management levels. These efforts are often hindered, however, by conflicting jurisdictional responsibilities and spatial-temporal scales, or a lack of integration across geographic regions and institutional levels. While the agendas of lower-level organizations are often relatively flexible and could ideally pave the way for greater adaptive management abilities, these actors are typically hindered by restrictive

budgetary guidelines dictated by higher government levels, or have limited formal authority to enact policy and management activities without the approval of government entities, therefore limiting possibilities for self-organization in the system.

8.5.2 Social Learning and Adaptation

Some of the main indications that social learning is occurring in a given governance system include the presence of shared actions (actors working together and learning through experimentation); modifications made in a continuous process of reflection (adaptive practices); responses to routine problems or errors (single-loop learning); responses to values and policies from which routines are derived (double-loop learning); and active questioning of the governing norms and protocols in which values and policies are embedded (triple-loop learning; Armitage et al. 2008).

In the marine turtle and dugong governance system, several instances of shared action among stakeholders exist. Examples are most prominent between research actors or mid-level organizations and Indigenous actors, in which a variety of comanagement, community-based management, or similar arrangements are being trialled and adapted as various components are evaluated. These collaborations include the community-based turtle and dugong management plans enacted to varying degrees across several Torres Strait Island communities, and Traditional Use Marine Resource Agreements (TUMRAs) in a number of communities along the coast of the Great Barrier Reef region. As discussed in previous chapters, the success of these various comanagement approaches varies from community to community according to the specific power dynamics,

capacities, leadership, and historical context of each case. The most successful agreements to date are those that have been considered stepping stones along a continuous pathway toward more adaptive, equitable management collaborations, rather than those designed as an end-all solution to stakeholder engagement.

The extent that current management strategies are reflected upon and modified similarly varies, particularly by government level. Within national government agencies, bureaucratic inertia tends to prevent substantial modification of resource management policy save for a few key historical instances—most notably the creation of the *Environmental Protection and Biodiversity Conservation (EPBC) Act of 1999*, and the *Native Title Act of 1993*. Normally, however, policy decisions at upper management levels remain relatively consistent and are based upon information sources that have undergone only minor modifications over the past decade (e.g., the 'Recovery Plan for Marine Turtles in Australia' which was drafted in 1998 and finalized in 2003, and the 'National Partnership Approach' for the sustainable harvest of marine turtles and dugongs, last updated in 2005). Modifications occur more frequently at lower management levels, where face-to-face negotiations and collaborative research activities are more common and allow for greater reflection on the local impact of management policies and strategies. However, adaptive capacity even at these lower levels is restricted by the rigid governance framework enacted by the Australian national government, as described previously.

It follows that double-loop learning, in which actors engage the values and policies upon which management routines are based, occurs less frequently than single-loop learning in

this governance system. While policy makers in national government agencies publicly acknowledge the importance of Indigenous values, for instance, they tend to take for granted that national sustainability and conservation priorities predominate and should dictate resource policy in Australia. At lower levels, this governance monoculture results in the reiteration of various management approaches based upon the same dominant set of values and policies, again limiting the flexibility and adaptability of the system to deal with new problems as they arise on the ground.

Triple-loop learning, consisting of the explicit questioning of the norms and protocols underlying values and policies, is a rare occurrence in the examined governance system. As I demonstrated in my exploration of the ways that marine managers engaged with scientific information versus traditional ecological knowledge, the world views in which these two knowledge systems are embedded are not fully recognized or understood. Limited engagement with contrasting knowledge and value systems prohibits the development of candid, equitable cross-cultural collaborations. In-depth questioning of the prevailing management protocols arises most often in Indigenous organizations and communities; Indigenous stakeholders tend to contrast their more holistic relationship with the land and sea (and with the species that exist within their traditional territories) with the fragmented approach to management represented by a variety of Australian government agencies who often have conflicting mandates and jurisdictions. Researchers, too, are more likely to question the underlying assumptions of resource management theory/practice, and to promote novel solutions to complex social-ecological problems.

However, because the power of researchers and Indigenous actors to influence policy decisions is mediocre in this governance system, changes to policies, values, and protocols are slow to materialize, and require vast amounts of energy and networking in order to reach the intended policy makers. Therefore, while social learning occurs to varying degrees throughout the governance system I examined, this learning mainly takes the form of incremental changes to routine problems (single-loop learning). Consideration of larger policy changes and value assumptions (double-loop learning, also called adaptive learning) occurs to a lesser degree. I observed only isolated instances of reassessment of the underlying norms and belief systems upon which current policies are based (triple-loop or transformative learning).

8.6 Improving Social-Ecological Resilience: Suggested Steps Forward

Based on the above considerations, the marine turtle and dugong governance system has a limited capacity for self-organization and multiple-loop learning at the present time. There are a number of conditions that, in line with Folke et al. (2005), may create better opportunities for adaptive comanagement to self-organize and for managers to learn and adapt, such as the creation of enabling legislation, flexible institutions, and recognition of bridging organizations—conditions which can be evaluated as the system evolves. The Australian government should support legislation that allows greater flexibility in management design and dispersed decision-making authority where appropriate.[1]

[1] The Australian Government's response on 24 August 2011 to an independent review of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) recognized the need for greater flexibility and innovation in the management of natural assets, the importance of managing at appropriate scales and being mindful of connections across landscapes and seascapes, and proposed developing regional environmental plans with the involvement of states, territories, and non-government stakeholders. This

Additionally, increased support for the important activities of bridging actors, such as more stable funding and provision of needed capacity building resources, would highlight the crucial role of these actors and provide them greater independence and flexibility.

Folke et al. (2003) outline four important factors for building social-ecological resilience: (1) learning to live with change and uncertainty, (2) nurturing diversity for reorganization and renewal, (3) combining different types of knowledge for learning, and (4) creating opportunity for self-organization. Davidson-Hunt and Berkes (2003) note that learning is fundamental to three of these factors; they argue that institutions of knowledge are the key characteristic of "adaptive learning", a term they use to describe the process of information feedback and development of social memory inherent to social-ecological systems. Social memory is important to the adaptive co-management process, as it can be drawn upon during times of reorganization following change to inform management decisions and help resolve conflicts (Folke et al. 2005). Social networks are essential mechanisms by which social memory is stored and mobilised.

As well, the creation of new institutional rules or policies more amenable to adaptive management is more likely when actors face novel problems, crises, or surprises (e.g., shifts in property or resource access rights, resource failures, or climate and acidification threats) not previously addressed within the governance system (Gunderson and Holling 2002; Manring 2007). New problems allow for quicker social learning and adaptive

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commitment to fostering greater cooperation among stakeholders holds much promise in improving natural resource governance, though it remains to be seen what on-the-ground changes will occur to the governance system. However, the Government declined to elaborate the language of the EPBC Act in regards to the need to engage Indigenous stakeholders and traditional ecological knowledge, despite the review's recommendation to make this goal more explicit.

responses due to the absence of prior political dominance or entrenched strategies related to the issue. In this way,

> "When an ecosystem management network is able to move (maturate) toward generative systems learning . . . it creates the opportunity for the ecosystem management network to engage in double-loop learning and to produce new rules that are not derived from predefined institutional roles and relationships" (Manring 2007, p. 337).

Timing is similarly crucial in regards to initiating change—specific policy windows may open or certain problems may peak public interest enough to create an opportunity to justify a shift in governance (Kingdon 1995). Again these opportunities hinge on the ability of charismatic leaders or entrepreneurs to take advantage of political momentum and facilitate policy change.

As evidenced in my case study however, governance systems, composed of institutional frameworks and actor networks that have co-developed over long periods of time, are prone to strong path-dependence and inertia that stabilizes the prevailing system structure and inhibits major change (Pahl-Wostl 2007). In this case, "unlearning" of deeply entrenched beliefs and protocols (i.e., triple-loop or transformative learning) is required in order to have any chance of reconsidering the underlying beliefs, assumptions, and world views within which current governance is embedded (Pahl-Wostl et al. 2011). Transformability relates to the capacity to develop novel governance systems in the face of flawed ecological, economic, or socio-political conditions. So how can we encourage such societal re-examination and reflection in order to overcome historical constraints on adaptive governance?

According to Folke et al. (2005), in order to push a social-ecological system towards adaptive governance, managers must build knowledge and understanding of resource and ecosystem dynamics, feed this ecological knowledge into adaptive management practice, support flexible institutions and multilevel governance systems, handle external perturbations, and anticipate uncertainty and surprise. The transformation to an adaptive resource governance system in Kristianstad, Sweden occurred through four phases: preparing the system for change; the opening of an opportunity; navigating the transition; and charting a new direction for management while building social-ecological resilience (Olsson et al. 2004). The process involved the mobilization of social networks across multiple scales, collaborative learning and trust-building, and coordination of ongoing activities. The recent shift in attention toward climate change adaptation in the Australian Government may provide an opportune window for marine wildlife managers to develop novel, flexible management approaches that integrate climate change concerns with other environmental and social considerations to create more robust governance networks.

Armitage et al. (2008) discuss several experimental approaches to cultivate social learning in order to achieve more resilient governance systems. Approaches include controlled experimentation that allows replication and identification of causal relationships, simulation and modelling to consider multiple factors and scenarios, and application of learning-by-doing processes that emphasize social-ecological feedback and account for uncertainty. I would add that risk assessment exercises, program logic workshops, and other multi-stakeholder gatherings that provide a forum for communication and learning are essential to developing shared definitions of the problem

and a common understanding of the management process *before* management experimentation commences. These meetings allow the development of trust, shared goals, and more equitable relations.

Additionally, it should be noted that the combined diversity and redundancy of institutions and their resultant overlapping functions across management levels may actually assist in enhancing resilience by spreading risk and facilitating social memory (Folke et al. 2005). Therefore, deriving ways to support redundancy where it has beneficial consequences, though it may require significant transaction costs, could be more important than creating a streamlined system. Bridging organizations may lower the costs associated with collaboration and redundancy by facilitating beneficial linkages, providing social incentives, and reducing potential conflicts, if they exist at the appropriate jurisdictional scale and their facilitation role is clearly outlined in their institutional mandate (Hahn et al. 2006).

Beyond bridging organizations, a variety of other social roles are important for catalysing adaptive governance, including knowledge generators and carriers, stewards, visionaries, innovators, leaders, and actors who can interpret and make sense of information (Folke et al. 2003; Olsson et al. 2004). Social capital emerges from the relationships between these various actors and the bridging and bonding links they create to form social networks, building the capacity of the system to process information and harness social memory. The expansion and linking of networks of engagement ultimately helps facilitate integrated and inclusive resource management (Tompkins and Adger 2004). Combining various social groups, however, can also create conflict or barriers that threaten to erode

social capital/memory if different cultural, value, or belief systems are not easily integrated. These difficulties require the deft leadership of key individuals or organizations who can harness informal networks to mediate interactions and facilitate the transition toward more inclusive forms of governance (Folke et al. 2005).

In regards to marine turtle and dugong governance, my study found that researchers and consultants often provide the social 'glue' that binds various social groups together. As long-term knowledge facilitators, they also tend to retain more social memory regarding resource management practices and outcomes than do government agencies with their frequent administrative restructuring and high staff turnover rates. Researchers and consultants therefore provide an important role in maintaining knowledge that can prepare the governance system for uncertainty and surprise, therefore enhancing adaptive capacity. This role, however, is often complex and subtle, and does not necessarily align with dominant political priorities. Hence, trust between policy makers and researchers is fickle, and as a result communication between the two social groups can be somewhat strained. Better recognition of the crucial contribution researchers and consultants make to social learning and memory, on the one hand, and more thorough consideration of the information needs of policy makers on the other, would pave the way toward better relations between these actors and reinforce the unique leadership provided by both social groups.

8.7 Recommendations for Future Research

My investigation into the network dynamics of marine migratory species governance in Australia has revealed a number of issues related to knowledge exchange, collaboration, and power dynamics that affect the ability of network actors to develop more adaptive approaches to management and increase social-ecological resilience. These insights open a gateway to a number of additional explorations that, together, can weave an even tighter interpretation of network governance that is applicable to an array of resource governance systems. Some of the more pressing research areas next to be explored include:

- In-depth examination of the structural and institutional characteristics that favour the dominance of particular social groups or coalitions, and how these coalitions harness resources and network position to their advantage
- Further research into the role that researchers and other social 'unifiers' provide as mainstays of social memory and catalysts for adaptive learning; additionally examine in-depth the linkages and relationships between these actors and other social groups
- Development and refinement of indicators useful for monitoring and evaluating the transformation toward adaptive network governance; this would involve the integration of indicators from multiple theoretical frameworks including adaptive co-management, resilience theory, complex systems theory, and network analysis
- Conduct risk assessments and vulnerability research alongside network analysis to help stakeholders prioritize management decisions and harness social networks to derive the most appropriate courses of action to manage resilience

- Conduct long-term research that extends our understanding of multilevel governance by considering the particular issues related to dynamic systems in which the nature of cross-scale influences within the system changes over time, thus affecting division of power, actor interactions, and definitions of scale

8.8 Conclusions

There is no question that a shift toward adaptive network governance will be daunting for stakeholders of marine turtle and dugong management. Some socio-political changes will be fraught with opposition while certain ecological changes may present complex problems never before dealt with. However, the successes and failures of various collaborative attempts throughout Northern Australia, many of which are documented herein, provide valuable sources of information that contribute to social learning, moving the system one step closer to adaptive management.

Hierarchical forms of government, such as the one that persists in regards to policy making power for migratory species in Australia, may provide the authority and capacity needed initially to establish the framework for region-wide changes to governance. However, polycentric governance approaches with multiple decision-making centres and flexible multilevel institutions are more likely to have the adaptive capacity to encourage collaboration and mutual learning while developing ways to deal with uncertainty at multiple scales. Ultimately, both top-down and bottom-up mechanisms should be integrated to create a multiscale governance system that is able to harness both informal

social networks and formal institutions to develop democratic, adaptive governance frameworks informed by a diversity of knowledge, values, and social groups.

This study has contributed substantial information regarding the relationship between network dynamics and the ability to manage social-ecological resilience in resource governance systems. By integrating multiple methodologies and data analyses, I was able to synthesize a great deal of rich qualitative data and also draw several quantitative conclusions regarding the present network structure of marine turtle and dugong governance in Australia. As I have recommended throughout this thesis, emphasis should be placed by all stakeholders on trust building, knowledge sharing, and creation of joint visions for more inclusive management. In some cases, the foundation for these processes is already in place, especially in the Torres Strait region and between certain actors in the Great Barrier Reef region. However, the capacity of the system overall to achieve both social and ecological resilience rests on strengthening and expanding networks of engagement. This transformative process will require a firm commitment on the part of government agencies to provide the necessary funding, resources, and political will, as well as the commitment of non-government actors to commit their time and expertise to developing governance frameworks that adequately protect marine species while respecting social diversity, and are able to cope with social-ecological change in a robust, sustainable manner.

9 Glossary of Acronyms

ACF	Advocacy Coalition Framework
AFMA	Australian Fisheries Management Authority
AIMS	Australian Institute of Marine Science
ATSIC	Aboriginal and Torres Strait Islander Commission
Balkanu	Balkanu Cape York Development Corporation
GBRMPA	Great Barrier Reef Marine Park Authority
GBRMPWHA	Great Barrier Reef Marine Park World Heritage Area
IK	Indigenous Knowledge
IPA	Indigenous Protected Area
IUCN	International Union for Conservation of Nature
MoU	Memorandum of Understanding
MPA	Marine Protected Area
MTSRF	Marine and Tropical Research Facility
NAILSMA	North Australia Indigenous Land and Sea Management Alliance
NGO	Non Governmental Organization
NQDT	North Queensland Dry Tropics NRM Body
NRM	Natural Resource Management
QDERM	Queensland Department of Environment and Resource Management
SEWPAC	Commonwealth Department of Sustainability, Environment, Water, Population, and Communities
SNA	Social Network Analysis
TEK	Traditional Ecological Knowledge
TSRA	Torres Strait Regional Authority
TUMRA	Traditional Use of Marine Resources Agreement
WSK	Western Scientific Knowledge

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11 Appendices

Appendix A: Summary of Documentary Films Produced for Stakeholders

Film 1: Iama Turtle and Dugong Management Project: Protecting natural resources in our sea country for the future (2009)

This ~40 minute film, narrated by head ranger Charles David, documents the development of the Turtle and Dugong Plan and related research and monitoring activities. The film includes interviews with local community leaders, and describes turtle tagging, nest monitoring, and beach profile/erosion monitoring conducted by the rangers and university researchers.. I assisted with some filming, and performed all editing and post-production of the film. Logistical support was provided by Torres Strait Regional Authority, James Cook University, and the Marine and Tropical Research Facility.

Film 2: Mabuiag Ranger Project and Turtle Tagging Program (2010)

This film was originally developed as a 30 minute educational film for the community and local schools. A 10 minute version was also created. The film features interviews with head ranger Terrance Whap, as well as other rangers and community members. The first half of the film describes the motivation behind the development of the ranger program, while the second half follows the Mabuiag rangers, community volunteers, and James Cook University Researchers out on a turtle tagging trip, as well as their visit to a local school where they teach children about their management activities. All filming, editing, and post-production was performed by myself and a colleague.

Copies of films are available upon request.

ADMINISTRATIVE DOCUMENTATION HAS BEEN REMOVED

ADMINISTRATIVE DOCUMENTATION HAS BEEN REMOVED

Appendix D: Interview Follow-up Survey

JAMES COOK UNIVERSITY AUSTRALIA

Resolving Issues of Scale in Marine Wildlife Management

PhD study conducted by Kristen Weiss, James Cook University

As a follow up to the research interview in which you participated, I would greatly appreciate if you could take just a few minutes to fill out the following 3 questions. The goal of this short survey is to better ascertain the various relationships that exist among government and non-government agencies involved in sea turtle and dugong management in Northern Australia. Your input will be a valuable asset in determining how communication and resource/information flows can potentially be improved among stakeholders involved in this management network. As with the interview, the information provided for this survey will be kept anonymous.

In each of the following three questions, please tick all boxes that apply.

1. Which of the following groups do you, as a representative of your group/agency, directly provide information to (e.g. data, knowledge, and advice) in regards to sea turtle and/or dugong management?

AFMA	
Balkanu	
Dept. Agriculture Fisheries & Forestry (DAFF)	
Dept. Environment & Resource Management (DERM)	
Dept. of Sustainability, Environment, Water, Population, and Communities (SEWPAC)	
Qld Dept. Primary Industries and Fisheries (DPIF)	
Qld Parks and Wildlife Service (QPWS)	
Great Barrier Reef Marine Park Authority (GBRMPA)	
Girringun Aboriginal Corporation	
Gudjuda Reference Group	
James Cook University (JCU)/Affiliated researchers	
Marine & Tropical Research Facility (MTSRF)	
North Australian Indigenous Land and Sea Management Alliance (NAILSMA)	
North Queensland Dry Tropics NRM (NQDT)	
Indigenous Rangers (community level)	
Torres Strait Protected Zone Joint Authority (PZJA)	
Torres Strait Regional Authority (TSRA)	
Consultants (Private/Independent experts/advisors)	

University of Queensland (UQ)	
University of Canberra (UC)	
Western Australia Gov't (specify Dept.)	
Northern Territory Gov't (specify Dept.)	
Other (e.g. a particular Industry, NGO, NRM regional body etc.):	
Other:	
Other:	

2. Which of the following groups do you influence either via policy and implementation guidelines/legislation or funding resources (please specify which for each) in regards to sea turtle/dugong management?

AFMA	
Balkanu	
Dept. Agriculture Fisheries & Forestry (DAFF)	
Dept. Environment & Resource Management (DERM)	
Dept. of Sustainability, Environment, Water, Population, and Communities (SEWPAC)	
Qld Dept. Primary Industries and Fisheries (DPIF)	
Qld Parks and Wildlife Service (QPWS)	
Great Barrier Reef Marine Park Authority (GBRMPA)	
Girringun Aboriginal Corporation	
Gudjuda Reference Group	
James Cook University (JCU)/Affiliated researchers	
Marine & Tropical Research Facility (MTSRF)	
North Australian Indigenous Land and Sea Management Alliance (NAILSMA)	
North Queensland Dry Tropics NRM (NQDT)	
Indigenous Rangers (community level)	
Torres Strait Protected Zone Joint Authority (PZJA)	
Torres Strait Regional Authority (TSRA)	
Consultants (Private/Independent experts/advisors)	
University of Queensland (UQ)	
University of Canberra (UC)	
Western Australia Gov't (specify Dept.)	
Northern Territory Gov't (specify Dept.)	
Other (e.g. a particular Industry, NGO, NRM regional body etc.):	
Other:	
Other:	

3. Which of the following groups do you communicate with directly to facilitate/coordinate sea turtle/dugong management?

AFMA	
Balkanu	
Dept. Agriculture Fisheries & Forestry (DAFF)	
Dept. Environment & Resource Management (DERM)	
Dept. of Sustainability, Environment, Water, Population, and Communities (SEWPAC)	
Qld Dept. Primary Industries and Fisheries (DPIF)	
Qld Parks and Wildlife Service (QPWS)	
Great Barrier Reef Marine Park Authority (GBRMPA)	
Girringun Aboriginal Corporation	
Gudjuda Reference Group	
James Cook University (JCU)/Affiliated researchers	
Marine & Tropical Research Facility (MTSRF)	
North Australian Indigenous Land and Sea Management Alliance (NAILSMA)	
North Queensland Dry Tropics NRM (NQDT)	
Indigenous Rangers (community level)	
Torres Strait Protected Zone Joint Authority (PZJA)	
Torres Strait Regional Authority (TSRA)	
Consultants (Private/Independent experts/advisors)	
University of Queensland (UQ)	
University of Canberra (UC)	
Western Australia Gov't (specify Dept.)	
Northern Territory Gov't (specify Dept.)	
Other (e.g. a particular Industry, NGO, NRM regional body etc.):	
Other:	
Other:	

Thank you for your time and assistance!
Any questions or comments, please direct to:
Principal researcher: Kirsten Weiss, PhD Candidate
James Cook University, Townsville
Contact info: Office: (07) 4781-6930

Appendix E: Summary of Coding Themes and Subthemes

- Knowledge
  - Traditional Ecological Knowledge
    - Empirical, ethics/values, cultural identity, past/present use, world view
  - Western Scientific Knowledge
    - Empirical, ethics/values, cultural identity, past/present use, world view
- Issues
  - Political
    - Legitimacy, accountability, leadership, time frames, governance
  - Socio-economic
    - Capacity, resources/funding, communication, engagement
  - Environmental
    - Lack of data, threats/mortality factors, predictability
  - Cultural
    - Ideologies, trust, history
- Scale
  - Institutional
  - Jurisdictional/Managerial
  - Socio-cultural
  - Ecological
  - Temporal
  - Knowledge/information
- Management Strategies/Goals
  - E.g. capacity building, monitoring and evaluation, regionalization, knowledge integration, relationship building, compliance, sustainable harvest, conservation